ISSN - 0873 - 7215

REVISTA PORTUGUESA DE

CIRURGIA CARDIO-TORÁCICA E VASCULAR

Volume 26 - N.º 2 - Abril - Junho 2019

EDITORIALS

- SPCCTV 4D Visions 2019
- Ethics and surgical innovation as moral strangers

COMMENTS

- Role of intraoperative echocardiography for sutureless Perceval aortic valve
- Post cardiopulmonary bypass renal failure – Do we need goal directed perfusion?

ORIGINAL ARTICLES

- Safety and feasibility of conservative aortic valve surgery: single center experience
- Patient prosthesis mismatch in stented biologic aortic valve prosthesis: 10 years' results
- Surgical approach to colorectal cancer pulmonary metastasis: One-year experience of a reference center
- Which aneurysm characteristics predict EVAR non-success?
- Type B aortic dissection – a single center series

REVISTA PORTUGUESA DE CIRURGIA CARDIO-TORÁCICA E VASCULAR

Indexada no Index Medicus e MEDLINE
(Rev Port Cir Cardiotorac Vasc)

ÓRGÃO OFICIAL DA SOCIEDADE PORTUGUESA DE CIRURGIA CARDIO-TORÁCICA E VASCULAR
FUNDADA EM 1984

Normas de Publicação - **www.spctv.pt**

Propriedade e Administração: Sociedade Portuguesa de Cirurgia Cardio-Torácica e Vascular
Hospital Curry Cabral, Rua da Beneficência, nº 8 - 1069-166 Lisboa, Portugal - manuscritos@spctv.pt

A Revista Portuguesa de Cirurgia Cardio-Tóracica e Vascular publica quatro números anuais, cada número avulso custa € 10,00. A assinatura para Portugal e Espanha é de € 40,00.
A assinatura para Angola, Brasil, Cabo-Verde, Guiné, Moçambique e S. Tomé é de USA $35. Para os outros países é de USA $40.
Para os sócios da Sociedade Portuguesa de Cirurgia Cardio-Torácica e Vascular, da Sociedade Portuguesa de Cirurgia e da Sociedade Portuguesa de Cardiologia a distribuição é gratuita.

The Revista Portuguesa de Cirurgia Cardio-Torácica e Vascular publishes four annual numbers, each number cost € 10,00.
The annual subscription for Portugal and Spain is € 40,00. The Annual subscription for Angola, Brasil, Cabo-Verde, Guiné, Moçambique and S. Tomé is USA $35. For the other countries is USA $40.
For the members of the Portuguese Society of Cardio Thoracic and Vascular Surgery, Surgery and Cardiology the distribution is free.

REVISTA PORTUGUESA DE CIRURGIA CARDIO-TORÁCICA E VASCULAR 2012
Publicação Trimestral
Tiragem deste número: 7500 exemplares
ISSN - 0873-7215
Depósito Legal nº60310/93

Sublinhado
PUBLICAÇÕES E PUBLICIDADE
Publicações e Publicidade Unipessoal
Rua Prof. Vieira de Almeida, nº38 - Lj. A - Bloco B - Piso 0
1600-371 LISBOA
Telf.: 21 757 81 35

Volume 26 - N.º 2 - April-June 2019

Regular issues referred in Index Medicus and Medline since July-September 2003

CONTENTS

PRESIDENT'S MESSAGE

SPCCTV 4D Visions 2019. 81
Adelino F. Leite-Moreira

EDITORIAL

Ethics and surgical innovation as moral strangers. 83
Miguel Guerra

EDITORIAL COMMENTS

Role of intraoperative echocardiography for sutureless Perceval aortic valve. 87
Catarina Celestino

Post cardiopulmonary bypass renal failure - Do we need goal directed perfusion? 91
Paulo Neves

ORIGINAL ARTICLES CARDIAC SURGERY

Safety and feasibility of conservative aortic valve surgery: single center experience. 93
Rui J. Cerqueira, Jéni Quintal, Soraia Moreira, Francisca A Saraiva, Mário J. Amorim, Jorge Almeida, Paulo Pinho, Adelino F. Leite-Moreira

Patient prosthesis mismatch in stented biologic aortic valve prosthesis: 10 years' results. 101
Márcio Madeira, Sara Ranchordás, Paulo Oliveira, Tiago Nolasco, Marta Marques, Miguel Sousa-Uva, Miguel Abecasis, José Neves

Predictors of acute kidney injury associated with cardiopulmonary bypass. 109
Raquel Moreira, Tiago Jacinto, Paulo Neves, Luís Vouga, Cristina Baeta

ORIGINAL ARTICLES THORACIC SURGERY

Surgical approach to colorectal cancer pulmonary metastasis: One-year experience of a reference center. 117
Maria João Jervis, Cristina Rodrigues, Daniel Cabral, D., Carolina Torres, Francisco Félix

Uniportal video-assisted thoracic surgery anatomical resections: Does previous tobacco exposure adversely influence post-operative outcomes? 121
Joana Rei, Susana Lareiro, Pedro Fernandes, Miguel Guerra, José Miranda, Luís Vouga

ORIGINAL ARTICLES VASCULAR SURGERY

Which aneurysm characteristics predict EVAR non-success? 127
Pedro Pinto Sousa, Pedro Brandão, Alexandra Canedo

Type B aortic dissection – a single center series 131
Isabel Poleri, Marina Dias-Neto, João Rocha-Neves, Sérgio Sampaio

CASE REPORTS

Persistent left superior vena cava with agenesis of the right superior vena cava in a patient with complete atrioventricular block. 139
Tiago R. Velho, Hugo Ferreira, Nuno Guerra, Javier Gallego, Ângelo Nobre

Acute prosthetic aortic valve obstruction leading to free aortic insufficiency - Veno-Arterial Extracorporeal Membrane Oxygenation as a bridge to surgery. 143
Marisa Passos Silva, Daniel Caeiro, Fátima Neves, Pedro Braga

Levosimendan in single ventricle heart failure after long-term survival of a modified Blalock-Taussig shunt. 147
João Tavares, Bernardo Baptista, Pedro Sarmento, Bebiana Gonçalves, Miguel Abecassis

Isolated Pulmonary Mucormycosis in an immunocompetent patient. 151
João Santos Silva, Carolina Torres, Susana Clemente, Paulo Calvinho

Epithelioid hemangioendothelioma of the internal jugular vein. 155
Márcio Luís Duarte, Lucas Ribeiro dos Santos, Augusto Cardoso Gonzalez Guatura Romão

Pulmonary sequestration supplied by the circumflex artery - a rare case report. 159
Diana Pissarra, Elson Salgueiro, Ana Catarina Oliveira, Graciete Malangatana, Paulo Pinho, Jorge Casanova

IMAGES IN MEDICINE

Inferior vena cava stenting after cardiac myxoma excision. 163
Pedro Magro, João Abecasis, José Calquinha, José Neves

Impending Ventricular Septal Defect: is it reasonable to be conservative? 165
Mariana Santos Castro, João Abecasis, Ana Braga, José Pedro Neves

Left diaphragm rupture due to blunt trauma. 167
Tiago Fonseca, Jorge Costa

MENSAGEM DO PRESIDENTE

Adelino F. Leite-Moreira
Professor Catedrático da Faculdade de Medicina da Universidade do Porto
Chefe de Serviço de Cirurgia Cardiotorácica,
Centro Hospitalar Universitário São João
Porto, Portugal

SPCCTV 4D Visions 2019

Dando continuidade ao enorme sucesso do conceito SPCCTV 4D Visions, que introduzimos há 2 anos para o nosso congresso anual, tenho o prazer de anunciar que a edição de 2019 será organizada em parceria com a Sociedade Portuguesa de Cardiologia (SPC) e irá decorrer, em Albufeira, no Hotel Grande Real Santa Eulália, de 22 a 24 de novembro de 2019.

Esta colaboração da SPCCTV com a SPC permitirá abordar um conjunto de problemas de interesse comum a todas as especialidades envolvidas, dando expressão real ao lema do congresso "Surgery without borders". Iremos cobrir tópicos que vão desde a medicina de translação até às técnicas cirúrgicas mais avançadas, tendo sempre como pano de fundo a discussão em torno da tomada de decisão que melhor serve o doente. Para o efeito contamos com um programa diversificado, baseado num modelo inovador, que privilegia a participação dinâmica, a discussão viva e a troca de experiências que esperamos vir a ser do agrado de todos.

Contamos ainda com um leque alargado de palestrantes estrangeiros que irão permanecer connosco durante todo o congresso e que vão estar disponíveis para a iniciativa "Lunch with the experts", na qual incentivamos os interessados a inscreverem-se com a maior antecedência possível.

Finalmente, não poderia deixar de mencionar o programa do dia 22 de novembro de 2019, a cargo da Academia da SPCCTV, que inclui múltiplos cursos pré-congresso, com temáticas muito diversificadas, de modo a responder aos interesses de todos os congressistas, bem como, a 5.ª edição do TALS que irá reunir especialistas de renome nacional e internacional em torno da patologia da aorta torácica.

Acreditamos que temos argumentos muito fortes para que o nível científico e social venha a corresponder às expectativas de todos. Mas o sucesso desta iniciativa não se faz sem a ajuda de todos. Apelamos por isso à vossa participação, juntem-se ao nosso entusiasmo, partilhem connosco as vossas ideias e sugestões, enviem os vossos trabalhos e não deixem de marcar presença no congresso.

Adelino Leite-Moreira | Presidente da SPCCTV

EDITORIAL

Miguel Guerra
Cardiothoracic Surgeon, CHVN Gaia/Espinho
Professor at Faculty of Medicine of Porto University
migueldavidguerra@yahoo.com

Ethics and surgical innovation as moral strangers

Science moves faster than ethics, and consequently the agility of biomedical research and surgical innovation far outstrips the pace of research ethics, even though both fields are increasingly active and productive. When one considers surgery, the improvement in patients' care is even more evident. Characteristic of the history of surgical innovation has been the lack of oversight over the creativity of surgeons to innovate. By contrast with new drugs, which are approved by regulatory agencies only after careful clinical trials, a new surgical technique needs no such approval. As a result of this lack of oversight, surgeons have been given the opportunity to exercise as much creativity as they wish when in the operating room. This situation has led to a series of ethical issues that warrant careful consideration for how future innovation should occur in surgery.

There are several reasons why a reflection on this mismatch is necessary and urgent. First, the soaring costs of research are straining the economy, requiring priorities to be set, value considerations to be analyzed, and some investigations to be curbed. Secondly, both biology and medicine are evolving at a pace that may transform mankind's reality. And thirdly, citizens and communities are faced with alternative technical options where value estimates are of essence (*Nunes et al. 2011; Howe 2019*).

Surgeons deal with the ethical, moral, legal, and compassionate practice of medicine. The principles are not always what we think of as being intuitively correct, and we are further challenged not to impose our own values on those of our patients who may come from moral and ethical value systems very different from our own. In recent decades, although we can technically and scientifically do more for our patients than ever before, our personal, trusting relationships with them have deteriorated to the point where they are sometimes adversarial. We have allowed medicine to become a business, guided in many cases by the financial bottom line rather than by an uncompromising concern for a sick person. Within this now fast-moving corporate system, we see too many patients, do too much surgery, and do not have time to develop a close mentoring relationship with our chosen role models or with our trainees. The cherished patient-physician relationship has been undermined by our own successful advances (*Platz and Hyman 2013*).

As surgeons in this era of exciting scientific and technologic advances that is complicated by the demands of limited financial resources, limited time, and the constraints of managed care and extensive bureaucracy, we are forced to deliver our care and compassion to patients and their families in a manner and timeframe many of us never contemplated when we entered medicine. Surgeons, unlike many members of the health care team, take on a different level of responsibility as they encounter patients. The surgeon and the surgical team take on the continued responsibility of the operative procedure itself, the postoperative care, and usually the long-term results and management of any complications. This intense relationship is often established very quickly and under frequently adverse circumstances. The family and religious beliefs may not be known, and the patient may be unconscious, and certainly will be once the procedure starts (*Angelos 2016*). Despite these difficulties, surgeons cannot abandon the needs of their patients and their families. To help them make informed choices, we must communicate completely and compassionately the requisite information about their disease, treatment options, and long-range plans. To do so, we must learn and apply the ethical principle of truth telling and the doctrine of informed consent for the effective care that has taken us so long to master (*Kottow 2009*).

In recent years, a number of innovative surgical procedures have been proposed that have little if any impact on morbidity and mortality, but instead are primarily focused on changing the cosmetic outcomes for patients. For example, minimally invasive surgery or robotics. In fact, whereas surgeons could traditionally assess the success of a

surgical innovation by objectively measuring certain specified outcome measures, many of the newer techniques are only potentially beneficial to patients if the patients place a significant value on the cosmetic change of the innovation. In this context, we are seeing a significant shift away from surgeon-defined benefit to patient-defined benefit (*Ergina et al. 2009*). As such, given the challenge of even determining whether an innovative approach is beneficial relative to a specific patient's values, in the current era of assessing surgical innovation, we must develop increasingly sensitive assessments of patient's subjective outcomes.

One of the central ethical challenges to the performance of innovative surgical procedures is how informed consent can be effectively obtained from patients (*Angelos 2010*). In order to obtain valid informed consent from a patient prior to surgery, the patient must have the capacity to make a decision regarding his or her best interests. The patient must be offered the opportunity to be informed of the risks, benefits, and alternatives of the procedure so that a decision can be made. As is readily apparent, if a patient is being offered an innovative surgical procedure, the surgeon may not know what the risks actually are. As such, the disclosure of unknown risks is impossible. In this circumstance, the best that can be done is for the surgeon to explain the limits of knowledge about the new procedure and the uncertainty about what the risks of the novel procedure actually are. Although it is possible to explain the lack of knowledge about the risks and for the patient to consent to a procedure with unknown risks, such disclosure of unknown risks is very challenging both for surgeons to explain and for patients to understand (*Bal and Choma 2012*). For example, despite the large numbers of minimally invasive aortic valve replacements performed, individual surgeons failed to acknowledge the increased risks of perivalvular prostheses leaks or massive hemorrhage.

Even if one could get past the uncertainty about the risks of innovative surgical procedures, another central ethical issue is the problem that the learning curve arises. The "learning curve" refers to the increased risks to patients during the time that a surgeon and surgical team need to become comfortable with a new procedure (*Johnson and Rogers 2012*). This means that the surgeon gets better with experience. When surgeons are using new techniques, the problem of the learning curve becomes particularly acute. How can we ensure that patients' safety is maintained while the surgeon gains the necessary experience in the new procedure? Many different approaches have been taken to solving the problem of the learning curve. For example, surgeons often begin by learning new techniques on inanimate models, animal models, and human cadavers before ever using the technique on a patient. In addition, when the first patients are being operated upon with the new technique, an experienced proctor is ideally present to improve the patient's safety (*Good et al. 2015*).

New procedures are often dependent on new technology that is almost always more expensive than what was used with the conventional operation. This additional cost may have implications for the availability of the innovative surgical procedure to the wider population. Depending on the health system, the additional costs might make the new procedure only available to those affluent enough to pay for it or the additional costs may be spread across the entire health system and take resources from other conventional therapies that might have proven benefit. Although what is costly is inherently neither good nor bad, we must clearly assess the cost implications of embarking on innovative procedures (*Howe 2019*).

Whether innovative surgery is dependent on new technology or not, there is another significant cost that must be considered - namely, operative time. The new procedure almost always takes longer than the conventional procedure. Since operating room time is an expensive and limited commodity, there are significant costs when a surgeon decides to offer an innovative procedure that may take twice as long in the operating room. How such increased costs should be weighed against the potential benefits to the individual patient is a complex determination (*Angelos 2013*).

Additionally, whenever discussing surgical innovation, we must not ignore the significant potential for conflicts of interest for the surgical innovators in their relationships with the companies that manufacture the technology that makes the innovation possible. The history of innovation in surgery has numerous examples of how the relationships between surgeons and industry have led to significant patient benefit. Without the input of surgeons, companies often would lack the knowledge of where to focus attention in developing new products. Unfortunately, there are also many examples of surgeons profiting greatly from using certain products. Whenever individual surgeon decision making for a patient is influenced by the potential to make large sums of money, there is the potential for significant abuse (*Parreco et al. 2017*).

At last, learning the ethical aspects of delivering patient care must become an integral part of surgical training programs, and we must be held accountable for mastering the skillful application of bioethical principles. After all, the concept of good clinical medicine and surgery implies the best use of scientific, technical, and ethical considerations. Just as with medicine and science, bioethics and legal underpinnings of bioethical decision-making are evolving all the time.

Miguel Guerra | Editor-in-Chefe

REFERENCES

1. Angelos P. Ethics and surgical innovation: challenges to the professionalism of surgeons. Int J Surg 2013; Suppl1:S2-5.
2. Angelos P. The ethical challenges of surgical innovation for patient care. Lancet 2010; 376(9746):1046–7.
3. Angelos P. The Ethics of Introducing New Surgical Technology Into Clinical Practice: The Importance of the Patient-Surgeon Relationship. JAMA Surg. 2016 May 1;151(5):405-6.
4. Bal BS, Choma TJ. What to Disclose? Revisiting Informed Consent. Clin Orthop Relat Res 2012; 470(5): 1346–1356.
5. Ergina PL, Cook JA, Blazeby JM, et al. Challenges in evaluating surgical innovation. Lancet 2009; 374(9695):1097–104.
6. Good DW, Stewart GD, Laird A, Stolzenburg JU, Cahill D, McNeill SA. A Critical Analysis of the Learning Curve and Postlearning Curve Outcomes of Two Experience- and Volume--Matched Surgeons for Laparoscopic and Robot-Assisted Radical Prostatectomy. J Endourol 2015; 29(8):939-47.
7. Howe EG. The Edge-of-the-Field of Clinical Ethics Now, After 30 Years: Does Research Ethics Show Us the Way? J Clin Ethics. Spring 2019; 30(1):3-16.
8. Johnson J, Rogers W. Innovative surgery: the ethical challenges. J Med Ethics 2012; 38(1):9–12.
9. Nunes R. Evidence-Based Medicine: A New Tool for Resource Allocation? Medicine, Health Care and Philosophy; 2003: 297-301.
10. Nunes R, Brandão C, Rego G. Public accountability and sunshine healthcare regulation. Health Care Anal 2011; 19(4):352-64.
11. Nunes R, Duarte I, Santos C, Rego G. Education for values and bioethics. Springerplus 2015; 4:45.
12. Parreco J, Donath E, Kozol R, Faber C. Comparing industry compensation of cardiothoracic surgeons and interventional cardiologists. J Surg Res 2017; 208:51-59.
13. Platz J, Hyman N. Mentorship. Clin Colon Rectal Surg 2013; 26(4): 218–223.

COMENTÁRIO EDITORIAL

Catarina Celestino
Anesthesiologist
catarinacelestino@gmail.com

Role of intraoperative Echocardiography for Sutureless Perceval Aortic Valve

A novel approach to surgical aortic valve replacement (SAVR) is the implantation of the sutureless bioprosthetic Perceval (LivaNova) aortic valve (AV). However, there are few recommendations available to perform intraoperative transesophageal echocardiographic (TEE) assessment for this valve.

The Perceval AV is a stented, trileaflet, bioprosthetic valve that comes in 4 sizes (S, M, L, and XL) corresponding to valve diameters of 21, 23, 25, and 27 mm, respectively (Table 1). The tissue component of the valve is from bovine pericardium that is encircled by a self-expanding stent, which supports the valve and anchors it in place within the aortic annulus.[1] The base of the valve contains a periannular sealing collar. The bare stent encircles the valve with an outflow ring that sits at the level of the sinotubular junction (STJ) with sinusoidal outpouching struts to fit the sinuses of Valsalva. For clinicians taking care of patients with an unknown prosthetic AV replacement, identifying these unique characteristics (trileaflet, periannular sealing collar, and stent extending to the STJ) on TEE can be suggestive of the presence of a Perceval AV.

Perceval AV implantation is designed to be deployed rapidly (sutureless), similar to a TAVR procedure but through an aortotomy, and different because repositioning and redeployment is possible. There are several advantages over standard SAVR, including the ease of valve placement, shorter cardiopulmonary bypass and aortic cross-clamp times.[2,3]

Patient-related contra-indications to using the Perceval prosthesis include the presence of aortic aneurysmal dilation, ascending aortic dissection, known hypersensitivity to nickel or cobalt alloys, and any anatomical characteristics outside of the specified measurements (Table 1). Additionally, there is limited data currently available regarding the safe use in patients with a mitral or tricuspid valve replacement or annuloplasty[4,5] isolated aortic insufficiency or a congenital bicuspid AV.[5,6] A growing trend in the treatment of recurrent aortic stenosis is a valve-in-valve prosthesis deployment.[7,8]

Pre-implantation Echocardiographic Assessment

Although a cardiac CT scan often is used for patient assessment prior to implanting the Perceval AV, it is not a prerequisite for valve placement as in TAVRs, since the surgeon has direct access to the aortic annulus for confirmatory measurement.[9] The first task of the echocardiographic examination includes measuring the diameters of the aortic annulus and the sinotubular junction. Based on the range of these anatomical measurements, the appropriate valve size can be determined (Table 1). Aortic annular diameters between 19 and 27 mm paired with a sinotubular junction diameter range of r24.7 mm to 35.1 mm can accommodate a Perceval AV successfully. In addition, it is vital to check that the ratio between the sinotubular junction and the annulus diameter is 1.3.[1,10] A ratio greater than 1.3 indicates possible pathological aortic annular or STJ dilation, being a contra-indication to Perceval AV. Correct valve and root sizing by echocardiography is imperative to avoid detrimental consequences, including valve migration, valve stent infolding, and aortic wall damage. Aortic annular diameter wanes initially reported from computed tomographic studies to be more oval than round. On 3D echocardiography, this is clearly appreciated, and 3DE aortic annular measurements from the en face views provide more accurate and reproducible measurements compared with 2D echocardiography.

The amount of aortic annular calcification is also important to communicate to the surgeon, as a thorough debridement of the aortic annulus must be done to ensure a homogenous landing zone and help guarantee a well-seated valve. Eccentric and bulky protruding intraluminal calcifications can be a nidus for poor valve seating and cause a paravalvular leak (PVL).

Post-implantation Echocardiographic Assessment

The initial step in evaluating the success of Perceval placement after deployment is to assess the valve

Table 1 **Valve Sizes and hemodynamic parameters**

Valve Size	Aortic Annulus Diameter (mm)	Sinotubular Junction Diameter (mm)	Mean Gradient (mmHg)	Effective orifice area (cm^2)
S (21)	19 - 21	≤ 24.7 – 27.3	10.1 ± 4.2	1.3 ± 0.3
M (23)	21 - 23	≤ 27.3 – 29.9	9.4 ± 5.5	1.5 ± 0.4
L (25)	23 - 25	≤ 29.9 – 32.5	8.5 ± 4.6	1.5 ± 0.4
XL (27)	25 - 27	≤ 32.5 – 35.1	9.7 ± 4.7	1.6 ± 0.4

position. The goal is to have a well-seated valve in the aortic root without rocking motion; the valve prosthesis and the aortic annulus should be flush with uninterrupted circumferential contact with the aortic inner lumen. The valve ring is hyperechoic, thus creating acoustic shadowing in midesophageal aortic long-axis view. As such, a deep transgastric view may be beneficial when evaluating the position of the valve.

Evaluation of valve position also entails evaluating patency of the valve stent frame and sinusoidal struts. An undersized valve can result in valve migration. An oversized valve can lead to excessive compression or rupture of the aorta and disruption of valve integrity, resulting in stent infolding. Patient-prosthesis mismatch can be an issue with any valve type, but given the intimate relationship of the valve stent frame and the annular valve ring for the Perceval AV, ensuring proper valve seating is crucial. However, it is not necessary that the outflow ring of the valve be flush with the aortic wall at the level of the sinotubular junction. A deep transgastric long-axis view should be obtained to evaluate hemodynamic parameters (Table 1).[10]

The reported incidence of PVL after Perceval implantation ranges from 4% to 8%.[10,11] Assessing PVL can be accomplished best in the midesophageal aortic long-axis view. Any PVL greater than mild should be addressed by either increasing the size of the valve prosthesis or redeploying the valve in a more optimal position.[1,10] Redeployment of the valve simply entails removing the valve (since it is not sutured) and collapsing the valve back onto the prosthesis-mounted holder prior to redeployment.

Pitfalls of Perceval AV Implantation

Prosthetic PVL can occur with any AV replacement, however, with the Perceval AV this potential pitfall can be easily corrected.

Central AV regurgitation can be observed, but in instances where the valve is properly sized prior to deployment, this is generally graded to mild. Coaptation of all 3 leaflets of the prosthetic valve is best viewed in the midesophageal AV short-axis view. Evaluating that the prosthesis commissural struts are properly oriented with the native commissures is best done in this view. Due to acoustic shadowing, this may be technically difficult but a 3D view may be helpful in the evaluation for proper leaflet function and mobility. In addition to prosthesis leaflet motion, confirmation that there is preserved diastolic anterior mitral leaflet movement is crucial to a successful outcome.[12]

Although visually inspected by the surgeon, it is always imperative to assure coronary ostia patency, demonstrating coronary blood flow with color flow Doppler or surrogate markers for coronary hypoperfusion (left ventricular wall motion abnormalities, right ventricule dysfunction, and functional mitral regurgitation). This prompt the echocardiographer to advise the surgeon of the need to reposition the valve. The patient can develop dysrhythmias, likely from the radial shear force of the expanding valve on the atrioventricular node.[4,10]

TEE is useful for perceval AV implantation to guide appropriate device implantation and to diagnose and treat complications that may occur during valve implantation. The suggestions provided may serve as a guide for safe implantation of the Perceval AV (Table 2).

Table 2 **Valve Sizes and hemodynamic parameters**

Perceval AV TEE Findings / Evaluation
Perceval valve appearance on TEE
Trileaflet valve
Hyperechoic periannular ring
Hyperechoic coronary sinus strut
Outflow ring abutting sinotubular junction
Intraoperative evaluation of Perceval valve
Measure diameter of aortic annulus
Measure diameter of sinotubular junction
Assess ratio of annulus:STJ < 1.3
Assure patency of stent from postdeployment
Evaluate valve seating
Assess level of PVL ≤ Mild
Interrogate valve for mean and peak gradients (Table 1)

REFERENCES

1. Shrestha M, Fischlein T, Meuris B, et al. European multicentre experience with the sutureless Perceval valve: Clinical and haemodynamic outcomes up to 5 years in over 700 patients. Eur J Cardiothorac Surg 2016;49:234–41.
2. Ramakrishna H, Patel PA, Gutsche JT, et al. Surgical aortic valve replacement—Clinical update on recent advances in the contemporary era. J Cardiothorac Vasc Anesth 2016;30:1733–41.
3. Meco M, Montisci A, Miceli A, et al. Sutureless Perceval aortic valve versus conventional stented bioprostheses: Meta-analysis of postoperative and mid- term results in isolated aortic valve replacement. J Am Heart Assoc 2018;7.
4. Shrestha M, Folliguet T, Meuris B, et al. Sutureless Perceval S aortic valve replacement: A multicenter, prospective pilot trial. J Heart Valve Dis 2009;18:698–702.
5. Nguyen A, Fortin W, Mazine A, et al. Sutureless aortic valve replacement in patients who have bicuspid aortic valve. J Thorac Cardiovasc Surg 2015;150:851–7.
6. U.S. Food and Drug Administration/Center for Drug Evaluation and Research. Sorin Perceval Sutureless Heart Valve - P150011. Available at: https://www.accessdata.fda.gov/cdrh_docs/pdf15/p150011b.pdf. Washing- ton, DC. 2017. Accessed November 23, 2017.
7. Dohmen PM, Lehmkuhl L, Borger MA, et al. Valve-in-valve replacement using a sutureless aortic valve. Am J Case Rep 2016;17:699–702.
8. Di Eusanio M, Phan K. Sutureless aortic valve replacement. Ann Cardiothorac Surg 2015;4:123–30.
9. Cerillo AG, Amoretti F, Mariani M, et al. Increased gradients after aortic valve replacement with the Perceval valve: The role of oversizing. Ann Thorac Surg 2018.
10. Laborde F, Fischlein T, Hakim-Meibodi K, et al. Clinical and haemody- namic outcomes in 658 patients receiving the Perceval sutureless aortic valve: Early results from a prospective European multicentre study (the Cavalier Trial). Eur J Cardiothorac Surg 2016;49:978–86.
11. Beckmann E, Martens A, Alhadi F, et al. Aortic valve replacement with sutureless prosthesis: Better than root enlargement to avoid patient-prosthesis mismatch? Interact Cardiovasc Thorac Surg 2016;22:744–9.
12. Lee T, Mittnacht AJC, Itagaki S, et al. Mitral regurgitation exacerbation due to sutureless aortic valve replacement. Ann Thorac Surg 2018;105: e103–5.

COMENTÁRIO EDITORIAL

Paulo Neves
Serviço de Cirurgia Cardiotorácica
Centro Hospitalar de Vila Nova de Gaia/Espinho, EPE
Vila Nova de Gaia, Portugal
pauloacn@gmail.com

Post cardiopulmonary bypass renal failure – do we need goal directed perfusion?

Cardiopulmonary bypass - associated acute kidney injury (CPB-AKI) is a very common complication in cardiac surgery, occurring in up to 50% of patients.[1] CPB-AKI is now recognized as an independent risk factor for mortality after cardiac surgery.[2] The pathophysiology of CPB-AKI is multifactorial and includes perioperative inflammation, hemolysis, changes in renal perfusion, oxidative stress, and ischemia-reperfusion injury.[3] All these factors are causing glomerular damage and ultimately necrosis, resulting in a decrease of glomerular filtration rate (GFR).

Assessment of serum creatinine (SCr) levels is the current gold standard for diagnosis of GFR changes and AKI. However, it is very important to keep in mind that SCr levels only start to increase after loss of more than 50% of glomerular function. Therefore, most of the times, both diagnosis and therapy of AKI are delayed. Nevertheless, it is well validated that early recognition and treatment is critical for the recovery of kidney function.[4,5]

Therefore, to early recognize and treat this potential lethal complication, it is essential to understand the risk factors associated with CPB-AKI. *Moreira et al.*, in the paper published in this issue of the Journal, found that age, CPB time, urine output during CPB, mannitol and furosemide administration during CPB were risk factors for CPB-AKI development. Additionally, it was reported that CPB had an influence on renal function's evolution in postoperative period after cardiac surgery, and that it may lead to the development of AKI. The percentage of patients who developed this complication (19%) is aligned with the literature. While some of these identified risk factors and non-modifiable ones, others can be modified, such as loop diuretic and mannitol administration.

Moreira et al. reported no statistically significant differences between the two groups (no AKI vs AKI) regarding preoperative values of hemoglobin and hematocrit (HCT), nor with respect to minimum hemoglobin values during CPB, and hematocrit, or as to addition of blood in the priming, blood transfusion during CPB or administration of blood collected in cell-saver. Regarding this issue, a relationship between the nadir HCT value during CPB and postoperative AKI was first reported in 1994.[6] This finding was further confirmed, and some authors have hypothesized that inadequate oxygen delivery (DO2) may be the associated mechanism between severe hemodilution on CPB and CPB-AKI.[7] Plus, it was subsequently identified a critical DO2, around 260 to 272 $mL \cdot min^{-1} \cdot m^{-2}$ for patients undergoing mild hypothermic (>32ºC) CPB. Based on these observations, there was developed the concept of goal-directed perfusion (GDP), shifting the target of the CPB from the cardiac index to the DO2, which should be maintained above the aforementioned critical level.[8] To validate these findings in a higher level, Goal-Directed Perfusion Trial (GIFT) was designed to test the hypothesis that the GDP approach to avoid a DO2 nadir $<280\ mL \cdot min^{-1} \cdot m^{-2}$ will decrease the degree of CPB-AKI in patients undergoing CPB with mild hypothermia. GIFT was able to demonstrate that GDP is effective in reducing risk of early stages of CPK-AKI, namely any SCr increase and Acute Kidney Injury Network (AKIN) stage 1.[9]

In conclusion, paper from Moreira et al. brings another contribution to this very important topic. GIFT results do not unquestionably advise a change in clinical practice, given the fact that GDP was only able to reduce minor degrees of CPB-AKI. Therefore, further studies are needed to define perfusion interventions that may decrease more severe degrees of CPB-AKI.

REFERENCES

1. Lagny M-G, Jouret F, Koch J-N, et al. Incidence and outcomes of acute kidney injury after cardiac surgery using either criteria of the RIFLE classification. BMC Nephrol 2015;16:76
2. Hobson CE, Yavas S, Segal MS, et al. Acute kidney injury is associated with increased long-term mortality after cardiothoracic surgery. Circulation 2009;119(18):2444-2453
3. O'Neal JB, Shaw AD, Billings FT IV. Acute kidney injury following cardiac surgery: current understanding and future

directions. Crit Care 2016;20(01):187
4. Zou H, Hong Q, Xu G. Early versus late initiation of renal replacement therapy impacts mortality in patients with acute kidney injury post cardiac surgery: a meta-analysis. Crit Care 2017;21 (01):150
5. Karvellas CJ, Farhat MR, Sajjad I, et al. A comparison of early versus late initiation of renal replacement therapy in critically ill patients with acute kidney injury: a systematic review and meta-analysis. Crit Care 2011;15(01):R72
6. Ranucci M, Pavesi M, Mazza E, Bertucci C, Frigiola A, Menicanti L, et al. Risk factors for renal dysfunction after coronary surgery: the role of cardiopulmonary bypass technique. Perfusion. 1994;9:319-26.
7. Karkouti K, Beattie WS, Wijeysundera DN, Rao V, Chan C, Dattilo KM, et al. Hemodilution during cardiopulmonary bypass is an independent risk factor for acute renal failure in adult cardiac surgery. J Thorac Cardiovasc Surg. 2005; 129:391-400.
8. Ranucci M, Romitti F, Isgro G, Cotza M, Brozzi S, Boncilli A, et al. Oxygen delivery during cardiopulmonary bypass and acute renal failure after coronary operations. Ann Thorac Surg. 2005;80:2213-20.
9. Ranucci M, Johnson I, Willcox T, Baker RA, et al. Goal-directed perfusion to reduce acute kidney injury: A randomized trial. J Thorac Cardiovasc Surg. 2018 Nov;156(5):1918-1927.e2.
4. Haifeng Qin, Fang Wang, Hui Liu, Zhen Zeng, Shasha Wang, Xin Pan, Hongjun Gao. New advances in immunotherapy for non-small cell lung cancer. Am J Transl Res 2018; 10(8):2234-2245. http://www.ajtr.org/files/ajtr0075629.pdf
5. G.Videtic, J Donington et all. Stereotactic body radiation therapy for early-stage non-small cell lung cancer: Executive Summary of an ASTRO Evidence-Based Guideline. Practical Radiation Oncology (2017) 7,295-301. http://dx.doi.org/10.1016/j.prro.2017.04.014
6. P. E. Postmus, K. M. Kerr et all. Early-Stage and Locally Advanced (non-metastatic) Non-Small-Cell Lung Cancer: ESMO Clinical Practice Guidelines. Annals of Oncology 28 (Supplement 4): iv1–iv21, 2017. doi:10.1093/annonc/mdx222
7. Chen-Yang Huang, Bo-Huan Chen, Wen-Chi Chou, Cheng-Ta Yang, John Wen-Cheng Chang. Factors associated with the prognosis and long-term survival of patients with metastatic lung adenocarcinoma: a retrospective analysis. J Thorac Dis 2018;10(4):2070-2078. doi: 10.21037/jtd.2018.03.143

ORIGINAL ARTICLE **CARDIAC SURGERY**

SEGURANÇA E EXEQUIBILIDADE DA CIRURGIA CONSERVADORA DA VÁLVULA AÓRTICA: EXPERIÊNCIA DE UM CENTRO CIRÚRGICO NACIONAL

Rui J. Cerqueira[1,2*], Jéni Quintal[1*], Soraia Moreira[1], Francisca A Saraiva[1], Mário J. Amorim[1,2], Jorge Almeida[1,2], Paulo Pinho[1,2], Adelino F. Leite-Moreira[1,2]

*Estes dois autores contribuíram equitativamente para o trabalho
[1]Faculdade de Medicina da Universidade do Porto, Departamento de Cirurgia e Fisiologia e Unidade de Investigação Cardiovascular, UnIC
[2]Centro Hospitalar Universitário de São João – Serviço de Cirurgia Cardiotorácica

***Contacto Autor:** amoreira@med.up.pt

Resumo

Introdução: Em casos selecionados, a reparação da válvula aórtica (RVAo) constitui uma alternativa à substituição por prótese.

Objetivo: Avaliar a sobrevida e necessidade de reoperação a médio prazo, bem como o resultado funcional após RVAo.

Métodos: Estudo de coorte retrospetivo, unicêntrico incluindo consecutivamente doentes com idade ≤70 anos, submetidos a RVAo por doença da válvula aórtica não-estenótica, entre 2012-2017. Os resultados foram comparados com os obtidos após substituição valvular aórtica por prótese mecânica (SVAo) no mesmo período. Os grupos foram caracterizados e comparados utilizando testes Qui-Quadrado e *t* para amostras independentes e a sobrevida e reoperações foram analisadas através de curvas de Kaplan-Meier e regressões de Cox.

Resultados: Foram incluídos 72 indivíduos submetidos a RVAo. O *follow-up* médio foi de 4 anos, máximo de 7. Apesar da idade média relativamente baixa à data da intervenção (47±13 anos), os doentes submetidos a RVAo apresentam uma baixa prevalência de etiologia reumática (3%). Os tempos de circulação extracorporal (148±74 minutos) e de clampagem aórtica (108±52 minutos) são os habituais para este tipo de cirurgias e semelhantes aos do grupo SVAo. Durante o seguimento ecocardiográfico (mediano de 3 meses) verificou-se uma regressão de massa do ventrículo esquerdo de 21% e uma prevalência de insuficiência aórtica de 4%. Aos 7 anos, a sobrevida cumulativa e a sobrevida livre de reoperação dos doentes submetidos a RVAo foram, respetivamente, 96,4% e 94,4%.

Conclusões: Com uma seleção adequada dos doentes, a RVAo pode ser uma alternativa segura e efetiva, com bons resultados a médio prazo.

Abstract

Safety and feasibility of conservative aortic valve surgery: single center experience

Background: *In selected cases, aortic valve repair (RVAo) is an alternative to prostesic aortic valve replacement.*

Aim: *To compare mid-term survival, need of reoperation and echocardiographic findings associated with RVAo.*

Methods: *Retrospective single-center cohort study including consecutive patients younger than 70 years-old, with non-stenotic aortic valve disease, who underwent RVAo between 2012 and 2017. A comparison was made with a group of patients who underwent mechanical aortic valve replacement (SVAo) in the same period. The groups were characterized and compared using Chi-Square and t-tests for independent samples and survival and reoperation were analyzed using Kaplan-Meier curves and Cox regressions.*

Results: *We included 72 patients submitted to RVAo. Mean follow-up time was 4 years, maximum 7. Although the mean age was relatively low (47±13 years), patients undergoing RVAo presented a lower prevalence of rheumatic etiology (3%). The cardiopulmonary bypass (148±74 minutes) and cross clamping aortic times (108±52 minutes) are the usual times for this type of surgery and similar to those of the comparing group (SVAo). In the echocardiographic follow-up (median of*

3 months), we verified a left ventricular mass regression of 21% and a prevalence of aortic insufficiency of 4%. At 7 years, cumulative survival and freedom from reoperation of patients undergoing RVAo were 98.8% and 97.6%, respectively.

Conclusion: *RVAo can be a safe and effective alternative, with good mid-term results if patient selection is judicious.*

INTRODUÇÃO

A substituição valvular, utilizando próteses mecânicas ou biológicas, é atualmente considerada o *gold standard* no tratamento cirúrgico da insuficiência aórtica.[1-3] Nas últimas décadas verificaram-se melhorias quer na técnica cirúrgica quer nos dispositivos, que incrementaram significativamente a segurança deste tipo de procedimento. Apesar das próteses mecânicas atuais apresentarem uma significativa melhoria na hemocompatibilidade e perfil hemodinâmico,[4] a necessidade de hipocoagulação permanente e o consequente risco hemorrágico têm diminuído a sua utilização, em detrimento das próteses biológicas.[1,2,6] Por sua vez, o inerente risco de deterioração estrutural destas últimas torna-as pouco atrativas para indivíduos mais jovens.[1,2,6]

É precisamente nesta faixa etária que a reparação valvular se afigura mais atrativa pelos benefícios potenciais decorrentes da preservação da válvula nativa, nomeadamente melhor performance hemodinâmica, menor risco de endocardite infeciosa (EI), menor deterioração valvular, dispensa de hipocoagulação, baixa morbimortalidade e melhor qualidade de vida do doente.[1,5,6,8,13-15]

Contudo, e ao contrário do que acontece na patologia degenerativa da válvula mitral, este tipo de cirurgia não é a primeira linha na abordagem da insuficiência valvular aórtica, parecendo ainda haver alguma relutância numa utilização mais ampla da plastia da válvula aórtica como alternativa à substituição valvular.[6,13] A atual abordagem integrada da reparação valvular aórtica exige uma combinação complexa de vários procedimentos, divididos em dois grandes grupos: a intervenção na raíz e anel aórtico e a intervenção nas cúspides.[2,9,10] O seu sucesso está dependente duma seleção criteriosa dos doentes e da avaliação imagiológica e funcional sistemática, bem como da preparação da equipa cirúrgica para a execução deste tipo de técnicas.[5,7,11,12]

Existem ainda poucos estudos clínicos a avaliar os resultados da reparação valvular aórtica fora dos grandes centros cirúrgicos de referência. Assim, este estudo teve como objetivos avaliar a sobrevida a médio-prazo, a necessidade de reoperação e as variáveis hemodinâmicas após reparação de válvulas aórticas não-estenóticas e comparar estes resultados com os obtidos com a substituição da válvula aórtica por prótese mecânica.

MATERIAIS E MÉTODOS

Tipo de estudo e seleção amostral

Estudo de coorte retrospetivo e unicêntrico.

Utilizou-se um método de amostragem não aleatório e consecutivo, tendo-se selecionado todos os doentes com idade compreendida entre os 18 e os 70 anos, com válvulas aórticas sem estenose significativa, submetidos a cirurgia de RVAo, durante um período de 6 anos (1 de janeiro de 2012 a 31 de julho de 2017), no Centro Hospitalar Universitário de São João (CHUSJ). Foi obtida uma amostra de doentes submetidos a substituição da válvula aórtica por prótese mecânica durante o mesmo período, com válvulas elegíveis para reparação, de acordo com a descrição pré-operatória ou intra-operatória (Figura 1).

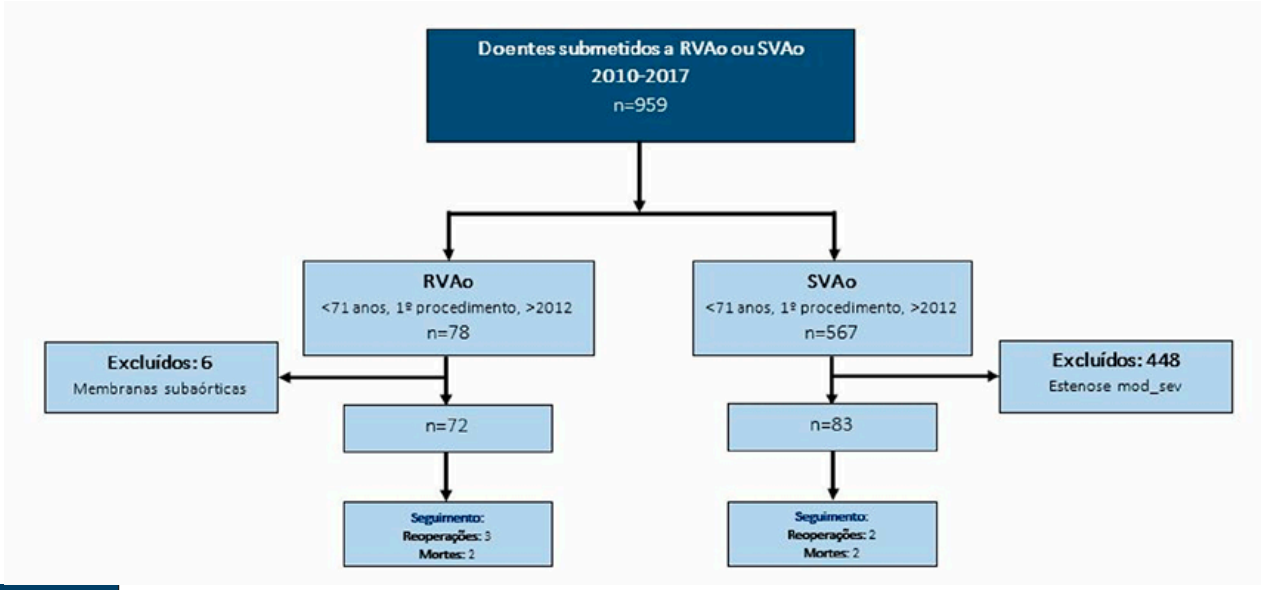


Figura 1 ***Fluxograma do protocolo do estudo.*** *RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica; Estenose mod_sev, estenose aórtica moderada a severa.*

Recolha de dados

Para a realização deste estudo foram consultadas, retrospetivamente, as bases de dados existentes no Serviço de Cirurgia Cardiotorácica do CHUSJ, bem como os processos clínicos dos doentes em suporte físico. A mortalidade foi verificada através do Registo Nacional de Utentes a 17 de novembro de 2018.

Variáveis

As variáveis foram organizadas em três grupos: pré-operatórias, intraoperatórias e pós-operatórias. Nas variáveis pré-operatórias foram incluídos dados antropométricos, informação clínica (incluindo comorbilidades), resultados de exames analíticos, provas de função respiratória, ecocardiograma transtorácico (ETT), eletrocardiograma (ECG) e outros meios complementares de diagnóstico pré-operatórios, com caracterização da anatomia, fisiologia e patologia da válvula aórtica. Relativamente às variáveis intraoperatórias, foram recolhidos dados referentes à prioridade e indicação primária para cirurgia, intervenções realizadas e suporte hemodinâmico (incluindo tempos de circulação extracorporal (CEC) e de clampagem aórtica). Do mesmo modo, do período pós-operatório, obteve-se informação relativa à monitorização dos doentes na unidade de cuidados intensivos (fármacos administrados, tempo de ventilação invasiva e complicações pós-operatórias), medicação prescrita para domicílio, ETT de follow-up, necessidade de reintervenção na válvula aórtica e mortalidade por todas as causas. A caracterização das variáveis utilizadas pode ser consultada na Tabela 1.

Análise estatística

A recolha de dados foi feita com recurso ao programa *IBM - SPSS Statistics versão 25.0* (IBM, Estados Unidos da América). A análise estatística e criação de gráficos foram executadas com o programa *Stata versão 14* (StataCorp, Estados Unidos da América).

De acordo com a distribuição dos dados foram utilizados os testes estatísticos apropriados para comparar amostras independentes, apresentando-se as variáveis categóricas em valor absoluto (n) e em percentagem (%), e as variáveis contínuas em média e desvio padrão, ou mediana e mínimo/máximo, conforme apropriado.

A sobrevida a médio prazo e a necessidade de reoperação foram estudadas com recurso a curvas de *Kaplan-Meier*, teste *Log-Rank* e regressão de Cox, apresentando-se os valores de *Hazard Ratio* (HR) e intervalos de confiança a 95%. O ponto de corte escolhido para a significância estatística foi 0,05.

Aspetos éticos

O estudo foi aprovado pela Comissão de Ética e Conselho de Administração do Centro Hospitalar de São João. A obtenção do Consentimento Informado foi dispensada pelo facto de se tratar de um estudo observacional retrospetivo, com recurso à consulta de dados registados por rotina nos processos clínicos dos doentes submetidos a cirurgia cardíaca. A confidencialidade e o anonimato dos

Tabela 1 Caracterização de variáveis

Variável (categorias)
Idade (anos, à data da cirurgia)
Género (feminino; masculino)
Classe funcional de NYHA (I; II; III; IV)
Hipertensão (sim; não)
Dislipidemia (sim; não)
Consumo de tabaco (sim, se fumador atual ou nos últimos 6 meses; não)
Diagnóstico de Síndrome de Marfan (sim; não)
Prioridade da cirurgia (*eletiva* - doente admitido por rotina para cirurgia; *urgente* - doentes que não foram admitidos eletivamente para cirurgia mas que requerem intervenção ou cirurgia no internamento atual; *emergente* - cirurgia que requer realização antes do início do próximo dia útil após a decisão de operar)
Cirurgia cardíaca prévia não aórtica (sim; não)
Doença arterial periférica (sim; não)
Endocardite infeciosa (sim; não)
Disseção aguda da aorta (sim; não)
Etiologia (congénita/bicúspide, monocúspide, endocardite, reumática, degenerativa/prolapso, raiz da aorta/Marfan, disseção, outra)
Função sistólica do VE (*normal*, se FE $\geq$ 55%, *ligeiramente deprimida*, se FE entre 45 e 54%, *moderadamente deprimida*, se FE entre 30 e 44%, e *gravemente deprimida*, se FE $<$ 30%)
Fração de ejeção do VE (em percentagem)
Insuficiência aórtica (ausente, ligeira, moderada, grave)
Espessura do SIV (em mm)
Espessura da PPVE (em mm)
Diâmetro telediastólico do ventrículo esquerdo (em mm)
Massa do ventrículo esquerdo (em gramas)
Intervenção na raiz da aorta (sim; não)
Intervenção na aorta ascendente (sim; não)
Válvulas tratadas cirurgicamente (aórtica; mitral; tricúspide; pulmonar)
Cirurgia de revascularização do miocárdio (sim; não)
Tempo de circulação extracorporal (em min)
Tempo de clampagem aórtica (em min)
Regressão de massa do ventrículo esquerdo (em %)
Reoperação (sim, se reintervenção até 17.11.2018; não)
Mortalidade (sim, se falecido até 17.11.2018; não)

NYHA, *New York Heart* Association; VE, Ventrículo esquerdo; FE, fração de ejeção; SIV, Septo interventricular; PPVE, Parede posterior do ventrículo esquerdo

dados identificativos foram respeitados, seguindo as orientações da Declaração de Helsínquia de 1964, revista em Fortaleza, em 2013.

RESULTADOS

Caracterização clínica da amostra

Foram incluídos 155 doentes no estudo: 72 doentes submetidos a RVAo e 83 doentes submetidos a SVAo. Os indivíduos do grupo RVAo eram significativamente mais novos que os do grupo SVAo (47±13 anos *vs.* 52±11 anos, p=0,005). Em ambos os grupos houve uma predominância do sexo masculino (83% no grupo RVAo, 73% no grupo SVAo, p=0,140).

Os indivíduos do grupo RVAo apresentavam classes funcionais de NYHA mais baixas que os do grupo SVAo (NYHA ≥III: 4% no grupo RVAo *vs.* 37% no grupo SVAo; p<0,001), assim como menor prevalência de etiologia reumática (3 vs. 14 %, p<0,011). Também neste grupo se verificou menor número de cirurgias cardíacas prévias não aórticas e de EI, embora sem diferença estatisticamente significativa (1 *vs.* 4, p=0,230; 1 *vs.* 4, p=0,230). A prevalência de doença arterial periférica foi ligeiramente superior no grupo RVAo (6 *vs.* 2%; p=0,310).

Os grupos não diferiram em termos de prevalência de hipertensão arterial, dislipidemia, consumo de tabaco, síndrome de Marfan nem disseção aórtica. Os dados relativos à caracterização clínica dos grupos podem ser consultados na Tabela 2.

Caracterização de parâmetros hemodinâmicos pré-operatórios

A prevalência de insuficiência aórtica grave foi semelhante entre os dois grupos (72 *vs.*79%, p=0,330, nos grupos RVAo e SVAo respetivamente). Verificou-se que a espessura do septo interventricular (11±2 *vs.* 11±2 mm, p=0,170) e a massa do ventrículo esquerdo (260±90 *vs.* 290±95 gr, p=0,120) eram semelhante entre os dois grupos. Não foram encontradas quaisquer diferenças entre os dois grupos nos restantes parâmetros avaliados.

Os dados relativos à caracterização destes parâmetros podem ser consultados na Tabela 3.

Caracterização cirúrgica

Os dados intraoperatórios dos grupos encontram-se disponíveis na Tabela 4. No grupo RVAo realizaram-se concomitantemente menos intervenções que no grupo SVAo, nomeadamente cirurgia da raíz da aorta (17 *vs.* 49%, p<0,001), revascularização do miocárdio (6 *vs.* 13%, p=0,110) e intervenção na válvula mitral (11 *vs.* 20%, p=0,110), tendo sido os tempos de CEC e de clampagem aórtica tendencialmente mais longos no grupo SVAo, embora sem atingir significância estatística (148±74 minutos *vs.* 166±69 minutos, p=0,150; 108±52 min *vs.* 118±50 min, p=0,250, nos grupos RVAo e SVAo, respetivamente). O número de intervenções na aorta ascendente foi semelhante entre os dois grupos (57 *vs.* 53%, p=0,620, nos grupos RVAo e SVAo, respetivamente).

Caracterização de parâmetros hemodinâmicos pós-operatórios

O primeiro ETT de *follow-up* foi realizado cerca de 3 meses depois da cirurgia (mediana). Verificou-se que a espessura do septo interventricular era ligeiramente inferior no grupo RVAo (11±2 *vs.* 12±2 mm, p=0,004), bem como a massa do ventrículo esquerdo (211±55 *vs.* 238±65 gr, p=0,023). A ausência de insuficiência aórtica, a regressão de massa e a espessura da parede posterior do ventrículo esquerdo foram semelhantes nos dois grupos (86 *vs.*

Tabela 2 **Caracterização clínica da amostra**

Variável	RVAo (n=72)	SVAo (n=83)	Valor de *p*
Idade à data da cirurgia [média (dp)]	47 (13)	52 (11)	0,005
Sexo masculino [n (%)]	60 (83)	61 (73)	0,140
Classe funcional de NYHA ≥ III [n (%)]	3 (4)	26 (37)	<0,001
Hipertensão arterial [n (%)]	38 (53)	50 (60)	0,350
Dislipidemia [n (%)]	24 (33)	37 (45)	0,150
Consumo de tabaco [n (%)]	27 (38)	25 (34)	0,640
Síndrome de Marfan [n (%)]	5 (7)	6 (7)	0,950
Cirurgia urgente [n (%)]	8 (11)	13 (16)	0,410
Cirurgia cardíaca prévia não valvular aórtica [n (%)]	1 (1)	4 (5)	0,230
Doença arterial periférica [[n (%)]	4 (6)	2 (2)	0,310
Endocardite [n (%)]	1 (1)	4 (5)	0,230
Disseção aórtica [n (%)]	4 (6)	5 (6)	0,900
Etiologia reumática [n (%)]	2 (3)	12 (14)	0,011

RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica; dp, desvio padrão; NYHA, New York Heart Association.

Tabela 3 **Parâmetros avaliados no ecocardiograma pré-operatório**

Variável	RVAo (n=72)	SVAo (n=83)	Valor de *p*
Função sistólica do VE [n (%)] Normal Moderadamente deprimida	 66 (97) 2 (3)	 74 (99) 1 (1)	0,500
Insuficiência aórtica [n (%)] Grau < III Grau ≥ III	 18 (28) 46 (72)	 16 (21) 60 (79)	0,330
Espessura do SIV [média (dp)]	11 (2)	11 (2)	0,170
Espessura da PPV [média (dp)]	9 (2)	10 (2)	0,280
DtdVE [média (dp)]	60 (8)	60 (9)	0,990
Massa do VE [média (dp)]	260 (90)	290 (95)	0,120

RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica; VE, Ventrículo esquerdo; SIV, Septo interventricular; dp, desvio padrão; PPVE; Parede posterior do ventrículo esquerdo; DtdVE, Diâmetro telediastólico do ventrículo esquerdo.

Tabela 4 **Caraterização cirúrgica dos grupos**

Variável	RVAo (n=72)	SVAo (n=83)	Valor de *p*
Intervenção na raiz da aorta [n (%)]	12 (17)	41 (49)	<0,001
Intervenção na aorta ascendente [n (%)]	41 (57)	44 (53)	0,620
Válvulas tratadas [n (%)] Aórtica Mitral	 64 (89) 8 (11)	 66 (80) 17 (20)	0,170
CRM [n (%)]	4 (6)	11 (13)	0,110
Tempo de circulação extracorporal [média (dp)]	148 (74)	166 (69)	0,150
Tempo de clampagem aórtica [média (dp)]	108 (52)	118 (50)	0,250

RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica; CRM, Cirurgia de revascularização do miocárdio; dp, desvio padrão.

93%, p=0,290; 21 *vs.* 18%, p=0,220; 9±1 *vs.* 9±1mm, p=0,018, nos grupos RVAo e SVAo, respetivamente). Os dados relativos à caracterização destes parâmetros podem ser consultados na Tabela 5.

Reoperação a médio prazo

O tempo médio de *follow-up* foi de 4 anos e o máximo de 7 anos. Ao longo do tempo de seguimento verificaram-se 5 reoperações: 3 no grupo RVAo e 2 no grupo SVAo (sobrevida livre de reoperação semelhante: 94,4% no grupo RVAo *vs.* 97,6% no grupo SVAo; HR: 1,84; IC 95%: 0,906-0,994; teste Log-rank, p=0,500). As curvas de Kaplan-Meier correspondentes à necessidade de reoperação estão disponíveis na Figura 2.

Relativamente às falências do procedimento no grupo RVAo: uma reintervenção cirúrgica ocorreu por EI,

Tabela 5 **Parâmetros avaliados no ecocardiograma de follow-up**

Variável	RVAo (n=72)	SVAo (n=83)	Valor de *p*
Fração de ejeção [média (dp)]	60 (7)	58 (9)	0,140
Insuficiência aórtica [n (%)] Ausente Grau I-II Grau ≥ III	 62 (86) 7 (10) 3 (4)	 77 (93) 3 (4) 3 (4)	0,290
Espessura do SIV [média (dp)]	11 (2)	12 (2)	0,004
Espessura da PPVE [média (dp)]	9 (1)	9 (1)	0,018
DtdVE [média (dp)]	54 (6)	54 (6)	0,820
Massa do VE [média (dp)]	211 (55)	238 (65)	0,023
Regressão de massa VE [%]	21	18	0,220

RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica; dp, desvio padrão; SIV, Septo interventricular; PPVE, Parede posterior do ventrículo esquerdo; DtdVE, Diâmetro telediastólico do ventrículo esquerdo; VE, Ventrículo esquerdo.

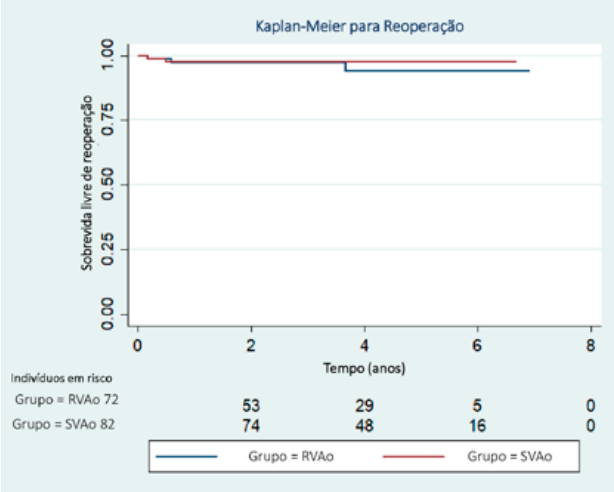


Figura 2 *Curvas de Kaplan-Meier para reoperação. RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica.*

com necessidade de substituição valvular (aos 2 meses pós-cirurgia), e as outras duas ocorreram por insuficiência aórtica grave (aos 7 e 44 meses). Já no grupo SVAo ocorreram duas reintervenções: uma por disfunção estrutural de prótese na sequência de trombose protésica (aos 2 meses, em indivíduo com Síndrome de Marfan, trombocitose e INR subterapêutico, submetido a Cirurgia de Bentall e com necessidade de substituição por nova conduta mecânica valvulada) e a outra por EI da conduta valvulada da aorta (aos 6 meses, com necessidade de substituição por nova conduta valvulada mecânica).

Sobrevida a médio prazo

A sobrevida a médio prazo foi ligeiramente inferior no grupo RVAo, embora sem diferença estatisticamente significativa (sobrevida cumulativa a 7 anos de 96,4% no grupo RVAo e de 97,6% no grupo SVAo, teste Log-Rank, p=0,450). Na Figura 3 apresentam-se as curvas de

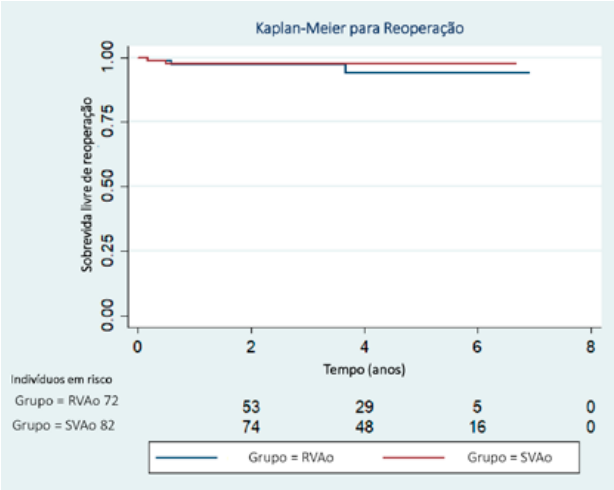


Figura 3 *Curvas de Kaplan-Meier para sobrevida a médio prazo. Legenda: RVAo, reparação da válvula aórtica; SVAo, substituição valvular aórtica por prótese mecânica.*

Kaplan-Meier correspondentes à sobrevida a médio prazo, nos dois grupos.

Ao longo do *follow-up* registaram-se 4 mortes: 2 no grupo RVAo e 2 no grupo SVAo. No grupo RVAo um indivíduo faleceu de causa infeciosa (aos 16 meses, tendo sido a indicação para plastia da válvula aórtica a disseção aguda da aorta tipo A) e no outro não foi possível aceder à causa do óbito (tendo este ocorrido aos 27 meses, tratando-se de um indivíduo que havia sido admitido para cirurgia com diagnóstico de dilatação da aorta ascendente, insuficiência aórtica grave e patologia pulmonar - DPOC mista com silicose pulmonar). No grupo SVAo, uma morte ocorreu no período intraoperatório e uma morte ocorreu a médio prazo. No que se refere à morte intraoperatória, ocorreu num indivíduo admitido por disseção aguda da aorta ascendente do tipo A, com necessidade de reentrada em CEC quase imediata, após saída de CEC e otimização do suporte aminérgico. Relativamente à morte a médio prazo, verificou-se aos 5 meses, num indivíduo com insuficiência aórtica grave, doença arterial coronária e síndrome coronário agudo (SCA) recente, não tendo sido possível aceder à causa do óbito.

DISCUSSÃO

Neste estudo retrospetivo sugere-se que, em doentes com menos de 70 anos e válvulas aórticas não-estenóticas, os parâmetros hemodinâmicos, a taxa de reoperação e a sobrevida a médio-prazo são semelhantes entre indivíduos submetidos a plastia da válvula aórtica ou a substituição valvular aórtica por prótese mecânica.

Nas últimas décadas, as técnicas de plastia da válvula e intervenção na raíz da aorta com preservação da válvula emergiram como alternativas válidas à substituição valvular mecânica em doentes selecionados com insuficiência aórtica e/ou patologia da raíz/aorta ascendente.[3,9,14,16,17] Ainda que a aplicação destas técnicas de reparação se acompanhe de benefícios óbvios, não é totalmente isenta de desvantagens. Entre estas destacam-se o maior risco de reintervenção na válvula aórtica, a necessidade de uma seleção meticulosa dos doentes e de uma maior preparação técnica da equipa cirúrgica, em comparação com a substituição valvular aórtica.[9,13,15-18]

Os indivíduos submetidos a técnicas de plastia da válvula aórtica, no nosso centro hospitalar, correspondem a uma amostra mais jovem em comparação com os indivíduos submetidos a substituição por prótese mecânica, facto que vai ao encontro da literatura já existente, tendo em conta que são os doentes jovens que frequentemente optam por preferir estas técnicas com o intuito de evitar a "doença protésica", i.e., a hipocoagulação sistémica permanente e os seus potenciais efeitos adversos ou limitações introduzidas no quotidiano.[3,6,10,15,16] São também estes doentes que constituem os melhores candidatos a plastia da válvula aórtica, por apresentarem menor número de comorbilidades, melhor condição física e válvulas menos degeneradas.[1,8,9] De facto, no grupo SVAo, os doentes apresentavam classes

funcionais de NYHA mais elevadas, maior número de cirurgias cardíacas prévias, e maior prevalência de etiologia reumática e de EI, refletindo, portanto, um status clínico mais comórbido e menos favorável à realização de plastia. Devemos salientar, contudo, que os indivíduos com válvulas aórticas reumáticas são, à partida, maus candidatos a plastia, o que poderá ter contribuído para acentuar esta diferença entre os dois grupos.[2,8,18]

Vários estudos têm apontado o ecocardiograma como o melhor método de triagem dos doentes candidatos a plastia da válvula e/ou cirurgia da raíz/aorta ascendente com preservação da válvula.[1,3,7,11,16] Tendo em conta este facto, acedeu-se aos parâmetros hemodinâmicos avaliados pelo ETT pré-operatório de todos os indivíduos. Verificou-se que o grupo SVAo apresentava uma prevalência ligeiramente superior de insuficiência aórtica grave, o que poderá refletir uma tendência deste centro para se intervir em estadios mais iniciais da insuficiência aórtica quando se recorre às técnicas de plastia. Não se verificaram diferenças relativamente a outros parâmetros hemodinâmicos pré-operatórios, o que revela, por um lado, a comparabilidade dos grupos relativamente aos dados da ecocardiografia, e por outro comprova a seleção criteriosa dos doentes submetidos a RVAo, no nosso centro hospitalar.

Subramian e Borger[16], Kearney *et al.*[15], Carr e Savage[8] relataram a necessidade de maiores tempos de CEC e de clampagem aórtica nas cirurgias de reparação da válvula aórtica comparativamente à substituição por prótese. O nosso estudo mostrou que estas duas variáveis foram tendencialmente inferiores no grupo RVAo, provavelmente pelo menor número de intervenções concomitantes neste grupo. Também foram equiparáveis a ausência de insuficiência aórtica significativa e semelhante a regressão de massa do ventrículo esquerdo, no ETT de *follow-up*, comprovando a excelente performance hemodinâmica da plastia, já descrita.[2,5]

Têm sido descritas na literatura taxas de sobrevida livre de reoperação da válvula aórtica, nos doentes com insuficiência aórtica submetidos a plastia valvular, de 86-91% aos 3 anos[13,16], de 74-100% aos 5 anos[5,8,13,16], de 83-91% aos 8 anos[5,13], de 51-100% aos 10 anos[2,8,13,16], e de 95% aos 18 anos.[10] A taxa de sobrevida livre de reoperação da válvula aórtica aos 7 anos no nosso estudo foi de 98% no grupo SVAo, e de 94% no grupo RVAo, não se tendo registado diferenças estatisticamente significativas em nenhuma das análises estatísticas realizadas. Os motivos de reoperação neste grupo foram semelhantes aos já descritos na literatura para este tipo de procedimento, nomeadamente EI da válvula aórtica (ainda que rara)[2,7,5] e insuficiência aórtica por falência da reparação valvular, tal como descrito por Minakata *et al.,*[6] por David,[10] por le Polain de Waroux *et al.*[7] e por Komiya.[13] Pese embora a maior durabilidade das próteses mecânicas e de, através das curvas de Kaplan-Meier, parecer haver um ponto temporal a partir do qual o risco de ser reintervencionado é superior para a plastia da válvula aórtica, estes resultados sugerem uma durabilidade satisfatória e uma necessidade de reoperação após reparação equiparáveis às da substituição por prótese mecânica. De facto, já Haydock e Haydock[19], referiam que a plastia da válvula aórtica poderá ser "extremamente duradoura" se bem selecionados os candidatos. Todavia, são necessários mais estudos e tempos de seguimento mais longos para que possamos afirmá-lo com maior segurança.

Quanto à análise da sobrevida a médio prazo, estão descritas taxas de sobrevida associadas à plastia da válvula aórtica de 93-96% aos 3 anos[6,13], 91-95% aos 5 anos[5,6,16], 85-88% aos 8 anos[5,13,16], 80-95% aos 10 anos[13,16] e de 77% aos 18 anos[10]. A taxa de sobrevida aos 7 anos dos indivíduos da nossa corte foi de 96%, sugerindo que a sobrevida a médio prazo não é influenciada pelo tipo de intervenção cirúrgica efetuada sobre a válvula aórtica, e, portanto, que a plastia valvular é capaz de atingir resultados a médio prazo sobreponíveis aos da substituição valvular mecânica.

Realçamos que poderão estar a contribuir para uma implementação mais lenta e menos aceite das técnicas de plastia da válvula aórtica comparativamente à plastia da válvula mitral os seguintes fatores: (i) o facto da anatomia desta válvula ser mais complexa e tecnicamente mais exigente que a da mitral; (ii) a substituição valvular mecânica aórtica ser considerada uma opção segura, eficaz e facilmente executada; (iii) a história natural da doença aórtica não se encontrar tão bem compreendida como a da mitral; (iv) o facto de ser mais fácil estabilizar o anel aórtico com substituição que com reparação, e ainda (v) o facto de não existirem técnicas de reparação tão protocoladas como para a mitral.[6,13,16]

LIMITAÇÕES

O nosso estudo apresenta algumas limitações, nomeadamente:

i) Estudo de coorte retrospetivo, limitado a um único centro hospitalar, condicionando a validade externa dos resultados;
ii) O tamanho amostral relativamente pequeno limita o poder dos testes estatísticos utilizados aumentando a probabilidade de erros tipo II;
iii) Ausência de alguns dados nos processos clínicos e impossibilidade de determinação de causas de morte para todos os indivíduos;
iv) A falta de informação sobre qualidade de vida;
v) A presença de indivíduos mais velhos e com mais comorbilidades no grupo SVAo, outros fatores de confundimento não identificados ou variáveis não medidas determinam o viés de seleção inerente a este tipo de estudos e condicionam a validade interna dos resultados;
vi) A incidência de eventos tromboembólicos ou hemorrágicos a médio prazo não foi estudada. Estes outcomes poderiam permitir comprovar que a plastia da válvula aórtica apresenta um perfil de maior segurança comparativamente à substituição valvular mecânica.
vii) Tempo de *follow-up* relativamente curto considerando a esperança de vida dos doentes incluídos.

CONCLUSÃO

Neste estudo unicêntrico, a plastia valvular aórtica parece ser uma alternativa segura e efetiva, mostrando resultados similares à substituição por prótese mecânica. Deve ser reforçada a necessidade de selecionar criteriosamente os doentes para estas técnicas cirúrgicas complexas (recorrendo ao ecocardiograma pré e intra-operatório, a uma caracterização aprofundada do estado clínico do doente e à avaliação visual da válvula pelo cirurgião) e de apostar no treino especializado da equipa cirúrgica. Salienta-se, contudo, a necessidade de mais estudos nesta área para que se possam desenvolver recomendações mais fidedignas sobre este tema.

REFERÊNCIAS

1. Baumgartner H, Falk V, Bax JJ, De Bonis M, Hamm C, Holm PJ, Iung B, Lancellotti P, Lansac E, Muñoz DR, Rosenhek R, Windecker S, Zamorano JL. 2017 ESC/EACTS Guidelines for the management of valvular heart disease. European Heart Journal. doi:10.1016/j.rec.2017.12.013.
2. Boodhwani M, El Khoury G. Aortic valve repair: indications and outcomes. Current cardiology reports. doi: 10.1007/s11886-014-0490-7
3. Augoustides JG, Szeto WY, Bavaria JE. Advances in aortic valve repair: focus on functional approach, clinical outcomes, and central role of echocardiography. Journal of cardiothoracic and vascular anesthesia. doi: 10.1053/j.jvca.2010.08.007
4. Bajona P, Suri RM, Greason KL, Schaff HV. Outcomes of surgical aortic valve replacement: the benchmark for percutaneous therapies. Progress in cardiovascular diseases. 2014 May 1;56(6):619-24. doi: 10.1016/j.pcad.2014.02.004
5. Boodhwani M, de Kerchove L, Glineur D, Poncelet A, Rubay J, Astarci P, Verhelst R, Noirhomme P, El Khoury G. Repair-oriented classification of aortic insufficiency: impact on surgical techniques and clinical outcomes. The Journal of thoracic and cardiovascular surgery. doi: 10.1016/j.jtcvs.2008.08.054.
6. Minakata K, Schaff HV, Zehr KJ, Dearani JA, Daly RC, Orszulak TA, Puga FJ, Danielson GK. Is repair of aortic valve regurgitation a safe alternative to valve replacement? The Journal of Thoracic and Cardiovascular Surgery. doi: 10.1016/j.jtcvs.2003.09.018
7. le Polain de Waroux JB, Pouleur AC, Robert A, Pasquet A, Gerber BL, Noirhomme P, El Khoury G, Vanoverschelde JL. Mechanisms of recurrent aortic regurgitation after aortic valve repair: predictive value of intraoperative transesophageal echocardiography. JACC: Cardiovascular Imaging. doi: 10.1016/j.jcmg.2009.04.013
8. Carr JA, Savage EB. Aortic valve repair for aortic insufficiency in adults: a contemporary review and comparison with replacement techniques. European journal of cardio-thoracic surgery. doi:10.1016/j.ejcts.2003.09.018
9. Prodromo J, D'Ancona G, Amaducci A, Pilato M. Aortic valve repair for aortic insufficiency: A review. Journal of cardiothoracic and vascular anesthesia. doi: 10.1053/j.jvca.2011.07.014
10. David TE. Current Readings: Aortic Valve–Sparing Operations. In Seminars in thoracic and cardiovascular surgery 2014 Sep 1 (Vol. 26, No. 3, pp. 231-238). WB Saunders. doi: https://doi.org/10.1053/j.semtcvs.2014.10.002
11. Lancellotti P, Tribouilloy C, Hagendorff A, Moura L, Popescu BA, Agricola E, Monin JL, Pierard LA, Badano L, Zamorano JL, European Association of Echocardiography. European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 1: aortic and pulmonary regurgitation (native valve disease). European Journal of Echocardiography. doi: 10.1093/ejechocard/jeq030
12. David TE. Aortic valve repair and aortic valve-sparing operations. The Journal of thoracic and cardiovascular surgery. doi: 10.1016/j.jtcvs.2014.11.019
13. Komiya T. Aortic valve repair update. General thoracic and cardiovascular surgery. doi: 10.1007/s11748-015-0523-1
14. Aicher D, Holz A, Feldner S, Köllner V, Schäfers HJ. Quality of life after aortic valve surgery: replacement versus reconstruction. The Journal of thoracic and cardiovascular surgery. doi: 10.1016/j.jtcvs.2011.02.006
15. Kearney K, Croce B, Harris R. Aortic valve repair. Annals of cardiothoracic surgery. doi: 10.3978/j.issn.2225--319X.2013.01.01
16. Subramanian S, Borger MA. Aortic valve reconstruction: current status. Herz. doi: 10.1007/s00059-010-3325-3
17. Aicher D, Schäfers HJ. Aortic valve repair—current status, indications, and outcomes. In Seminars in thoracic and cardiovascular surgery 2012 Sep 1 (Vol. 24, No. 3, pp. 195-201). WB Saunders. doi: 10.1053/j.semtcvs.2012.08.003
18. Antunes MJ. Aortic valve repair: still a dream?. European Journal of Cardio-Thoracic Surgery. doi: https://doi.org/10.1016/S1010-7940(96)01104-9
19. Haydock MD, Haydock DA. Aortic valve repair: 49 year follow-up. Heart, Lung and Circulation. doi: 10.1016/j.hlc.2012.12.001

ORIGINAL ARTICLE **CARDIAC SURGERY**

PATIENT PROSTHESIS MISMATCH IN STENTED BIOLOGIC AORTIC VALVE PROSTHESIS: 10 YEARS' RESULTS.

Márcio Madeira, Sara Ranchordás, Paulo Oliveira, Tiago Nolasco, Marta Marques, Miguel Sousa-Uva, Miguel Abecasis, José Neves

Cardiothoracic surgery, Hospital de Santa Cruz - Centro Hospitalar de Lisboa Ocidental, Carnaxide, Portugal

***Contacto Autor**: madeira.marcio@gmail.com

Abstract

Objectives: The goal of this study is to establish the relation between aortic bio prosthesis, patient prosthesis mismatch (PPM) and short-term mortality and morbidity as well as and long-term mortality.

Methods: This is a single center retrospective study with 812 patients that underwent isolated stented biologic aortic valve replacement between 2007 and 2016. The projected indexed orifice area was calculated using the in vivo previously published values. Outcomes were evaluated with the indexed effective orifice area (iEOA) as a continuous variable and/or nominal variable. Multivariable models were developed including clinically relevant co-variates.

Results: In the study population 65.9% (n=535) had no PPM, 32.6% (n=265) had moderate PPM and 1.5% (n=12) severe PPM. PPM was related with diabetes (OR:1.738, CI95:1.333-2.266; p<0.001), heart failure (OR:0.387, CI95:0.155-0.969; p=0.043) and older age (OR:1.494, CI95:1.171-1.907; p=0.001). iEOA was not an independent predictor of in-hospital mortality (OR 1.169, CI 0.039-35.441) or MACCE (OR 2.753, CI 0.287-26.453).

Long term survival is significantly inferior with lower iEOA (HR 0.116, CI 0.041-0.332) and any degree of PPM decreases survival when compared with no PPM (Moderate: HR 1.542, CI 1.174-2.025; Severe HR 4.627, CI 2.083-10.276).

Conclusions: PPM appears to have no impact on short-term outcomes including mortality and morbidity. At ten years follow-up, moderate or severe PPM significantly reduces the long-term survival.

INTRODUCTION

Patient prosthesis mismatch (PPM) was initially described in 1978 by Rahimtoola as "the effective orifice valve area, after insertion into the patient, is less than a normal human valve".[1] Later it was defined by Pibarot et al. for the aortic valve as an indexed effective orifice area (iEOA) ≤0,85cm²/m², being moderate for values between 0.65-0.85 and severe when <0.65.[2]

The definition used the iEOA that is measured after surgery, however it is clinically relevant to predict the EOA before surgery. Each prosthetic valve has a projected EOA derived from *in vivo* measurements and the internal geometric orifice area (GOA) that are published by the prosthesis manufactures.[2] The three values are significant predictors of PPM but the discriminative power for severe mismatch is lower with GOA and higher to EOA.[3]

A higher severity of PPM is associated with increased long-term and operative mortalities and neurologic complications.[4] Conflicting results have been published as some studies showing no impact on long term mortality or only in subgroups.[5] A recent STS database analysis demonstrated a longterm impact on survival [6]. Some surgical strategies, such as aortic root enlargement and stentless bioprosthesis, can be used to avoid PPM. Transcatheter valve implantation (TAVI) was associated with less PPM than surgical aortic valve replacement in the initial trials.[5]

The goal of this study is to establish the relation between aortic bioprosthesis PPM and short-term mortality and morbidity as well as long-term mortality.

MATERIALS AND METHODS

Patients

Our internal database was retrospectively analyzed to identify all consecutive patients submitted to isolated aortic valve replacement (AVR). The initial population included 1496 patients. Patients were excluded if there was a mechanical prosthesis implanted (n=470), sutureless or stentless prosthesis (n=38), valve size larger or equal to 25 (n=68), reoperations (n=71), emergent procedures (n=6) or active endocarditis (n=31). These exclusion criteria were selected a priori because they could contribute to biased results. Therefore, the study population consisted

of 812 patients that underwent isolated stented biologic aortic valve replacement between 2007 and 2016.

Surgical technique

Surgery was done under standard cardiopulmonary bypass (CPB) and cardioplegic arrest using cold blood cardioplegia. Bioprosthesis were implanted in either a supra annular or annular position, using interrupted polyester sutures with or without pledgets according to the surgeon's choice. Postoperative single antiplatelet therapy was prescribed unless there was other indication for vitamin K antagonists or double antiplatelet therapy.

Outcomes and variable definition

Early post-operative outcomes were in-hospital mortality and major adverse cardiac and cerebrovascular events (MACCE). Late post-operative outcome was all-cause mortality.

In-hospital mortality is defined as mortality of any cause before discharge. MACCE is defined as a composite endpoint including at least one of the following in-hospital variables: all-causes mortality, stroke, myocardial infarction, multiple organ failure or cardiac arrest.

Follow-up data was obtained from a national database and represents the all-cause mortality. It was 99.8% complete (2 patients lost to follow-up) with a mean time of 4,5±2.77 years (median 4.19 years, interquartile range 2.17-6.6).

PPM was classified according to the published criteria by Pibarot et al as an iEOA $\leq 0.85 cm^2/m^2$, values between 0.65-0.85 as moderate and <0.65 as severe.[2] The calculations were done using projected indexed EOA, obtained by previous published in vivo measurements for different valve types and sizes (Table 1). The PPM group in this study was defined as iEOA$\leq 0.85 cm^2/m^2$. iEOA was analysed as a continuous variable for all outcomes. Categorized PPM (none, moderate or severe) was studied only for long-term mortality.

Statistical analysis

Categorical variables are presented as number and valid percentage (excluding missing values). Continuous variables are presented as mean±standard deviation or median (interquartile range) depending on the distribution. Kolmogorov-Smirnov test was used to access the normal distribution. Categorical variables were compared using $\chi 2$ test or Fisher exact test (when at least one cell <5). Normal distributed continuous variables were compared with Student's T-test and Levene's test for variance equality assessment. Mann–Whitney U-test was used for independent samples not normally distributed.

Logistic regression analysis was performed to evaluate predictors of in-hospital mortality and MACCE. All covariates included on the model were selected a priori based on clinical relevance and it was not a stepwise method.

Survival was analysed with Kaplan-Meier and log rank test. Cox regression was used to evaluate predictors of long-term mortality. All covariates included in the model were selected a priori based on clinical relevance and it was not a stepwise method. Covariates include: age, gender, diabetes, smoking, NYHA, heart failure, history of stroke, other neurologic disability, extra-cardiac arteriopathy, haemodialysis, pulmonary disease, hepatic disease, gastrointestinal disease, sinus rhythm, urgent procedure and aortic regurgitation.

A p value <0.05 was considered significant. Statistical analysis was done with IBM SPSS Statistics for Windows, Version 22.0 Armonk, NY: IBM Corp.

RESULTS

PPM incidence and predictors

In the study population 65.9% (n=535) of patients had no PPM, 32.6% (n=265) had moderate PPM and 1.5% (n=12) severe PPM. Due to the small number of cases of severe PPM, and small number of events except for the long-term survival, no further separated evaluations were made, so the PPM group consisted of 277 (34.1%) patients and the control group of 535 (65.9%) patients.

The most relevant pre-operative and operative data are reported in table 2. Both groups were similar, except that female gender, diabetes, older age and higher body surface area (BSA) were more prevalent in the PPM group.

The most frequent prosthesis size implanted was 21 mm (47.4%), then 23 mm (31.2%) and finally 19 mm

Table 1 **Projected effective area by brand and prosthesis size**

Valve prosthesis	19	21	23	Reference
Mitroflow and Crown (Sorin Group, Milan, Italy)	1.2	1.5	1.8	[22]
Perimount Magna (Edwards Lifesciences, Irvine, CA)	1.58	1.9	2.07	[23]
Epic (St. Jude Medical, Minnesota, USA)	1.44	1.57	1.69	[24]
Trifecta (St. Jude Medical, Minnesota, USA)	1.4	1.6	1.8	[25]
Mosaic (Medtronic, Minneapolis, MN)	1.2	1.3	1.5	[26]
Hancock II (Medtronic, Minneapolis, MN)		1.48	1.83	[27]

Table 2 **Population baseline characteristics**

Variables	Overall n=812, n (%)	No PPM n=535, n (%)	PPM n=277, n (%)	p-value*
Female gender	477 (58.7)	300 (56.1)	177 (63.9)	0.032
Age, (IQR)	76 (72-80)	76 (71-80)	77 (73-80)	0.02
Active smokers	118 (14,6)	85 (16)	33 (12)	0.12
BSA kg/m², mean±SD	1.79±0.19	1.75±0.19	1.85±0.17	<0.001
NYHA class III-IV	173 (21.5)	107 (20.2)	66 (23.9)	0.222
LVEF less than 50%	101 (13.8)	68 (14,1)	33 (13)	0.683
Heart failure	26 (3.3)	20 (3,9)	6 (2.2)	0.22
Non-Sinus rhythm	96 (11.9)	71 (13.4)	25 (9.1)	0.071
Urgent procedure	43 (5.4)	29 (5.5)	14 (5.2)	0.865
Extracardiac arteriopathy	59 (7.7)	35 (6.5)	24 (8.7)	0.269
History of stroke	62 (7.6)	40 (7.5)	22 (8)	0.83
Pulmonary disease	85 (10.5)	54 (10.2)	31 (11.2)	0.647
Gastrointestinal disease	60 (7.4)	44 (8.3)	16 (5.8)	0.119
Hepatic disease	2 (0.2)	1 (0.2)	1 (0.4)	0.647
Hemodialysis	19 (2.4)	15 (2.8)	4 (1.5)	0.224
Aortic regurgitation moderate or severe	87 (10.9)	56 (10.7)	31 (11.3)	0.78
EuroSCORE II, median (IQR)	1.41 (0.98-2.52)	1.4 (0.97-2.52)	1.42 (0.997-2.52)	0.683
CPB time (min), median (IQR)	81 (72-95)	80 (72-95)	84 (72-96)	0.147
Aortic cross-clamping time (min), median (IQR)	60 (51-71)	60 (51-72)	60 (50.5-71)	0.473

BSA – body surface area; CPB – Cardiopulmonary bypass; IQR - interquartile range; LVEF – Left ventricle ejection fraction
*Comparation between No PPM and PPM groups.

(21.4%). PPM is significantly more prevalent in smaller valvular sizes ((p<0.001), 66.7% (n=116) in 19 mm) than in larger sizes (15.4% (n=39) in 23 mm).

On our multivariable model PPM was related with diabetes (OR:1.738, CI95:1.333-2.266; p<0.001), non-heart failure (OR:0.387, CI95:0.155-0.969; p=0.043) and older age (OR:1.494, CI95:1.171-1.907; p=0.001).

Early post-operative Outcomes

Overall in-hospital mortality was 3.1% (n=25), 1.4% in the PPM group and 3.9% in the non PPM group, statistically non-significant (p=0,055) on univariable analysis. On multivariable analysis, extra cardiac arteriopathy was an independent predictor of in-hospital mortality (OR 3.49 CI 1.02-11.91) and iEOA was not (Table 3).

Overall MACCE was 7.2% (n=54), 5.7% in the PPM group and 8% in the non PPM group with non-significant difference (p=0.247) on univariable analysis. On multivariable analysis pulmonary disease (OR 2.533 CI 1.104-5.811) and haemodialysis (OR 4.324 CI 1.008-18.555) were MACCE's independent predictors. iEOA was not a MACCE independent predictor (Table 4).

Late outcome

Survival decreases with the severity of the operative PPM over a ten year follow-up period (p<0.001). The curves separated at two years and thereafter the difference increases (Figure 1). When PPM is classified under three categories,

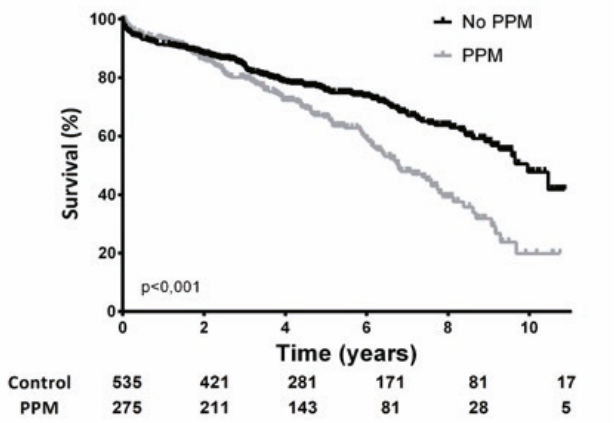


Figure 1 *Prevalence of patient prosthesis mismatch by prosthesis number.*

Table 3 **In-hospital mortality predictors**

Variable	Odds ratio (95% CI)	p-value
Age (years/10)	2.387 (0.981-5.808)	0.055
Females	0.792 (0.313-2.006)	0.623
Diabetes	0.322 (0.084-1.235)	0.099
NYHA III/IV	0.851 (0.261-2.78)	0.79
History of Stroke	3.011 (0.753-12.04)	0.119
Extracardiac arteriopathy	3.490 (1.023-11.905)	0.046
Haemodialysis	3.385 (0.345-33.238)	0.296
Pulmonary disease	1.657 (0.434-6.316)	0.46
Gastrointestinal disease	0.469 (0.056-3.890)	0.483
Non-sinus rhythm	0.983 (0.278-3.469)	0.979
Urgent	2.037 (0.399-10.413)	0.393
Aortic regurgitation (mod-sev)	0.471 (0.06-3.71)	0.475
iEOA (cm^2/m^2)	1.169 (0.039-35.441)	0.929

iEOA – Indexed effective orifice area

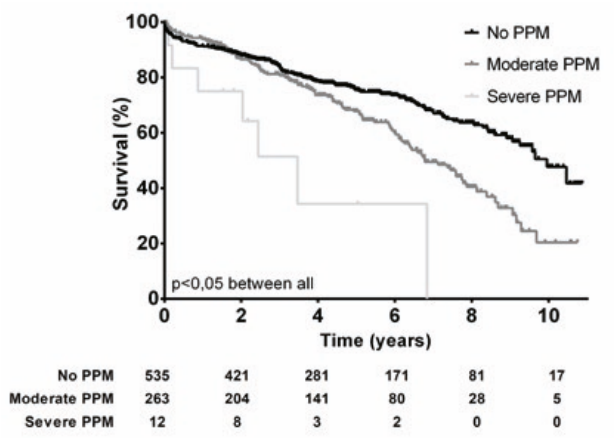


Figure 2 *Survival by the presence of patient prosthesis mismatch.*

survival is significantly different between the three degrees, being inferior in severe PPM (Figure 2). On univariable analysis, survival is significantly lower on patients with 19 mm prosthesis compared with 23mm (p=0.015).

On multivariable analysis, the risk of death increases with the reduction of the iEOA (HR 0.116, CI 0.041-0.332) as a continuous variable. The independent predictors of death were: older age, diabetes, pulmonary disease, hepatic disease and non-sinus rhythm (Table 5).

Moderate or severe PPM raises the risk of death by 60% (HR 1.608, CI 1.230-2.102). Dividing in the three classes, moderate PPM against no PPM raises the risk of death by 54.2% (HR 1.542, CI 1,174-2.025; p=0.002) and severe PPM leads to a 4.627 fold increase of risk (HR 4.627, CI 2.083-10.276; p<0.001). The other long-term mortality independent predictor remains the same in all models.

DISCUSSION

This single center study reached two main findings. Firstly, PPM moderate or severe has no correlation with in-hospital mortality or MACCE after biological AVR. Secondly, survival decreases with lower iEOA for any degree of PPM.

One meta-analysis reported female gender, older age, hypertension, NYHA class III or more and diabetes as the main predictors of moderate or severe PPM.[4] Our study reached similar results, as diabetes, non-heart failure and older age are predictors of moderate or severe PPM.

Literature has contradictory conclusions regarding the relation between in-hospital mortality and PPM on aortic biological AVR. Several studies only on aortic bioprosthesis showed no association between PPM and in-hospital mortality[7-10] or only such a relation in patients less than 70 years.[11] Other studies, with biological and mechanical prosthesis, have found an increase in-hospital mortality[12-14] One meta-analysis has shown a 50% increase in 30 days mortality for any degree of PPM.[4] Our study found no relation between PPM and in-hospital mortality or the composite endpoint of mortality and morbidity.

Long-term survival is reported in literature with conflicting results. Some studies have found an increased long-term mortality related to PPM[14,15], other failed to find impact on long-term mortality.[8,10,13] Bleiziffer *et al.* analysed iEOA as a continuous variable and found a significant impact on cardiac mortality that was not significant when

Table 4 **MACCE predictors**

Variable	Odds ratio (95% CI)	p-value
Age (years/10)	1.43 (0.849-2.409)	0.178
Females	0.791 (0.415-1.507)	0.476
Diabetes	0.712 (0.353-1.438)	0.343
Smoker	0.687 (0.257-1.84)	0.455
NYHA III/IV	0.677 (0.295-1.557)	0.359
Heart failure	1.184 (0.233-6.021)	0.839
History of Stroke	1.714 (0.653-4.502)	0.274
Extracardiac arteriopathy	2.095 (0.841-5.217)	0.112
Haemodialysis	4.324 (1.008-18.555)	0.049
Pulmonary disease	2.533 (1.104-5.811)	0.028
Gastrointestinal disease	0.368 (0.083-1.632)	0.189
Non-Sinus rhythm	0.992 (0.424-2.323)	0.986
Urgent	1.061 (0.287-3.929)	0.929
Aortic regurgitation (mod-sev)	0.276 (0.064-1.198)	0.086
iEOA (cm^2/m^2)	2.753 (0.287-26.453)	0.38

iEOA – Indexed effective orifice area

Table 5 **Long term mortality predictors**

Variable	Hazard ratio (95% CI)	p-value
Age (years/10)	1.99 (1.53-2.588)	<0.001
Females	0.955 (0.718-1.268)	0.748
Diabetes	1.428 (1.082-1.885)	0.012
Smoker	1.218 (0.808-1.837)	0.347
NYHA III/IV	1.048 (0.76-1.446)	0.775
Heart failure	1.441 (0.809-2.566)	0.214
History of Stroke	0.865 (0.513-1.457)	0.585
Extracardiac arteriopathy	1.253 (0.832-1.888)	0.28
Haemodialysis	1.667 (0.655-4.24)	0.284
Pulmonary disease	1.746 (1.208-2.522)	0.003
Hepatic disease	14.742 (3.493-62.216)	<0.001
Gastrointestinal disease	0.936 (0.588-1.492)	0.782
Non-Sinus rhythm	1.567 (1.114-2.204)	0.01
Urgent	1.441 (0.858-2.418)	0.167
Aortic regurgitation (mod-sev)	0.988 (0.673-1.449)	0.949
iEOA (cm^2/m^2)	0.116 (0.041-0.332)	<0.001

iEOA – Indexed effective orifice area

iEOA was dichotomized.[16] A recently published STS database based study reported an 8% higher risk of late death in moderate PPM and 32% in severe PPM.[6] Three meta-analyses reported an increased risk with any degree of PPM but not when moderate PPM is compared with no PPM.[4,17,18] One meta-analysis demonstrated a decreased survival in moderate and severe PPM.[19]

In our study, we chose to include only isolated AVR with biological prosthesis to eliminate the possible bias related to concomitant procedures, especially coronary surgery. Mechanical prosthesis implantation is reducing year by year, and as percutaneous biological options are increasing, so we decided to study specifically biological valves. Our main result, namely, the increased risk of late mortality with any degree of PPM is different from some of the previous published meta-analysis and is in concordance with the STS database study.[6]

These findings can have direct clinical implications, as the risk of PPM can be predicted using iEOA. The surgeon can evaluate several options to reduce that risk, which may include: new generation prosthesis, careful consideration of aortic root enlargement[20] and TAVI.[21]

Limitations

Due to the retrospective nature of the study, there are several confounders that can bias the results. An effort to minimize this was made by using several clinical relevant variables in the multivariable analysis. However, we are aware that some confounders are very difficult to measure and were not recorded, such as frailty and other subjective characteristics that can influence surgeon decisions, short and long-term outcomes.

Due to the small number of events regarding in-hospital mortality and MACCE, we decided not to do group analysis and iEOA was only evaluated as a continuous variable. These results need to be interpreted with caution.

We used the projected iEOA that is derived from previous published in vivo measurements. These values have a greater discriminative power than the geometrical orifice area, but the best value is the iEOA measured by echocardiogram after surgery.[3] However, these measurements are useless at the time of surgery when choices need to be made and the surgeon needs a way to predict the result. Therefore, we decided to use projected iEOA because it is the most important value for the surgeons.

Another limitation is the lack of echocardiographic follow up studies with late iEOA and left ventricle mass regression assessment that could provide potential mechanisms for the observed correlation between PPM and decreased long-term survival.

CONCLUSIONS

In conclusion, we found that PPM appears to have no impact on short-term outcomes including mortality and morbidity. In a ten-year follow-up, however moderate or severe PPM significantly reduces the long-term survival. Therefore, every effort should be made to reduce the incidence of any degree of PPM.

Acknowledgement

We want to acknowledge Luis Baptista, Helena Brandão, Sofia Marque, Ana Cortes and Nuno Varela by their contribution in building and maintain the internal database.

REFERENCES

1. Rahimtoola SH. The problem of valve prosthesis-patient mismatch. Circulation 1978;58:20-4.
2. Pibarot P, Dumesnil JG. Prosthesis-patient mismatch: definition, clinical impact, and prevention. Heart (British Cardiac Society) 2006;92:1022-9.
3. Florath I, Albert A, Rosendahl U, Ennker IC, Ennker J. Impact of valve prosthesis-patient mismatch estimated by echocardiographic-determined effective orifice area on long-term outcome after aortic valve replacement. American Heart Journal 2008;155:1135-42.
4. Dayan V, Vignolo G, Soca G, Paganini JJ, Brusich D, Pibarot P. Predictors and Outcomes of Prosthesis-Patient Mismatch After Aortic Valve Replacement. JACC Cardiovascular imaging 2016;9:924-33.
5. Morita S. Aortic valve replacement and prosthesis-patient mismatch in the era of trans-catheter aortic valve implantation. General Thoracic and Cardiovascular Surgery 2016;64:435-40.
6. Fallon JM, DeSimone JP, Brennan JM, O'Brien S, Thibault DP, DiScipio AW et al. The Incidence and Consequence of Prosthesis-Patient Mismatch After Surgical Aortic Valve Replacement. Ann Thorac Surg 2018;106:14-22.
7. Astudillo LM, Santana O, Urbandt PA, Benjo AM, Elkayam LU, Nascimento FO et al. Clinical predictors of prosthesis-patient mismatch after aortic valve replacement for aortic stenosis. Clinics 2012;67:55-60.
8. Chacko SJ, Ansari AH, McCarthy PM, Malaisrie SC, Andrei AC, Li Z et al. Prosthesis-patient mismatch in bovine pericardial aortic valves: evaluation using 3 different modalities and associated medium-term outcomes. Circulation Cardiovascular imaging 2013;6:776-83.
9. Hoffmann G, Ogbamicael SA, Jochens A, Frank D, Lutter G, Cremer J et al. Impact of patient-prosthesis mismatch following aortic valve replacement on short-term survival: a retrospective single center analysis of 632 consecutive patients with isolated stented biological aortic valve replacement. The Thoracic and cardiovascular surgeon 2014;62:469-74.
10. Pibarot P, Dumesnil JG, Lemieux M, Cartier P, Metras J, Durand LG. Impact of prosthesis-patient mismatch on hemodynamic and symptomatic status, morbidity and mortality after aortic valve replacement with a bioprosthetic heart valve. The Journal of heart valve disease 1998;7:211-8.
11. Moon MR, Lawton JS, Moazami N, Munfakh NA, Pasque MK, Damiano RJ, Jr. POINT: Prosthesis-patient mismatch does not

affect survival for patients greater than 70 years of age undergoing bioprosthetic aortic valve replacement. J Thorac Cardiovasc Surg 2009;137:278-83.
12. Blais C, Dumesnil JG, Baillot R, Simard S, Doyle D, Pibarot P. Impact of Valve Prosthesis-Patient Mismatch on Short--Term Mortality After Aortic Valve Replacement. Circulation 2003;108:983-88.
13. Koene BM, Soliman Hamad MA, Bouma W, Mariani MA, Peels KC, van Dantzig JM et al. Impact of prosthesis-patient mismatch on early and late mortality after aortic valve replacement. Journal of cardiothoracic surgery 2013;8:96.
14. Walther T, Rastan A, Falk V, Lehmann S, Garbade J, Funkat AK et al. Patient prosthesis mismatch affects short- and long-term outcomes after aortic valve replacement. European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery 2006;30:15-9.
15. Jamieson WR, Ye J, Higgins J, Cheung A, Fradet GJ, Skarsgard P et al. Effect of prosthesis-patient mismatch on long-term survival with aortic valve replacement: assessment to 15 years. Ann Thorac Surg 2010;89:51-8; discussion 59.
16. Bleiziffer S, Ali A, Hettich IM, Akdere D, Laubender RP, Ruzicka D et al. Impact of the indexed effective orifice area on mid--term cardiac-related mortality after aortic valve replacement. Heart (British Cardiac Society) 2010;96:865-71.
17. Chen J, Lin Y, Kang B, Wang Z. Indexed effective orifice area is a significant predictor of higher mid- and long-term mortality rates following aortic valve replacement in patients with prosthesis-patient mismatch. European Journal of Cardio-Thoracic Surgery 2014;45:234-40.
18. Takagi H, Yamamoto H, Iwata K, Goto S-n, Umemoto T. A meta-analysis of effects of prosthesis–patient mismatch after aortic valve replacement on late mortality. International Journal of Cardiology 2012;159:150-54.
19. Head SJ, Mokhles MM, Osnabrugge RLJ, Pibarot P, Mack MJ, Takkenberg JJM et al. The impact of prosthesis–patient mismatch on long-term survival after aortic valve replacement: a systematic review and meta-analysis of 34 observational studies comprising 27 186 patients with 133 141 patient-years. European heart journal 2012;33:1518-29.
20. Kulik A, Al-Saigh M, Chan V, Masters RG, Bédard P, Lam BK et al. Enlargement of the Small Aortic Root During Aortic Valve Replacement: Is There a Benefit? The Annals of Thoracic Surgery 2008;85:94-100.
21. Pibarot P, Weissman NJ, Stewart WJ, Hahn RT, Lindman BR, McAndrew T et al. Incidence and Sequelae of Prosthesis--Patient Mismatch in Transcatheter Versus Surgical Valve Replacement in High-Risk Patients With Severe Aortic Stenosis: A PARTNER Trial Cohort-A Analysis. Journal of the American College of Cardiology 2014;64:1323-34.
22. Ugur M, Suri RM, Daly RC, Dearani JA, Park SJ, Joyce LD et al. Comparison of early hemodynamic performance of 3 aortic valve bioprostheses. J Thorac Cardiovasc Surg 2014;148:1940-6.
23. Dalmau MJ, Mariagonzalez-Santos J, Lopez-Rodriguez J, Bueno M, Arribas A. The Carpentier-Edwards Perimount Magna aortic xenograft: a new design with an improved hemodynamic performance. Interact Cardiovasc Thorac Surg 2006;5:263-7.
24. Maitland A, Hirsch GM, Pascoe EA. Hemodynamic performance of the St. Jude Medical Epic Supra aortic stented valve. The Journal of heart valve disease 2011;20:327-31.
25. Bavaria JE, Desai ND, Cheung A, Petracek MR, Groh MA, Borger MA et al. The St Jude Medical Trifecta aortic pericardial valve: results from a global, multicenter, prospective clinical study. J Thorac Cardiovasc Surg 2014;147:590-7.
26. Fradet GJ, Bleese N, Burgess J, Cartier PC. Mosaic valve international clinical trial: early performance results. Ann Thorac Surg 2001;71:S273-7.
27. Dumesnil JG, Yoganathan AP. Valve prosthesis hemodynamics and the problem of high transprosthetic pressure gradients. European Journal of Cardio-Thoracic Surgery 1992;6:S34-S38.

ORIGINAL ARTICLE **CARDIAC SURGERY**

PREDICTORS OF ACUTE KIDNEY INJURY ASSOCIATED WITH CARDIOPULMONARY BYPASS

Raquel Moreira[1], Tiago Jacinto[1,2], Paulo Neves[3], Luís Vouga[3], Cristina Baeta[1,3]

[1]Health School, Polytechnic Institute of Porto, Porto, Portugal
[2]CINTESIS - Center for Research in Health Technologies and Information Systems, Faculty of Medicine - University of Porto, Porto, Portugal;
[3]Department of Cardiothoracic Surgery, Centro Hospitalar de Vila Nova de Gaia/Espinho, Vila Nova de Gaia, Portugal

***Contacto Autor**: raquel_moreira15@hotmail.com

Abstract

Objectives: To study the incidence of acute kidney injury (AKI) in the postoperative period of cardiac surgery in patients without preoperative renal insufficiency who underwent cardiac surgery with cardiopulmonary bypass (CPB), and to explore the association between the incidence of AKI and predictors related to CPB.

Methods: Observational, cross-sectional study. Participants were divided in two groups, those who developed AKI in the postoperative period and those who did not develop AKI. Kidney Disease: Improving Global Outcomes - Clinical Practice Guideline for Acute Kidney Injury (KDIGO) classification was used to characterize AKI. The analysis included preoperative variables (anthropometric data, cardiovascular risk factors and blood parameters), as well as the type of surgery, intraoperative variables related to CPB, and postoperative creatinine variation. Association between variables was studied with binary logistic regression.

Results: We have included 329 patients, of which 62 (19%), developed AKI. There were statistically significant differences between the groups in age ($p<0.001$; OR (95%)-1.075 (1.037-1.114)), duration of CPB ($p=0.011$; 1.008 (1.002-1.014)), urine output during CPB ($p=0.038$; 0.998 (0.996-0.999)), mannitol and furosemide administration during CPB, (respectively, $p=0.032$; 2.293 (1.075-4.890) and $p=0.013$; 2.535 (1.214-5.296)).

Conclusions: A significant number of patients developed AKI in the postoperative period of cardiac surgery and this incidence was influenced by factors related to CPB, namely: age, duration of CPB, urine output during CPB, mannitol and furosemide administration during CPB.

INTRODUCTION

The incidence of acute kidney injury (AKI) in postoperative period of cardiac surgery varies from 1% up to 30% of the patients.[1-3]

One of the main causes for AKI after cardiac surgery is ischemia secondary to renal hypoperfusion.[4,5] Renal perfusion is autonomously regulated for the maintenance of glomerular filtration rate (GFR) until the mean arterial pressure falls below 80 mmHg. In cardiopulmonary bypass (CPB), whenever mean pressure is below this limit, the risk of developing AKI increases.[5,6] This incidence can also be affected by the type of surgery. Coronary artery bypass grafting (CABG) is associated with a lower occurrence of AKI, followed by valvular replacement surgeries (VRS), and finally the combination of both.[7,8]

The most commonly classifications used to characterize AKI are: RIFLE (Risk, Injury, Failure, Loss of kidney function and End-stage kidney disease), AKIN (Acute Kidney Injury Network), and KDIGO (Kidney Disease: Improving Global Outcomes - Clinical Practice Guideline for Acute Kidney Injury).[2,9] These classifications have different diagnostic criteria for AKI, which may contribute to the variability of results between previous studies. The KDIGO classification has a higher prognostic power when compared to others, since it maintains its prognostic power when hemodynamic variables (e.g.: CPB time) are taken into account.[2]

There are non-modifiable risk factors associated with an increased risk of developing AKI, such as advanced age, female gender, diabetes mellitus, hypertension or pre-operative chronic kidney disease, as well as factors related to CPB such as duration of CPB, aortic cross-clamp time, hypothermia, hemodilution, and reduced urinary output during CPB.[8,10,11]

CPB duration influences the development of AKI.[6,10] The visceral hypoperfusion that it causes reduces oxygen supply and compromises renal function, contributing to ischemia-reperfusion injury.[8] It is a multifactorial aggression to the body, particularly to renal function, and the

longer it is, the bigger the risk of postoperative complications in various organs and systems.

Blood transfusion, due to the transformations that erythrocytes undergo during storage (release of free iron and haemoglobin), may lead to compromise of oxygen transport, increased oxidative stress and leukocytes and coagulation cascade activation, triggering an inflammatory response.[3,5,12]

Hemodilution during CPB is a risk factor for AKI, because although it makes blood more fluid and theoretically improve visceral perfusion[8,11], the risk of AKI may double when the haematocrit during CPB is less than 23% and transfusions are required.[13] According to The Society of Thoracic Surgeons and The Society of Cardiovascular Anaesthesiologists Guidelines, during CPB, haemoglobin should be maintained at least at 7 g/dL.[14]

We aim to evaluate the incidence of AKI in postoperative period of cardiac surgery in patients without preoperative renal insufficiency and who underwent cardiac surgery with CPB, and to determine the association between the incidence of AKI in the postoperative period of cardiac surgery and factors related to CPB.

METHODS

Study Design

Observational, retrospective and cross-sectional study.

For data collection, *SClinic*® database, as well as surgical, CPB and daily records of hospitalization were consulted.

Data was collected between January 2016 and January 2017.

In patients who returned to the operating room during the postoperative period, only records from the second intervention were considered.

Analytical data was collected according to service's blood tests plan, i.e., 1st and 4th postoperative days, and hospital discharge (which may coincide with the 4th day). Blood tests that were not collected on the 4th postoperative day (3rd or 5th day) were considered as the second harvests to be performed at the hospital. In those patients who developed AKI, all blood tests during hospitalization were scrutinized to obtain maximum serum creatinine (SCr) value.

To characterize AKI, the first two criteria of the three of the KDIGO Clinical Practice Guideline for Acute Kidney Injury classification were used[9]:

- Increase in SCr by ≥ 0.3 mg/dl within 48 hours;
- Urine volume < 0.5 ml/kg/h for 6 hours;
- Increase in SCr to ≥ 1.5 times baseline, which is known or presumed to have occurred within the prior 7 days.

The third criterion was not used in this study because it applies to a period of analysis superior to patients' standard time of hospitalization in this service (5 days).

This classification also allows characterizing the degree of severity of AKI, according to the criteria described in Table 1.

Participants selection

Sampling method was non-random.

Inclusion criteria were:

- Patients with age ≥ 18 years undergoing cardiac surgery with CPB at Cardiothoracic Surgery Department of Centro Hospitalar de Vila Nova de Gaia/Espinho (CHVNG/E) from January 1st to December 31th 2015.
- Although KDIGO 2012 G2 stage translates a slight decrease in GFR, it may or may not be associated with renal injury and was considered for inclusion.[15]

Exclusion criteria were:

- Patients with preoperative renal insufficiency identified by KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease, (Table 2);
- Patients who according to KDIGO 2012 classification were in G3 to G5 stages;

Table 1 **Staging of acute kidney injury according to KDIGO classification**

Stage	Serum creatinine	Urine output
1	1.5 – 1.9 times baseline or ≥ 0.3 mg/dl (≥ 26.5 μmol/l) increase	< 0.5 ml/kg/h for 6–12 hours
2	2.0 – 2.9 times baseline	< 0.5 ml/kg/h for ≥ 12 hours
3	3.0 times baseline or Increase in serum creatinine to ≥ 4.0 mg/dl (≥ 353.6 μmol/l) OR Initiation of renal replacement therapy or, in patients < 18 years, decrease in eGFR to < 35 ml/min per 1.73 m^2	< 0.3 ml/kg/h for ≥ 24 hours or Anuria for ≥ 12 hours

Source: Kellum & Lameire, (2012) (9)

Table 2 **Chronic kidney disease stages according to KDIGO 2012 classification.**

GFR category	GFR (mL/min/1.73m²)	Terms
G1	≥ 90	Normal or high
G2	60 - 89	Mildly decreased
G3a	45 - 59	Mildly to moderately decreased
G3b	30 - 44	Moderately to severely decreased
G4	15 - 29	Severely decreased
G5	< 15	Kidney failure

Source: Eknoyan & Lameire, (2013) (15)

- Patients who died at the time of data collection, who underwent re-operation during the study period, who had no blood tests on the first day after surgery, and those submitted to circulatory arrest during CPB.

Preoperative GFR was calculated using Cockcroft--Gault formula (((140- Age) x weight (kg)) / (serum creatinine (mg/dL) x 72)) x 0, 85 (if female).[16]

Participants were divided into two groups, the group that underwent CPB and developed AKI (dAKI) in postoperative period of cardiac surgery and the group that underwent CPB but did not develop AKI (nAKI) in postoperative period.

Ethical issues

Anonymity and confidentiality of the data identifying the participants were guaranteed, respecting Helsinki Declaration (revised in Fortaleza in 2013).

A number was assigned to each case/patient, and a specific database was created for this study, stored on the principal investigator's personal computer, with encrypted access.

Patient's informed consent did not apply as it was an observational and retrospective study based on the collection of data and information routinely recorded in databases/clinical records.

Study protocol was submitted and approved by CHVNG/E Ethics Committee in December 2015.

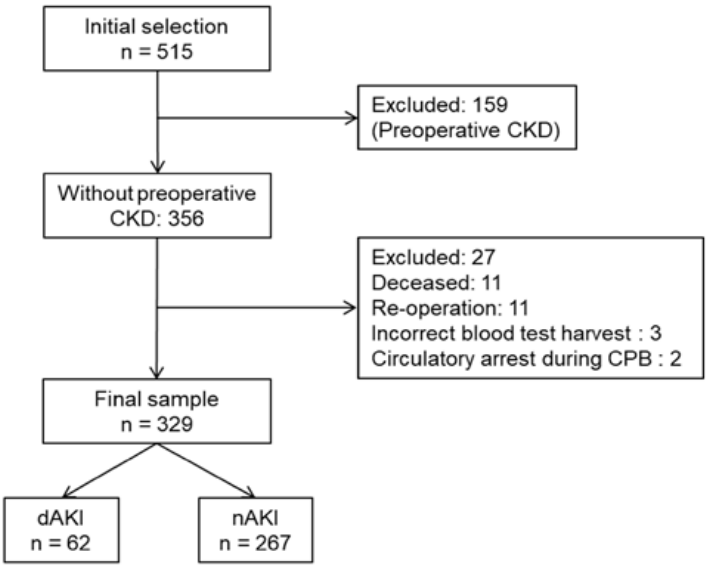
Statistical analysis

Frequencies and proportions for categorical variables, as well as measures of central tendency and dispersion for quantitative variables were used to characterize the sample.

To study the relationship between independent and dependent variables, Binary Logistic Regression was performed. Results were adjusted for some confounders, namely: gender, age, weight, height, body mass index and CPB duration, since these were considered to be variables that could influence the results of the other variables analysed. A significance level of 5% ($p=0.05$) was considered. To analyse the data collected, IBM® SPSS® Statistics (Statistical Package for the Social Sciences) Version 24.0 software was used.

RESULTS

We included patients undergoing cardiac surgery with CPB between January 1st and December 31st 2015 at the CHVNG/E's Cardiothoracic Surgery Department. The final sample consisted of 329 patients of which 62 (18.8%) developed AKI and 267 (81.2%) did not develop (Figure 1).



Footnotes: AKI – acute kidney injury; CPB – cardiopulmonary bypass; dAKI – group that developed AKI; nAKI – group that did not develop AKI.

Figure 1 *Sample selection.*

Table 3 **Sample characterization**

Variables	dAKI (n=62)	nAKI (n=267)	*p*
Age (years)	70.4 (7.7)	64.7 (10.0)	< 0.001
Weight (kg)	79.5 (12.3)	73.8 (12.5)	0.776
Height (m)	1.7 (0.1)	1.6 (0.1)	0.957
BMI (kg/m2)	28.9 (3.8)	27.6 (4.1)	0.950
Sex Female Male	 21 (33.9) 41 (66.1)	 123 (46.1) 144 (53.9)	0.906
Arterial hypertension	43 (69.4)	153 (57.3)	0.592
Dyslipidemia	36 (58.1)	123 (46.1)	0.676
Diabetes	23 (37.1)	64 (24.0)	0.166
Overweight	54 (87.1)	192 (72.0)	0.410
Hb pre-CPB (g/dL)	12.6 (1.8)	14.1 (13.1)	0.527
Ht pre-CPB (%)	38.7 (5.7)	38.9 (5.0)	0.824
Cr pre-CPB (mg/dL)	0.9 (0.2)	0.8 (0.2)	0.275
GFR pre-CPB (ml/min)	84.2 (22.7)	88.8 (22.4)	0.398

Footnotes (1): Categorical variables are described in n (%) and quantitative variables in mean (SD).
Footnotes (2): CPB – cardiopulmonary bypass; Cr – creatinine; dAKI – group that developed AKI; GFR – glomerular filtration rate; Hb – haemoglobin; Ht – haematocrit; nAKI – group that did not develop AKI; SD – standard deviation.

Characteristics of the group that developed AKI (dAKI) and the one that did not develop AKI (nAKI) are described in Table 3. There are statistically significant differences in age between dAKI and nAKI groups, OR (95% CI) = 1.08 (1.03 – 1.11).

Table 4 shows the different types of surgery performed and the proportion of patients who underwent each type of surgery in each group. There were no statistically significant differences between the groups regarding the type of surgery and the subsequent development of AKI.

Table 5 shows the intraoperative variables, and their behaviour in the two groups analysed. There are statistically significant differences in CPB time, urine output during CPB, mannitol and furosemide administration during CPB. CPB time, mannitol and furosemide administration during CPB results translate into a positive association between a longer CPB and the development of AKI, as well as between the administration of these drugs and the development of this pathology. In urine output during CPB, results suggest a negative influence of this variable on the development of AKI. In the remaining variables there were no significant associations between their occurrence and AKI development.

According to the two criteria selected, the patients who developed AKI were categorized in severity stages, 47 patients were classified in stage 1, (36 according to creatinine criterion, 10 by urine output and 1 by both criteria). In stage 2 we have 10 patients, and in stage 3, 5 patients, all by creatinine criterion. Five patients were classified in different stages with the two criteria, but the creatinine value stages them in a higher stage, so this criterion was validated.

Table 6 shows dAKI's creatinine variation during postoperative period. The maximum value recorded shows a 36.8% (in female) and 53.8% (in male) increase in relation to normality's upper limit. In postoperative period, 2 subjects (3.2% of dAKI group) required a dialysis technique (venovenous hemofiltration), being included in stage 3.

DISCUSSION

In this study, the incidence of AKI in the postoperative period was 19%, using KDIGO classification. Age, CPB

Table 4 **Type of surgery and acute kidney injury development**

Type of surgery	n	dAKI (n=62)	nAKI (n=267)	*p*	Odds Ratio (95% CI)
CABG – n (%)	19 (5.8)	3 (4.8)	16 (6.0)	0.599	1.436 (0.372 – 5.544)
VRS – n (%)	224 (68.1)	41 (66.1)	183 (68.5)	0.501	0.799 (0.415 – 1.537)
CABG + VRS – n (%)	45 (13.7)	12 (19.4)	33 (12.4)	0.654	1.197 (0.545 – 2.629)
Others – n (%)	41 (12.5)	6 (9.7)	35 (13.1)	0.916	1.058 (0.372 – 3.011)

Footnotes: CABG - coronary artery bypass grafting; CI – confidence interval; dAKI – group that developed AKI; nAKI – group that did not develop AKI; VRS - valvular replacement surgeries.

Table 5 **Intraoperative variables and acute kidney injury development**

Variables	dAKI (n=62)	nAKI (n=267)	*p*	Odds Ratio (95% CI)
Addition of blood in the priming	2 (3.2)	11 (4.1)	0.529	0.586 (0.111 – 3.088)
CPB time (minutes)	118.8 (92.6)	94.3 (38.2)	0.011	1.008 (1.002 – 1.014)
Aortic cross-clamp time (minutes)	80.1 (44.7)	71.7 (35.0)	0.177	0.991 (0.979 – 1.004)
Urine output during CPB (ml)	255.3 (208.9)	308.5 (284.3)	0.038	0.998 (0.996 – 0.999)
Mean pressure during CPB (mmHg)	68.7 (8.9)	66.2 (7.7)	0.052	1.039 (1.00 – 1.079)
Min BP during CPB (mmHg)	53.4 (9.7)	52.3 (8.4)	0.272	1.020 (0.985 – 1.057)
Min T during CPB (ºC)	37.3 (38.1)	36.1 (30.9)	0.737	1.001 (0.993 – 1.010)
Min Hb during CPB (g/dL)	8.5 (1.5)	8.5 (1.4)	0.520	0.919 (0.711 – 1.188)
Min Htc during CPB (%)	26.0 (4.6)	26.1 (4.1)	0.554	0.975 (0.896 – 1.061)
Blood transfusion during CPB	10 (16.1)	30 (11.2)	0.489	1.357 (0.572 – 3.220)
Cell-saver used	6 (9.7)	10 (3.7)	0.273	2.049 (0.567 – 7.401)
Mannitol administration during CPB	15 (24.2)	28 (10.5)	0.032	2.293 (1.075 – 4.890)
Furosemide administration during CPB	17 (27.4)	36 (13.5)	0.013	2.535 (1.214 – 5.296)

Footnotes (1): Categorical variables are described in n (%) and quantitative variables in mean (SD).
Footnotes (2): BP – blood pressure; CI – confidence interval; CPB – cardiopulmonary bypass; dAKI – group that developed AKI; Hb – haemoglobin; Ht – haematocrit; Min – minimum; nAKI – group that did not develop AKI; SD – standard deviation; T- temperature.

Table 6 **dAKI's creatinine variation during postoperative period.**

Creatinine value (mg/dL)	dAKI			
	Female	Normal range	Male	Normal range
1st postoperative day - *Mean (SD)*	1.2 (0.4)	0.51 – 0.95	1.6 (0.5)	0.67 – 1.17
4th post-operative day - *Mean (SD)*	0.8 (0.3)		1.2 (0.6)	
Maximum during stay - *Mean (SD)*	1.3 (0.7)		1.8 (0.8)	
At the day of discharge - *Mean (SD)*	0.7 (0.2)		1.1 (0.4)	

Footnotes (1): Categorical variables are described in n (%) and quantitative variables in mean (SD).
Footnotes (2): BP – blood pressure; CI – confidence interval; CPB – cardiopulmonary bypass; dAKI – group that developed AKI; Hb – haemoglobin; Ht – haematocrit; Min – minimum; nAKI – group that did not develop AKI; SD – standard deviation; T- temperature.

time, urine output during CPB, mannitol and furosemide administration during CPB were risk factors for AKI development. We also find that CPB had an influence on renal function's evolution in postoperative period of cardiac surgery, and that it may lead to the development of AKI.

The incidence of AKI after CPB is similar to the values described in literature, 26.6% by Schopka *et al.* (2014) (AKIN classification), 19% by Sampaio *et al.* (2013) (KDIGO classification) and 24.3% by Pontes *et al.* (2007) (classification not specified).[1,2,17]

With regard to preoperative characteristics, there were statistically significant differences in age. Age is often referred in literature as an AKI risk factor.[2,6,8] For Sampaio *et al.* (2013) and Rodrigues *et al.* (2009), age was associated with the development of AKI, and, as in this study, the older the subjects were, the bigger the risk of AKI.[2,6] Age is also reported in the literature as an integral part of the pathophysiological process of AKI because elderly patients are more likely to develop variations in their analytical parameters related to renal function, such as creatinine (due to hypovolemia, atherosclerotic disease of the renal arteries, and changes in the renal autoregulation mechanisms), and so may be more prone to develop some degree of renal compromise.[4,5] According to Schopka *et al.*, (2014), Pontes *et al.*, (2007) and Brito *et al.*, (2009), age was not associated with AKI development, which, in Pontes et al. (2007) and Brito *et al.* (2009) studies, may be due to the fact that the mean ages of the groups that developed and didn't develop AKI were lower than those of this study so that creatinine values could also be lower, reflecting a more preserved renal function. The study by Schopka *et al.* (2014) had different methods from this study.[1,17,18]

Regarding the type of surgery to which patients were submitted, literature indicates that CABG is associated with a lower occurrence of AKI, followed by VRS and finally the combination of both[7,8], and that was not observed in this study. In Rodrigues *et al.* (2009) study only valvular surgery was associated with AKI, but its sample was considerably higher than ours.[6]

Regarding CPB related variables, there were statistically significant differences in CPB time, urine output during

CPB, mannitol and furosemide administration during CPB. Several studies have evaluated the influence of CPB time on AKI development, showing that the longer it is, the bigger the risk[6,10,11,18], as found by this study. The longer the CPB the longer the time the organism is exposed to non-pulsatile flow, microembolic aggressions that affect renal capillaries circulation, and to inflammatory response caused by free hemoglobin or by the contact of blood with an artificial surface.[4,5,7,8] These results are in contrast to those of Schopka *et al.*, (2014) and Pontes *et al.*, (2007), who did not find any relationship between the variables in CABG, which may be due to the fact that the study by Schopka *et al*. (2014) had a significantly different methodology from this study, and the mean CPB time in both groups (with and without AKI) in the study by Pontes *et al.* (2007) was significantly lower than that in this study.[1,17]

Concerning urine output during CPB, the results obtained revealed that there are statistically significant differences between the two groups analysed, showing a negative association between this variable and AKI development. That is, the greater the volume of diuresis obtained during CPB the more protected the individual is against AKI development. Literature reports that a low urinary output during CPB is a risk factor for AKI, supporting the results obtained in this study.[10] According to Pontes *et al.*, (2007), diuresis volume in CPB did not influence AKI development, however the study of the association between these variables was made using different statistical tests from those used in this study, (t-Test).[17]

Results obtained for mannitol and furosemide administration during CPB demonstrate a positive association of these variables with AKI development. According to Goren and Matot (2015), the use of mannitol or loop diuretics (e.g.: furosemide) during surgery may be detrimental to renal function because of its potential nephrotoxicity and should only be used to treat hypervolemia.[3,9] According to Karajala *et al.* (2009), the danger of loop diuretics is that they decrease the circulating volume, leading to renal blood flow and GFR reduction. The reduction of effective arterial volume stimulates adrenergic and renin-angiotensin systems, causing vasoconstriction in renal cortex, which redistributes kidney circulation, and affects oxygen consumption's self-regulation, worsening renal injury.[19]

Aortic cross-clamp time was not associated with AKI development, although the mean was higher in dAKI group than in nAKI group. This is referred as a risk factor for deterioration of renal function[18], and this was not observed in this study, as it was not observed in the study by Schopka *et al.*, (2014), and that may be due to the application of different AKI definition criteria.[1]

In the present study, there were no statistically significant differences between the two groups regarding preoperative values of haemoglobin and haematocrit, nor with respect to minimum haemoglobin values during CPB, and haematocrit, or as to addition of blood in the priming, blood transfusion during CPB or administration of blood collected in cell-saver. In the study by Keyvan Karkouti *et al.* (2009)[5], sample size was significantly higher than that of this study, and patients who underwent reoperations during the period under analysis were analysed according to the first surgery, which may coincide with a period of hemodynamic instability and compromise intra-operative blood parameters. All these factors may positively influence the association with AKI development, justifying their results.

With regard to AKI staging, 75.8% of the patients who developed AKI were included in the less severe stage. In the study by Schopka *et al.*, (2014) the majority of patients undergoing CABG with CPB were enrolled in stage 2 (unspecified classification).[1]

Regarding postoperative creatinine variation in dAKI group, it is similar between both sexes during hospitalization, being normalized at the day of discharge. According to Pontes *et al.*, (2007), postoperative creatinine in dAKI group presented a mean (SD) of 1.8 (0.3) in the average of the first 5 days, being this value different from those recorded in this study because it results from an average.[17]

Regarding the need for renal replacement therapy, in this study 2 subjects (3.2% of dAKI group) required veno-venous hemofiltration. According to Schopka *et al.*, (2014), 2.9% (n=21) of the group who underwent CABG with CPB required renal replacement therapy. In the study by Sampaio et al. (2013), 7% (n=4) of patients who developed AKI (KDIGO classification) required hemodialysis, in the study of Rodrigues *et al.* (2009), 23% (n=18), and in the study by Pontes *et al.*, (2007), 5.6% (n=1) of the patients with AKI required dialysis.[1,2,6,17]

During the study, some limitations were observed: sample size; the nature of the study, not allowing to standardise the way data was collected; not having access to data on physical files of deceased patients; the KDIGO classification for the definition of AKI was not used in most of the studies consulted, making it difficult to adequately compare the results.

CONCLUSION

In conclusion, these results fit in the results spectrum described in literature, however it should be analysed cautiously once AKI incidence after CPB after cardiac surgery may also be influenced by other variables that were not considered in this study.

A prospective study that analyses the variables collected in this study and others that might influence the development of AKI may be carried out, with the application of new AKI biomarkers discussed in literature (e.g.: NGAL - neutrophil gelatinase-associated lipocalin), allowing an earlier detection of this pathology and thus probably a more rapid intervention.

Acknowledgements

The authors would like to thank the Cardiothoracic Surgery Department and Clinical Archive of Centro Hospitalar de Vila Nova de Gaia/Espinho's staff, for collaborating in data collection.

REFERENCES

1. Schopka S, Diez C, Camboni D, Floerchinger B, Schmid C, Hilker M. Impact of cardiopulmonary bypass on acute kidney injury following coronary artery bypass grafting: a matched pair analysis. J Cardiothorac Surg. 2014;9:20.
2. Sampaio MC, Máximo CAG, Montenegro CM, Mota DM, Fernandes TR, Bianco ACM, et al. Comparison of diagnostic criteria for acute kidney injury in cardiac surgery. Arquivos brasileiros de cardiologia. 2013;101(1):18-25.
3. Goren O, Matot I. Perioperative acute kidney injury. British journal of anaesthesia. 2015;115(suppl 2):ii3-ii14.
4. Bove T, Monaco F, Covello RD, Zangrillo A. Acute renal failure and cardiac surgery. HSR Proceedings in Intensive Care & Cardiovascular Anesthesia. 2009;1(3):13-21.
5. Karkouti K, Wijeysundera DN, Yau TM, Callum JL, Cheng DC, Crowther M, et al. Acute kidney injury after cardiac surgery focus on modifiable risk factors. Circulation. 2009;119(4):495-502.
6. Rodrigues AJ, Evora PRB, Bassetto S, JÚNior LA, Filho AS, Araújo WF, et al. Fatores de risco para lesão renal aguda após cirurgia cardíaca. CEP. 2009;14048:900.
7. Rosner MH, Okusa MD. Acute kidney injury associated with cardiac surgery. Clinical journal of the American Society of Nephrology. 2006;1(1):19-32.
8. Kumar AB, Suneja M. Cardiopulmonary bypass-associated acute kidney injury. Anesthesiology. 2011;114(4):964.
9. Kellum JA, Lameire N. KDIGO Clinical Practice Guideline for Acute Kidney Injury. Official Journal of the International Society of Nephrology - Kidney International Supplements. 2012;2(1):1-138.
10. Kolh P. Renal insufficiency after cardiac surgery: a challenging clinical problem. European heart journal. 2009:ehp282.
11. Calvert S, Shaw A. Perioperative acute kidney injury. Perioper Med (Lond). 2012;1(6).
12. Karkouti K. Transfusion and risk of acute kidney injury in cardiac surgery. British journal of anaesthesia. 2012;109(suppl 1):i29-i38.
13. Ranucci M, Biagioli B, Scolletta S, Grillone G, Cazzaniga A, Cattabriga I, et al. Lowest Hematocrit on Cardiopulmonary Bypass Impairs the Outcome in Coronary Surgery. Texas Heart Institute Journal. 2006;33(3).
14. Ferraris VA, Ferraris SP, Saha SP, Hessel EA, Haan CK, Royston BD, et al. Perioperative blood transfusion and blood conservation in cardiac surgery: the Society of Thoracic Surgeons and The Society of Cardiovascular Anesthesiologists clinical practice guideline. The Annals of thoracic surgery. 2007;83(5):S27-S86.
15. Eknoyan G, Lameire N. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Official Journal of the International Society of Nephrology - Kidney International Supplements. 2013;3(1):1 -163.
16. Michels WM, Grootendorst DC, Verduijn M, Elliott EG, Dekker FW, Krediet RT. Performance of the Cockcroft-Gault, MDRD, and new CKD-EPI formulas in relation to GFR, age, and body size. Clinical Journal of the American Society of Nephrology. 2010;5(6):1003-9.
17. Pontes J, Silva GVRd, Benfatti RA, Machado NP, Pontelli R, Pontes E. Fatores de risco no desenvolvimento de insuficiência renal aguda após cirurgia de revascularização miocárdica com CEC. Rev Bras Cir Cardiovasc. 2007;22(4):484-90.
18. Brito DJdA, Nina VJdS, Nina RVdAH, Salgado Filho N. Prevalência e fatores de risco para insuficiência renal aguda no pós-operatório de revascularização do miocárdio. Rev bras cir cardiovasc. 2009;24(3):297-304.
19. Karajala V, Mansour W, Kellum JA. Diuretics in acute kidney injury. Minerva anestesiologica. 2009;75(5):251-7.

ORIGINAL ARTICLE **THORACIC SURGERY**

SURGICAL APPROACH TO COLORECTAL CANCER PULMONARY METASTASIS – ONE-YEAR EXPERIENCE OF A REFERENCE CENTER

Maria João Jervis[1], Cristina Rodrigues[2], Daniel Cabral[2], Carolina Torres[2], Francisco Félix[2]

[1]Serviço de Cirurgia Geral, Hospital José Joaquim Fernandes, ULSBA
[2]Serviço de Cirurgia Torácica,Hospital Pulido Valente, CHLN

***Contacto Autor:** mariajoaojervis@gmail.com

Abstract

Introduction: Colorectal cancer is the third most common malignancy, being associated with metastatic disease in 50% of cases. The lung is the second organ most affected by metastasis in colorectal cancer. In this study, we aim to review the cases submitted to resection of pulmonary colorectal metastasis at Hospital Pulido Valente, comprised in the period from the 1st of January to the 31st of December 2017.

Methods: Retrospective analysis. Data were collected from clinical records.

Results: There were 21 patients operated during this period, with a total of 22 surgeries performed, all with curative intent. Data were collected regarding age, gender, site of primary tumour, number of resected lesions, surgical approach, performed procedure, disease-free interval, presence of bilateral disease and existence of extra-pulmonary metastasis.

Conclusion: Lung metastases are frequent in colorectal cancer. Pulmonary metastasectomy is currently accepted as a potentially curative therapy as part of a multimodal approach to metastatic colorectal cancer.

INTRODUCTION

Colorectal cancer is the third most common malignancy, being associated with metastatic disease in 50% of cases.[1] Around 10 to 25% of patients with colorectal tumours will present with metastatic disease at the time of diagnosis, and 15 to 26% of the patients submitted to curative surgery of the primary tumor, will develop distant metastasis.[1]

The lung is the second most affected organ by metastasis in colorectal cancer.

Isolated pulmonary metastasis of colon cancer occurs in less than 10% of patients[2], with twice the incidence in rectal cancer.

In this study, we aim to review the cases of patients referred for lung metastasectomy at the Thoracic Surgery Service, due to colorectal cancer, during the year of 2017. All surgeries were performed with curative intent.

METHODS

Retrospective analysis of clinical records.

All patients were operated as inpatients, in the Thoracic Surgery Service of Hospital Pulido Valente. Data were collected regarding age, gender, site of primary tumour, number of resected lesions, surgical approach, performed procedure, disease-free interval, and existence of bilateral disease or extra-pulmonary metastasis.

RESULTS

There were 21 patients operated for suspected pulmonary metastasis of colorectal cancer during this period. 5 patients did not attain confirmation as colorectal metastasis in the histologic analysis: four had primary pulmonary adenocarcinoma (two synchronous, two metachronous) and one had a pulmonary hamartoma.

There were 16 patients operated with confirmed colorectal adenocarcinoma metastasis during this period, with a total of 17 surgeries performed, all with curative intent.

Regarding the gender, there were 7 female and 9 male patients. The mean age at diagnosis of the primary tumour (colorectal cancer) was 60,5 years, with a standard deviantion of 7,4, minimum of 49 and maximum 74 years. Table 1 lists these demographic data.

The primary tumour was in the colon in 11 patients, and rectal in 5 patients. The number of resected lesions

Table 1 **Demographic data**

Variable	N
Operated patients	16
Age Mean (SD)	60.5(7,4)
Gender	
Female	7
Male	9

ranged from 1 to 5 in each surgery (Table 2). The performed procedures were: single or multiple wedge resections, lobectomy with or without accompanying wedge resection and double segmentectomy. Lymph node sampling was performed in 5 cases, whereas only 2 patients underwent full nodal dissection, due to suspicion of lung primary tumour.

A minimally invasive surgical approach, VATS was used in 5 patients: 3 patients were submitted to wedge resection (2 for a single lesion and 1 for two lesions); 2 patients underwent lobectomy for a single central lesion by this approach.

Thoracotomy was used in the remaining 11 patients: 7 patients underwent lobectomy, 2 of them with associated wedge resection of other lesions; 1 patient underwent single wedge resection; 2 patients underwent multiple wedge resection (2 to 5 lesions); and finally, 1 patient underwent bissegmentectomy and lymph node dissection.

Table 2 **Clinical data**

Variable	N
Site of primary tumour	
Colon	11
Rectum	5
Number of lesions resected	
1	9
2	3
3	1
5	3
Surgical approach	
VATS	5
Thoracotomy	11
Performed procedure	
Single wedge resection	3
Multiple wedge resection	3
Bissegmentectomy	1
Lobectomy	9
Lymph node approach	
Lymphatic node sampling	5
Full nodal dissection	2

VATS – video assisted thoracic surgery

The disease free interval (DFI), is defined as the time occurred between the resection of the primary tumour and the first day of recurrence, whether systemic or loco-regional (3). We will consider the disease free interval as the time occurred between the surgery for colorectal cancer and the time of diagnosis of lung metastasis. In this study, that time interval varied between 0 and 15 years (Table 3).

Table 3 **DFI**

Disease free interval	N
0	5
1	3
2	2
3	1
4	1
5	1
9	1
10	1
15	1

DFI – disease free interval in years

There were 5 patients with synchronous pulmonary metastasis at the time of colorectal cancer diagnosis (DFI of 0 years); 3 patients had a DFI of 1 year;

2 patients a DFI of 2 years and 6 patients with a DFI of 3, 4, 5, 9, 10 and 15 years, respectively.

Regarding the patients with synchronous presentation of pulmonary metastasis, 4 underwent chemotherapy before the pulmonary resection, achieving 30% of reduction of the lesion size in only 1 case.

Of all patients, 5 had already a history of previous pulmonary metastasectomy. Two patients had two previous surgeries and one patient had one previous surgery. Of these 5 patients, 4 had bilateral pulmonary disease.

As for the 11 patients whose first pulmonary resection occurred in 2017, 3 presented with bilateral disease. The contralateral pulmonary metastases were treated with radiotherapy in two cases and with contralateral resection in one patient. In this patient, the interval between the two surgical resections was 48 days. This case explains why we have a total of 16 patients operated, with a total of 17 surgeries performed.

As for post-surgical complications we report two cases of empyema and one bilateral pulmonary embolism.

Concerning extra-pulmonary dissemination, 8 patients had a history of hepatic metastasectomy previous to the pulmonary resections, with 3 hepatic lesions in one case. We report only one patient with extra-pulmonary and extra-hepatic metastasis: a cerebellum metastasis resected 2 years before pulmonary resection.

The analysis of the majority of the specimens of the lesions resected (14 out of 16) was made with immunohistochemistry. The lesions were positive to cytokeratin 20 and CDX-2 and negative to cytokeratin 7 and thyroid

transcription factor 1 (TTF1), which is compatible with colorectal origin of the metastasis.

DISCUSSION

Pulmonary metastasectomy in colorectal cancer is a potentially curative therapy[4] and may be associated with an increase of the 5 year survival (30-71%).[4,5,6] This survival is superior to the natural history of stage IV colorectal cancer, which has a 5 year survival of only 10%.[6]

The decision to perform metastasectomy should be made by a multidisciplinary team, regarding the following resectability criteria[1,5]: control of the primary tumour; resectability of all the metastatic disease; pulmonary function allowing resection of all lesions; and absence of extra-pulmonary unresectable metastasis. In patients in whom these criteria are not met, resection might be indicated in symptomatic cases or primary lung tumour suspicion.

The characteristics of the metastatic lesions will dictate their surgical approach. These characteristics are: number of lesions, size, over-time stability[1] and anatomical distribution.[7]

The surgical approach preferred in the Thoracic Surgery Service in Hospital Pulido Valente is the minimally invasive. Before surgical proposal, the lesions are evaluated for their stability over time with serial exams, and the assessment of feasibility of complete excision is also performed.

The open approach is chosen in cases of deep, non-palpable lesions by VATS approach, multiple lesions, or if there are technical difficulties to obtain a clear margin.

The wedge resection by VATS is appropriate for preferably single to two[7] lesions, stable, peripheral lesions and nodules smaller than 3 cm.[6]

Some authors consider that the VATS approach has the disadvantage of the inability to palpate the remaining pulmonary parenchyma. This is defended by some thoracic surgeons[9], in order to permit identification of small metastatic foci.[6]

Patients approached by VATS do as well as thoracotomy approached patients, and have similar disease free survival and overall survival.[6]

The pulmonary resection should be performed in the manner that will allow the best preservation of parenchyma, in order to allow eventual future resections.[6]

The presence of bilateral pulmonary metastatic disease is no longer considered a contra indication for resection.[1] The interval between resections for bilateral disease can by 4 to 6 weeks.[8] Multiple metastasectomy might improve overall survival.[9]

Similarly, the existence of extra-pulmonary metastatic disease is not a formal contra-indication for pulmonary metastasectomy, as long as the lesions are ressectable.

About 5% of patients with colorectal cancer will develop pulmonary and hepatic metastasis, whether synchronous or metachronous.[1] In cases of synchronous lesions, an initial hepatic approach is preferred for several reasons: it might be more laborious; there is a greater probability of progression of the hepatic lesions over time[7] and it will allow excluding abdominal disease that had not been previously identified. On the other hand, the initial abdominal approach will allow to maintain a better pulmonary reserve in the post-operative period.[9] The pulmonary resection may be performed 6 weeks after the hepatic resection.[9]

Several studies have identified prognostic factors associated with a decreased survival: stage III/IV at presentation of the colorectal cancer, multiple metastatic lesions[6], presence of both lung and liver metastasis[5], elevated CEA[9] and a disease free interval inferior to 12 months (7). In these patients who present with poor prognostic factors, it is accepted to adopt a *watchful waiting* of 6 to 12 weeks. If there is no disease progression in this interval, surgery may be performed.[9]

For the patients who do not meet criteria for surgical resection, there are alternatives such as stereotaxic radiotherapy, radiofrequency ablation[6,10], microwave energy, cryotherapy[6] or systemic chemotherapy.

CONCLUSION

Pulmonary metastases are frequent in colorectal cancer. Pulmonary metastasectomy is currently accepted as a potentially curative therapy in the multimodal approach of metastatic colorectal cancer.[4]

REFERENCES

1. Niederhuber J E. Abeloff's Clinical Oncology, Elsevier, 2014:764-777
2. Yeo C J. Shackelford's Surgery of the Alimentary Tract, Elsevier, 2013: 2133-2148.
3. Nahler G. Disease Free Interval. Dictionary of Pharmaceutical Medicine. Vienna: Springer, 2009:53.
4. Kim J Y. Post-pulmonary metastasectomy prognosis after curative resection for colorectal cancer. Oncotarget, 2017: 36566-36577.
5. Jarabo, J. (2018). Combined Hepatic and Pulmonary Metastasectomies From Colorectal Carcinoma. Data From the Prospective Spanish Registry 2008-2010. Arch Bronconeumol, 2018, 54(4):189-197.
6. Lareiro S, Fernandes P, Vouga L, Miranda J, Guerra M. Surgical resection of lung metastases. RevPort Cir Cardiotorac, XXIII 2016;(3-4): 131-136.
7. Moorcraft S. Management of ressectable colorectal lung metastases, Clin Exp Metastasis, 2015. DOI 10.1007/s10585-015-9774-6.
8. Internullo E. Pulmonary Metastasectomy, A Survey of Current Practice Amongst Members of the European Society of Thoracic Surgeons. Journal of thoracic Oncology, 2008:1257-1266.
9. Shah SA. Surgical Resection of Hepatic and Pulmonary Metastases from Colorectal Carcinoma. J Am Coll Surg, 2006, Vol. 202(3):468-475.
10. Andres A. Surgical management of patients with colorectal cancer and simultaneous liver and lung metastases. British Journal of Surgery, 2015. 102: 691–699.

ORIGINAL ARTICLE **THORACIC SURGERY**

UNIPORTAL VIDEO-ASSISTED THORACIC SURGERY ANATOMICAL RESECTIONS – DOES PREVIOUS TOBACCO EXPOSURE ADVERSELY INFLUENCE POST-OPERATIVE OUTCOMES?

Joana Rei[1], Susana Lareiro[1], Pedro Fernandes[1], Miguel Guerra[1,2], José Miranda[1], Luís Vouga[1]

[1]Cardiothoracic Surgery Department, Centro Hospitalar de Vila Nova de Gaia/Espinho-EPE, Vila Nova de Gaia, Portugal
[2]Faculty of Medicine of the University of Porto, Oporto, Portugal

***Contacto Autor:** jcfrei93@gmail.com

Abstract

A high percentage of patients presenting for lung surgery are either current or former smokers, which is typically associated with many anatomical and physiological pulmonary changes. The influence of tobacco on postoperative pulmonary complications remains controversial. The main goal of this study was to analyse the effects of smoking on the risk of post-operative complications and morbidity in patients submitted to lung resection surgery through uniportal VATS.

Peri-operative data on all cases of anatomical lung resection surgery through single-port VATS performed between December 2013 and July 2018 at three Portuguese institutions were collected and retrospectively reviewed Demographic data, diagnosis, pre-operative lung function tests, in-hospital length of stay (LOS) and intra and post-operative drainage levels were registered. Patients were divided in two groups according to tobacco exposure. Post-operative complications and morbidity were compared through statistical analysis

We performed 313 procedures, 303 of which were evaluated in regard to outcome. Mean age at time of surgery was of 62,85 years (SD=12,24). One hundred and sixty patients (52,81%) had a history of tobacco use, while 47,19% (n=143) had never smoked. Non-smokers had significantly better lung function than smokers ($p<0,05$). Smoking history showed a contribution to post-operative prolonged air leaks ($p=0,025$) morbidity ($p=0,05$), 2-day longer LOS ($\mu=5,36$ days vs. $\mu=7,53$ days; $p<0,05$), longer operative times and higher intra and post-operative drainage levels.

A history of smoking during a patient's life negatively impacts morbidity in patients submitted to uniportal VATS for anatomical lung resection, increasing early post-operative complications and prolonging in-hospital stays.

INTRODUCTION

Lung cancer is a leading cause of death worldwide. A high proportion of patients who suffer from lung cancer have a history of smoking, proven to contribute to a 12 to 20-fold increase in risk of lung malignancy.[1] Given the growing extent of life expectancy we see in current years, in face of technological and medical evolution, we can expect a concomitant increase in the diagnosis of all types of malignancies, including those involving the lung. Hence, pneumologists and thoracic surgeons are now faced with a new cluster of target population: those with life-long risk exposure.

The best conceivable treatment for early stage non-small cell cancer is surgery, whenever possible.[2] In face of our aging population, video-assisted minimally invasive approaches have risen and are now standard of care in most surgical centres for the treatment of lung cancer.[3] In our centre, Video-Assisted Thoracic Surgery (VATS) is performed through a single port, minimizing the aggressiveness to the thoracic cage and consequently minimizing post-operative pain.

Despite this trend for less traumatic surgical procedures, post-operative complications still occur, and many risk factors have been advocated in the literature as to contributing to their development.[4,5]

Most authors agree that smoking highly increases postoperative risks in all surgical procedures, hence, smoking cessation is recommended, especially in lung surgery. How duration of cessation impacts post-operative complications is still largely debatable, as some studies show

that short-term pre-operative cessation does impact outcome.[1,6] Most studies evaluate overall morbidity and mortality between smokers in comparison to non-smokers, not specifying the impact of tobacco abuse in the specific complications after thoracic surgery. With this in mind, the main goal of our study was to analyse the impact of smoking in the development of post-operative complications and overall morbidity in patients submitted to lung resection surgery performed through uniportal VATS.

MATERIALS AND METHODS

Study design

A retrospective study was conducted, including all patients submitted to anatomical lung resection surgery performed through uniportal VATS in three institutions located at the north of Portugal, within the period comprised between the 1st of December 2013 until the 31st of July 2018. The population was subsequently divided into two groups according to active smoking history: those with a history of smoking during their lifetime, regardless of active smoking at time of evaluation, were included in Group A, while those who had never smoked were included in Group B. Groups were compared according to pre-operative, intra-operative and post-operative variables in order to evaluate to what extent smoking impacts post-operative complications.

Collection of data

Data were collected through the patient's medical records and included in three clusters: patient-related data, including demographic variables such as age and gender; pre-operative data, regarding results of lung function testing (FEV1; FVC and DLCO) and diagnosis prior to surgery; surgery-related data, including laterality, choice of procedure, location and number of excised lymph nodes, operative time, the inadvertent need for conversion to thoracotomy and operative drainage counts; and post-operative data, including in-hospital length of stay (LOS), post-operative 24 hour drainage counts and post-operative complications. The post-operative complications evaluated in our study were, in particular: prolonged air leaks, defined as air leak lasting more than 7 days; atrial fibrillation development; fever; respiratory insufficiency leading to Acute Respiratory Distress Syndrome (ARDS); atelectasis; haemorrhage with the need for re-intervention and overall morbidity. Morbidity was defined as the development of two or more post-operative complications.

Patients were excluded from our study whenever data regarding post-operative complications was not attainable.

Statistical analysis was performed using SPSS Statistics software.

RESULTS

Population

A total of 313 procedures were performed during the study's timespan, in ten of which post-operative data was lacking, being excluded from out study's main goal evaluation. The male to female ration was approximately 1:1 and mean age at time of surgery was of 62,85 years of age (SD=11,17).

Patients were divided into two homogenous groups according to their smoking history: 160 (52,81%) patients were included in group A, the smoking group, while 143 (47,19%) were attributed to group B, the non-smoking group.

Regarding pre-operative evaluation, the attainment of all intended variables was not possible, although patients in group A showed lower means in all the evaluated variables (Table 1). Comparing between groups, this difference was statistically significant.

Table 1 **Pre-operative lung function tests results**

		FEV1 (%)	FVC (%)	DLCO (%)
Group A	Mean	104,80	116,63	93,16
	n	119	118	71
	SD	19,30	83,85	20,34
Group B	Mean	93,51	101,93	84,76
	n	139	136	86
	SD	20,01	16,92	17,57

The majority of patients (91,75%, n=278) were pre-operatively diagnosed with malignant lung disease, while the remaining 8,25% (n=25) were submitted to surgery for the treatment of benign lesions. There was a slightly higher percentage of patients being submitted to surgery on the right side (60,8%) while the remaining had left-sided procedures. These ranged from lesser resections such as segmentectomies to bilobectomies and pneumonectomies, all performed through a single 3-4cm intercostal port.

Regarding intra-operative data, the mean number of lymph nodes sample was similar in both groups (μ=6,93 in group A and μ=5,67 in Group B) and in both, two stations (hilar and mediastinal) were sampled. Mean operative times were longer in group A, *t= 104,50; SD=45,97*, comparing to group B, *t= 96,32; SD=50,55*, although this difference was not statistically significant (p=0,166).

Similarly, intra and post-operative drainage levels were about 10mL higher in group B, which was also insignificant both in clinical and statistical terms ($p>0,05$). In 18 procedures there was an intra-operative need for conversion to thoracotomy due to surgical difficulties, but no relation was found between this necessity and the patient's smoking status.

Complications and morbidity

Post-operative complications occurred in about 26,4% of patients submitted to thoracic surgery, although most had low severity and no long-term impact.

The incidence of discriminated post-operative complications in both groups is presented in table 2.

Table 2 **Incidence of post-operative complications among groups**

		Prolonged air leak	Fever	Respiratory insufficiency	Atrial Fibrillation	Atelectasis	Haemorrhage	Morbidity
Group A	n	40	4	4	5	2	3	52
	% (between groups)	25,00%	2,50%	2,50%	3,12%	1,25%	1,87%	32,50%
Group B	n	21	2	2	2	2	3	27
	% (between groups)	14,60%	1,40%	1,40%	1,40%	1,40%	2,10%	18,89%

Prolonged air leak occurred more frequently in patients with a history of smoking. Chi-square tests proved a statistical correlation between smoking and the development of prolonged air leaks ($p=0,025$). Accordingly, the remainder of post-operative complications, with the exception of atelectasis, had a slightly higher incidence in the smoking group, although in these cases, no statistical significance was reached.

Overall morbidity was also higher in group A, chi-square: $p=0,05$.

In-hospital length of stay was longer in the smoking group ($\mu=5,36$ days) when comparing to group B, (7,53 days) and this difference was considered significant after statistical analysis ($p<0,05$).

DISCUSSION

Despite current information on the potential damages of cigarette smoking, more than one billion people smoke tobacco products worldwide.[7] Smoking has damaging effects all throughout our organs and systems, contributing to premature death, chronic obstructive lung disease (COPD) development, cardiovascular disease and malignancy.[1,8,9] Being a proven carcinogen, tobacco contributes not only to the development of lung cancer, but also oral, laryngeal and oesophageal cancer, a finding possibly correlated to the connection between smoking and increased oxidative stress, along with its definitive impact on the lung parenchymal transcriptome.[7,10]

Tobacco products cause particle-related lung injury. CT scan analysis comparing the effects of tobacco in lung architecture performed by Soejima *et al* demonstrated that respiratory bronchiolitis, lung nodules and the development of upper lung field emphysema along with concomitant ground glass opacities suggesting fibrosis, are more prevalent in smokers than in non-smokers.[11] These preferential upper lobe changes are often expressed in lung function testing, through an accelerated decline in forced expiratory volume in 1 second (FEV1) values. Our study corroborated this association, with worse performance of smokers in pre-operative lung function tests due to chronic tobacco-induced emphysema, as previously shown in multiple studies.[1,5,12]

A high proportion of patients diagnosed with lung cancer are either current smokers or have a previous history of active tobacco exposure during their lifetimes. Surgical resection is widely considered the optimal therapy in the treatment of early stage non-small cell lung cancer (NSCLC).[3,5] With the development of video-assisted thoracic surgery, minimally invasive procedures are becoming the gold-standard for lung cancer treatment worldwide.[13] Since the end of 2013, our center began to perform uniportal VATS, which quickly became our preferred approach for all procedures in lung surgery. Although current literature on the theme is scarce, uniportal VATS has not shown inferiority when comparing to the multiportal variant. We believe, along with Louis *et al* and other authors, that, besides safe and feasible, a single port approach limits post-operative pain, a highly relevant factor in our patient's post-operative wellbeing and quality of life, especially in smokers, who have shown lower pain tolerance.[14-16]

VATS is historically associated with less post-operative complications than thoracotomy. Studies report a post-operative complication rate ranging from 3% in larger series to 30% in smaller series, such as ours.[5,17-19] In

our series, complication rate is in line with most studies with similar population size. It must be enhanced that a high number of studies contemplates solely potentially life--threatening complications, consequently lowering their post-operative complication rates.

Previous studies have investigated pre-operative risk factors influencing post-operative outcomes and complications after thoracotomy, although, few of them have done so in VATS.[5] Smoking has been advocated in most studies as a risk factor for post-operative complications and worse outcome, and smoking cessation is advisable in all cases, prior to surgery.[4,20,21] Despite this, consensus still lacks on the duration of time from smoking cessation to surgery. There are even, in fact, reports stating that current smoking can be correlated with lower mortality rates and that recent cessation could increase complication risk, although these findings might be biased, mainly due to the fact that current smokers are frequently younger than ex-smokers and hence, less prone to post-operative complications.[22,23] In their study, Nakagawa and his colleagues have proposed a 4-week minimum smoke-free period in order to diminish post-operative complications, while Mason's reports state that there is no minimum time for cessation, since any history of smoking seems to negatively impact outcome.[21,24] Bearing this in mind, we conducted our study in order to investigate whether smoking at any point during a patient's lifetime influences outcome after lung surgery, and have thus found that, in our population, a history of tobacco exposure constitutes a risk factor for specific post-operative complications and morbidity, regardless of duration from cessation.

Prolonged air leak, defined in our study as lasting over 7 days, is one of the most frequent complications after lung surgery. We have found that smoking significantly increases the risk for prolonged air leak, possibly due to tobacco-induced changes in lung architecture, with destruction of alveolar walls leading to pulmonary emphysema. The higher the rate of pulmonary emphysema, the higher the risk for prolonged air leaks, hence, a possible correlation between smoking duration and the risk for this complication may exist and can and should be a target for future investigation.[25]

Prolonged air leaks also contribute to longer in-hospital stays. In concordance, we have found that patients in our smoking group had approximately 2-day longer hospital stays than their abstinent counterparts, increasing infection risk, patient anxiety and hospital costs.

Procedure duration and intra and post-operative drainage levels do not seem to be influenced by smoking status. In light of our results, we can speculate that smoking increases post-operative pulmonary complications (with slightly higher, although non-significant) rates of pulmonary insufficiency and similar rates of lung atelectasis, but not cardiac complications, such as arrhythmia development. Although, given the size of our series, this cannot be confirmed.

Although in this series we have not evaluated the incidence of post-operative surgical site infection, smoking can also be a risk factor for its development, given its role in delaying wound closure, causing skin atrophy and reducing peripheral blood flow to infection-prone areas.[9]

Overall morbidity is affected by cigarette smoking in patients submitted to lung resection surgery even through minimally invasive approaches, such as uniportal VATS. Smoking cessation is advisable, although there is no clear desirable length for cessation duration, rather, population--based sensitization on the effects of tobacco must continue to be performed by Public Health ministries, so that overall exposure can be lessened.

Study limitations

This study has some limitations. First, because this was a small-sized retrospective study, it had low statistical power. Besides, the role of smoking in post-operative pain was not evaluated and could be of interest to evaluate its impact in prolonged length of stay in smokers. Besides, we could not compare outcomes between uniportal VATS and thoracotomy, since data from thoracotomy patients was not accessible.

CONCLUSIONS

Cigarette smoking at any time during a patient's life negatively impacts post-operative outcomes and morbidity in patients in need to be submitted to anatomical lung resection even through minimally invasive approaches such as uniportal VATS. More studies exploring the relationship between duration from smoking cessation and post-operative complications are needed.

REFERENCES

1. Erhunmwunsee, L. and M.W. Onaitis, Smoking cessation and the success of lung cancer surgery. Curr Oncol Rep, 2009. 11(4): p. 269-74.
2. Vansteenkiste, J., et al., 2nd ESMO Consensus Conference on Lung Cancer: early-stage non-small-cell lung cancer consensus on diagnosis, treatment and follow-up. Ann Oncol, 2014. 25(8): p. 1462-74.
3. Berry, M.F., et al., Impact of Pulmonary Function Measurements on Long-Term Survival After Lobectomy for Stage I Non-Small Cell Lung Cancer. Ann Thorac Surg, 2015. 100(1): p. 271-6.
4. Bedat, B., et al., Clinical outcome and risk factors for complications after pulmonary segmentectomy by video-assisted thoracoscopic surgery: results of an initial experience. J Thorac Dis, 2018. 10(8): p. 5023-5029.
5. Agostini, P.J., et al., Risk factors and short-term outcomes of postoperative pulmonary complications after VATS lobectomy. J Cardiothorac Surg, 2018. 13(1): p. 28.
6. Groth, S.S., et al., Impact of preoperative smoking status on postoperative complication rates and pulmonary function test results 1-year following pulmonary resection for non-small cell lung cancer. Lung Cancer, 2009. 64(3): p. 352-7.

7. Bosse, Y., et al., Molecular signature of smoking in human lung tissues. Cancer Res, 2012. 72(15): p. 3753-63.
8. Clark, K.D., et al., Cigarette smoke inhalation and lung damage in smoking volunteers. Eur Respir J, 1998. 12(2): p. 395-9.
9. Argintar, E., et al., The musculoskeletal effects of perioperative smoking. J Am Acad Orthop Surg, 2012. 20(6): p. 359-63.
10. Mizuno, Y., et al., Influence of smoking on perioperative oxidative stress after pulmonary resection. Surg Today, 2016. 46(2): p. 183-7.
11. Soejima, K., et al., Longitudinal follow-up study of smoking-induced lung density changes by high-resolution computed tomography. Am J Respir Crit Care Med, 2000. 161(4 Pt 1): p. 1264-73.
12. Zhao, J., et al., Smoking status and gene susceptibility play important roles in the development of chronic obstructive pulmonary disease and lung function decline: A population-based prospective study. Medicine (Baltimore), 2017. 96(25): p. e7283.
13. Howington, J.A., et al., Treatment of stage I and II non-small cell lung cancer: Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest, 2013. 143(5 Suppl): p. e278S-e313S.
14. Louis, S.G., et al., Uniportal video-assisted thoracoscopic surgery (VATS) technique is associated with decreased narcotic usage over traditional VATS lobectomy. J Vis Surg, 2017. 3: p. 117.
15. Ismail, M., et al., Uniportal video-assisted thoracoscopy major lung resections after neoadjuvant chemotherapy. J Thorac Dis, 2018. 10(Suppl 31): p. S3655-s3661.
16. Oh, T.K., et al., Relationship between pain outcomes and smoking history following video-assisted thoracic surgery for lobectomy: a retrospective study. J Pain Res, 2018. 11: p. 667-673.
17. Boffa, D.J., et al., Fewer complications result from a video-assisted approach to anatomic resection of clinical stage I lung cancer. J Thorac Cardiovasc Surg, 2014. 148(2): p. 637-43.
18. Desai, H., et al., Decreased In-Hospital Mortality after Lobectomy Using Video-assisted Thoracoscopic Surgery Compared with Open Thoracotomy. Ann Am Thorac Soc, 2017. 14(2): p. 262-266.
19. Imperatori, A., et al., Peri-operative complications of video-assisted thoracoscopic surgery (VATS). Int J Surg, 2008. 6 Suppl 1: p. S78-81.
20. Sardari Nia, P., et al., Prognostic value of smoking status in operated non-small cell lung cancer. Lung Cancer, 2005. 47(3): p. 351-9.
21. Mason, D.P., et al., Impact of smoking cessation before resection of lung cancer: a Society of Thoracic Surgeons General Thoracic Surgery Database study. Ann Thorac Surg, 2009. 88(2): p. 362-70; discussion 370-1.
22. Mediratta, N. and M. Poullis, Smoking status and 30-day mortality in patients undergoing pulmonary resections. Asian Cardiovasc Thorac Ann, 2016. 24(7): p. 663-9.
23. Rodriguez, M., et al., Refraining from smoking shortly before lobectomy has no influence on the risk of pulmonary complications: a case-control study on a matched population. Eur J Cardiothorac Surg, 2017. 51(3): p. 498-503.
24. Nakagawa, M., et al., Relationship between the duration of the preoperative smoke-free period and the incidence of postoperative pulmonary complications after pulmonary surgery. Chest, 2001. 120(3): p. 705-10.
25. Murakami, J., et al., Grading of Emphysema Is Indispensable for Predicting Prolonged Air Leak After Lung Lobectomy. Ann Thorac Surg, 2018. 105(4): p. 1031-1037.

COMMENT

Cristina Rodrigues
Associated Editor for Thoracic Surgery

Smoking cessation: a matter of timely opportunity!

Tobacco exposure increases the risk of lung cancer and many other malignancies. So, smoking cessation is of paramount importance in public health.

A diagnosis of lung malignancy, as bad as it is, represents a major target for intervention in the enrolment in a smoking cessation program.

These programs are run by specialists, mostly pneumologists, but can be extended to primary care, through the family doctors. A multidisciplinary team evaluates and monitors the patients throughout the entire process.

Ideally, as referred by Rei *et al*[1], there should be a gap of at least 4 weeks between smoking cessation and lung surgery, but the need for lung cancer surgery is not usually compatible with a 30 day waiting period for a completion of a drug cessation program. The fact is that from the time of the first suspicion, to the operating table there is time for an early enrolment in such a program.

The benefits in improvement in lung function test, quality of life and decrease of post-operative complications are highly motivating and the opportunity should not be wasted.

REFERENCES

1. Rei J, Lareiro S, Fernandes P, Guerra M, Miranda J, Vouga L. Uniportal video-assisted thoracic surgery anatomical resections: Does previous tobacco exposure adversely influence post-operative outcomes? Rev Port Cir Cardiotorac Vasc. 2019; 26(2):121-5.

ORIGINAL ARTICLE **VASCULAR SURGERY**

WHICH ANEURYSM CHARACTERISTICS PREDICT EVAR NON-SUCCESS?

Pedro Pinto Sousa[1], Pedro Brandão[1], Alexandra Canedo[1]

[1]Centro Hospitalar Vila Nova de Gaia/Espinho

***Contacto Autor:** pedro_psousa@hotmail.com

Abstract

Introduction: Hostile anatomic characteristics in patients undergoing endovascular abdominal aortic aneurysm repair (EVAR) may lead to technical non-success, late complications, reintervention or death.

Objective: To analyze specific anatomical features of abdominal aortic aneurysms and to study the association with postoperative endoleak and survival.

Methods: Retrospective review of all consecutive elective EVARs between 2010 and 2016, with available data, at one institution, for infra-renal aortic aneurysms. Patients comorbidities and preoperative computed tomography scans were analyzed considering characteristics of the proximal and distal landing zones, the aortic aneurysm and eventual concomitant iliac aneurysm or peripheral occlusive disease. Outcomes were endoleak development and survival.

Results: We analyzed 56 patients, 54 (96%) male with a mean age of 78 (min 61, max 89) years. During a mean of 3.4 years of follow up, 12 (21%) patients developed endoleak (10 type II and 2 type I) and 18 (32%) died. The adjusted analysis showed a significant association between aneurysm angulation (p=0.044), patency of the inferior mesenteric artery and the lumbar arteries (p=0.044) and aneurysm diameter (p=0.009) with endoleak development. All except one endoleak were diagnosed within the first year after EVAR. None of the deaths that occurred during the follow up period were correlated to post intervention aneurysm enlargement or rupture.

Conclusion: Unfavorable aneurysm morphologic characteristics for EVAR may predict complicated endograft placement or higher incidence of post intervention endoleak, which should be taken into consideration. For such clinical cases, complementary endovascular procedures or a surgical approach should be considered.

INTRODUCTION

Endovascular aneurysm repair (EVAR) has become the standard method for abdominal aortic aneurysm (AAA) treatment. The main reason for that evolution is the minimally invasive approach when compared to open surgery with consequent lower short-term patient morbidity and mortality.[1,2]

Nevertheless, each manufacture establishes their own instructions for use for specific aortic stent grafts which requires precise anatomic characteristics (aortic neck diameter, length and neck angle; iliac artery morphology) so that the patient may be suitable for EVAR. Still, the literature describes that about 20% of patients have hostile necks for current endografts[3] while some other studies consider that 60% of AAA patients are excluded from EVAR due to their unfavourable anatomy.[4]

Considering that data, recent endograft evolution has expanded its applicability from conventional AAA with favourable anatomy to aorto-iliac aneurysms with more complex anatomy, particularly in high-risk patients.

Notwithstanding initial technical deployment success, endograft failure may develop along follow up secondary to stent graft migration, endoleak or sac enlargement which may lead to a higher risk of aortic rupture. And the reason for that non-success in not necessarily correlated to technical skills but to specific anatomic predictors. That is why, despite latest advancements, EVAR on patients with unfavourable anatomy remains a challenge.

OBJECTIVE

The purpose of the present study was to analyze the data from previous EVAR's conducted in our Vascular Surgery department considering anatomic characteristics and correlate them with technical short and long-term success (endoleak development and survival).

MATERIALS AND METHODS

We conducted a retrospective study. Data from every patient who underwent elective EVAR for an infra-renal

AAA between January 2010 and December 2016 at our Vascular Surgery department was retrospectively reviewed. The study excluded patients who underwent EVAR for ruptured, thoracoabdominal, pararenal or isolated iliac aneurysms.

Patient demographic information was obtained from the electronic medical record, available at the Institutional software program, SClinico®, including age, sex and medical history with analysis of risk factors (smoking, chronic obstructive pulmonary disease (COPD), chronic renal disease, dyslipidemia, diabetes mellitus and hypertension) and described in table 1. Data was analyzed in conformity with applicable safety standards published by the *Serviços Partilhados do Ministério da Saúde*.[5]

Table 1 **Pre-operative patients characteristics**

	N
Age, mean (SD)	78 (5)
Male, n (%)	54 (96%)
Smoking, n (%)	42 (78%)
COPD, n (%)	16 (30%)
Chronic Renal Disease, n (%)	18 (33%)
Dyslipidaemia, n (%)	36 (67%)
Diabetes Mellitus, n (%)	12 (%)
Hypertension, n (%)	44 (83%)

SD: Standard deviation

All measurements and evaluations were based on the computed tomographic angiography (CTA) previous to the procedure. The software used for this propose was Osirix with implementation of center lumen line. Measurements were always made by the same operator to avoid inter-observer variability and done three times for each parameter analyzed and used the mean of those values. Aneurysm characteristics taken into consideration were:

1) The proximal landing zone: cross sectional diameter (inner to inner), length from the inferior renal artery to the aneurysm, presence of thrombus (< 25% of cross sectional lumen, 25-50% or >50%) and calcification (<25% of the perimeter of the aortic circumference, 25-50% or >50%);
2) The distal landing zone: length of the endograft limb anchored on a disease-free zone and cross sectional diameter of that zone;
3) Eventual presence of concomitant iliac aneurysm. Only accepted fusiform aorto-iliac aneurysms, without involvement of the internal or external iliac artery. No maximum aneurysm diameter was established;
4) Eventual presence of concomitant peripheral occlusive disease identified on the pre-operative CTA or Doppler ultrasound or by a reduced ankle--brachial pressure index;
5) Aneurysm: maximum cross sectional diameter (inner to inner), axis deviation (ratio between central lumen-line distances/straight-line distances), mural thrombus (< 25% of cross sectional lumen, 25-50% or >50%) and patency of the inferior mesenteric artery and the lumbar arteries with registration whenever their diameter was superior to 3mm. According to the aneurysm diameter, patients were divided into three groups (> 60mm; 60 – 70mm and > 70mm).

Statistical analysis was performed using the IBM SPSS Statistics®. Descriptive analysis was performed using mean and standard deviation or minimum/maximum for continuous variables, and absolute and relative frequencies for categorical variables. An exploratory univariate analysis was preformed to assess possible factors associated to outcomes; the T-test was used for continuous variables and the X^2 for categorical variables. Then, a multivariate analysis (logistic regression) was performed to evaluate which risk factors were associated with late complications. Primary outcomes (used as dependent variables for multivariate analysis) were endoleak development or death during follow-up (FU). Also, subgroup analysis for differences between endoleak type (I and II) was performed. Statistical significance was set for a p-value < 0.05 in inferential analysis and described in table 2.

The patients included in this study underwent a surveillance protocol following the European Society of Vascular Surgery guidelines[6] applicable at the intervention date. Every patient submitted to AAA repair by EVAR received: best medical treatment including aspirin, statin and β-blocker if tolerated; plain radiographs with anteroposterior and lateral projections and CTA with delayed images at one month and twelve after the procedure. If no endoleak and a good component overlap, thereafter annually, otherwise would be orientated accordingly to the findings. Complementary, they received a medical consultant with evaluation of peripheral pulses. Once missed an appointment the patient would be re-scheduled. Endoleaks present at the end of the procedure on the control angiogram were excluded. Only new endoleaks during follow up were considered.

RESULTS

The studied population comprised 56 patients, 54 (96%) males with a mean age of 78 (minimum 61, maximum 89) years.

Throughout a mean of 3.4 years of FU, 12 (21%) patients developed endoleak. We detected 2 Type Ia endoleaks due to a caudal migration of the stent graft and 10 type II endoleaks due to back-bleeding (from the inferior mesenteric artery in four cases and in the other six from lumbar arteries). All except one endoleak were diagnosed within the first year after EVAR procedure. During FU, 18 (32%) patients died. None of the deaths occurred, were correlated to post intervention aneurysm enlargement or rupture. Four patients died due to a malignant disease, 8

Table 2 **Predictors of endoleak and mortality in multivariate analysis not considering the aneurysm characteristics**

	Endoleak	P	Mortality	P
Total, n (%)	12 (21%)	n.a.	18 (32%)	n.a.
Female	2 (17%)	0.060	2 (11%)	0.014*
Male	10 (83%)		16 (89%)	
Concomitant iliac aneurysm				
Yes	3 (25%)	0.080	7 (39%)	0.090
No	9 (75%)		11 (61%)	
Peripheral occlusive disease				
Yes	2 (17%)	0.060	8 (44%)	0.080
No	10 (83%)		10 (64%)	

n.a.: not applicable. * statistical significant

due to a cardiovascular event (coronary or cerebrovascular) and the other of unknow cause.

The adjusted multivariate analysis of preoperative clinical information showed only a statistically significant association between gender (female) and death during follow-up (p=0.014). COPD showed a positive trend with endoleak development.

When considering the proximal landing zone only aneurysm angulation superior to 60º had a statistical correlation with endoleak development (p=0.044) and none analyzed factor correlated statistically to death during FU.

Reflecting aneurysm diameter analysis, the diameter larger to 70mm was predictive of endoleak development (p=0.009). According to the ROC curve, a diameter of 64mm was the threshold. Patency of the inferior mesenteric artery (IMA) and the lumbar arteries (p=0.044) were associated to endoleak. Despite without statistical significance we noticed a tendency for endoleak when in presence of a significant axis deviation.

None of the factors analyzed concerning the distal landing zone were predictors of endoleak nor death during FU.

DISCUSSION

We present a retrospective study with a reduced pool of patients that led to limited data, and still a short period of follow-up where the specificities of each endograft were not analysed. All those factors imply cautionary measurers when looking at the results. The authors tried to compare the results with what is written in the literature. Recently, on the basis of different experience, there has been a trend in the literature towards preventing endoleaks instead of treating their complications once they develop. For such specific clinical cases with unfavorable anatomic characteristic, additional previous or intra-operative procedures should be considered while undertaking EVAR. Analysing our data and, despite the fact that most of our endoleaks were diagnosed within the first year after intervention, which suits the literature, and even considering the fact that still, most of the time they are not associated with patient's mortality, they may imply further complementary procedures and increased morbidity, thus should be prevented.

Type II endoleaks were the most frequent type of endoleaks and are associated with patency of aortic side branch vessels, specially the inferior mesenteric artery. These results are in concordance with other published studies. Piazza M *et al*, suggested that more aggressive intraoperative aneurism sac embolization should be considered for patients with a preoperative aneurysm sac volume >125 cm^3.[7] He published an article where he suggested that thrombus volume <35% was an additional predictor for endoleak type II and endoleak-related reintervention among patients at risk.[8] Muthu *et al* have already described routine intraoperative selective IMA embolization and thrombin injection into the aneurysm sac just before EVAR.[9]

Type I endoleaks occurred in patients with severe aneurysm angulation and larger aneurysms were associated with both types of endoleaks. Schuurmann *et al* identified maximum curvature over the length of the aneurysm sac (>47 m-1; p=0.023), largest aneurysm sac diameter (>56 mm; p=0.028), and mural neck thrombus (>11° circumference; p<0.001) as independent predictors of late migration and type Ia endoleak. Endograft failure may be associated with this factors because they do not provide a stable attachment of the endograft and leave it more prone to change over time.[10] Large aneurysm diameter and high curvature over the proximal part of the sac may reduce positional stability, inducing movement of the endograft within the sac.

Association between COPD and endoleak is debatable. Literature suggests an association between lung tissue destruction that occurs in emphysema and aortic wall degeneration.[11]

Analysing our data, we noticed that women have not benefited as men from EVAR, presenting higher mortality. Bendermacher BL *et al* published the same results suggesting that differences in hormones, a higher rate of undiagnosed cardiovascular disease and also anatomical differences between them could influence the outcome.[12]

Table 3 **Predictors of endoleak and mortality in multivariate analysis considering aneurysm characteristics**

	Endoleak	P	Mortality	P
Axis deviation				
Yes	8 (67%)	0.080	4 (22%)	0.062
No	4 (33%)		14 (78%)	
Patency of IMA or lumbar				
Yes	11 (92%)	0.044*	7 (39%)	0.090
No	1 (8%)		11 (61%)	
Thrombus				
< 25%	6 (50%)	0.060	6 (33%)	0.070
25-50%	5 (42%)		4 (22%)	
>50%	2 (8%)		8 (44%)	
Cross sectional diameter				
< 60mm	3 (25%)	0.009*	11 (61%)	0.055
60-70mm	2 (17%)		4 (22%)	
>70mm	7 (58%)		3 (17%)	
Proximal landing zone Thrombus				
< 25%	3 (25%)	0.090	10 (56%)	0.060
25-50%	5 (42%)		4 (22%)	
>50%	4 (33%)		4 (22%)	
Neck angulation				
< 60%	1 (8%)	0.044*	14 (78%)	0.100
>60%	11 (92%)		4 (22%)	
Neck length				
< 15mm	6 (50%)	0.100	8 (44%)	0.080
> 15mm	6 (50%)		10 (56%)	
Calcification				
< 25%	4 (33%)	0.060	3 (17%)	0.070
25-50%	7 (58%)		10 (56%)	
>50%	1 (8%)		5 (28%)	
Distal landing zone				
Length < 20mm	2 (17%)	0.060	8 (44%)	0.080
Length > 20mm	10 (83%)		10 (56%)	

n.a.: not applicable. * statistical significant

REFERENCES

1. Blankensteijn JD, de Jong SM, Prinssen MM, et al; Dutch Randomized Endovascular Aneurysm Management (DREAM) Trial Group. Two-year outcomes after conventional or endovascular repair of abdominal aortic aneurysms. N Engl J Med. 2005; 352(23):2398-2405
2. Lederle FA, Freischlag JA, Kyriakides TC, et al. Outcomes following endovascular vs open repair of abdominal aortic aneurysm. JAMA. 2009;302(14):1535-1542.
3. Malina M, Resch T, Sonesson B.EVARand complex anatomy: An update on fenestrated and branched stent grafts. Scand J Surg 2008;97:195-204
4. Prinssen M, Verhoeven EL, Buth J, et al: A randomized trial comparing conventional and endovascular repair of abdominal aortic aneurysms. N Engl J Med 2004; 351:1607-1618
5. http://ciberseguranca.spms.min-saude.pt/wp-content/uploads/2018/03/Guia-Privacidade-SMPS_RGPD_digital_20.03.172-v.2.pdf
6. Eur J Vasc Endovasc Surg (2011) 41, S1eS58
7. Piazza M et all; Role of aneurysm sac embolization during endovascular aneurysm repair in the prevention of type II endoleak-related complications;J Vasc Surg 2013 Apr;57(4):934-41. doi: 10.1016/j.jvs.2012.10.078. Epub 2013 Feb 4.
8. Piazza M et all, Definition of Type II Endoleak Risk Based on Preoperative Anatomical Characteristics, J Endovasc Ther. 2017 Aug;24(4):566-572. doi: 10.1177/1526602817712511. Epub 2017 Jun 5
9. Muthu C, Maani J, Plank LD, Holden A, Hill A. Strategies to reduce the rate of type II endoleaks: routine intraoperative embolization of the inferior mesenteric artery and thrombin injection into the aneurysm sac. J Endovasc Ther 2007;14:661-8
10. Schuurmann RCL et al, Aortic Curvature Is a Predictor of Late Type Ia Endoleak and Migration After Endovascular Aneurysm Repair, J Endovasc Ther. 2017 Jun;24(3):411-417. doi: 10.1177/1526602817700378. Epub 2017 Mar 28.
11. T. Ohrlander et al; Preoperative Spirometry Results as a Determinant for Long-term Mortality after EVAR for AAA; European Journal of Vascular and Endovascular Surgery 43 (2012) 43e47
12. Bendermacher BL et al; Influence of gender on EVAR outcomes with new low-profile devices; J Cardiovasc Surg (Torino). 2013 Oct;54(5):589-93.
13. Gallitto E et all, Impact of iliac artery anatomy on the outcome of fenestrated and branched endovascular aortic repair; J Vasc Surg. 2017 Sep 6. pii: S0741-5214(17)31359-9. doi: 10.1016/j.jvs.2017.04.063. [Epub ahead of print]

ORIGINAL ARTICLE **VASCULAR SURGERY**

TYPE B AORTIC DISSECTION - A SINGLE CENTER SERIES

Isabel Poleri[1], Marina Dias-Neto[1,2], João Rocha-Neves[1,2,3], Sérgio Sampaio[1,2].

[1]Faculty of Medicine, University of Porto, Portugal.
[2]Department of Angiology and Vascular Surgery, São João Hospital, Porto, Portugal.
[3]Department of Biomedicine – Unity of Anatomy, Faculdade de Medicina da Universidade do Porto, Portugal

***Contacto Autor:** marina_f_neto@hotmail.com

Abstract

Background: Type B aortic dissection (TBAD) is associated with high morbidity and mortality. The DISSECT classification aims to reunite clinical and anatomical characteristics of interest to clinicians involved in its management. This paper aims to characterize a cohort of patients admitted for type B aortic dissection in a tertiary institution.

Methods: This is a retrospective study that included all patients admitted to the hospital due to TBAD from 2006 to 2016. The computerized tomographic angiography that enabled the TBAD diagnosis were reevaluated using DISSECT classification.

Results: Thirty-two patients were included in this case series. As to DISSECT classification, 79.3% were acute (Duration), 66% had a primary Intimal tear location in aortic arch, the maximum aortic diameter was 44±13mm (Size), 60% extended from aortic arch to abdomen or iliac arteries (Segmental Extent), 28% presented with Complications, and 28% had partial Thrombosis of false lumen. Six patients underwent intervention during the follow-up period. At 12 months, overall survival was 75.4%±8.3% and survival free of aorta-related mortality was 87.0±6.1%. Survival free of aortic dilatation was 82.6±9.5%. In univariate analysis, the presence of complications and chronic kidney disease associated with increased overall and aorta-related mortality rates. Hypertension was associated with aortic dilatation.

Conclusions: The outcomes after TBAD in a Portuguese center are reported. All interventions in TBAD were performed due to complications. The presence of complications and chronic kidney disease was associated with overall mortality and aorta-related mortality and hypertension with aortic dilatation. DISSECT classification was possible to apply in all patients.

INTRODUCTION

Type B aortic dissection (TBAD) consists in a tear in the inner lining of aorta, causing the presence of a false lumen that allows blood circulation on the media layer.[1] Stanford classification divides this pathology, based on the anatomic involvement of the aorta, involving the ascending aorta (Type A), and distally to the left subclavian artery (Type B).[2] TBAD corresponds to 40% of all aortic dissections and has an estimated incidence between 2.9 and 3.5 per 100,000. This condition is associated with high morbidity and mortality.[3-6] Portuguese studies are scarce and mostly small cases series. Exceptions are reported outcomes of aortic dissection together with other thoracic pathologies undergoing TEVAR.[7,8]

The classic presentation consists in sudden and intense chest and interscapular pain associated with hypertension.[3,9] In fact, although the etiology of TBAD is multifactorial, hypertension is an important risk factor and is present in 80% of cases.[1,9] The clinical management of this patients has been highly controversial mainly since the development of endovascular techniques that allow the repair of the dissected aorta in a less invasive way.[10] The patients with complicated TBAD (malperfusion syndrome, aortic rupture, aneurismal dilatation, proximal or distal progression of the dissection, refractory pain and refractory hypertension) – about 20%, were classically treated with thoracotomy. However, European Society of Cardiology and the new guidelines of European Society for Vascular Surgery now recommend primary treatment with endovascular approach if anatomically fit.[1,5,9,11,12]

The management of uncomplicated TBAD is more complex. The classic treatment consists on pharmacologic management with antihypertensive drugs, being beta-blockers the first line choice.[13] However, the advance of thoracic endovascular aortic repair (TEVAR) has provided an alternative to the treatment of uncomplicated TBAD. Two randomized trials evaluated the possibility of using endovascular methods as first line therapy. The ADSORB (Acute Dissection Stentgraft OR Best Medical Treatment) trial[14] demonstrated, after a year of follow up, that TEVAR in addition to best medical treatment is safe and is related with aortic remodeling, false lumen thrombosis and reduction of its diameter

when compared with best medical treatment alone.[14] The INSTEAD-XL (Investigation of Stent Grafts in Aortic Dissection with extended follow-up) trial concluded that TEVAR in addition to best medical treatment allowed a 5-year improvement in aorta-related mortality.[11]

The natural history of uncomplicated TBAD and, especially, who are the patients that benefit of an interventive strategy is yet to be clarified. Thus, the evaluation of patients with TBAD treated with the different available modalities is needed.

The aim of this paper is to characterize a cohort of patients admitted for type B aortic dissection in a tertiary institution from 2006-2016.

METHODS

This paper consists in a retrospective study that included all patients with TBAD admitted to a tertiary hospital with a referral area of about 0.7 million habitants, in the period from march of 2006 to the end of 2016.

The sample was obtained from the analysis of all patients codified with aortic dissection in ICD9 (4441 – Aneurysm and Aortic Dissection; 44100 - Aortic Dissecting Aneurysm, site non-specified; 44101 – Thoracic Aortic Dissecting Aneurysm; 44102 – Abdominal Aortic Dissecting Aneurysm; 44103 – Thoraco-abdominal Aortic Dissecting Aneurysm). Demographic characteristics, comorbidities such as diabetes, hypertension, hyperlipidemia, carotid disease, coronary disease, chronic kidney disease, pulmonary disease, heart failure, history of coronary treatment (percutaneous transluminal coronary angioplasty and coronary artery bypass surgery), peripheral artery disease, history of heart surgery and usual medication of all patients were collected from clinical registries. For each patient, the computerized tomographic (CT) angiography that enabled the TBAD diagnosis was classified using the DISSECT classification. The date of the first CT scan was considered the inclusion date. The DISSECT classification, proposed by Dake *et al*[15], is a new mnemonic based approach on the evaluation of aortic dissections that aims at standardizing the imaging and clinical classification of this patients. This classification includes the analysis of six variables that influence the therapeutic decision: Duration of dissection, (primary) Intimal tear location within the aorta, Size based on the maximum trans-aortic diameter (true lumen), aortic involvement Segmental extent from proximal to distal boundary, Clinical complications related to dissection and aortic false lumen Thrombosis. While a recent consensus document on aortic pathology recommends that arch involvement either by the most proximal tear or by retrograde extension to be referred to as non-A-non-B aortic dissection[16], the DISSECT classification for TBAD do not address this question directly and contemplates the arch as a possible location for the primary entry tear in TBAD.

The primary outcomes of this paper were defined as overall mortality, aorta-related mortality and aortic dilatation (>3 mm). The need for aortic surgery after TBAD diagnosis was also analyzed.

Table 1 **Demographic characteristics and comorbidities of 32 patients with type B aortic dissection. Legend: MI – myocardial infarction**

	No. or mean	%
Gender		
Male	27	84
Female	5	16
Age	60±13	
Tobacco		
No	14	534
Ex-smoker	5	19
Smoker	7	27
Diabetes Mellitus		
No	28	88
Diet or oral medication controlled	13	9
Insulin dependent	1	3
Hypertension		
No	5	16
Regulated by monotherapy	25	78
Regulated by 2 drugs	2	6
Regulated by > 2 drugs	0	0
Carotid disease		
No	28	88
Asymptomatic significant stenosis	0	0
History of transient ischemic attack	1	3
Ischemic stroke	3	9
Coronary disease		
No	29	91
Stable Angina	0	0
Unstable Angina	0	0
MI > 1 year	0	0
MI <1 year	3	9
Chronic kidney disease		
No	21	66
Mild increased serum creatinine <210μmol/L	7	22
Severe increased serum creatinine 220-250μmol/L	2	6
Serum creatinine >250μmol/L or dialysis/ kidney transplantation dependent)	2	6

The statistical analyses were performed using SPSS (IBM Corp., released 2017. IBM SPSS Statistics for Windows, version 25.0, Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) when normally distributed and as median and interquartile range (IQR) when skewed. Categorical variables were presented as percentages. Overall mortality rates and aorta-related mortality rates were estimated using Kaplan-Meier method. Univariate analyses for predictors of overall mortality, aorta-related mortality and aortic dilatation was undertaken using Log-Rank test. In order to adjust for multiple comparisons, p value was considered significant if <0.017.

RESULTS

We included 32 patients, ascertaining a TBAD rate of approximately 5 per 1.000.000 in the last 10 years. The median follow up time was 38 months (95% confidence interval of 8-68 months). The majority were male (84%) with a mean age of 60±13 years; 84% presented hypertension, 46% were ex-smokers or active smokers, 13% had diabetes and 9% had myocardial infarction in the previous year (Table 1).

DISSECT classification

Regarding DISSECT classification, 79% were acute, 66% had a primary intimal tear location in the aortic arch (non-A non-B aortic dissection), the maximum aortic diameter was 44±13mm, 60% extended from aortic arch to abdomen or iliac arteries, 28% presented with complications, being rupture (16%) and branch vessel malperfusion (9%) the most frequent, and 28% had partial false lumen thrombosis (versus 66% with permeability of false lumen). DISSECT classification among patients is represented in Table 2.

Aortic Intervention

Six patients underwent surgery, 3 of them in acute phase, 1 of them in subacute phase and 2 of them in chronic phase. All patients that underwent surgery did so due to complications of TBAD. In the acute phase, TEVAR was performed due to branch vessel malperfusion (1) or aortic rupture (3). In the subacute phase, an open correction of abdominal aortic aneurysm was performed in a patient with TBAD due to abdominal aortic rupture. Two additional patients were treated in the chronic phase due to aortic valve insufficiency and ascending aorta aneurysm (1) and due to abdominal aorta aneurysm (1). Three of these patients died, all of them with aortic-related deaths.

Mortality and Aortic dilatation

Thirty days survival and survival free of aorta-related mortality was, respectively, 87.5±5.8% and 90.6±5.2%. At 12 months, overall survival was 75.4%±8.3% and survival free of aorta-related mortality was 87.0%±6.1% (Figure 1 A and B). Mortality causes are reported in Table 3. Univariate analysis identified the presence of complications and chronic kidney disease (CKD) as risk factors of overall mortality and

Table 2 **DISSECT classification in patients of type B aortic dissection**

	No. or mean	%
Duration		
Acute - < 2 weeks from onset of symptoms	23	79
Subacute - 2 weeks to 3 months after symptom onset	1	3
Chronic - > 3 months from initial symptoms	5	17
Intimal tear location		
Ascending aorta	0	0
Aortic arch	21	66
Descending aorta	11	34
Abdominal aorta	0	0
Unknown	0	0
Aortic size		
maximum trans-aortic diameter	22.7±10.8 43.7±13.2	
Segmental extent		
Aortic Arch to Abdominal Aorta	10	30
Aortic Arch to Iliac	11	33
Descending exclusively	5	15
Descending to abdominal Aorta	1	3
Descending to iliac	5	15
Complications		
Aortic valve involvement	0	0
Cardiac tamponade	1	3
Rupture	5	16
Branch vessel malperfusion	3	9
Progression of aortic involvement with proximal or distal extension of dissection	0	0
Other	0	0
None	23	72
False lumen thrombosis		
Patent aortic false lumen	21	66
Complete thrombosis	2	6
False thrombosis	9	28

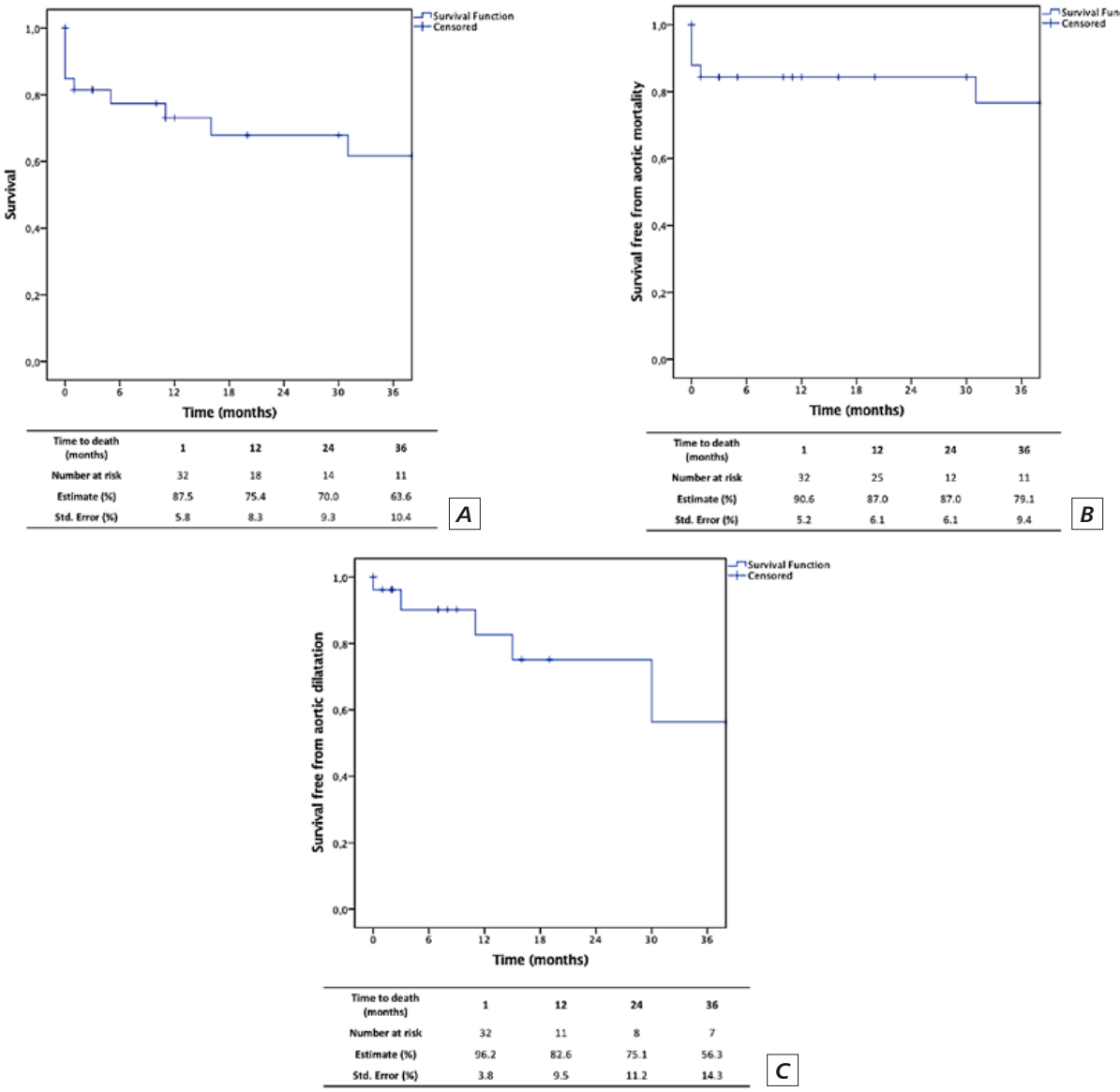


Figure 1 *Overall survival (**A**), survival free of aorta-related mortality (**B**) and survival free of aortic dilatation of 32 patients with TBAD (**C**).*

Table 3 **Causes of mortality in patients with type B aortic dissection**

Time between inclusion and death (days)	Cause of death
1	Ventricular fibrillation
8	Aortic rupture
10	Aortic rupture
13	Aortic rupture
21	Aortic rupture
50	Aortic rupture
344	Intracerebral hemorrhage
513	Septic shock
965	Aortic rupture

aorta-related mortality. Other two variables included in the DISSECT classification presented association with mortality (acute presentation, p=0.046) and with aortic-related mortality (intimal tear location, p=0.045), but this statistical significance was lost after adjustment for multiple comparisons.

At 12 months, survival free of aortic dilatation was 82.6±9.5% (Figure 1 C). Hypertension was identified as a risk factor of aortic dilatation. No significant differences were found in the remaining groups. Univariate analyses for predictors of overall mortality, aorta-related mortality and aortic dilatation are presented in Table 4.

DISCUSSION

Management of aortic dissection has been challenged by recent evidence both in the diagnostic and in the

Table 4 **Univariate analyses for predictors of overall mortality, aorta-related mortality and aortic dilatation. *P value was considered significant if <0.017***

Variables	Overall mortality (P-value)	Aorta-related mortality (P-value)	Aortic dilatation (P-value)
Demographics and comorbidities			
Male gender	0.546	0.546	0.179
Smoker	0.899	0.384	0.728
Diabetes	0.500	0.750	0.210
Hypertension	0.585	0.186	<0.001
Carotid disease	0.575	0.110	0.072
Coronary disease	0.835	0.406	0.637
Chronic Kidney disease	0.002	0.002	0.454
Heart failure	0.749	0.515	0.391
Peripheral arterial disease	0.240	0.703	0.690
DISSECT classification			
Duration of presentation	0.046	0.052	0.469
Intimal tear location	0.276	0.045	0.768
Complications	<0.001	<0.001	0.052
False lumen thrombosis	0.399	0.255	0.955

therapeutic fields. Due to the absence of Portuguese publications dedicated to this topic, it is not known whether these developments are affecting the real practice and in what extent. In this paper, a low rate of admissions due to TBAD was reported and most interventions were performed due to acute complications. The presence of complications and CKD were associated with overall mortality and aorta-related mortality and hypertension with aortic dilatation. DISSECT classification was possible to apply in all patients and demonstrated association with mortality and aortic-related mortality.

Regarding the Portuguese literature about TBAD, a study reviewed all patients that underwent TEVAR (n=52) from 2007 to 2017. Chronic TBAD was the second most frequent surgical indication, being performed in 18 patients. In-hospital mortality was 3.9% and survival at 1, 2 and 5 years was 87.9%, 85.6% and 71.5%, respectively.[7] Another study assessed 27 patients who were eligible to TEVAR, 3 of them due to TBAD complicated with rupture. Thirty days and 24 months global mortality for the whole group were, respectively, 4% and 13% but specific mortality due to TBAD was not available.[8] Like in this paper, the sample size of these series was small, despite including similar time frames. Even though these studies provide some background on TEVAR as a strategy to treat thoracic aorta diseases, none of them approaches TBAD as the main topic of debate.

In this series most patients had acute TBAD (79%) and TEVAR was performed mostly in the acute phase and in the presence of complications. In the literature, in-hospital survival in complicated TBAD patients treated conservatively is about 50%. Technical success of complicated TBAD patients treated with TEVAR ranged from 95% to 99%, and hospital mortality ranged from 2.6% to 9.8%.[9] The global mortality obtained in this case series was comparable, being of 12.5% at 30 days.

The randomized trials that compare the endovascular with standard medical treatment[10,14] lead to the general recommendation that, to prevent aortic complications in uncomplicated acute type B aortic dissection, early thoracic endografing may be considered selectively (Class IIb, Level of evidence B).[9] Despite this evidence, no patients were treated due to isolated non-complicated TBAD in this series. It is worth of note that the cited guidelines were published only in 2017 based on randomized trials from 2014. It would of interest to compare this case series with recent cohorts to assess in what extent the recent guidelines are changing the indications for intervention in TBAD and its prognosis.

The univariate analyses demonstrated an association between the presence of complications and CKD on overall mortality and aorta-related mortality. Hypertension was identified as a risk factor of aortic dilatation. Some independent risk factors for mortality in TBAD have been described in literature (Table 5). These include age and some other clinical co-morbidities, as acute renal injury, coronary heart disease or pulmonary disease as independent predictors of mortality.[4,6,17-22] Other studies have been carried to evaluate image determinants in non-complicated TBAD to determinate the patients that would benefit from

Table 5 Predictors of mortality in type B aortic dissection

Glower. 1990[15]	Presenting complication of dissection Age Rupture
Umaña. 2002[16]	Shock Visceral ischemia Arch extension Rupture Stroke Previous sternotomy Coronary artery disease Pulmonary disease
Suzuki. 2003[17]	Branch vessel involvement Lack of chest/back pain Hypotension/shock
Tsai. 2006[18]	Female gender History of prior aortic aneurysm History of atherosclerosis In-hospital renal failure Pleural effusion on chest radiograph In-hospital hypotension/shock
Jonker. 2013[4]	Age ≥ 70 years Descending aortic diameter ≥ 5.5 cm Hypotension/shock Visceral ischemia Acute renal failure
Ray. 2016[19]	Aortic diameter >44 mm Age>60 years
Matsushita. 2017[20]	Initial aortic diameter >40mm False-lumen diameter > true-lumen diameter
Guo. 2017[21]	Maximum diameter of the affected aorta

an endovascular procedure as first line therapy. Schwartz et al, evaluated 254 patients with medical treatment and concluded that an aortic diameter >40mm, an entry tear >10mm and patency of true lumen are associated with an increased risk of subsequent aortic intervention and recommend treatment with TEVAR in these cases.[23] Also, a false lumen >22mm and an aortic diameter >44mm are predictors of intervention.[20] A study conducted by Sailer *et al*[24] demonstrates that the presence of connective tissue disease and 4 morphological features identified by CT scan (false lumen circumferential coverage, maximum aortic diameter, false lumen outflow volume and number of intercostals arteries) are independently associated with late adverse events. These types of studies aim at the development of a risk-prediction model that allows to calculate the individual risk of adverse events after an initially uncomplicated TBAD, identifying patients who would benefit of an endovascular intervention at an early stage.

The two classical classifications of TBAD (DeBakey and Stanford) are based mostly on anatomic characteristics and have been used to allow the division of the patients in two groups: those who will benefit from surgical treatment and those who will be submitted to medical treatment alone. However, these classifications are too simplistic and not validated for the complex demand of the treatment of TBAD where endovascular techniques may play an important role. In this decision, factors such as duration of the disease, presence of complications or false lumen thrombosis need to be considered and the previously referred classic methods do not take them into account. Another difficulty in the patient selection for endovascular treatment is the heterogeneity in the reports of cases of TBAD. The DISSECT classification was proposed to address these problems. Being a mnemonic--based method, it is easy to apply and takes into consideration a group of characteristics of interest in contemporary therapeutic decision of patients with aortic dissection, particularly those with TBAD. This classification allows an easy interaction between anatomical and clinical aspects that are relevant to assist the decision of contemporary treatment of patients with TBAD, in which endovascular techniques are emerging.[15] The classification was suitable and feasible as it was easily applied to all patients in this cases series and some of its variables associated with the studied outcomes.

LIMITATIONS

One of the most intriguing results of this paper is the verified rate of TBAD that was lower than in previous reports.[3] This low rate might reflect a lower prevalence of the disease in the North of Portugal or the lack of an appropriate diagnose. Since there is no codification that corresponds directly to patients with TBAD, miscoding of patients with this pathology might have happened. Absolute numbers of incidence of TBAD reported in this study are thus of limited value and deserve further studies. The small sample size obtained did not allow for multivariate analysis, so complications, CKD and hypertension could not be tested as independent prognostic factors.

CONCLUSION

TBAD is an entity whose best approach to patients is yet to be clarified. DISSECT classification is valuable in the staging and decision making of these patients. New trends in the treatment of patients with TBAD show endovascular techniques as a viable option for their treatment, especially in those which clinical and anatomic characteristics whom predict later intervention. Referral centers may improve decision making of low incidence diseases such as TBAD. Notwithstanding, further studies are needed to characterize TBAD in Portugal.

REFERENCES

1. Tang DG, Dake MD. TEVAR for acute uncomplicated aortic dissection: immediate repair versus medical therapy. Semin Vasc Surg 2009;22:145-51.
2. Daily PO, Trueblood HW, Stinson EB, Wuerflein RD, Shumway NE. Management of acute aortic dissections. Ann

Thorac Surg 1970;10:237-47.
3. Scott AJ, Bicknell CD. Contemporary Management of Acute Type B Dissection. Eur J Vasc Endovasc Surg 2016;51:452-9.
4. Jonker FH, Trimarchi S, Muhs BE, et al. The role of age in complicated acute type B aortic dissection. Ann Thorac Surg 2013;96:2129-34.
5. Hughes GC, Andersen ND, McCann RL. Management of acute type B aortic dissection. J Thorac Cardiovasc Surg 2013;145:S202-7.
6. Suzuki T, Mehta RH, Ince H, et al. Clinical profiles and outcomes of acute type B aortic dissection in the current era: lessons from the International Registry of Aortic Dissection (IRAD). Circulation 2003;108 Suppl 1:II312-7.
7. Cruz Tomas A, Laranjeira Santos A, Pinheiro Santos J, Varela-Afonso D, Fragata J. TEVAR - A Primary or Adjunct Procedure Helpful in the Surgical Correction of Complex Pathology of the Thoracic Aorta? Rev Port Cir Cardiotorac Vasc 2017;24:128.
8. Dias-Neto M, Ramos JF, Dias PG, et al. [TEVAR: a strategy for the diversity of thoracic aorta disease. Series of cases and national prospect]. Rev Port Cir Cardiotorac Vasc 2014;21:43-54.
9. Riambau V, Bockler D, Brunkwall J, et al. Editor's Choice - Management of Descending Thoracic Aorta Diseases: Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). Eur J Vasc Endovasc Surg 2017;53:4-52.
10. Nienaber CA, Rousseau H, Eggebrecht H, et al. Randomized comparison of strategies for type B aortic dissection: the INvestigation of STEnt Grafts in Aortic Dissection (INSTEAD) trial. Circulation 2009;120:2519-28.
11. Nienaber CA, Kische S, Rousseau H, et al. Endovascular repair of type B aortic dissection: long-term results of the randomized investigation of stent grafts in aortic dissection trial. Circ Cardiovasc Interv 2013;6:407-16.
12. Erbel R, Aboyans V, Boileau C, et al. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). Eur Heart J 2014;35:2873-926.
13. Nienaber CA, Divchev D, Palisch H, Clough RE, Richartz B. Early and late management of type B aortic dissection. Heart 2014;100:1491-7.
14. Brunkwall J, Kasprzak P, Verhoeven E, et al. Endovascular repair of acute uncomplicated aortic type B dissection promotes aortic remodelling: 1 year results of the ADSORB trial. Eur J Vasc Endovasc Surg 2014;48:285-91.
15. Dake MD, Thompson M, van Sambeek M, Vermassen F, Morales JP, Investigators D. DISSECT: a new mnemonic-based approach to the categorization of aortic dissection. Eur J Vasc Endovasc Surg 2013;46:175-90.
16. Czerny M, Schmidli J, Bertoglio L, et al. Clinical Cases Referring to Diagnosis and Management of Patients With Thoracic Aortic Pathologies Involving the Aortic Arch: A Companion Document of the 2018 European Association for Cardio-Thoracic Surgery (EACTS) and the European Society for Vascular Surgery (ESVS) Expert Consensus Document Addressing Current Options and Recommendations for the Treatment of Thoracic Aortic Pathologies Involving the Aortic Arch. Eur J Vasc Endovasc Surg 2019;57:452-60.
17. Glower DD, Speier RH, White WD, Smith LR, Rankin JS, Wolfe WG. Management and long-term outcome of aortic dissection. Ann Surg 1991;214:31-41.
18. Umaña JP, Lai DT, Mitchell RS, et al. Is medical therapy still the optimal treatment strategy for patients with acute type B aortic dissections? The Journal of Thoracic and Cardiovascular Surgery 2002;124:896-910.
19. Tsai TT, Fattori R, Trimarchi S, et al. Long-term survival in patients presenting with type B acute aortic dissection: insights from the International Registry of Acute Aortic Dissection. Circulation 2006;114:2226-31.
20. Ray HM, Durham CA, Ocazionez D, et al. Predictors of intervention and mortality in patients with uncomplicated acute type B aortic dissection. J Vasc Surg 2016;64:1560-8.
21. Matsushita A, Hattori T, Tsunoda Y, Sato Y, Mihara W. Impact of initial aortic diameter and false-lumen area ratio on Type B aortic dissection prognosis. Interact Cardiovasc Thorac Surg 2017.
22. Guo B, Hou K, Guo D, et al. Outcomes of thoracic endovascular repair for type B aortic dissection with multichanneled morphology. J Vasc Surg 2017;66:1007-17.
23. Schwartz SI, Durham C, Clouse WD, et al. Predictors of late aortic intervention in patients with medically treated type B aortic dissection. J Vasc Surg 2017.
24. Sailer AM, van Kuijk SM, Nelemans PJ, et al. Computed Tomography Imaging Features in Acute Uncomplicated Stanford Type-B Aortic Dissection Predict Late Adverse Events. Circ Cardiovasc Imaging 2017;10.

AGENÉSIA DA VEIA CAVA SUPERIOR DIREITA COM PERSISTÊNCIA DA VEIA CAVA SUPERIOR ESQUERDA ASSOCIADA A BLOQUEIO AURÍCULO-VENTRICULAR COMPLETO

Tiago R. Velho, Hugo Ferreira, Nuno Guerra, Javier Gallego, Ângelo Nobre

Serviço de Cirurgia Cardiotorácica – Hospital de Santa Maria, Centro Hospitalar Lisboa Norte

*Contacto Autor: tiagovelho48@hotmail.com

Resumo

A persistência da veia cava superior esquerda é uma alteração rara do sistema venoso, que pode ou não estar associada a agenesia da veia cava superior direita. É normalmente assintomática e diagnosticada maioritariamente durante a realização de procedimentos cirúrgicos ou não invasivos. Apresentamos um caso clínico de um homem de 72 anos, submetido a cirurgia de substituição de válvula aórtica, com diagnóstico intra-operatório de agenesia da veia cava superior direita e persistência da veia cava superior esquerda. O doente desenvolveu bloqueio aurículo-ventricular completo no período pós-operatório, com necessidade de colocação de um *pacemaker* definitivo pela veia braquiocefálica e através do seio coronário. Este caso pretende demonstrar as possíveis implicações clínicas com a identificação desta alteração, e as modificações necessárias da estratégia cirúrgica.

Abstract

Persistent left superior vena cava with agenesis of the right superior vena cava in a patient with complete atrioventricular block

Persistant left superior vena cava is a rare systemic venous anomaly that can be associated with agenesis of the right superior vena cava. It is usually assymptomatic and discovered incidentally during surgery or other procedures. The authors present the case of a 72-year-old male submitted to an aortic valve replacement surgery. After sternotomy, persistant left superior vena cava and absence of the right superior vena cava were identified. The patient developed complete atrioventricular block after surgery, requiring the implantation of a definitive cardiac pacemaker through the brachiocephalic vein and coronary sinus. This case highlights and ilustrates the clinical implications of the described systemic venous anomalies, discussing the necessary management both in the perioperative and intraoperative periods.

INTRODUÇÃO

A persistência da veia cava superior esquerda (PVCSE) é uma alteração do sistema vascular venoso, estando presente em 0.3-0.5% dos indivíduos sem patologia, e 3-10% nos indivíduos com patologia cardíaca congénita.[1]

A agenesia da veia cava superior direita concomitante é mais rara, ocorrendo em 10-17% dos casos de PVCSE.[2] Nestes casos, a VCS esquerda drena maioritariamente para o seio coronário (identificando-se no ecocardiograma dilatação do seio coronário), embora também possa drenar para a veia cava inferior, veia hepática ou diretamente para a aurícula esquerda.[2]

A PVCSE é normalmente inócua, embora possa criar dificuldades na colocação de acessos venosos centrais, durante cirurgias cardíacas (pode alterar a proteção

miocárdica e a estratégia de CEC) ou na implementação de dispositivos cardíacos como *pacemakers*.[3] Adicionalmente, quando a drenagem ocorre para a aurícula esquerda, pode haver um shunt direito-esquerdo.[3]

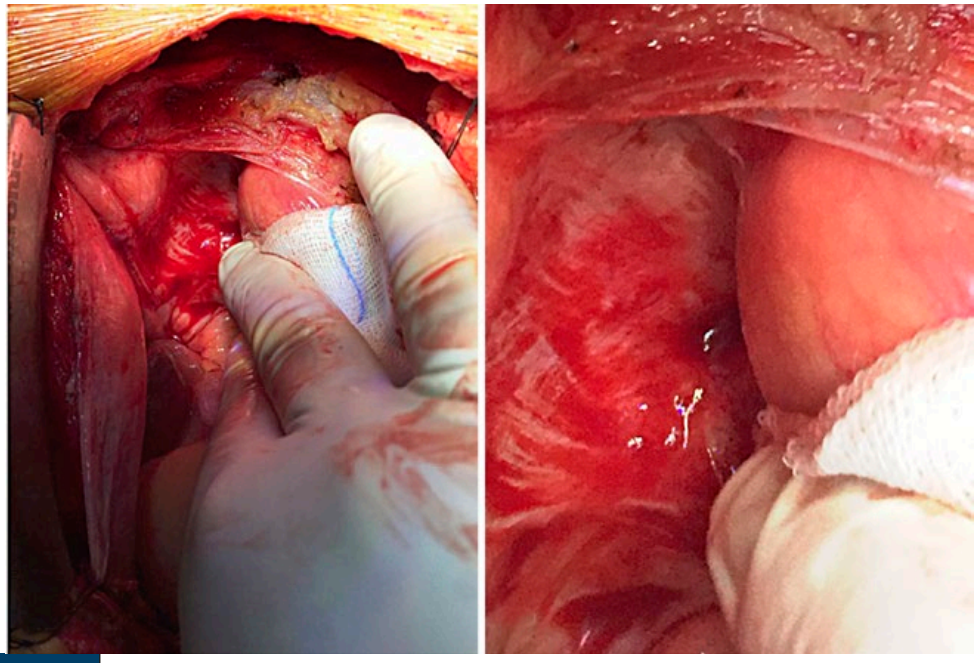


Figura 1 *Constatação intra-operatória de agenésia da veia cava superior direita.*

CASO CLÍNICO

Doente do sexo masculino, 72 anos, com história de hipertensão arterial, dislipidémia, diabetes *mellitus* insulino-tratado, fibrilhação auricular e enfarte agudo do miocárdio sem elevação do segmento supra-ST em 2006 [com angiodisplasia prévia da artéria coronária descendente anterior (DA) e coronária direita (CD)], observado na consulta de Cardiologia por cansaço progressivo para médios esforços, com 3 meses de evolução, sem angor. Na auscultação cardíaca apresentava um sopro sistólico na área aórtica.

O ecocardiograma transtorácico realizado documentou uma válvula aórtica tricúspide, fibrocalcificada, com gradiente médio de 39mmHg, velocidade máxima 3,8m/s, área valvular de 0,7cm^2, ventrículo esquerdo ligeiramente hipertrofiado, com função sistólica globalmente conservada (fração de ejeção de 53%), sem outras alterações valvulares ou sinais de cardiopatia congénita.

A coronariografia apresentava lesão de 50-70% na artéria coronária circunflexa (Cx), sem outras lesões (*stents* permeáveis). Foi proposto para cirurgia de substituição de válvula aórtica e eventual revascularização cirúrgica do miocárdio.

A cirurgia foi realizada com esternotomia mediana, com circulação extracorporal, com cardiolegia realizada de forma anterógrada. Intra-operatoriamente verificou-se agenesia da veia cava superior direita (Figura 1A e 1B), com PVCSE (Figura 2) com conexão ao seio coronário. Realizou-se substituição de válvula aórtica por prótese biológica *Perimount Magna*® 23mm, sem intercorrências. O tempo de circulação extra-corporal foi de 59 minutos e o tempo

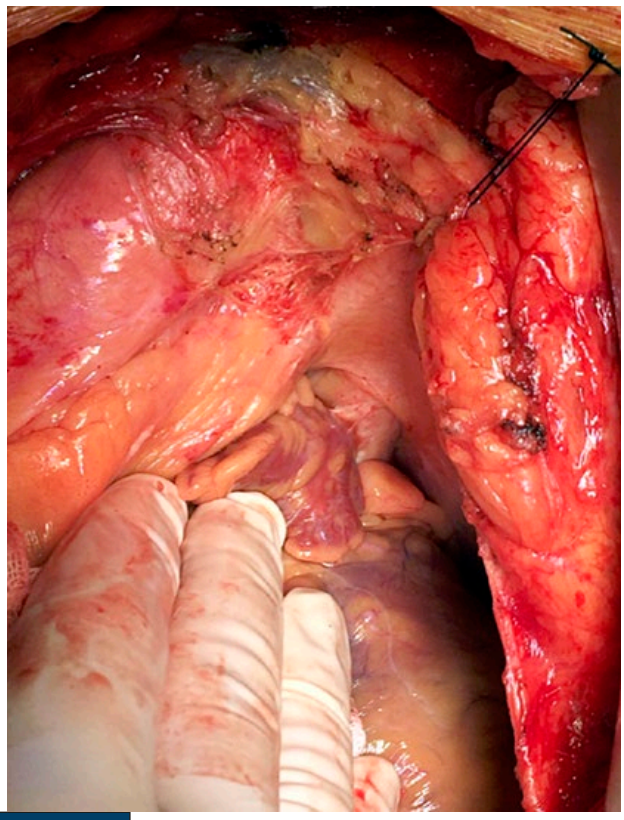


Figura 2 *Persistência de veia cava superior esquerda, com conexão com o seio coronário.*

de clampagem da aorta de 49 minutos. Não foi realizada revascularização cirúrgica do miocárdio por vasos do território da Cx e CD finos e calcificados.

O período pós-operatório na Unidade de Cuidados Intensivos (UCI) caracterizou-se pela necessidade de suporte aminérgico prolongado, lesão renal aguda com creatinina máxima de 2,1mg/dL e bloqueio aurículo-ventricular completo.

Colocou pacemaker definitivo (monocâmara ventricular VVRI) através da veia cefálica esquerda, com trajecto pela veia cava superior esquerda persistente e seio coronário, com colocação do electrocateter no ápex do ventrículo direito (Figura 3), ao sexto dia de pós-operatório. Foi transferido para a Enfermaria ao oitavo dia pós-operatório, tendo tido alta para o domicílio no décimo dia pós-operatório.

Foi observado na consulta pós-operatória quatro semanas após a cirurgia, não tendo ocorrido nenhuma intercorrência relevante desde a alta clínica.

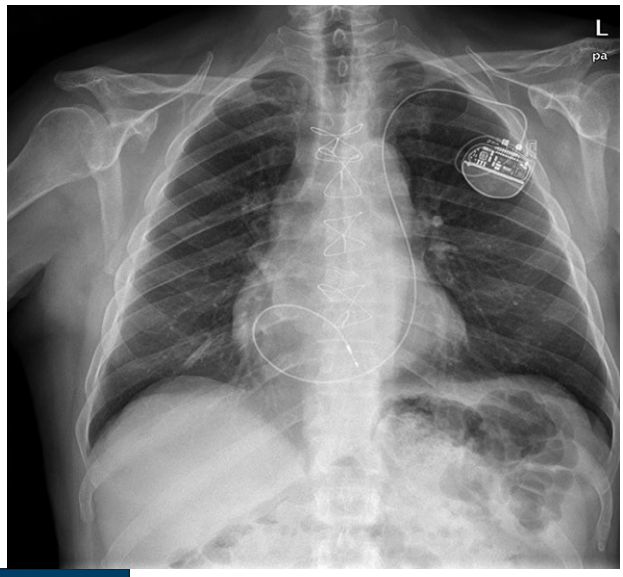


Figura 3 *Radiografia de tórax postero-anterior após colocação de pacemaker definitivo, com trajecto através da veia braquiocefálica, veia cava superior esquerda persistente e seio coronário. O electrocateter foi colocado no ápex do ventrículo direito.*

DISCUSSÃO

No desenvolvimento embriológico normal, a veia cardinal anterior esquerda colapsa e eventualmente degenera, como consequência da criação de uma ponte entre as veias cardinais anteriores esquerda e direita (a última dá origem à veia cava superior), dando origem à veia inominata.

A persistência da veia cava superior esquerda ocorre como consequência da interrupção deste processo embriológico ou quando ocorre a degeneração da veia cardinal anterior direita, ao invés da esquerda.

Nos casos em que a veia cava superior direita não está presente, a drenagem venosa cefálica e braquial normal faz-se através do seio coronário ou da aurícula esquerda. No caso apresentado a drenagem faz-se aparentemente pelo seio coronário, como verificado pela dilatação do seio coronário no ecocardiograma transesofágico realizado intra-operatoriamente.

A PVCSE tem implicações clínicas e deve ser identificada para prevenir possíveis complicações. Do ponto de vista cirúrgico, a PVCSE pode alterar a estratégia de proteção miocárdica, uma vez que não é recomendado que se faça cardioplegia retrógrada.[4] Com a utilização de cardioplegia retrógrada nestes casos, não se consegue garantir a oclusão total por balão do seio coronário, pela sua dilatação, não conseguindo garantir o fluxo retrógrado para o miocárdio.[4,5]

Adicionalmente, a cardioplegia seria distribuída pelas veias jugular interna esquerda e subclávia esquerda.[5]

Alguns estudos descrevem uma associação entre a agenesia da veia cava superior direita e a PVCSE e a ocorrência de bloqueio aurículo-ventricular completo (BAVC).[6,7] Embora não esteja completamente conhecida a relação, julga-se que as anomalias que levam à PVCSE são acompanhadas de alterações do tecido condutor, pela associação destas áreas no desenvolvimento inicial cardíaco intrauterino.

Apesar desta associação, neste caso clínico o BAVC pode estar apenas relacionado com a cirurgia de substituição valvular. Em doentes com diagnóstico de agenesia da veia cava superior e PVCSE, a colocação de eléctrodos de *pacemaker* definitivo pode ser benéfica, pela alta incidência de BAVC no período pós-operatório, e pela dificuldade técnica que pode representar a sua colocação percutânea.

REFERÊNCIAS

1. T. Tak, E. Crouch, and G. B. Drake, "Persistent left superior vena cava : incidence, significance and clinical correlates," Int. J. Cardiol., vol. 82, pp. 91–93, 2002.
2. C. Lalenis, A. Pittaro, F. Geraldini, G. Barbiero, and A. Boscolo, "A Persistent Left-Sided Superior Vena Cava With Agenesis of the Right Superior Vena Cava in a Patient Who Underwent Liver Transplantation : A Case Report," J Med Cases, vol. 7, no. 7, pp. 253–257, 2016.
3. S. Bisoyi, U. Jagannathan, and D. Nayak, "Isolated Persistent Left Superior Vena Cava: A Case Report and its Clinical Implications," Ann. Card. Anaesth., vol. 20, no. 1, pp. 104–107, 2017.
4. N. S. Clarke, R. A. Murthy, and K. J. Guleserian, "Persistent Left Superior Vena Cava : Incidence and Management in Patients Undergoing Repair of Partial Anomalous Pulmonary Venous Connection," World J. Pediatr. Congenit. Hear. Surg., vol. 8, no. 4, pp. 440–444, 2017.
5. B. G. Drinkwater DC Jr, Cushen CK, Laks H, "The use of combined antegraderetrograde infusion of blood cardioplegic solution in pediatric patients undergoing heart operations," J Thorac Cardiovasc Surg, vol. 104, no. 5, pp. 1349–55, 1992.
6. O. D. Morgan, DR, Hanratty CG, Dixon LJ, Trimble M, "Anomalies of cardiac venous drainage associated with abnormalities of cardiac condution system," Europace, vol. 4, no. 3, pp. 281–7, 2002.
7. S. P. Couto GJ, Saraiva RS, Deslandes Ade O, "Agenesis of the right superior vena cava associated with total heart block," Rev Bras Cir Cardiovasc, vol. 23, no. 1, pp. 135–8, 2008.

ACUTE PROSTHETIC AORTIC VALVE OBSTRUCTION LEADING TO FREE AORTIC INSUFFICIENCY VENO-ARTERIAL EXTRACORPOREAL MEMBRANE OXYGENATION AS A BRIDGE TO SURGERY

Marisa Passos Silva[1], Daniel Caeiro[1], Fátima Neves[2], Pedro Braga[1]

[1]Cardiology department, Vila Nova de Gaia/Espinho Hospital Center, Portugal
[2]Cardiac Surgery department, Vila Nova de Gaia/Espinho Hospital Center, Portugal

***Contacto Autor**: marisa.passos.silva@gmail.com

Abstract

Introduction: Mechanical prosthetic valve thrombosis (PVT) and obstruction is a lifethreatening event. The significant morbidity and mortality associated with this condition warrants rapid diagnostic evaluation and treatment.

Case report: A 66-year-old female patient with a history of aortic valve replacement 13 years before, was admitted to our intensive cardiac care unit with symptoms and signs of prosthetic aortic valve dysfunction. During cardiac angiography, she collapsed and fluoroscopy showed an immobile disc, stopped in an open position and causing free aortic regurgitation. Cardio-pulmonary resuscitation (CPR) was initiated and a VA-ECMO was inserted as a bridge to emergent cardiac surgery. Surgery was then performed and the patient was successfully discharged with no neurological impairment.

Discussion: We present a case where Veno-Arterial Extracorporeal Membrane Oxygenation (VA- ECMO) was successfully used as a bridge to emergent surgery in a cardiac arrest patient due to prosthetic valve thrombosis.

Conclusions: This case illustrates how a relative contraindication (severe aortic insufficiency) to VA-ECMO may, in the end, be an indication in a very particular scenario.

CASE REPORT

A 66-year-old female patient with a history of aortic valve replacement 13 years before, presented to our emergency department because of syncope. Before sudden loss of consciousness, she felt severe chest pain and dizziness. In the previous week, she developed complains of heart failure with shortness of breath and orthopnea. She was medicated with an angiotensin receptor blocker, beta blocker and warfarin. On physical examination: slightly hypotensive but peripheral perfusion and lactate level were normal.

A holossystolic murmur was heard on cardiac auscultation and bibasal rales on pulmonary auscultation. Electrocardiogram showed sinus rhythm with no ST-T-anomalies; high sensitivity troponin: 0,096 to 0,194 ng/mL. International normalized ratio level was 2,8.

She was admitted to our intensive cardiac care unit with the leading diagnosis of non-STsegment elevation myocardial infarction or prosthetic aortic valve dysfunction.

Transthoracic echocardiogram (TTE) showed intermittently severe prosthetic aortic valve insufficiency with preserved left ventricle dimensions and function. Transesophageal echocardiography (TOE) showed an apparent monodisc valve with an intermittent delay in disc closure resulting in severe aortic regurgitation (AR). Pulsed-wave Doppler at descending thoracic aorta level showed an intermittent pandiastolic reversal flow indicating acute and severe intermittent AR (Figure 1).

Fluoroscopy was performed to identify the leaflet excursion and confirm the valve type; coronary angiography to exclude coronary artery disease. During this procedure, the patient suddenly collapsed and cardio-pulmonary

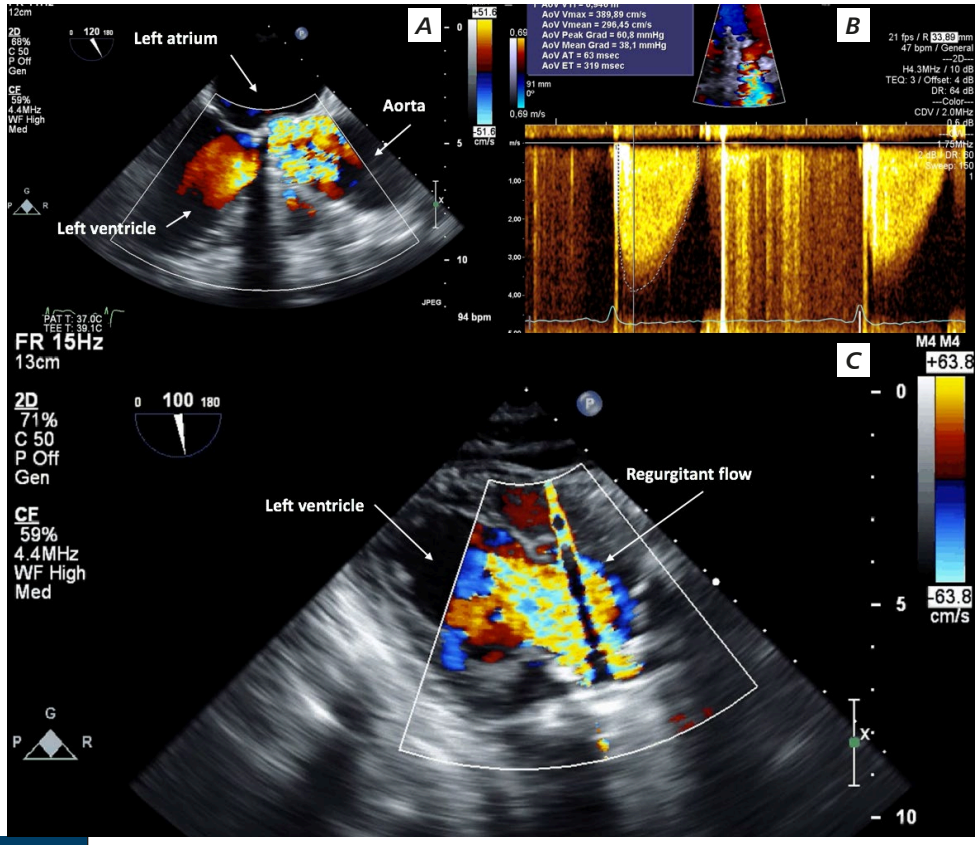


Figure 1

A *- Transesophageal echocardiography (TOE) showing turbulent flow across prosthetic aortic valve;* ***B*** *- Apical four chamber view on transthoracic echocardiography with spectral continuous Doppler demonstrating a peak gradient of 60 mmHg and a mean gradient of 36 mmHg;* ***C*** *- TOE displaying a large aortic regurgitation jet.*

resuscitation (CPR) was initiated. Fluoroscopy showed an immobile disc, stopped in an open position and causing free aortic regurgitation, (Figure 2).

Cardiac surgery was immediately contacted but the operating room was only available in 60 minutes. As a life treating measure it was decided to put a VA-ECMO while

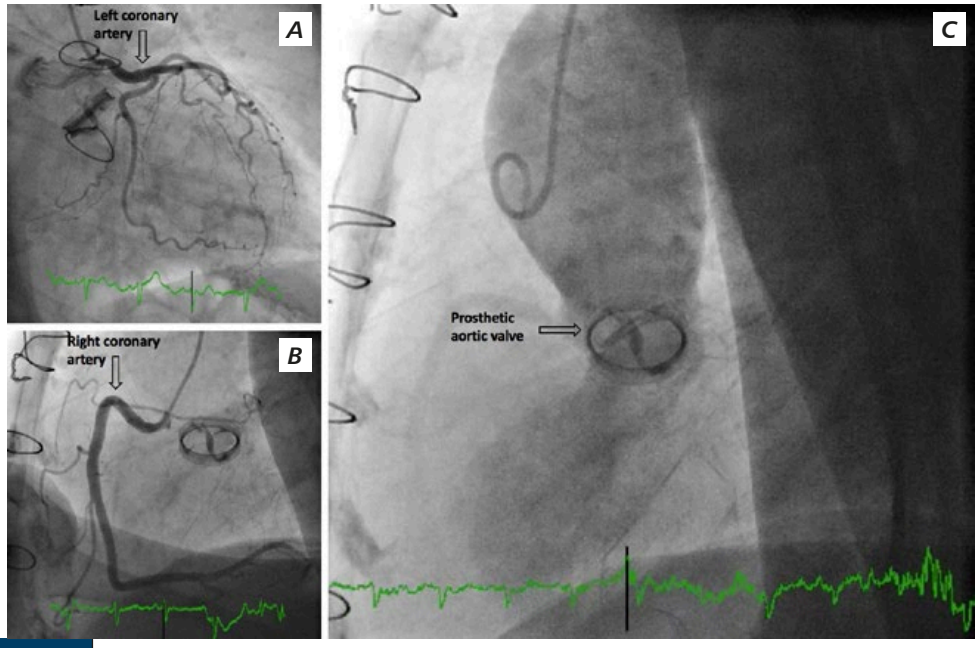


Figure 2

A *and* ***B*** *- Coronary angiography showing normal coronary arteries;* ***C*** *- Severe aortic insufficiency due to disc immobilization in an open position.*

waiting definitive treatment. VA-ECMO was inserted, during CPR, in 20 minutes, and patient hemodynamic condition quickly improved. Forty-five minutes later the patient was operated. Intra-operatively there was thrombus in the valve. The valve was explanted and a biologic aortic valve was inserted. VA-ECMO was also removed during the surgery due to hemodynamic and electrical stability.

The patient fully recovered and 10 days later was discharged with no neurological impairment.

DISCUSSION

Prosthetic valve obstruction (PVO) is a rare and serious complication, most often found with mechanical prosthesis. Due to the different clinical presentations of these patients, diagnostic and treatment is often delayed, conferring to this entity a high morbidity and mortality risk.[1]

The possible causes of obstruction include thrombus formation, pannus and rarely vegetations. The differentiation between pannus and thrombus by TTE is challenging; duration of symptoms, state of anticoagulation, and ultrasound mass intensity may aid in the differentiation of these entities.[2] Fluoroscopy and TOE are also recommended in diagnostic workup of PVO.

Obstruction requires aggressive treatment (surgery or fibrinolysis), as anticoagulant treatment will usually be insufficient. According to the American College of Cardiology/ American Heart Association guidelines, surgery is the preferred treatment for left-sided PVT. Fibrinolysis should be reserved for patients with poor functional class (New York Heart Association (NYHA) III or IV), with high surgical risk or contraindications to surgery. It can also be considered in patients with good functional class (NYHA I or II) and a small thrombus, after failure of heparin treatment.[3,4]

In our case surgery became emergent during left heart catheterization when disk suddenly stopped. Free aortic regurgitation lead to cardiac arrest and an emergent VA-ECMO, during CPR, was implanted as a bridge to cardiac surgery. Use of VA-ECMO as a bridge to surgical valve replacement is a rare procedure, even more when the main dysfunction is due to aortic insufficiency.

With this case report the authors pretend to alert how important is this entity and how serious it can become. Although severe aortic insufficiency is, generally, a contraindication for VA-ECMO, this case illustrates that in very specific situations this support may gain time for other interventions.

REFERENCES

1. Roudaut R, Serri K, and Lafitte S. Thrombosis of prosthetic heart valves: diagnosis and therapeutic considerations. Heart, 2007; 93(1): p. 137-42.
2. Barbetseas J, Nagueh SF, Pistavos C et al. Differentiating thrombus from pannus formation in obstructed mechanical prosthetic valves: an evaluation of clinical, transthoracic and transesophageal echocardiographic parameters. J Am Coll Cardiol 1998; 1410–1417.10.1016/S0735-1097(98)00385-4.
3. Nishimura, R et al. 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014; 129(23): p. e521-643.
4. Huang G, Schaff HV, Sundt TM, et al. Treatment of obstructive thrombosed prosthetic heart valve. J Am Coll Cardiol 2013; 62:1731.

LEVOSIMENDAN IN SINGLE VENTRICLE HEART FAILURE AFTER LONGTERM SURVIVAL OF A MODIFIED BLALOCK-TAUSSIG SHUNT

João Tavares[1], Bernardo Baptista[1], Pedro Sarmento[1], Bebiana Gonçalves[1], Miguel Abecassis[2]

[1]Medicine Department, Hospital
[2]Cardiovascular Surgical Department, Hospital

*Contacto Autor: joao.ttavares@hospitaldaluz.pt

Abstract

We report the case of a 44 year-old patient with complex ACHD, admitted with acute decompensated heart failure (ADHF) in hemodynamic profile B. He had a single ventricle with pulmonary atresia, previously submitted to three modified Blalock-Taussig shunts (mBTs) at the age of 2, 12 and 19 years old. Despite conventional treatment with diuretics, β-blockers (BB) and isosorbide dinitrate the patient progressed to profile C and the transthoracic echocardiogram disclosed a reduced systolic function. Likewise, levosimendan was commenced and an appropriate decongestion and a marked reduction in the NT-proBNP were seen. Treatment with angiotensin-converting-enzyme inhibitor, BB, ivabradine and mineralocorticoid receptor was optimized. The patient was discharged home after 26 days in NYHA class III and referred for heart transplant after right heart catheterization. To our knowledge, this is the first report of successful levosimendan's use in ADHF in a mBTs long-term survivor.

INTRODUCTION

A single ventricle anomaly accounts for 1-2% of the CHD and is frequently associated with other cardiac abnormalities.[1] The adequacy of pulmonary blood perfusion will determine the initial clinical presentation (degree of cyanosis) and the need for a surgical intervention. Blalock-Taussig shunt is a surgical procedure first attempted in 1944 by Alfred Blalock and Helen Taussig. Its purpose is to enable blood oxygenation by joining the subclavian and pulmonary arteries. Nowadays, a prosthetic graft tube is used to create the shunt (modified Blalock-Taussig shunt - mBTs). This systemic-to-pulmonary artery shunt optimizes pulmonary blood perfusion until neonates can grow enough to be submitted to a more definitive procedure, a Fontan-like surgery.[2] We report a case of acute decompensated heart failure (ADHD) in a mBTs long-term survivor patient with a single ventricle who was successfully treated with levosimendan.

CASE DESCRIPTION

A 44 year-old man with a single ventricle with pulmonary atresia, previously submitted to three mBTs at the age of 2, 12 (Figure 1) and 19 years old (this last procedure was a Fontan-like surgery attemptation that ended in another mBTs (due to technical problems), presented with dyspnea on exertion, peripheral edema, orthopnea and paroxysmal nocturnal dyspnea shortly after arriving from an intercontinental flight. He recalled having coryza 2 weeks before. On physical examination the patient was tachycardic, hypertensive and tachypneic. He was afebrile, cyanotic and the peripheral oxygen saturation was 80% while breathing with a facial mask at 40% fraction of inspired oxygen.

Pulmonary congestion, lateral and inferior ictus cordis, and a grade 4 systolic murmur with a thrill were noticed. The electrocardiogram showed sinus rhythm, right bundle branch block and marked repolarization abnormalities. The hemoglobin was 21.9 g/dL, the N-terminal pro-B-type natriuretic peptide was 2324 pg/mL, and troponin I was 2.19 ug/L. Serum chemistry was unremarkable. A transthoracic echocardiogram (TTE) performed at admission (Figure 2) documented a severe ventricular systolic dysfunction, not present in previous exams. A thoracic CT angiography confirmed shunt patency (Figure 3) and had no signs of pulmonary emboli.

Conventional ADHF treatment (diuretics, beta-blockers, intravenous dinitrate) was initiated but the patient

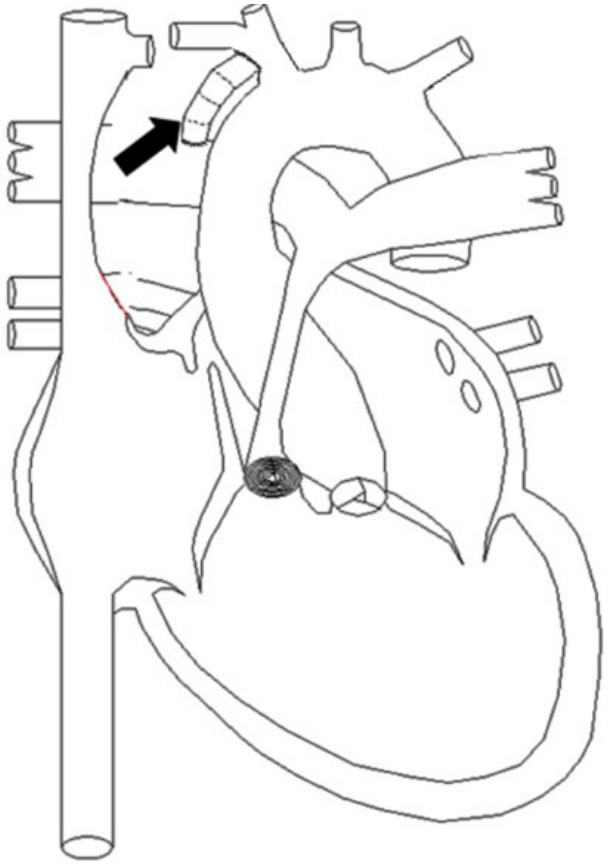


Figure 1 *Patient anatomy. High complexity adult congenital heart disease with univentricular phisiology with two atrioventricular valves opening in a single ventricle, pulmonary artery atresia and anterior and left position Aorta. He had a functional right BTS (arrow).*

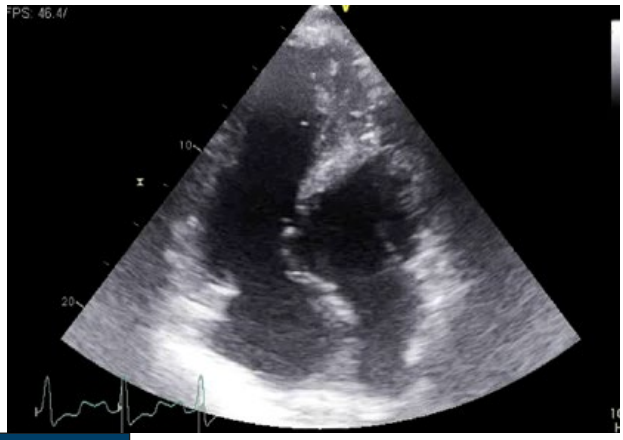


Figure 2 *Admission transthoracic echocardiogram documented a severe ventricular systolic dysfunction, not present in previous examinations.*

progressed to profile C. Levosimendan was added at a perfusion rate of 0.05 mcg/kg/min and maintained for 24 hours. There was a favorable clinical improvement with appropriate decongestion and a marked reduction of the NT-proBNP (Figure 4). A brief episode of atrial fibrillation was observed 24 hour after levosimendan's perfusion

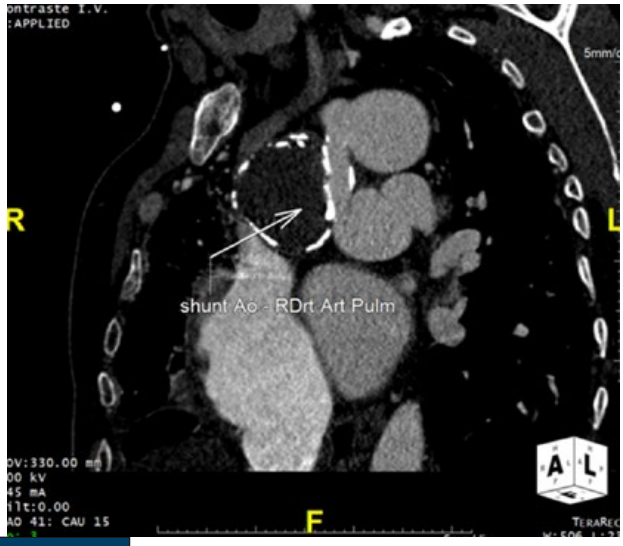


Figure 3 *Left-anterior sight thoracic computed tomography angiography confirmed a patent Blalock-Taussig shunt (arrow).*

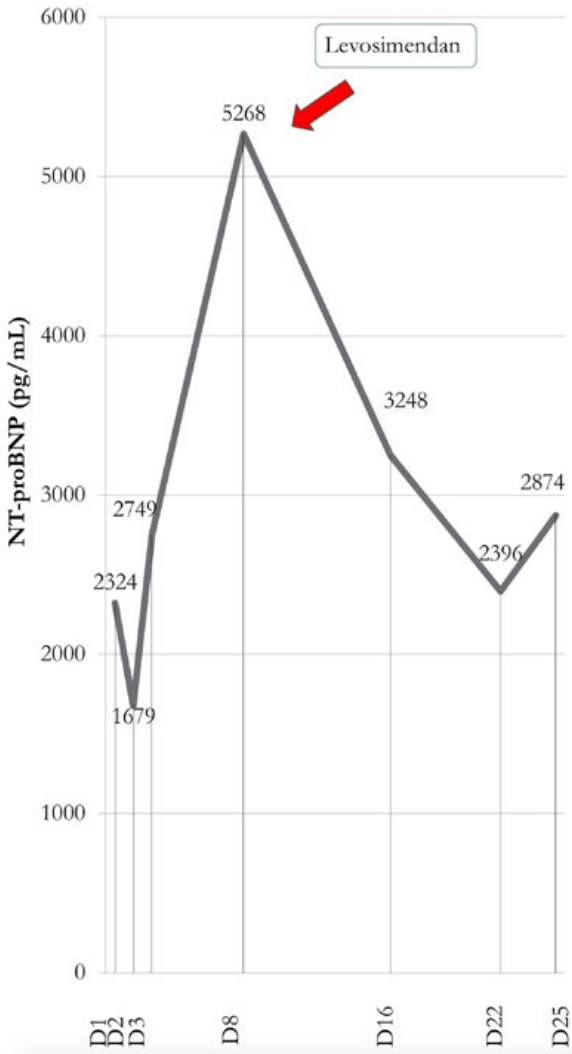


Figure 4 *NT-pro-BNP values evolution, in days after admission (D). There is a coincidence between a drop of Pro-BNP values and the introduction of levosimendan (arrow).*

and successfully managed with amiodarone and correction of the hypomagnesaemia.

Optimization of treatment with carvedilol, ramipril, eplerenone and ivabradine was well tolerated. A repeated TTE 5 days after levosimendan showed qualitative improvement in ventricular systolic function.

A moderate increase in pulmonary artery pressure (PAP) (right PAP 44/31 (38) mmHg; left PAP 48/30 (42) mmHg), and moderately elevated pulmonary vascular resistance (PVR) 3,4 Wood units (mm Hg.min/L) were documented. The patient was discharged home on the 26th day, in functional class III of the New York Heart Association (NYHA) and referred for heart transplant.

At 3 months' follow-up the patient was in NYHA class II. One year later the patient was submitted to heart tranplant in another hospital, but unfortunately died during the procedure due to early right ventricular graft failure.

DISCUSSION

We report a case of ADHF in a mBTs long-term survivor patient with a single ventricle who was successfully treated with levosimendan. This patient survived a total of 44 years (25 years after the last mBTs) without great limitation of his daily routine. To our knowledge, there are only three case reports of such a long-term survival in patients with similar clinical background.[3,4]

We used conventional adult heart failure treatment but, as the patient progressed with hypoperfusion and congestion, inotropic therapy was commenced. Levosimendan was our first choice for inotropic support as the patient was on beta-blockers and systolic blood pressure was above 90mmHg. We decided not to use loading dose. A marked reduction of the brain natriuretic peptide coupled with appropriate decongestion ensued.

Rafik et al[5] reported two cases of complex congenital heart disease [atrial and ventricular septal defect (VSD) and pulmonary atresia with a large VSD] with chronic end stage heart failure treated with pulsed levosimendan. To our knowledge, this is the first report of successful use of levosimendan in acute heart failure of a mBTs long-term survivor. This case report is an example of the unique challenge of adult congenital heart disease management.

Acknowledgments

We would like to thank Dr. João Sá and Dr. Alexandra Bayão Horta for manuscript correction and Dr. Rui Anjos, Dr. Natália Marto and Dr. Daniel Ferreira for patient medical co-management.

BIBLIOGRAPHY

1. Hoffman JIE, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol [Internet]. 2002;39(12):1890–900.
2. Stout KK, Daniels CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Colman JM, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease. J Am Coll Cardiol. 2018 Aug;
3. Scholtz W, Jategaonkar SR, Dimitriadis Z, Haas NA, Horstkotte D. 63-year Survival after Blalock-Taussig Shunt Operation in a Patient with Single Ventricle, Tricuspid Atresia, and Pulmonary Stenosis. Congenit Heart Dis. 2011;6(2):179–82.
4. Saab FG, Aboulhosn JA. Hemodynamic Characteristics of Cyanotic Adults with Single-ventricle Physiology without Fontan Completion. Congenit Heart Dis. 2013;8(2):124–30.
5. Rafiq I, Freeman LJ. Pulsed levosimendan therapy in the management of chronic end stage cardiac failure in "adult congenital heart disease." Vol. 195, International Journal of Cardiology. 2015. p. 283–4.

ISOLATED PULMONARY MUCORMYCOSIS IN AN IMMUNOCOMPETENT PATIENT

João Santos Silva[1], Carolina Torres[3], Susana Clemente[2], Paulo Calvinho[1]

[1]Cardiothoracic Surgery Department, Hospital Beatriz Ângelo, Loures, Portugal.
[2]Pneumology Department, Hospital Beatriz Ângelo, Loures, Portugal.
[3]General Surgery, Emergency Department, Hospital Beatriz Ângelo, Loures, Portugal.

*Contacto Autor: joao.mss88@gmail.com

Abstract

Mucormycosis is a life-threatening fungal infection that occurs mainly in immunocompromised patients. Its occurrence isolated in the lung rare and carries a high mortality risk if untreated.

We report the case of a 76-year old male immunocompetent patient, under treatment for pulmonary tuberculosis, admitted to the emergency department with hemoptysis.

Bronchoscopy was performed and active bleeding from the middle lobe bronchus was found. Chest CT scan identified a solitary cavitary lesion in the middle lobe.

The patient was proposed for urgent open middle lobectomy. Postoperative period was uneventful. Pulmonary mucormycosis was confirmed and adjuvant therapy with Amphotericin B was performed for 30 days.

Despite its rarity, mucormycosis prevalence is expected to raise together with increasing number of immunocompromised patients. A high level of suspicion is recommended as early diagnosis can be determinant.

INTRODUCTION

Mucormycosis is a life-threatening fungal infection that occurs mainly in immunocompromised patients.[1] Its prevalence is very low, with only with only 87 cases reported in a 30-year review published in 1999.

Typically an airborne infection, it extends to the rest of the body by invading alveolar blood vessels.[2] Its occurrence isolated in the lung is extremely rare[1], specially in the immunocompetent population, and clinical manifestations are non-specific, including fever, cough, hemoptysis or dyspnea.

The most common underlying risk factors are diabetes, glucocorticoids use, hematologic malignancies, transplantation, treatment with deferoxamine, iron overload, AIDS, injection drug abuse, trauma/burns and extreme malnutrition.

Several sites of infection have been described, but all syndromes have in common is an underlying infarction and necrosis of host tissues, that result from blood vessel invasion by hyphae, with marked and accelerated tissue destruction[2], which carries a high mortality reported between 40 and 76%.[3,4]

Pulmonary mucormycosis may present as lobar consolidation, solitary nodule, cavitation or in a disseminated form.[5]

Differencial diagnosis of pulmonary mucormycosis may include lung neoplasm, other mycotic or fungal infections, pulmonary infarction and tuberculosis.

CASE REPORT

A 76-year-old immunocompetent male presented to the emergency department with severe hemoptysis.

Previous medical history of repeated urinary infections due to ureteral stenosis and a 6-month history of known pulmonary condensation with bronchial biopsy compatible with pulmonary tuberculosis under anti-bacillary treatment.

Urgent flexible bronchoscopy identified active bleeding from the middle lobe bronchus and CT scan confirmed a cavitary lesion confined to the middle lobe (Image 1). The patient was proposed to urgent middle lobectomy by right thoracotomy. The middle lobe had some adhesions in the fissures and to the parietal pleura, easily debrided, and a hard consistency lesion. Upper and lower lobes were inspected with no signs of invasion or additional lesions. Middle lobectomy was performed without opening of the bronchus and sequential division of vein-bronchus-artery with mechanical staplers.

Postoperative period was uneventful. Drainage removed on day 3 and at 6-month postop, patient asymptomatic with no signs of lung infection in CT scan (Image 2).

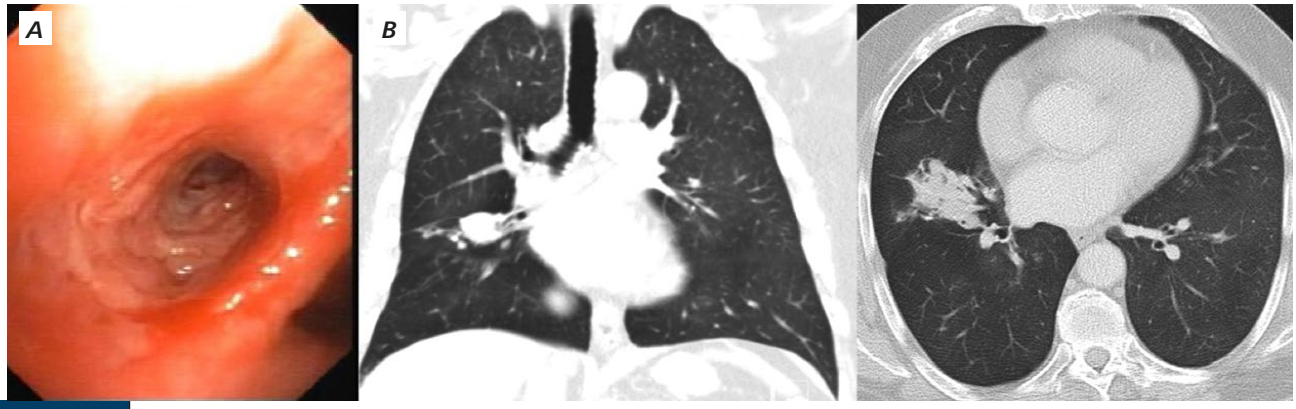


Figure 1 *Preoperative workup with **A** - bronchoscopy findings showing bleeding from medium lobe bronchus, and **B** - CT scan showing coronal (left) and axial (right) views of the lung cavitated lesion.*

Histopathological examination confirmed pulmonary mucormycosis and adjuvant treatment with liposomal Amphotericin B was performed for one month.

DISCUSSION

Clinical presentation of pulmonary mucormycosis is non-specific but the presence of hemoptysis should be a red flag due to the angioinvasive capacity of the fungi.[4]

The failure of the pneumonic process to improve after medical treatment, should raise the alertness to other differential diagnosis. Other radiologic signs such as upper lobes predominance or indirect signs of necrosis – cavitation, air crescendo, halo sign and rim enhancement – are usual.[4,5]

Transthoracic biopsy or endobronchial ultrasound with a radial probe may be of some help but its value is usually poor unless to exclude underlying malignancy. Sputum cultures are difficult to be conclusive[4], and specimen analysis is usually needed for diagnosis.

Therefore, several studies agree that a prompt and aggressive approach, including antifungal systemic therapy, surgical resection and control of the underlying disease, if present, should be the mainstay of treatment . Some studies report mortality rates as high as 96% in the non-treated groups comparing to 27% of operated patients.[4] Usually, massive hemoptysis or bacterial coinfection due to obstruction are the causes of death.

Differential diagnosis should include malignancy and a special attention to this pathology in the transplant-recipient population should be present.

Despite mucormycosis being a rare infection, its prevalence is expected to raise together with increasing number and survival of the organ transplantation population as well as acquired immunodeficiencies. A high level of suspicion is recommended in the presence of the right clinical setting, as early diagnosis may be determinant for the prognosis.

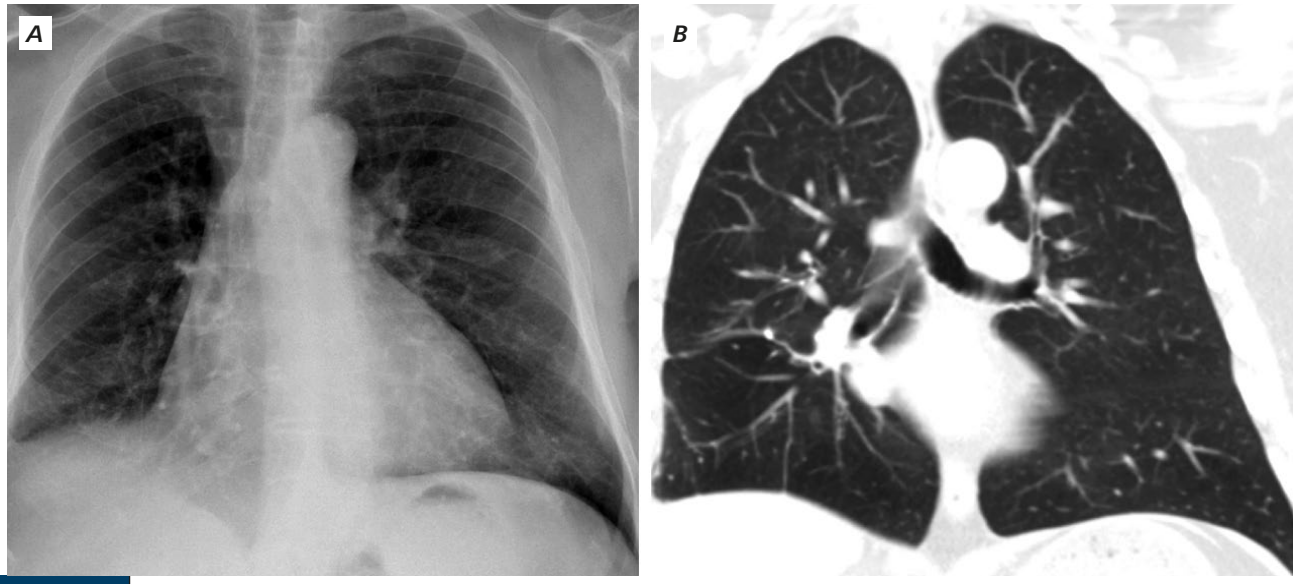


Figure 2 ***A** - Chest X-ray at discharge and **B** - Chest CT scan at 6-month postop with no signs of disease recurrence.*

REFERÊNCIAS

1. Ibrahim AS, Spellberg B, Walsh TJ, Kontoyiannis DP. 2012. Pathogenesis of mucormycosis. Clin Infect Dis 54 Suppl 1:S16-22
2. Petrikkos G, Skiada A, Lortholary O, Roilides E, Walsh TJ, Kontoyiannis DP. 2012. Epidemiology and clinical manifestations of mucormycosis. Clin Infect Dis 54 Suppl 1:S23-34
3. Roden MM, Zaoutis TE, Buchanan WL, Knudsen TA, Sarkisova TA, et al. 2005. Epidemiology and outcome of zygomycosis: a review of 929 reported cases. Clin Infect Dis 41:634-53
4. Lee FY, Mossad SB, Adal KA. 1999. Pulmonary mucormycosis: the last 30 years. Arch Intern Med 159:1301-9
5. Georgiadou SP, Sipsas NV, Marom EM, Kontoyiannis DP. 2011. The diagnostic value of halo and reversed halo signs for invasive mold infections in compromised hosts. Clin Infect Dis 52:1144-55

EPITHELIOID HEMANGIOENDOTHELIOMA OF THE INTERNAL JUGULAR VEIN

Isabel Armas[1], José Vidoedo[2], Luís Pedro Afonso[3], Augusto Moreira[4], Joaquim Abreu de Sousa[4]

[1]General Surgery / Unidade Local de Saúde do Nordeste (ULSNE)
[2]Vascular Surgery / Centro Hospitalar Tâmega e Sousa (CHTS)
[3]Patology Department / Instituto Português de Oncologia do Porto (IPO Porto)
[4]Surgical Oncology / Instituto Português de Oncologia do Porto (IPO Porto)

***Contacto Autor:** isabel.armas@hotmail.com

Abstract

Ephitelioid Hemangioendothelioma (EHE) is a rare type of tumor with vascular and sarcomatous components. There's only another case published of an internal jugular vein (IJV) EHE. A case of a 50 years-old woman with a palpable and pulsatile mass on the left cervical area is reported. Doppler ultrasound and magnetic resonance imaging showed an IVJ' 4 cm mass. Cytology was inconclusive. Surgical treatment was therefore decided and during surgery a mass inside the left IJV, with local nonsuspicious lymph nodes, was confirmed. The mass was resected including a segmental resection of the IJV and one affected tributary vessel. Lymphadenectomy of the adjacent cervical levels was performed. Histologic examination depicted an EHE without metastatic lymph nodes. Tumor was staged as pT1bN0M0 and a multidisciplinary sarcoma group proposed surveillance. Patient remained well, without evidence of disease and without complications in a twenty-four months follow-up period.

INTRODUCTION

The diagnosis of vascular tumors is challenging, particularly epithelioid types due to the cells' morphology.[1] Sarcomas showing endothelial differentiation represent < 1% of all sarcomas' diagnosis.[2] Hemangioendotelioma epithelioids' (EHE) clinical severity is intermediate between hemangioma and high-grade angiosarcoma.[2] Most EHEs are indolent, however 20-30% can metastasize and 15% mortality is reported.[2]

METHODS

The authors report a clinical case and present a literature review using PubMed with the key terms "epithelioid hemangioendothelioma" and "internal jugular vein".

CASE REPORT

A case of a 50 years-old caucasian woman, asymptomatic, with a left cervical mass, and relevant past medical history of multinodular goiter, referred to Vascular Surgery after positive findings in a routine cervical ultrasound (US). Upon physical examination, the cervical mass was located at II/III left levels, 4 cm long, well delimited, painless, pulsatile, without palpable cervical lymph nodes. The cervical doppler US showed a 42 mm mass in the left internal jugular vein (IJV) lumen, vascularized. A magnetic resonance imaging (MRI) showed a heterogeneous lesion in the left IJV path, measuring 46 mm, resembling a paraganglioma (Figure 1). The patient was referred to a surgical oncology referral center. Citology examination, after guided fine needle biopsy, showed a vascular proliferation, but wasn't able to define the lesions' malignant potential. Byogenic amines screening showed normal range values. In this context, surgical excision was proposed and a left lateral cervicotomy was performed showing a 4 cm nodular lesion in the left IJV extending to a thyro-facial tributary and local nonsuspicious adenomegalies (Figure 2). The mass was resected including a segmental resection of the left IJV and the affected tributary vessel (R0). Lymphadenectomy of the adjacent cervical levels was performed. Histologic examination documented a malignant angiocentric vascular neoplasm, obliterating the lumen and spreading into surrounding soft tissue, measuring 45 mm. Tumor was characterized by anastomosing cords and small nests of epithelioid cells, with abundant eosinophilic cytoplasm, containing vacuoles, some with fragmented erithrocytes;

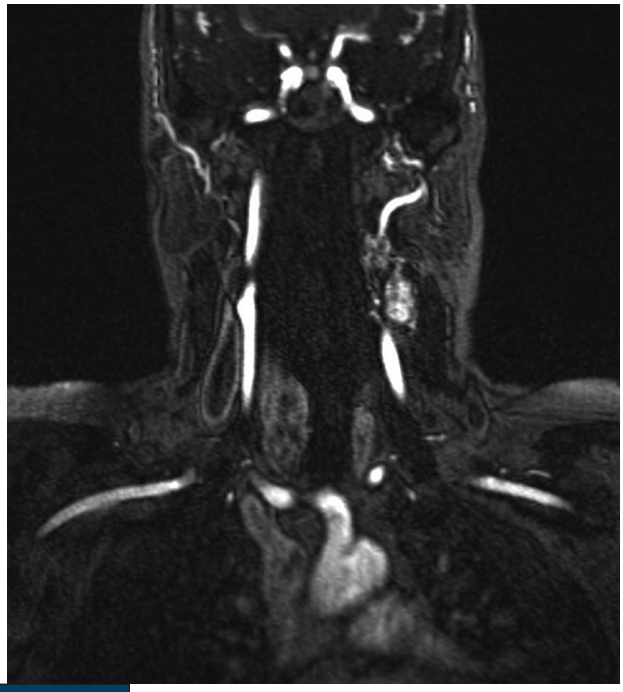


Figure 1 *MRI showing a heterogenous lesion in the left internal jugular veins' path, resembling a paraganglioma.*

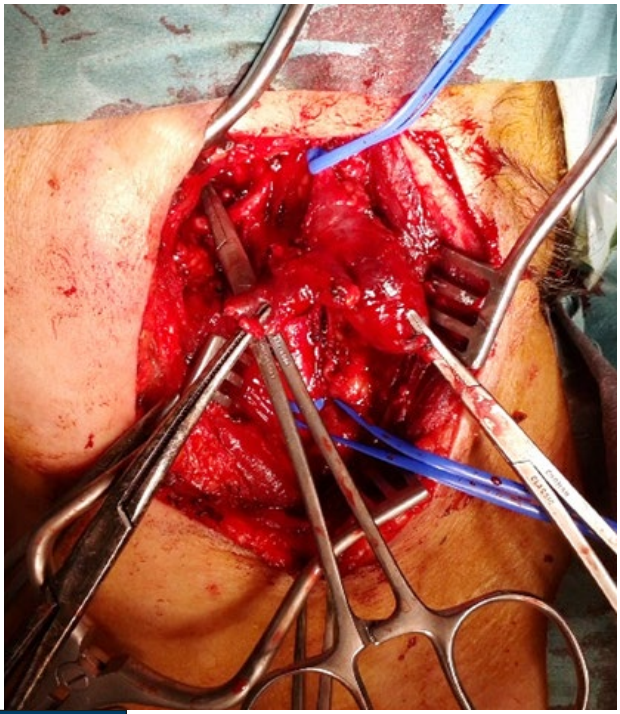


Figure 2 *Intra-operative image showing blue vascular references in distal and proximal control of the internal jugular vein (IJV); an IJV' mass; needle-holder under a tumor affected tributary vein.*

nuclei are round and may be indented, with mild to moderate pleomorphism. Minimal mitotic activity and no necrosis, lymphovascular or perineural invasion was also documented (Figure 3). The surgical margins weren't available, due to fragmentation. The eleven retrieved lymph

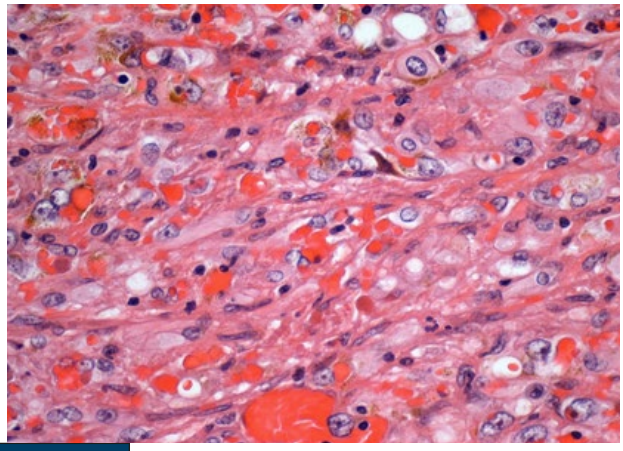


Figure 3 *Hemangioendotelioma. Malignant vascular neoplasm composed by chains and cords of epithelioid endotelial cells with abundant eosinophilic cytoplasm, containing vacuoles, some with fragmented erithrocytes; nuclei are round and may be indented, with mild to moderate pleomorphism. There are scattered inflammatory cells.*

nodes show no evidence of tumor. Epithelioid tumor cells expressed strongly endothelial markers CD31 (Figure 4) and CD34, confirming endothelial differentiation and epithelial antigens (pan-cytokeratins). The EHE was staged as grade 1 pT1bN0M0, stage Ia. A Multidisciplinary Sarcoma Group proposed surveillance, no other adjuvant treatments. Over the course of 24 months the patient remained asymptomatic, without evidence of disease (local, regional or systemic), and no complications were reported.

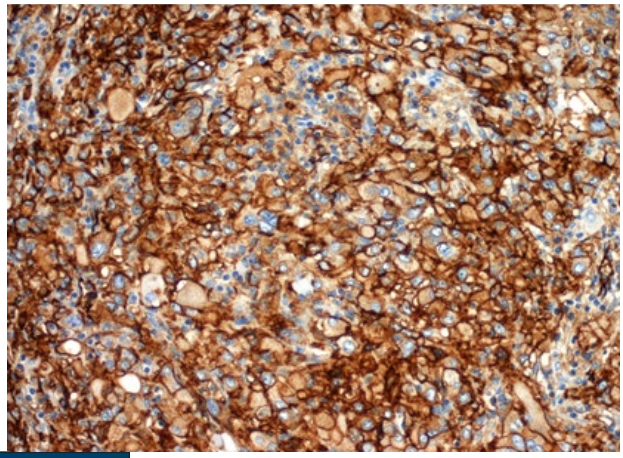


Figure 4 *Epithelioid cells express strongly endothelial marker CD31, confirming endothelial differentiation.*

DISCUSSION

To the best of our knowledge, this is the second case published of EHE of the IJV.[4] EHE has a peak incidence in the 4th-5th decade and women seem to be more affected.[5] Most of the EHE are asymptomatic, although edema or thrombosis can develop.[6] The differential diagnosis of intravascular EHE is usually difficult and often misdiagnosed as thrombosis[7] or other tumors. EHE is defined (World Health Organization) as an angiocentric vascular

tumor with metastatic potential, composed of epithelioid endothelial cells arranged in short cords and nests set in a distinctive myxohialine stroma. Immunohistological tests confirm the diagnoses, CD31 being the most sensitive and specific marker.[4] When feasible, the adequate treatment is surgical resection[5,8] and in-line prosthetic or autogenous venous reconstruction, to restore patency.[8] With veins, revascularization is seldom needed due to redundancy of the venous circulation. A complete local excision, with or without local lymphadenectomy, is positively related to long-term survival.[9] Radiation therapy should be considered in cases of high-risk features or when complete resection is not feasible.[9] Low response rates to chemotherapy makes it unattractive, used more frequently in the metastatic setting.[7] Mitotic activity and tumor size can stratify tumors into low and high-risk groups: tumors $>$ 3 cm and $>$ 3 mitosis/50HPFs have a 5-year disease-specific survival of 59% in contrast to 100% in those that lacked these features.[2] Other authors consider necrosis, atypia, and increased mitotic activity has prognostic factors.[10]

In conclusion, EHE is a rare form of vascular sarcoma. Literature available is mainly as case reports. This is the second case published of an IJV EHE. The adequate treatment is surgical resection. Diagnosis is often obtained after excision. Adjuvant treatments and patient' follow-up relies on prognostic factors. Despite the known prognostic factors, EHE behavior remains unpredictable.

REFERENCES

1. Ko JS, Billings SD. Diagnostically Challenging Epithelioid Vascular Tumors. Surg Pathol Clin. 2015;8(3):331-51.
2. Antonescu C. Malignant vascular tumors - an update. Mod Pathol. 2014;27 Suppl 1:S30-8.
3. Requena L, Kutzner H. Hemangioendothelioma. Semin Diagn Pathol. 2013;30(1):29-44.
4. Yun JS, Kang SK, Kim SH, Na KJ, Song SY. Epithelioid Hemangioendothelioma Arising from Interanl Jugular Vein Mimicking Cervical Metastatic Lymphadenopathy. Korean J Thorac Cardiovasc Surg. 2015;48(4):294-7.
5. Cioffi A, Reichert S, Antonescu CR, Maki RG. Angiosarcomas and other sarcomas of endothelial origin. Hematol Oncol Clin North Am. 2013;27(5):975-88.
6. Campos J, Otero E, Dominguez MJ, Gonzalez-Quintela A. Epithelioid hemangioendothelioma in the posterior mediastinum. Eur J Intern Med. 2007;18(4):331-2.
7. Gao L, Wang Y, Jiang Y, Lai X, Wang M, Li J. Intravascular epithelioid hemangioendothelioma of the femoral vein diagnosed by contrast-enhanced ultrasonography: A care-compliant case report. Medicine (Baltimore). 2017;96(49):e9107.
8. Niemela M, Maenpaa H, Salven P, Summanen P, Poussa K, Laatikainen L, et al. Interferon alpha-2a therapy in 18 hemangioblastomas. Clin Cancer Res. 2001;7(3):510-6.
9. Ciliberti MP, Caponio R, Pascali A, Matichecchia G, Lioce M. A rare case of intravascular epithelioid hemangioendothelioma of the cephalic vein treated with surgery and postoperative radiation therapy: a case report and review of the literature. J Med Case Rep. 2015;9:91.
10. Anderson T, Zhang L, Hameed M, Rusch V, Travis WD, Antonescu CR. Thoracic epithelioid malignant vascular tumors: a clinicopathologic study of 52 cases with emphasis on pathologic grading and molecular studies of WWTR1-CAMTA1 fusions. Am J Surg Pathol. 2015;39(1):132-9.

PULMONARY SEQUESTRATION SUPPLIED BY THE CIRCUMFLEX ARTERY – A RARE CASE REPORT

Diana Pissarra[1], Elson Salgueiro[1], Ana Catarina Oliveira[2], Graciete Malangatana[3], Paulo Pinho[1], Jorge Casanova[1]

[1]Department of Cardiothoracic Surgery, S. João Hospital, Oporto, Portugal
[2]Department of Radiology, Pedro Hispano Hospital, Matosinhos, Portugal
[3]Department of Cardiology, Pedro Hispano Hospital, Matosinhos, Portugal

*Contacto Autor: dianafcpissarra@gmail.com

Abstract

Pulmonary sequestration (PS) is a rare congenital malformation, even more when its arterial supply is a coronary artery. We present a case of a 68-year-old man admitted in the emergency room with an acute coronary syndrome and no evidence of significant coronary disease. Instead, he had an abnormal branch from the circumflex coronary artery nourishing a mass in the left lower pulmonary lobe. A coronary steal phenomenon was proposed to explain the clinical presentation. An anterior left thoracotomy with ligation of the abnormal branch and atypical resection of the lung segment comprising the sequestration was performed.

INTRODUCTION

Pulmonary sequestration (PS) is a rare congenital lung malformation in which a non-functioning mass of lung tissue develops with abnormal connection to the tracheobronchial tree and abnormal arterial supply.[1] Abnormal arterial supply from a coronary artery is extremely rare[2], being the term "coronary lung sequestration" proposed by some authors for these cases.[3]

Here, we present a case of a coronary lung sequestration supplied by the circumflex coronary artery.

CASE REPORT

A 68-year-old man was admitted to the emergency room of his local Hospital with the diagnosis of acute non-ST elevation myocardial infarction. Physical examination was unremarkable, the electrocardiography (ECG) revealed sinus rhythm and 1 mm ST depression from V3-V5. The echocardiogram showed mild left atrium (LA) dilation and normal ventricular function, without any regional wall motion abnormality. The chest X-ray suggested an abnormal shadow on left hilum and the computed tomography diagnosed a just-cisural solid lesion in the left lower lobe (Figure 1). After the initial treatment the patient remained asymptomatic. Maximum troponin I (hs) was 2825 ng/ml.

He had a past medical history of hypertension, dyslipidemia and stable angina, with increasing symptoms in the three days before admission. He had no recall of recurrent chest infections.

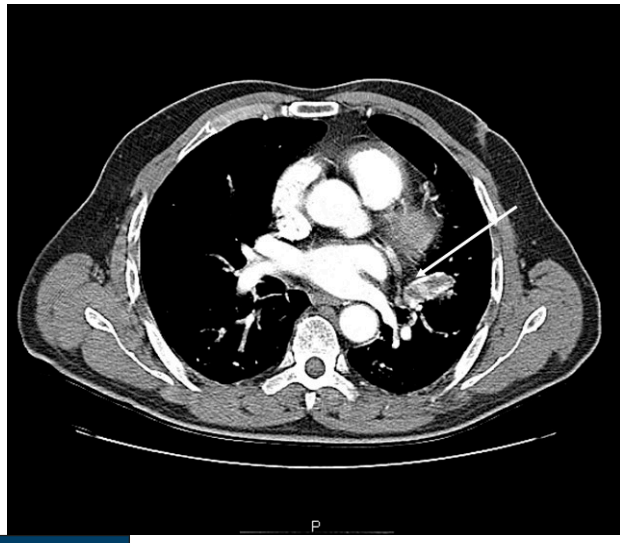


Figure 1 *Lesion on the antero-superior segment of the left lower lobe, irrigated by the circumflex artery (arrow).*

Coronary angiography revealed absence of significant coronary lesions and an abnormal early large branch arising from the proximal third of the circumflex artery supplying the lesion of the left lung (Figure 2).

In the absence of significant angiographic coronary

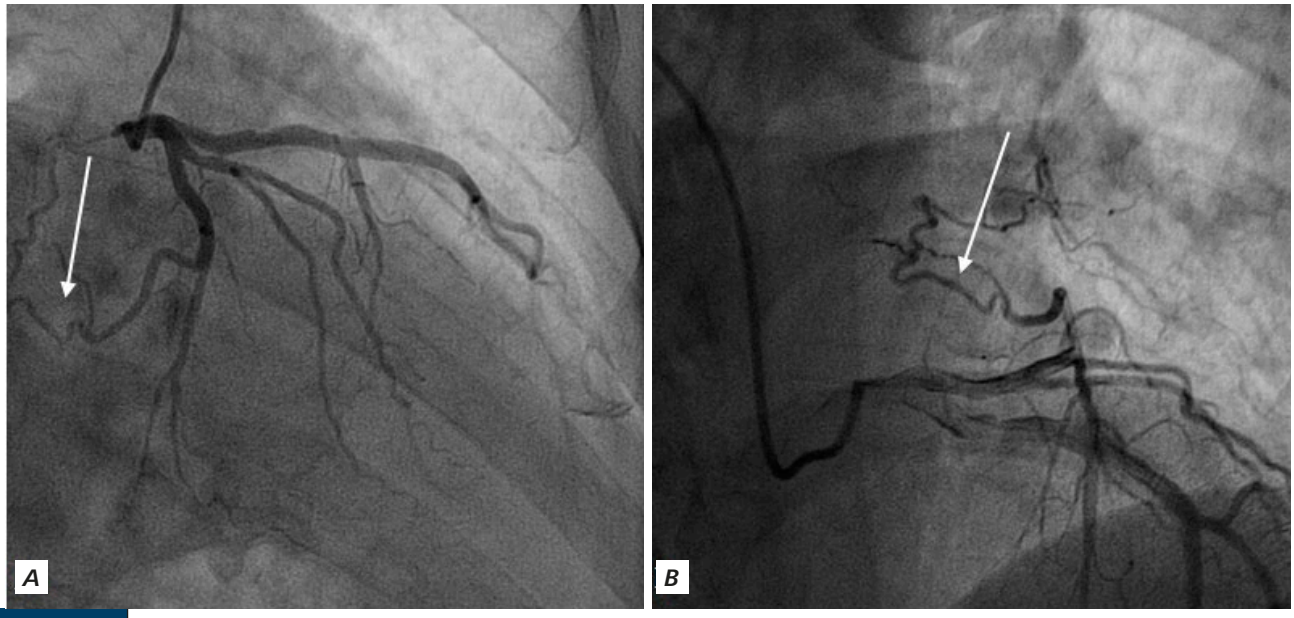


Figure 2 *A and B – Branch from the circumflex coronary artery irrigating the sequestration (arrow).*

lesions, a coronary steal phenomenon was proposed to explain the patient's acute coronary syndrome. After Heart Team discussion, he was transferred to our department and submitted to a limited anterior left thoracotomy, with ligation of the abnormal branch and excision of the anterior-superior segment of the left lower lobe, comprising the sequestration (Figure 3 and 4). Pathological examination confirmed an intra-lobar sequestration. The patient was discharged 5 days after surgery, uneventfully. One year after surgery, he remains asymptomatic, with normal left ventricular perfusion, volume and function on a myocardial perfusion scintigraphy.

DISCUSSION

Pulmonary sequestration (PS) accounts for only 0.15-6.4% of all congenital pulmonary abnormalities.[1]

There are two forms of PS: intra-lobar pulmonary sequestration (ILS), representing 84% of all cases[2,4], and extra-lobar pulmonary sequestration (ELS).

ILS is surrounded by normal lung parenchyma, almost always in the lower lobes and generally on the left side. ELS is separated from normal lung and has its own visceral pleura.[5]

Most PS receives its arterial supply from a systemic

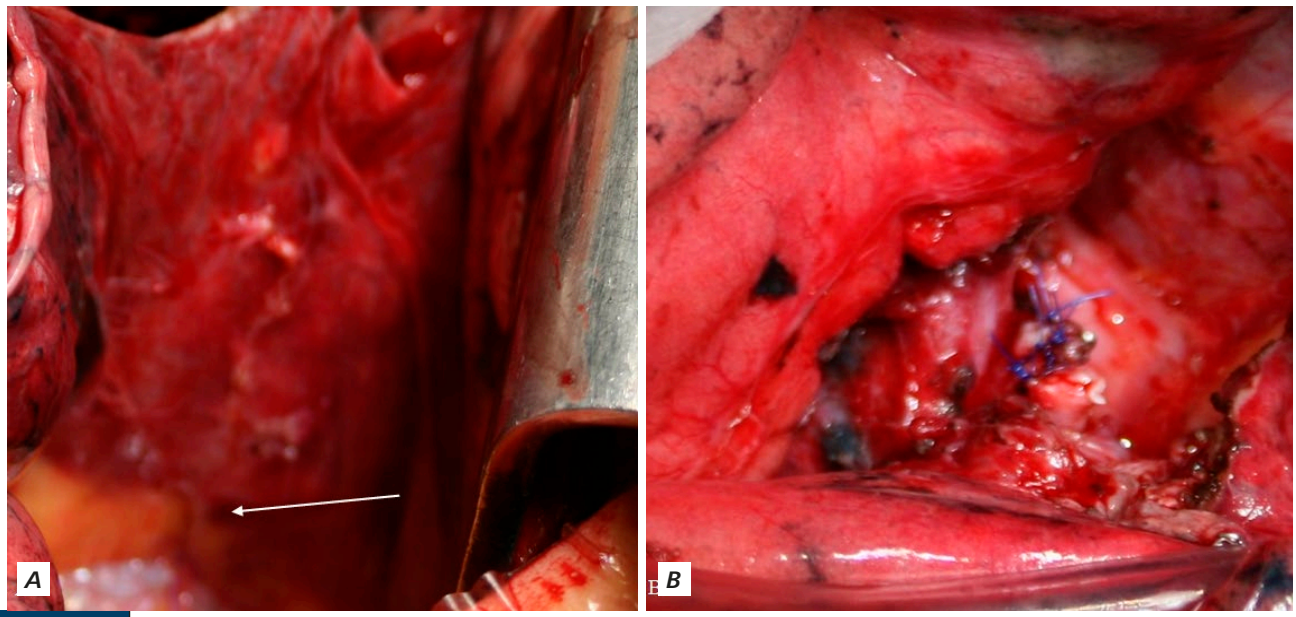


Figure 3 *A – Feeding artery to the sequestration; B – After resection of the sequestration with 3 prolene ligatures for vessels.*

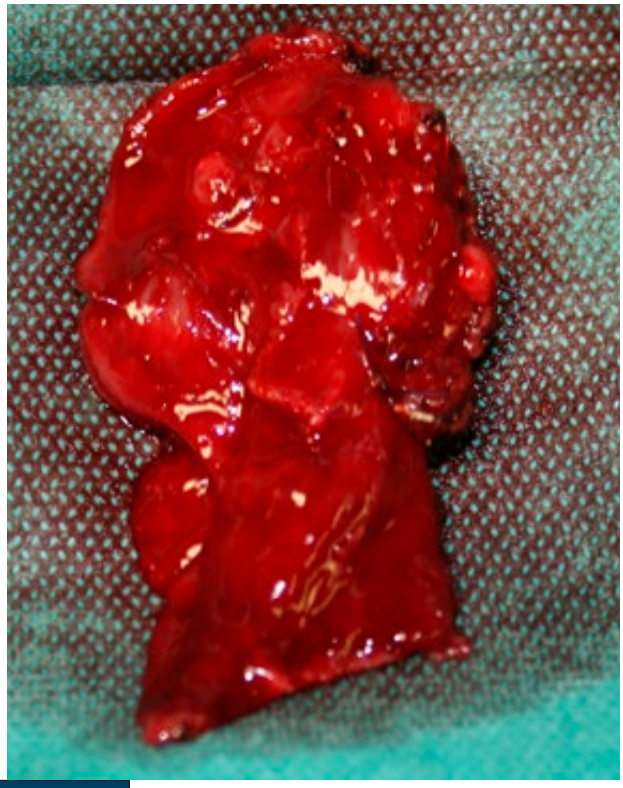


Figure 4 *Sequestration. There was no airway connection to the lesion.*

artery, mainly from the thoracic aorta (74%), the abdominal aorta (18,7%) and the intercostal arteries (3,2%).[1,2] Arterial supply of an ILS from the coronary circulation is extremely rare (0,1%)[2], but when it does occur, the left circumflex artery is the most frequently involved.[3,6]

Traditionally, the gold standard for the diagnosis of PS was arterial angiography, as it explicitly reveals the aberrant arterial blood supply. Nowadays, with the advent of non-invasive techniques, such as computed tomographic angiography (CTA) and magnetic resonance angiography (MRA), conventional angiography has been replaced.[7] Both CTA and MRA are reliable imaging modalities for demonstrating the anomalous artery supplying the PS.[8]

The natural history of sequestration supplied by a coronary artery remains unknown because of its rare incidence. Several complications related to PS include recurrent pulmonary infections, unpredictable fatal hemoptysis and heart failure from persistent left-to-right shunt.[6] The reported case underlies myocardial ischemia due to coronary steal phenomenon as a potential complication of this rare pulmonary sequestrations supplied by a coronary artery, as previously reported by Nakayama.[9] In this group of patients with an acute coronary event in the absence of native coronary artery disease there is no doubt that a surgical approach is needed.

The discussion arises in the asymptomatic patients with incidental finding of a pulmonary sequestration, with some authors advocating that owing to the potentially severe complications all diagnosed lesions should be removed[4], and others supporting an expectant approach.[3,5,10]

Currently, the most consensus treatment for PS is surgical resection. We performed a limited conventional thoracotomy so that we could easily and safely identify the abnormal arterial branch and the pulmonary sequestration.

In centers experienced in video-assisted thoracic surgery (VATS) it would be a feasible alternative method for PS resection and abnormal vessel ligation.[11]

Preoperative imaging evaluation is essential to identify the location of the arterial supply and pattern of venous drainage, especially when a minimally invasive approach is to be considered.[2,12] In PS with arterial supply from a coronary artery, beside the usual imaging tests, a coronary angiography is also required both for diagnosis and to exclude hemodynamically significant atherosclerotic disease.

Recent studies have suggested interventional therapy, such transcatheter endovascular embolization and thoracic endovascular stent-graft exclusion, for treatment of PS.[12]

CONCLUSION

Although rare, coronary steal phenomenon from a pulmonary sequestration may cause myocardial ischemia and acute coronary events. It underlies the importance of early recognition and correct diagnosis of this entity to assure the best clinical management.

Several surgical and interventional approaches have been proposed, but no treatment guidelines have yet been established.

Therefore, it is essential to report all cases of lung sequestration with coronary arterial supply both to better understand its natural history and define its better clinical approach.

REFERENCES

1. Savic B, Birtel Fj, Tholen W, Funke HD, Knoche R. Lung sequestration: report of seven cases and review of 540 published cases. Thorax 1979, 34:96-101.
2. Wei Y, Li F. Pulmonary sequestratrion: a retrospective analysis of 2625 cases in China. Eur J Cardiothorac Surg 2011, 40:39-42.
3. Fernandez-Vega A, Vilacosta I, Vedial O A e tal. A kidnapper left circumflex artery. Eur Heart Journal 2015. doi:10.1093/eurheartj/ehv658.
4) Gezer S, Tastepe I, Sirmah M et al. Pulmonary sequestration: a single-institutional series composed of 27 cases. J Thorac Cardiovasc Surg 2008, 133:955-959.
5) Temes RT, Talbot WA, Carrillo YM, Keck GM, Wernly JA. Sequestration of the lung arising from the circumflex coronary artery. Ann Thorac Surg 1998; 65: 257-259.
6. Rao D S, Barik R. Rare presentation of intralobar pulmonary sequestration associated with repeated episodes of ventricular tachycardia. World J Cardiol 2016, 8(7): 432-5.

7. Sun X, Xiao Y. Pulmonary sequestration in adult patients: a retrospective study. Eur J Cardiothorac Surg 2015, 48:279-282.
8. Gompelmann D, Eberhardt R, Heussel CP, Hoffmann H, Dienemann H, Schuhmann M, Böckler D, Schnabel PA, Warth A, Lopez-Benitez R, Herth FJ. Lung sequestration: a rare cause for pulmonary symptoms in adulthood. Respiration 2011; 82: 445-450.
9. Nakayama Y, Kido M, Minami K, Ikeda M, Kato Y. Pulmonary sequestration with Myocardial Ischemia caused by Vasospasm and Steal. Ann Thora Surg 2000; 70:304-5.
10. Falsini, Giovanni et al. Bilateral intralobar pulmonary sequestrations receiving separate arterial supply from the right and circumflex coronary arteries: A case report. International Journal of Cardiology , Volume 166 , Issue 1 , e12 - e13.
11. Liu C, Pu Q, Ma L, Mei J, Xiao Z, Liao H et al. Video-assisted thoracic surgery for pulmonary sequestration compared with posterolateral thoracotomy. J Thorac Cardiovasc Surg 2013; 146:557–61.
12. Zhang SX, Wang HD, Yang K, Cheng W, Wu W. Retrospective review of the diagnosis and treatment of pulmonary sequestration in 28 patients: surgery or endovascular techniques? J Thorac Dis 2017;9(12):5153-5160. doi: 10.21037/jtd.2017.10.145

INFERIOR VENA CAVA STENTING AFTER CARDIAC MYXOMA EXCISION

Pedro Magro[1], João Abecasis[2], José Calquinha[1], José Neves[1]

[1]Department of Cardiothoracic Surgery, Santa Cruz Hospital, Carnaxide, Portugal.
[2]Department of Cardiology, Santa Cruz Hospital, Carnaxide, Portugal.

***Contacto Autor:** pedromagro@gmail.com

A 63-years-old female developed shock after cardiac myxoma excision.

Echocardiography identified inferior vena cava (IVC) stenosis and re-intervention with atrial and septal patch augmentation was attempted. The patient maintained hemodynamic instability as well as high IVC gradient and intraluminal thrombus. IVC percutaneous stenting was achieved and enabled full hemodynamic recovery.

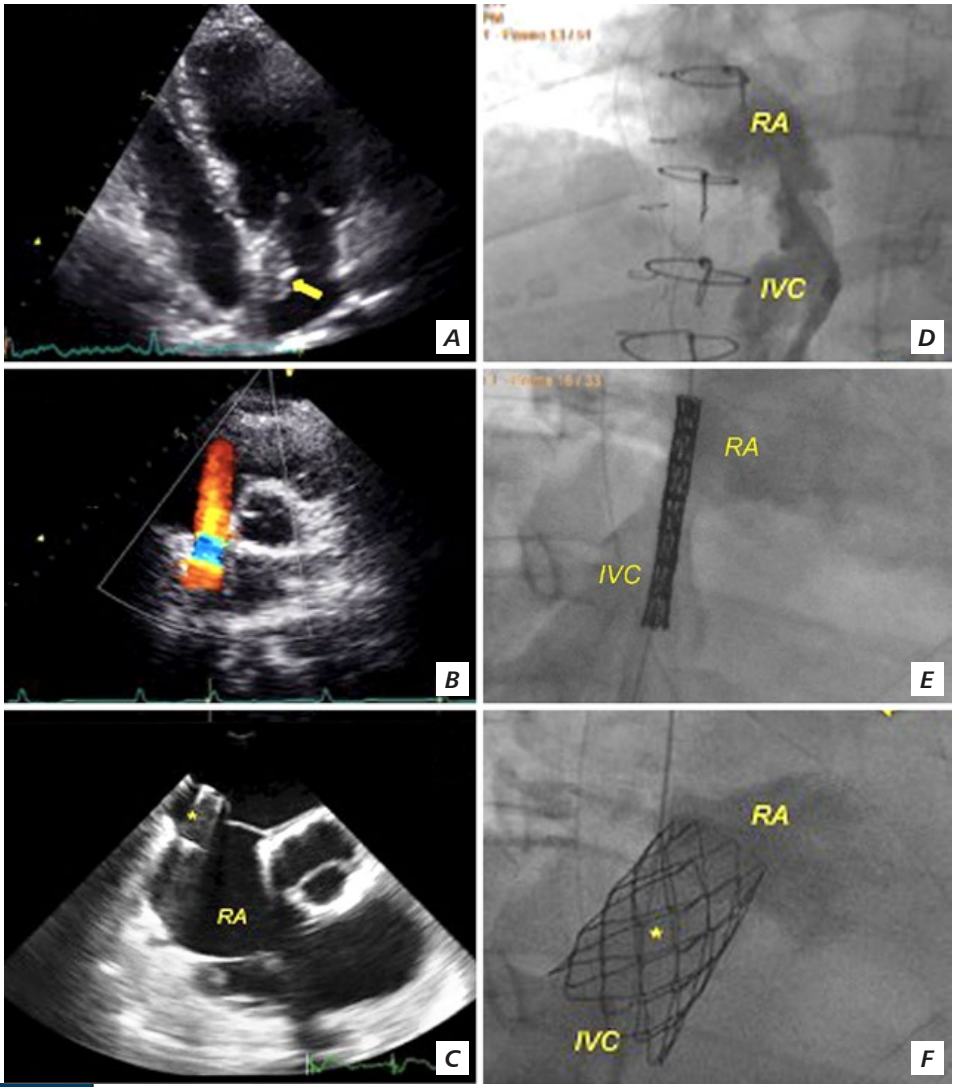


Figure 1

***A** - transthoracic echocardiography (TTE) depicting a left atrial mass (arrow); **B** - TTE after surgery, showing color flow acceleration at inferior vena cava (IVC) - right atrium (RA) opening; **C** - Final appearance of IVC stent; **D,E** and **F** - Angiographic appearance of IVC stenosis before and after stent (*) implantation.*

IMPENDING VENTRICULAR SEPTAL DEFECT: IS IT REASONABLE TO BE CONSERVATIVE?

Mariana Santos Castro[1], João Abecasis[1,2], Ana Braga[3], José Pedro Neves[3]

[1]Serviço de Cardiologia, Hospital de Santa Cruz, Carnaxide, Portugal
[2]Faculdade de Ciências Médicas, Universidade Nova de Lisboa
[3]Serviço de Cirurgia-Cardíaca, Hospital de Santa Cruz, Carnaxide, Portugal

***Contacto Autor**: marianacpsc@gmail.com

A 72 year-old men admitted for a two week old myocardial infarction had a septal intra-myocardial cavity at first echocardiographic evaluation (A,B). Cardiac magnetic resonance showed extensive no-reflow on the septum (C). Owing to clinical stability, a conservative strategy was decided. Without a complete VSD (D), fibrosis filled the gap in two weeks (E), followed by a septal remodelling scar (F).

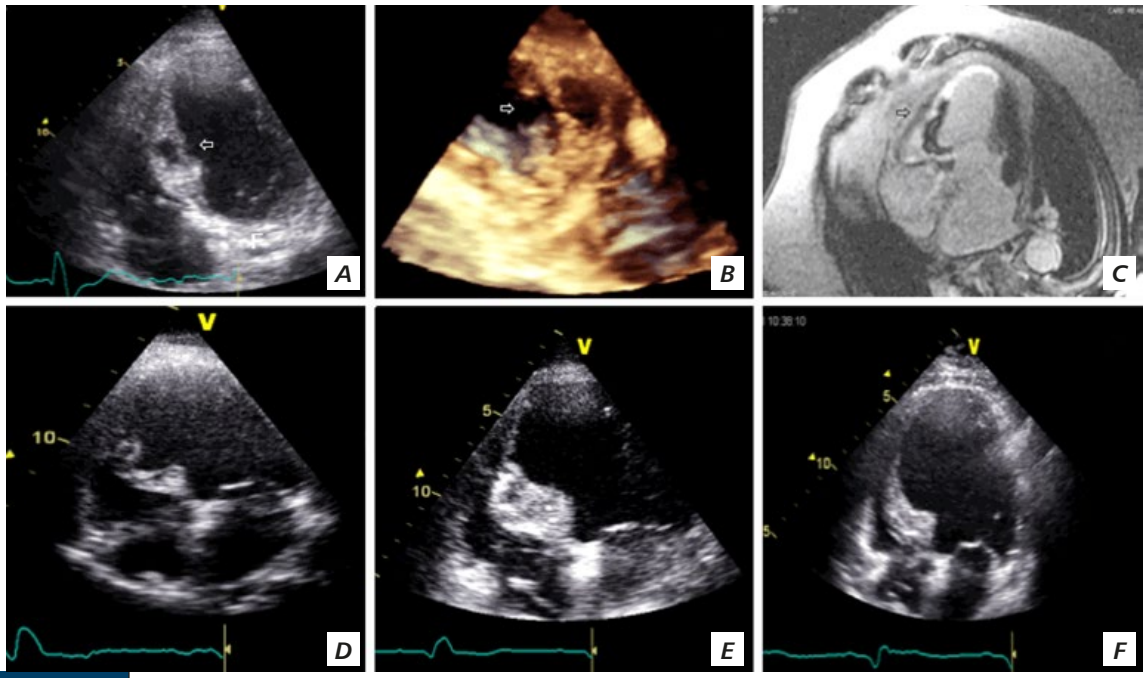


Figure 1

LEFT DIAPHRAGM RUPTURE DUE TO BLUNT TRAUMA

Tiago Fonseca, Jorge Costa

[1]General Surgery Department - Centro Hospitalar Entre o Douro e Vouga - Santa Maria da Feira, Portugal

***Contacto Autor:** tiagofeiteirafonseca@gmail.com

We present the case of a 56-year-old man involved in a motorcycle accident. The thoraco-abdominal examinations revealed multiple rib fractures, pneumohemothorax; left diaphragmatic hernia containing the stomach and colon and splenic lacerations.

These lesions were addressed surgically by repositioning the stomach, placing a left thoracic drain and suturing the diaphragm.

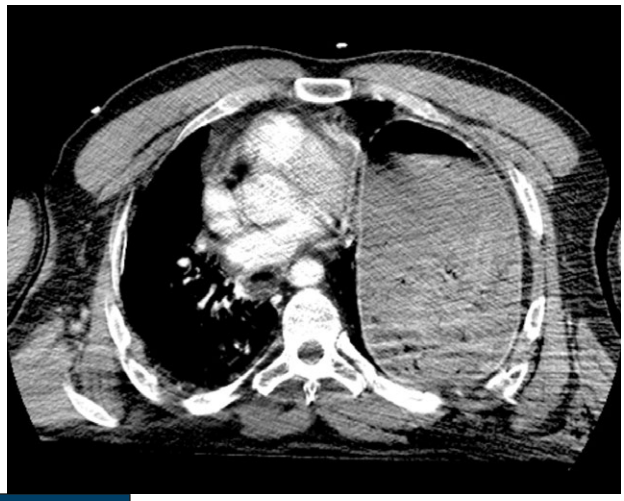


Figure 1 *Axial contrast enhanced CT scan shows discontinuity of the left hemidiaphragm with gastric herniation (dependent viscera sign), mediastinal shift to the right and rib fractures.*

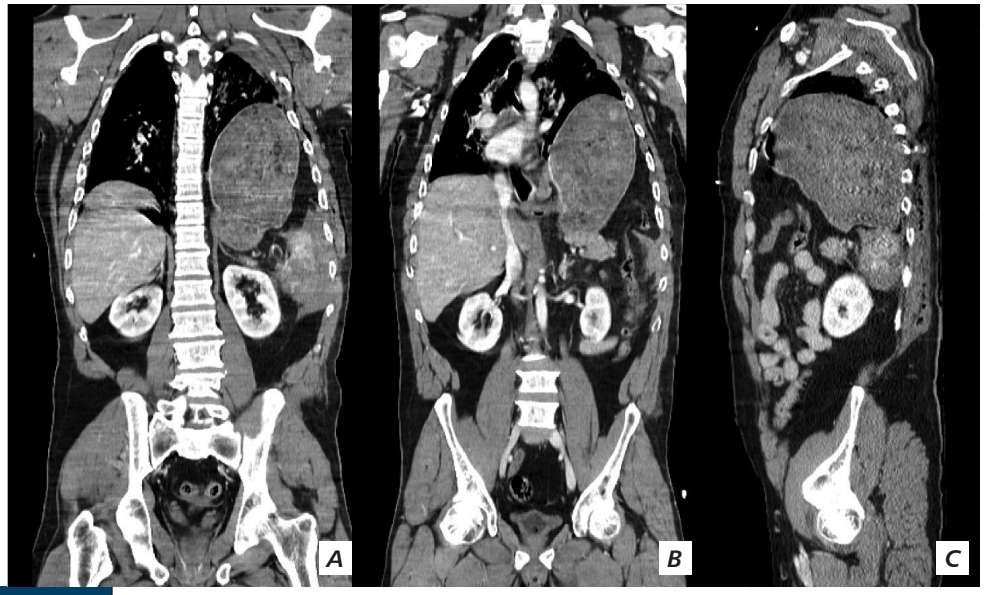


Figure 2 *Coronal and sagital reformated CT images. **A.** Gastric herniation and spleen laceration; **B.** curvilinear flap extending away from the chest wall toward the center of the abdomen (dangling diaphragm sign); **C.** free edge of the left hemidiaphragm, the distal part of which appears thickened (thickening of the diaphragm sign).*


SPCCTV