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REVIEW ARTICLE

Epidemiology of Aortic Dissections – Understanding the Aortic Catastrophe

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ABSTRACT

Acute aortic dissections are unpredictable aortic catastrophes. Although significant recent improvements have been accomplished in the treatment and management of aortic dissections, a significant amount is still not fully understood regarding this deadly condition. Comprehension of aortic dissections is especially important due to the impact of the disease, since a lot of patients die before reaching the hospital and a significant number of the ones who do survive the initial event end up dying during follow-up. The epidemiology and disease characteristics of these conditions are still under investigation and not completely clear. In this article we aim to review the current knowledge on the epidemiology and clinical characteristics of aortic dissections.

Keywords: Aortic dissection; Epidemiology; Review [Publication Type]

INTRODUCTION

Acute aortic dissections are known to be unpredictable, and challenging being classified by most as "aortic catastrophes". One of the first descriptions of aortic dissection was described by Frank Nicholls in 1760 on the autopsy of King George II, who supposedly died of a type A aortic dissection.[1,2] In 1800, Shekelton et al introduced the concept of true and false lumen.[3] Since then knowledge in aortic dissections have evolved significantly, however, a significant number of questions remain to be answered regarding this condition. Comprehension of aortic dissections is especially important due to the impact of the disease. About 38% of patients do not survive enough to reach the hospital alive for a diagnosis and are only discovered in autopsies. If not treated, mortality may be as high as 23%, 50% and 68% in the first 6h, 12h and first week.[4] Mortality is mainly dependent on the prompt diagnosis of the condition, timely treatment, and surgical repair, if necessary. Since they may present with a varying of clinical symptoms, disease awareness and access to adequate diagnostic methods are key factors influencing outcomes.[5]

The epidemiology and disease characteristics of these conditions are still under investigation and not completely clear. In this article we aim to review the current knowledge on the epidemiology and clinical characteristics of aortic dissections.

CURRENT CLASSIFICATIONS OF AORTIC DISSECTIONS

Aortic dissection may be classified according to their anatomic presentation, timing of presentation and presence of complications.[6]

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Anatomical classifications:

• **Stanford Classification:** According to the location of the proximal entry tear location they are classified as type A if involving the ascending aorta and type B if the proximal tear is distal to the ascending aorta. Recently the Society of Vascular Surgery (SVS) and Society of Thoracic Surgeons (STS) has further proposed the addition of type I dissection if the entry tear is not identified, and that Stanford classification be followed by the proximal and distal extension of the dissection according to the SVS aortic zones in the case of type B and type I dissections and distal extension in case of type A dissections. For example, a type B dissection which extends proximally to zone 2 and distally to zone 6 would be classified as type B.[2-6]

• **DeBakey Classification:** According to the extent of the dissection involvement, the DeBakey classification classifies aortic dissections into type I if all the aorta is involved, type II if only the ascending aorta is involved and type III if only the distal thoracic aorta is involved. Type III dissections may further be subclassified into type IIIA or IIIB if only the proximal descending thoracic aorta is involved or the whole distal thoracic aorta is involved, respectively.[6]

Classification according to the timing of presentation:

In 1990, Stanley Crawford[7] introduced the definition of acute aortic dissection by understanding that most patients would die during the first two weeks and that the disease tended to stabilize after this. Currently, as endovascular repair has become more common, recent studies have understood that there is a timing after these two weeks where the dissected aorta retains some of the plasticity allowing for remodeling but also remains dynamic and unstable. Steuer et al[8], have proposed therefore that there is also a sub-acute phase between 14 and three months.

Currently timing of dissection may be divided into 4 time-periods: hyper-acute phase if presenting in the first 24h, acute phase if presenting in the first two weeks, sub-acute phase between 2 weeks and three months and chronic phase after 3 months.[8] Timing of the dissection is especially important regarding surgical management and surveillance, especially for type B aortic dissections.[8]

Classification regarding the presence of complications:

Dissections may further be classified according to the presentation of complications, such as intractable pain and hypertension, malperfusion, progression of the dissection and rupture. This classification is especially relevant for type B aortic dissections since it will determine whether the patient is treated surgically or with medical management.[6]

With all these different factors coming into play, in 2013, Dake et al[9], proposed the mnemonic DISSECT in order to categorize aortic dissections: D- duration of dissection; I- Intimal tear location; S- Size of the Aorta (maximum trans-aortic diameter); S E - Segmental Extent of aortic involvement; C- Clinical complications related to dissection and T- Thrombosis of aortic false lumen. Each of these categories are further subdivided to specifically characterize each factor.

DEMOGRAPHICS AND RISK FACTORS FOR AORTIC DISSECION

One of the biggest contributors to clinical knowledge on aortic dissections has been the International Registry of Acute Aortic Dissection (IRAD).[5,10,11] This registry including patients from North America, Europe, Asia and Australia has a current database of over 7300 cases.[5,10,11] In one of the most recent publications, they report that two-thirds of patients presented with type A aortic dissections, and the remaining with type B. Most of patients were male (66.9%) and mean age was 63 years.[5] The most common risk factor was hypertension being prevalent in 76.6% of patients.[5] This is similar to the findings of a population-base systematic review study we published, in which mean age varied between 58.9 and 77.3 years, male sex between 49.6%-84% and hypertension was present in 70% of aortic dissection (AD) patients.[12]

Other less common causes of AD such as connective tissue disease and cocaine abuse were still present in the IRAD study in 5% and 1.8% of cases, respectively, which were more frequent in younger patients.[5]

INCIDENCE OF ACUTE AORTIC DISSECTIONS

Calculating the incidence of acute aortic dissections in the population is challenging. Most of the studies published are based on administrative coding data which may depend on factors such as the accuracy of coding in each hospital, differences in coding systems across different hospitals or missing diagnosis in patients with multiple other pathologies. Moreover, in-hospital diagnosis of acute aortic dissections may miss some patients who die outside of the hospital, leading to an under-reporting of the actual incidence of the disease.[12,13] However, contrary to thoracic aortic aneurysms, which are mainly asymptomatic, acute aortic dissections are usually very symptomatic and lead the patient to seek medical attention, which makes diagnosis more likely.

We have performed a systematic review and meta-analysis analyzing the incidence of acute aortic dissections in population-based studies. In this study we found the pooled incidence of acute aortic dissections to be 4.8 per 100 000 individuals/year (95%CI: 3.6; 6.1), varying between 2.0 and 15.0 per 100 000 individuals/year across the studies. When analyzing type A and type B aortic dissections individually, the incidence rate was 3.0 (95%CI: 1.8; 4.4) and 1.6 (95%CI: 1.1; 2.2) per 100 000 individuals/year, respectively.[12]

On performing sensitivity analysis, the incidence seemed to be increasing over time and tended to be higher in European studies. The increase of the incidence may be due to two factors, one may be the higher awareness for the disease and access to better diagnostic tools, and secondly to the increase of the actual disease due to increase in cardiovascular risk factors. If the second theory is true, the global changes on the burden of cardiovascular risk factors, such as hypertension (the most significant risk factor for AD) may also lead to changes in AD epidemiology.[12] Currently, there seems to be a trend towards a higher growth of hypertension prevalence in developing economies.[14,15] This

may mean that these countries will develop a higher degree of AD incidence, similar to what is observed currently in developed countries. Since there is lack of reporting of AD incidence studies in developing studies, there is no way to confirm or deny this theory currently and may be a topic of future research.

Information of aortic dissection incidence, besides leading to a better understanding of the disease is important to understand the burden on healthcare, such as cost and funding allocation, but also the impact on mortality. In our review we found that 1.33 per 100.000 patients/year will die due to an aortic dissection and 1.43 per 100.000 patients/year will require an aortic repair.[12] If we extrapolate these numbers to the Portuguese adult population over 50 years (age in which most studies were conducted), approximately 270 patients will be diagnosed with an aortic dissection each year, 74 patients will die due to an aortic dissection and 80 patients will be submitted to surgical repair.

CLINICAL MANIFESTATIONS

Clinical presentation of acute aortic dissections may vary and usually depends on three main factors, the location of the proximal tear, the extension and direction of the dissection (ie. Antegrade, retrograde or both) and the involvement of aortic side branches, such as the coronary arteries, supra-aortic trunks, visceral arteries, intercostal arteries and arteries of the lower limbs.

For type A aortic dissections, the first and most significant symptom tends to be chest pain, whereas type B aortic dissections usually present with back or abdominal pain.[5,10,11] This pain is usually described as the worst pain they ever felt. Abdominal pain is especially warrying since a significant number of these patients tend to have a delayed diagnosis due to the atypical presentation and may have mesenteric ischemia. Painless presentation of AD may also occur in about 6% of patients, usually presenting with syncope, heart failure or stroke and may be associated with a higher mortality risk. [5,10,11]

Regarding clinical signs, hypertension is one of the key findings in type B aortic dissection, whereas it is not as common as in type A aortic dissections, which may present normotensive or even hypotensive. When shock is the presentation of AD, it is usually due to either cardiac tamponade, cardiogenic shock due to myocardial infarction due to retrograde involvement or due to aortic rupture. Other signs may also be present such as diastolic murmur due to aortic valve insufficiency or pulse deficit due to involvement of either the supra-aortic trunks or lower limb malperfusion. [5,10,11,16]

CLINICAL BEHAVIOUR AND MANAGEMENT OF AORTIC DISSECTIONS

Type A aortic dissections:

Acute type A dissection is considered a surgical emergence and most patients are operated if they reach the hospital alive.[16] Surgical repair of type A aortic dissection has changed over time. Contrary to the past where centers tend to prefer a short repair of the ascending aorta, currently more extensive repairs are preferred since they lower the rate of post-operative surgical failure and need for re-intervention.16 Complete repairs of the aortic arch are more commonly performed for dissection extending into the arch or distal aorta to allow for future distal repairs. In the last years frozen elephant trunks have gained more adherence and have significantly facilitated distal aortic repairs in the future.[16]

One area of discussion regarding acute type A aortic dissection management however seems to be regarding patients with concomitant mesenteric malperfusion. In these cases, which have a very high mortality either way, some centers have advocated a delayed proximal aortic repair following mesenteric revascularization.[17,18]

One current problem, however, seems to be the follow-up of patients following acute repair of type A aortic dissection repair. In a recent study by An et al, showed that in Canada, of a total of 888 patients who survived a type A acute aortic dissection repair, only 14% received guideline directed imaging surveillance.[19] This is especially worrying as aortic dilatation and aortic related mortality after type A aortic repair is substantial and non-negligible.[20,21]

Regarding re-interventions following type A acute aortic dissection repair, endovascular strategies have gained more adherence. Positive factors for endovascular repair are the absence of the need to perform a re-do sternotomy which carry a significant inherent morbidity and mortality, with in-hospital mortality rates of 14%[22] and the low burden of atherosclerotic disease in these patients which significantly lower the risk of peri-operative stroke with endovascular arch repair. Versheure et al[23], published the multicenter experience with the COOK a-branch for the treatment of type A chronic aortic arch dissections. The results were surprisingly optimal with technical success of 94.3%, perioperative mortality of 2.9% and permanent stroke of 2.9%.[23]

Type B aortic dissections:

Most type B aortic dissections will present without complications, being classified as uncomplicated type B aortic dissections. This accounts for about 80% of cases. In the remainder, surgical repair is required being that aortic repair or target artery revascularization due to malperfusion.[10,11]

Uncomplicated dissections submitted to medical treatment seem to have good results in the acute phase, with in-hospital mortality of 10.7% as described in the IRAD experience.[10,11] However, in the long term it seems that aortic-related complications tend to occur in these so-called uncomplicated cases. Durnham et al[24], showed that 25-50% of uncomplicated type B aortic dissections develop late aortic related complications such as rupture, aneurysmal degeneration, and malperfusion, with an aortic related mortality at 4 years of 38.3%. This has led a lot of surgeons to regard “uncomplicated” dissections as a misnomer. Furthermore, studies such as the INSTEAD-XL and the ADSORB trial have shown that performing a TEVAR in uncomplicated type B dissections might improve aortic remodeling and lower late-aortic related mortality.[25,26]

Currently, a significant amount of research has been performed on the natural history of uncomplicated type B dissections, trying to identify clinical and anatomic factors which may be associated with late onset complications.

Spinelli et al[27] have performed a systematic review analyzing these factors and have found the most consistent factors to be aortic size at presentation (being >40mm associated with poor prognosis) and total false lumen thrombosis (associated with good prognosis). Other factors associated with a worse prognosis, but which were not so consistent were: increased entry tear size >10mm; proximal location of the entry tear; location of the entry tear in the inner curvature; patent or partially thrombosed false lumen; increased number of branch vessels involvement; lower number of entry tears; false lumen arch extent; false lumen arch inner curvature extent and false lumen length.[27]

Regarding treatment of selected uncomplicated cases, question remains in which timing this should be performed. The VIRTUE trial has shown that this seems to be better in the sub-acute phase, where the dissected flap still retains its plasticity and the risk for complications related to TEVAR are not as frequent.[28] One of the problems of TEVAR in this setting, however, has been with the possibility of complications in the distal non-stented aorta, leading some centers to argue for a more extensive approach, especially if distal aortic involvement of dissection exists with absence of true lumen expansion after simple TEVAR.[29-34] The STABILISE technique has been described as a promising therapeutic strategy for these patients with optimal short and mid-term results reported in small series.[29-34] A similar strategy but without distal bare metal stent ballooning and flap disruption has been described as the PETTICOAT technique.[35]

Regarding complicated type B dissections, treatment may be dependent on the type of complication, namely malperfusion.[36,37] Some authors have argued that in every case, the proximal tear and the aortic dissection should be treated with an endovascular repair with either a simple TEVAR or TEVAR plus distal bare metal extent, and if the malperfusion is not resolved, such as cases of static malperfusion then a direct stenting or bypass surgery should be performed.[37-39] The main rationale behind this is that treating the malperfusion first, may bring some difficulties in the future aortic repair or even worsen the dissection due to destabilization of the pressure gradients between the true and false lumen.[40]

Performing TEVAR with distal bare metal stent extension for complicated dissection has been analyzed in the STABLE I and STABLE II trials.[41,42] In the STABLE II trial, 73 patients were included, 20 presenting with rupture and 57 with branch vessel obstruction/compromise. Overall freedom from 30-day and overall mortality (at 1 year) was 93.25% and 80%, respectively. Retrograde dissection following repair only occurred in 4.5% of patients during follow-up, however about 20% of patients still developed aortic enlargement of more than 5mm during follow-up, which brings to light the importance of follow-up even after repair.[42]

In cases where patients survive the initial event and aortic degeneration occurs, repair of the post-dissection aneurysm may be necessary when the diameter threshold for repair is reached. Most of these aneurysms are extensive, involving the thoraco-abdominal aorta and are complex to treat. In a recent systematic review and metanalysis study we performed, we reported a population-based prevalence of thoracic aneurysms of 0.16% being even higher in autopsy studies (0.76%), and when looking at the etiology of these aneurysms a significant number of them were post-dissection (between 14 and 51%).[43]

Treatment of post-dissection is challenging as one has to deal with not only the aneurysmal aorta but with the different dynamics of the dissected flap and respective side branches. Endovascular repair of these aneurysms has become more popular as fenestrated and branched endovascular technologies and expertise has increased.[44-46] We have published our experience with these aneurysms with both open and endovascular repair. In our study we found that open repair was preferred for young and fit patients, and those with connective tissue disease, and endovascular repair to more older and frail patients.[47] This is similar to what is described in other studies.[45,46] However, as endovascular technologies evolve with more complex techniques such as dissection flap perforation, better imaging guidance systems, more robust and flexible bridging stents and better comprehension of the behavior of these grafts in dissections, endovascular repair is expected to be preferred in most patients, with open repair reserved for very selected patients. Furthermore, as more patients are treated in the acute or subacute phase with either simple TEVAR or TEVAR plus distal bare metal extent, this will probably lead to easier endovascular solutions even in cases where the aorta still degenerates since narrow true lumens will not be so big of an issue.

CONCLUSION

In this study we have reviewed some key aspects of aortic dissection epidemiology and disease characteristics. A significant number of questions still remain regarding this aortic conundrum, such as the natural history of the remainder of the dissected aorta following a type A aortic repair, what is impact of aortic dilation following endovascular aortic dissection repair, which "uncomplicated" type B aortic dissections warrant repair and which we should only follow with medical therapy, what is the impact of hypertension prevention on the development of aortic dissection in the population. Furthermore, there is scarcity of research on the epidemiology of aortic dissections in developing countries with growing rates of hypertension. Also, in our country, in Portugal, where hypertension is one of the most significant and prevalent risk factors, a very small number of research has been published on aortic dissection epidemiology.

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