Minimal access aortic valve surgery has become one of the accepted forms of surgical therapy for patients with isolated aortic valve disease. The world of therapeutic interventions for aortic valve disease has navigated from the classic full sternotomy approach, which is still extensively used today, all the way to the transfemoral and transapical catheter-based valve implantation. Various minimal access techniques represent a transition point during this evolution. Although there is concern among surgeons and hope among the catheter-based enthusiasts that percutaneous techniques will supplant conventional surgery, I believe that the truth will come to settle somewhere in between with a happy merger between the 2 techniques. Only time will tell. Meanwhile, it is our duty, as surgeons, to continue to improve surgical techniques and outcomes to provide the best care to our patients, who are more and more in the aging population.

Multiple minimal access techniques exist. The upper hemisternotomy approach is one of the most popular. Potential advantages are an elegant small incision associated with earlier recovery, reduced pain and blood loss, and improved postoperative respiratory function—all of which are vital, especially to our high-risk older patients. The other minimal access techniques include the upper right parasternal approach, the transverse sternotomy approach, and the right anterior thoracotomy approach.

This article describes the upper hemisternotomy approach to the minimal access aortic valve replacement as performed at the Brigham and Women's Hospital in Boston.
Operative Technique

Figure 1 The patient is prepped and draped in the standard fashion as for any routine cardiac surgical case. Anesthetic management remains unchanged. Transesophageal echocardiography is almost mandatory as it will not only aid in the assessment of the valve and myocardial function before and after surgery, but also in placement of percutaneous femoral venous cannulae, transjugular retrograde coronary sinus catheter (when needed), and also in deairing of the heart.

The skin incision is marked—usually 8 to 10 cm long. Other important landmarks like the second and third interspaces and the xiphoid process are also marked with a marking pen.
Figure 2 The skin incision starts as marked, at or slightly above the manubriosternal angle.
A midline sternotomy is performed down to the level of the 4th intercostal space using a standard saw. The sternum is then “T’d” off into the right 4th intercostal space using an oscillating saw. Adequate control of the oscillating saw is mandatory to prevent injury to underlying structures. Care should be taken to maintain the precision of the sternotomy to prevent longitudinal or transverse fractures. Prophylactic division of the right internal mammary vessels is not necessary unless bleeding from inadvertent injury is identified.
Figure 4  Intraoperative photograph of a midline sternotomy.

Upper midline sternotomy

Sternotomy extended laterally into 4th intercostal space
Figure 5 A retractor is placed and the pericardium is opened in the midline. Pericardial edge sutures are placed. The retractor is then removed.
The pericardial sutures are tacked up to the dermis/skin and the retractor is replaced inside the tacked-up pericardium.

Care must be taken to ensure gentle opening of the incision after pericardial tacking as sudden elevation of pericardial structures could cause hemodynamic instability, especially in patients with severe aortic stenosis.

After performing an epiaortic ultrasound to confirm the absence of atheromatous disease in the ascending aorta, the patient is systemically heparinized and appropriate cannulation sutures are placed in the distal ascending aorta and the right atrium.
Figure 7 Cannulation is completed in the standard fashion using a standard aortic perfuser and a three-stage right atrial venous cannula. When the right atrium is not adequately visible, a percutaneous femoral venous cannula is placed. This is guided into the right atrium using transesophageal echo guidance. Gentleness is of paramount importance with both versions of right atrial cannulation, especially in frail and fragile elderly patients.
The patient is then placed on cardiopulmonary bypass. We use tepid bypass with core cooling to 35°C. The need for vacuum-assisted venous drainage to facilitate this operation cannot be overemphasized. If needed, a retrograde cardioplegia catheter can be placed in the coronary sinus via the right atrial appendage (not shown in the picture) using transesophageal echocardiography for guidance. A retrograde catheter can also be placed by the anesthesiologist before surgical incision via the transjugular route. The left ventricle can be vented via the right superior pulmonary vein, the left atrial dome, or a transaortic vent through this incision.

The aorta is cross-clamped and the patient is given 1 L of 8:1 cold blood antegrade cardioplegia. Transesophageal echocardiogram is used to monitor left ventricular distension in patients who may have aortic insufficiency. Retrograde cardioplegia and additional doses of cardioplegia are administered as necessary. An oblique aortotomy is made for the exposure of the aortic valve. a. = artery.
Figure 9  (A) The aortic valve is removed and the annulus is debrided. Care must be taken to prevent embolization of calcium debris. (B) The annulus is then sized for the appropriate valve. (C) We use pledgeted horizontal mattress sutures of 2-0 Ethibond (everting for intra-annular mechanical valves and noneverting for bioprosthetic and other supra-annular valves). (D) These sutures are passed through the cuff of the valve and the valve is lowered into position.
The sutures are then tied and cut. Before closure of the aortotomy, it should be confirmed that the valve is well seated in/on the annulus and that the coronaries are clearly above the valve.
After placement of an appropriate deairing needle in the ascending aorta, the patient is placed in steep Trendelenburg position and the aortic cross-clamp is released. If defibrillation/cardioversion is required, external defibrillator pads placed before commencement of the operation are used. Reduction of bypass flow to decompress the heart or other medical maneuvers (lidocaine, magnesium, esmolol) can be used to facilitate defibrillation. It is almost impossible to introduce internal defibrillator blades through this incision.

The heart is then deaired. We use transesophageal echocardiography to assist us in this process. Certain maneuvers will facilitate deairing. These include tilting of the table, manual external compression, and table agitation (make sure that the anesthesiologist holds the head of the patient firmly). Complete deairing will need either partial bypass or complete emergence from cardiopulmonary bypass. The deairing needle is removed after absence of air is confirmed on the echocardiogram.

Atrial and ventricular pacing wires and fluted silastic drainage tubes will have to be placed while the heart is decompressed on full cardiopulmonary bypass to prevent injury. Indeed, some surgeons place the drainage tubes even before the cross-clamp is released. We use a combination of tactile and visual control with a long clamp to place drainage tubes. In case it is impossible to place these drainage tubes this way, or if the surgeon forgets to do this before emergence from bypass, the right pleural space can be opened and drains can be placed transpleurally. We are usually able to visualize an adequate amount of atrial and ventricular myocardium to place temporary pacing wires. The pacing wires are brought out in the right infra-mammary area through the right-sided “T.”
The pericardium is left open. Important areas to look at while policing for bleeding are areas of pacing wire placement and drainage tube entry, sites of left ventricular vents, the lower edge of the sternotomy/pericardiotomy, the internal mammary vessels on the side of the “T” and venous bleeding from behind the inferior vena cava. Major bleeding may require conversion to full sternotomy for control, and no hesitation should be made in doing so.
Figure 13  The sternum is closed using 3 or 4 horizontal sternal wires, and an oblique wire is placed between the lower intact segment of the sternum and the “T’d” off segment to ensure stability.
Conclusions

Upper hemisternotomy provides a useful, reproducible, and safe approach for minimal-access aortic valve surgery.