

Salvaging a Missed Opportunity: The Inverted Free Functional Gracilis Muscle Transfer for Restoration of Elbow Flexion Following an Upper Trunk Injury

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INTRODUCTION

- Following injury to the upper trunk of the brachial plexus, elbow flexion can often be restored through the use of fascicular nerve transfers from the ulnar and/or median nerves.^{1,2}
- However, delayed presentation (>12 months) or a failed fascicular nerve transfer may result in native elbow flexors that are no longer suitable for reinnervation. In this setting, restoration of elbow flexion is commonly sought through use of a free functional gracilis muscle transfer (FFGMT).^{3,4}
- As typically described, the origin of the gracilis muscle is anchored to the clavicle and the tendinous insertion portion woven into the biceps aponeurosis or flexor tendons. This conventional flap orientation places the recipient obturator nerve close to the clavicle, where it is commonly coapted to the spinal accessory nerve or intercostal nerves.⁴
- Given the superiority of intra-plexal donor nerves over extra-plexal sources for functional muscle transfer,⁵ an upper trunk injury provides an opportunity to use lower trunk fascicles to power the transferred gracilis.
- This case describes the first report of inverting the gracilis muscle so as to orient the obturator nerve closer to the donor median nerve fascicle in the distal upper arm.
- The goal of this modified orientation is to decrease the time to reinnervation, while facilitating use of a superior donor nerve source and preserving other potential donor nerves for further functional restoration of upper extremity.

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METHODS

- A 32 year-old man with a traumatic C5-C6 brachial plexus injury presented to our clinic with a persistent upper trunk palsy 2 years after having undergone an upper trunk nerve grafting procedure at an outside institution.
- In an attempt to restore elbow flexion, the patient underwent an inverted gracilis muscle transfer, whereby the origin of the gracilis was anchored to the biceps aponeurosis and the tendinous insertion sutured to the clavicle.
- Given a concomitant partial ulnar nerve injury, the median nerve fascicle to the flexor carpi radialis was coapted to the obturator nerve approximately 5 cm from the motor entry point.
- Vascular anastomosis was performed end-to-side between the flap artery to the brachial artery. Venous anastomosis was performed between the flap vein and brachial venae comitantes.

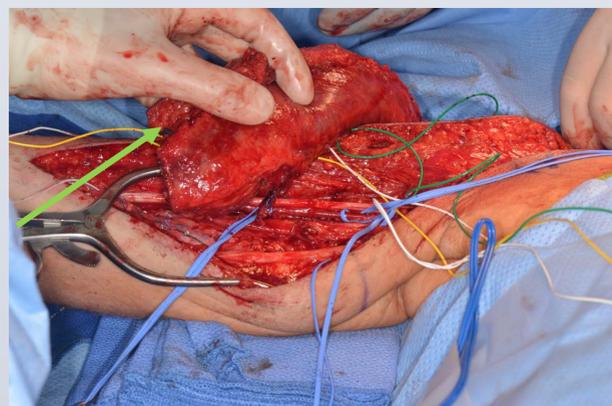
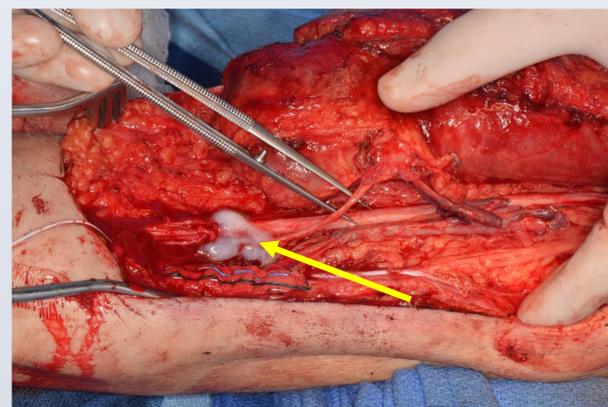


Figure 1: Insetting the gracilis with the muscle's origin (green arrow) initially anchored to the biceps aponeurosis distally.

RESULTS

- Electrophysiologic evidence of reinnervation was detectable within 4 months of the procedure, with flap muscle contraction visible on ultrasound
- M4 elbow flexion was obtained approximately 9 months following surgery.
- The patient retained M5 wrist flexion. Co-contraction of the FCR with elbow flexion was not clinically significant.
- The patient had an uncomplicated post-operative course.



Figures 2 (top): Co-aptation of the median fascicle with the obturator nerve augmented with fibrin glue (green arrow).
Figure 3 (bottom): Length of coapted nerve is approximately 5 cm.

DISCUSSION

- Restoring elbow flexion is a top priority in brachial plexus reconstruction.
- The gracilis muscle is an ideal muscle for functional elbow reconstruction due to its adequate strength of contraction, range of excursion, low complication profile, reliable anatomy, and ease of harvest.⁴
- The quality of functional outcome depends largely on the donor nerve used to reinnervate the FFGMT.⁵
- Better outcomes are associated with use of intra-plexal donor nerves (ie median fascicle, ulnar fascicle) compared to extra-plexal donors (ie intercostal nerves, spinal accessory nerve) due to intra-plexal nerves' higher axon counts, shorter reinnervation distances, and more intuitive motor re-education.⁵
- In upper trunk injuries, an ulnar and/or median nerve fascicle can be used if a double fascicular transfer or Oberlin procedure has not been performed previously and hand function remains intact.⁶
- Selection of the median and/or ulnar nerve fascicles for wrist flexion is more straightforward in the distal upper arm as these motor fascicle are less diffusely spread than in the shoulder area.¹
- Inverting the gracilis places the muscle's proximally located pedicle more distally in the arm, thereby facilitating nerve coaptation with either a median or ulnar fascicle in the middle or distal arm. As a result, the distance for nerve regeneration is shorter, and thus the time required for reinnervation is decreased.

CONCLUSION

- This case provides proof of concept that inverting the orientation of a conventional FFGMT can facilitate use of an intra-plexal donor nerve in the setting of a failed nerve transfer or delayed presentation of an upper trunk brachial plexus injury.
- Orienting the recipient obturator nerve closer to its donor appears to decrease the time to reinnervation and should optimize functional restoration of elbow function for upper trunk injury patients undergoing FFGMT for elbow reconstruction.



Figure 4: The upper extremity immediately following muscle transfer and wound closure.

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