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CASE REPORT
Reconstructive

Median Nerve Neuropathy following Radial Forearm Free Flap Phalloplasty: A Case Report

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Summary: As the transgender population increases, gender-affirming surgeries are being performed at unprecedented rates. Despite this increase, complications and long-term outcomes of gender-affirming interventions are largely understudied. We present a transgender patient who underwent radial forearm free flap (RFFF) phalloplasty as part of gender affirmation. Immediately following surgery, the patient reported paresthesia in the donor arm in the median nerve distribution followed by a neuropathic pain after 1 week. The patient complained of shooting and burning pain and reported a loss of sensation and function at the donor site. Electromyography and magnetic resonance imaging results indicated median nerve damage several inches above the donor site. The symptoms persisted for several months before spontaneously resolving. The spontaneous resolution and location of injury suggest that nerve damage occurred as a result of pneumatic tourniquet application despite adherence to all clinical guidelines for a safe tourniquet application of the same. This is the first reported case of neuropathic pain following RFFF phalloplasty occurring at the donor site. Given the large donor area and the long time of tourniquet application, surgeons offering RFFF phalloplasty must be aware of and actively counsel patients seeking this procedure about the potential for nerve-related damages before surgery. *(Plast Reconstr Surg Glob Open 2020;8:e3027; doi: 10.1097/GOX.0000000000003027; Published online 14 August 2020.)*

Transgender individuals may pursue a variety of medical and surgical options as part of gender transition. Genital surgery options for transmasculine individuals, or those assigned female at birth who identify with a gender other than woman, commonly involve phalloplasty and metoidioplasty. These procedures are performed with a wide array of complications such as flap loss, urethral strictures and fistula, and donor site morbidity.[1]

During a radial forearm free flap (RFFF) phalloplasty, considered the "gold standard" of phalloplasty,[2] nerves and tendons required for hand function are exposed, placing the patient at risk for injury to vital structures. Additionally, the large size of the RFFF coupled with known objective impairment in sensation and function presents a significant concern for both patients and surgeons.[3,4]

As more patients seek a gender-affirming surgery, there is an increased need to understand the potential complications that can occur. In this case study, we present the first known case of a tourniquet injury following RFFF phalloplasty for gender affirmation.

CASE

A 26-year-old transgender man presented for a gender-affirming, single-stage RFFF phalloplasty. The patient had been on testosterone for 3 years and previously had bilateral mastectomy, bilateral salpingo-oophorectomy, and hysterectomy. Preoperative Allen testing of the forearm showed an intact superficial palmar arch.

Due to tattooing of the nondominant arm, the patient selected the dominant (right) arm as the donor site. The operative arm was positioned on a hand table with the shoulder abducted. The flap was harvested using a pneumatic arm tourniquet inflated at 250 mm Hg. During dissection, the median nerve was observed in the distal aspect of the forearm, which appeared intact and injury

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The devices and products named in this manuscript are VAC GranuFoam (KCI Licensing, Inc.) and Semmes–Weinstein monofilaments (Stoelting Co.).

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free. The tourniquet was deflated at the 2-hour mark and never reinflated. A split-thickness graft from the thigh was placed to cover the donor site. A vacuum-assisted closure GranuFoam (KCI Licensing, Inc., San Antonio, Tex.) dressing was placed on the donor site at 100 mm Hg with a loosely applied volar resting splint. The patient's arm remained on the hand table throughout the case, with varying degrees of shoulder abduction ranging from 30 to 80 degrees (estimate) as the arm was manipulated during flap harvest.

On postoperative day 1, the patient complained of numbness and tingling in all fingers of the right hand. Mild swelling was noted. Despite the sensory impairment, particularly in the thumb, the patient could move all digits, but range of motion was limited, presumably by swelling and pain. The forearm compartments were soft, and the hand was well perfused. The forearm was rewrapped lightly and elevated with improvement. The following day, the patient complained of diminished sensation in the median nerve distribution. Even though the splint was not tight, it was removed, and the pressure of the vacuum-assisted closure dressing was lowered to 75 mm Hg. Gradual sensory improvement was noted over the following days.

For the next 2 weeks, the patient complained of persistent shooting and burning forearm pain. A complete examination revealed decreased sensation in the median nerve distribution in the fingers and palm and marked motor weakness of flexor pollicis longus (FPL), flexor digitorum profundus (FDP), and flexor digitorum superficialis (FDS) to the index and middle fingers. (**See Video 1 [online],** which displays a video taken 2 weeks following RFFF phalloplasty, demonstrating motor weakness in the right, dominant arm. Motor weakness was seen in the FPL, FDP, and FDS to the index and middle fingers. Mild weakness was seen in the FDP to the ring and small fingers). Ulnar and radial nerve sensation and function were intact. Mild stiffness of the elbow was noted. No Tinel's sign could be elicited.

An electromyography (EMG) study conducted at 6 weeks postoperatively showed fibrillation and sharp spikes as proximal as the pronator teres muscle. Magnetic resonance imaging conducted 8 weeks postoperatively suggested median nerve injury beginning at the level of the tourniquet cuff (Fig. 1). A neurologist assessed the patient and diagnosed a tourniquet injury.

After 8 weeks, motor improvement occurred spontaneously, first in the middle finger and then in the index and thumb, with slow return of both FDP and FDS functions, and finally FPL. Intrinsic muscle function return lagged.

Sensation did not improve for the first 2 months following surgery and then slowly improved. Improvement in motor and sensory recovery coincided with decreasing neuropathic pain and decreased need for analgesics. A year following surgery, the pain had completely subsided, and grip strength had returned (Table 1). (**See Video 2 [online],** which shows a video taken 14.5 months following RFFF phalloplasty, demonstrating full motor recovery of the right, dominant hand.) Sensory testing revealed normal sensory function with mildly decreased sensation at the hypothenar eminence of the right hand (Table 2).

DISCUSSION

Although current literature has addressed patient-reported loss of function and skin grafting complications,[6] this is the first reported case known to the authors of a median nerve injury following RFFF phalloplasty. Impairment suggested a high median nerve injury without

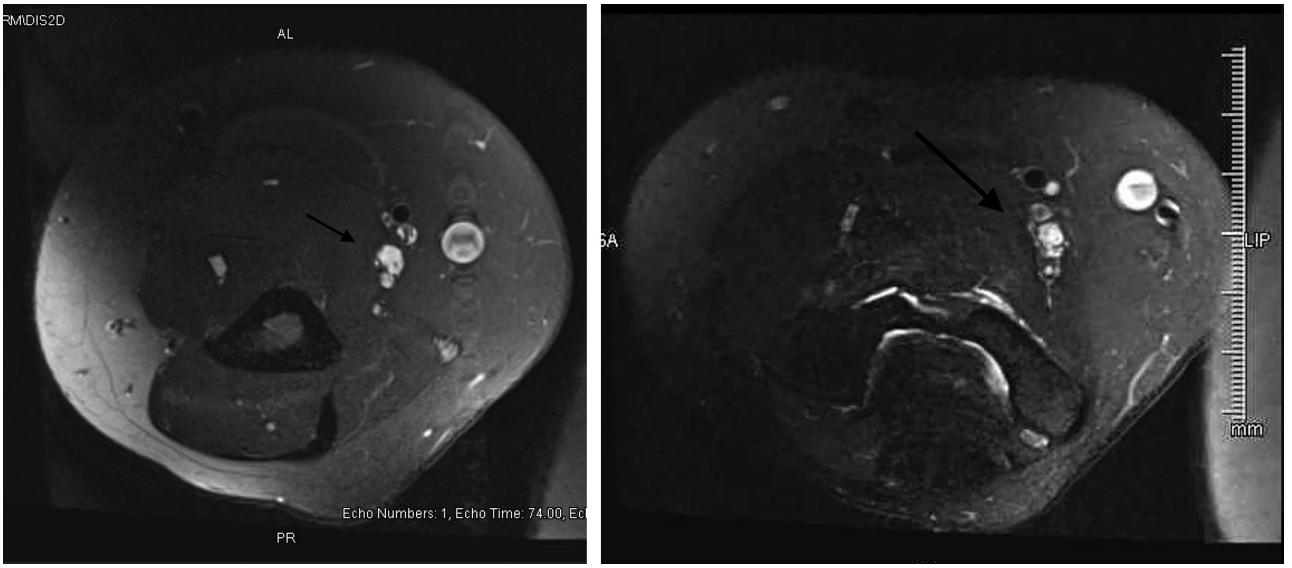

Fig. 1. Magnetic resonance images taken 8 weeks postoperatively. The images revealed enlarged, lobulated contoured, and prominent fascicles within the median nerve, with increased signal on T2 hyperintense images throughout its visualized course from the level of the distal humeral diaphysis to the wrist. No discontinuity of the nerve was identified. Milder, similar changes of the ulnar and radial nerves were seen. No Tinel's sign could be elicited along the entire arm into the axilla at this time.

Table 1. Grip and Pinch Strength Measurements of the Patient, at 14.5 Months following the Procedure

	Left (Nonoperative, Nondominant)			Right (Operative, Dominant)		
Measurement	Trial 1	Trial 2	Average	Trial 1	Trial 2	Average
Grip strength (lbf)	77.3	68.3	72.8	72.3	74.7	73.5
Key pinch (kgf)	10.0	9.0	9.5	10.1	10.1	10.1
Tip to tip pinch (kgf)	5.5	6.5	6.0	6.0	7.5	6.8
Palmar pinch (kgf)	8.0	7.5	7.8	8.0	8.0	8.0

Values are within established norms for natal females.[5]

Table 2. Results of Semmes–Weinstein Monofilament (Stoelting. Co, Wood Dale, Ill.) Testing for Sensory Recovery at 14.5 Months following the Procedure

	Left (Nonoperative, Nondominant)	Right (Operative, Dominant)
Thumb	2.83	2.83
Palmar index finger	2.83	2.83
Small finger	2.83	2.83
Hypothenar eminence	2.83	3.22
Dorsum	2.83	3.61

The lowest detectable sensory threshold is noted for each testing site.

a Tinel's sign, with the source likely at the tourniquet application site,[7] thus suggesting a tourniquet-related injury. This etiology was also suggested by the evaluating neurologist. Such impairments are relatively uncommon among procedures done on the upper extremities using pneumatic tourniquets[8]; injury is far more likely to occur when tourniquets are applied for >2 hours or at a high pressure.[9] Despite following safe practice guidelines, the median nerve sustained injury.

Peripheral nerve injury following tourniquet application often occurs as a result of direct nerve compression or from ischemia. However, ischemia is unlikely because it generally occurs during applications lasting for >3 hours. Furthermore, it would be unlikely for only the median nerve to sustain injury, with clinically significant presentation if ischemic insult occurred. This outcome suggests that the most likely explanation was direct nerve compression, resulting in cellular damage of the nerves from the pressure gradient between the compressed and uncompressed tissues.[10] Because the pressure gradient is greatest at the cuff's edge, the resulting gradient likely damaged the surrounding median nerve fibers, resulting in diminished sensation, motor function, and neuropathic pain.

As with other reported tourniquet injuries, the symptoms spontaneously resolved within the course of a year.[8] However, the patient required gabapentin for several months before the pain resolved. The duration and severity of pain, as well as significant functional compromise of the dominant hand, suggest that despite a highly favorable long-term prognosis, there are considerable impacts to the patient.

CONCLUSIONS

This report presents the first reported case of a tourniquet injury leading to donor site impairment following an RFFF phalloplasty. Practitioners should be aware of such risks when performing complex, microsurgical procedures. Extra precautions should be taken during surgical planning to ensure a safe pneumatic tourniquet application.

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