

Is Right Anterior Thoracotomy the Only Remaining Surgical Competitor of TAVI?

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Abstract

Since the 1990-ies, the demand for smaller scars, less trauma, faster recovery, and lower healthcare costs has forced cardiac surgery to become minimally invasive. This evolution has led to the invention of transcatheter aortic valve interventions (TAVI), resulting in the pre-extinction of our surgical specialty, which we have to face today: the massive increase of truly minimally invasive TAVI has resulted in a dramatic decrease of aortic valve surgeries worldwide despite the high incidence of aortic stenosis in the growing aging population. The future of cardiac surgery is uncertain and will depend on the highly selective heart team decision-making process: all incoming aortic valve patients will be planned for TAVI, unless they have contraindications. Heart surgery will become an exclusion criterion. With this review, I would like to highlight the current issues of aortic valve replacement strategies, the outcomes of the different techniques, and the heart-team approach of my center and try to predict the future of cardiac surgery.

Keywords: Minimal invasive aortic valve surgery, right anterior small thoracotomy, heart team

Introduction

In our high-tech medical world of rapidly increasing and improving new transcatheter valve technologies, many cardiac surgeons have come to ask themselves if they will be able to perform heart surgery in ten years. Therefore, some have begun to learn how to perform transcatheter

interventions although it is far from their vocation, belief, and passion. However, they did what every other living creature does when their evolving environment threatens them: they adapt to it to avoid extinction. However, is this radical step really necessary in the case of cardiac surgery? At the beginning of the 21st century, there were already comparable concerns: percutaneous angioplasty became



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so successful that the medical world was convinced that within ten years, nobody would need to undergo by-pass surgery. But way off the mark! Twenty years later, our daily bread is still coronary bypass surgery. However, will this be the same in the case of aortic valve surgery? During the past 15 years since TAVI was introduced to clinical practice, the number of surgical aortic valve replacements has decreased dramatically worldwide⁽¹⁾. It is increasingly difficult to provide cardiac surgery trainees with straightforward aortic valve cases because more and more patients are scheduled for TAVI. The international guidelines have included TAVI into their recommendations worldwide in contrast to minimally invasive aortic valve surgery (MIAVS), which is not mentioned⁽²⁾. Since the Food and Drug Administration has approved the use of TAVI for intermediate- and low-risk patients, the question is more justified than ever: will there be any isolated aortic valve surgery in the future?. I am sure that the answer is “YES”. The only remaining questions are the following: which patients, which access, and which valve will be used?

Treatment of Severe Aortic Stenosis: A Gold Standard

The current gold standard for treating severe aortic stenosis is aortic valve replacement through median sternotomy. Its short- and long-term (>20 years) outcomes are proven to be excellent⁽³⁾. Every other new therapy (MIAVS, TAVI) must be compared to it to define its superiority or inferiority. As a comparison, we have <10 years outcome studies for TAVI and only time can show its long-term outcomes which will probably be the turning point where we have to ask ourselves if treatments with limited durability are sustainable enough for our health care system⁽⁴⁾.

Treatment of Severe Aortic Stenosis: Minimally Invasive Approaches

Many studies have shown that MIAVS is safe and non-inferior to full sternotomy, resulting in less morbidity and mortality due to less trauma, bleeding, transfusion, pain, infection, atrial fibrillation, shorter ventilation and stay [even fast-track is possible in selected patients:

intermediate care instead of intensive care⁽⁵⁾], better cosmesis, faster recovery and reintegration⁽⁶⁻¹⁰⁾.

There are various options to perform MIAVS (it either involves the sternum or not): the most invasive is a full sternotomy with a small skin incision, followed by an upper partial hemi-sternotomy (mini-sternotomy either J or inverted T) or the manubrium-limited mini-sternotomy performing central or femoral cannulation (cut-down or percutaneous Seldinger technique)^(11,12). These approaches have the advantage that conversion can be performed rapidly. The MAVRIC randomized controlled trial comparing full and manubrium limited sternotomy did not find any superiority of MIAVS, but longer bypass and cross clamp times did not seem to negatively influence the outcomes⁽¹²⁾. These above -mentioned approaches still involve the sternum, which can lead to deep wound infections, a dreadful and uneconomic complication of sternotomy, and are therefore, in my opinion untruly minimal invasive. Right anterior small thoracotomy (RAST) has the advantage that the sternum is usually not touched. The small incision (5 cm) makes it a very well-accepted approach by both patients and referring cardiologist. Due to its minimal invasiveness, it has evolved into a standard procedure in specialized centers worldwide with excellent outcomes^(7,8,13). By installing a transthoracic videoscope, it is even possible to perform root, aortic, and hemi-arch replacements through RAST.

There were always concerns about the safety of MIAVS approaches: the prolonged clamp and pump times might result in increased morbidity and mortality, which could not be confirmed in specialized centers^(6,7,13,14). The reason might be proper patient selection, which is mandatory (especially for RAST) and includes well-defined clinical and radiological aspects^(8,15). Furthermore, the invention of knotting devices (Core-Knot) and rapid deployment and sutureless valves have dramatically decreased these prolonged times⁽¹⁶⁻¹⁸⁾. Another concern of MIAVS is retrograde perfusion from the femoral cannulation site, which can result in an increased risk of stroke due to atheroma emboli. This can also be avoided

with proper preoperative radiological patient selection⁽¹⁹⁾. The incidence of femoral artery lesion, dissection, or groin infection is very low, and seroma might occur less than 5%⁽²⁰⁾. The next concern is the technical difficulty and learning curve of MIAVS, whereas the sternum-involved approaches are more easily reproducible than RAST. In specialized centers, the residents are trained in minimally invasive cardiac surgery and are able to learn it easily. It is somewhat comparable to children learning several languages at the same time. Otherwise, it might be a steep learning curve if fully trained cardiac surgeons want to switch to MIAVS (RAST > mini-sternotomy). However, the learning curve always depends on the skills of each surgeon⁽²¹⁾. Another concern is the cost-effectiveness of MIAVS: a study from the US showed comparable results of mini-sternotomy versus RAST, with the latter being more expensive, which surely depends on the health care system model of each country⁽²²⁾.

As a minimally invasive cardiac surgeon I don't remember when it was the last time I performed a full sternotomy for an isolated valve, aortic root surgery, or replacement of the ascending aorta. I believe that this type of traumatic access is outdated and worsens the outcome. My patients and referring cardiologists appreciate this attitude, which is an advantage compared with other departments. Therefore, I believe that cardiac surgeons should specialize in minimally invasive cardiac surgery (especially RAST for aortic valve surgery) instead of transcatheter interventions.

Currently used Prosthetic Aortic Valves

The literature shows excellent long-term durability (>20 years) of surgically implanted mechanical and stented biological valves with low need for re-intervention, which unburdens our suffering healthcare system⁽³⁾. MIAVS can use these excellent valves through a small incision, which is an advantage compared with TAVI. The currently used TAVI valves still lack long-term outcome studies (>8 years), whereas it can be assumed that their durability might be shorter than that of the surgical prosthesis.

Sutureless or rapid deployment valves are hybrids of conventional and TAVI valves. They decrease clamp time, do not seem to be inferior to stented valves in the short-term and up to 5 years, and are therefore frequently used in MIAVS, despite the documented increased risk of pacemaker implantation^(16,17). However, long-term outcomes are still lacking and might not be as favorable as conventional valves due to their hybrid character. An advantage of sutureless valves is their excellent hemodynamics, optimal performance in small and calcified aortic annuli, and short implant time, which is especially helpful in MIAVS and complex conventional procedures⁽²³⁾. While comparing MIAVS using sutureless valves with TAVI, it was shown that surgery had better short- and mid-term outcomes^(24,25).

Despite the enthusiastic launch of tissue engineered valve research at the beginning of the century, clinically usable products still lack, and their availability does not seem to be realistic soon.

Another player that might change our clinical practice dramatically once it becomes available: a TAVI valve with the inspires resilia technology.

Surgery Versus TAVI in Severe Aortic Stenosis: Outcomes

In the past 15 years, TAVI has become a standard clinical therapy, and the technique and devices have improved continuously, which has resulted in their approved use in intermediate- and low-risk patients^(26,27). Initially, the interventions used to be more expensive than aortic valve surgery despite the shorter hospital stay but due to the high-tech devices. Nowadays, they are comparable to surgery, which makes them even more competitive⁽²⁸⁾.

A recent meta-analysis of matched cohort studies compared 2,346 TAVI patients with 2,328 MIAVS patients⁽²⁹⁾. At 30 days, there was no difference in all-cause mortality, whereas at 1 year, TAVI had significantly worse survival. Stroke, atrial fibrillation, and major bleeding were comparable, the incidence of paravalvular leak was

higher, and acute kidney injury was lower in the TAVI group.

The literature shows that short-term outcomes of TAVI are excellent and better than surgery, but from mid-term on, it seems to result in higher mortality, as already shown in the PARTNER and SURTAVI trials⁽³⁰⁻³²⁾. The reason might be faster valve degeneration with increased need for reintervention and/or paravalvular leaks with moderate/severe regurgitation. This is comparable to the findings of a study analyzing quality of life, which showed a better outcome in TAVI until 1 year but no difference after 2 years⁽³³⁾. One of the latest studies in low-risk patients showed that TAVI had comparable all-cause mortality and disabling stroke at 3 years with better hemodynamics but a higher incidence of paravalvular leaks and pacemaker implants compared with surgery⁽²⁷⁾.

Future Strategies: Heart Team Decision-Making Algorithm

Ten years ago, my department established a structural heart-team center. The aim was to offer patient-tailored medicine by discussing every valve case in a dedicated interdisciplinary Heart-Team meeting (surgery versus catheter intervention) to reduce interventional risk and guarantee long-term outcomes.

The team meets weekly and consists of cardiac surgeons, cardiologists (interventionalists, and non-invasive cardiologists including imaging specialists), cardiac anesthetists, and intensivists. It is a financially independent organ where decision making is performed according to guidelines, risk assessment, and long-term durability.

Our decision-making algorithm for aortic valve patients is as follows: all incoming patients receive a CT angiogram and 3-mensio calculations. If they are not found eligible for TAVI, as decided by the Heart Team (according to our national guidelines <75 years, calcified LVOT, low coronary, bicuspid or unicuspid valve), they are planned for RAST. If they are ineligible for RAST (radiological findings: aorta left of the sternum

or low behind the xyphoid, small annulus and need for root enlargement to prevent patient prosthesis mismatch, porcelain aorta, multiple atheromas of the aorta, calcified femoral arteries and suspected pleural adhesions), they are planned for mini-sternotomy. We do not perform full sternotomy in isolated aortic valve patients.

Because of our decision-making algorithm, we could already show in our consecutive minimally invasive mitral valve cohort that the outcomes of the surgical candidates are excellent and even female patients do not seem to have an increased risk of surgery^(34,35).

The outcome study of our consecutive RAST patients operated between 2013 and 2022 is currently under review. The cohort of 340 patients had a thirty-day mortality of 0.9% and a survival of 99.3% at one and 98.7% at 5 years, respectively. Only one patient (0.3%) required reoperation because of endocarditis 6 months after the first surgery. We do not use sutureless valves because we are not convinced of their long-term durability, and we only reduce clamp time by using the Cor-Knot device.

Overall, the outcomes of our RAST cohort are very favorable, which might be the result of patient-tailored heart-team decision-based patient selection. We believe that this algorithm ensures low morbidity and mortality and optimal long-term outcomes (durability, low need for re-intervention) in both interventional and surgical candidates⁽³⁶⁾.

Conclusion

The gold standard of aortic valve replacement is still conventional sternotomy with proven excellent long-term outcomes, low morbidity and mortality, good quality of life, and low need for re-intervention. MIAVS can be performed with non-inferiority to this gold standard in specialized centers with the advantage of less trauma, blood loss, and faster recovery, which is very well accepted by referring cardiologists and patients. Despite these excellent outcomes, heart surgery is losing more and more patients because even MIAVS is more traumatic than TAVI, which has also proven excellent short- and

mid-term outcomes, whereas its long-term durability is yet to be confirmed.

The future of our healthcare system will be turbulent because the aging population will cause an explosion in treatment. Therefore, to avoid its collapse, to maintain sustainability and cost-effectiveness, the goal must be one single intervention per patient without the need for re-intervention, which can only be achieved by applications with proven long-term durability. The Heart Team will be responsible for the patient-tailored decision-making process by including guidelines, risk assessment, quality of life, short- and long-term morbidity, mortality, durability, and risk of re-intervention (prosthetic valve selection) resulting in the unloading of the health care system.

I believe that RAST is currently the only true surgical competitor of TAVI because of its superior long-term durability. Cardiac surgeons of today should seek training in RAST instead of learning how to implant TAVIs.

Interestingly, Mr. Chitwood predicted in 1997 that heart surgery in the future will be performed as day cases⁽³⁷⁾. He was not far off, but the only thing he did not foresee was that it would not be surgery anymore but transcatheter interventions.

And who knows what the future really holds: TAVI will be outdated as well on day, because it will be possible to teleport prosthetic valves right into the body without the need of any incision or puncture: “Beam it in Scotty!”

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