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Original Research

Partial Versus Total Trapeziectomy With Interposition Arthroplasty for Trapeziometacarpal Osteoarthritis Grade II to III Eaton-Littler: A Clinical Trial

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Purpose: Total trapeziectomy is the most widely used technique to treat isolated thumb trapeziometacarpal joint osteoarthritis. However, this technique has been associated with proximal migration of the thumb metacarpal, which has led some physicians to consider partial trapeziectomy as a valid alternative. The purpose of this study was to assess whether partial trapeziectomy improves final key pinch strength compared with total trapeziectomy.
Methods: We randomized 34 patients with basal thumb osteoarthritis into 2 groups to undergo partial or total trapeziectomy with interposition arthroplasty. Key pinch strength at 12 months was the primary outcome measure. Other variables measured included trapezial space height, range of motion, grip strength, change in key pinch strength, patient-reported outcome measures, and pain.
Results: No difference between groups was detected regarding final pinch strength, trapezial space height, grip strength, range of motion, change in pinch strength, patient-reported outcomes (*Quick*—Disabilities of the Arm, Shoulder, or Hand), or pain.
Conclusions: We cannot conclude that partial trapeziectomy provides an advantage over total trapeziectomy at 1 year after surgery. Although trapeziometacarpal space was substantially preserved in the partial trapeziectomy group at 12 months, this difference was not statistically or clinically significant.
Type of study/level of evidence: Diagnostic III.

Trapeziectomy was first described in 1947 by Gervis.[1] Since then, this method has been used as an effective treatment for trapeziometacarpal osteoarthritis (TMOA) improving mobility and pain. Trapeziectomy has also been associated with a loss of thumb strength resulting from proximal migration of the metacarpal.[2]

In 1986, Burton and Pellegrini[3] described a new technique consisting of ligament reconstruction and tendon interposition arthroplasty, which reduced proximal migration of the metacarpal.

Partial trapeziectomy (PT) was later introduced to preserve maximum thumb length.[4] The aim of PT is to preserve healthy joints to maintain stability and strength and prevent first ray collapse. It is mainly indicated in patients without trapezioscaphoid involvement.

The purposes of this study were to assess whether PT improves final key pinch strength compared with total trapeziectomy (TT) and to correlate the radiographic findings with patient outcomes. We hypothesized that PT would preserve final key pinch strength better than TT for basal thumb arthritis surgery.

Materials and Methods

This study was conducted as a single-center, single-blinded, randomized controlled trial at the Department of Hand and Wrist

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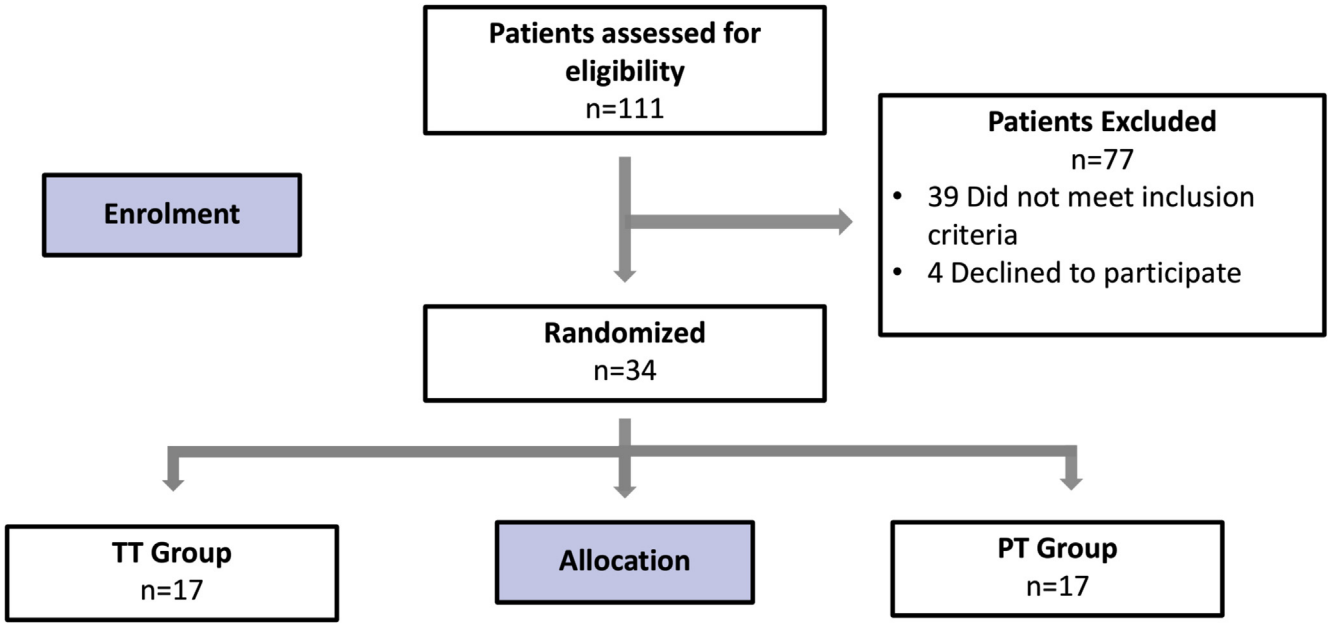

Figure 1. Study flowchart.

Surgery at our institution. A total of 34 patients were included between February 2014 and February 2015. The sample size was calculated with 2-tailed $\alpha = 0.05$ and $(1\text{-}\beta) = 0.80$, considering as relevant a difference of 0.3 kg in final pinch strength using the same calibrated dynamometer each time. This difference was considered relevant based on a previous local pilot study and using a published paper with a similar population.[5] Using these values, a sample size of 34 patients was calculated.

Inclusion criteria were patients with isolated TMOA grade II to III (Eaton-Littler) with articular pain and loss of hand function. All patients provided written informed consent. Patients with TMOA grade IV (Eaton-Littler) and those with cognitive impairment and posttraumatic osteoarthritis were excluded, as well as those with hyperextension of the metacarpophalangeal joint. Figure 1 shows a study flowchart.

Block randomization was accomplished by means of sequentially numbered sealed opaque envelopes. Allocation ratio was 1:1, and the allocation sequence was previously generated by an external analyst. The same physician performed all surgical procedures.

Patients who consented to participate were randomly assigned to undergo PT or TT with suspension and interposition arthroplasty based on the Weilby technique.[6] The incision was made on the radial edge of the first metacarpal, preserving the sensory branch of the radial nerve, and performing total or partial trapeziectomy, according to the randomized treatment previously assigned. Partial trapeziectomy was performed with the help of a saw and the distal 5 to 10 mm of the trapezium was resected, leaving enough space for the ligament suspension plasty. As shown in Figure 2, we harvested half of the flexor carpi radialis tendon and wove it in a figure-of-8 form around the insertion of the abductor pollicis longus tendon and a remaining strand of flexor carpi radialis. Fixation of the tendon was done with a nonabsorbable suture and then pulled together into the trapezial space. The thumb was then immobilized for 3 weeks with a thumb spica orthosis, followed by 3 months of physiotherapy until stabilization.

Objective outcomes included trapezial space height, key pinch strength, grip strength, and joint range of motion. Subjective outcomes were function and pain.

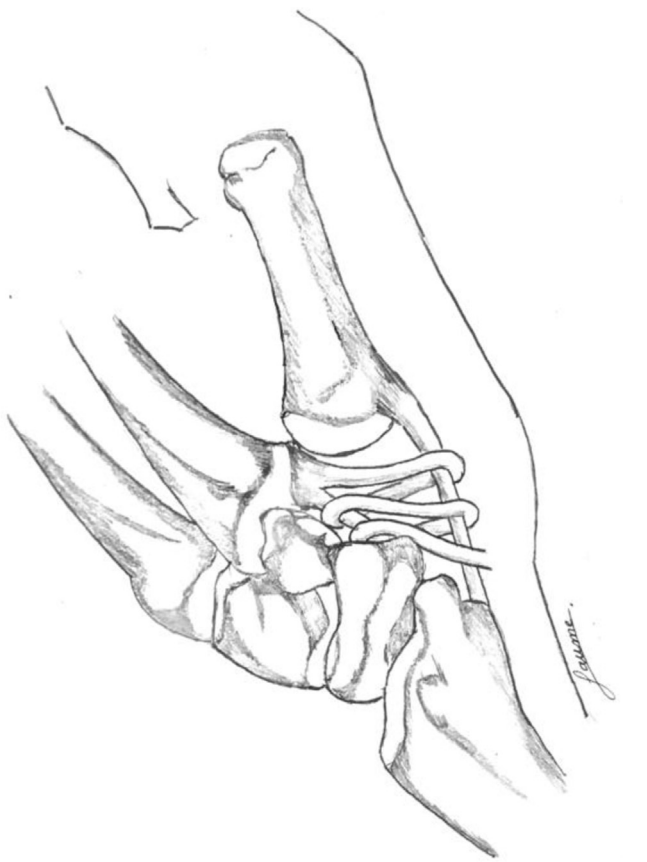

Figure 2. Harvested half of the flexor carpi radialis tendon woven in a figure-of-8 form around the insertion of the abductor pollicis longus tendon and a remaining strand of flexor carpi radialis.

Outcomes were evaluated at different time points: before surgery at 3 and 12 months after surgery. Trapezial space height was evaluated only before surgery and 1 year after surgery. Trapezial

Figure 3. Lateral x-ray view of the thumb metacarpal used to measure trapezial height, measured as the distance in millimeters between 2 parallel lines marked by the articular surface of the distal pole of the scaphoid and the thumb metacarpal base.

space height was measured using calibrated x-rays. It was measured as the distance in millimeters between 2 parallel lines marked by the articular surface of the distal pole of the scaphoid and thumb metacarpal base in the lateral x-ray view. Two radiologists who were blinded to the functional outcome but not to the method of treatment performed all radiographic measurements (Fig. 3).

Key pinch and grip strength were assessed using a baseline pinch gauge and grip dynamometer, respectively. In all cases, 3 measurements were made at each medical examination and the mean of the measurements was recorded. All recordings were performed with the same calibrated instruments. The main variable was final key pinch strength at 12 months; however, we also analyzed the difference in pinch strength from baseline to 12 months and final grip strength at 12 months. Joint range of motion was measured as thumb opposition evaluated using the Kapandji score.[7]

To measure physical function and symptoms, a patient-reported outcome (*Quick*—Disabilities of the Arm, Shoulder, and Hand questionnaire [*Quick*DASH])[8] was administered. In addition, the degree of pain was assessed by a visual analog scale.

Collected data were processed by an independent analyst to ensure observer blinding of results. Patients' characteristics were expressed as the mean and SD or number and percentage.

Student *t* test and Mann-Whitney U test were used to compare numerical variables between groups. Categorical data were analyzed with chi-square. $P < .05$ was considered statistically significant.

We conducted per-protocol data analysis. The study received institutional review board approval and the protocol was registered at the US National Institutes of Health (clinicaltrials.gov) with the identifier NCT02693600. The authors have adhered to Consolidated Standards of Reporting Trials guidelines.

Results

The study was completed in February 2017 after a sample size of 34 patients was obtained; surgery was performed with a minimum of 1-year follow-up. Seventeen patients were assigned to each group. Two patients were lost to follow-up: one in the PT group owing to an unrelated death during follow-up and another in the TT group because a patient kept no subsequent appointments and did not answer phone calls. Table 1 lists baseline characteristics of groups.

One year after surgery, both groups improved in both pain and subjective outcomes (*Quick*DASH), as shown in Tables 1 and 2. No significant differences were observed between groups in the final key pinch strength (TT: 3.6 kg, SD = 1.9; PT: 3.6 kg, SD = 3.1) at 12

Table 1
Baseline Characteristics for TT and PT Groups

Variable Description	Total (n = 34)	TT (n = 17)	PT (n = 17)
Age in years (SD)	60.5 (9.8)	61.0 (8.9)	60.5 (9.8)
Female, n (%)	28 (82.4)	15 (88.2)	13 (76.5)
Male, n (%)	6 (17.6)	2 (11.8)	4 (23.5)
L:R	10:24	4:13	6:11
Dominant hand, n (%)	29 (85.3)	14 (82.5)	15 (88.2)
Eaton stage osteoarthritis II, n (%)	9 (27)	5 (29)	4 (25)
Eaton stage osteoarthritis III, n (%)	24 (73)	12 (71)	12 (75)
Mean visual analog scale pain (SD)	7 (1)	6.8 (1.0)	7.3 (1.8)
Mean *Quick*DASH (SD)	43 (8)	42.1 (6.5)	43.3 (8.7)
Mean key pinch strength, kg (SD)	3.6 (2.1)	4.1 (2.0)	3.1 (1.7)
Mean grip strength, kg (SD)	11.6 (6.4)	13.5 (7.2)	9.8 (5.1)
Mean trapezial space height, mm (SD)	10.8 (1.3)	11 (1.3)	10.5 (1.2)

Table 2
Outcome Parameters for Variables Between TT and PT Groups at 12 Mo Follow-Up

Variable Description	TT (n = 16)	PT (n = 16)	*P* Value
Mean trapezial space height, mm (SD)	6.6 (1.7)	9.3 (1.2)	.091
Mean key pinch, (SD)	3.6 (1.9)	3.6 (3.1)	.568
Mean Δ key pinch, kg (SD)*	−0.5 (1.6)	0.6 (2.2)	.126
Mean grip strength, kg (SD)	15.6 (7.8)	13.4 (6.3)	.384
Kapandji index (median [range])	8 (6–10)	8 (5–10)	.259
Mean visual analog scale pain (SD)	2.6 (2.7)	2.3 (2.3)	.328
Mean *Quick*DASH (SD)	27.3 (9.4)	29.2 (10.8)	.180

* Change in key pinch strength (12 months after surgery strength minus baseline strength).

months' follow-up. However, the change observed in key pinch strength from baseline to the 12-month visit showed an improvement in the PT group (Δ 0.5 kg; SD = 1.6) and a deterioration in the TT group (Δ −0.6 kg; SD = 2.2), although this difference was not statistically significant ($P = .126$). There was no difference in final trapezial space height (TT: mean = 6.7 mm, SD = 1.7 mm; PT: mean = 9.3 mm, SD = 1.2 mm; $P = .09$). No other secondary variables showed differences at 12 months.

Discussion

The relationship between trapezial space height and key pinch strength is currently debated. Some studies show that a decrease in trapezial space height has no relation to key pinch strength or subjective outcomes.[9–12] In contrast, other authors found a relationship among trapezial space height decrease, key pinch strength,[13] first metacarpal subluxation, and DASH score.[14] Yet the relationship among partial trapeziectomy, a decrease in trapezial space height, and key pinch strength has poorly been described.

Trumble et al[14] showed a 21% decrease in trapezial space height with partial trapeziectomy with ligament reconstruction and interposition with costochondral allograft and an improvement in key pinch strength compared with baseline. Menon[4] found that key pinch strength and grip strength increased significantly after PT and interpositional arthroplasty but did not relate to trapeziometacarpal space height. In a retrospective series of 33 patients undergoing PT with suspension and interposition tendinoplasty, Martinel et al[15] found a decrease in trapeziometacarpal space of 2.54 mm at 5 years but did not assess preoperative key pinch strength values.

The results obtained in this randomized controlled trial comparing the evolution of patients with TMOA grade II to III (Eaton-Littler) who underwent PT or TT with suspension and interposition arthroplasty showed a decrease in trapezial space height in both groups, markedly lesser with PT (11.4%) than with TT (39.4%). Nevertheless, this difference was not associated with a better functional outcome at 1 year after surgery.

To the authors' knowledge, few studies have compared the TT and PT techniques. A retrospective study performed by Park et al[16] compared trapeziectomy with hematoma distraction arthroplasty, hemitrapeziectomy with osteochondral allograft, and ligament reconstruction tendon interposition and found no significant difference among groups in terms of DASH score or key pinch strength. Another retrospective study, by García-Mas et al,[5] with a minimum follow-up of 3 years, reviewed 112 arthroligamentoplasties performed to basal thumb arthritis Eaton grade II, III, and IV, comparing 93 PT and 9 TT. The authors concluded that both techniques resulted in similar outcomes. Thoma et al[17] reported on the feasibility of performing a large-scale trial comparing both techniques, highlighting that although it would be feasible, the main challenges were follow-up visits and collecting data in subsequent appointments.

A biomechanical study in cadaveric models by Salas et al[18] assessed trapezial space after TT and PT with capsular interposition (CI) and found that under lateral pinch load, PT CI resulted in less proximal metacarpal subsidence and better maintenance of thumb length than TT CI.

In the current study, a rapid improvement in subjective outcomes (pain and DASH score) was observed at 3 months, with further improvement at 1 year, in concordance with other studies.[5,18–20]

One year after surgery, no clear differences were observed in final grip strength or final key pinch strength between groups. Similarly to other studies,[21,22] we found differences in the change of key pinch strength from baseline to 1 year after surgery, with a small improvement in the PT group and a small deterioration in the TT group. However, this difference was not statistically significant and was well within 1 SD of the mean value, but it may be important to consider for clinical decision-making and future studies.

There were no complications or revision surgeries in this series during the first year of follow-up. A systematic review of failure rates associated with different techniques reported a 4.5% revision rate for PT with interposition compared with a 0.23% for TT with ligament interposition.[23] However, the partial trapeziectomy group in that review included the use of implants and not ligament interposition, and we have not found another study showing a higher complication rate for PT.

This study had limitations. The clinical examiner was not blinded to the study protocol. We did not include patients with hyperextension of the metacarpophalangeal joint of the thumb in the study, so we cannot assess the effect this may have had on clinical outcomes.[24] The follow-up assessment 1 year after surgery might be insufficient to evaluate the radiological and clinical evolution of both procedures in the long term.[25] Interrater agreement between radiologists for trapezial height measurement was not assessed, which with the quality of the images might be a source of error.[26]

Although patients who were treated with a PT had a lower decrease in trapeziometacarpal space height compared with TT patients, this was not statistically significant, nor did it have a clinical advantage of PT over TT at 1 year after surgery.

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