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Editorial

Evolution of atrial septal defect closure: Is MICS a new standard of care?

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1. Introduction

Atrial septal defects (ASDs) are one of the common congenital cardiac defects and human endeavours to close it started way back in 1940s when people suggested blind closure of the defect by inversion of atrial appendage, attempted by Gordon Murray and Bailey in different ways. It was followed by a semi open technique of Robert Gross making a well to perform ASD closure. Lewis et al. closed it under vision by using deep hypothermia and inflow occlusion. Later, with the invent of cardiopulmonary bypass, open surgical closure became the gold standard, till percutaneous device closure introduced by King and Mills in 1976 became widespread. But in the last decade minimally invasive cardiac surgery (MICS) has come up in a big way, removing the ill effects of sternotomy and overcoming the shortcomings of device closure. In this review, we present food for thought if MICS ASD closure is the new gold standard and should be offered to all individuals as first therapy.

2. History of ASD Closure

Gordon Murray's pioneering clinical intervention in 1948 involved externally suturing an atrial septal defect (ASD) in a 12-year-old patient. Murray passed two sutures through the atrial septum and connected them posteriorly, permanently knotting them when the right atrium was reduced to less than half its original size. However, a subsequent catheterization revealed that the defect was only partially closed. On August 28, 1949, Paul Santy and his associates from Lyon, France, successfully completed a clinical procedure by intussusception of the right auricular appendage via the defect into the left auricular appendage.

2.1. Indirect closure techniques

Early in the 1950s, Henry Swan of Denver proposed the simultaneous invagination of the two auricular appendages, after the passage of a threaded, curved probe through the defect from one auricular tip to the other.[1–3] Plastic buttons threaded on the transatrial sutures were approximated by tightly tying the sutures[4]. In 1951 K. Alvin Merendino and coauthors described a method of plugging an ASD by the use of a pericardial bag or a tampon of autogenous fat, which was fashioned by suture in the general shape of mushroom.[5] During that same year, Hufnagel and Gillespie also reported an experimental procedure that was the forerunner of contemporary umbrella device techniques. It involved placing two halves of a polyethylene button, respectively, to the opposing sides of an artificially formed septal defect. Sadly, all three patients who received this treatment passed away.[6]

In order to manually examine the right atrium and septal defect, Bailey performed atrioseptopexy in 1952 by passing his index finger through the right atrial appendage. Then, he

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assisted in suturing the right atrial wall to the defect's rim with his finger as guide. While the procedure gained some popularity, there were numerous disadvantages, including a substantial distortion of the right atrium and possible coronary sinus stenosis.

In 1955, Conrad L. Lam published a description of an enhanced method of atrioseptopexy that involved finger guided suture placement and pulmonary vein mobilization to avoid stenosis. Tyge Sondergaard published a report on his circumclusion method for closing ASD in 1954.[7]

Despite encouraging outcomes in the experimental laboratory, Henry Swan and colleagues realized in 1954 that "experience with several types of indirect techniques for the closure of ASDs led to realization that indirect methods did not secure complete closure of the large defects frequently occurred clinically."[8]

2.2. Semi-open well technique

The atrial well semi open technique was described by Robert Edward Gross in 1953. He applied a clamp on right atrium and exteriorised a section of its wall. A rubber well or cone was sutured to the edges of an atriotomy incision. Blood shot into the well as soon as the clamp was removed. The surgeon might apply sutures under digital control through this blood pool to close the defect directly or in patches.

2.3. First ASD closure under vision – Hypothermia and Inflow occlusion technique

Hypothermia was used to complete the first ASD closure under direct view. The patient's body temperature was 28°C, and the inflow occlusion lasted for five minutes and thirty seconds. This procedure launched the era of open-heart surgery and was the first successful operation performed on an open human heart under direct vision in history.[9] Two hypothermic techniques were created. One approach involved submerging the patient in an ice bath until their body temperature fell to 28° to 30°C, which allowed them to stop their circulation for a maximum of 6 minutes. The other was a technique for chilling venous blood that Edmond Delorme and Ite Boerema created. They quickly gave up on this approach due to several issues, and they created an intrathoracic cannulation technique for cooling.

Even though complete inflow occlusion and hypothermia were major contributing factors to the advent of open-heart surgery, the procedure was too dangerous and did not give enough time for significant intracardiac surgery.

2.4. Cardiopulmonary bypass and controlled cross circulation

On May 6, 1953, an 18-year-old patient had a direct closure of an ASD, marking the first successful operation with a CPB machine in history. One patient experienced cardiac arrest prior to the start of CPB, and two patients had incorrect cardiac anomaly diagnoses.[10]

John Gibbon was not happy with the outcomes and gave up on the idea of cardiopulmonary bypass machine. Walton C. Lillehei used controlled cross-circulation approach in 1954, for closing intra cardiac defects, successfully.[11] But by the late 1960s, with improvisations in technology, practically all surgeons were using the heart lung machine for open heart surgery.

2.5. Conventional Midline sternotomy Vs MICS ASD closure

Partial sternotomy, right parasternal mini-incision, right anterolateral thoracotomy, trans-axillary, right posterolateral thoracotomy, video-assisted mini-thoracotomy, robot-assisted surgery, and total thoracoscopic surgery without robotic assistance are the various MICS techniques for ASD closure. MICS has the advantage of cosmesis and shorter hospital stay as compared to full sternotomy. On the other hand, limited operational field and technical challenges with peripheral cannulation and need for emergency conversion are some of the drawbacks of MICS. Several studies have been conducted on MICS approach for the closure of ASD, and the majority have shown equivalent outcomes, while the MICS group has the additional advantage of enhanced cosmesis, and shorter hospital stay.[12,13]

Total endoscopic or robotic ASD closure may have higher cross clamp times especially in the learning phase, but have similar outcomes with less pain and early recovery.

2.6. MICS ASD Closure Vs ASD Device Closure

Recent meta-analysis has compared MICS ASD closure with percutaneous device closure. MICS surgical closure has higher treatment efficacy, lower residual shunt rates, and lower device related problems except longer hospital stay. So, minimally invasive surgical approach has comparable outcomes, offering a safe and effective alternative to device closure.[14]

3. Our Experience

We have done 20 cases so far in our institute, without any mortality or morbidity. Out of these, one was done with a trans axillary incision with central cannulation while others were with an inframammary incision and femoral cannulation. About half of them were females and there were no re-explorations or wound infection.

4. Conclusion

The evolution of ASD closure reflects the relentless pursuit of safer and more effective techniques. From pioneering surgical interventions to modern innovations in

minimally invasive surgery, each milestone has contributed to improved patient outcomes and quality of life. As technology continues to advance, the future of ASD closure may lie in MICS and robotics. With increasingly obvious benefits of MICS and similar outcomes, we ponder if we can offer MICS as first line gold standard treatment option to our patients in future guidelines.

5. Source of Funding

None.

6. Conflict of Interest

None.

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