Novel surgical procedure of the half palmaris longus transfer for the opponensplasty of the thumb in patients with carpal tunnel syndrome: A Technical Note

Running title: Half PL transfer for the opponensplasty

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Abstract

Thumb opposition is an essential movement for daily use of the hand, including precise pinch or grasping as well as fine and complicated hand movement. Although previous studies have reported several donor tendons for opponensplasty, opponensplasty using palmaris longus, Camitz opponensplasty, have been utilized in patients who have loss of opposition function due to long-standing carpal tunnel syndrome, because the procedure involves a simple and useful tendon transfer without causing functional deficits. To obtain enough length to transfer the tendon to the metacarpophalangeal joint of the thumb, the PL tendon should be obtained along with the palmar aponeurosis. However, the palmar aponeurosis is not always available for the opponensplasty, as it occasionally appears thin and is not sufficient for the elongation of the palmaris longus. The extended skin incision over the palm causes painful scar formation or postoperative residual pain. This procedure restores the palmar abduction function of the thumb, but not the opposition function. In the present article, we present the modified Camitz opponensplasty using half split of palmaris longus, which has enough length to anchor to the insertion of the adductor pollicis at the metacarpophalangeal joint of the thumb.

Key words: Modified Camitz opponensplasty; palmaris longus; opponensplasty; tendon transfer; technical note
Introduction

Thumb opposition is an essential movement for the daily use of hand, including precise pinching or grasping as well as fine and complicated hand movement.\(^1\) Thus, thenar muscle atrophy due to long-standing carpal tunnel syndrome (CTS) results in thumb opposition deficiency and activity of daily living disabilities. Although several donor tendons for opponensplasty have been used,\(^1,2\) the palmaris longus (PL) elongated with palmar aponeurosis is the most frequently utilized tendons for patients with severe thenar muscle atrophy, because the procedure involves a simple and useful tendon transfer without sacrificing other functional tendons.\(^1,2\) To obtain enough length to transfer the tendon to the metacarpophalangeal (MP) joint of the thumb, the PL should be obtained along with the palmar aponeurosis.\(^1,2\) However, the palmar aponeurosis is not always available for the opponensplasty, because it occasionally appears thin and has insufficient length. The extended skin incision over the palm frequently causes painful scar formation or postoperative residual pain.\(^1,2\) Furthermore, this procedure provides palmar abduction of the thumb, but does not provide opposition of the thumb.\(^1,2\) In the present article, the modified Camitz opponensplasty using the half split and elongated PL tendon (half-PL transfer) is proposed. This procedure provides the PL tendon enough length to anchor to the insertion of the adductor pollicis at the MP joint. The half-PL transfer is simple and easy to perform without the sacrifice of functional tendons and without extended skin incision on the palm.

Indications
The general indication for opponensplasty is thumb opposition deficiency due to long-standing CTS. This procedure is contraindicated in patients with too thin or defective PL tendon.

**Preoperative management**

Preoperative assessment of PL strength is performed by asking the patient to flex the wrist in neutral deviation against resistance as the examiner simultaneously palpates the tendon. Since several studies have already reported the absence of the PL in approximately 15% of hands of the normal population,³ other opponensplasty should be considered in patients who have thin or defected PL tendon.

**Surgical technique**

The patient is placed in supine position. According to patient preference, either local anesthesia or regional anesthesia is administered, and a pneumatic tourniquet is applied.

Mini-incisions through a 1.0-cm incision in the proximal wrist crease and the anterior forearm are made to expose the PL tendon. The exposed PL tendon is split into two halves with a 6-to-8-cm distance from the insertion point, which is enough to perform an interlacing suture to the extensor mechanism around the MP joint of the thumb. A radial half strip of the PL is resected at the proximal forearm incision and reflected back to the distal insertion (Fig. 1A). The PL tendon is pulled out from the middle forearm incision (Fig. 1B). The insertion of the PL tendon is resected at the wrist (Fig. 1C) and reflected back 1-cm distal to the
insertion of the PL at the wrist (Fig. 1D-a, b). The radial half of the PL is piled on the ulnar half of the PL and augmented with 4-0 nylon sutures (Fig. 1D-c).

A mini-incision through a 1.5-cm incision is made over the palmer hand crease, and the transverse carpal ligament is exposed (Fig. 2A). The transverse carpal ligament is released from the attachment of the hook of hamate to avoid damaging the thenar branch of the median nerve (Fig. 2B), and the proximal part of the transverse carpal ligament and the forearm fascia are simultaneously released from the incision at the distal wrist crease. After the open release of carpal tunnel, several horizontal mattress sutures are made between the ulnar margin of the transverse carpal ligament and the radial margin of the subcutaneous tissue of palmer incision using 4-0 polypropylene sutures to create a pulley for the half-PL tendon (Fig. 2C). The half-PL tendon are passed through the palmar incision using a tendon passer at the ulnar side of the transverse ligament (Fig. 2D). The half-PL tendon is passed under the fascia of the abductor pollicis brevis to prevent the bowstringing of tendon and pulled out at a mini-incision on the radial side of the thumb at the level of the MP joint (Fig. 2E). Another incision on the ulnar side of the MP joint of the thumb is made, and the half-PL tendon is pulled out (Fig. 2F). The half-PL tendon is sutured to the insertion of the adductor pollicis using interlacing suture with 4-0 nylon sutures with the thumb in full opposition during maximum tension in maximal palmar abduction of the thumb (Fig. 2G).

After the tourniquet is released, the incision is closed using 4-0 nylon sutures. A cotton gauze is applied over the incision. Then, a thumb spica splint is applied at full thumb opposition.
Postoperative management

Postoperative rehabilitation is encouraged from several days after the tendon transfer. After the rehabilitation, the patient’s ability to oppose the thumb to the little finger with the wrist in neutral position is immediately restored. The splint is applied for three weeks postoperatively, and rehabilitation exercises, such as active range of motion of the wrist and thumb, are freely performed. Six weeks after surgery, the patients can grip with full strength. Return to heavy manual labor and sport is generally started 12 weeks after surgery.

Case presentation

A 65-year-old woman with long-standing CTS presented to our hospital requesting to restore her thumb opposition function. Physical examination revealed complete lack of active left thumb opposition function and thenar muscle atrophy. A half-PL transfer was performed for the opponensplasty. After the open release of carpal tunnel, the half-PL tendon (Fig. 3A) is passed under the fascia of the abductor pollicis brevis and sutured to the insertion of the adductor pollicis (Fig. 3B, C). At a final follow-up of 6 months, the patient was able to achieve palmar abduction of the thumb and thumb opposition to the tip of the little finger with the wrist in neutral position (Fig. 3D, E).

Discussion

Camitz opponensplasty is superior over other procedures because the PL tendon can be utilized without obvious functional deficit.1-5 However, the
conventional Camitz opponensplasty has several disadvantages. Firstly, the extended incision in the palm and wrist involves extensive soft tissue dissection increasing the risk of iatrogenic injury to the palmar cutaneous branch of the median nerve \(^2,7,8\) and a painful scar on the wrist. \(^5,9\) The prominent bowstringing of the transferred tendon is one of the main shortcomings. \(^4,8\)

Another disadvantage is that the conventional Camitz opponensplasty has little benefit to thumb flexion and pronation. \(^1,4,7\) Since the movement of the thumb opposition consists of a combination of palmar abduction, pronation, and adduction, Camitz opponensplasty does not restore the thumb pronation function against the palm. \(^1,3\)

To address these disadvantages, modified Camitz opponensplasty using the transverse carpal ligament as a pulley to further improve the thumb opposition function. \(^4,7,8\) Moreover, various techniques have been adopted to anchor the ligament to the radial or dorsal side of MP joint of the thumb to restore the thumb opposition. \(^1,2,10\) However, it is difficult to obtain the PL tendon using the accompanying palmar aponeurosis as it does not have enough length to anchor to the radial or dorsal side of MP joint of the thumb to restore the thumb opposition.

Our technique has several advantages. Firstly, using the transverse carpal ligament as a pulley improves the line of pull of the transferred PL tendon that was shifted to the ideal axis for opposition \(^4,7,8\) Secondly, since the half-PL tendon has enough length to anchor to the insertion of the adductor pollicis at the MP joint of the thumb, the interlacing suture applied to the insertion of the adductor pollicis at the ulnar side of the MP joint restores the pronation and
opposition function of the thumb. Our procedure does not involve harvesting of the palmar aponeurosis, but it requires the creation of an incision on the palm, which is smaller than that on the conventional Camitz procedure. By contrast, this technique has several disadvantages, among which is the need for an additional skin incision on the anterior forearm. Moreover, a further biomechanical study would be needed to reveal the tensile strength of the half PL tendon. Although further evaluation is needed, our procedure may be an alternative method for restoring the thumb opposition function of severed CTS patients.

**Conflict of interest**

No conflicts of interest.

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Figure legends

Fig. 1. Surgical technique (1). The palmaris longus (PL) tendon is exposed and split into 2 halves at over a 6-to-8-cm distance from the insertion point, which is enough to perform an interlacing suture to the extensor mechanism around the metacarpophalangeal joint of the thumb. The PL is dissected, and a radial half strip of the PL is resected and reflected back to the distal insertion (A). A radial half strip of PL is pulled out from the distal incision of the anterior forearm (B). The insertion of the PL tendon is resected at the wrist (C). The PL is reflected back 1-cm distal to the insertion of the PL at the wrist (D–A,B). The radial half of the PL is piled on the ulnar half of the PL and augmented with 4-0 nylon (D–C).
Abbreviation; PL: palmaris longus

Fig. 2. Surgical technique (2). Mini-incision through a 1.0-to-1.5-cm incision is made over the palmer hand crease (A). The transverse carpal ligament is released from the attachment of the hook of hamate to avoid damaging the thenar branch of the medial nerve from the incision made over the palmer hand crease (B). After the open release of carpal tunnel, several horizontal mattress sutures are made between the ulnar margin of the transverse carpal ligament and the radial margin of the subcutaneous tissue of the palmer incision using 4-0 PDS sutures to create a pulley for the half-PL tendon (C). The half-PL tendon is passed through the palmar incision using a tendon passer at the ulnar side of the transvers ligament (D). The half-PL tendon is passed under the fascia of the abductor pollicis brevis to prevent the bowstringing of tendon and pulled out from an incision on the radial side of the thumb at the level of the MP joint (D and E).
Another incision is made at the radial side of the metacarpophalangeal joint of the thumb, and the PL tendon is pulled out and sutured to the insertion of the adductor pollicis (F). The half-PL tendon is sutured to the insertion of the adductor pollicis using interlacing suture with 4-0 polypropylene sutures with the thumb in full opposition during maximum tension in maximal palmar abduction of the thumb (G). Abbreviation; APB: abductor pollicis brevis, Add Pol: adductor pollicis, EPL: extensor pollicis longus, PL: palmaris longus

Fig. 3. Case presentation, a 67 year-old woman with severe atrophy of the left hand due to long-standing carpal tunnel syndrome. Intraoperative photograph of the half-PL transfer for opponensplasty. The half-PL tendon is resected at the insertion of the wrist and reflected back to the distal insertion (A). The PL tendon is pulled out from the ulnar side of the metacarpophalangeal joint of the thumb after pulleyed at the ulnar margin of the transverse carpal ligament (B). The PL tendon is interlaced to the insertion of the adductor pollicis, reflected back, and then sutured to the adductor pollicis (C). Postoperative photographs of the left hand of a patient who underwent half-PL transfer for opponensplasty. The perfect “O” sign of the left hand is nearly same as that of the right hand (D). After the half-PL transfer opponensplasty, the patient’s left hand can now perform the thumb opposition to the little finger with the wrist in neutral position, the same as that of the right hand.
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