



## Minimally invasive cardiac surgery—a Fad or the Future?

Over recent years there has been significant progress in the development and adoption of minimally invasive techniques in cardiac surgery (1). In thoracic surgery, video-assisted thoracoscopic surgery (VATS) has become the norm (2). In cardiac surgery, the median sternotomy has been, and remains, the trusted, well-established and gold standard access route for many decades. However, perhaps motivated by developments in other surgical specialties, there has been a slow movement towards minimally invasive cardiac surgery (3). To support this movement, a professional society emerged: the International Society for Minimally Invasive Cardiothoracic Surgery (ISMICS).

Unlike in general surgery where laparoscopy has become the standard of care (for example the laparoscopic cholecystectomy), minimally invasive cardiac surgery (MICS) has been slow to develop (4). For cholecystectomy, the laparoscopic approach reduces surgical trauma and has significantly reduced complications leading to a much faster recovery—and there is good evidence supporting this (5). In cardiac surgery there are very few prospective randomised controlled trials comparing minimal access and standard sternotomy, and those that do exist mostly have small patient numbers and are powered only to show non-inferiority (1). To date there are no trials demonstrating a mortality advantage of MICS. The majority of the literature on MICS is based on observational studies from specialised centres which introduces publication bias towards positive outcomes. As a result, there remain ongoing debates regarding safety, outcomes and quality in MICS.

Why has it been difficult to demonstrate the superiority of MICS? One consideration is that of ‘invasiveness’. In cardiac surgery the access route is only a minor component of the invasiveness, unlike in general surgery. Cardiopulmonary bypass (CPB), aortic cross clamping and cardioplegic arrest, opening of cardiac chambers and the requirement for de-airing are all much more important contributors to the invasiveness and risk of complications following cardiac surgery than the mere size of the incision. These are all identical in MICS which should perhaps be more appropriately considered minimal access rather than minimally invasive surgery. Furthermore, the median sternotomy is a relatively pain-free incision when compared to a thoracotomy with a relatively low incidence of chronic pain. The other challenge is that through much evolution and factors such as publication of surgeon- and centre-specific results, outcomes following cardiac surgery are generally excellent making it very difficult for a new technique to demonstrate superiority in hard outcome measures.

As a result of all of these factors, there appear to be several barriers to the adoption of MICS techniques:

- (I) The surgery is technically more demanding and there is a slow learning curve with typically no standardised training programmes;
- (II) Studies tend to show that bypass and ischaemic times are prolonged—particularly during the learning curve;
- (III) There are higher costs associated with the equipment and instruments required—without any demonstrable mortality benefit, nor reproducible evidence of other superiority making it challenging for surgeons to set up new services.

Balanced against this though, is an increasing demand from both referring physicians and patients who perceive MICS to be superior (1). To some patients, the improved cosmesis associated with MICS is a very important factor. To others, the goal of reduced pain and perceived earlier return to full functionality is the dominant motivator. As with all areas of medicine, the patient perspective must be an important consideration (6–8). There is little doubt that these are benefits to MICS if performed safely by experienced centres and offered to appropriate patients.

Despite these challenges the practice of ‘minimal access’ cardiac surgery is widespread and appears to be increasing in popularity. In this special series a series of reviews highlighting the breadth and current status of minimally invasive cardiac surgery are presented.

It is of course important to recognise that MICS is a multidisciplinary endeavour and it is essential to be surrounded by a supportive team who are ideally trained together and all contributed to the local guidance, before embarking upon new techniques. An important component is an anaesthetic team skilled in the peri-operative assessment and management of patients undergoing MICS. In their review, White *et al.* highlight the skills required to facilitate MICS—in particular emphasising the enhanced importance of transoesophageal echocardiogram in guiding various steps of the procedure, such as positioning of cannulae (9). Similarly, the management of postoperative pain is essential in MICS to ensure a full and rapid recovery.

Another important component of a successful MICS team is the conduct and strategy of extra-corporeal circulatory support. MICS will often involve alternative cannulation strategies and perfusionists familiar with managing these more challenging cases is essential. Anastasiadis *et al.* highlight that the perfusionists themselves can contribute to MICS with minimally invasive extracorporeal circulation (often referred to as ‘mini-bypass’), demonstrated to improve outcomes following cardiac surgery, thought to be due to amelioration of the inflammatory response (10).

In coronary artery bypass grafting, the surgical assistance team responsibilities are also evolving to minimally invasive techniques with conduit harvesting, making a contribution to MICS. Akowuah *et al.* review the literature on endoscopic vein harvesting and highlight the potential advantages of this less invasive technique (11).

In the remaining articles, the product of these expert teams is reported. Almost all cardiac surgical procedures are represented: coronary artery bypass grafting (12), aortic valve surgery (13), mitral valve surgery (14,15), tricuspid valve surgery (16), cardiac tumour resection (17), implantation of ventricular assist devices (18) and surgical ablation of atrial fibrillation (19).

Through reading these reviews, it is abundantly clearly apparent that, in the current era, there is a huge role for minimally invasive approaches in cardiac surgery, which continues to increase in popularity. To become more established, it will be important that high level evidence confirming the benefits is sought through appropriately conducted clinical trials. As with most procedures, the correct operation, by an able surgeon, through the right approach in the right patient, yields the best outcomes.

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## References

1. Doenst T, Lamelas J. Do we have enough evidence for minimally-invasive cardiac surgery? A critical review of scientific and non-scientific information. *J Cardiovasc Surg (Torino)* 2017;58:613-23.
2. Klapper J, D'Amico TA. VATS versus open surgery for lung cancer resection: moving toward a minimally invasive approach. *J Natl Compr Canc Netw* 2015;13:162-4.
3. Zubair MH, Smith JM. Updates in minimally invasive cardiac surgery for general surgeons. *Surg Clin North Am*

- 2017;97:889-98.
4. Antoniou SA, Antoniou GA, Antoniou AI, et al. Past, Present, and Future of Minimally Invasive Abdominal Surgery. *JLS* 2015;19:e2015.00052.
  5. Antoniou SA, Antoniou GA, Koch OO, et al. Meta-analysis of laparoscopic vs open cholecystectomy in elderly patients. *World J Gastroenterol* 2014;20:17626-34.
  6. Percy ED, Hirji SA, Kaneko T, et al. Patient-reported outcomes: How to advance the minimally invasive debate. *J Thorac Cardiovasc Surg* 2019;157:e355-e356.
  7. Kent WDT, Fedak PWM. Minimally invasive cardiac surgery and the importance of qualitative patient-centered metrics to guide innovations. *J Thorac Cardiovasc Surg* 2019;157:e356-e357.
  8. İyigün T, Kaya M, Gülbeyaz SÖ, et al. Patient body image, self-esteem, and cosmetic results of minimally invasive robotic cardiac surgery. *Int J Surg* 2017;39:88-94.
  9. White A, Patvardhan C, Falter F. Anesthesia for minimally invasive cardiac surgery. *J Thorac Dis* 2021;13:1886-98.
  10. Anastasiadis K, Antonitsis P, Deliopoulos A, et al. From less invasive to minimal invasive extracorporeal circulation. *J Thorac Dis* 2021;13:1909-21.
  11. Akowuah E, Burns D, Zacharias J, et al. Endoscopic vein harvesting. *J Thorac Dis* 2021;13:1899-908.
  12. Bonatti J, Wallner S, Crailsheim I, et al. Minimally invasive and robotic coronary artery bypass grafting—a 25-year review. *J Thorac Dis* 2021;13:1922-44.
  13. Di Bacco L, Miceli A, Glauber M. Minimally invasive aortic valve surgery. *J Thorac Dis* 2021;13:1945-59.
  14. Toolan C, Palmer K, Al-Rawi O, et al. Robotic mitral valve surgery: a review and tips for safely negotiating the learning curve. *J Thorac Dis* 2021;13:1971-81.
  15. Abu-Omar Y, Fazmin IT, Ali JM, et al. Minimally invasive mitral valve surgery. *J Thorac Dis* 2021;13:1960-70.
  16. Abdelbar A, Kenawy A, Zacharias J. Minimally invasive tricuspid valve surgery. *J Thorac Dis* 2021;13:1982-92.
  17. Kenawy A, Abdelbar A, Zacharias J. Minimally invasive resection of benign cardiac tumors. *J Thorac Dis* 2021;13:1993-9.
  18. Al-Naamani A, Fahr F, Khan A, et al. Minimally invasive ventricular assist device implantation. *J Thorac Dis* 2021;13:2010-7.
  19. Witkowska A, Suwalski P. Insights from advancements and pathbreaking research on the minimally invasive treatment of atrial fibrillation. *J Thorac Dis* 2021;13:2000-9.



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