ORIGINAL ARTICLE

Abductor pollicis longus hemitendon looping around the first intermetacarpal ligament as interposition following trapeziectomy: A one-year follow-up study

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Summary

Background: Trapeziectomy and ligament reconstructions are favoured by surgeons concerned that telescoping of the thumb may reduce its function. However, theoretically ligamentoplasties are at risk to develop tendinosis or tendon rupture or trigger a complex regional pain syndrome type 1.

Hypothesis: Authors tested the looping of a slip from the abductor pollicis longus (APL) tendon around the first intermetacarpal ligament. They intended to use a surgical treatment which does not require bone tunnelling or looping around a tendon. Their results support the hypothesis that this new technique is a valid addition among treatments for carpometacarpal arthritis.

Patients and methods: Forty-two patients were followed up to one year. Each patient had subjective assessment for: pain; function (DASH score); overall satisfaction. An objective assessment was used for: first web span angle; abduction and opposition; key pinch; grip strength. Tests were performed prior to surgery, then at three, six and 12 months. X-ray films were taken to monitor thumb height.

Results: A substantial improvement in all these parameters was measured in all patients. X-ray films showed the maintainance of a physiological height after one year. We recorded one complication of keloid and two of temporary dysesthesia but no case of tendinosis, delayed rupture, or CRPS 1. Mean operative time was 27 minutes.

Discussion: Simplification and search for a technique which avoids the looping around a tendon is why the authors undertook this study. Advantages are the small number of required steps, short time of surgery and comfortable postoperative rehab regimen for the patient. The technique provides a distal anchoring point (without bone tunnelling). It is quite respectful

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Introduction

The trapeziometacarpal (TMC) joint osteoarthritis (or first carpometacarpal joint osteoarthritis) is one of the most common degenerative joint disease of the hand and affects mostly middle-aged and elderly post-menopausal women; it is usually idiopathic (primary osteoarthritis) and less frequently associated with rheumatoid arthritis or trauma.

Pain and severe adduction contracture with narrowing of the first web space (with or without secondary hyperextension of the metacarpophalangeal joint) make this pathology an often disabling condition which compromise pinch and grasp, because TMC joint is instrumental for thumb opposition; not only is the kinematics of the first digital ray much impaired, but the overall hand function as well.

The degree and the control of pain should guide in the final decision as to whether or not propose a surgical treatment [1]. Surgical treatment aims at relieving pain while restoring thumb stability and strength. Many operative procedures have been described for treating this condition which can be grouped into four categories:

1) trapeziectomy alone [2];
2) trapeziometacarpal joint fusion (arthrodesis) [3–5];
3) total joint arthroplasty [6]; for a review of the literature see: [1]);
4) trapeziectomy followed by soft tissue interposition and/or ligamentous reconstruction (ligamentoplasty) [7–9].

Despite several comparative studies failed to highlight significant differences in the outcome of the different techniques, trapeziectomy and ligamentoplasties are favoured by surgeons concerned that “sinking” of the thumb may impair its function [10]. The several ligamentoplasties proposed in the literature in the past 20 years showed, cumulatively, good results in terms of pain relief and restoration of function. In the majority of the papers, they have been reported to achieve a better range-of-motion in respect with fusion; a lower rate of complications when compared with total joint arthroplasty; a lower percentage of thumb “sinking” in respect with simple excision.

In principle, a ligamentoplasty provides a new ligament which keeps the first metacarpal suspended in its physiological place, after trapeziectomy has been performed. This “suspensory” ligament acts together with the functional fibrous pad which eventually develops as a filler of the void left by the excised trapezium. However, several of the ligamentoplasties which have been proposed may require the looping of the suspensory ligament around a chosen tendon of the wrist (like the flexor carpi radialis tendon) or the passage through bone tunnels (mostly drilled through the first metacarpal) [10]; these techniques may put the patient at risk to develop a tendinosis [11], tendon rupture or complex regional pain syndrome type 1 (CRPS 1) [12] which may be severe, long lasting and disabling.

We treated 50 cases of TMC arthritis by a new ligamentoplasty developed by one of the authors, namely Francesco Brunelli, as a variation of the abductor pollicis longus (APL) tendon slip arthroplasty [13,14]. The technique is based on the looping of a slip from the APL tendon to the first intermetacarpal ligament, aiming at a surgical treatment which does not require bone tunnelling and looping around a tendon, in so doing avoiding to cause tendinosis. The purpose of the study was to report the clinical results obtained, to support this new technique as a valid addition for the treatment of carpometacarpal arthritis.

Patients and methods

Inclusion criteria

Patients presenting a painful and disabling primary TMC arthritis with a radiographic Eaton-Littler Stage 2 trough 3 [8,15,16] were selected for this study. No patient in the series was suffering from rheumatoid arthritis, nor scapho-trapeziotrapezoid arthritis, nor from the sequela of trauma.

The patients

Fifty patients were treated, starting from January 2007 to June 2008. Eight were lost at follow-up.

At preoperative controls, 26 patients presented an Eaton-Littler Stage 2 and 16 patients a Stage 3. In 31 cases, the operated hand was on the dominant side. The onset symptoms ranged from 6 to 12 months prior to surgery (with a mean period of 30 ± 25 months). Women prevailed in sex distribution (34 women versus eight men). The mean age was 60 years ± 9 (range 49–79). A full informed consent was obtained from every patient.

The operative technique and postoperative care

The APL tendon possesses the anatomical peculiarity of being usually composed of two slips: a dorsal one which is inserted on the base of the first metacarpal bone, and a palmar one which is inserted on the fascia of the thenar muscles (Fig. 1a). We use the palmar slip to customize a suspension ligament as a makeshift “hammock” for the first metacarpal, anchored on the thenar fascia on the radial side, and looped around the first dorsal intermetacarpal ligament on the ulnar side. Surgery is performed under regional anaesthesia and using the tourniquet to control bleeding. A longitudinal skin incision of about 30 mm is made between the APL and the extensor pollicis longus (EPL) tendons (Fig. 2). The superficial branches of the radial nerve and
The thenar fascia and looped around the first dorsal intermetacarpal ligament (c). Finally, the hemitendon was pulled back in the trapezial space and sutured, under tension, to itself and to the joint capsule (d).

The radial artery are identified and protected by retractors, then a longitudinal capsulotomy is performed. The trapezium is removed carefully, excising every osteophyte as well. The competence of the first dorsal intermetacarpal ligament (1st–2nd intermetacarpal ligament) is assessed by gently pulling it by a palpator (a practice derived from arthroscopy) so, in the hypotetical case that the ligament is absent or inadequate, an alternative ligamentoplasty could be performed from this same surgical entry route. The palmar slip of the APL tendon is identified, then cut through a little skin incision (Fig. 3), just proximal to the first extensor compartment, and exposed outside from the distal incision. The distally inserted hemitendon thus obtained (Fig. 1b), usually 60 mm in length, is passed beneath the dorsal slip of the APL tendon (Fig. 1c), the extensor pollicis brevis (EPB) tendon and the EPL tendon, through the now empty trapezial space (Fig. 4). By a sharp incision of about 2 mm, made inside-out through the ulnar wall of the capsule (once occupied by the trapezium), the hemitendon is looped around the first dorsal intermetacarpal ligament (which originates from the dorsal-radial aspect of the second metacarpal base and inserts into the ulnar side of the first metacarpal) (Fig. 1d); the empty space of the excised medial osteophyte of the trapezium facilitates this manoeuvre. It must be taken into account that the looping procedure needs to be performed with care to avoid, obviously, any injury to the dorsal branch of the radial artery which is in the nearby. Finally, the hemitendon is pulled back in the trapezial space and sutured, under tension, to itself and to the joint capsule with a non-adsorbable suture (Fig. 5); this tendon slip now suspends the base of the first metacarpal bone. Capsular suture, haemostasis and skin suture complete the procedure.

Figure 1 The abductor pollicis longus (APL) tendon possess the anatomical peculiarity of being usually composed of two slips: a dorsal and a palmar (a). We used the palmar slip (b) to customize a makeshift ‘‘hammock’’ for the first metacarpal, anchored on the thenar fascia and looped around the first dorsal intermetacarpal ligament (c). Finally, the hemitendon was pulled back in the trapezial space and sutured, under tension, to itself and to the joint capsule (d).

Figure 2 A longitudinal skin incision of about 30 mm was made between the abductor pollicis longus (APL) and the extensor pollicis longus (EPL) tendons.

Figure 3 The palmar slip of the abductor pollicis longus (APL) tendon was identified, then cut through a little skin incision, just proximal to the first extensor compartment, and exposed outside from the distal incision.
interphalangeal joint of the thumb, to encompass the wrist; the first metacarpal is positioned in slight abduction. An X-ray film is taken immediately after. From the first day postoperative, active thumb interphalangeal joint movements are prescribed. After one week, the plaster splint is replaced, for additional three weeks, by a thermoplastic splint with incremented abduction and opposition of the thumb. These four weeks of full-time splinting avoid mechanical stresses to the ligamentoplasty and to promote the structuring of the fibrous pad which eventually replaces the empty trapezial space. After these initial four weeks, splinting is prescribed for night use only, for additional two weeks. All patients were instructed about exercises to regain full ability; as an example, opposition exercises which gradually progressed from aiming at the tip of the fifth finger, then towards reaching its base. Only for eight patients a rehabilitation program was deemed necessary and exercises of passive, active-assisted and active range-of-motion were started.

**Assessment methods**

**The functional assessment**

Each patient had subjective assessment for:

- pain, by a visuo-analogic scale (VAS);
- function in daily living activities, by a questionnaire for the disabilities of the arm, shoulder and hand (DASH) [17];
- overall satisfaction, by a 1–10 scale (1 = totally dissatisfied and 10 = completely satisfied).

An objective assessment was enterprise for:

- the first web span angle between the longitudinal axis of the thumb and the second metacarpal;
- palmar and radial abduction and opposition of the thumb, scoring them from 1 to 10 according to Kapandji [18];
- key pinch, recorded in kg by a Preston pinchmeter [19];
- grip strength, recorded in kg by a Jamar dynamometer [20].

All these tests (subjective and objective) were performed in four stages: just prior to surgery, then at three, six and 12 months after surgery.

**Radiographic assessment**

Radiographic assessment included an anteroposterior and lateral views to measure the distance between the scaphoid and the base of the first metacarpal; they were taken routinely: a) – preoperatively; b) – immediately after surgery; c) – one year after surgery. The latter was taken to evaluate the stability of the thumb under stress (stress view); the patient is asked to press the pulp of the thumb against the pulp of the index finger like making an "O".

**Statistical analysis**

Numerical data were reported as a mean and standard deviation.
Results

Eight patients were lost at follow-up from the original 50 patients. So, a total of 42 patients were studied and controlled for one year after surgery.

Complications

We recorded one case of keloid and two cases of temporary dysesthesia of the dorsal-radial region of the thumb. The case of keloid was treated by sylkon foam gel and sheets. The two cases of temporary dysesthesia had a spontaneous resolution, after two and four months respectively.

No case of tendinosis, delayed rupture of the tendon slip, or CRPS 1, were recorded.

Subjective outcome

Pain
Patients experienced a considerable improvement after surgery, as shown in Table 1. One year after operation, no patients complained for any pain at rest and only one reported an occasional mild pain which maintained a limited restriction.

Function in daily living activities
Subjective assessment of functional disability in daily living activities totalled a DASH score of 43.3 preoperatively. After surgery, however, DASH score progressively lowered to 25.5 three months postoperatively; then to 19.1 six months postoperatively; and reached 14.5 one year postoperatively, as shown in Table 1.

Overall satisfaction
The group totalled a 9.6 ± 0.8 score in overall satisfaction.

Objective outcome

Surgery lead to a marked improvement in reducing stiffness and enhancing strength. No patient in this series reported any alteration at the metacarpophalangeal joint.

Web span angle
Starting from 43° ± 5° preoperatively, it ended as 77° ± 3° one year after surgery.

Kapandji score
It improved from the figure of six preoperatively to nine one year after surgery.

Key pinch
The value was 3.7 kg ± 1.2 preoperatively and reached 5.6 kg ± 1.5 one year after surgery.

Grip strength
The value was 16.0 kg ± 1.2 preoperative and reached 19.2 kg ± 0.5 one year after surgery.

Radiographic outcome

X-ray films taken at one-year follow-up (Fig. 6) showed a distance between the distal scaphoid and first metacarpal base of 6.7 mm (±0.6); these values where basically confirmed in "stress views" were the distance was 6.4 mm (±0.6).

Anatomical variations

We enlisted four patients where the APL tendon is not composed by two different slips but has a large insertion which encompasses both the metacarpal base and the thenar fascia. The solution we used was to split a palmar slip of the single tendon by a lancet and dissected it, from distal to proximal, until reaching the distal exit of the first extensor compartment; the freshly made "sibling" palmar slip was then used as the usual one. We did not record any difference in the outcome with the rest of the patients.

Discussion

Trapeziectomy combined with a suspension ligamentoplasty is the procedure of choice in the treatment of trapeziometacarpal arthritis in many hand surgery departments. To combine restoration of motion and strength of the first ray with stability of results in the long term, the trapeziectomy + ligamentoplasty must achieve the creation of an effective support for the first metacarpal. The new ligament is required to keep the first metacarpal suspended in place for the time necessary to the functional fibrous pad to develop. Proximal migration of the first metacarpal is often encountered when the simple excision of the trapezium is the treatment of choice but some authors have reported that the loss of height of the thumb is of little disadvantage

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<th>Table 1</th>
<th>Pain score and disabilities of the arm, shoulder and hand (DASH) score.</th>
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<td></td>
<td>Preoperative</td>
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<td>Pain (in 42 patients)</td>
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<tr>
<td>No pain and restriction</td>
<td>0</td>
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<tr>
<td>Mild pain with use: some restriction</td>
<td>6</td>
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<tr>
<td>Pain at rest: some restriction</td>
<td>16</td>
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<tr>
<td>Pain at rest: severe restriction</td>
<td>20</td>
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<td>DASH score</td>
<td>43.3</td>
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for the patients in terms of satisfaction, pain relief and improvement of thumb function [21]. However, in our opinion, we ask why should the surgeon and the patient accept this possible functional and cosmetic diminution when an alternative surgical procedure exists, which can achieve both restoration of anatomy and functional strength? Furthermore, simple trapeziectomy has been less favoured in recent past due to reports of postoperative weakness [22] while kinematic analysis showed that ligament reconstruction and tendon interposition can achieve a joint radius of motion and a three-dimensional work area close to that of the intact thumb [23].

"Hematoma distraction arthroplasty" and procedures that advocate simple removal of the trapezium without any suspension at least in part rely on the first dorsal intermetacarpal ligament to prevent proximal migration. However, sinking of the thumb is a common occurrence and this should rule out the efficacy of the first dorsal intermetacarpal ligament alone as a valid suspensory ligament. It may be plausible that the looping proposed in our technique, with the creation of a "hammock" from the tenar musculature (where the APL palmar slip originates) to the first web space, produces a coarser and strengthened first dorsal intermetacarpal ligament as it is now embedded in this new tenar-2nd metacarpal structure.

The fact that trapeziectomy is quite a simple and straightforward technique is a good point in its favour; consequently, a simple and straightforward trapeziectomy + ligamentoplasty has to be proposed to be a competitive alternative. Simplification is part of the reason why authors enterprise the search for a new ligamentoplasty; the remaining part is the search for a technique which could avoid looping around a tendon and, in so doing, avoid the possibility to cause tenidiosis. In our opinion, the finding that no tendinosis, or delayed ruptures of the tendon slip, or CRPS 1, were recorded in this reported series is one of the most relevant.

Clinical reports on trapeziectomy + ligamentoplasty procedures have shown good results in regards to pain relief and functional outcomes [24–37]. However, many procedures seem more difficult to perform than the one proposed in this paper. Many involve larger dissections of wrist tendons, or bone tunnelling, or bigger exposure of the first metacarpal with an associated bigger scar. In our opinion, the procedure that we propose has shown some advantages in its easy performing, short time of surgery and comfortable postoperative prescriptions for the patient. It is very respectful of the normal anatomy and physiology in minimizing the re-routing of functioning tendons (or hemitendons) apart from the negligible sacrifice of the palmar slip of the APL. The mechanical reliability of the technique is reflected by the negligible difference in thumb height which has been recorded on the X-ray films at one-year follow-up. It will be useful to follow-up further this result which, however, it is likely to be maintained in the future as long as a structured fibrous pad is responsible for it. It can be outlined that this technique provides a distal suspension point (the first intermetacarpal ligament) without the need of bone tunnelling.

A point worth to be discussed is the fact that, to better achieve a permanent stabilization of the thumb in place, some authors advocate its temporary stabilization by the pinning (for about one month) of the first metacarpal to the second metacarpal (performed by one or more Kirschner’s wires) [21,38]. This method can be uncomfortable for the patient, requiring the removal of the pin(s) postoperatively, and being the possible cause of a pin-tract infection, CRPS 1 and pin-breakage; we applied this side-procedure in the past and experienced those complications. Furthermore, once again a report has been published which did not show any significant difference with simple trapeziectomy [39].

However, the proposed technique presents a controversial point in the fact that in some patients the APL tendon is not composed by two different slips but has a single large
insertion [40] (in our series we enlisted four patients with such variation, as already stated), however the solution we presented (namely, the splitting of a palmar slip) seemed effective for these rare cases.

A final consideration is that, in principle, different categories of surgical procedures may be mastered in solving the individual problem of each different patient suffering from CMC joint osteoarthritis: maybe, artificial joint replacement, fusion, trapeziectomy ± ligamentoplasty, may all have preferential indications (as the favourable outcome results, reported for all of these techniques, could imply). However, in reality, the single surgeon and the practical management of a Hand Surgery Unit may lean on the “one technique” approach for practical purposes. We propose the presented technique as an effective procedure both to expand the “weaponary” for treating the CMC joint osteoarthritis and/or to simplify the ligamentoplasties one may be using already. The future observations, when a follow-up longer than five or 10 years will become available, will be helpful in assessing the effectiveness of this new technique also in regard to these practical issues.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References

Abductor pollicis longus hemitendon as interposition after trapeziectomy


