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Original Research

Bone-Preserving Arthroplasty With Abductor Pollicis Longus Tenodesis for Trapeziometacarpal Osteoarthritis

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Purpose: The objective of this study was to describe an original method of bone-preserving arthroplasty with abductor pollicis longus (APL) tenodesis and determine its safety and effectiveness as a treatment for early-stage osteoarthritis of the trapeziometacarpal joint.

Methods: Eleven patients underwent a trapezium-preserving arthroplasty with APL tenodesis for stage 1 and 2 osteoarthritis were retrospectively reviewed. This arthroplasty consisted of a distally-based APL tendon being passed through the trapeziometacarpal joint. The proximal end of the tendon was then pulled and passed through a drill hole made at the neck of the second metacarpal and sutured to itself. Thus, distraction of the first metacarpal and interposition of the tendon were created. Postoperative radiologic and clinical follow-up visits were performed at 4, 8, and 12 weeks. Range of motion and strength were assessed after surgery. Patient satisfaction and outcome were assessed, and the disabilities of the arm, shoulder, and hand (DASH) score was used.

Results: After a mean follow-up of 29.5 months (range, 16–43 months), the mean patient visual analog scale pain score improved from 7.1 to 2.3. The average DASH score of all patients at the follow-up examination was 18.3 ± 19.8. Patients' mean grip strength was 25.3 kg, which represented 102% of the value on the contralateral side. The key-pinch strength was 6.2 kg on the operated hand compared with 6.5 kg on the contralateral side. The mean thumb opposition Kapandji index was 9.4, which was similar to that of the contralateral side. Three patients were very satisfied with the postoperative outcome and 3 patients were satisfied. Two patients were lost to follow-up, 1 patient did not consent to share her data, and 2 patients had to undergo trapeziectomy.

Conclusions: Although a larger study population and a longer follow-up period are needed to draw conclusions, bone-preserving arthroplasty with APL tenodesis showed satisfying results in patients presenting with early-stage osteoarthritis. This method is technically simple and time-efficient, does not reduce the range of motion, and leaves open all other surgical options.

Type of study/level of evidence: Therapeutic IV, Case Series.

The treatment of early-stage osteoarthritis of the trapeziometacarpal (TM) joint includes primary activity modification, nonsteroidal anti-inflammatory drugs, splinting, steroid injection, and, eventually, surgery.[1,2] Young and middle-aged patients with stage 1 and 2 arthritis[3,4] who do not respond to nonsurgical treatment present a challenging situation for the treating surgeon. There are many surgical options including osteotomy, carpometacarpal (CMC) arthroscopy with debridement, trapeziectomy with or without ligament reconstruction and tendon interposition, trapeziectomy with tightrope suspension, arthrodesis, and implant

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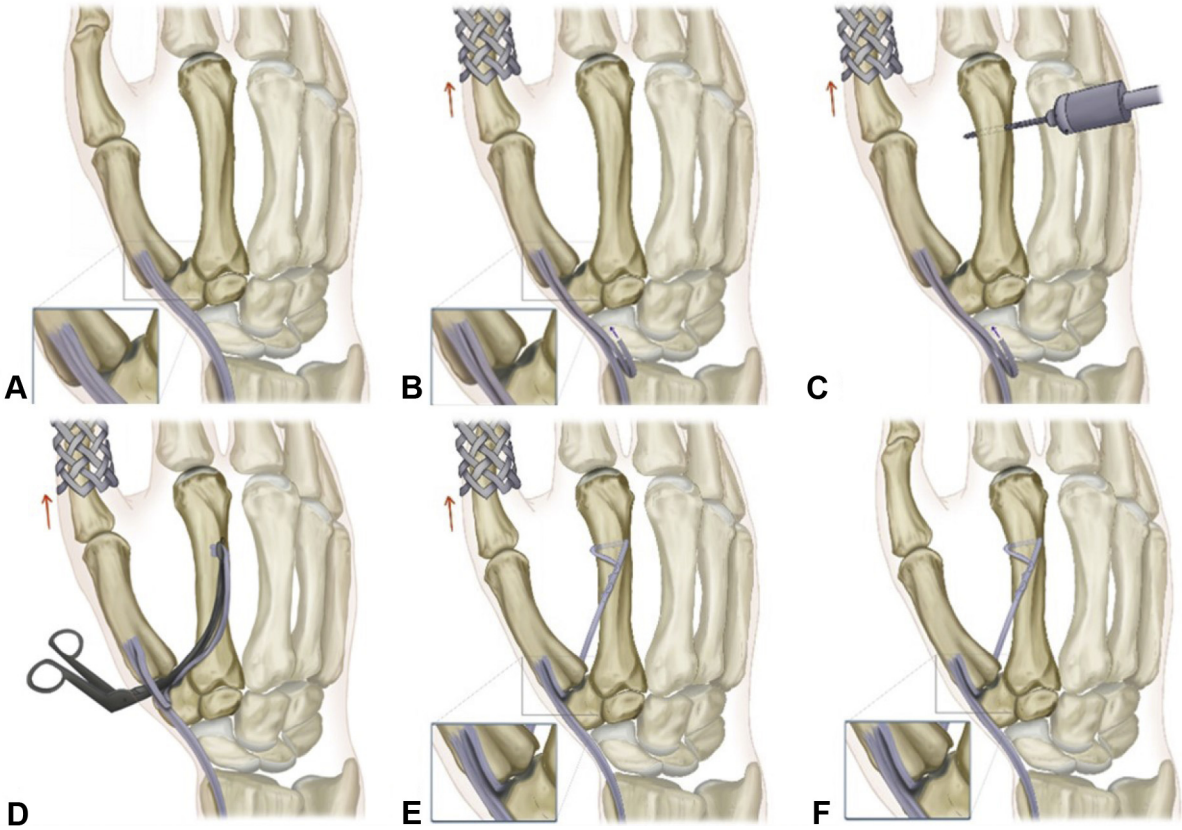

Figure 1. Illustration showing the operative technique. **A** Exposure of the APL tendon. **B** Distraction of the thumb (red arrow) and harvesting of at least 1 slip of the APL tendon, keeping its distal insertion intact. **C** A small incision is made over the neck of the second metacarpal and a vertical drill hole is made through it. **D** The pedicled APL tendon is inserted through the TM joint with a curved tendon passer. **E** It is then pulled through the drill hole in the second metacarpal bone and sutured to itself through the Pulvertaft technique. **F** Finally, the traction is released.

arthroplasty. Thus far, there is no consensus regarding the optimal treatment[1,5,6] but for young or middle-aged patients with early stages of arthritis, it may be particularly indicated to preserve all or part of the trapezium.[7] Trapezium-sparing suspension arthroplasty with a free palmaris longus tendon was introduced in 2007 by Bufalini and Perugia,[8] showing satisfying clinical and radiological results in a small series of patients.[8,9] Our study describes a technique in which a bone-preserving arthroplasty with suspension-tenodesis of the abductor pollicis longus (APL) tendon is performed and evaluated in a series of 6 patients with TM osteoarthritis.

Materials and Methods

Patients

This study was approved by the local ethics committee. Between February 2015 and August 2018, 11 women, mean age of 47.5 years (range, 37–61 years), underwent a bone-preserving TM arthroplasty with APL tenodesis. Two patients developed the progression of pain and dysfunction without radiologic progression of osteoarthritis, and they had to undergo trapeziectomy after 11 and 19 months, respectively. Although these 2 patients did not undergo a clinical follow-up assessment, they were included in the results and discussion sections. Two patients were lost to follow-up, and 1 patient did not consent to have her data included in the analysis. Thus, a total of 6 operated patients with informed consent were evaluated after a mean follow-up time of 29.5 months (range, 16–43 months), among whom 1 patient could only be assessed by a phone interview. All patients had stage 1 or 2 TM osteoarthritis. In all patients, nonsurgical therapy including splinting, steroid injection, and hand therapy had failed over time. The dominant hand was involved in 4 of the 6 patients. Three patients had a manual occupation.

Descriptive statistics were used to evaluate patient demographic data, and continuous data were expressed as mean and standard deviation.

Surgical technique

A 4-cm long longitudinal incision was made on the dorsal aspect of the first metacarpal base and TM joint. The branches of the superficial radial nerve were identified and spared. The extensor pollicis brevis and APL tendons were exposed, and the first extensor compartment was opened to free the APL tendon and harvest it proximally, whereas the insertion at the base of the first metacarpal was left intact. The steps of the operation are shown in Figure 1. The deep branch of the radial artery was then identified and secured. The TM joint was exposed, and a 2.5-kg pull was put on the thumb to distract the joint. An incision was made in the dorsal capsule, and the proximally pedicled APL tendon was pushed through the TM joint with a curved tendon passer. A small incision was made over the neck of the second metacarpal and a vertical drill hole (3.5 mm) was created through it. The harvested tendon was then pulled through the drill hole in the second metacarpal bone and sutured to itself using the Pulvertaft technique.[10] In 2 patients, a single 1.0 mm (0.039 in) K-wire was inserted through the first and second metacarpals to

improve stability. After surgery, a wrist and thumb splint sparing the interphalangeal joint was applied for 4 weeks. If a K-wire was used, removal was performed after 4 weeks and hand therapy was initiated. Weight bearing started 6 weeks after surgery.

Assessment of operative results

A clinical assessment was performed by the first author of this study (F.T.). As there were no reliable preoperative data, the postoperative results were compared with that of the contralateral side. Grip strength was determined bimanually using a Jamar-Dynamometer (Baseline Hydraulic Hand Dynamometer, Fabrication Enterprises, Inc.). Tip-pinch and key-pinch strength were assessed bimanually using a pinch dynamometer (Baseline Pinch Gauge, Orthopartner AG). Three measurements were performed each time, and the average was calculated. These measurements were not corrected according to dominance. Radial abduction of the thumb was measured in the frontal plane using a goniometer and thumb opposition was documented using the Kapandji index on both hands, respectively.[11]

The intensity of pain was assessed with a visual analog scale (VAS; 0 indicating no pain and 10 indicating intolerable pain). Patients were asked to compare the pain with the preoperative intensity. In addition, patients subjectively classified their satisfaction with surgical results as "very satisfied," "satisfied," "neutral," "dissatisfied," or "very dissatisfied". The disabilities of the arm, shoulder, and hand (DASH) score was used to evaluate the operative outcome.[12]

Finally, standard anteroposterior, lateral, and oblique hand radiographs were performed after surgery and compared with the preoperative radiographs, particularly regarding osteoarthritis progression. Osteoarthritis on radiographs was analyzed and classified into 4 stages according to Eaton et al[3] The operation time and complications were also retrospectively recorded and analyzed.

Results

The average time of operation was 71 minutes (range, 55–98 minutes). The mean VAS pain score of patients improved from 7.1 ± 1.0 before surgery to 2.3 ± 3.0 after surgery. The average DASH score of all patients at the follow-up examination was 18.3 ± 19.8. At the final follow-up, patients' mean grip strength was 25.3 ± 8.6 kg, which represented 102% of the value on the contralateral side. The key-pinch strength was 6.2 ± 1.7 kg compared with 6.5 ± 1.3 kg on the contralateral side. The mean thumb opposition Kapandji index was 9.4 ± 0.48 at the last follow-up, which was similar to that of the contralateral side. The mean thumb abduction to the radial side in the plane of the palm of the hand was 63° ± 17.2° at the last follow-up compared with 65° ± 14.8° on the contralateral side (Table 1). Radiological progression of osteoarthritis was observed in 4 of the 8 patients (Fig. 2).

In total, 3 of the 8 patients required revision surgery: 1 because of a painful scar and 2 (not included in the clinical follow-up assessment) because of the progression of pain and dysfunction. The latter 2 patients underwent trapeziectomy after 11 and 19 months, respectively. The preoperative radiological evaluation of these 2 patients showed progression of osteoarthritis in 1 of the 2 patients. Although these 2 patients did not have a clinical follow-up assessment, they were considered unsatisfied with the results and unwilling to repeat the surgery. Three patients were very satisfied with the postoperative outcome, and the remaining 3 patients were satisfied. Five of the 6 patients who underwent the follow-up assessment stated that they would have elected to have the procedure again.

Table 1
Continuous Variables

Variables	Range	Mean (SD)
Age (years)	37–61	47.5 (9.2)
Follow-up (months)	16–43	29.5 (10.7)
Thumb opposition (Kapandji index)		
Operated side	9–10	9.4 (0.55)
Contralateral side	9–10	9.4 (0.55)
Grip strength (kg)		
Operated side	15.3–37.6	25.3 (9.6)
Contralateral side	18.3–33.4	24.6 (6.8)
Key pinch (kg)		
Operated side	4–8	6.3 (1.9)
Contralateral side	5–9	6.6 (1.6)
Tip pinch (kg)		
Operated side	3.3–7.2	5.3 (1.4)
Contralateral side	4.6–7.5	5.9 (1.4)
Thumb abduction (degree)		
Operated side	40–90	63 (19.2)
Contralateral side	50–90	65 (16.6)
VAS pain		
Before surgery	6–8.5	7.1 (1.0)
After surgery	0–8	2.3 (3.0)
DASH score	0–55	18.3 (22.1)

Discussion

The treatment of early-stage trapeziometacarpal osteoarthritis remains a matter of debate, particularly in young and middle-aged patients who do not respond to nonsurgical treatment. This has been shown in an online questionnaire study conducted by Wolf and Delaronde[6] with 1156 members of the American Society for Surgery of the Hand. A total of 18% of surgeons considered trapeziectomy, with or without ligament reconstruction and tendon interposition, for a 42-year-old patient with moderate to severe pain and minimal narrowing of a TM joint that was recalcitrant to splinting and steroid injection. The study highlighted the discrepancy in the choice of procedure between surgeons and showed that almost 80% preferred trapezium-sparing treatment in a young patient population.[6]

In a systematic review, arthroscopic debridement, with or without interposition, has shown satisfactory results in early stages of arthritis among the trapezium-sparing techniques, despite the relatively limited documentation on outcomes, short follow-up period, and a small number of patients.[13] Basal osteotomy of the first metacarpal for the treatment of thumb CMC arthritis was first described in 1973.[14–17] It reduced pain through the unloading of the palmar contact area and shifting of the loading area more dorsally.[18] Furthermore, it has been shown to reduce CMC joint laxity in the lateral pinch position.[19,20] In a follow-up review of 13 patients, Chou et al[21] found that 77% of patients were satisfied or very satisfied at a mean follow-up of 9.9 years (range, 6–14 years). Bachoura et al[22] found that 7 of 32 operated thumbs (22%) required reoperation. Kaplan-Meier analysis of this series indicated a 70% probability that patients who had an extension osteotomy would not require additional CMC surgery for up to 14 years. Parker et al[23] found excellent functional outcomes in 6 of 8 patients after a mean follow-up of 9 years (range, 6–13 years). In another small review of 12 patients with extension osteotomy, among whom 7 had early degenerative changes, motion and pinch strength were slightly improved compared with the preoperative value, whereas the grip strength in this group decreased by −7 kg (range, from −24 kg to 4 kg).[24] However, complications related to this technique have been reported, including nonunion, persistent pain, injury to the radial sensory nerve, and trapeziometacarpal joint instability.[24]

Ligament reconstruction as described by Eaton and Littler[4] has shown 67% excellent and 30% good results at a mean follow-up of

Figure 2. **A** Anteroposterior and **B** oblique preoperative radiographs showed early-stage TM osteoarthritis. **C**, **D** Radiographs taken 40 months after surgery showed no signs of osteoarthritis progression.

5.2 years (range, 1–17 years) in 37 consecutive cases.[25] Among 19 patients with stage 1 and 2 arthritis, 13 patients had excellent results and 5 patients had good results at a mean follow-up of 7.1 years (range, 4–13 years).[3] Comparatively, Schoenaers et al[26] reported satisfaction in only 45% of patients and revision surgery in 20% of patients. Trapezium-sparing suspension arthroplasty with a free palmaris longus tendon was described by Bufalini and Perugia in 2007.[8] The results obtained in 25 patients using this surgical technique at a mean follow-up of 18 months showed complete or almost complete disappearance of pain in all patients. In a series of 7 patients (8 hands) with a mean follow-up of 46.5 months (range, 29–63 months), Fatzer et al[9] described very good results with 6 very satisfied patients and 2 satisfied patients. This technique used a tendon graft (palmaris longus or a strip of the flexor carpi radialis tendon), and it limited friction of the joint surfaces through the suspension and reduced subluxation of the CMC joint.

Our technique presents the advantage of avoiding the harvest of the palmaris longus tendon, thus reducing the risk of further soft tissue damage. Moreover, the insertion of the APL tendon at the base of the first metacarpal is left intact; thereby, providing a proximally more stable bone-tendon fixation of the distraction than that of an anchored autograft. By doing so, the risk of graft failure might in theory be reduced. In our series of patients, no graft failure was reported, whereas Fatzer et al[9] reported 2 likely graft failures in their patients treated with the original Bufalini procedure. Furthermore, the anchoring of the tendon only in the second metacarpal is considered time-efficient compared with a free graft, which requires fixation at the first and second metacarpals. Moreover, by rerouting the tendon through the joint, a tendon sling at the base of the first metacarpal is automatically created, offering good stability and a lever arm to reduce the subluxation of the thumb metacarpal joint. At the same time, the attrition between the thumb metacarpal and the trapezium is decreased by the distraction of the first metacarpal and interposition of the tendon.

In this series, although 5 of the 6 patients assessed stated that they would undergo reoperation, 3 of 8 patients had a complication, which was a substantial number. One patient with a painful scar needed a revision of the scar 9 months later. No peripheral nerve injury could be found; however, superficial branches of the radial nerve are at risk during the approach and should be carefully identified and protected. Two patients presented with aggravating pain and dysfunction, and they underwent trapeziectomy after 11 and 19 months, respectively.

Only 1 of those 2 patients presented progression of osteoarthritis. This technique included a small arthrotomy and passing the abductor pollicis tendon through the joint. If not done carefully with the distraction of the joint, the cartilage can be further damaged.

The only patient who stated that she would not undergo such surgery again also showed radiologic progression of osteoarthritis at a follow-up interval of 21 months. Her pain level had increased compared with that before surgery, and her DASH score was the worst among the population under study. However, thumb opposition scores and grip, tip-pinch, and key-pinch strength were similar in the other patients. The patient was reported to be generally satisfied with the outcome of the surgery. Two more patients in our group also showed progression of osteoarthritis but reported improvement in pain and function. One of these patients, however, did not experience any pain. As mentioned earlier, only 1 of 2 patients who developed the progression of pain and underwent trapeziectomy showed a progression of osteoarthritis on radiographs. The reason for these contradictory results remains unclear but underlines the fact that the presence of radiologic osteoarthritis in the hand seems to have only a modest to weak association with pain and disability.[27,28] Moreover, this might be due to the different daily activities required by a patient's occupation: 1 patient with worsening pain had to perform manual tasks requiring a key-pinch motion, 1 was working at an office with 80% workload, and 1 was receiving workers' compensation. Compared with the trapezium-sparing arthroplasty of Bufalini and Perugia[8], they did not include the radiologic progression of osteoarthritis in their original report. In the series by Fatzer et al,[9] they reported no radiologic progression of osteoarthritis at a mean follow-up of 46.5 months (range, 29–63 months), whereas our series showed progression of osteoarthritis in 50% of patients at a mean follow-up of 25.5 months (range, 8–43 months). This discrepancy might be due to coincidence, owing to the small number of patients in each group. One might also speculate that osteoarthritis is triggered by passing the tendon through the TM joint or the residual non-physiological loading of the joint.

This study has some limitations. First, this is a retrospective series consisting of a small number of patients. Only 6 of 11 patients could be included in the follow-up assessment, thereby missing potentially important data. If more patients were assessed, the results might have been different. Second, postoperative results were compared with those of the contralateral side, as there were no reliable preoperative data.

Although a larger patient group and a longer follow-up period are needed to draw conclusions on the outcomes, this bone-preserving arthroplasty with APL tenodesis for TM osteoarthritis showed satisfying early results in patients presenting with early-stage osteoarthritis. However, it is important to underline that a number of patients undergoing this technique might require a revision surgery and osteoarthritis progression (although not always symptomatic) can be expected. This approach is technically simple and time-efficient, does not reduce the range of motion, and leaves open all other future surgical options.

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