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**Comparison Between Thoracic Endovascular Aortic Repair and Medical Management of
Type B Aortic Dissections on Cardiovascular Outcomes**

By

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Abstract

Objective: To quantify the benefits and the survival rates between Thoracic Endovascular Aortic Repair (TEVAR) and medical management for Acute Uncomplicated Type B Aortic Dissection (TBAD).

Methods: The investigation was based on a literature review of evidence-based articles that were relevant to the study. The articles were critiqued to compare the benefits of TEVAR and medical management of TBAD on cardiovascular outcomes and survival rates in concerned stakeholders.

Results: The literature review reflected that TEVAR is more effective than the medical management of TBAD when the condition was in the acute and uncomplicated stages.

Uncontrolled blood pressure remains an independent and significant risk factor for the disease.

The review further indicated that open surgery significantly increased the risk of hospitalized mortality in TBAD patients. Conversely, medical management aimed to reduce blood pressure showed an increase in complications such as malperfusion. Therefore, endovascular surgical procedures such as TEVAR are gaining acceptance in the management of acute uncomplicated TBAD.

Keywords: TBAD, TEVAR, aortic dissection, hypertension, treatment, and management

Type B Aortic Dissection Definition and Clinical Significance

Type B aortic dissection (TBAD) is a clinical condition that affects the aorta distal to the left subclavian artery (LSA) but does not affect the aortic arch and the ascending aorta. The aorta is the largest artery in the body and can be described as a cane shaped blood vessel that originates in the chest beginning at the top of the heart and extending into the abdomen. The aorta, being an artery, carries oxygen-rich blood from the heart to the rest of the body. Structurally, the aorta consists of three layers: the inner layer- tunica intima, the middle layer- tunica media, and the outer layer- tunica adventitia, all which provide strength to incur the large amount of blood volume that is continuously pumping against the artery walls. However, in some circumstances there is weakening of these layers creating a tear in at least one layer of the aorta also known as an aortic dissection.

As previously mentioned, a tear typically occurs at a weak point in the artery-- in this case through the layer of the tunica intima. If the tear is left untreated it will enlarge. This occurs when blood passes through the tear between the inner and middle layer of the aortic wall, causing the layers to separate from one another, or dissect. This new space is referred to as a false lumen. Since blood is now entering the false lumen it is no longer flowing properly to the rest of the body. Over time, the pooling of blood in between the tunica intima and tunica media layers further weakens the aortic wall and, in some instances, can break through the tunica adventitia layer causing a life-threatening loss of blood and drop in blood pressure. The lack of blood flow to more distal portions of the body also negatively affects other important organs that were previously perfused by the aorta and can lead to complications such as heart attack, kidney failure, stroke and intestinal ischemia to list a few.

Risk Factors for TBAD

TBAD is a detrimental condition of patients suffering from a variety of diseases including, but not limited to smoking, Marfan syndrome, atherosclerotic cardiovascular disease (ASCVD), aortic valve defects, certain systemic rheumatic diseases, syphilis and uncontrolled blood pressure.^{1,2} Hypertension (HTN) being the major independent and predisposing risk factor for an aortic dissection. In 2017, new guidelines from the American Heart Association (AHA), the American College of Cardiology (ACC); and nine other health organizations lowered the numbers for the diagnosis of HTN to 130/80 millimeters of mercury (mm Hg) and higher for all adults. The previous guidelines set the threshold at 140/90 mm Hg for people younger than age 65 and 150/80 mm Hg for those ages 65 and older.³ Managing uncontrolled hypertension is a major priority for preventing the severity and risk of TBAD. High blood pressure predisposes an individual to the risk of TBAD based on the simple pathophysiology-- blood pressure is the product of minute volume and cardiac output. The risk of aortic dissection is increased if a larger amount of blood enters circulation and the power of accommodation of the aorta is compromised.

Low blood pressure is often considered an added advantage in patients with aortic dissection. However, hypotension still puts the patient at risk of developing illnesses such as ischemia and malperfusion; complications that are detrimental to overall health.⁴ Maintaining blood pressure lower than the recommendations made by the above health organizations, including ACC and the AHA, are optimal and crucial in urgent resolution of aortic dissections.

Classifications of TBAD

TBAD is classified into acute and chronic based on the onset of symptoms related to the dissection. The disease is acute when the symptoms of dissection surface within two weeks and

symptoms occurring after thirty days are considered chronic.² However, some guidelines suggest a sub-acute phase occurs when symptoms surface beyond the first two weeks but within 30 days of the aortic dissection. Studies suggest that 74% of the patients with acute TBAD exhibit complications and mortality within the first two weeks.^{2,5}

Apart from its classification based on the time of onset of symptoms, TBAD is also classified into complicated and uncomplicated. Complicated TBADs are referred to as those where the rate of hospitalized mortality is approximately 50% or greater. Uncomplicated TBADs are if the rate of hospitalized mortality approximates 10% or less.² Approximately 25-40% of TBADs are considered complicated with at least one of the following characteristics: end organ or lower extremity malperfusion, rupture, shock, neurologic compromise, refractory pain, refractory hypertension, or early progression of disease.²

Traditionally TBADs have been managed therapeutically, by controlling pain and providing anti-impulse therapy in the form of blood pressure lowering medications or open surgery. Surgical mortality is reported to exceed more than 30% and considerable morbidity; including spinal cord ischemia, cerebrovascular accident, and renal failure. However, new research suggests a superior treatment option, minimally invasive Thoracic Endovascular Aortic Repair (TEVAR).

TEVAR Technique and Procedure

Endovascular surgical procedures, such as TEVAR, are associated with improved clinical outcomes in TBAD patients. The objective is not only meant to treat acute and complicated TBAD, but also to reduce the adverse effects of hypertension.⁵ The TEVAR technique is revolutionary in the field of cardiovascular surgery. Widely agreed upon is the improvement in early outcomes seen with TEVAR for acute complicated TBAD. In non-randomized studies,

morbidity and mortality were improved with early adoption of endovascular repair.⁶ First introduced by Drake et al in 1994, the first commercial device which gained US Food and Drug Administration approval for this indication in 2005.^{7,8}

The goal of treatment is to redirect blood flow back to the true lumen by sealing the proximal entry tear, hindering frank or impending aortic rupture and restoration of dynamic malperfusion- this process is termed as aortic remodeling. During this process the false lumen is gradually thrombosed and true lumen is enlarged but without enlargement of the total aortic diameter.⁹ The factors that are considered when gauging the procedures viability are the lumen diameter, which must be larger than 22 mm; the location of the affected area of the aorta, and the areas that have suffered dissection. The treatment of TBAD is conducted at the lumen level- involving identification of the healthy aorta zone and the ability to gain entry through the dissection. Appropriately sized sections of endograft are then placed on areas called landing zones, or unaffected areas, alleviating blood pressure on the aorta, allowing blood to pass through it without pushing on the weakened aortic wall.¹⁰ The endograft is then covered depending on the aorta's length as a measure to contain the aortic dissection within the specific setting and avert its progression. In this setting, the descending aorta is aligned towards the subclavian artery and any form of alteration can be detrimental to the patient's health; then the endovascular repair is conducted comprehensively.¹¹ To minimize the retrograde perfusion that stems from the subclavian artery, the graft has to enter through the false lumen. Using this technique allows for better control of protrusions into the ostium of a branch vessel, known as dynamic dissection, which is the most common cause of malperfusion syndrome. The significance of this cautionary measure is to ensure that the proximal artery is covered from any form of tearing. Using the endograft to create an expansion of the lumen is sufficient to fix the

problem. If there is failure in achieving reperfusion, the most suitable solution is to expand the lumen for inserting the stent through the bare stent technique. Furthermore, aortic remodeling after TEVAR has been reported to be a significant prognostic factor for better outcomes.

There has been significant progress in treating aortic dissections with the use of endovascular technology.¹³ The first successful TEVAR surgery was conducted using stent grafting. TEVAR has been recorded as an impactful process in lowering the incidence of late complications in patients who are prone to recurrence during remodelling.¹⁴ Moreover, patients who are suffering from TBAD and undergo alternative treatment options, such as being managed medically or with open surgery, could be subjected to other complications such as the development of malperfusion syndrome and future rupture events. TEVAR is a noteworthy therapeutic option for the treatment and diagnosis of acute uncomplicated TBAD. Despite the introduction and superiority of TEVAR assisting in elective repairs, its adoption is low across the medical community.

Medical Therapy

Traditionally medical therapy, composed of pain medications, anti-impulse therapy (beta-blockers, vasodilators and short acting calcium channel blockers), and a goal systolic blood pressure of (100-120 mm Hg and heart rate under 60 beats per minute), was the most viable treatment option for treating aortic dissection.¹⁵⁻¹⁸ While medical therapy for acute complicated TBADs remains relevant and should be initiated in all patients as soon as a diagnosis of dissection is made, it should no longer be considered an appropriate solo therapy unless the patient is unsuitable for TEVAR anatomically, or high risk for an open surgical approach. The International Registry of Acute Aortic Dissection (IRAD) highlighted the mortality that occurs after the administration of medical therapy itself leads to the development of refractory

hypertension. TBAD patients must have strict blood pressure requirements and ensure that their blood pressure remains within the optimal range. Moreover, a substantial difference was noted when TEVAR therapy was applied over the use of medical therapy and/or open surgery in treatment of TBAD, which supports evidence that TEVAR is highly effective and does not affect patients who have refractory hypertension.^{10, 19} IRAD revealed that patients with refractory hypertension were at a 20-fold risk of mortality from TBAD when they were managed with medical therapy alone.¹ Hence, thoracic endovascular repair (TEVAR) has emerged as a viable option for managing TBAD. Unfortunately, patients of acute and uncomplicated TBAD are typically forced to use pharmaceuticals as first-line treatment being that this is universally considered the mainstay treatment; even though there is a better survival rate when medical therapy is accompanied by TEVAR.¹⁴ The use of medication alone is not effective in the treatment of TBAD as it presents an increased risk of mortality due to malperfusion and there is a need to utilize TEVAR as early as possible. TEVAR boosts the restoration of open perforations, especially to those at risk of complicated TBADs.²⁰ In addition, the current pharmaceutical therapy used to facilitate the repair of these perforations could be damaging to the circulatory system causing inadequate cerebral, coronary, and renal perfusion.

Treatment of TBAD

Currently there is an ongoing debate regarding the most appropriate management of TBADs due to the clinical complications that arise with both endovascular and pharmaceutical therapy. The most important aspect of treating TBADs is identifying a sustainable, stable and long-term treatment plan that not only prevents rupture but also controls further aneurysmal degeneration. The treatment of TBAD is only conclusive if it involves aggressive management of a patient's uncontrolled blood pressure, and this is achieved through the use of pharmaceutical

management.⁴ Several studies assert that medical treatment alone is not sufficient in eliminating the adverse effects of TBADs as it may lead to considerable risks including disease progression and aneurysmal degeneration, especially in those who are prone to developing hypertension, as opposed to controlling the state.^{14,2} Also, when dealing with pharmaceutical management alone, there is a likelihood of developing thrombosis with an estimated rate of 97%.^{21,13} This rate is high in comparison to the adverse effects that occur when curative treatments are compared with TEVAR, which indicates that the latter is more effective in the treatment of TBAD.

In comparison, it is clear that the TEVAR with pharmaceutical management is more effective than medication alone in the treatment of acute and uncomplicated TBAD as it involves the direct insertion of the regimen to the area affected by the aortic dissection.⁵ Also, the use of TEVAR technique has been deemed successful as it does not interfere with the aortic dilation as it is advanced through the false lumen leaving the true lumen untouched. Therefore, it does not cause aortic rupture if the patient undergoes follow-up for at least a year after treatment. No mortality has been observed after 30 days of intervention when dealing with either medical management or TEVAR and the overall endpoint is typically found to be successful.¹⁰

In another study undertaken to gauge the most effective intervention between TEVAR and medical treatment alone, the authors concluded that the former was appropriate due to the prevention of developing thrombosis after the initial diagnosis.¹⁰ This infers that the interventions are highly effective in the reduction of lumen diameter and the restoration of the artery rupture as a result of acute and uncomplicated TBAD. The study also affirms that the use of drugs for TBAD patients is a viable intervention for those who cannot afford a comprehensive endovascular treatment at least two years after the initial diagnosis.^{1,5} Therefore, TEVAR presents an appropriate response for patients depending on the level of disease severity and the

type of medication being used to reduce blood pressure to ensure the stability of the condition. Overall, TEVAR is seen as a lower risk procedure in the treatment of acute and uncomplicated TBAD and it has short-term adverse effects and long-term survival rates of at least 70%, but there is a need for follow up for at least a year.¹¹ There is a level of agreement that pharmaceutical management is the first line intervention in the treatment of TBAD, but it is only successful in the presence of surveillance imaging and when the condition is short-term and uncomplicated.

Quality of Evidence and Affect in Clinical Practice

Following the analysis of research on TBAD, a life-threatening condition that alters the cardiac system, various interventions have been evaluated to gauge the most suitable and cost-effective option to patients. The understanding of all available medical interventions will help health practitioners and patients decide on the most appropriate treatment plan for a patient depending on the severity of TBAD. According to the systemic reviews of articles on TBAD and its treatment, it is clear that using TEVAR as the intervention is more appropriate as it has fewer adverse effects, and it has long-lasting positive results. TEVAR is highly effective as it does not alter the functions of the aorta.

The choice of medication alone is successful if the patient's need in containing the acute and uncomplicated TBAD is short-term, and if it is detected early. Medical treatment alone has adverse effects, including rebound high blood pressure, which can be fatal for TBAD patients. Therefore, as much as medical therapy is beneficial to the treatment of short-term and uncomplicated TBAD, it is not sustainable for patients who have a chronic disease progression and the health risks are likely to elevate over five years.

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