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Evolution of basal joint arthroplasty and technology in hand surgery

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ABSTRACT

There are many surgical procedures that provide pain relief and improve function for trapeziometacarpal (TM) arthritis. The aim of this article is to review the history of surgical treatment of thumb basal joint arthritis and to discuss some of the recent advances based on evolving technology. Our preferred treatment is described, and explanation provided for why we have avoided the temptation to change to the "latest and greatest" treatment for this condition.

Introduction

The carpometacarpal (CMC), or basal joint of the thumb, is the most common joint in the upper extremity treated with surgical reconstruction due to osteoarthritis,[1] with a variety of surgical procedures and many variables for postoperative rehabilitation. When a multitude of procedures are available for a condition, it is a result of either none of the procedures being effective, with researchers continuing to search for a good treatment, or because many procedures provide good outcomes and clinical research is used in effort to determine which procedures consistently produce the best outcomes. Surgical treatments of trapeziometacarpal (TM) arthritis fall in the latter category, as there are many procedures that provide pain relief and improve function. The aim of this article is to review the history of surgical treatment of thumb basal joint arthritis, discussing some of the recent advances based on evolving technology, and describe our preferred treatment, explaining why we have avoided the temptation to change to the "latest and greatest" treatment for this condition.

History

Gervis described the initial treatment for symptomatic basal joint arthritis of the thumb in 1949, which involved removal of the trapezium. He reported the outcomes for 15 patients and described them as "uniformly good" in 13 of the patients during the period of 1944–1946. The two with inferior outcomes both showed global osteoarthritis and complained of persistent thumb weakness. Overall, patients expressed satisfaction in terms of function and pain relief. The postoperative rehabilitation program consisted of "supervision" to facilitate motion, but did not mention immobilization. Outcomes were better in patients with isolated trapeziometacarpal arthritis and younger patients had a quicker recovery.[2] This technique is still used by some surgeons, with excellent results, as described by Gray and Meals. At an average of 88 months following surgery, they reported 18/22 patients were pain free, with 21/22 opposing the thumb to the small finger metacarpal head and abduction into the plane of the palm. Grip and tip pinch strength increased 21% and key pinch strength increased 11%. Metacarpal subsidence did not correlate with strength or functional outcomes and improvement in their subjective outcomes measurement (Arthritis Impact Measurement Scales 2 – AIMS 2).[3]

In 1970, Froimson described his technique of tendon interposition following trapezial resection. Upon careful dissection and excision of the trapezium, the flexor carpi radialis (FCR) tendon was split and a portion was used as a graft, rolling it into a ball, or "anchovy," and placing this in the void created by trapezial excision. A bulky soft dressing (rather than a cast) held the thumb "in functional position" for 3 weeks. Patients were instructed to use their hands immediately, and no therapy was required. He reported on 10 patients (12 thumbs), all having pain-relief and stability, with minimal shortening of the thumb. Grip and pinch strength were

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illustrated pictorially, to demonstrate the "normal" appearance of the thumb, as removal of the trapezium allowed for release of adduction contracture, facilitating an abducted position to maximize function.[4]

In spite of the good results reported following trapeziectomy, weakness and instability were concerns and this led other investigators to search for a better alternative. Eaton and Littler demonstrated that hypermobility at the thumb CMC joint, due to degeneration and laxity of the anterior oblique, or volar beak ligament, was responsible for the development of basal joint arthritis. They developed a technique to reconstruct this ligament and reported their outcomes in 38 thumbs in 36 patients. Half of the FCR tendon was used, passing it through a hole created in the base of the metacarpal to stabilize the joint. Outcomes were measured by pain relief, instability, pinch strength, motion, function and radiographic evaluation. Pain was resolved or substantially improved in all patients. Pinch strength was improved in all patients and although they could not place the hand flat on the table, they all could oppose the thumb to the tip of the small finger and only one patient had persistent mild instability. There was radiographic progression of arthrosis in patients with more advanced disease (Stage III and IV) which was seen in only 18% of patients with Stage II disease and none with Stage I disease (Table 1, Fig. 1). The authors concluded that while patients with severe articular involvement appeared to have some success with this procedure, ligament reconstruction in isolation was recommended only for patients with early stages of disease (slight to no cartilage destruction). Perhaps more importantly, they proposed that a more comprehensive arthroplasty was certainly an option after ligament reconstruction, if arthritic changes advanced.[5]

Seeking further refinement of techniques to treat patients with more advanced basal joint arthritis, Burton developed the ligament reconstruction and tendon interposition (LRTI) arthroplasty. Initially, either the distal portion of the trapezium, or (if pantrapezial arthritis and/or adduction contracture was present) the entire trapezium was excised. The radial half of the FCR tendon was harvested, and the first metacarpal pinned in an abducted, functional position. The FCR tendon was used for reconstruction of the anterior oblique ligament, similar to the technique performed by Eaton and Littler,[5,6] and the remaining portion of the FCR tendon was rolled and used as an "anchovy," similar to the technique of Froimson.[4,6] Over time, the procedure was revised and the entire trapezium was routinely excised for better exposure of the FCR tendon and the scaphotrapezial (ST) joint, while use of the entire FCR tendon became standard, for a stronger ligament reconstruction and tendon interposition.[7]

In 1986, Burton and Pellegrini published a retrospective review on a series of 25 patients who underwent the LRTI, to demonstrate early outcomes of the procedure. Postoperatively, patients were immobilized with a short-arm thumb spica cast and K-wire fixation for 4 weeks, and then transitioned to an isoprene thumb spica orthosis. At this point, active range of motion was initiated, emphasizing metacarpophalangeal (MCP) and interphalangeal (IP) joint mobility and CMC abduction, but specifically avoiding CMC flexion/adduction to prevent excessive stress to the ligament reconstruction. Thenar strengthening began at 6 weeks and grip/pinch strength at 8 weeks. The orthosis was worn full time for 6 weeks, and used for a total of 12 weeks following surgery, until motion and strength were considered functional.

Table 1
Radiographic staging of thumb CMC arthritis

Stage	Radiographic findings
I	Normal articular contours; TM widening if effusion is present
II	Slight TM narrowing; spurs/debris <2 mm at joint margins; early erosion of trapezium
III	Marked TM narrowing; spurs >2 mm; cystic and sclerotic changes in subchondral bone; ST appears normal
IV	Marked narrowing or destruction of TM and ST joints; multiple joint involvement

Adapted from Eaton et al Ligament reconstruction for the painful thumb carpometacarpal joint: A long-term assessment. J Hand Surg 1984; 9A:692–699.
TM = trapeziometacarpal joint, ST = scaphotrapezial joint.

Fig. 1. Radiograph demonstrating Eaton Stage II CMC thumb arthritis.

In their initial report, 92% of the cases were found to have excellent results, including restoration of function with activities of daily living (ADL) and work in labor-intensive settings. Grip and pinch strength improved when comparing preoperative to postoperative assessments; strength and function were reported to improve for 6–12 months after surgery.[6] Long term follow up demonstrated that these good results did not deteriorate over time.[7]

In effort to simplify the technique, spare the FCR tendon, and produce consistent outcomes,[1,8] or as a salvage for a failed procedure, such as silicone implant arthroplasty, Thompson described a technique using a slip of the abductor pollicis longus (APL) and coined the term "suspensionplasty." He used a distally based strip of the APL to suspend the base of the first metacarpal to the second metacarpal, after trapeziectomy. Reporting on 50 suspensionplasties over an 8-year period, using tendon interposition to fill the space of the trapezium, Thompson described "generally excellent" outcomes, with pain reduction and improved mobility and strength.[9] Others have described modifications of the "suspensionplasty"[10] including a Mersilene sling[11] and suturing the APL and extensor pollicis brevis (EPB) together.[12]

In effort to determine the differences in various procedures, Davis et al performed a prospective randomized trial comparing trapeziectomy, trapeziectomy with palmaris longus tendon interposition, and the LRTI (using Burton's original description). They reported on 174 thumbs in 153 subjects who had Eaton stage 2–4 arthritis, with follow up ranging from 5 to 18 years. Additional