Technical Note

Robotic Transfer of the Latissimus Dorsi for Irreparable Subscapularis Tear

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Abstract: This Technical Note presents an endoscopic robotic anterior axillary shoulder approach using of the DaVinci (Intuitive Surgical, Sunnyvale, CA) robot, which allows one to endoscopically access and harvest the latissimus dorsi tendon for occasions in which the patient presents an irreparable lesion of the subscapularis tendon. Harvesting the latissimus dorsi through an anterior axillary approach is specially desirable when one needs to access the anterior portion of the shoulder, as happens for subscapularis irreparable lesions.

Introduction

Robotic surgery has been used for a long time,[1-2] and it is earning space and expanding use to daily medical practice in several surgical specialties with advantages over the traditional surgical methods,[3,4] Within orthopedics, we highlight the use of robotics in brachial plexus,[5-7] and neurologic releases.[7-9]

The association of the robotic technology with endoscopy has further allowed a faster recovery for the patient for many applications with shorter time of hospitalization and minimally invasive approach.[10]

Advantages of this method include movement accuracy, high-resolution imaging with three-dimensional vision, gas infusion rather than saline solution (better visualization), filtering of the surgeon's tremor when manipulating objects, movement scaling, and hands-free camera manipulation.[11-14] In addition, in the future, there is the possibility of remote surgery (telesurgery) where the surgical team can treat a patient far away[1,2] or a surgical team may be composed of professionals located in different cities or countries, treating the same patient simultaneously.

Some shoulder pathologies that will need axillary approach may need aggressive and traumatic exposure with extensive manipulation of soft neurovascular structures.[15,16]

The minimally invasive procedures have demonstrated decrease of adhesions, avoiding reoperations and physical therapies during long times. Indeed, this advantage mentioned above make these procedures cost-effective.[10]

In shoulder surgery, robot-assisted surgery is used for better identification of the quadrangular space of the shoulder, identification of the axillary and radial nerves, and better identification of the latissimus dorsi muscle, and its use as free flap was previously done.[17-19] In a cadaver trial, the identification of the latissimus dorsi tendon was also achieved.[20] Its manipulation in live patients to treat massive rotator cuff lesions[21] and transfers for scapula were also reported.[22]

Recently, the latissimus dorsi transfer to the subscapularis using the axillary approach was successfully suggested to treat the subscapularis irreparable lesions.[23]

This Technical Note aims to present the use of the DaVinci (Intuitive Surgical) robot for endoscopic transfer of the latissimus dorsi through an anterior axillary endoscopy.

Indications, Preoperative Evaluation, and Imaging

This procedure is indicated for patients presenting subscapularis tendon, irreparable lesions, or intractable fatty degenerations of the subscapularis muscle.

Functional loss or internal rotation strength can be a key factor for suspecting the subscapularis lesion or

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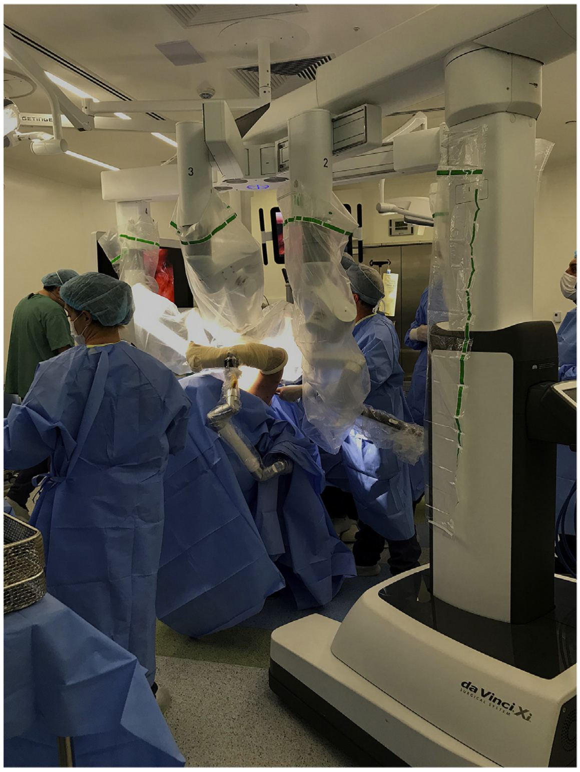

Figure 1. Position of the patient, anterolateral decubitus with upper limb in abduction and external rotation, as well as robot docking.

incompetence. Patients will also experience pain, movement restrictions, and sometimes even shoulder instability. Besides the clinical exam, magnetic resonance images and ultrasound can also confirm the lesion.

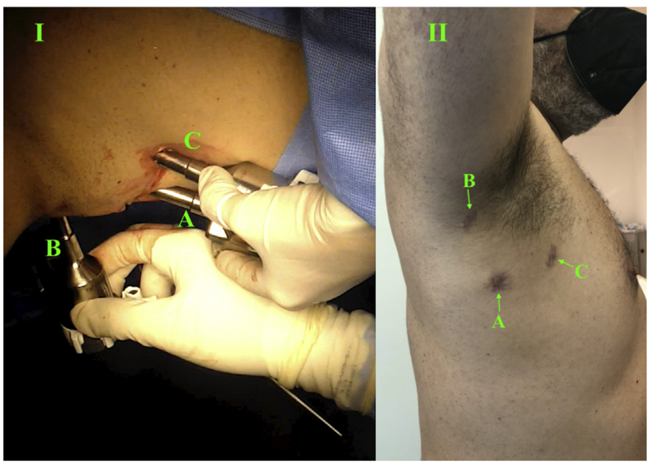

Figure 2. I. Portals. A: central portal (optics) 10 cm from the axilla just above the latissimus dorsi. B: lateral robotic hand through the axillary portal (AP) on the axillary line. C: robotic hand through the medial portal (MP) 7 cm from axilla 7 cm medial from the central portal (CP) on the thorax. II. Same portals, three months after surgery.

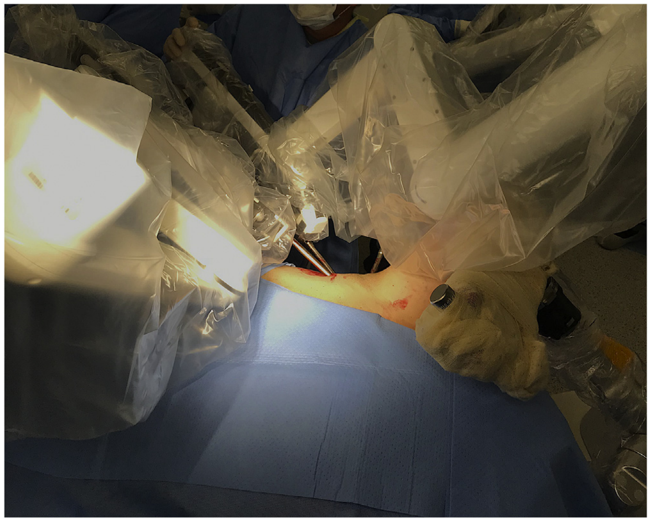

Figure 3. Robot docking on the axillary space and view of the trocars inserted. Same portals 3 months after surgery.

An assessment of the latissimus dorsi muscle is required in order to show indication of this procedure.

Surgical Technique

Patient is placed in the dorsolateral decubitus tilt of 30°, the arm being maintained 90° in abduction and in external rotation by using a Trimano (Arthrex, Naples, FL) (Fig 1).

The anterior border of the latissimus dorsi can be localized by palpation. A draw of the muscle is done in the skin based on its known anatomy. A central line of the latissimus dorsi is also drawn. A 1-cm incision is made in the skin, 10 cm from the axilla, the central portal.

If there are no natural cavities in this space, then a digital divulsion and Allis-assisted divulsion are done in

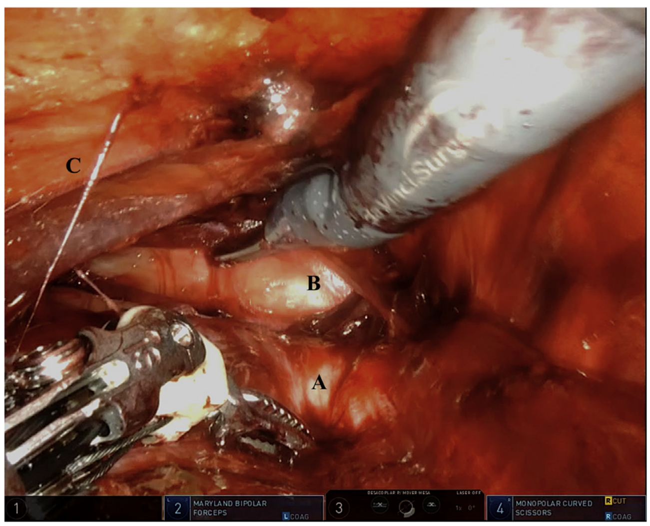

Figure 4. Robotic view, right axilla. A, latissimus dorsi tendon; B, biceps tendon; C, radial nerve.

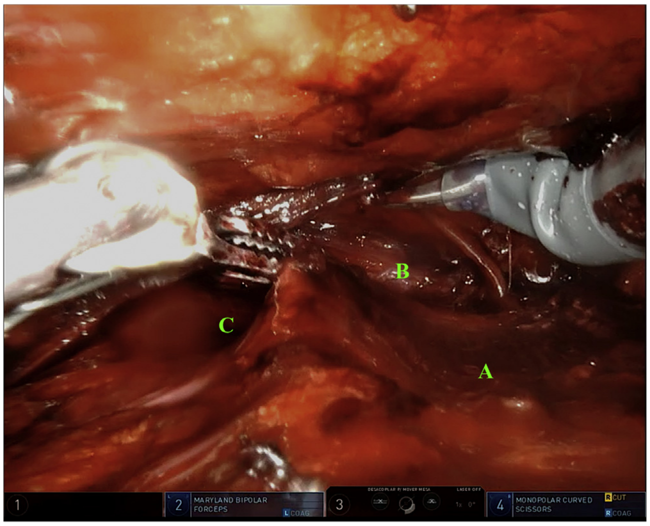

Figure 5. Robotic view, right axilla. A, latissimus dorsi tendon; B, biceps tendon; C, teres major.

order to create a cavity just over the tendon to its insertion on the bone.

This cavity is made under the radial nerve and other neurovascular structures; the cavity is completed when one feels the bone and the biceps. The central portal is used to insert the optics, and through the other two portals, the robotic hands are introduced to access the muscular fascia where a cavity was formed through blunt dissection.

The central portal (CP) is located 10 cm from the axilla. Two other portals are made, one 7 cm medial (medial portal, MP) and 7 cm from the axillary line, on the thorax; and the other on the axillary line, the axillary portal (AP), located 2 cm posterior to the line of the CP on the coronal plan in a triangular configuration (Fig 2).

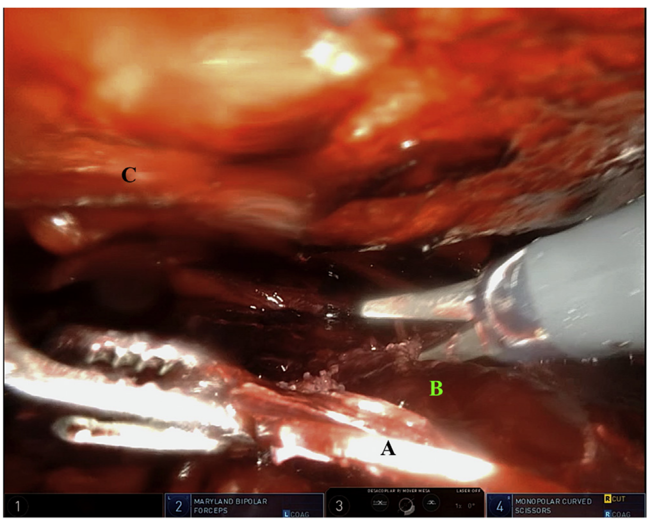

Figure 6. Robotic view, right axilla. A, latissimus dorsi tendon; B, teres major; C, radial nerve.

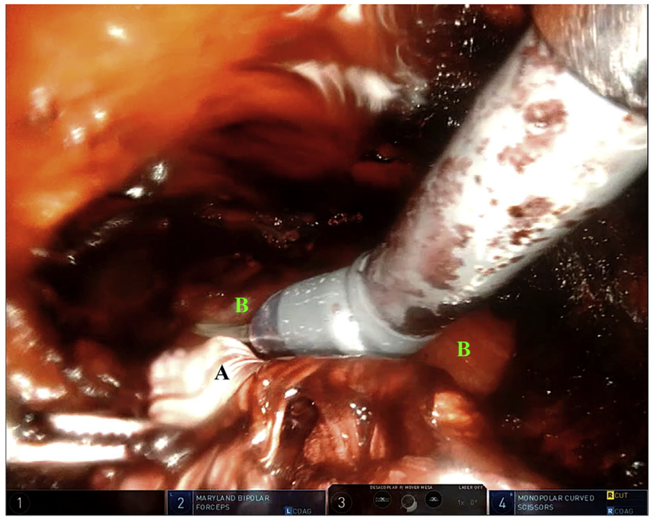

Figure 7. Robotic view, right axilla. A, latissimus dorsi tendon during the release; B, teres major.

In the first portal over the latissimus dorsi, the camera of the DaVinci SI or Xi robot (Intuitive Surgical, Sunnyvale, CA), with an optic of 30° is introduced. The latissimus dorsi tendon is then easily identified.

The robot is docked, and robotic hands are introduced through the other 2 portals in a common direction in the cavity the surgeon created (Fig 3). Depending on the position and necessity, the 30° optic can be changed to a 0° optic.

Carbon dioxide was inflated at a constant 8-14 mmHg pressure through the central portal into the working cavity, stretching the soft tissues and opening the cavity. The robotic arms used a Maryland bipolar forceps 8 mm (Intuitive Surgical, Sunnyvale, CA), a Hot Shears Monopolar and Curved Scissor 8 mm (Intuitive Surgical). The third and fourth robotic arms are not used in this procedure.

The first objective was to clean the area around the camera so that the best dissection and identification of

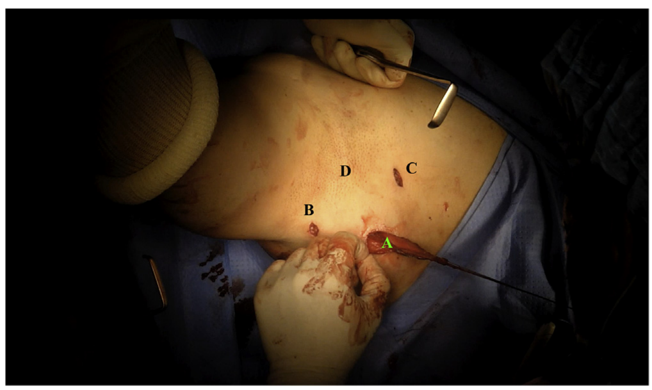

Figure 8. External view, right axilla. A, latissimus dorsi tendon through the central portal; B, lateral robotic hand portal; C, medial robotic hand portal; D, axilla.

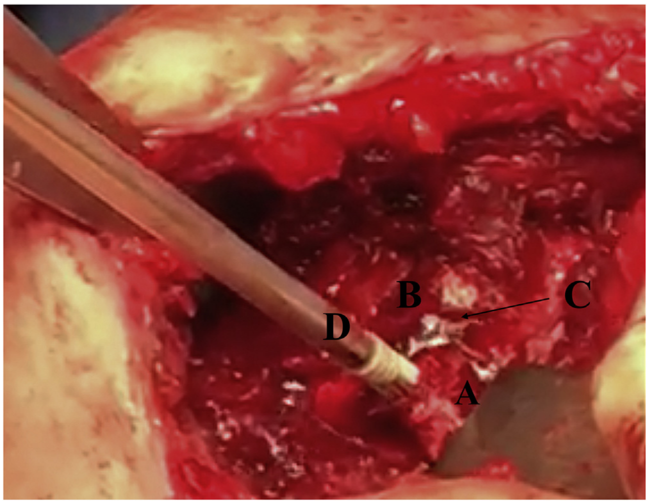

Figure 9. External view, right axilla. A, latissimus dorsi tendon; B, lesser tuberosity; C, 1st anchor; D, 2nd anchor.

the initial working cavity can be done. After this first stage, we search for the biceps at the superior border of the latissimus dorsi muscle (Fig 4) and its division with teres major (Fig 5). Dissection using this muscular plane is carefully done (Fig 6). Fibers of latissimus are tendinous, while on the other hand, the teres major is muscular, making this division evident during the dissection (Fig 7). On some occasions, dissection between the latissimus dorsi and teres major is difficult and demanding.

After the latissimus dorsi release, it is pulled out through the optics portal by using a regular Kocher. If one needs an extra release for more excursion, the portal can be opened more. The tendon is sutured using two no. 2 Maxibraid Sutures (Zimmer-Biomet Warsaw, IN) (Fig 8). One needs to take care the neurovascular pedicle of the latissimus dorsi, avoiding damages during the tendon harvesting.

The upper limb now placed in adduction at an internal rotation, and the surgeon uses a small deltopectoral approach. A grasper passes from the deltopectoral approach to the central portal, and the tendon is pulled to the deltopectoral approach.

The tendon is attached on the lesser humeral tuberosity by using two knotless anchors QuattroLink (Zimmer-Biomet Warsaw, IN) (Fig 9). More details of the procedure are available on the video. Pearls and pitfalls of the procedure are summarized in Table 1. Advantages and disadvantages of the procedure are summarized in Table. 2. Patient is sutured and is left in a sling for 6 weeks.

Table 1. Tips and Tricks

	Pears and Pitfalls
Portals	To have a suitable cavity, a digital subcutaneous release just above the latissimus dorsi needs to reach the biceps and the humerus.
Robotic tendon management	The robotic view allows one to better visualize the limits between latissimus dorsi and teres major, making easier a suitable separation between these structures
Release	Release of the latissimus dorsi needs to be wide to allow its mobilization and careful to avoid lesions to this muscle's neurovascular supply.
Radial nerve	It will be on the roof of the cavity.

Table 2. Comparison of Transfers: Open Versus Endoscopic+Axillary Open to Harvest the Latissimus Dorsi Versus All Endoscopic Versus Robotic

LD transfer to subscapularis	Open	Endoscopic	All Endoscopic	Robotic
Duration	+	+++	++++	++
Exposition	+++	++	+	++
Cosmetic	+	+++	++	++
visualization of LD	+	+	++	+++
Visualization of other structures	+	+	+++	+++

Rehabilitation

A regular sling is used for 6 weeks. Pendular movements and passive elevation until 90° are allowed just 6 weeks after surgery. After removing the sling, active exercises isometric for rotator cuff can begin. In more

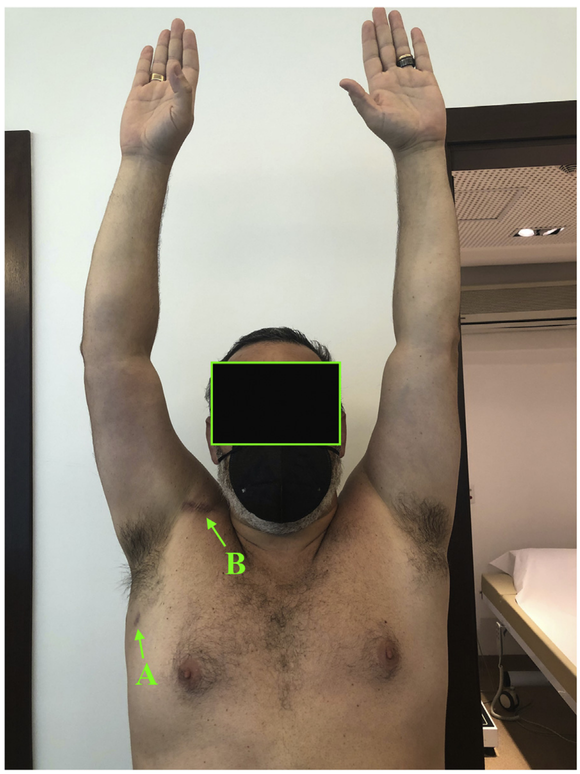

Figure 10. Three months postsurgery, range of motion.

than 2 weeks, isokinetic and proprioception movements begin. Three months after surgery, the patient is allowed free movement with load-bearing restrictions for 3 months more (Fig 10).

Discussion

The subscapularis presents an utmost importance on the shoulder movement and balance. Its irreparable subscapularis tendon lesions or atrophy are not common and difficult to be managed. The traditional treatment uses the pectoralis major and minor transfers; however, reported results have not been satisfactory for internal rotation.[24-28]

It was suggested that once the subscapularis presents an axis more similar and a more similar innervation with the latissimus dorsi, it seems more rational to use the latissimus dorsi instead of pectoralis major to restore the subscapularis function to be as accurate as possible. This configuration can potentially improve vector forces, with evident better dynamic function of the latissimus dorsi over traditional transfers of the pectoralis major.[23]

Traditional approaches for the latissimus dorsi are wide, requiring big incisions with implications for scar formation. Even the axillary approaches are not free of these same complications.

The robotic endoscopic approach, however, can be useful avoiding the skin scar formation. Another advantage is that it provides a good three-dimensional view of the neurologic and other structures, making this procedure much safer. The endoscopic approach can also avoid neurologic complications related with overload of retractors against nerves.

The robot also presents the advantage of 7 degrees of freedom movements, enabling the use of two hands to perform the procedure, making it simpler, faster, and easier than the arthroscopic approach.[21,22]

Previous cadaveric and live patients experience in robotic latissimus dorsi transfer for massive rotator cuff treatment, and accessory nerve lesions were used to establish robotic surgery principles in this Technical Note.[20-22]

The challenge in this procedure was to establish the patterns of portals used into the anterior axillary robotic approach of the latissimus dorsi, allowing its use for subscapularis lesions, once all other robotic approaches for latissimus dorsi were posterior.[17-22]

Limitations of using this technique are the cost of the robot, robotic hands, and its scissors; the necessity of specific training on robotic surgery, which is currently costly and not available in many hospitals; and the requirement for a mini-open approach for suture the latissimus dorsi on the lesser tuberosity. This mini-open necessity may no longer be a problem in the future, with the evolution of the robotic devices and the technique itself.

Risks associated with this technique are similar to those of the open techniques for assessing the latissimus dorsi tendon. This tendon is very near the radial nerve, and therefore, requires care to avoid lesions.

At this moment, surgical time is longer than in the full open procedure; however, this situation tends to improve in time.

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