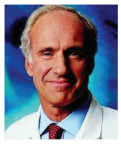


Hugo Vanermen

Investigating the potential benefits of minimally invasive cardiac surgery (MICS) for mitral valve repair

Minimally invasive cardiac surgery (MICS) for mitral valve repair has the potential to reduce pain, leave minimal scarring and afford quicker rehabilitation compared with conventional surgery. *Confluence* spoke to Dr Hugo Vanermen, UC Louvain, Knokke, Belgium, who first developed the technique in 1997, to find out more about the benefits and challenges associated with this procedure.

What options are available for mitral valve repair?

Hugo Vanermen (HV): Mitral valve disease is becoming more and more important, certainly in the elderly. Estimations are that mitral valve degenerative disease and ischaemic disease will be more prevalent in the elderly than aortic valve disease actually. It is vital, therefore, that we have less invasive techniques for mitral valve disease, because the elderly ask for less invasive techniques. In the 21st century, they certainly no longer ask for a sternum-splitting technique.

Therefore, I developed a technique in 1997 – minimally invasive cardiac surgery (MICS) for mitral valve repair – which was intended to be almost painless, with minimal scarring, and a very fast rehabilitation to full recovery, which means that we are talking about 2 to 3 weeks instead of 2 to 3 months in case of sternotomy.

There are three key features of this procedure. First, the technique is based on the use of an endoscope as, in the intercostal space, it is impossible to look at the mitral valve when your hands are in front of the working port (figure 1). Secondly, we install extra-corporeal circulation on the big femoral vessels: the femoral artery and femoral vein. We have techniques that allow us to arrest the heart and preserve the myocardium for, when necessary, 2 hours and more, to be able to expose the mitral valve and repair it. The third point is that it is impossible to do this surgery with classical – that is to say, two-pronged instruments – instruments that look like classical scissors that you open wide in order to operate with them. The instruments that I have used for more than 15 years are shafted instruments, which look very much like the instruments that laparoscopic surgeons use.

Could you give us more specific detail about how the procedure is carried out and why is it beneficial for patients?

HV: In a lady, the incision is made in the intra-mammary groove on the right-hand side. It is a 5 cm long incision. In a man, it is made just around the nipple, so of that 5 cm incision only 2 cm is visible. From there, I approach the fourth intercostal space on the right-hand side. There, I make a working port – that is to say, a port that is 5 cm in length and the width of the interspace. From there, when the heart is arrested, it is easy to make an incision in the inter-atrial groove in between the right atrium and the left atrium, after opening the pericardium. I developed a special retractor that can broaden this incision to open up the left atrium and, at that moment, a camera can be introduced into the left atrium, to have the best possible look at the mitral valve (figure 2).

On average, the entire procedure will take three to three-and-a-half hours, depending on the difficulty of the repair procedure. In an easy repair procedure it will take two-and-a-half to three hours, while in a difficult one it may take three-and-a-half to four hours.

We have developed a website where you can see lots of pictures and videos clips, and testimonials by patients, which should help readers become more accustomed with this technique – www.minimitralrepair.org.

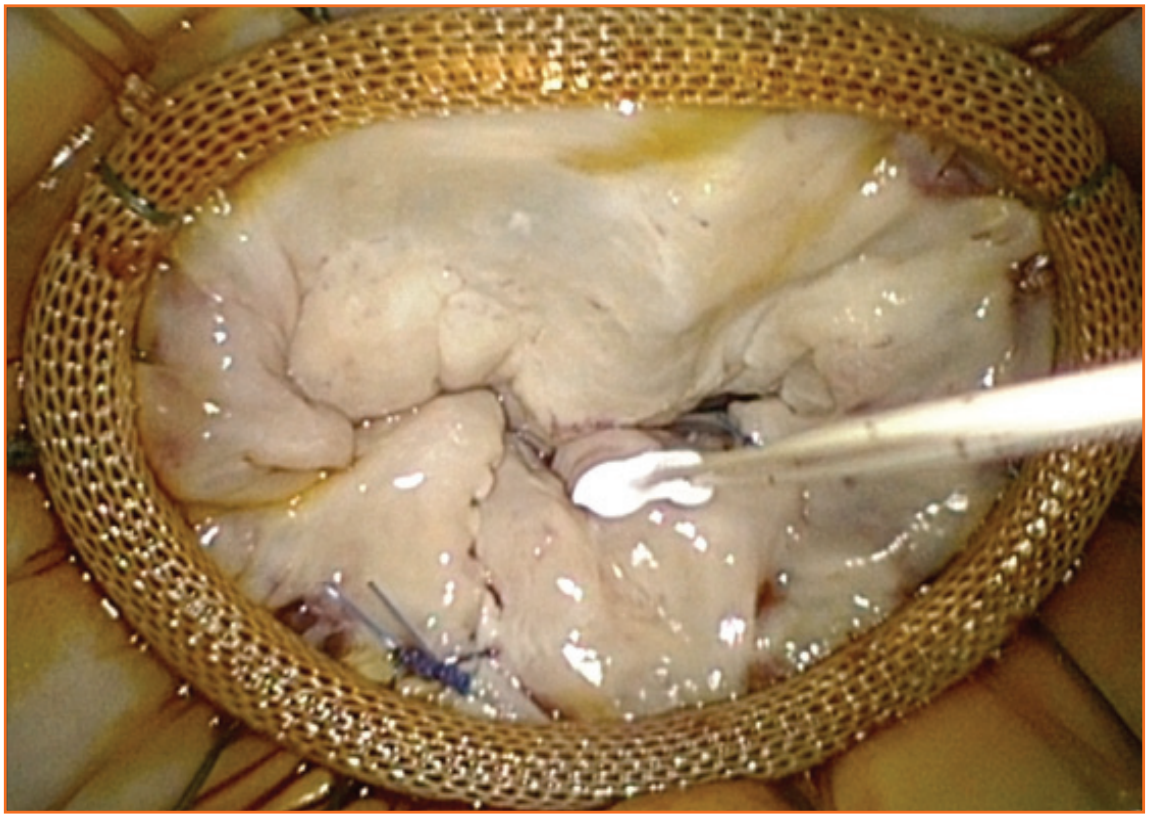
I started using this procedure in February 1997, and I have now carried out more than 2,500 completely endoscopic mitral valve repairs and

fig. 1

The patient is in dorsal decubitus and the right hemithorax is slightly elevated. We see a "working port" in the fourth interspace with 'soft tissue retraction' only: the bony structure of the thorax remains untouched to sort of guarantee a painless approach. We see a small (5 mm) camera-port more dorsal to it and a trocar port (7 mm) for venting and CO_2 inflow more caudal of it. In both groins we can see both femoral vein and arterial percutaneous cannulation

fig. 2

Close to 100% of degenerative mitral valves can be repaired; the endoscope provides exceptionally good images of the mitral valve. This image shows the image that the surgeon looks at to do the repair: one can see a closure line after some tissue resection has been carried out on P1, an artificial Goretex chord on P2 and a annuloplasty ring in place



replacements, some of them combined with tricuspid repair. For the patient, the difference is like day and night when it comes to pain, scar and fast rehabilitation. I always talk about the 'three Cs' – cosmetics, comfort and complete rehabilitation within weeks. That happens to be the case, both in young and in elderly patients.

Is any of this procedure done robotically, or is it all manual, using endoscopes?

HV: The core of this operation is that conventional cardiac surgeons, who were trained in the 1980s and 1990s, have a hard time switching to this procedure because there are many new elements coming into play – new instruments, new extracorporeal circulations and new ways to clamp and visualize the heart. This brings them a long way out of their comfort zone.

If they have problems with the video-assisted visualization, and the shafted instruments, then robots may help a great deal, because robots will give a 3D image of the mitral valve. The robot will allow you to do moves with your wrist inside the patient, because your own wrist stays outside of the patient – that is to say, at the console and at the joysticks, with mechanical arms that go into the heart and mimic the exact same movements inside. This is a way for surgeons to overcome the learning curve and it is a way to more quickly adapt to the new hand–eye co-ordination that is necessary in order to do this. On the other hand, however, it makes it much more cumbersome and time consuming and, last but not least, considerably more expensive.

What else can be done to help people to learn and feel confident with this technique?

HV: A great deal of resistance for the general adoption of this technique is due to the fact that surgeons – when they master all the techniques to repair the mitral valve – have very often come to an age where it becomes more difficult for them to adopt new instruments, or new visualizations. Sometimes, they are no longer flexible enough to switch to a new technique.

However, I expect a great deal from a new generation. Some mitral valve surgeons are now 20 years younger than their senior colleagues. They were almost all born with their hands on a keyboard and their eyes focused on a screen. This means that they will pick up these techniques much more easily and I am so happy to see that, 15 years after the development of my technique, many young surgeons all over Europe now – in France, in Switzerland, in Germany – are picking up the techniques and doing very well. This is mainly because the conventional surgeons, who wanted the prestige of the mitral valve surgery but didn't want to become flexible to adopt new techniques, are actually disappearing and leaving in place the younger surgeons.

On the other hand, we definitely need a simulator. Airline pilots use simulators for thousands of hours before becoming actual pilots. Actually, for brand new techniques like this one, the use of a simulator would be fantastic, but this is obviously costly to set up. I have, however, developed a great many set-ups with endoscopes, with plastic human skeletons of thoraxes, to let surgeons feel what it would be like to work on the mitral valve through a tiny opening, with their hands on the shafted instruments and eyes focused on the screen. The only thing is that it is amazing how well you can see the mitral valve – you see it much more clearly than from the glimpse you might have of the mitral valve through sternotomy. However, it is the hand–eye co-ordination that is challenging, to a large extent.

Given how good the view of the mitral valve is with this technique, are any other imaging techniques required, in terms of a work-up for a patient? Do you need to have a good understanding of the anatomy and of the disease as well?

HV: Absolutely. Ultimately, it is important to have a bedside echocardiographer or, even better, an anaesthesiologist, who is there from the very beginning until the very end, who masters all the techniques of transoesophageal echo (TEE). TEE is our way to monitor the proper cannulation of the femoral vein and femoral artery, and it is the way to bring up the balloon into the ascending aorta to arrest the heart, to look at the mitral valve pathology. Last but not least, it can be used to look at the result at the end of the procedure – to see with your own eyes whether the procedure has been a success or whether you have to go back to correct and to do final adjustment. That is very, very important.

It is, so to speak, an intervention where teamwork is critical and, as you will know – or as perhaps you will not know – surgeons used to be dictators

in the OR in the 1960s and 1970s. They yelled to their perfusionist and to the scrub nurse, and they actually ignored the anaesthesiologist. At that time, it was very important to have a very strong personality in the OR, to make sure that the operation came to a good end. Today, however, it is impossible to work like that, not only because of changes in culture in the OR, but because it is vital to communicate effectively with each other as peers – that is to say, with the perfusionist about the pressures in the ascending aorta and arterial line, and with the anaesthesiologist to have optimal venous drainage and so on. This is so important, to ensure the success of the operation.

Are there specific patient populations for whom this technique is particularly suited?

HV: Yes. The mitral valve is by far the best valve to be approached with an endoscope from the right-hand side. You slide an endoscope in the axilla of the patient and, with your endoscope, you can go all the way to 3 cm of the mitral valve – in a plane that is perfectly perpendicular compared with the plane of the mitral valve, and you can see it marvellously well. You can do the same with the tricuspid valve.

However, there are limitations. The first is the limitation of the right lung. In patients who have right-lung adhesions to the pleura, it is impossible to gain access to the heart, to the inter-atrial groove and then it is better just to forget it because, if you start to loosen up all these adhesions, you might ruin the right lung.

The second is that you need peripheral cannulation and retrograde flow. This means that patients should not have any peripheral artery disease – although it is very well known that patients with degenerative mitral valve disease, even when they are in their 60s or 70s, do not have peripheral vascular disease. That is a big help.

The third obstacle might be thoracic deformities, for example, a *pectus excavatum*, because then it will be difficult to approach the mitral valve from the right-hand side, given the limited space between the sternum and the vertebrae. There are ways to overcome that, but it is not very easy.

When we talk about the pathology of the mitral valve itself, repair is possible in all cases of degenerative disease – although I would actually emphasise the fact that, if surgeons are inexperienced, they should limit their cases to easy repairs. By that, I mean easy P2s – but fortunately, easy P2s are by far the majority of all the MRs, that is to say close to 70%. However, when there is calcification in the posterior leaflet or a challenging rheumatic repair in a young lady, for example, I would leave that up to more experienced surgeons. Annulus calcifications, however, are only present in a minority of patients. Fortunately, such a complication does not present a big obstacle for MICS mitral procedures.

We have spoken a good deal about the benefits to the patient in terms of the three Cs, but what are the benefits to the physicians from using this technique?

HV: From a personal point of view, it is just amazing to see how people, today, go on the internet. I operate now in four or five different centres in Europe – in Switzerland, in Italy, in Paris and in Brussels. I have patients who just go to their computer and Google 'I have mitral valve insufficiency and I want a small incision, or I want a less invasive procedure'. They go on the internet for hours and they follow the websites and read all sorts of articles. They come to me with a bundle of things that they have printed out from the internet: they come to see me and say, 'this is what I want; we have found that you are the most experienced person in the world to do this'. So it is amazing that more and more people are well aware of the fact that less invasive techniques are possible today, are perfectly safe and give a perfect result in terms of quality of repair. That is the first point.

It also benefits the hospital as it is pretty obvious that if you have a patient who remains in hospital for 4 days instead of 8 days, there is a difference in bed occupancy. We have seen that the number of days that patients stay in hospital after less invasive procedures decreases significantly, and that allows a reorganization in terms of bed occupancy and so on. That is an advantage for the physician as well.

The third advantage for the physician is that, more and more, we come across cases where patients have been operated on before. They are in their 80s and were operated on 20 years previously for coronary artery disease, coronary artery valve replacement and so on, and they now need mitral valve repair. It can become terribly difficult to go through a median sternotomy if there are open grafts, if there is a mechanical valve in place in the aortic position and so on. This is even more true

in patients who have had two or three interventions already. The real advantage of MICS mitral is that the approach from the side is sometimes amazingly easy and leaves much less risk to the patient than when you go once again through the same median sternotomy scar. In terms of re-do situations, it is an amazingly easy approach.

What are the potential challenges and complications associated with this technique?

HV: A great deal has been said about retrograde perfusion. Opponents of the technique have said that this is a less good technique because there is retrograde perfusion. Not in a single, perfect comparison between articles with lots of cases of very experienced centres, has it been proven that there is a difference in terms of cerebrovascular accident or transient ischaemic attacks when there is retrograde perfusion in these patients.[1,2]

There has been one meta-analysis[3] in which there were more cerebrovascular accidents but, if you look at this meta-analysis in detail, it happens to be an analysis where, in many centres, five to six mitral valves were done with this technique over an entire year – which is a very low number. Over the last 10 years, I have carried out up to 250 mitral valves every year. Indeed, I have become a mitral valve surgeon and that is all I do. In future, I think young surgeons really have to look for what their ideal profile should be: you are either a coronary artery surgeon, an aortic valve repairer, an ascending aortic surgeon, or a mitral valve repair surgeon. If you focus on that and if you really want to go for it, then it is not that difficult today to build an entire practice on perfect mitral valve surgery.

It sounds as though experience is a key factor in determining the success rate for this operation. Is it fair to say that?

HV: That is absolutely right. Many who have learned this technique have mentioned the steepness of the learning curve. Therefore, I now go to different centres in Europe to proctor young surgeons and accompany them in the technique, to make sure that they go through the learning curve without additional risk to the patient.

Do you think there are sufficient data to provide a convincing argument for this technique?

HV: There is perhaps not quite enough evidence. We have brought up on a couple of occasions already the fact that the surgeons who have picked up this technique very early – and I can only mention a few in the world, like Randy Chitwood, like Fred Mohr, like Patrick Perier – they have seen such an improvement in the quality of life and the outcomes of their patients that, for them, this has become the technique of choice.

We no longer do any comparison in terms of patients with the same amount of risk, divided into two groups and do sternotomy, because I no longer dare to do sternotomy. I feel very uncomfortable now, if I have to do mitral valve through sternotomy, because the difference for myself in terms of visualization and for the patient in terms of invasiveness – is that big.

What more data are needed to support this technique?

HV: We need data now from young surgeons who have picked up the technique with good proctoring, accompanied by older guys with a great deal of experience. They will come out with articles and data that will make it pretty obvious for everybody that it is better to go this way.

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DISCLOSURES: HV is Course Director of the Master of Valve Repair with Edwards Lifesciences, having received honoraria as a speaker, moderator, surgeon during live-surgery, Consulting and Development Agreement for Minimally Invasive Cardiac Surgery Techniques and devices. He has also received honoraria for teaching, education and the development of products with with Edwards Lifesciences. HV is an Inventor with royalty agreements: for the Contour Tricuspid Annuloplasty-Ring (Medtronic, Inc.). He is a consulting with USB Medical regarding the development of HV-Left Atrial Retractor, for which he is also an Inventor with royalty agreements. He is a consultant with Valtech for the development of mitral repair and replacement devices: cardinal and cardioband, as well as for the development of percutaneous tricuspid device. He is a stock owner and founder of 4-tech with Valtech.