Novel Automated Suturing Technology for Minimally Invasive Aortic Valve Replacements

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Purpose. **Annular suture placement during minimally invasive right anterior thoracotomy aortic valve replacements (MI-AVR) can be challenging. We present the early clinical experience with novel automated suturing technology that may reduce the technical difficulty of this operation.**

Description. **The technology presented involves an automated articulating suturing device that simultaneously drives dual-curved needles through the aortic annulus to place a pledgeted horizontal mattress suture remotely; a second device with 2 straight needles places suture through the sewing cuff of a prosthetic heart valve.**

Evaluation. **Automated annular suturing was used in five MI-AVR procedures, which were successfully completed, with no paravalvular leaks detected and a mean aortic valve gradient of 6.4 mm Hg postprocedure. Mean aortic cross-clamp and cardiopulmonary bypass times were 100 and 134 minutes, respectively. All 5 patients were successfully discharged home, with a mean intensive care unit and total length of stay of 2 and 7 days, respectively.**

Conclusions. **Automated suturing during MI-AVRs is feasible and may reduce the technical challenge of this operation. Further research is necessary to determine its effect on patient outcomes.**

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A technical challenge that surgeons encounter during minimally invasive aortic valve replacement (MI-AVR) procedures through a right anterior mini-thoracotomy (RMT) involve the placement of sutures in the aortic annulus with rigid instruments in a limited space. Visualization of the annulus can be difficult and is often aided by using a camera, which when used can lead to the inherent difficulties of video-guided fine-needle manipulation. The development of new technology that reduces this challenge can simplify this approach while delivering the many advantages of a minimally invasive operation. We present an early clinical evaluation of the feasibility of novel automated suturing technology that was developed for this purpose and discuss its use during MI-AVRs.

Technology

Two automated suturing devices were used to facilitate annular suturing during MI-AVRs by using a RMT. The RAM device (LSI SOLUTIONS, Victor, NY) is an adjustable, long-shafted, suturing device with 2 curved needles that places a horizontal mattress pledgeted 2-0 polyester suture in the aortic annulus (Fig 1A). The proximal end of this device contains 2 rotational knobs that manipulate the device tip and shaft for improved ergonomics and suturing accuracy. One knob rotates the shaft in a 360-degree motion, and the other articulates the tip in a flexion/extension fashion. After the operator

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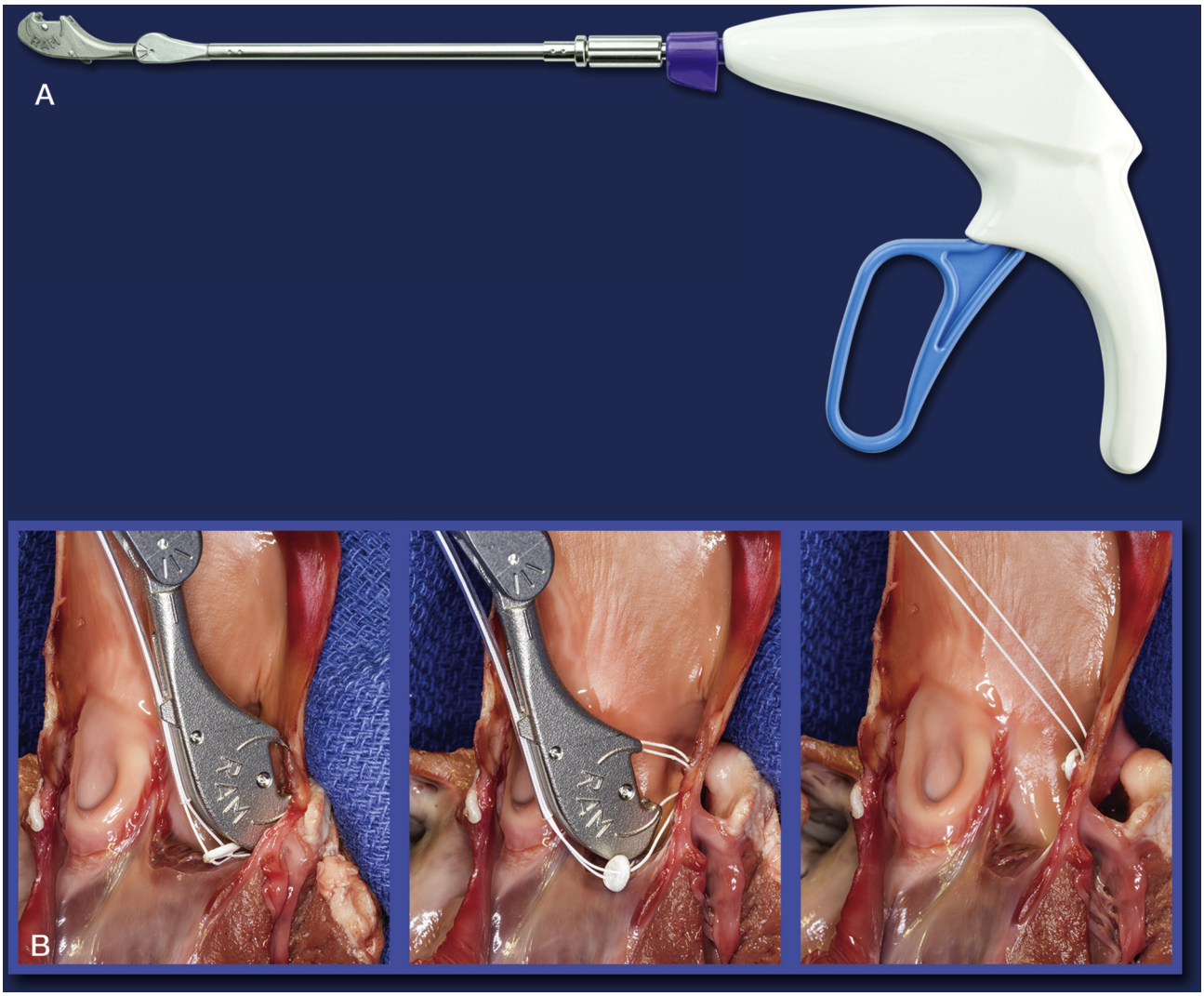

Fig 1. (A) An automated suturing device with 2 curved needles for placement of pledgeted interrupted horizontal mattress sutures in the aortic annulus. (B) Mechanism of action of the RAM device (LSI SOLUTIONS, Victor, NY).

approximates the desired portion of the annulus within the tissue gap of the device, depressing the device lever extends 2 curved needles simultaneously in a fixed arc through the annular tissue to engage the suture located within the tip of the device. Releasing the lever retracts the needles back into the device, through tissue, bringing the suture loop and pledget with it, and seating a pledgeted horizontal mattress suture in a subannular position (Fig 1B); pulling forward on the device lever automatically releases the suture ends. The process is repeated until all annular sutures are placed.

A second device, the SEW-EASY (LSI SOLUTIONS), is a shafted device with 2 straight needles that places the 2 ends of the horizontal mattress suture from the aortic annulus through the valve sewing cuff (Fig 2A). After the suture ends are loaded into the device, the valve cuff is placed within a recess in the device tip. Depressing the lever drives the 2 straight needles simultaneously through the sewing cuff to engage the suture ends. Releasing the lever retracts the needles back into the sheath and brings the suture with it through the sewing cuff; the suture is then removed from the device (Fig 2B).

Technique

MI-AVRs through a RMT were performed through a 5-cm incision in the right second intercostal space. Soft tissue and rib-spreading retractors further exposed the field. The third rib was routinely dislocated to improve exposure of the aortic root and ascending aorta for central cannulation. Cardiopulmonary bypass (CPB) was instituted through central arterial and right femoral venous cannulation in all cases. A Chitwood-DeBakey aortic cross-clamp (Scanlan International, St. Paul, MN) was inserted percutaneously at the level of the anterior axillary line in the second intercostal space. A trocar inserted midway between the cross-clamp and the lateral edge of