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Successful Elbow Flexion Reconstruction Using Latissimus Dorsi Muscle Transfer Following a Road Traffic Accident and Upper Limb Trauma

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Statistical Analysis C
Data Interpretation D
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Patient: Male, 30-year-old
Final Diagnosis: Biceps brachii muscle necrosis
Symptoms: Impaired elbow flexion
Medication: —
Clinical Procedure: —
Specialty: Orthopedics and Traumatology • Plastic Surgery

Objective: Rare disease

Background: Several surgical procedures to restore elbow flexion have been reported in the literature. Multiple factors direct the selection of appropriate procedures for each patient, including hand dominance, neurovascular injury, and comorbidities. Traumatic damage to the anterior compartment of the arm is an indication for latissimus dorsi transfer, which can restore elbow flexion. Bipolar pedicled latissimus dorsi (LD) flap is a design used very rarely to simultaneously reconstruct biceps brachii soft-tissue defects and regain complete flexion function. We report the case of a 30-year-old man who underwent successful elbow flexion reconstruction using latissimus dorsi muscle transfer following a road traffic accident and upper limb trauma.

Case Report: A 30-year-old man presented with acute compartment syndrome caused by a road traffic accident and impact trauma to the left arm. The surgical evaluation revealed proximal biceps tendons rapture; therefore, immediate repair and therapeutic fasciotomy were done. Subsequently, unsuccessful repair resulted in total necrosis of the biceps muscle, which necessitated debridement of the biceps muscle. Delayed reconstruction with an LD flap was successfully done after stabilization of the patient's condition. The flap was harvested as free-pedicled, then modified into a tube-like shape to resemble the biceps muscle.

Conclusions: This report has shown that the surgical procedure of latissimus dorsi muscle transfer can successfully restore elbow function following upper limb trauma; however, preoperative planning and postoperative follow-up are crucial for functional reconstruction of the upper extremity. In addition, carefully selecting reconstructive surgery considering patient factors, degree of injury, and the institution's capacity are essential factors in achieving optimal function restoration with minimal complications.

Keywords: Activities of Daily Living • Compartment Syndromes • Elbow Joint • Surgical Flaps • Superficial Back Muscles • Case Reports • Elbow • Upper Extremity

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Background

The anatomy of the upper limb makes it one of the most challenging and complex structures in the human body [1]. Elbow flexion is an action directed by many muscles; the biceps brachii is responsible mainly for elbow flexion and supination of the forearm. The musculocutaneous nerve enervates the biceps brachii [1].

Elbow flexion loss can be debilitating and limit activities of daily living (ADL). Generally, many factors affect the performance of ADL, such as age, gender, hand dominance, and functional angle of a joint. Elbow flexion requires a higher flexion angle (≥135°) to perform half of the ADLs [2]. One of the main factors influencing a surgeon's choice of surgical procedure is the degree of tissue injury. Several options for reconstruction and restoration of elbow flexions have been reported, such as pectoralis major transfer, Steindler flexorplasty, unipolar or bipolar transfer of latissimus dorsi, triceps to biceps transfer, pectoralis minor transfer, and sternocleidomastoid transfer [3].

Elbow flexion impairment can be due to brachial plexus injury, injury to the musculocutaneous nerve, and trauma or infection of the anterior compartment of the arm. Latissimus dorsi muscle transfer allows a surgeon to fabricate and design it for multiple applications. Zancolli has discussed the use of bipolar latissimus dorsi transfer and the advantage of achieving active flexion up to 120 degrees and better muscle power compared to other procedures [4].

Several authors emphasized the need for a multidisciplinary approach and case-by-case selection of the surgical procedure [5-7]. Preoperative assessment of the latissimus dorsi flap is not a routine practice. However, evaluating the muscle flap beforehand is crucial, as this muscle will replace soft-tissue defects and restore function [8]. A free gracilis flap has been used to restore the elbow flexion, receiving nerve innervation from either the intercostal or spinal accessory nerves [9].

There are no specific guidelines on how to restore the function of elbow flexion; it depends mainly on the etiology of the trauma and the diagnosis. However, similar surgical techniques were previously reported to manage varying presentations and degrees of tissue loss [8].

Traumatic damage to the anterior compartment of the arm is an indication for latissimus dorsi transfer, which can restore elbow flexion. Here, we present a case of a 30-year-old man who underwent successful elbow flexion reconstruction using latissimus dorsi muscle transfer following a road traffic accident and upper limb trauma.

Case Report

A 30-year-old man presented to the Emergency Department with traumatic injury to the upper limb secondary to a road traffic accident. Initial trauma evaluation was done at another hospital and revealed crush injury with an open wound to the upper limb (arm) without fractures. Sensory examination in the periphery was diminished, and the whole limb appeared swollen. Intercompartmental measurements of the forearm were high. Surgical exploration showed avulsion injury of the biceps muscle from its origin with a muscle tear, and no other injuries were noted. The patient underwent immediate surgical repair of the biceps muscle and fasciotomy of the arm and forearm. Three days later, increasing creatine kinase (CK) level necessitated a second surgical exploration, which revealed total necrosis of the biceps muscle. Debridement of the muscle was done, and after stabilizing the patient's condition, he was discharged with wound care instructions. At follow-up, the patient's forearm supination was entirely lost, and elbow flexion was limited to 90 degrees only. Three weeks from the initial trauma, we decided to perform a latissimus dorsi muscle transfer to restore elbow flexion function. Physical rehabilitation and training programs focusing on elbow mobilization started after the reconstructive surgery. The patient successfully achieved full supination and elbow flexion more than 120 degrees after 4 months of physiotherapy (**Figure 1**).

Surgical Technique

First, the muscle was located as part of preoperative planning. Then, the incision border was marked with an incorporated skin paddle to monitor the flap postoperatively. It was placed 10 cm distal to the axillary fold and was 4 cm wide. We began the procedure by positioning the patient in lateral decubitus position, making incisions as planned. During initial dissection, the flap was fixed to the underlining fascia to prevent shearing forces, and resting muscle tension was measured. Next, the muscle flap was mobilized, and the thoracodorsal pedicle was dissected and freely mobilized. Then, the flap was designed in a tubular shape and passed to the anterior arm. The proximal part of the flap was attached to the coracoid process, and the distal part was fixed to the bicipital tendon.

Discussion

We successfully used a latissimus dorsi flap to replace the volumetric loss of biceps muscle and to restore elbow flexion. There are multiple surgical techniques used to restore active elbow flexion. Functional transfer of the pectoralis muscle was used in war injuries, as described by Ghahremani et al [10]. Multiple modifications were implemented to reach the goal of restoring elbow flexion. The pectoralis major flap was combined

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Figure 1. Preoperative and postoperative images of elbow flexion. (**A**) Demonstrating the maximum elbow flexion of the patient. At this point, the patient's biceps muscle was completely debrided (preoperative). (**B**) Four-month follow-up after reconstruction of the elbow with latissimus dorsi flap. Notice elbow flexion with more than 120° with the hand reaching to the oral cavity (postoperative).

with tensor fascia lata as an interposition graft [11]. Steindler flexorplasty, transferring the pronator-flexor muscles group, has also been assessed and revised with several modifications [12]. Triceps muscle transfer can be done without sacrificing elbow extension independence, which is achieved by transferring the long head of the triceps as a pedicled flap [13,14]. Free muscle transfer has been commonly used to reconstruct elbow flexion with brachial plexus injuries [15,16]. Since our patient had an intact brachial plexus and was a suitable candidate for LD flap, to avoid the complications of the free flap, free muscle transfer was not performed.

Upper arm injury and the loss of elbow flexion can be challenging to reconstruct back to the usual upper limb's physiological function and for the patient to resume ADL. Latissimus dorsi flap was one of the first functional musculocutaneous tissue transfers used to restore upper extremity function, including elbow extension [17] and flexion [4]. In our patient, there was a substantial volumetric defect that needed coverage; therefore, the pedicled LD flap was a suitable choice to fill the defect site and a reliable muscle to handle elbow flexion movement. Furthermore, since this surgery was not designed as a free flap, it had a short recovery time with minimal possible complications compared to a free flap.

We reviewed recent cases in the literature with a similar surgical procedure. Etiologies and outcomes are summarized in **Table 1** [6,18-21].

Since the development of this surgical technique, the outcomes have been variable, and it has been noted that preoperative assessment of the LD muscle plays a significant role in prognosis [22]. Many surgeons used this technique to restore elbow flexion, considering evaluating the LD muscle before surgery, and most of them reported a good result in active ROM [23,24]. Harvesting the flap with a skin paddle will allow for flap monitoring postoperatively [8].

One of the disadvantages of the LD flap is the risk of donor-site morbidity, including the possibility of developing functional impairment at the shoulder level [25]. However, it has been shown by prospective cohort studies that there is no significant difference between patients who underwent reconstruction with LD flap after mastectomy in comparison with mastectomy alone [26,27]. In addition, Ali et al reported that a combination technique of quilting and fibrin glue reduced the time for drains at the donor site and reduced the risk of seroma, hematoma, and infections [28]. After harvesting the LD flap, risk factors for seroma formation have been demonstrated by Gruber et al, including comorbidities, BMI, selective serotonin reuptake inhibitors (SSRIs), and surgical technique [29].

A bipolar pedicelled LD flap is useful when radiation or chemotherapy was used in the recipient area [19] or if severe trauma with extensive soft-tissue defect was the main issue [8]. Furthermore, the LD flap is a reliable flap to reconstruct the upper extremity, including restoration of elbow flexion, if combined

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Table 1. Recent cases reported using functional LD flap transfer for flexorplasty.

Author	Year	Number of patients	Etiology	Active ROM	Comments
Lupon et al [19]	2020	1	Sarcoma	0-140	The exact surgical technique not mentioned
Kameda et al [18]	2019	1	Nerve injury	0-135	
Sood et al [21]	2017	1	Sarcoma	NR	Follow-up 3 months after reconstruction revealed an MRC score of M3
Cambon-Binder et al [6]	2012	7	Tiger bite (n=1) Anterior arm compartment trauma (n=3) Brachial plexus injury (n=3)	Average 45-130 (mean 91°)	
Ma et al [20]	2008	20	Soft-tissue defect	0-130 (n=16) 0-105 (n=3) 15-85 (n=1)	

ROM – range of motion; year – year of publication; NR – not reported; MRC – medical research council.

with good preoperative assessment, organized postoperative rehabilitation care, and regular follow-up [30].

Conclusions

Several surgical techniques are used to restore elbow flexion. This report shows that latissimus dorsi muscle transfer is a reliable option for restoring elbow flexion following upper limb trauma. For a better outcome, a complete preoperative assessment and a comprehensive postoperative rehabilitation program are fundamental. A multiprofessional approach and consideration of patient characteristics, including the degree of injury, are important in selecting an appropriate surgical procedure.

Declaration of Figures' Authenticity

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