

Robotic Transfer of the Latissimus Dorsi



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Abstract: Robotic surgery has been used for a long time; it is earning space and its use is expanding in daily medical practice in several surgical specialties, with advantages over traditional surgical methods. This Technical Note presents an endoscopic robotic posterior shoulder approach that allows the surgeon to perform latissimus dorsi transfer endoscopically. This Technical Note describes the use of the da Vinci robot (Intuitive Surgical, Sunnyvale, CA) for transfers related to rotator cuff tears.

Robotic surgery has been used for a long time^{1,2}; it is earning space and its use is expanding in daily medical practice in several surgical specialties, with advantages over traditional surgical methods.^{3,4} Within orthopaedics, we highlight the use of robotics in brachial plexus treatment^{5,6} and neurologic releases.⁷⁻⁹

The association of robotic technology with endoscopy further allowed a faster recovery for the patient with many applications, with a shorter time of hospitalization and minimally invasive approach.¹⁰ The advantages of this method include movement accuracy, high-resolution imaging with 3-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) in which a 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 require a posterior shoulder approach may need aggressive and traumatic exposure with extensive manipulation of soft tissues. The possibility of using a minimally invasive approach can potentially be important for both the timing of rehabilitation and avoidance of local soft-tissue adhesions. In addition, when performing a large posterior open approach, one needs to use tensioned retractors to properly maintain the surgical field. The use of these tensioned retractors can eventually damage the deeper muscle layer as well as other neurovascular structures.^{15,16}

Minimally invasive procedures have shown a decrease in adhesions, avoiding reoperation and physical therapy over a long period. Indeed, this advantage makes these procedures cost-effective.¹⁰

Literature regarding robotic assisted orthopedic surgery is scarce, as opposed to other surgical specialties.¹⁷⁻¹⁹ The use of robotic-assisted surgery 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 was described previously in a cadaveric trial on shoulder surgery.²⁰

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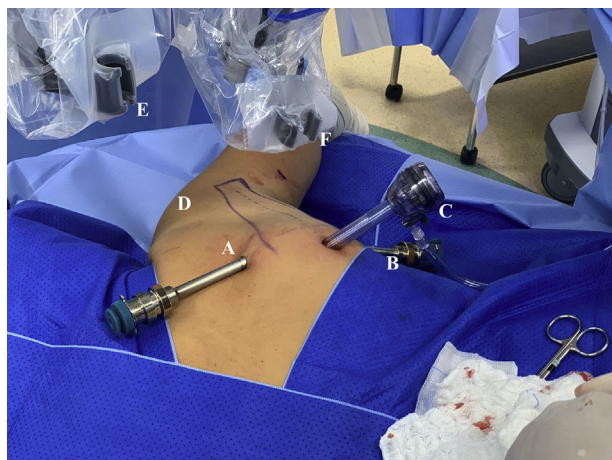


Fig 1. Patient in ventral decubitus position. Right shoulder and thorax. (A, B) Robotic hand trocars. (C) Optics trocar. (D) Shoulder. (E) Robotic exterior hand. (F) Robotic exterior hand for optics.

The visualization and partial manipulation of the latissimus dorsi muscle have already been reported to aid the transportation of the muscular pedicle, with a technique that we used as a reference for our study.¹⁹ Axillary nerve identification has also been described,⁹ making a contribution to our study and confirming the viability of the method. Regarding bleeding, studies in live patients have shown that air insufflation was effective at avoiding it.⁸ This Technical Note is based on a previous cadaveric trial²⁰ and aims to present the use of the da Vinci robot for transfers of the latissimus dorsi tendon to the humeral head; we have performed this technique to treat massive rotator cuff tears in 4 live patients.



Fig 2. A robotic optic of 30° with 2 cameras allows a stereoscopic view.

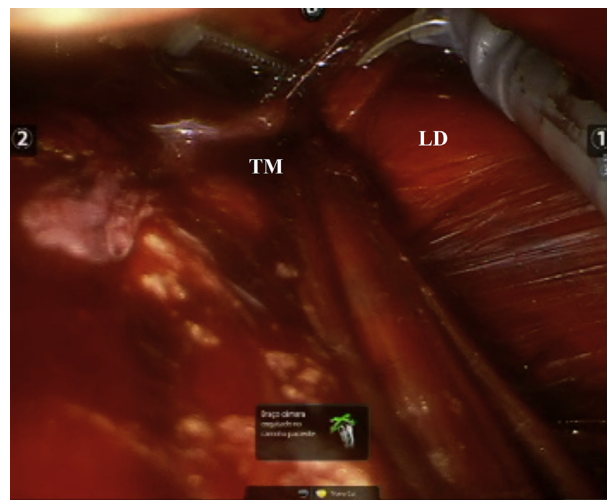


Fig 3. Optics are placed in the central portal. (LD, latissimus dorsi; TM, teres major.)

Indications, Preoperative Evaluation, and Imaging

This procedure has the same indications as traditional open transfer of the latissimus dorsi tendon: patients with massive rotator cuff tears with poor biological characteristics of the tendon. The ideal surgical indications are grade 3 or 4 fatty infiltration according to the Goutallier classification with retraction of more than 4 cm in a patient younger than 60 years presenting with a functional subscapularis tendon. The patient will present with pain, and shoulder elevation and abduction will be difficult or impossible to perform. The younger the patient is, the better the results tend to be.

Surgical Technique

The patient is placed in the ventral decubitus position; the arm is maintained in a position similar to 90° of

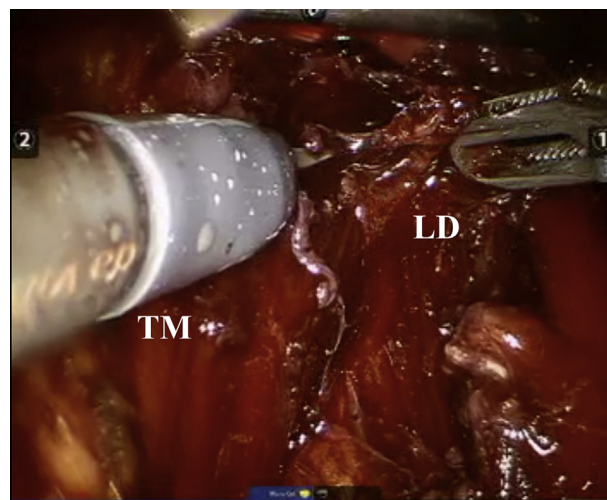


Fig 4. With optics within the central portal, the latissimus dorsi (LD) is released. (TM, teres major.)

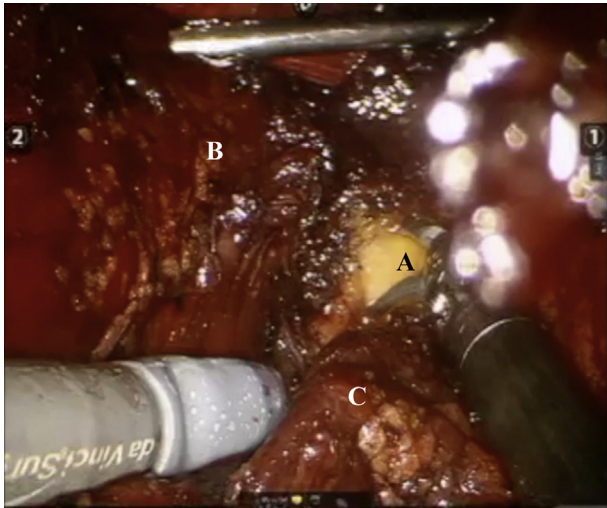


Fig 5. Optics within central portal showing radial nerve (A), teres major insertion (B), and retracted latissimus dorsi (C).

elevation. The inferior border of the latissimus dorsi can be localized by palpation. A drawing of the muscle is made on the skin based on its inferior border and its known anatomy. The central line of the latissimus dorsi is also drawn. A 1-cm incision is made in the skin, 10 to 15 cm from the axilla, to establish the central portal. Two other portals are made 5 to 7 cm perpendicular medial and lateral to the central line. These portals are located 7 to 10 cm from the axilla. The central portal is used to insert the optics, and through the other 2 portals, the robotic hands are introduced to access the muscular fascia, where a cavity is formed through blunt dissection. This space is made for triangulation as an initial working cavity once there are no natural cavities in this region.

A trocar and cannula are introduced into each incision in a common direction in the cavity the surgeon

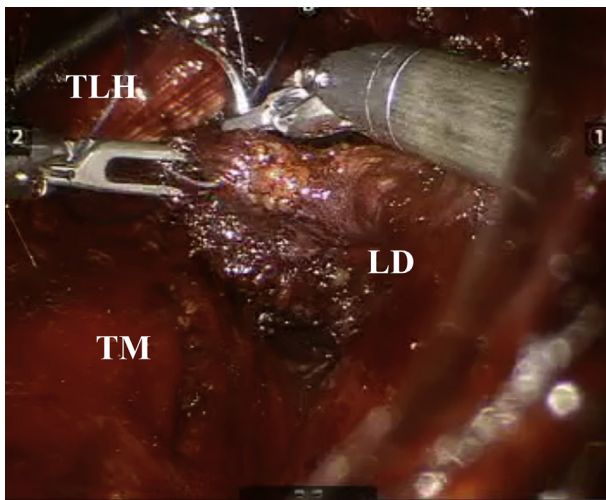


Fig 6. Optics within central portal showing latissimus dorsi (LD), long head of triceps (TLH), and teres major (TM).

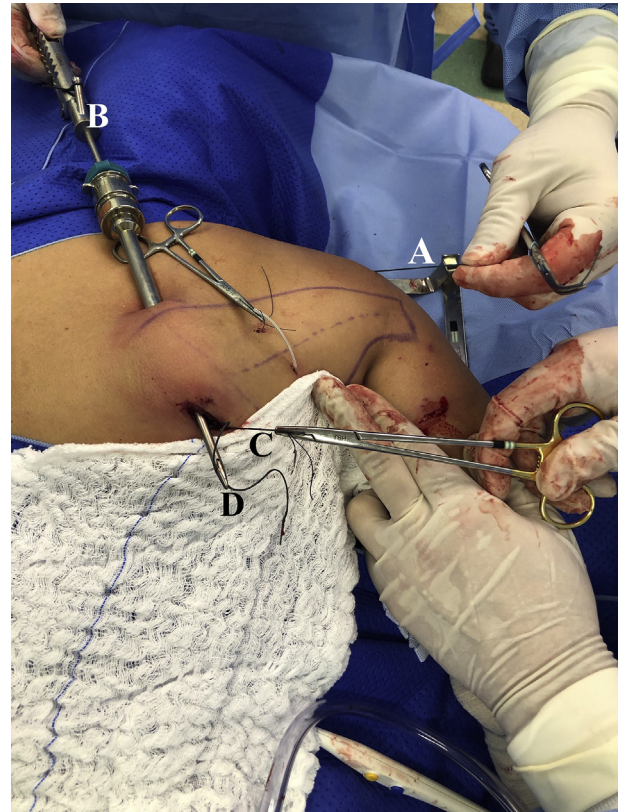


Fig 7. The patient is in the ventral decubitus position; the shoulder and scapular area are exposed. (A) Polyester guidewire through deltoid approach. (B) Gastric forceps. (C) Wires where latissimus dorsi was sutured. (D) Polyester guidewire exit.

created (Fig 1). The camera of the da Vinci SI or Xi robot (Intuitive Surgical, Sunnyvale, CA), with an optic of 30° (Fig 2), is introduced in the first portal on the trapezius.

Carbon dioxide is inflated at a constant pressure of 8 to 14 mm Hg through the chamber portal into the working cavity, stretching the soft tissues and opening the cavity. The robotic arms use Cadieere Forceps (8 mm; Intuitive Surgical) and Hot Shears Monopolar Curved Scissors (8 mm; Intuitive Surgical).

The first objective is to clean the area around the camera so that the best dissection and identification of the initial working cavity are achieved. After this first stage, we search for the superior border of the latissimus dorsi muscle and its division with the teres major. Dissection using this muscular plane is performed until its entrance deep into the medial border of the long head of the triceps (Fig 3).

The latissimus is released and separated from the teres major (Fig 4); the radial nerve is just below the latissimus, and it is possible to visualize it but not required (Fig 5). Care must be taken to avoid damaging the neurovascular pedicle. A No. 0 Vicryl (J318; Johnson & Johnson, São Paulo, Brazil) is inserted by the cephalic

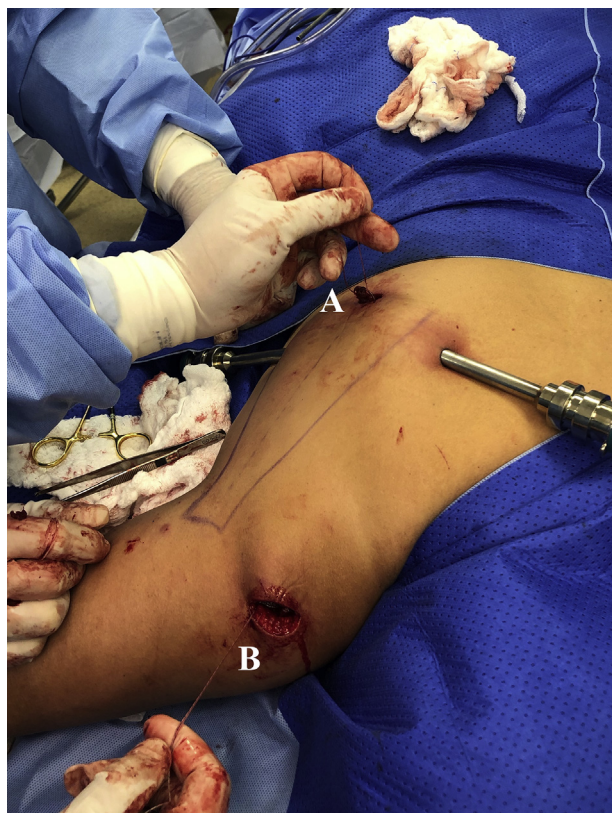


Fig 8. The patient is in the ventral decubitus position; the shoulder and scapular area are exposed. (A) The latissimus dorsi is sutured with suture anchor wires. (B) The other parts of the suture anchor wires are shown; these will pull the tendon to the humeral head.

robotic hand's portal. The latissimus dorsi tendon is sutured by using Cadere and DeBakey Forceps (Intuitive Surgical) (Fig 6, Video 1). The sutured tendon is pulled out of the body through the central portal of the optics using a gastric forceps.

A small 3- to 5-cm incision is made on the lateral deltoid, and by use of a finger, dissection of the subdeltoid space is performed until the cavity created by the robot is reached. A long gastric grasper is inserted through the cephalic robotic hand's portal until it reaches the subdeltoid space. A guide polyester No. 5 wire is passed by using this grasper, leaving the optics portal (Fig 7).

The humeral head is drilled, and 2 anchors are inserted. The anchor wires are passed, through the deltoid approach, to the optics portal using the No. 5 polyester wire as a guide. The tendon is sutured to the anchor wires using Krackow stitches (Fig 8) and is passed to the subacromial space pulled by the anchor wires, and standard tendon-to-bone suturing is performed. More anchors and sutures can be placed after the tendon lies on the humerus' greater tuberosity. The portals and deltoid lateral approach are sutured.

Rehabilitation

A sling is used for 5 weeks. Pendular movements and passive elevation until 90° are allowed 2 weeks after surgery. After this period, active exercises with isometric external rotation and elevation begin. Two weeks thereafter, isokinetic and proprioception movements begin. Scapular retraction and shoulder extension need to be stimulated in the initial movements, once the latissimus dorsi can also be activated during these movements. Better evolution is present in patients with better active movements before surgery.

Pearls and pitfalls of the described technique are summarized in Table 1. Advantages and disadvantages are summarized in Table 2.

Discussion

Traditional approaches for the latissimus dorsi are wide, requiring large posterior incisions with cosmetic and scar-formation implications. Previous cadaveric and live-patient studies were used to establish the principles for the robotic latissimus dorsi transfer presented in this Technical Note. We aim to present a surgical technique that can be improved on and can even be used for other orthopaedic applications with the future introduction of robots, robotic arms, and smaller optics.

Few studies have assessed the latissimus dorsi using the aid of robotics; all of them accessed the muscle and

Table 1. Pearls and Pitfalls

	Pearls and Pitfalls
Robot docking	The da Vinci robot is designed for abdominal exploration; the robot will need to be cephalic with the optics pointed to the central line drawn on the patient's skin.
Movements and subcutaneous dissection	The movements in robotic surgery are different from those in regular endoscopy. Subcutaneous can be better dissected by using horizontal movements of both robotic hands, as usual in robotic surgery, just above the superior portion of the latissimus dorsi and teres major.
Triceps tendon	The triceps tendon tends to be close to the working space; the assistant surgeon within the surgical field can insert the aspirator through the triceps to aspirate blood and help the surgeon open the working space. The best location is chosen by an endoscopic view with a needle.
Radial nerve	The radial nerve is just a few centimeters under the latissimus dorsi; anatomic knowledge of this area and training on a cadaveric model are strongly recommended to avoid neurologic complications.

Table 2. Advantages and Disadvantages Comparing Robotic, Arthroscopic, and Open Surgical Procedures for Latissimus Dorsi Transfer

	Robotic	Arthroscopic	Open
Scarring	Low	Intermediate	High
Tendon visualization	Good	Intermediate	Intermediate
Movement precision	High	Low	Intermediate
Surgical time	Longer	Intermediate	Faster
Cost	Intermediate	More Expensive	Less Expensive
Minimal invasiveness	Less Invasive	Intermediate	Open

the origin of the latissimus for free flaps.¹⁷⁻²⁰ We describe the first in vivo robotic-assisted shoulder surgical procedure performed for transfer of the latissimus dorsi insertion to improve function after a rotator cuff tear. We previously robotically identified the tendon, neurovascular structures, and quadrangular space in cadaveric trials in other trials; thus, the surgical viability and safety of the procedure were previously examined.^{9,20} In addition, other robotic orthopaedic applications in live patients have shown the effectiveness of air insufflation in achieving better bleeding control.⁸

We have shown the viability of the introduction of robotics in shoulder surgery in the hope of encouraging further studies in the area. The limitations of this technique are the cost of the robot, robotic hands, and scissors. The necessity for specific training on robotic surgery, which is currently costly and not available in many hospitals, can also limit its current use. The surgical time is currently longer than that of the open procedure; however, this situation tends to improve in time.

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