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How I Do It

Self-Retaining Atrial Retractors for Robotic and Minimally Invasive Mitral Valve Surgery

Norihiko Ishikawa, MD, PhD,[1,2] You Su Sun, MD,[1] L. Wiley Nifong, MD,[1] Go Watanabe, MD, PhD,[2] W. Randolph Chitwood Jr, MD[1]

[1]Center for Robotics and Minimally Invasive Surgery, Brody School of Medicine at East Carolina University, Greenville, North Carolina, USA; [2]Department of General and Cardiothoracic Surgery, Kanazawa University School of Medicine, Kanazawa, Japan

ABSTRACT

Successful surgery, particularly on the heart valves, is dependent on excellent and consistent exposure of the operative field. In this report, we describe 2 types of new atrial retractors designed for robotic and minimally invasive mitral valve surgery. These simple and easy-to-handle atrial retractors provide exceptional and consistent exposure of the left atrium in robotic and minimally invasive mitral valve surgery and prevent traumatic injury.

INTRODUCTION

Successful surgery, particularly on the heart valves, is dependent on excellent and consistent exposure of the operative field. In robotic and minimally invasive mitral valve surgery, the procedure is performed through a small thoracotomy and several thoracoports. To enhance visualization of the operative field, a customized transthoracic atrial retractor was developed [Kypson 2003]. However, there are still problems with this retractor, and in this report we describe 2 types of new atrial retractors designed for robotic and minimally invasive mitral valve surgery.

TECHNIQUE

Prototype 1. The prototype 1 retractor consists of 2 parts: V-shaped arms and blades, of which several types and sizes were prepared. This retractor has a structure that sandwiches the chest wall and the heart (Figure 1A). On one side of the V-shaped arms, a fixation pad is applied with appreciable flexibility to the chest wall. The other arm has a sliding adjuster to which the blades can be attached and that can regulate the depth of the blades as desired (Figure 1B). This unique retractor enhances visualization of the left atrium and the mitral valve. Since the joint linking the V-shaped arms has a ratchet, the retractor can immobilize the left atrium upward consistently and enhance the presentation of the superior mitral valve.

Prototype 2. The prototype 2 retractor consists of 2 parts: a flexible arm and several sizes of blades like the prototype 1. We improved an existing heart stabilizer (Octopus 3; Medtronic, Minneapolis, MN, USA) so that it could be attached to the blades. The ball-like attachment can flex the blades with unlimited articulation, and the retractor has greater maneuverability and flexibility (Figure 2A). But once the arm mounted on the rib opener is fixed, the small-diameter arm and the blade are firmly immobilized, and it maintains consistent exposure of the operative field (Figure 2B).

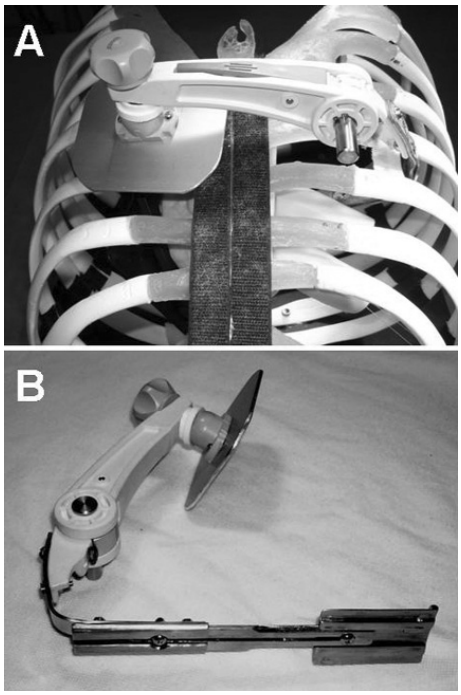

Figure 1. A, The prototype 1 retractor has V-shaped arms and sandwiches the chest wall and left atrium. B, A flexible pad can be mounted on one side of the arms and an adjustable blade can be attached to the other side.

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Correspondence: Norihiko Ishikawa, MD, PhD, Center for Robotics and Minimally Invasive Surgery, Brody School of Medicine at East Carolina University, 600 Moye Boulevard-LSB 248, Greenville, NC 27858, USA; 1-252-744-2187; fax: 1-252-744-3542 (e-mail: nori-i@mnx.jp).

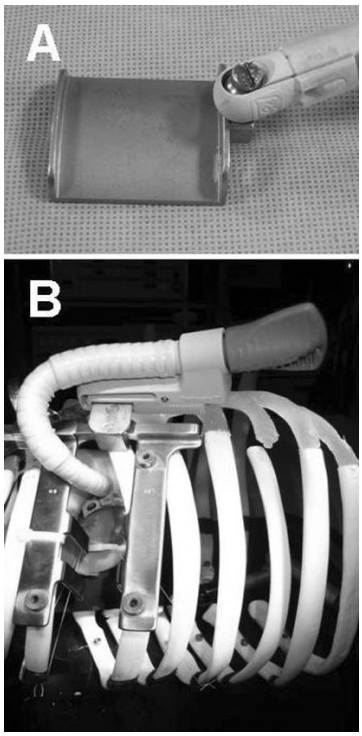

Figure 2. A, A ball-like attachment can attach to the blade with free-degree articulation. B, The prototype 1 retractor is mounted on the rib opener.

The usefulness of these retractors was evaluated in 4 robotic mitral valve repairs with freshly frozen human cadavers using the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA). Both of the retractors provided flexible handling and allowed easier access to the heart, and they provided optimized atrial retraction and superior mitral valve presentation without impinging on the robotic arms.

DISCUSSION

Traditionally, mitral valve surgery has been performed though a median sternotomy. However, several developments following from technologic advances, such as closed-chest cardiopulmonary bypass and cardioplegic arrest [Pompili 1996; Stevens 1996], the endoscopic technique, and the robotic telemanipulation system, have encouraged the performance of minimally invasive cardiac surgery. Recently, minimally invasive valve surgery through a small thoracotomy has become a standard procedure [Chitwood 2005; Nifong 2005].

In conventional robotic and minimally invasive mitral valve surgery, the mitral valve is exposed by opening the left atrium just posterior to the intra-atrial groove and anterior to the right pulmonary veins. The blade of the customized transthoracic atrial retractor attached to the rod lifts the roof of the left atrium.

However, there are still problems with this technique, such as the need for additional incisions and the risk of vascular injuries to the internal thoracic vessels and intercostal vessels. With these points in mind, 2 types of unique atrial retractors have been designed specifically for use in robotic and minimally invasive mitral valve surgery. The blades of both retractors are inserted though the 4-cm minithoracotomy without causing vascular injury or necessitating additional skin incision. These self-retaining retractors provide excellent exposure of the left atrium and mitral valve. Furthermore, because they are relatively compact, the retractors do not limit the movement of the robotic arms and permit the greatest possible access to the heart. The retractors can be removed when not required for the intracardiac portion of the procedure, and use of them prevents tissue damage.

These simple and easy-to-handle atrial retractors provide exceptional and consistent exposure of the left atrium in robotic and minimally invasive mitral valve surgery and prevent traumatic injury.

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