Successful Restoration of Elbow Extension Using the Latissimus Dorsi Flap: Case Report

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Summary: The latissimus dorsi (LD) myocutaneous flap is heavily used in reconstructive plastic surgery as either a local or distant flap, and mostly for coverage of large defects. To date, only a limited number of studies have described the use of an LD flap for functional reconstruction. Restoration of the extensor mechanism remains an unexplored area, and several issues remain to be addressed. First, generally accepted recommendations for the surgical technique do not include specific steps to achieve functional qualities of the upper extremity after complete removal of the triceps brachii muscle. Second, to date, it has not been clarified whether elbow extension requires correction because the movement can be naturally compensated for by gravity. To contribute to the current knowledge base in this field, the authors describe a technique for the reconstruction of an extensor mechanism of the elbow by transferring a pedicled functional LD flap while maintaining an intact insertion. Reconstruction was performed in a patient who experienced a second recurrence of a malignant peripheral nerve sheath tumor and underwent complete excision of the triceps brachii muscle. After excision, a meshed epidermal graft was used for wound closure. The patient’s postoperative course was uneventful. His elbow was immobilized for 3 weeks using an elbow splint, followed by intensive rehabilitation. The functional result was excellent, with an Enneking limb function score of 26. During the 16-month follow-up, no signs of local recurrence or systemic spread were observed. (Plast Reconstr Surg Glob Open 2022;10:e4121; doi: 10.1097/GOX.0000000000004121; Published online 15 February 2022.)

Sarcomas of the upper extremities account for approximately 15% of all sarcomas. Patients with suspected sarcoma should be referred to specialized sarcoma centers. The first treatment option is usually the most important and radically affects the final result. Complex care in a sarcoma center(s) results in better outcomes, which have been previously confirmed in terms of greater local control of the disease and overall survival.1 If there is a high risk for amputation or nonradical resection, neoadjuvant modalities, such as chemotherapy, radiotherapy, or isolated limb perfusion, must be incorporated into the treatment strategy.2

Limb-sparing surgery has become the mainstay of treatment for sarcomas of the extremities. In most cases, wide excisions or partial compartmental resections are possible, with only minimal impact on the function of the upper extremity. Cases in which the triceps muscle requires complete resection but the limb is preserved are extremely rare. We conducted a comprehensive review of the literature addressing latissimus dorsi (LD) flap reconstruction. Keywords used in the search included “LD flap,” “function,” “restoration,” and “flexion/extension.” Only peer-reviewed studies published in indexed, international, English-language journals up to April 2021 were reviewed. Databases used for the search included Medline/Pubmed, Scopus, and Web of Science. To our knowledge, there are no systematic recommendations regarding operative techniques. Previous studies largely differ in multiple aspects, such as indication, extent of resection, and type of reconstruction using the LD flap. It has not been clarified whether elbow extension requires correction because the movement can be naturally compensated for by gravity. Active extension is necessary in many activities of daily living, such as rising from sitting, and for those who work overhead, and patients who use their upper extremities

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Received for publication May 18, 2021; accepted December 14, 2021.

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DOI: 10.1097/GOX.0000000000004121

Disclosure: The authors have no financial interest to declare in relation to the content of this article.

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for mobilization and transfers. Restoration of extension in the elbow is, therefore, as valuable as flexion; therefore, we attempted to restore triceps function using the LD flap.

CASE REPORT

A case involving a 47-year-old male patient who experienced a second local recurrence of a malignant peripheral nerve sheath tumor in his right arm is presented. The patient underwent his first wide excision of a superficially (epifascially) localized tumor in May 2017 at another medical facility. He received adjuvant radiotherapy at a dose of 70 Gy; however, local recurrence was observed. At the same facility, he also underwent a second nonradical surgical excision with macroscopic residue before being referred to the authors’ sarcoma center. Standard staging procedures were also performed. Magnetic resonance imaging of the right upper arm revealed a tumorous expansion, measuring 90 × 60 × 40 mm in size, infiltrating the triceps brachii muscle, and having intimate contact with the humerus without signs of edema or destruction of the bone. A certain level of suspicion was generated by the presence of radial nerve involvement (Fig. 1). Metastatic spread of the disease was excluded based on computed tomography results. Physical examination of the patient revealed normal findings regarding sensitivity and motor function of the upper arm. As such, the patient was indicated to undergo limb-sparing surgery and reconstruction using an LD flap.

The LD flap was first described by the Italian surgeon Iginio Tansini in 1906. Since the 1970s, it has been used in various applications, including breast reconstruction after mastectomy, subtotal scalp and cranium defect reconstruction, coverage of large soft tissue injuries around the elbow, and restoration of upper-extremity function. A recent study by Sood et al described a case of LD flap reconstruction of a soft tissue defect. In this study, the authors also performed an operative technique after extirpation of an upper extremity sarcoma. However, in this case, the patient required an elbow replacement, and the LD flap served mostly as coverage for the osteosynthesis rather than a functional replacement of the missing muscle.

Patient and Surgical Methods

To optimize surgical outcome, several aspects were considered before and during surgery. First, muscle strength decreases after transfer. Therefore, some authors have suggested performing LD transfer only if the patient is able to adduct the arm against resistance. Second, a postoperative overtake of the flexors after resection can be expected; thus, proper tensioning of the muscle is critical.

A compartmental resection of the triceps brachii muscle was performed during the first phase of the operation. The patient was positioned prone with adduction in the right arm. The surgery began with wide excision of the previous scar, skin, and subcutaneous tissue, together with two small satellite tumorous expansions. The entire extent of the triceps muscle was also identified. Using electrocautery, the long head of the triceps brachii was released from its origin on the infraglenoid tubercle of the scapula. The lateral and medial heads of the triceps brachii were released from their origins in the humerus. The triceps brachii insertion on the olecranon was divided into the tendinous portion of the muscle. During the operation, the radial nerve was identified and dissected free from the tumor (Fig. 2).

In the second phase, reconstruction using a pedicled functional LD flap was performed. A curvilinear incision, running from the posterior axillary fold to the midpoint of the iliac crest with a skin paddle, was used. The flap was freed from its lateral, medial, and distal borders. The muscle was detached from the underlying muscles in a distal-to-proximal direction with ligation of the secondary blood supply to the muscle. It is crucial to avoid harming the neurovascular pedicle in the proximal third of the muscle. The thoracodorsal arteries, veins, and nerves were dissected. The vascular branch of the serratus anterior

Fig. 1. Preoperative MRI finding. MRI of the right upper extremity with visible main portion of the tumor of the triceps brachii. A, axial plane; B, coronal plane.
muscle was ligated. The insertion on the floor of the intertubercular groove of the humerus was kept intact. The flap was then passed through a subcutaneous tunnel on the posterior arm to replace the triceps muscle. Its origin was sutured to the tendinous residue of the triceps brachii muscle on the olecranon, with 60 degree flexion in the elbow (Fig. 3) using multiple #1 nonabsorbable sutures (NUROLON Polyamide 66, Ethicon, Cincinnati, Ohio).

The authors experienced good results with this type of suture in their previous reconstructions in different locations, such as restoration of quadriceps muscle function by a hamstring transfer. This suture is sufficiently strong and safe, with minimal risk for complications. In addition, the quality of the sutured tissue was excellent. Therefore, a decision was made not to drill through the bone. Wound closure was performed using a meshed skin graft 1:1.5 and vacuum therapy.

A definitive histological examination confirmed the presence of a malignant peripheral nerve sheath tumor. All tumorous nodules consisted of uniform fascicular spindle cells. The lesions were mitotically active. Sections of ischemic necrosis were identified in the tumors. Immunohistochemistry revealed positivity for marker S100 and was negative for CD57, CD34, desmin, SMA, EMA, and CK-AE. The KI-67 proliferative index was 20%.

No postoperative complications were observed. The elbow was immobilized using an elbow splint. Three weeks after surgery, assisted active flexion rehabilitation was initiated. In the ensuing 3 weeks, assisted extension of the elbow was primed. Six months after the operation, the range of movement in the elbow was 15–130 degrees. (See Video [online], which shows the range of movement in the elbow.) The Enneking limb function score was 26. At the multidisciplinary sarcoma board, the possibility of adjuvant radiotherapy was ruled out because of previous 70 Gy radiotherapy after the first surgery. The patient was considered to be at high-risk for disease relapse. For this reason, he is being closely followed using magnetic resonance imaging of the upper extremity and computed tomography of the lung every 4 months. During the 16 months of postoperative follow-up, the patient remained without signs of local recurrence or systematic spread.

**CONCLUSIONS**

The LD flap is widely used in reconstructive plastic surgery. It is an excellent source of muscle tissue that can be used in single-stage reconstructions. Due to the long vascular pedicle, large range, and rotation around the neurovascular bundle, it can be used for soft-tissue coverage and for restoration of the movement of the upper extremity in various oncological or non-oncological indications. Several studies have described the use of an LD flap for quadriceps muscle reconstruction. The muscle is expendable. There is minimal morbidity associated with the loss of this muscle. Most current studies discuss LD use in the upper arm for the coverage of large defects, or for functional restoration of flexion in the elbow. Regarding elbow extension, most of the data collected have been from tetraplegic patients, in whom procedures such as the deltoid muscle into the triceps and biceps muscle into the triceps transfer are described. These procedures are efficient but require the presence of the triceps muscle. We describe our successful approach to preserve elbow function after radical oncological surgery, which included extirpation of the triceps brachii muscle and excision of a significant amount of skin and the underlying tissue, leaving a huge defect. Only a few reports have described the restoration of elbow extension...
after complete removal of the triceps muscle.13,14 These rare case reports differ in various respects. Landra et al13 described a traumatic loss of extension in the elbow, with a fracture of the elbow, loss of skin, and loss of the distal third of the triceps and its tendon. This case was complicated by infection and necrosis. The authors rolled the origin of the LD upon itself for better fitting to the defect. Unfortunately, this is a short report in which the extent of the lost muscle tissue and operation technique is not presented with sufficient details. This study also had no follow-up; therefore, it could not evaluate any short- or long-term results. Pruzansky et al14 used the LD flap after resection of the triceps and deltoid muscles. The operative technique included dissection and repositioning of the origin and tendon of the LD.

The present report describes a resection of the triceps muscle while maintaining an intact insertion. Compared with the study by Pruzansky et al,14 we achieved a wider range of elbow movement (115 degrees versus 95 degrees) but the same strength. However, the authors provided only these two study endpoints with no additional data regarding clinical follow-up of the patients. To provide a complex overview of the efficacy of our surgical approach, we assessed our results using the Enneking score indicator.

To our knowledge, there is no uniform recommendation regarding operative techniques. Previously published case reports vary widely in several details, such as indication, extent of resection, and type of reconstruction with the LD flap. Therefore, providing sufficient guidelines has become a significant challenge. Under specific circumstances, a wide excision of the muscle with preservation of at least some muscle tissue should be performed. Limb-sparing surgery should not be performed in cases in which oncological radicality is affected. In addition, the risk for altering limb function must be considered. Currently, more data are urgently needed to determine optimal functional results. These data should define the most suitable candidates for reconstruction using the LD flap, and for the evaluation of the necessity of dissection of the insertion in these patients. Other aspects of the surgical procedure, such as proper tensioning of the muscle, selecting an optimal angle of the elbow during the muscle suture, defining the need for drilling through the bone, or the use of suture anchors, need to be further clarified.

In addition, the extent of postoperative care and rehabilitation needs to be assessed. All of these aspects can influence the final result. Moreover, there are currently no studies comparing LD transfer with other muscle transfers for the restoration of elbow extension.

The LD flap has several clinical benefits. Not only can function be restored, which is the main goal, but it can also cover huge defects after resection, providing a good contour of the arm. Due to the preservation of the neurovascular bundle, microsurgical reconstruction is not required. Most importantly, the use of an LD flap decreases surgical duration and the risk for postoperative complications and enables faster rehabilitation with restoration of elbow motor function. Collectively, the procedure performed in our patient yielded satisfactory oncological, functional, and aesthetic outcomes.

In our case, LD was a reliable method to restore elbow extension after complete removal of the triceps muscle. The patient is capable of extending the elbow against resistance with no limitations to the activities of daily living.

Our study, however, had several limitations, the first of which was that it was a case report describing a single patient undergoing a novel surgical approach. We did not observe any complications; therefore, our study lacks evaluation and treatment guidelines for the potentially complicated postoperative course. In addition, our patient has currently been followed up for only 16 months; as such, more prospective data are needed, especially in terms of long-term LD flap function and disease recurrence. Finally, only two previous case reports have described minimal correlations with our novel surgical approach; thus, the extent of the discussion is limited in the context of various reliable sources.

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