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ORIGINAL ARTICLE

Functional pectoralis minor myocutaneous flap transplantation for reconstruction of thumb opposition: An anatomic study with clinical applications

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Summary *Objective:* To develop a myocutaneous flap for reconstruction of thumb opposition function in patients with loss of the thenar muscles and skin.
Methods: An anatomic experiment on the dimensions of the pectoralis minor muscle and its neurovascular supply in 10 adult human cadavers was conducted to evaluate the feasibility of microsurgical transplantation using part of the muscle for thumb opposition reconstruction. Based on these results, we performed surgical thenar reconstruction with a pectoralis minor myocutaneous flap in seven patients (34.7 ± 9.8 years of age) from December 2007 to October 2010.
Results: The transferred muscle was reinnervated with the third lumbrical branch of the ulnar nerve. Six to twelve months after the surgery, follow-up assessment showed that all patients had recovered functional opposition of the carpometacarpal joint with survival of the skin and a muscle power of M4 to M5.
Conclusion: Our results support the use of this new technique for thenar and opposition reconstruction in patients with severe loss of the thenar muscles and skin and damage to the median nerve and who wish to improve the appearance of the thenar eminence.

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1. Introduction

Restoration of thumb opposition for significant thenar soft tissue defects remains a considerable surgical challenge.[1] The most crucial muscle for thumb opposition is the abductor pollicis brevis.[2] A precise balance among the other thenar muscles is also necessary for complete thumb function. Reconstruction of thumb opposition usually involves tendon or muscle transfer. The donor of the tendon is the palmaris longus,[3,4] flexor superficialis,[5] extensor indicis proprius,[6] extensor pollicis longus,[7] or one of the wrist extensors.[8] The intrinsic muscles of the hand, such as the abductor digiti quinti, have also been used for thumb opposition reconstruction[9] and for congenital hypoplastic thumbs.[10] In addition, the flexor pollicis brevis has been used for reconstruction of abductor pollicis brevis function.[11,12]

In previous research,[13] we found that functional pectoralis minor muscle flap transplantation for reconstruction of thumb opposition achieved satisfactory clinical results. However, there are important limitations of this surgical approach, including scarring and skin defects at the recipient site due to a lack of wound coverage after transplantation. In this study, we aimed to resolve the issues related to thumb opposition and skin defects by transferring the pectoralis minor muscle along with a lateral thoracic skin flap.

2. Materials and methods

2.1. Anatomic study

2.1.1. Cadaveric specimen and instruments

Ten adult human cadavers (died at age 20—50 years) with the bilateral thorax available for obtaining specimens were dissected. Among them, eight embalmed cadavers and ten fresh specimens with arteries filled with red latex were supplied by university. The instruments used included an operating microscope, micro-dissecting instruments, surgical instruments, a vernier caliper, and a Nikon 5900 camera. The microscopic camera system (Olympus, Japan) and microscopic image analysis system (Leica, Germany) were supplied by university.

2.1.2. Methods

The pectoralis minor was exposed after incision of the pectoralis major. The pectoralis minor was severed near its insertion in the coracoid process to expose the lateral thoracic artery and medial pectoral nerve at this anatomical level. Anatomical observation of the lateral thoracic artery was carried out to identify the cutaneous arteries and branches of the lateral thoracic artery running along the pectoralis minor muscle and to measure the length and outside diameter of the vascular pedicle. We examined the location, branches, and muscular entrance points of the medial pectoral nerve to determine the nerve suture region; we also assessed the deep branches of the ulnar nerve and the number of myelinated nerve fibers.

2.1.3. Statistical analyses

Analyses were performed using SPSS for Windows, version 23 (IBM Corporation, Armonk, NY). Descriptive statistics were used for the measurement data, including mean, standard deviation, and range. The probability of vessel appearance is presented as a percentage. Statistical significance was set at alpha = 0.05.

2.2. Clinical study

2.2.1. Participants

The mean age of all patients was 34.7 years (standard deviation, 9.84; range, 22—49 years). Five patients were male and two were female. Two injuries were in the left hand and five were in the right hand. Impairment of thumb opposition had been present for at least 6 months. The thumb was unable to touch the middle finger pulp, and muscle strength was weaker than M3. Function was poor. The local conditions of the hands were stable, with scars in the thenar region or first web. The skin could hardly cover the surface of the wound after transfer of the pectoralis minor muscle.

2.2.2. Methods

The details of the surgical procedure are described in the case report section below. Postoperative management included administration of anti-inflammatory, anticonvulsant (Beraprost Sodium Tablets), anticoagulation (Low Molecular Weight Dextran), and neurotrophic (Methylcobalamin) agents. Three weeks after the operation, rehabilitation training was performed when the Kirschner wires were removed. We followed up all patients regarding the thenar shape, condition of the flap, function of thumb opposition, and condition of shoulder activities. The patients underwent electromyographic testing at 2 months postoperatively. Three months after the surgery, two patient underwent flap debulking surgery and muscular tissue obtained for histological examination.

2.3. Case 1

A 25-year-old male molding machine operator sustained a severe hot crush injury of his right hand 6 months previously. Physical examination showed scar contracture in the thenar region with partial loss of the thenar muscles. The thumb was unable to touch the little finger pulp, and thumb opposition function was poor (Fig. 1).

2.3.1. Recipient site preparation

According to the position of the hand scar, a Z-shaped incision was designed in the thenar area from the mid wrist to the radial margin of the first metacarpophalangeal joint. The scar on the first web of the palm was removed, and the fibrotic thenar muscles were cut off. The superficial palmar branch of the radial artery and branch of the cephalic vein were separated and labeled for preservation.

2.3.2. Donor site dissection

During the preoperative assessment, the cutaneous branch of the lateral thoracic artery was measured by Doppler ultrasound from the lower edge of the pectoralis major to

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