Review Article

Emergent aortic surgery in octogenarians: is the advanced age a contraindication?

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Abstract: Surgery of both the ascending and descending aortic segments in the context of an acute aortic syndrome is one of the greatest challenges for the cardiac surgeon. In the case of surgery of the descending aorta, surgical risk increases due to the technical complexity, the required aggressive approach and because surgical indication is usually established as a result of complications and therefore involves, almost always, critically ill patients. The aging of the population is causing such surgery to be considered in an increasing number of octogenarians. The present review analyzes the available scientific evidence on the surgical indications and outcomes of these complex procedures in this population, particularly in the emergent scenario. Ascending and descending thoracic aortic diseases are reviewed separately, and the role of both the current risk scores and frailty assessments are comprehensively discussed.

Keywords: Acute disease; aneurysm, dissecting/diagnosis/therapy; aortic diseases/complications/diagnosis/therapy; endovascular procedures/methods; frail elderly

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Acute aortic syndromes (AAS) are probably the most challenging diseases that cardiac surgeons can face in clinical practice. The extremely high mortality of AAS in the absence of treatment, and the risk associated to the aggressive and complex techniques needed for their surgical management (1) imply that an early diagnosis and proper selection of surgical candidates are essential to achieve acceptable results. At the same time, different carefully planned surgical techniques must be selected, suited to each individual clinical and anatomical situation.

The progressive aging of the population and increasing life expectancy result in more frequent high risk surgical cases involving elderly candidates (2).

In the last few decades, the repair of the descending thoracic aorta diseases has evolved considerably, focused predominantly on improving endovascular therapy techniques and materials, with new surgical techniques and device developments, and both outcomes and prognosis of these patients has greatly improved, especially in those with complex comorbidities or advanced age, in which conventional open surgical procedures have been traditionally contraindicated (3).

We therefore will separately address the management of the ascending and descending aortic segments.

Acute aortic syndromes of the ascending aorta and aortic arch

Clinical practice guidelines and the real world

Stanford type A AAS remains the most frequent disease and globally considered, induces greater immediate mortality risk than when the descending aorta is affected. The mortality rate associated to ascending aortic dissection (AAD)—the most common form of AAS—is 90% one month after the event in the absence of surgical treatment (1), and although the in-hospital mortality rate (between 17–26% according to the latest report of the International Registry of Aortic Dissection, IRAD) (4) and the incidence of neurological complications are also high (15–20%), surgery undoubtedly improves outcomes. The latest [2014] European Society of Cardiology Guidelines on the Diagnosis and Treatment of Aortic Diseases maintain the recommendation of urgent surgical treatment for all patients with type A AAD (Class IB recommendation) (1). Very briefly, the recommendation is to replace the supracoronary aorta with or without the aortic hemiarch, and with resuspension of the aortic valve if the leaflets are morphologically normal, reasonable residual diameters are left, and the intimal tear is completely resected. Patients with poor visceral perfusion and intimal tears located in the descending aorta are precisely those who may benefit from more extensive surgical treatments including replacement of the ascending aorta and arch (with individual reimplantation of the supra aortic vessels) and intraoperative endovascular management (with a stent integrated in the descending aorta prosthesis or "frozen elephant trunk") performed in a single step in order to minimize the postoperative visceral ischemic complications and reduce the number of mid- and long term aorta-related events (especially reinterventions) during follow-up.

In the case of postoperative persistent distal malperfusion syndromes, endovascular treatment, flap fenestration or revascularization (specially in the case of lower limb ischemia) may be considered as reasonable options. Emergent surgical treatment is indicated in type A intramural hematoma if the patient presents pericardial effusion, periaortic hematoma or a large aneurysm, while urgent surgery is advised in the great majority of the rest of cases (Class IB recommendation). In type A penetrating ulcer (the least frequent presentation of AAS), a Class IIaB recommendation for surgical treatment is suggested. Surgery should be clearly indicated if refractory or recurrent pain occurs, as well as signs of contained rupture such as rapid ulcer growth, associated periaortic hematoma or pleural effusion. Some authors consider that asymptomatic patients, with an ulcer diameter of >20 mm or a neck of >10 mm, are at a high risk of disease progression and therefore might also be considered as candidates for early surgery, though the decision-making process in the treatment of asymptomatic type A penetrating ulcers remains controversial.

Nevertheless, neither the 2014 European Society of Cardiology (ESC) nor other guidelines specifically address the treatment approach in type A acute aortic syndrome among octogenarians. They mention the IRAD (5), the largest aortic dissection registry in the world, in which age is identified as a predictor of mortality (2). This report specifies that patients between 80–90 years of age present lesser in-hospital mortality with surgery than with conservative management (37.9% versus 55.2%), although this difference was not significant, however, probably because of the limited sample size (6). The German Registry for Acute Aortic Dissection Type A (GERAADA) analyzed the results of 640 patients over 70 years of age and found mortality to increase with advancing age, with a peak among octogenarians. However, the reported figure (25%) was very acceptable, and no correlation was observed between age and the appearance of neurological events (7). This study showed that in older patients isolated supracoronary replacement procedures are more frequently performed. In a recent study, Suenaga *et al*. evaluated 25 octogenarians that underwent AAD emergent surgery between 2000–2013, and reported a 30-day mortality rate of 8%, with no significant differences between them and the group of patients under 80 years of age (5%, P=ns) (8). Furthermore, during follow-up, very acceptable survival rates were observed after 1 and 5 years (80% and 59.7%, respectively), but clearly better among the younger individuals (90.6% and 81.9%, respectively; P=0.036). In another series of 24 patients with a mean age of 83 years that underwent emergent surgery between 2005–2015, the in-hospital mortality rate was 0% versus 10.4% in younger patients. Likewise, over a mean follow-up of 3.4±3 years, the mortality rate was 12.5% versus 6.7% in the younger patients, with survival rates after 1, 3 and 5 years of 94.4%, 81.5% and 81.5%, respectively, among the octogenarians and of 86.9%, 85.6% and 83.9% in the younger group, with no statistically significant differences (9).

In turn, El-Sayed *et al.* analyzed 39 patients with a mean age of 82±2 years subjected to replacement of the ascending aorta and hemiarch (82%) and to full arch replacement surgery (18%) between 2005–2013. The in-hospital mortality rate was 26%, with an estimated 5-year survival rate of 46%±16% (10). Finally, a very recent meta-analysis has been published including 11 retrospective observational studies published in the last 5 years, and concluded that patients over 70 years of age have a greater mortality risk than younger individuals

[19.9% versus 14.9%; relative risk (RR) =2.25; 95% confidence interval (95% CI), 1.79–2.83; I^2=0%; P<0.0001], with this finding also being confirmed for octogenarians. However, the incidence of neurological complications and renal failure was similar in both groups (11).

In any case, other studies report a high incidence of postoperative neurological complications (12), with a surgical mortality rate up to 83% (13,14). In conclusion, and based on the current evidence, the guidelines state that age *per se* should not be considered as an exclusion criterion for surgery, though in the specific case of type A intramural hematoma in elderly patients or those with significant comorbidities, initial optimal medical management and serial imaging tests could be a very reasonable option particularly in the absence of aortic dilatation (<50 mm) and with a hematoma size of <11 mm (15,16).

An explanation for the acceptable results obtained in the series of very elderly patients, particularly in those with no significant differences in mortality or serious adverse events after surgery, is the careful selection of patients and surgical techniques. Piccardo *et al*. (17) conducted a prospective follow-up of all the octogenarians operated upon in their center between 2000–2010 (79 consecutive patients with a mean age of 81.6 years; range, 80–89 years). Those individuals on stable conditions and without ischemic complications or the need for cardiopulmonary resuscitation before surgery presented mortality rates of 33.3%, versus 44.3% in the case of patients operated upon with such complications. The 1 and 5-year survival rates were 63% and 38% respectively, significantly better in the group without critical preoperative conditions.

In relation to the subgroup of elderly patients of the GERAADA, isolated supracoronary replacement was found to be more frequent than complete aortic arch repair (7). The previously commented excellent outcomes without in-hospital mortality (9) are probably due to the fact that 95.8% of the octogenarians underwent ascending aortic replacement surgery versus 65.7% of the younger group, where arch replacement was more often performed. Similarly, in another comparative study analyzing 21 octogenarians versus another group of patients under 80 years of age with similar preoperative characteristics subjected to emergent surgery between 2005–2011, the observed mortality rate was 0% and 9%, respectively. Preoperatively, younger patients had more frequently malperfusion syndrome (40% versus 9%; P=0.002), were more often subjected to Bentall-type complete root replacement surgery (26% versus 5%; P=0.04), and needed longer circulatory arrest times (20±7 versus 16±9 minutes; P=0.03) (6). Likewise, many studies suggest that arch replacement in these patients increases mortality (14,18), and recommend a single distal anastomosis (hemiarch tailored when needed) even in the case of intimal tears located in the arch, provided that their complete resection is performed. All these data suggest that in order to achieve acceptable outcomes in these patients, the preoperative clinical condition must be sufficiently stable, and the extension of the surgical technique must be sufficiently limited.

In conclusion, age *per se* should not be considered as an exclusion criterion for surgery, though it must be taken into account that older age and a poorer preoperative clinical condition are associated to increased morbidity and mortality. In this regard, it should be advisable that the chosen surgical techniques be as little aggressive as needed to solve the acute problem of the patient, even if the surgical strategy probably provides less lasting results over the long term.

At this point, and facing the extremely difficult clinical decisions of indicating complex, very aggressive and non-routine surgical techniques in very high risk patients, we must answer two important questions: how can the current risk scores help us in the decision-making process and how does the frailty of a patient, apparently without other comorbidities, influence the perioperative course?

Risk scores and emergent aortic surgery in octogenarians

The improving life expectancy of industrialized countries populations induces the above-mentioned proportional increase in the mean age of surgical candidates for both elective and urgent/emergent open heart surgery. Thus, it has made necessary to proceed with current risk scores adjustments or to design alternative predictive models to adequately predict surgical risk in scheduled and urgent operations in elderly patients (19-23). However, when patients with AAS are focused, the under-representation of patients aged 80 years or older, and the lack of specific discrimination according to pre- and intraoperative variables with a tremendous impact upon mortality (e.g., the presence of previous malperfusion, the need for circulatory arrest and deep hypothermia, or the more or less extensive thoracic aortic segment requiring replacement), cause current risk scores to become far from being useful in this setting. An 80-year old male with a Stanford type A aortic dissection, clinically stable and asymptomatic when entering the operating room, in which an isolated emergent supracoronary ascending aorta replacement is indicated and with no associated comorbidities, has a predicted surgical mortality risk of 28.72% according to the logistic EuroSCORE I (19,20), 3.35% according to EuroSCORE II (24), and 30% according to the additive Parsonnet score (25). These mortality risk predictions would remain constant if the same patient presents with abdominal pain due to severe mesenteric ischemia and if after aortotomy we discover an intimal tear located at the distal arch with extension to the descending aorta that requires extensive arch replacement, supra aortic vessels reimplantation and a "frozen elephant trunk". In addition, many other standard predictive models such as the Society of Thoracic Surgeons (STS) score or the Ontario Province Risk Score, among others, are not applicable to surgery of the aorta, since they were specifically designed to calculate exclusively the risk of valvular, coronary or combined valvular and coronary surgery (21-23).

Reports about current risk scores validation in thoracic aortic surgery are very limited, particularly in the specific context of octogenarians with AAS. However, Nishida *et al.* (26) observed better adjustment of the EuroSCORE II versus EuroSCORE I when surgery of the aorta was considered, in a validation series of 461 patients (one-third with type A AAD), showing an adequate predictive capacity with an area under the curve (AUC) of 0.77. With regard to goodness of fit, many publications have reported a systematic trend to overestimate surgical risk with the EuroSCORE I versus EuroSCORE II. Furthermore, the goodness of fit of EuroSCORE II seems to be adequate for risks levels of <30%, beyond which a systematic tendency to risk overestimation is likewise observed (27). Therefore, we can state that current scores do not meet the requirements to address the complex decision-making process characterizing multiple open heart surgery scenarios, including AAS (28-30).

Accordingly, different proposals have been made to adapt the existing scores to the context of AAS surgery. Nissinen *et al.* (31) suggested to modify the assigned weights of the different classical variables, increasing those of "surgery of the thoracic aorta" and "critical preoperative status". Berbel *et al.* (32) have defined a new score selecting only those previous score variables with a significant impact upon surgical mortality in this subpopulation of patients, and discarding the rest. Barmettler *et al.* (33) propose a modification of the EuroSCORE I involving the implementation of two additional variables: "aortic dissection" and "preoperative peripheral malperfusion". In any case, new risk scores redefinition based on multicenter projects including large sample sizes of patients and contemplating all the preoperative and predicted intraoperative variables with an impact upon survival is clearly warranted. Motomura *et al.* (30) have proposed the only specific thoracic aortic surgery score based on the Japan Adult Cardiovascular Surgery Database, with the participation of 180 hospitals throughout Japan and the final recruitment of over 4,400 patients in 97 centers. This model adds clinical variables specifically associated to aortic disease and its surgical outcomes, such as the presence of malperfusion or rupture, Marfan syndrome, acute dissection or active anticoagulation therapy, as well as certain variables specific of the performed surgical procedure and closely correlated to periprocedural mortality, such as preoperatively non-planned coronary artery bypass grafting. Obviously, a model development exclusively based on Japanese population may limit the possibilities of extrapolating the results to other settings. On the other hand, the mean age of the selected population was 66.5±12.8 years, and although the age range was not reported, assuming a normal distribution for this variable (and this is rather unlikely, considering that these patients are more frequently considered as surgical candidates at younger ages) would mean that only a little more than 15% of the patients would be over 79 years of age.

Lastly, it must be remarked that very severe and disabling morbidity can occur in the postoperative course of AAS surgery (perioperative stroke, acute renal failure and permanent dialysis, prolonged mechanical ventilation, etc.). In this context, risk scores must be powered to predict, not only mortality but also the occurrence of such events, particularly in this very elderly patient population, significantly more prone to long-term postoperative permanent residual disability and dependency. Unfortunately this is far from being methodologically feasible. Likewise, the above-mentioned scores may probably become an acceptable alternative for risk prediction in ascending aorta and aortic arch surgical procedures (type A AAS). However, their predictive value is even less in type B acute aortic syndrome patients, with its different clinical presentations, treatment alternatives and specific associated postoperative complications (22,23).

In conclusion, there is a lack of clearly useful and really predictive scoring systems for the decision-making process in this disease. Nevertheless, there is extensive information in the literature to identify predictors in these patients of poor survival and, even more important in these extremely elderly population, functional outcome (28,29). In this regard, the variables contemplated in these scores may be more useful in identifying such independent risk factors than the estimated percentage risk associated to the operation. Consequently, in our opinion, the assessment of mortality and morbidity risk in type A AAS repair surgery among octogenarians should focus on integration of the values of these scores with a thorough evaluation of the baseline clinical and functional condition of the patient (which will be usually very difficult in the emergent surgery scenario), the existence of associated complications and the surgical procedure probably required. Furthermore, risk prediction must be systematically individualized for each specific patient in a multidisciplinary approach (34).

Importance of patient frailty in emergent surgery of the aorta in octogenarians

The previously mentioned increase in life expectancy is nowadays associated with significant improvements in quality of life induced by advances in the prevention, diagnosis and treatment of a wide variety of age-related diseases, such as some types of cancer, cardiovascular disease, etc. This means that many very elderly patients have so well-preserved baseline physical and mental conditions that induce physicians to indicate more frequently complex and aggressive surgical or invasive treatments that some decades ago should be clearly contraindicated. Furthermore, the implementation of less aggressive surgical approaches and the developments in conventional techniques and intra- and postoperative care have contributed to improve the outcomes in these individuals. As a result, the "red line" separating medical from surgical management has become less clearly defined, and the concept of "frailty" has become increasingly important in the overall evaluation of elderly patients, representing an important factor that must be strongly considered in the decision-making process.

The definition of "frailty" has changed over the past decades. It initially focused only on general motor and physical capacity (35), though subsequently patient cognitive defects or mental health were also taken into account (36), along with the sociocultural conditions and family support (37). In fact, these elements must also be considered as part of the complex frailty syndrome and as contributors to the postoperative survival and functional outcomes, particularly when considering surgical techniques with a high risk of postoperative disabling complications.

A number of scores are being incorporated to routine clinical practice for objectively identify and, more importantly, quantify the presence of frailty. These instruments range from simple scores such as the gait speed (5-meter walk) test or the 6-minute walking test, which only assess the presence or absence of "physical frailty" (38,39), to the very comprehensive 70-item Frailty Index, which moreover explores cognitive, sociocultural and familial aspects and global patient disability (40).

In recent years, some studies have been designed to examine the impact of frailty parameters upon the predictive capacity of the scores commonly used in heart surgery. Afilalo *et al.* (38) investigated the changes in the predictive value of the STS score on adding a new frailty parameter—the aforementioned gait speed (5-meter walk) test—in a population of elderly patients subjected to elective coronary artery bypass grafting or valve replacement/repair surgery. The presence of frailty was defined as a time of over 6 seconds in walking 5 meters, and proved to be an independent predictor of 30-day morbidity and mortality. In addition, its combination with the STS score provided greater mortality and morbidity predictive capacity than the STS score alone (AUC 0.74 versus AUC 0.7).

Following these results, the authors analyzed the predictive value of different frailty, disability and surgical risk scores in non-emergent heart surgery, with the aim of identifying the best combination for predicting adverse events. In this regard, a "slow" 5-meter walk test (frail patient) and a Nagi disability score of ≥3 points were seen to be independent predictors of increased in-hospital morbidity and mortality, significantly improving the predictive capacity of the Parsonnet score (AUC 0.76 versus 0.72) (41).

de Arenaza *et al.* (39) found the 6-minute walking test (defining frailty as a walking distance of under 300 m) to be an independent predictor of mortality, infarction and major cardiac and cerebrovascular adverse events one year after surgery. Another finding of this study was that the 6-minute walking test applied to patients at increased risk according to the EuroSCORE I (mortality rate >6%) was able to improve the stratification of surgical risk into low and high risk profiles, improving its predictive and discriminating capacity.

These results clearly indicate that the presence of "physical" frailty and a degree of disability have a significant negative impact upon the clinical outcomes of open heart surgery. It is also clear that the inclusion of frailty and disability variables in the surgical risk scores is important, since they can improve the predictive capacity of the scores in these patients. Nevertheless, future studies are still needed to confirm this hypothesis (42) and to identify those variables with the greatest negative impact in these settings (43). On the basis of this evidence the EuroSCORE II included a frailty variable ("poor mobility", which unfortunately only analyzes patient musculoskeletal reserve) among its items (24).

With regard to AAS in octogenarians, identifying and quantifying frailty is undoubtedly of crucial importance in making decisions, probably even more than in other cardiac surgical disorders in view of the aggressiveness of the required surgical procedures and the associated risk of postoperative neurological complications. Unfortunately, however, all the previously mentioned studies, and practically all the reports about frailty scores, share the condition "emergent surgery" as an exclusion criterion. Furthermore, as has been mentioned above, many of the risk scales to which fragility variables or scores have been added have not been designed to predict risk in thoracic aortic disease, such as the STS score. In fact, to our knowledge, no studies have specifically addressed the potential impact of frailty in the management of AAS among octogenarians. Moreover, it is obviously extremely difficult to apply most of the frailty scores tests to patients with conditions as critical as an AAS in which an emergent surgical procedure is being indicated.

In conclusion, the presence of frailty as assessed by the scales commonly used in clinical practice implies an increased probability of mortality, morbidity, functional impairment and of major cardiac and cerebrovascular adverse events among open heart surgical patients. Unfortunately, there is no scientific evidence about the validation or usefulness of the existing frailty scales in improving the prediction of surgical morbidity and mortality among octogenarians with AAS, and even less so in the context of emergent surgery. Indeed, it is methodologically unlikely that such evidence can be reached. Nevertheless, we strongly consider that cardiologists, anesthesiologists and cardiac surgeons must know the variables that have an impact upon the presence and degree of patient frailty, since at the time of diagnosis of AAS and during decision making it is crucial to explore the information that the patients and their relatives can provide regarding physical and mental health, independence, quality of life and frailty level before the diagnosis, in order to successfully proceed with the extremely complex decision-making process of these clinical scenarios. Furthermore, this again must be individualized for each concrete patient and for each anatomical and clinical context.

Acute aortic syndromes of the descending thoracic aorta

The surgical repair of type B AAS, particularly the type B aortic dissection (TBAD)(the most frequent presentation of type B AAS) implies a very high risk in terms of patient mortality, spinal cord injury, mesenteric ischemia and renal failure (1), clearly greater than in ascending aortic repair surgery. Open descending thoracic surgery requires a left posterolateral thoracotomy with or without circulatory arrest and deep hypothermia for the replacement of the diseased aorta, that must include the proximal intimal tear in case of TBAD. Although surgical outcomes have improved, the overall in-hospital mortality rate is high and ranges between 25-50%, with an incidence of stroke, spinal cord ischemia, mesenteric ischemia and acute renal failure of 9%, 6.8%, 4.9% and 19%, respectively (1). On the other hand, the risk of rupture and death without surgical treatment is significantly lower than in acute AAD. The analysis of the IRAD showed in-hospital mortality rates of 0–8% for non-complicated medically treated TBAD (44). Consequently, medical management is the treatment of choice in these patients in the absence of complications, particularly in high risk cases such as very elderly subjects, and is basically based on blood pressure and pain control combined with close monitoring of potential complications occurrence (rupture or malperfusion syndrome). In contrast, patients with complicated acute TBAD have a poor prognosis with mortality rates of 10–30%, and surgical management is usually indicated in such cases. Introduction and development of the endovascular management of these disorders in the 1990s made it possible to treat descending thoracic aortic disease in subgroups of patients with too much risk for conventional open surgery (45), due to advanced age, associated pulmonary, renal and other complications. Since then, many published series have suggested significant clinical benefits, improved quality of life, fewer complications and increased survival among patients in which a thoracic endovascular aneurysm repair (TEVAR) has been performed for both acute (46-49) and chronic elective thoracic aortic disease (3). In a nonrandomized, prospective controlled study, Patel *et al*. (3) found that the elective endovascular treatment of 21 asymptomatic patients with chronic disease of the descending aorta and a high surgical risk because of advanced age (≥80 years) and/or significant comorbidities, with an indication for surgical repair, obtained survival benefits over the middle term compared with the medical treatment of 22 patients not amenable to TEVAR due to anatomical factors or that voluntarily didn't give informed consent for the operation. There was no in-hospital or 30-day mortality after TEVAR, and the median length of total postoperative/intensive care unit (ICU) stays was 8 and 2 days, respectively. No patients required dialysis, and three patients had perioperative stroke with no residual sequelae after 4 months. After 1 and 2 years of follow-up, survival among the TEVAR patients was significantly better (95% and 70%, respectively) than in the case of their medical treatment counterparts (68%; P=0.03 and 51%; P=0.05, respectively). Regarding AAS, the INSTEAD trial (50) had already suggested in 2009 that TEVAR in patients with subacute (>14 days) uncomplicated TBAD results in significantly more effective aortic remodeling after two years compared with medical treatment (91.3% versus 19.4%; P<0.001) and greater survival, though in this case statistical significance was not reached (95.6% versus 88.9%; P=0.15). However, after a folllow-up of 5 years (INSTEAD-XL trial) (51) TEVAR has resulted in significantly lesser aorta-related mortality (6.9% versus 19.3%; P=0.04) and lesser disease progression (27% versus 46.1%; P=0.04). Consequently, a class IIaB recommendation has been suggested for TEVAR in this setting in the latest 2014 guidelines of the ESC (1). Likewise, in the case of intramural hematoma and type B penetrating ulcer, an initially conservative approach is recommended. TEVAR could be indicated in cases of hematoma expansion or the appearance of an intimal tear in the acute phase as confirmed on serial control imaging tests. On the other hand, in the case of complicated type B penetrating ulcer, TEVAR receives Class IIaC recommendation. Traumatic aortic rupture is considered a surgical emergency in the case of free rupture or periaortic hematoma. In the rest of cases, surgery can be deferred for 24 hours until the patient has been stabilized. TEVAR is likewise preferred to open surgery, because of its benefits in terms of survival and the lesser risk of paraplegia.

In complicated TBAD, TEVAR is more strongly indicated (class IC recommendation). There are no prospective, controlled randomized trials, but increasing evidence suggests that TEVAR is even more clearly the treatment of choice in such cases in comparison to medical and open surgical management. In the European registry the 30-day mortality rate was 8%, with an incidence of stroke and spinal cord ischemia of 8% and 2%, respectively (5). Open surgery therefore would only be indicated in patients with lower limb severe peripheral arterial disease, severe tortuosity of the iliac arteries, very narrow angulation of the arch and/or absence of an adequate proximal aortic neck for successful endoprosthesis implantation. The very aggressive open surgical approaches and techniques required increase mortality and complications even further in vulnerable populations such as octogenarians (52,53). The most classical series reported high mortality rates and defined patient age as an independent mortality predictor even in elective procedures (52,54). Furthermore, when emergent management is necessary, a 5-fold increase in mortality is reported (55). Even in experienced and large volume centers, conventional open surgical management of this disease can result in a mortality rate of 50% in the case of high risk patients, including emergent surgery (54).

Despite the above, until relatively recently, controversy remained regarding the use of endovascular procedures in very elderly patients, defined as individuals from age 70–75 onwards when patients with this disease are considered (56,57). Many studies have been carried out in this field in recent years. As expected, there are no randomized studies comparing open surgery and endovascular treatment outcomes. Therefore, most of the currently available information has been retrieved from registries and studies mostly involving a retrospective design with the subsequent methodological bias. Preventza *et al*. reports an overall in-hospital mortality rate of 10% in octogenarians, of which only 13% underwent emergent surgery. Mortality was significantly higher in the emergent surgery cases than in the elective patients both in-hospital (46% versus 3.4%; P<0.0001) and after 5 years of follow-up (P=0.012) (49). In a recent study involving 141 patients subjected to TEVAR, of which 57 were over 75 years of age, De Rango *et al*. (58) found significantly higher mortality in the emergent surgery group among the older patients than in the younger individuals [41.2% versus 9.8%, odds ratio (OR)=6.5; 95% CI: 1.6-26.6; P=0.01], with no significant differences in the case of elective surgery, in which the mortality was very low in both age groups (5% versus 0% in the older and younger patients, respectively). These rates are significantly lower than those reported by the majority of open surgery series of the descending thoracic aorta. Likewise, 90-day survival was significantly reduced in the emergent surgery subgroup. Analysis of the IRAD data reveals that in the real world, the proportion of patients treated aggressively with open surgery or TEVAR decreases with age even in complicated acute TBAD. Medical treatment was offered to 32% of patients aged 70 years or younger, whereas 58% of the elderly group was treated medically (P<0.001) and only 24% and 18% were treated with endovascular or open surgical repair, respectively. Mortality rates of medical, endovascular and surgical patients increased significantly with age, and an age over 70 years was identified as a potent independent predictor of in-hospital mortality in the multivariate analysis (OR =2.37; 95% CI, 1.23–4.54; P<0.010). In this study, procedure urgency and its impact on procedural outcomes or mortality have not been analyzed. Of note is the fact that the in-hospital mortality rates among medically treated patients with complicated TBAD were only slightly and non-significantly greater than those of surgical patients. Therefore, medical treatment may be a reasonable alternative for the management of this disease in very elderly and comorbid patients with poor anatomical conditions for TEVAR, though surviving medically treated patients could have presented with less lethal complications (persistent pain or uncontrolled hypertension) than non-surviving surgically treated patients.

In conclusion, open surgical repair of TBAD is an excessively aggressive option for very elderly patients, with high mortality and morbidity rates that further increase in complicated dissections and emergent scenarios. TEVAR should be strongly considered the treatment of choice in this subgroup of patients. Medical treatment could be a reasonable option for octogenarian patients presenting comorbidities with TBAD and without immediately catastrophic complications (uncontrolled pain or refractory hypertension), in which successful TEVAR is not feasible.

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Footnote

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