



How to start a minimally invasive mitral valve surgery program?

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“An expert is a person who has made all the mistakes that can be made, in a narrow field.”—Niels Bohr, Nobel Prize Physics 1922.

Surgical procedures are composed of many technical steps and their outcomes are dependent on skills of individual surgeons and anatomy of the individual patients. This is reflected by plethora of studies showing an association between surgical volume and outcome across all the surgical subspecialties (1,2).

The surgical volume is in fact a surrogate marker of surgical skills and cumulated experience to address the variability in individual anatomy of patients subjected to the same surgical procedure. Indeed, even experienced surgeons acknowledge that the most routine surgical procedure can exhibit variable difficulties based on individual anatomy of the patients.

Additional to the above, surgical procedures have become more technical and more diverse with advance of minimally invasive procedures. There is also a paradigm-shift in medicine moving from pathology-based treatment to Personalized Medicine. In Personalized Medicine, we do not ask which treatment is more superior but which patients are more suitable for which treatment. For surgical procedures this means whether a patient is anatomically suitable for the procedure in question.

For minimally invasive mitral valve surgery, I have ten recommendations for those who want to start the program.

Teamwork approach

Everything we do in cardiac surgery is based on coordinated teamwork approach. We work most of the time in an association or departmental environment. One needs to have the full support of immediate colleagues to start any

new program. Additional to this, because of complexity of mitral valve pathology, one needs to focus on building a quality-based program for treatment of mitral valve disease rather minimally invasive mitral valve surgery. This means coordinated program together with cardiologists with expertise on mitral valve pathology. Additional to this for minimally invasive mitral valve surgery, one will also need to work with dedicated anesthesiologist, perfusionist and OR nurses to ensure the safe and efficient start of the program.

Volume and outcome

It is well established in many studies for mitral valve surgery that outcome is very dependent on the individual surgeon's volume. Indeed, there are many techniques a surgeon can choose from to address the mitral valve pathology. Consequently, the success of the repair is predominantly a reflection of the surgeon's skills and experience. This is best demonstrated by Bolling *et al.*, utilizing the Society of Thoracic Surgeon database of patients undergoing mitral valve surgery in the USA. The mean repair rate was 41%, and the median number of operations per surgeon was 5 cases per year. In this study, increased surgeon-level volume was independently associated with an increased probability of mitral repair (3). Conversely, minimally invasive mitral valve repair is one of the most difficult procedures to learn. The learning curve is steep. It has been shown that one needs to do between 75 to 125 cases to overcome the learning curve (4).

It is obvious that one needs mitral valve dedication and adequate volume to start minimally invasive mitral valve surgery program. How many cases per surgeon per year should be the cut-off point is a matter of debate, but what is more important is the potential of the program to grow.

Heart-team approach: patient-centered care

An individual surgeon or cardiologist should not make the decision of any intervention on their own, as they may be biased to provide only the treatment in which they have expertise, rather than what is the best treatment option. The heart team provides a platform of different opinions and perspectives that will only benefit the decision-making process. The true heart team approach is the one that makes treatment decision regarding all those with mitral valve pathology than those highly selected patients that are referred for an intervention.

Additional to this the heart-team concept is the cornerstone of pathology-based treatment teams that bundles expertise, dedication and ownership over the whole program.

Although the heart team approach is intuitive and has a class I recommendation in most guidelines, supportive data regarding its implementation is lacking. We have created and implemented dedicated mitral valve team for mitral valve pathology and recently published the feasibility of its implementation (5).

Skills development

Endoscopic mitral valve repair is one of the most difficult procedures to learn. The learning curve is steep. This steep learning curve has “partially” to do with the fact that the operation is done with long-shafted instruments, with surgeon looking at the monitor rather than into the wound. Acquiring endoscopic skills with long-shafted instruments is a process that no one can escape from. Acquiring these skills in patients is not logical or efficient.

Additional to this, with the current limited working hours and rapid introduction of new surgical techniques, training should move outside the operating theatre, where new educational tools could be used to overcome the learning curve. It has been shown that simulation-based training may subsequently allow training of residents to achieve proficiency in basic skills within shorter training periods, while practicing surgeons can be swiftly trained in novel techniques (6).

We have developed a high-fidelity minimally invasive mitral valve simulator and created an air pilot training course to train surgeons across the world (7). Incorporation of simulation training of minimally invasive mitral valve surgery could shorten the learning curves and speed the adaptation of this approach.

Mentorship instead of proctorship

One need to appreciate the complexity of minimally invasive mitral valve surgery that is composed of many layers namely; transcatheter techniques, minimal access, working with long-shafted instruments, endoscopic approach, mitral valve repair, variability of techniques and management of the program. Unfortunately, the proctorship from industry is focused on product proctorship rather the procedure as whole. Therefore, one needs to liaise with an expert, absorbing his or her platform and ask for his or her mentorship. One needs to involve the mentor in the whole process of the program and absorb the most from his or her expertise.

Operative planning

Our operations are composed of many technical steps, and their outcomes are logically dependent on an individual surgeon's experience and individual patient's anatomy. Even an experienced surgeon doing routine operations daily would experience that the same operation is more difficult in some patients than others, according to each individual patient's anatomy.

Nowadays we have technology that enables us to create a hologram of the operative field and go through it layer by layer. Three-dimensional reconstruction and 3D printing enable us to have the knowledge of exact surgical anatomy preoperatively, and to draw a surgical plan to address the anatomical variabilities to enhance the safety, efficacy, and reproducibility of our surgical procedures. Additionally, the surgical anatomy is crucial for planning minimally invasive cardiothoracic surgical procedures, whereby we perform the same operations through smaller incisions. We are also moving away from pathology-based interventions towards individualized interventions, with the central question being which patients will be suitable for which surgical technique, rather than which technique is superior? To answer this question for individual patients, we need the exact knowledge of individual surgical anatomy.

We have shown that almost 30% of those referred for minimally invasive aortic and mitral valve surgery are anatomically less suitable on 3D reconstruction based on CT-scan (8). This does not mean that one cannot perform these kind of procedure in this subset of patients but one can modify its approach or/and at least the starting surgeons should not start with these subset of patients.

Copy-paste in beginning

There are many variability's in available techniques, therefore one should choose a platform and copy-paste this in beginning. For experienced surgeons is sometimes difficult to set aside their intrinsic creativity and experience with conventional cardiac surgery and to copy-paste. However, one should realize that a platform that works is mostly based on vast experience of experts accumulated after years of ups and downs. One should not start a program based on trial and error. The most common pitfalls start here.

Intolerance for imperfection

In cardiac surgery one knows that cutting corners will haunt one at the end of operation and one cannot escape imperfection. Sometimes in the beginning one is tempted to do this because of time or/and inadequate exposure. In minimally invasive mitral valve surgery, there is no margin of error and one needs to have intolerance for imperfection. There are two important elements that one needs to remember; speed is economy of motion and exposure is everything.

Transparency: outcome and complications

Complications are inherent to any intervention. Complications are also triggering for improving once program. In cardiac surgery we are very dependent on affiliated specialties and our complications affects their practices as well. Therefore, complications should be discussed and reviewed by the whole team with intent of improving the program. Furthermore, follow-up and long-term outcomes should be discussed and reviewed.

Concept of personalized medicine: successful formula?

There is a lot of pseudo-science and craftsmanship within cardiothoracic surgery, resulting in the quality of our interventions being very dependent on an individual surgeon's performance. Many successful programs are built around successful individuals. We surgeons all want to excel and perform surgeries that are both unique and of superior quality, but what is important is to have reproducibility in quality in the hands of as many surgeons possible for as many patients as possible. We need to go from successful

individual to successful formula adaptable by others to provide excellence to our patient.

We introduced the concept of personalized medicine for mitral valve disease in an article published at the beginning of 2017 (9). This concept has three pillars:

- (I) Concentrating on the whole process of treatment from the pre-treatment phase to the post-treatment phase. So, not focusing exclusively on the operation;
- (II) Working with dedicated teams throughout the pre-treatment phase to the post-treatment phase. Why dedicated teams? Because we know from a plethora of publications that there is a direct association between volume and outcomes across all surgical procedures, and especially for mitral valve disease;
- (III) Preoperative/pre-treatment planning: using the new technologies of 3D imaging reconstruction, 3D printing, and simulation in a dedicated mitral valve heart team to evaluate the treatment option to which patients are most suited.

This concept is to enhance the quality of care by enhancing the patient safety, efficacy, and reproducibility of our treatments. In an ongoing prospective study, we will provide evidence of the merits of this new concept and think that this could be a formula of success that can be adapted by others.

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