SCA REGIONAL ANESTHESIA FOR CARDIOTHORACIC ENHANCED RECOVERY (RACER) SPECIAL INTEREST GROUP

Surgical Approaches to Minimally Invasive Valve Surgery: A Guide for Regional Cardiac Anesthesiologists

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Commentary by

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Regional and neuraxial anesthesia for cardiac surgery has evolved from a niche practice to one that has gained popularity beyond select medical centers in the United States. While spinal analgesia, epidural analgesia and the thoracic paravertebral (TPV) block are not new techniques, the recent development of novel fascial plane blocks including pectoralis (PECS) I and II blocks (2011, 2012), serratus anterior plane (SAP) block (2013), pecto-intercostal fascial (PIF) block (2014) and erector spinae plane (ESP) block (2016) largely contributed to widened acceptance.1-5 In 2017, the Enhanced Recovery After Surgery (ERAS) Society first gathered a group of expert cardiac anesthesiologists and surgeons to formalize consensus recommendations which included the use of regional techniques.6 After years of teaching these methods at the Annual Meeting & Workshops, in 2019 the Society of Cardiovascular

Anesthesiologists further recognized this movement by forming the Regional Anesthesia for Cardiothoracic Enhanced Recovery (RACER) special interest group (SIG) to serves as a forum for member discussion.

The vast and growing number of regional techniques can be overwhelming. While there are numerous high quality review articles that cover the blocks used in cardiac surgery,

nomenclature can be confusing and recently there has been an effort to standardize terms.7,8 There is less discussion amongst cardiac anesthesiologists regarding the variations in surgical incision sites used in the most common types of minimally invasive cardiac surgery. While spinal, epidural, TPV and ESP blocks can provide broad analgesia for the thorax or hemithorax, a truly minimally invasive anesthetic approach aims to provide only necessary sensory coverage, while minimizing unnecessary physiologic effects. An understanding of surgical anatomy ultimately helps the anesthesiologist select a proper regional approach. On behalf of RACER SIG, this article will discuss the location and anatomy of surgical incisions commonly used in minimally invasive valve surgery involving the lateral chest wall.

Surgical Aortic Valve Replacement via Right Anterior Mini-Thoracotomy

The first surgical aortic valve replacement (SAVR) via a right anterior mini-thoracotomy (RAT) was performed in 1993.9 Along with the upper hemisternotomy, this remains a common minimally invasive approach.10 This technique begins with a 4-6 cm skin incision in the 2nd or 3rd right intercostal space (ICS) near the sternal border, after which soft tissue retractors and rigid retractors with narrow blades provide visualization of the operative site (Figure

1). Following pericardiotomy, cannulation for cardiopulmonary bypass (CPB) is established peripherally by percutaneous or cut-down access of the common femoral vessels or centrally via direct cannulation of the ascending aorta and right atrium.11 A low-profile aortic cross- clamp is placed either via the primary incision or through a separate stab incision inferolateral to the right clavicle (2).12 Ascending aortic endoballoon occlusion can also be used via a femoral arterial cannula. Following completion of the procedure, a small chest drainage tube is placed in the right pleural space through a separate intercostal space.

Given the relatively medial incision site of SAVR via RAT, a regional anesthetic must be chosen carefully. The superficial parasternal intercostal plan (PIP) block, a standardized term used to encompass the PIF block, transversus thoracis plane block, parasternal pectoral block and others, would be appropriate.8 This block targets the anterior cutaneous branches of the intercostal nerve responsible for innervation from the sternum to the midaxillary line. Case reports have demonstrated successful use of the superficial PIP block following RAT SAVR to provide analgesia from the sternum to the midaxillary line, effectively reducing postoperative opioid administration and postoperative numerical pain scores.13

Minimally Invasive Mitral Valve Repair and Replacement Surgery

Minimally invasive lateral approaches have been similarly embraced in the realm of mitral valve repair (MVr). The most common approach is a right mini-thoracotomy under direct visualization. The primary thoracotomy incision is 5-8 cm and placed in the 4th right ICS, inferolateral to the areola in men and in the submammary crease in women.14 A soft tissue retractor with or without a small thoracic retractor is used to then spread the ribs. Optionally, a thorascope is introduced through the 2nd right ICS. The aorta can be cross clamped via a transaxillary approach in the 2nd/3rd right ICS using a Chitwood clamp, through the primary incision with a flexible clamp or via the femoral artery with ascending aortic endoballoon occlusion. Finally, a left atrial retractor is inserted parasternally to expose the valve. Like SAVR via RAT, some centers prefer peripheral femoral cannulation for MVr, which may allow for better exposure, while others utilize direct aortic cannulation to avoid the risks of retrograde arterial perfusion.

Robotic MVr presents the least invasive technique for surgical treatment of mitral valve disease, with the largest incision as small as 12-20 mm (Figure 2).15 Generally, the working (access) port is created in the 4th right ICS anterior axillary line. The left arm port is placed 2 interspaces cranial while the right arm port is placed 2 interspaces caudal, both on the anterior axillary line. Finally, the camera port is placed anteriorly in the same ICS as the working port while the LA retractor port is placed in the 4th or 5th ICS, medial to the midclavicular line.

Because the primary incision is lateral in both of these MVr approaches, the optimal regional technique is different than for RAT SAVR. The superficial or deep SAP blocks is may be appropriate, as they provide analgesia from T2-T7 with variable spread to T9.3 This approach spares the anterior cutaneous branches of the intercostal nerves and therefore has limited coverage medial the midclavicular line. The pectoserratus plane block, previously referred to as PECS II, may also be considered The principal targets of this block are the medial pectoral, lateral pectoral, long thoracic, thoracodorsal nerves, with possible medial effects via the anterior branches of intercostal nerves. This technique provides excellent coverage of the axilla and T1-T4 dermatomes with variable spread to T6.16 Depending on placement of accessory ports, these blocks may require supplementation with a superficial PIP block, or alternatively a TPV or ESP block can be used. A recent review specifically highlighted the use

of SAP or pectoserratus plane blocks in the setting of robotic MVr, though the authors stated

that pre-induction TPV block was their analgesic preference.17 Multi-level TPV Block has demonstrated efficacy in reducing intraoperative and postoperative opioid requirements as well as postoperative pain scores following robotic MVr when compared to control.18

Transapical Approaches to Transcatheter Valve Procedures

Transapical (TA) transcatheter aortic valve implantation (TAVI) was a frequently used approach in patients with unfavorable transfemoral access anatomy. Although infrequently used in contemporary TAVI due largely to a reduction in sheath size, the TA approach has been used more recently in transcatheter mitral valve interventions, including chordal repair with the NeoChord DS1000 system or valve replacement with the SAPIEN 3 and Tendyne systems. The TA approach uses a left anterolateral mini-thoracotomy to gain direct anterograde access to the left ventricle. Identification of the optimal interspace is frequently guided by preoperative computed tomography, or with surgical palpation and transthoracic echocardiography (Figure 3). A 5-7 cm skin incision is usually made in the 5th

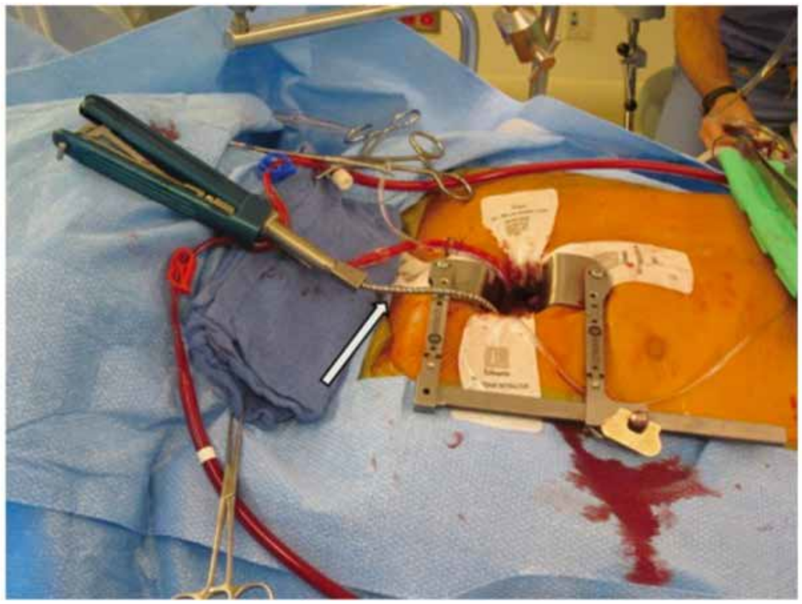
or 6th left anterolateral ICS on the anterior axillary line.19 The use of soft tissue retractors and rigid retractors allows apical access which permits transapical sheath insertion and valve intervention under echocardiographic and fluoroscopic guidance.

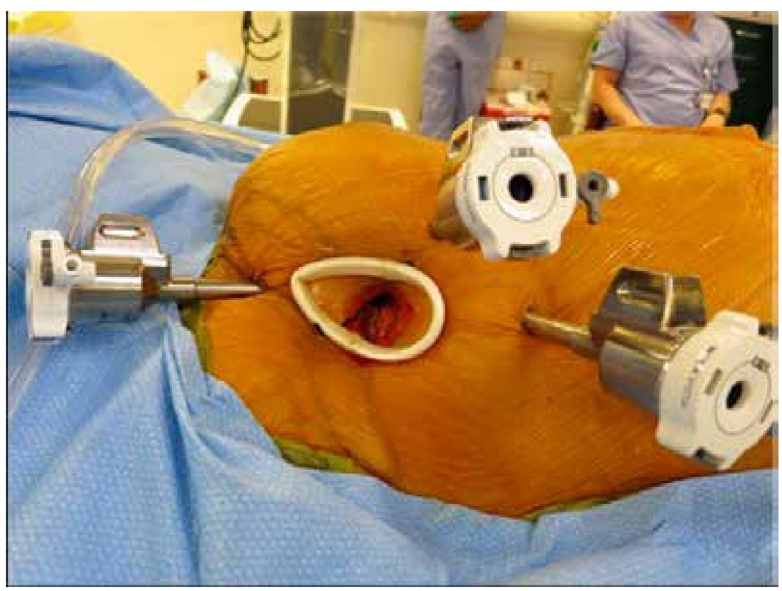
The left mini-thoracotomy for a transapical approach lends itself to most of the blocks

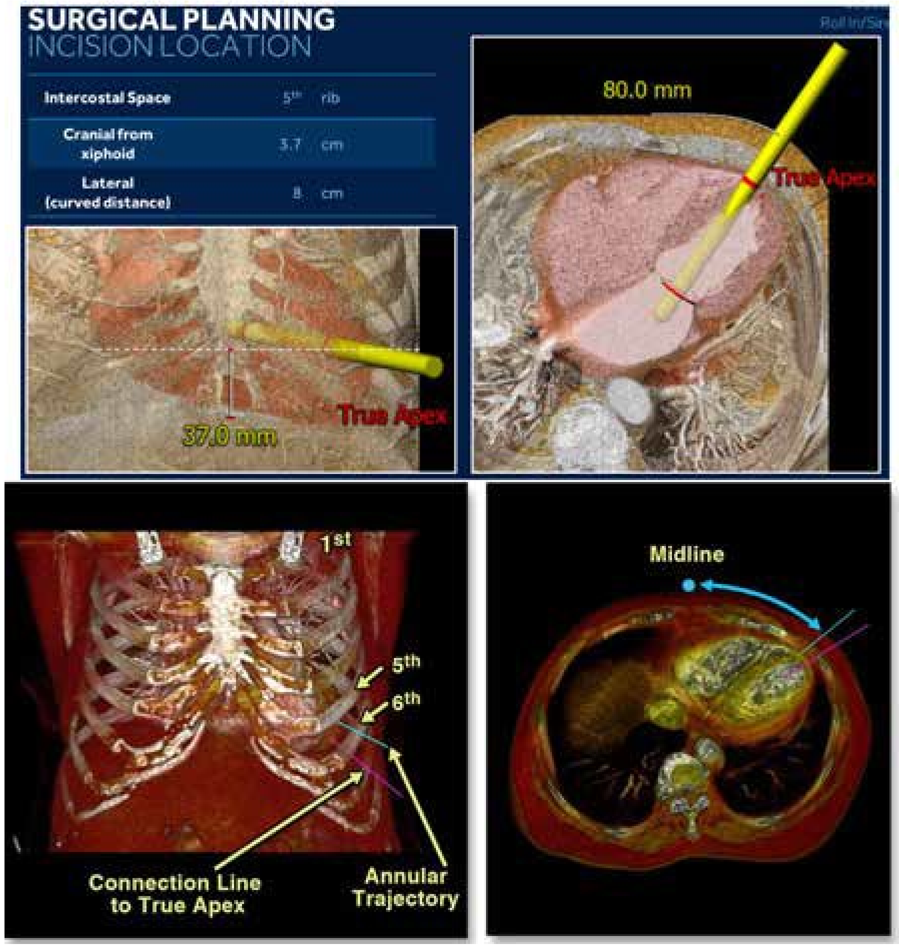
previously described for MVr. TPV block has been shown to reduce opioid administration and decrease incidence of atrial fibrillation after TA TAVI with limited impact on hemodynamic stability.20, 21 SAP or pectoserratus plane blocks have also been used in case studies.22, 23

Traditional cardiac anesthesia utilized systemic opioids can treat postsurgical pain regardless of the surgical approach, albeit with unnecessary side effects. Likewise, neuraxial anesthesia can provide near complete coverage of somatic pain receptors, at the expense of profound vasodilation and increased procedural risk. The modern ERAS cardiac surgery approach

calls for a “less is more” technique, and only through a complete understanding of surgical anatomy can the most appropriate regional block be selected by the cardiac anesthesiologist.







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Since the inception of RACER SIG in ASRA and SCA in 2019, there has been an explosion of interest in matching the analgesic needs of minimally invasive cardiac surgery with regional anesthetic techniques beyond the neuraxis, as wonderfully narrated above. Mr. McGrath and Dr. Neuburger provide an excellent timeline of recently described fascial plane blocks, with careful descriptions of minimally invasive surgical approaches with which these blocks

may marry well. In addition to the anterior mini-thoracotomy, the authors point out common locations of accessory ports, which can be additional sources of nociception. Indeed, the block needle's reach has literally come full circle along the chest wall (Chin et al.). As evidence continues to build on these techniques' effects on pain scores and opioid consumption, how can we simultaneously demonstrate their effectiveness and value? Waiting for randomized, controlled, multicenter trial data must be weighed with reports of successful integration

of chest wall blocks into enhanced recovery after cardiac surgery (ERACS) protocols from hospitals around the world (Sondekoppam et al.).

A team-based approach in a culture of collaboration and communication is crucial for any enhanced recovery pathway, no less for the incorporation of chest wall blocks into cardiac surgery (Kim et al.). Engaging the surgeon early as a stakeholder can allow cardiac and regional anesthesiologists for any block-related concerns to be addressed and for shared agreements on specific, targetable outcome goals, whether that be facilitating fast-track extubation, decreasing opioid consumption, and/or accelerating transfer from the intensive care unit to the ward. Furthermore, deciding on the block based on any discussed variation from the aforementioned surgical approaches can encourage further buy-in. If a dedicated regional anesthesia service is available, the cardiac and regional anesthesiologists can decide on the choice and technique of block placement. For example, a single local anesthetic injection versus a continuous infusion catheter may be considered. A separate block team can further optimize the timing of the block, especially if decreases in intraoperative opioid administration and fast-track extubation are also desired.

Follow-up can further provide quality assurance while enhancing the visibility and value of a perioperative anesthesia service. Additional stakeholders in the intensive care unit and the surgical wards include intensivists, nursing staff, hospitalists, and additional allied healthcare professionals. Education on the regional analgesia techniques must happen, including clear expectations on the scope of analgesia, as well as issues that warrant further consultation from the regional anesthesia and acute pain medicine team (e.g., block disconnect, pump programming, pain not covered by block). This is particularly important for ERACS pathways that utilize regional analgesia catheters which facilitate continuous infusions or intermittent boluses, which merit daily management until catheter removal. As a watched kettle is oft- said to never boil, a well-managed nerve block catheter may improve outcomes (and never fail). Close tracking of the blocks' effects on outcomes are important to further demonstrate their cost-saving potentials. For instance, if a serratus anterior plane block can facilitate earlier extubation in the OR and decrease the staffing need for respiratory therapists postoperatively, is this not valuable and worth making the block work? (Mariano ER)

Minimally invasive cardiac surgery has created a wealth of opportunities for improving healthcare outcomes across the perioperative spectrum. As Mr. McGrath and Dr Neuberger point out, the extremes of neglecting postoperative pain in the cardiac surgical patient and risking unnecessary complications with neuraxial analgesia can be circumvented by "minimally invasive" regional anesthesia that maximizes results. Cardiac and regional anesthesiologists look forward to engaging with both the broader cardiac and regional anesthesia communities to share best practice insights and to advance clinical practice.

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