Technical Note

Robotic Transfer of the Latissimus Dorsi Associated With Levator Scapulae and Rhomboid Minor Mini-Open Transfers for Trapezium Palsy

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Abstract: Robotic surgery has been used for a long time. With advantages over traditional surgical methods, it is earning space and expanding use to daily medical practice in several surgical specialties. This Technical Note presents an endoscopic robotic posterior shoulder approach using the DaVinci® robot. It can allow the surgeon to perform latissimus dorsi transfer endoscopically and associate it with levator scapulae and rhomboid minor mini-open transfers to treat accessory nerve lesions with trapezium muscle palsy. This technique is an alternative to Eden-Lange and triple-tendon transfer.

Robotic surgery has been used for a long time.[1,2] With advantages over traditional surgical methods, it is earning space and expanding use to daily medical practice in several surgical specialties.[3,4] Within orthopedics, we highlight the use of robotics in brachial plexus and neurologic releases.[5-8] The association of the robotic technology with endoscopy has further allowed faster recovery for the patient, with shorter time of hospitalization and minimally invasive approaches.[9]

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 hand-free camera manipulation.[10-13] In addition, there is the possibility in the future of remote surgery (telesurgery) with which 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 need a posterior shoulder approach may call for aggressive and traumatic exposure with extensive manipulation of soft tissues. The possibility to use a minimally invasive approach can potentially be important for both shortening the duration of rehabilitation and avoiding local soft tissue adhesions. In addition, when performing a large posterior open approach, tensioned retractors are needed to maintain the surgeon's field. The use of these tensioned retractors can eventually damage the deeper muscle layer as well as other neurovascular structures.[14,15] Minimally invasive procedures have demonstrated decreased adhesions, avoiding reoperations and physical therapy in the long term. Indeed, these advantages also make these procedures cost-effective.[9]

In shoulder surgery, robotic-assisted surgery has been 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.[16-18] In a cadaver trial, the latissimus dorsi was identified,[19] and its manipulation to treat massive rotator cuff lesions was performed in some patients. Axillary nerve identification has also been described,[8] making a contribution to the field and confirming the viability of the method. Studies in live patients have shown that the air insufflation has been effective in avoiding bleeding.[7]

This Technical Note is based on previous cadaveric trials[19] and aims to present the use of the DaVinci®

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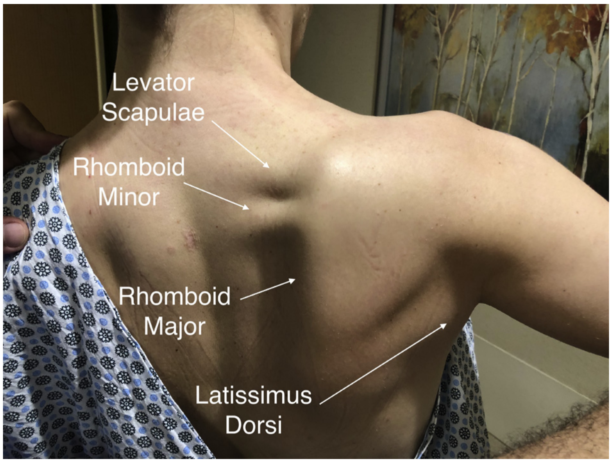

Fig 1. Posterior view of the right hemithorax of a patient presenting with trapezium muscle palsy. Arm in 70° abduction. Patient making forced scapula retraction against resistance.

robot (Intuitive Surgical, Sunnyvale, CA) for endoscopic transfer of the latissimus dorsi associated with mini-open transfers of the levator scapulae and rhomboid minor to treat accessory nerve lesion with trapezium muscle palsy. This procedure is presented as an alternative to Eden-Lange and triple-tendon transfers, which are currently used to treat this condition.

Indications, Preoperative Evaluation, and Imaging

This procedure is indicated for patients presenting with spinal accessory nerve lesions and therefore losing trapezium muscle function. Once the trapezius muscle contributes an important function related to scapular dynamics, its absence will impair the scapular girdle, resulting in pain and other mechanical problems. Patients with this impairment will present with atrophic trapezius muscle and consequent downward drooping of the scapular girdle. Winging scapula is also present, but less than in patients with palsy of the anterior serratus muscle.

Pain can also be present, but it is result of the dynamic compromise of scapula—thoracic articulation. Eligible patients present with functional levator scapulae, rhomboid minor, and latissimus dorsi muscles. For testing levator scapulae and rhomboid minor, the patient is asked to abduct 70° to 90° and rotate the arm axially against resistance (Fig 1). The latissimus dorsi and rhomboid major can also be analyzed using this test.

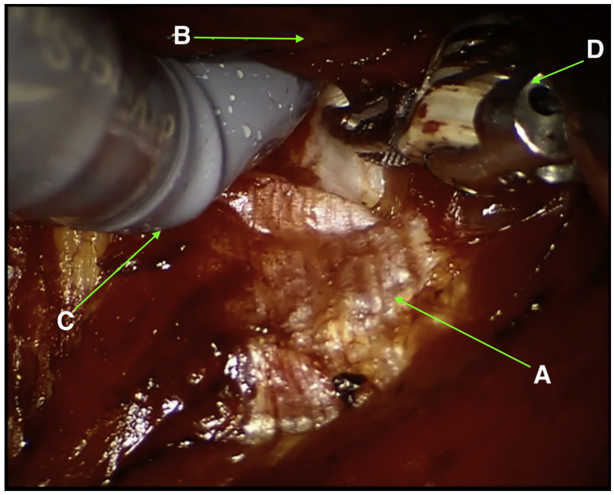

Fig 3. Robotic view, right hemithorax, distal axillary region. (A) Latissimus dorsi tendon. (B) Triceps long head. (C) Robotic scissure. (D) Maryland® bipolar forceps.

Surgical Technique

The patient is positioned in ventral decubitus, the arm being maintained in a position similar to 90° elevation. The inferior border of the latissimus dorsi can be localized by palpation. The muscle is drawn on the skin based on its inferior border and known anatomy. The central line of the latissimus dorsi is also drawn. A 1-cm

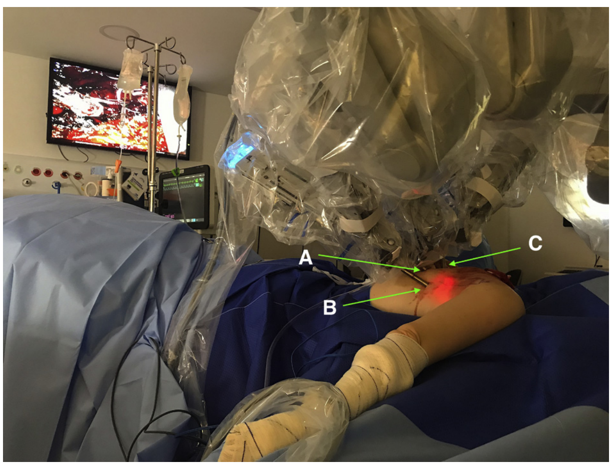

Fig 2. Robot positioning, right hemithorax and upper limb. (A) Central portal (optics). (B) Lateral robotic hand portal. (C) Medial robotic hand portal.

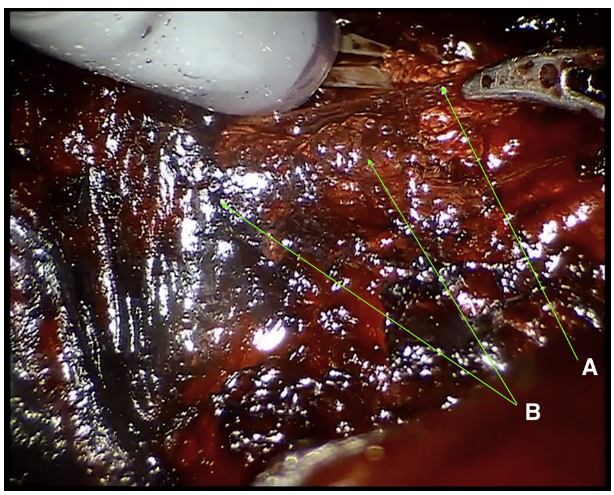

Fig 4. Robotic view, right hemithorax, distal axillary region. (A) Latissimus dorsi tendon. (B) Teres major muscle.

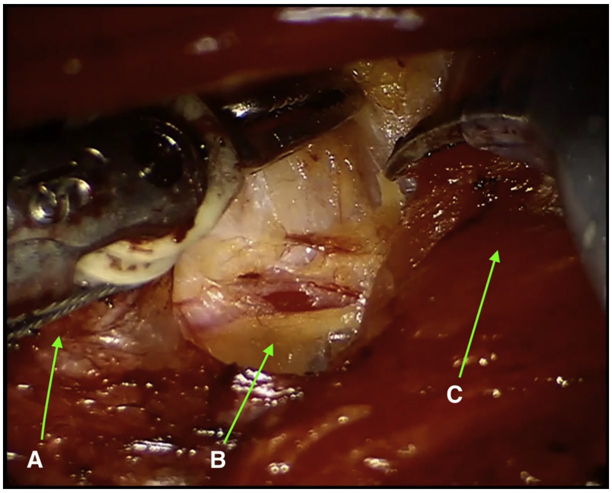

Fig 5. Robotic view, right hemithorax, proximal axillary region. (A) Teres minor. (B) Quadrangular space. (C) Teres major.

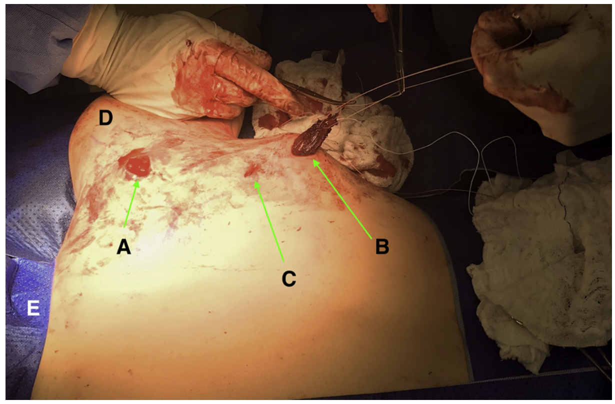

Fig 7. Posterior view, right hemithorax. (A) Approach over the scapular spine. (B) Latissimus dorsi through the central portal (small augmentation needed to provide space to the latissimus). (C) Lateral robotic hand portal. (D) Right shoulder. (E) Neck.

incision is made in the skin, 10 to 15 cm from the axilla, for the central portal. Two other portals are made 5 to 7 cm perpendicular medially and laterally to the central line. These portals are located 7 to 10 cm from the axilla. The central portal is used to insert the optics; 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, as there are no natural cavities in this region.

A trocar and a canula are introduced into each of the incisions, in a common direction in the cavity. In the first portal over the latissimus dorsi, the camera of the DaVinci® SI or Xi robot is introduced, with an optic of 30° (Fig 2). Depending on position and necessity, near the axilla, a 0° optic is generally required instead.

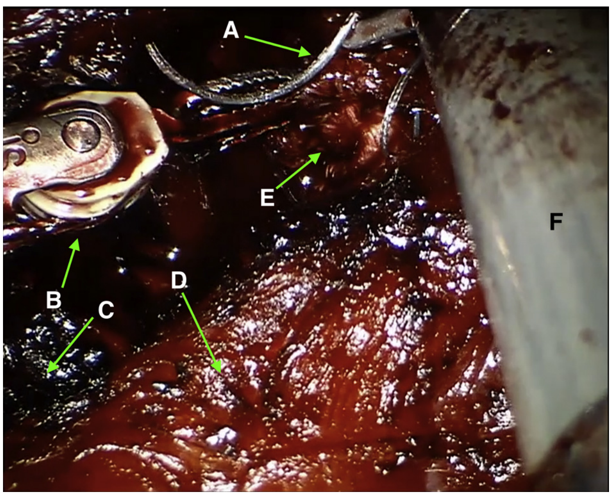

Fig 6. Robotic view, right hemithorax. (A) Ethbond® needle. (B) Maryland® forceps. (C) Teres major muscle. (D) Latissimus dorsi muscle. (E) Sutured latissimus dorsi tendon. (F) Large Needle Driver®.

Carbon dioxide is inflated at a constant 8 to 14 mmHg through the central portal into the working cavity, stretching the soft tissues and opening the cavity. The robotic arms use a Maryland® bipolar forceps 8 mm (Intuitive Surgical) and 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 is to clean the area around the camera for best dissection and identification of the initial working cavity. After the first stage, the superior border of the latissimus dorsi muscle is found, and its division with teres major. Dissection using this muscular plane is performed until it enters deep into the medial border of the long head of the triceps and tendinous tissue is visualized (Fig 3).

The latissimus dorsi is released and separated from the teres major (Fig 4). It is important to maintain tension on the latissimus dorsi tendon during its release; if it does not have traction, the scissor cannot suitably cut the tendon. The radial nerve is just below the latissimus, and it is possible but not required to visualize it. The quadrangular space is found by dissecting upward (Fig 5), but it is not required.

Care must be taken not to damage the neurovascular pedicle. 2-0 Ethibond Excel® (Johnson & Johnson, São Paulo, Brazil) is inserted by the cephalic robotic hand's portal. The latissimus dorsi tendon is sutured by using a Maryland and a Large Needle Driver® 8 mm (Intuitive Surgical) (Fig 6; Video 1). The sutured tendon is pulled out of the body through the central portal of the optics (Fig 7).

A small 5-cm incision in the sagittal plane is made just above the superomedial border of the scapula. The atrophic trapezium muscle is found and incised. Under this muscle, the superomedial border of the scapula and the levator scapulae muscle are found. Points of continuity are maintained with the rhomboid minor; however, they

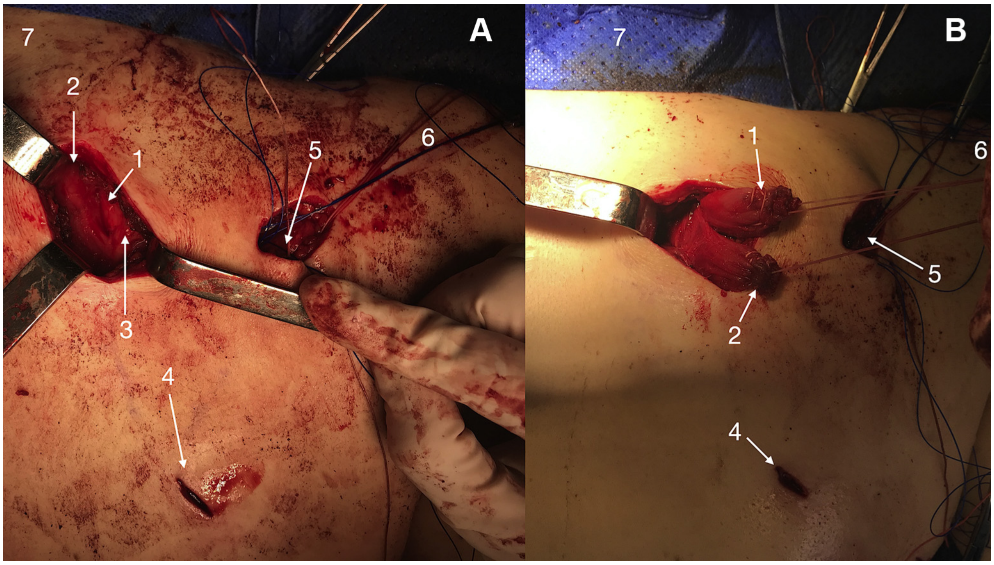

Fig 8. Posterior view, right hemithorax. (A) Before levator scapulae and rhomboid minor release. (B) After levator scapulae and rhomboid minor release. (1) Levator scapulae. (2) Rhomboid minor. (3) Superolateral scapula border. (4) Lateral robotic hand portal. (5) Approach to scapular spine. (6) Shoulder. (7) Neck.

can be easily split by following their fiber directions. A small portion of the scapular bone is kept in the final position of the released levator scapulae and rhomboid minor tendons to improve healing.

The rhomboid major stays in its original insertion with its function untouched. A small 5-cm incision in the axial plane is made just above the scapular spine medial to the original insertion of the trapezium (Fig 8). the scapular spine is exposed, and latissimus dorsi, levator scapulae, and rhomboid minor are subcutaneously transferred (Fig 9). The patient is sutured.

Rehabilitation

The patient wears an abduction sling with double pillow for 6 weeks. Pendular movements and passive elevation to 90° are allowed 6 weeks after surgery. After removal of the sling, active exercises isometric for the scapular girdle begin, with elevation, depression, retraction, and protraction. After 2 more weeks, isokinetic and proprioception movements begin. Patients with better active movements before the surgery have better outcomes. Pearls and pitfalls are summarized in Table 1.

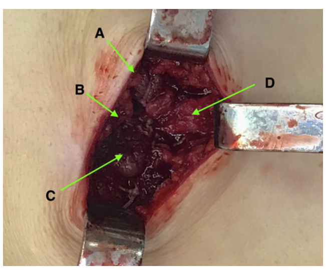

Fig 9. Posterior view, right hemithorax. (A) Levator scapulae. (B) Rhomboid minor. (C) Latissimus dorsi. (D) Scapula spine.

Discussion

Traditional approaches for the latissimus dorsi are broad, requiring big posterior incisions with implications for cosmetic results and scar formation. Previous experience in cadaveric and live patients with robotic latissimus dorsi transfer for massive rotator cuff treatment was used to establish robotic surgery principles and portals used in this Technical Note.[19,20]

Even the single-incision treatments for trapezius palsy have presented with broad approaches.[21] Elhassan and Wagner[22] published a case series of triple-tendon transfer, as an Eden-Lange. Their study resulted in improved vector forces, with evident better dynamic function of the scapular girdle, and therefore better outcomes.[22] However, this improvement lacks a cosmetic approach.

Studying the force vectors of the trapezium, we suggest that the latissimus dorsi can be a good option to

Table 1. Pearls and pitfalls

	Pearls and Pitfalls
Robotic tendon management	The tendon's cut needs tension on the latissimus dorsi; If it is not under suitable tension, the robotic scissor will not be as effective.
Release	Release of the latissimus dorsi needs to be wide to allow its mobilization. and care must be taken to avoid lesions to this muscle's neurovascular supply.
Subcutaneous	Subcutaneous cavities need to be suitable for both robotic assessment and minimally invasive transfers.
Levator scapulae and rhomboid minor	Sometimes differentiation of these muscles is not easy; one can follow the muscular fiber lines for better understanding.

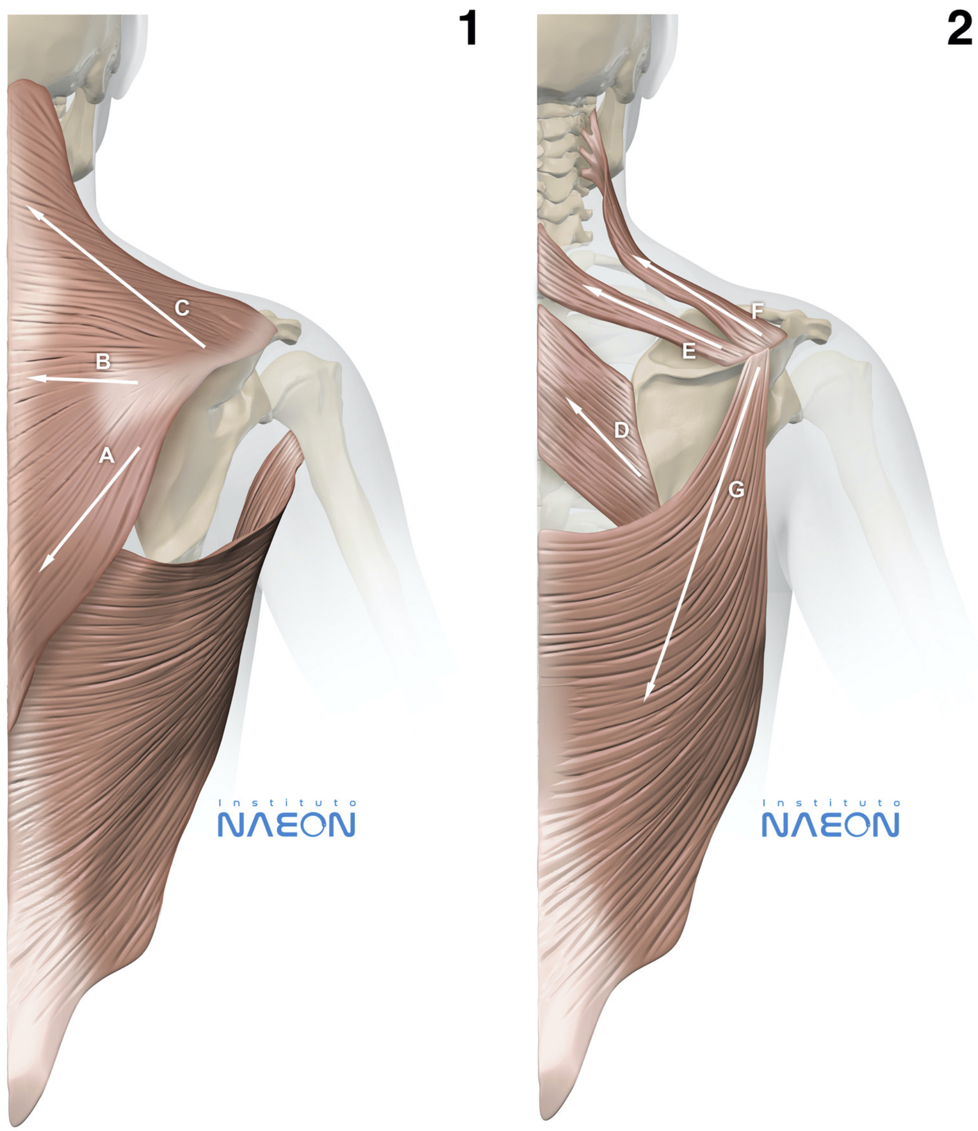

Fig 10. (1) Trapezium force vectors. (A) Lower. (B) Middle. (C) Upper. (2) Force vectors of transferred muscles. Rhomboid major was not transferred, keeping its original force vector. (D) Rhomboid major. (E) Transferred rhomboid minor. (F) Transferred levator scapulae. (G) Transferred latissimus dorsi.

restore the lower trapezium function and vector. The upper and middle trapezium's functions can be respectively replaced by the levator scapulae and rhomboid minor, but by using mini-open approaches. The rhomboid major can remain in its original position to provide better scapular retraction, keeping one of the strongest scapular retractors in its original position and function (Fig 10). Dorsal scapular nerve anatomy needs to be respected and its integrity is mandatory to achieve better results in this and other procedures.[23]

The idea of using latissimus dorsi instead of rhomboid major with less scar formation is possible because of the robotic approach. It is less invasive and potentially mitigates harm related to traditional open approaches.

The latissimus dorsi also seems to present a better force vector, closer to the lower trapezium's vector, working

Table 2. Comparison of robotic LD + Minimally Invasive LS & RMi

	Robotic LD + Minimally Invasive LS & RMi	Triple-Tendon Transfer	Eden-Lange
Surgical time	Higher	Moderate	Lower
Force vectors	Better	Good	Worst
Size of approach	Small	Wide	Wide
Minimally invasive	Yes	No	No
Price	More expensive	Less expensive	Less expensive

as a scapular depressor and retractor (Fig 10). The role of the transferred latissimus dorsi on the scapular rotation seems to be also similar to that of the native lower trapezium. During elevation, the instantaneous center of the scapular rotation runs from medial to lateral; therefore, the transferred latissimus dorsi will be an internal rotator on lower degrees of elevation and become an external rotator on higher degrees of elevation. It seems to be an advantage over other previous techniques, as the rhomboid major transfer seems to be related more to scapular retraction then rotation or depression.[21,22]

Limitations of this technique are cost of the robot, robotic hands, and scissors, as well as the necessity of specific training on robotic surgery, which is currently costly and not available in many hospitals. Risks associated with this technique are similar to those of open techniques for assessing the latissimus dorsi tendon. This tendon is very near the radial nerve, and care is needed to avoid lesions. Right now, surgical time is longer than for the full open procedure; however, operating time will improve (Table 2).

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