The abductor pollicis longus: A key to basal joint surgery

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GA Robertson, C Hong, CD Zimmerman. The abductor pollicis longus: A key to basal joint surgery. Can J Plast Surg 1993;1(1):30-35. Anatomical studies show that the abductor pollicis longus acts primarily as a radial deviator of the wrist and as the main stabilizer of the basal joint of the thumb. An advancement and reinforcement technique of this muscle is used in conjunction with a standard silastic replacement arthroplasty for osteoarthritis of the trapezio-metacarpal joint. Excellent postoperative stability is achieved together with good pain relief and improvement in strength.

Key Words: *Abductor pollicis longus, Arthroplasty, Osteoarthritis, Trapezio-metacarpal joint*

L'abducteur pollicis longus : clé de la chirurgie de l'articulation basale

RÉSUMÉ: Des études anatomiques montrent que l'abducteur pollicis longus agit surtout à titre de déviateur radial du poignet et de stabilisateur principal de l'articulation basale du pouce. Une technique d'avancement et de renforcement de ce muscle est utilisée en conjonction avec une arthroplastie de remplacement silastique standard pour l'ostéoartrite de l'articulation trapézo-métacarpienne. Une excellente stabilité post-opératoire a été obtenue de même qu'un bon soulagement de la douleur et une amélioration de la force.

Osteoarthritis of the trapezio-metacarpal joint is a common and disabling condition. Eaton and Glickel (1) have classified the disease process into four stages. Stage I demonstrates normal articular contours, though there may be widening due to joint effusion. Stage II shows slight narrowing of the joint space and early subchondral sclerosis. If joint debris is present, these should measure less than 2 mm in diameter. Stage III has significant narrowing or obliteration of the joint space, cystic changes, debris exceeding 2 mm in diameter and varying degrees of dorsal subluxation. Stage IV has all the features of stage III, but also includes arthritic changes in the scapho-trapezial joint. This classification can be of help in deciding which surgical procedure to select and in evaluating postoperative recovery. It is based, however, solely on radiological evidence and should not be used as an indicator for surgical intervention; this must still be decided on clinical grounds.

A wide variety of surgical procedures have been developed. Simple excision of the trapezium (2,3) is no longer practised. Arthrodesis has its proponents (4,5), but is not

applicable in stage IV disease or where there is significant secondary deformity at the metacarpo-phalangeal joint. Abduction-extension osteotomy of the metacarpal (6,7) has recently re-emerged with good results in terms of pain relief and correction of subluxation. The technique produces a shift in joint contact surface from a palmar to a more dorsal position. Pelligrini (8) has shown that in the earlier stages of disease, the articular changes are primarily on the palmar surface areas, but with progression the entire articular surface becomes involved. Osteotomy may not be applicable in stage III and stage IV disease. Resurfacing techniques such as the Ashworth (9) silicone interposition and the Swanson hemicondylar implant are contraindicated in stage IV disease and appear to be more prone to fragmentation and silicone synovitis than total replacement.

Replacement arthroplasty remains the most common and popular choice. It is accomplished either by an implant device (10,11) or through the interposition of autogenous tissue, usually tendon (12-14). Pain relief has been uniformly excellent with all these procedures. However, in the quest for greater range of motion, the problem of instability persists together with recurrence of subluxation and adduction collapse of the metacarpal. Recent anatomical studies of the abductor pollicis longus (APL) suggest a method whereby greater stability can be achieved.

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Figure 1 The common tendinous insertions of the abductor pollicis longus (APL). S Superficial slip; DA Deep slip to the abductor pollicis brevis; DT Deep slip to the trapezium

Figure 2 Direct stimulation of the abductor pollicis longus (APL): radial deviation of the wrist

ANATOMICAL STUDIES

Topographic

Two recent studies by Oudenaarde (15,16) have significantly expanded our knowledge of the basic anatomy of the APL. The muscle belly has both a superficial and a deep head. The superficial head has two parts, an ulnar arising from the ulna and interosseous membrane and a radial from the deep fascia of the forearm and the radius. The muscle fibres of this component are long and parallel, and end in a single tendon that inserts into the base of the first metacarpal. The deep head arises more proximally from the ulna, interosseous membrane and the radius. The muscle fibres are short, oblique and pennate. The tendon divides into a varying number of slips (two being the most common), which insert into the trapezium, the joint capsule and the abductor pollicis brevis (Figure 1).

Excursion of these tendons was studied by passive manipulation in the cadaveric model. Passive movements of the thumb produced excursion of the superficial tendon only. There was no excursion of the slips from the deep head. Passive movements of the wrist produced simultaneous excursion of both tendons over almost equal distances.

Electromyographic

It is difficult to guarantee accurate insertion of the electromyographic needle directly into the APL percutaneously due to the close proximity of the extensor pollicis brevis. Accordingly, we selected as an experimental model those patients undergoing release of a de Quervain's tenosynovitis under local anesthesia. The APL tendon can be retracted distally and the needle inserted into the muscle belly under direct vision on the side furthest from the extensor pollicis brevis. First, the muscle was stimulated directly. The result was radial deviation of the wrist as the main component, with slight abduction and extension of the first metacarpal ray (Figure 2).

Secondly, the patients were asked to place their thumbs in a variety of positions and the electrical activity recorded. Radial deviation of the wrist demonstrated maximal activity. Abduction, extension and adduction of the thumb showed smaller and approximately equal levels of activity. The same smaller levels were noted with both power and pinch grips, while virtually no activity was recorded with full flexion.

The lack of excursion of the deep head taken in conjunction with the constant presence of electrical activity through a wide range of thumb motion strongly suggests an isometric contraction of the APL that is providing stability to the basal joint.

It appears that the APL is a prime radial deviator of the wrist and the main stabilizer of the basal joint. There is a secondary minor action of abduction and extension of the thumb. A better term for this muscle would be the deviator carpi radialis.

SURGICAL TECHNIQUE

A radial approach is used. A zig-zag incision is made, skin flaps reflected and usual precautions taken to avoid damage to the branches of the radial sensory nerve and the radial artery as it courses through the snuff-box.

The APL tendon slips are divided approximately 1.5 cm from the main insertion in the base of the first metacarpal. A modified Kessler suture is placed at this time in the proximal end to prevent retraction (Figure 3A).

A transverse incision is made in the joint capsule and the trapezium is exposed. An osteotome is used to make a cruciate incision in the trapezium and the four quadrants are then excised piecemeal with a rongeur. Care is taken to prevent damage to the flexor carpi radialis in the depths of the wound (Figure 3B).

After reaming the medullary cavity of the metacarpal, a Swanson trapezial implant is inserted (Figure 3C). If there is any doubt over which size to use, the slightly smaller one is chosen.

The capsule is closed. The distal cut slip of the APL is split and the shortened proximal end of the APL is advanced and sutured to the base of the metacarpal. This results in immediate passive abduction and extension of the thumb ray. The distal slips of the APL are then used to reinforce the joint capsule (Figure 3D).

In those patients where there is significant secondary hyperextension of the MCP joint (greater than 10°) a volar capsulodesis is performed. If this is not done, the patient runs a significant risk of a reverse zig-zag deformity developing postoperatively with adduction collapse of the metacarpal

Figure 3) Surgical technique. **A (top left)** Site of division of the APL. Retaining suture in proximal end. **B (top right)** Gap following trapeziumectomy. Note FCR in base of wound. **C (bottom left)** Silastic arthroplasty in place. **D (bottom right)** Advancement of proximal end of APL. Reinforcement of capsule with distal slips

Figure 4) Stage IV disease. **Top left** Preoperative radiograph. **Bottom** Secondary MCP hyperextension. **Top right** Radiograph three years following arthroplasty

and subluxation of the newly reconstructed joint. The technique used is similar to that described by Eaton and Floyd (17).

The patient is placed in an occlusive dressing with a volar slab extending to the first web space. One week later the sutures are removed and a well-padded cast applied with the thumb in abduction. This is removed five weeks later and a therapy program started which lasts for four to six weeks.

RESULTS AND DISCUSSION

Patient population

Twenty-eight implant arthroplasties were performed using this technique of which 17 were available for long term follow-up. Bilateral implants were carried out in four patients. The female to male ratio was 12:1. The average age of the group was 61 years (range 48 to 73 years). All patients had

advanced (stage III or stage IV) disease. The mean period for follow-up assessment was 34 months with a range from seven to 84 months.

Complications

One patient developed reflex sympathetic dystrophy that slowly but successfully resolved with treatment. One patient sustained an implant fracture three years following surgery that required replacement. One patient stated that there had been no improvement in her pain. One patient developed silicone synovitis two years postoperatively; the implant and pseudo-sheath were removed and a conversion to a dermal interposition arthroplasty carried out.

Pain relief

The visual analogue pain scale is an excellent method for the objective measurement of a subjective symptom.

First described by Beecher (18) in 1969, it compares well with the McGill-Melzack questionnaire and is a great deal simpler (19). It has been used successfully in evaluating other arthroplasties of the hand and wrist (20).

A line is drawn 100 mm long. The zero point on the left represents no pain at all, while the 100 mm point represents the pain endured prior to surgery. The patients are asked to make their mark along the line where they feel their pain is now. The average for the group was an 84% improvement in pain. This included the one patient who claimed no relief of pain at all. In common with the global experience in replacement arthroplasty, an excellent overall result in pain relief was achieved.

Strength

Power grip improved by 40% from preoperative values with a very wide range from 10% to 155%.

Pinch strength is a significant test of basal joint surgery. Eaton (21) places emphasis on this as "a single determination which encompasses freedom from pain, stability and patient usage". The average result in this series was 4.2 kg, an increase of 32% from preoperative levels. This contrasts favourably with the long term results of Swanson replacement reported by Creighton and colleagues (22), who found no statistically significant difference between their preoperative and postoperative measurements.

Stability

No patient in this study demonstrated any postoperative instability, adduction collapse or recurrent subluxation. The majority returned to full activities of daily living. Figures 4 and 5 illustrate the preoperative appearance of a typical case and the results three years later.

APL advancement and reinforcement appears to confer greater stability to a trapezial arthroplasty. Although used in this series in conjunction with a Swanson replacement, the technique is capable of being incorporated into any of the arthroplasty techniques presently in use.

Figure 5) Same patient as in Figure 4 three years following bilateral implants and MCP volar capsulodeses. **Top left** Abduction. **Bottom left** Extension. **Top right** Flexion. **Bottom right** Return to full activities

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