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Original Article

Long-term follow-up of trapeziectomy with abductor pollicis longus tendon interposition arthroplasty for osteoarthritis of the thumb carpometacarpal joint

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ABSTRACT

Purpose: To evaluate the long-term clinical and radiographic outcomes of trapeziectomy with abductor pollicis longus tendon interposition arthroplasty for moderate to severe osteoarthritis of the thumb carpometacarpal joint (Eaton stages III–IV).

Methods: We evaluated 13 patients (15 thumbs) who underwent trapeziectomy and abductor pollicis longus tendon interposition arthroplasty for end-stage osteoarthritis of the thumb carpometacarpal joint, at an average follow-up of 15 years. Subjective clinical outcomes evaluated included visual analogue scale scores and disability of arm shoulder and hand score questionnaires. Objective clinical evaluation included lateral pinch and grip tests, and a range of active and passive thumb movements. All patients underwent a radiological assessment by two independent senior radiologists. Wherever possible, results obtained from the operated thumbs were compared to the non-operated side.

Results: At a mean of 15 years post operation (range 15–17 years), there was no statistical difference between the operated and non-operated hands with regards to grip and pinch strength. In all cases CMC and MCPJ range of motion in the operative hand was either equal to or greater than non-operative counterparts. Mean visual analogue scale score was 2.13 and mean DASH score was 16.85. Mean carpal height was 0.52 and mean trapezium space ratio was 0.163. There were no early or late complications recorded and no revision surgery was required.

Conclusion: It is the opinion of these authors that abductor pollicis longus tendon interposition arthroplasty is able to provide high-quality long-term results for patients who suffer from moderate to severe osteoarthritis of the thumb carpometacarpal joint.

Level of evidence: Therapeutic Level IV.

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1. Introduction

The carpometacarpal joint (CMC), also known as the basal joint or trapeziometacarpal joint, is the most commonly involved arthritic joint in the hand with an incidence of up to 25% in women and 8% in men.¹ The pain, weakness, and deformity associated with CMC arthritis can confer marked disability to those affected.

The pathophysiology of CMC arthritis is controversial. One explanation for the high prevalence witnessed in the general population is that in an evolutionary adaptation humans have sacrificed stability at the basal joint in exchange for the ability to mobilize the thumb in multiple planes. The resultant instability and incongruity produces areas of high-contact stress during use, with resulting cartilage erosion and subsequent arthritis.² A competing theory is that the palmar beak ligament, which serves to anchor the volar lip of the first metacarpal to the trapezium, thereby maintaining the volar stability of the saddle joint, is weakened. The subsequent increased translation of the first metacarpal on the trapezium produces high-contact stress with subsequent degenerative change.

The primary aims in the treatment of CMC arthritis are to reduce pain and preserve function of the joint. When deciding treatment one should account for factors including; patient age, occupation, hand dominance, severity of disease, comorbidities and radiographic changes. Treatment may be non-operative or operative. Non-operative interventions include; splinting, non-steroidal anti-inflammatory drugs, and injections of corticosteroid or hyaluronic acid. There is little high-level evidence to support the long-term efficacy of any of these measures. A review of prospective studies evaluating the effect of non-operative treatment for CMC arthritis reveals comparable results; good short-term pain relief across all stages of arthritis (Eaton–Glickel stages I–IV, and Dell’s stages I–IV) with a sustained benefit seen only in the earliest stages of CMC arthritis (Eaton–Glickel stage I and Dell’s stages I–II).³ Consequently, surgical intervention is required when these measure fail or advanced disease is encountered.

A number of surgical techniques are described in the literature however controversies remain as to which ought to be considered the ‘gold-standard’ of care. Furthermore, where agreement is seen to exist based upon best evidence, closer evaluation reveals this evidence pertains only to the short-term post-operative period, with little evidence of outcomes over 6 years. The purpose of this study is to present the long-term (15 year) results of trapeziectomy with abductor pollicis longus (APL) interposition arthroplasty. In addition to presenting our data, we describe the operative technique and review the literature for best evidence on competing surgical interventions before concluding with a recommendation for future studies to further the discussion on the optimal treatment for CMC arthritis.

2. Materials and methods

Following approval of the research protocol by the institutional review board all patients who had undergone APL

tendon interposition arthroplasty at our institution during the years 1993–1995 were contacted by letter ($n = 29$). In all cases the indication for surgery included established osteoarthritis of the CMC joint (Eaton grade III–IV) with severe pain located at the base of the thumb limiting the patient in activities of daily living. All patients had failed trials of non-operative management. All patients described themselves as independent and active, and were seeking treatment to maintain their quality of life. The mean pre-operative VAS score of affected hands was 7.4 (SD 2.12).

Thirteen patients were available to participate in the study. Two patients underwent bilateral basal joint arthroplasty with a resulting 15 surgical procedures evaluated. Sixteen patients were lost to follow-up, two of which were confirmed deceased by family members. The mean age of the patients was 72 years (range 56–82) and the mean time of assessment post procedure was 15 years (range 15–17 years).

2.1. Clinical and radiographic assessment methods

All patients underwent a symptomatic and functional evaluation by two independent assessors including VAS grading on both the operated and non-operated hands, and the DASH outcome measure – a validated functional outcome measure which uses a series of 30 questions to assess overall upper-extremity function and performance of common activities of daily living involving the hand.⁴ Patients were questioned and records were reviewed for evidence of any complications relating to the surgery or subsequent interventions on the operated thumb.

Clinical evaluation consisted of measurements of a range of active and passive thumb movements including; first CMC joint extension, metacarpophalangeal joint (MCPJ) flexion and extension, and tip to palm distance measured by ruler and goniometry. As part of a comparative analysis, lateral pinch and grip strength were evaluated on both the operative and non-operative hands using the Jamar pinch-meter and dynamometer. The highest value achieved from three consecutive measurements was recorded for data analysis. In the case of two patients who received bilateral interventions it was not possible to perform this comparison and recordings for mean data were used exclusively.

Radiographic evaluation comprised of antero-posterior and lateral radiographs of the operated and non-operated hand and wrists hands in order to confirm or exclude contra lateral CMC arthritis (Fig. 1). Carpal height was measured from the distal articular surface of the radius to the distal articular surface of the capitate. To accommodate for discrepancies in image magnification and patient size, the carpal height ratio was calculated by dividing this measurement by the length of the third metacarpal (normal range 0.54 ± 0.003). The trapezial space was measured from the subchondral surface of the distal pole of the scaphoid to the first metacarpal base. The trapezial space ratio (TSR) was calculated by dividing the trapezial space by the proximal phalangeal length. Reference values for TSR include 0.40 for pre-operative arthritic thumbs, and 0.18 for post-operative thumbs following trapeziectomy with or without ligament reconstruction and/or tendon interposition.⁵

Fig. 1 – AP view of wrist joint, 15 years after trapeziectomy and APL interposition arthroplasty. No scaphotrapezoid arthritis was demonstrated while TMR was significantly reduced.

2.2. Surgical procedure

All patients underwent APL tendon arthroplasty via a dorsal approach by the senior authors in a technique previously reported.⁶ An incision is made originating 1 cm distal to the base of the first metacarpal bone and continuing proximally over the CMC joint, through the anatomical snuff-box, ending approximately 2.5 cm proximal to the radial styloid (Fig. 2A). The branches of the superficial radial nerve are identified and retracted. The capsule is approached via the first extensor compartment (Fig. 2B). The radial artery is dissected free and retracted in an ulnar direction. The capsule of the CMC joint is longitudinally incised and the trapezium is exposed and excised piecemeal (Fig. 2C). Any osteophytes occurring between the first and second metacarpals are excised. At this level the APL is generally found to consist of multiple tendons. The radial tendon is dissected and released approximately 3.5 cm proximally to the trapezium (Fig. 2D). It is rolled up and used as a spacer by anchoring it to the flexor carpi radialis (FCR) tendon (Fig. 2E). This enhances thumb metacarpal abduction. In the case of a single tendon, we advocate harvest of up to 50% of the APL. The capsule edges are sutured and the skin is closed. The post-operative regimen consists of a thumb spica cast for 3 weeks followed by mobilization under the auspices of hand-therapists.

3. Results

Fifteen post-operative thumbs at a mean of 15 years (SD 1.632) were included in the study.

At an average of 15 years the mean VAS score in the operated hand was 2.133 (SD 1.19) and the mean DASH score was 16.85 (SD 11.51). This was compared to an original mean VAS score of 7.4 (SD 2.12) in the hands which subsequently underwent surgery. The mean VAS score in the non-operated hand was 2.0 (SD 1.23) at 15 years.

In the clinical assessment, mean MTPJ flexion and extension were 31.33° (SD 12.74) and 1.66° (SD 3.62) respectively. Mean tip to palm distance was 0.166 mm (SD 0.36).

Mean pinch strength on the operated hands was 4.3 kg (SD 1.36) compared with a mean strength of 4.5 kg (SD 1.14) on the non-operated hands. Application of the paired T-test confirmed that there was no statistical difference between the two groups ($p = 0.735$).

Mean grip strength on the operated hands was 25.4 kg (SD 8.25) compared to a mean of 24.9 kg (SD 7.62) on the non-operated hands. Application of the paired T-test confirmed that there was no statistical difference between the two groups ($p = 0.483$).

The Pearson Correlation test was applied to confirm that the results of the DASH scores, VAS scores, grip strengths and pinch strengths were not influenced by the age of the patients.

Antero-posterior and true lateral radiographs centred on the base of the CMC joint failed to demonstrate evidence of metacarpophalangeal joint arthropathy. There was no radiographical indication of thumb metacarpal adduction, and this correlated with clinical findings. A single case demonstrated peri-articular calcification at the site of the previously excised trapezium, with no clinical significance. The mean carpal height ratio was 0.525 (SD 0.40), a figure not significantly different to the normal population, demonstrating long-term preservation of the carpus. The mean TSR was 0.163 (SD 0.47), a value significantly lower than that accepted in a normal population therefore demonstrating subsidence of the metacarpal due to loss of the bony support of the trapezium. A review of the radiographs of non-operated hands demonstrated a range of CMC OA (Eaton grade II–III). With an associated mean VAS score of 2.0 (SD 1.23) none of these hands were sufficiently symptomatic so as to require intervention at the time of the study.

There was no record of any peri-operative, early, or late complications relating to the surgery and none of the patients had undergone any further interventions on the operative or non-operative thumbs.

4. Discussion

The results of this study suggest that trapeziectomy with APL tendon interposition arthroplasty for moderate to severe CMC arthritis is able to provide consistently good long-term results with respect to both symptomatic and functional outcomes.

The treatment of CMC arthritis remains controversial with a number of surgical techniques described in the literature. These include simple trapeziectomy,⁷ trapeziectomy with ligament reconstruction and or tendon interposition,⁸ and a selection of implant arthroplasties.^{9,10} Despite significant interest and investigation, a wide variety of techniques is seen in current practice.

Fig. 2 – (A) An incision is made originating 1 cm distal to the base of the first metacarpal bone and continuing proximally over the CMC joint, through the anatomical snuff-box, ending approximately 2.5 cm proximal to the radial styloid. **(B)** The first dorsal compartment is opened and the carpal ligaments are exposed and incised. **(C)** After the capsule of the CMC joint is longitudinally incised and the trapezium is exposed and excised piecemeal. **(D)** The radial tendon is dissected and released approximately 3.5 cm proximally to the trapezium. **(E)** The radial tendon is rolled up and used as a spacer by anchoring it to the flexor carpi radialis (FCR) tendon.

In 2004 Martou concluded that despite a general consensus that trapeziectomy plus ligament reconstruction and tendon interposition (LRTI) was the optimal surgical intervention, evidence from comparative studies failed to demonstrate any advantages over trapeziectomy or trapeziectomy with isolated tendon interposition.¹¹ In a Cochrane review in 2005, Wajon came to the same conclusion that no procedure demonstrated superiority over another.¹² However, those patients undergoing trapeziectomy alone suffered fewer complications than any other procedure. This study was repeated in 2009 with unchanged outcomes but a firmer conclusion that isolated trapeziectomy was the procedure associated with the fewest complications. Conversely, LRTI was associated with significant rates of scar tenderness, tendon rupture, and chronic regional pain syndrome type 1.¹³

Vermeulen systematically reviewed 35 articles comparing contemporary surgical techniques.¹⁴ Whilst the heterogeneity of the populations studied precluded statistical pooling, the study demonstrated that trapeziectomy with ligament reconstruction or LRTI is not superior to alternative techniques including simple trapeziectomy, arthrodesis, and total joint replacement. However, LRTI is associated with a high complication rate. When utilizing tendon interposition, autologous tissue is associated with a lower complication rate than non-autologous alternatives.

It appears that current evidence suggests that there is no advantage to the addition of ligament reconstruction and/or tendon interposition over simple trapeziectomy. Furthermore, as the complication rate associated with additional elements is significantly greater, one may argue that simple

trapeziectomy ought to be considered the ‘gold-standard’ of care for CMC arthritis. It is noted however that those studies of the highest evidence level (level II) report on outcomes up to a period of 12 months only.^{15–17} There are no high-level comparative studies demonstrating maintenance of this advantage in the long-term. This may be an explanation for the wide variation in practice seen today.

Since Gervis first described the simple trapeziectomy in 1949, numerous modifications have been proposed.⁷ In 1970, Froimson described a technique using autologous tendon interposed in the potential space created by the trapeziectomy thereby reducing the risk of metacarpal subsidence and subsequent contact with the remaining carpus.¹⁸ Subsequently a number of alternative grafts were proposed as the ideal interposition material including palmaris longus,¹⁹ APL,^{20,21} and FCR.²² Whilst there is evidence supporting the use of these substitutes, certain limitations exist. Palmaris longus is absent in 15% of the population and a bulky muscle belly may leave the surgeon with a prohibitively short length of available tendon. FCR tendon interposition has yielded good results however, Naidu has demonstrated a significantly lower average flexion-to-extension peak torque ratio and diminished wrist flexion fatigue resistance after use of the entire FCR tendon as an autograft.²³ Furthermore, studies have demonstrated that in direct comparison with APL, FCR tendon interposition arthroplasty is technically more difficult to perform with significantly longer surgery times and significantly lower values in force parameters including grip strength, key grip, and pinch grip.²⁴ A further potential advantage of the APL tendon is that it is generally comprised of multiple tendon slips (Fig. 2D). This feature allows the surgeon to dissect one of the slips leaving the rest of the tendon intact, avoiding any potential functional deficit.

The ability of APL interposition arthroplasty to relieve symptoms of CMC arthritis in the short and medium term is well documented.^{25,26} Few studies report on long-term outcomes. Kaarela et al presented outcomes of APL interposition arthroplasty at a mean of 6 years (range 1–11).²⁷ Overall satisfaction was excellent or good in 79% of cases with considerable pain relief achieved in 76% of cases. However, thumb strength was less than normal in 68% of cases, 58% of patients reported a slight or severe restriction to thumb range of motion, and 29% of patients had clear limitations in everyday tasks. Six thumbs required revision surgery and 18 patients retired either partly or wholly due to CMC arthritis.

There are number of possible explanations for the inferior outcomes seen in this study. The cohort was significantly younger with a mean age of 53.8 year (range 28–82) and therefore not representative of the population described in our study. Forty three percent of patients were involved in ‘heavy work’ pre-operatively. It is not clear whether a sub analysis was performed to clarify whether the inferior subjective outcomes were occurring in the younger, more active patients who wished to return to high intensity labour. The functional requirements of these patients are considerably different to those of an elder population and these patients may well require alternative procedures. Nevertheless, despite 58% of patients subjectively reporting restrictions of thumb range of motion, there was no statistical difference between operated and non-operated hands in objective

measurement of range of motion or strength. Finally, it is well reported that rehabilitation following surgery for CMC arthritis is extensive with improvements seen at up to 6 years.²⁸ At a mean follow-up of 6 years (range 1–11) it could be argued that a number of the patients in this study had scope for further improvement.

The mean follow-up in our study was 15 years. Subjective outcome measures including the pre and post-operative VAS grades and the post-operative DASH outcome scores indicate that patients perceived significant improvements from surgery, and these improvements persevered in the long-term. This is further evidenced by the direct comparison of pinch and grip strength in operated versus non-operated hands, which failed to demonstrate any statistical differences. The DASH outcome measure was not available at the time of original surgery and therefore it was not possible to perform a comparative analysis of this outcome measure.

Radiographic parameters demonstrated maintenance of carpal height at 15 years similar to that expected in a normal population. Conversely, there was a significant reduction in the TSR demonstrating subsidence of the first metacarpal. This finding is consistent with those of other studies and suggests that in the long-term, preservation of thumb height is not required to maintain strength or prevent pain. As a final observation, there was no evidence of adjacent joint disease on any radiographs at final follow-up.

Patients were immobilized for 3 weeks only post surgery. The rationale for this protocol is the belief that early mobilization permits a faster return to activity and reduces the rates of chronic regional pain syndrome (CRPS). Whilst not proven in evidence, shorter rehabilitation periods are well described, and a review of current literature reveals a lack of studies comparing one rehabilitation regime with another.²⁷ Maqsood et al reported data on LRTI using FCR tendon interposition and mobilizing patients at 2 weeks.²⁹ At 5.5 years their series of 60 patients had normal mobility and no cases of CRPS. De Smet et al reported data on a cohort of patients undergoing trapeziectomy and/or LRTI who mobilized within a week.³⁰ In their series of 56 patients, only one procedure failed requiring arthrodesis. It is our opinion that the optimum period of immobilization has not yet been determined and this is an area requiring further research.

This study is limited by its retrospective character and a restricted sample size. Fourteen out of 29 patients were lost to follow-up and it is assumed that patient death contributed to this figure. A larger cohort is required before definitive conclusions regarding the long-term success of APL interposition arthroplasty are agreed. We believe that current best evidence has not definitively answered which technique provides the greatest long-term benefit for patients with moderate to severe CMC arthritis, nor what the optimal rehabilitation regimen is. This conclusion is shared by the authors of similar recent studies.³¹ There is a need for further high-powered, long-term, comparative randomized controlled trials before a ‘gold-standard’ intervention is determined. However, in the absence of comparable long-term data, we believe that our 15-year outcomes demonstrate the potentially enduring benefits of APL interposition arthroplasty for moderate to severe CMC arthritis.

Conflicts of interest

All authors have none to declare.

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