Chapter 2

Trapeziometacarpal Joint Arthritis

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- Epidemiology
- Anatomy and Biomechanics
- Pathogenesis
- Classification
- Clinical Examination, Investigations, and Differential Diagnosis
- Management
- Selection of Appropriate Surgical Procedure
- Splints and Rehabilitation

Trapeziometacarpal joint (TMJ) arthritis typically affects women between the ages of 50 and 60, who for a period of 7–10 years can observe their thumbs develop an "M" or adduction deformity. The periods of inflammation are either very painful, leading the patient to seek treatment, or are well tolerated until the patient experiences problems grasping large objects and develops pain at the metacarpophalangeal joint. The surgical management is difficult because the three requirements of a mobile, painless and strong joint have to be balanced. Irrespective of the surgical technique used, it is a strong joint that is the most difficult to achieve. Simple and total trapeziectomy as proposed by Gervis *et al*. in 1949 still has some followers, but many procedures have been constructed around this technique in the last 40 years.[35] At first, we used the Swanson prosthesis and have performed more than 900 cases using it. However, in more than 25% of the cases, we had to reoperate due to problems of instability, subluxation, web space narrowing and, rarely, the silicone synovitis. From 1985, we have limited the use of the Swanson prostheses for salvage of failed total prostheses or for revision of complete collapse posttrapeziectomy. Ninety-two percent of our cases involve a trapeziectomy with tendon interposition. The rationale behind this choice lies not only in anatomic and biomechanical considerations, but also that an evaluation of our patients with bilateral TMJ arthritis revealed that 93% requested surgery to be repeated on the other side, this within an average of 16 months.

Epidemiology

TMJ arthritis was first described by Forestier in 1937.[30] It affects mainly women (90%) and is bilateral. Armstrong *et al*. found a prevalence of 25% in postmenopausal women.[2] This condition is also present in 8% of women below 50, while it is absent in men of the same age. Women who have had hysterectomies have a higher prevalence of TMJ arthritis than women who have not. On the other hand, Felson,[29] having studied the Framingham epidemiological study, did not find any correlation between estrogen intake, hysterectomy and TMJ arthritis.[38] The condition is three times more common in Caucasians than the Chinese or the Japanese.

There are no studies that have looked at the incidence after surgery. One must bear in mind that many patients remain asymptomatic despite joint degradation and that splints and intra-articular steroids are effective in acute flare-ups. A number of patients reach the stage of adduction deformity without much pain. Medical advice is sought when compensatory hyperextension at the metacarpophalangeal joint causes pain. It is to be regretted that many physicians are not aware of the surgical options and refer a patient only when a functional deficit is permanent. Our experience shows that only 10% of TMJ arthritis cases are operated upon.

Anatomy and Biomechanics

The thumb carpometacarpal joint is the key articulation of the thumb column. With its two degrees of freedom and its ability to rotate automatically, it makes possible opposition with the long fingers. The trapezium appears in the embryo at 46 days and moves anterior to the hand anticipating its capacity for opposition. The thumb is positioned on the lateral and proximal part of the hand, with a forward obliquity of 45°.[64] The TMJ has been described as a combination of a saddle and an universal joint (Fig. 2.1). In reality, its structure is complex as there is no close congruence between the two articular surfaces. Rongières, giving a precise radiological description of the joint said, "…the distal surface of the trapezium is convex from anterior to posterior and concave transversally. For the base of the metacarpal, this is inverted…"[64] (Fig. 2.2). Weitbrecht, in 1742, was the first to describe the ligamentous arrangement of this joint.[74] There have been many studies subsequently (Rouvière,[65] Haynes,[39] Napier,[56] Lanz and Wachsmuth,[50] Kaplan,[47] De la Caffinière,[14] Pieron,[62] Drewniany,[24] Bonnel,[7] Pellegrini,[58] Imaeda,[42] Bettinger[5,6] and Kuhlmann.[49]) It is the last two that have refined our understanding of the ligaments. Bettinger described up to 16 ligaments and Kuhlmann emphasized the importance of the posteromedial

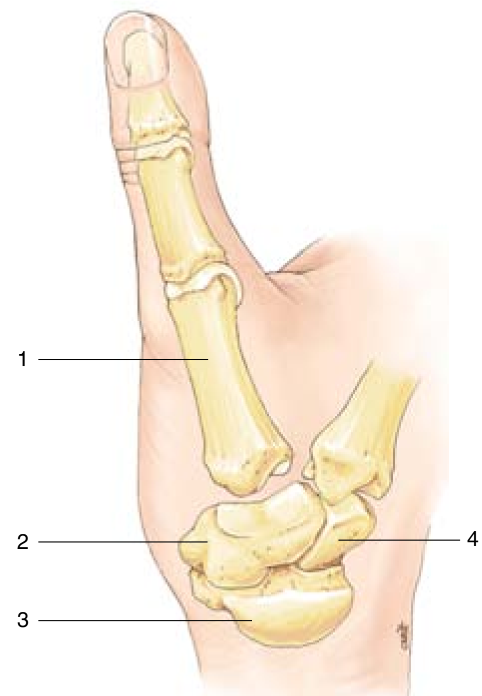


Figure 2.1.

Anatomy of the trapeziometacarpal joint. The TMC joint is saddle-shaped; the distal surface of the trapezium is convex from anterior to posterior and concave transversely. This is inverted for the base of the metacarpal, but there is no close congruence between the two articular surfaces due to the difference in curvature. (1) metacarpal; (2) trapezium; (3) scaphoid; (4) trapezoid.

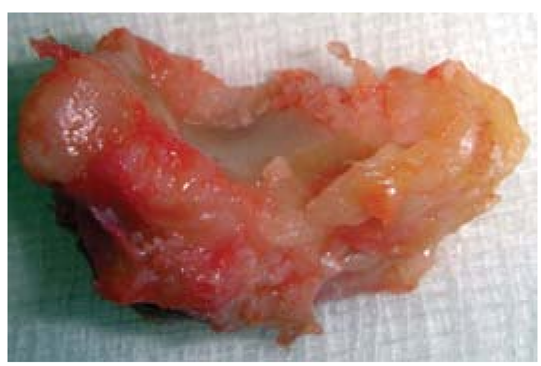


Figure 2.2.

Trapezoidal cartilage degeneration associated osteophytic spurs.

Table 2.1.

Insertions and Functions of Ligamentous Structures

Ligamentous Structure	Insertions	Function
Deep and superficial anterior oblique ligament (DAOL and SAOL) (*Beak ligament*)	Scaphoid tubercle of the trapezium and palmar aspect of the first metacarpal (close to the ulnar tubercle)	Tension in pronation and extension Limits laxity
Posterior oblique ligament (POL)	Medial aspect of the dorsoradial tubercle of the trapezium to the dorsoulnar tubercle of the metacarpal with the IML	Stabilizes rotation
Intermetacarpal ligament (IML)	Dorsoradial aspect of the base of the second metacarpal and ulnar tubercle of the first metacarpal	Opposes extreme abduction, supination and opposition. Stabilizer of the thumb column after a trapeziectomy
Dorsoradial ligament of Kuhlmann	Dorsoradial tubercle of the trapezium and dorsal edge of the base of the first metacarpal	Resists extreme positions, extended in supination flexion adduction, opposes the SAOL and DAOL, ensures stability. Principle of Eaton-Litter's plasty (FCR)

complex. The stability of the trapeziometacarpal joint is essentially due to four ligaments (Table 2.1) (Fig. 2.3):

— The superficial anterior oblique ligament (SAOL)
— The posterior oblique ligament (POL)
— The intermetacarpal ligament (IML)
— The posterior oblique ligament of Kuhlmann or the dorsoradial ligament (DRL).

The movements of this joint have been studied by Cooney *et al*.[19] The flexion-extension arc is 53+/−11° and abduction-adduction is 42+/−4°. The actual bony contact in this biconcave-convex joint is limited. When the joint is in neutral, the contact surface is small and the forces are increased (Fig. 2.4). Thus, for a one kg pinch between the thumb and index, the force exerted on the thumb CMC joint is 13.42 kg; on the metacarpophalangeal joint, 6.61 kg; and on the interphalangeal joint, 3.68 kg.[19] The greatest articular congruence occurs when the thumb is maximally abducted and or adducted. Stresses around a normal joint are already considerable, so when an arthritic process begins, degeneration is inevitable, accompanied as such by

(a)

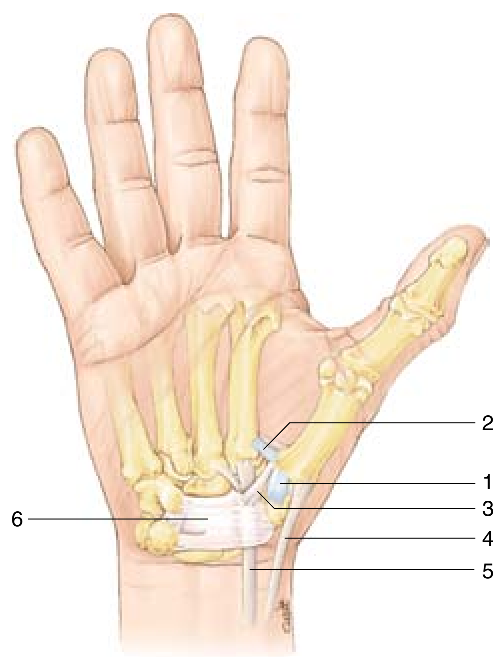


Figure 2.3a.

Ligamentous structures of the trapeziometacarpal joint. Palmar ligaments. (1) Superficial anterior oblique ligament (SAOL). (2) Intermetacarpal ligament (IML). (3) Ulnar collateral ligament. (4) Abductor Pollicis longus (APL). (5) Flexor carpi radialis (FCR). (6) Flexor retinaculum.

(b)

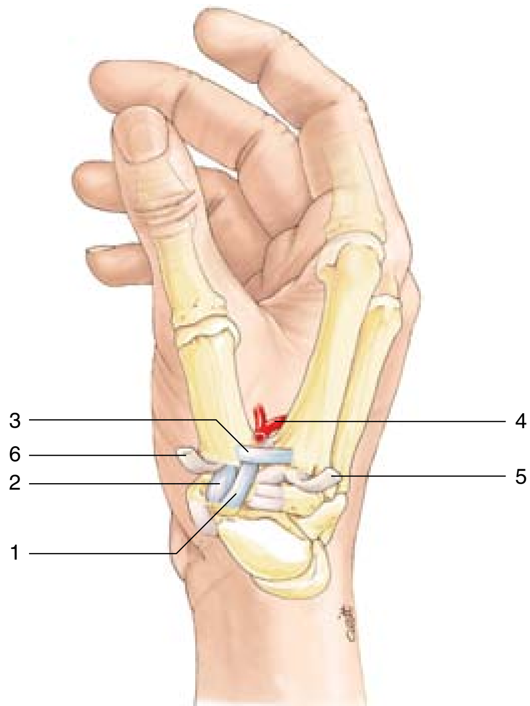


Figure 2.3b.

Dorsal ligaments. (1) Posterior oblique ligament (POL). (2) Kuhlmann posterior oblique ligament or dorsoradial ligament (DRL). (3) Dorsal intermetacarpal ligament (DIML). (4) Radial artery. (5) Extensor carpi radialis longus (6) Abductor Pollicis Longus (APL).

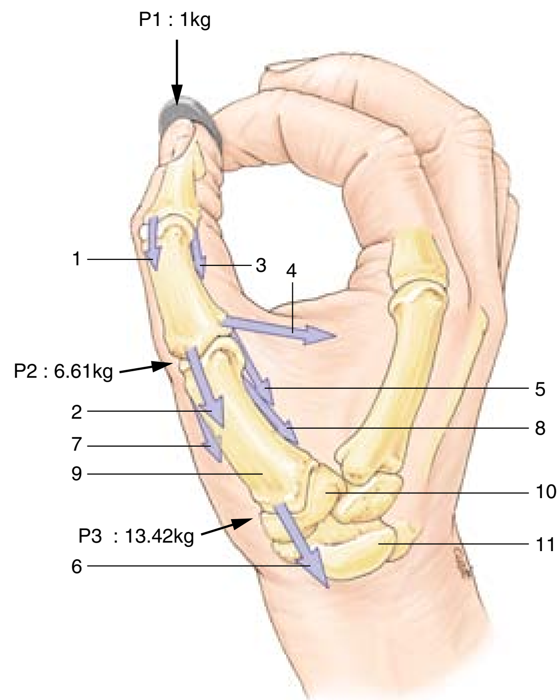


Figure 2.4.

Distribution of the forces on the joints of the thumb for a pinch of 1 kg (F1) between the thumb and index. A force (F2) of 6.61 kg acts on the metacarpophalangeal joint and a force (F3) of 13.42 kg on the trapeziometacarpal joint. Action of the 8 muscles contributing to the mobility and stability of the thumb.
(1) Extensor pollicis longus (EPL). (2) Extensor pollicis brevis (EPB). (3) Flexor pollicis longus (FPL). (4) Adductor (AP). (5) Flexor pollicis brevis (FPB). (6) Abductor pollicis longus (APL). (7) Abductor pollicis brevis (APB). (8) Opponens (OP). (9) First metacarpal. (10) Trapezium. (11) Scaphoid.

degradation of the ligaments, atrophy of the intrinsic muscles and an additional deforming force from the abductor pollicis longus. The thumb, which is most often utilized in a position of opposition, a combination of flexion, abduction and pronation, also aggravates the articular instability.

The automatic rotation of the thumb is explained by a subtle interplay of tension and relaxation of the ligaments. In abduction, the posterior oblique ligament (POL) is taut and the dorsoradial ligament (DRL) relaxes, facilitating the alignment as well as rotation of the first metacarpal.[46] The intermetacarpal ligament (IML) is an important stabilizer and opposes subluxing forces, allowing a balanced and powerful opposition of the thumb. Conversely, the destruction of the intermetacarpal (IML) and posterior oblique (POL) ligaments makes opposition impossible. The ligamentous apparatus alone cannot guarantee stability and function, the role of the intrinsic and extrinsic musculature being fundamental. Eight muscles contribute to the optimum mobility and stability of the thumb (Fig. 2.4):

— Extensor pollicis longus (EPL)
— Extensor pollicis brevis (EPB)
— Flexor pollicis brevis (FPL)
— Adductor pollicis (AP)
— Flexor pollicis brevis (FPB)
— Abductor pollicis longus (APL)
— Abductor pollicis brevis (APB)
— Opponens (OP)

The APB and opponens abduct, antepulse and flex the thumb. They center the joint and with the stabilizing POL and DRL rotate the first metacarpal. There is a coupling between the ligamentous and muscular apparatus. Thus, Zancolli links abduction to the POL and IML, adduction to the DRL, flexion to the AOL and DRL and extension to the DRL and POL.[76] The complexity of this anatomic organization has the result that the centers of rotation vary with movement. With circumduction, the center of rotation is situated at the surface of the trapeziometacarpal joint; with flexion-extension; it is in the trapezium, and with abduction-adduction, it is to be found in the base of the first metacarpal.[43]

Trapeziometacarpal osteoarthritis is rarely isolated; Swanson demonstrated pan-trapezial arthritis in 80% of case.[67] One has to take into account the biomechanics of the scapho-trapezio-trapezoidal joint while making therapeutic choices. It is in fact on the trapezium that the distal lateral articular facet of the scaphoid oscillates. This joint aids in antepulsion of the thumb column. The trapezium glides anteriorly on the scaphoid during opposition and posteriorly during retropulsion. This, of course, requires a perfectly functioning scaphoid and ligamentous apparatus. Trapeziectomy changes the biomechanics of the scaphoid and before performing this procedure, it is imperative to verify that the scapholunate ligament is intact to avoid creating a severe instability of the remaining carpus.

Pathogenesis

Ligamentous laxity and instability of the TMJ are the factors which predispose to osteoarthritis. Pelligrini, analyzing surgical and post-mortem specimens, observed that there was a constant association between arthritis and degeneration of the deep and superficial anterior oblique ligaments (DAOL and SAOL). Loss of integrity of these ligaments leads to dorsal subluxation of the joint with flexion and adduction of the thumb and a painful synovitis.[58,59] Using stereophotogrammetry of frozen cadaveric specimens, Koff *et al*. demonstrated that articular degradation started in the radial quadrants of the metacarpal base and progressed to the volar quadrants. In the later stages, for the trapezium, cartilage wear seen in the dorsoradial quadrant progressed to the volar quadrants.

Trapeziometacarpal instability causes, over a period of 7–19 years, a severe deformity called the "M" thumb or Pollux adductus (Fig. 2.5). Initially, dorsal and radial subluxation of the first metacarpal causes a step in the joint (sign of Forestier). Pain and deformity limit range of motion and a compensatory hyperextension of the metacarpophalangeal

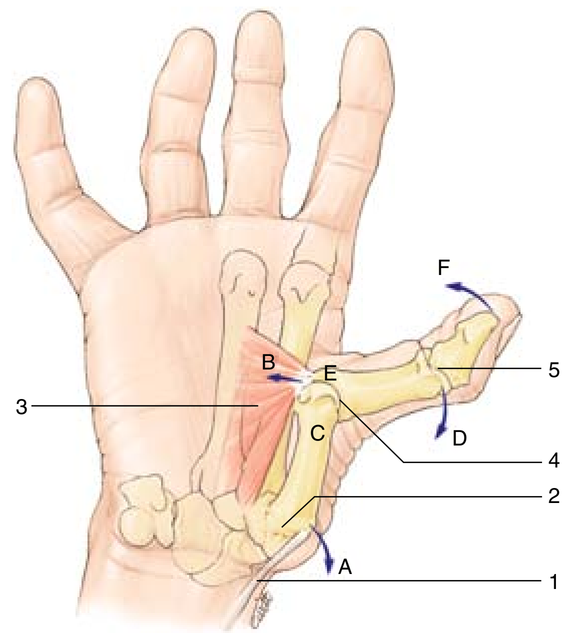


Figure 2.5.

Trapeziometacarpal arthritis, final stage. Adducted or "M" thumb. The progressive subluxation of the trapeziometacarpal joint is caused by the degradation of the capsuloligamentous apparatus and of the action of the abductor pollicis longus (APL).
(1) The deformity causes a step in the joint (sign of Forestier). (2) The first web contracts under the action of the adductor. (3) The first metacarpal becomes parallel to the second. Large objects can only be taken with the hyperextension of the metacarpophalangeal joint. (4) Lateral constraints on the thumb MP cause the elongation of the ulnar collateral ligament. (5) Fine grip is done with flexion of the thumb IP.

joint results. Contractures of the muscles close the first web and the first metacarpal becomes parallel to the second. The interphalangeal joint of the thumb now flexes to conserve a tip to tip pinch and the ulnar collateral ligament becomes overloaded, creating a painful instability.

Classification

A number of classifications have been proposed in the literature, such as that of Burton,[11] or Smith *et al*.[23] which includes mechanical, clinical and radiologic criteria. The modified four-stage classification of Eaton and Littler is the most popular.[27] It is a radiographic classification based on a true lateral of the thumb centered on the trapezium and with the sesamoids superimposed.[27] (Fig. 2.6)

— Stage I: Normal articular surface with possible widening from synovitis
— Stage II: Joint space narrowing with loose bodies and osteophytes less than 2 mm; no scaphotrapezial arthritis
— Stage III: Severe trapeziometacarpal destruction with subchondral sclerosis, loose bodies and osteophytes more than 2 mm, no scaphotrapezial arthritis
— Stage IV: Both the scaphotrapezial and trapeziometacarpal joints are affected.

Clinical Examination, Investigations, and Differential Diagnosis

Clinical Examination

Classically, TMJ arthritis presents with pain at the base of the thumb, the pain radiating to the thenar eminence and the metacarpophalangeal joint. This pain is worsened by pinch and during gripping of large objects. Many daily activities become difficult, like turning a car key, opening a jar, sewing, cutting, writing, etc. In the early stages, patients have a sense of instability with a joint that tends to "slip." Then, with the development of chondromalacia and peritrapezial osteophytes, there is stiffening and dorsal subluxation, which places the thumb into adduction. At a late stage, the joint ankylosed and the pain is reduced. Deformity in the form of a pollux adductus constitutes the final stage.

When inflammation is present, pressure exerted by the index finger of the examiner on the radiopalmar aspect of the joint causes pain. One centimeter more proximal, it is the scaphotrapezial joint which is examined and pain here confirms a pan-trapezial arthritis. The grind test demonstrates joint degeneration by producing crepitus and pain when the thumb is subjected to an axial compression accompanied by circumduction (Fig. 2.7a). The same test applied with an axial distraction stresses the capsuloligamentous complex and causes pain when inflammation is present early on in the disease.[28] The compression test of the base of the 1st metacarpal as described by Glickel is equally sensitive. The head of the 1st metacarpal is put into extension by the thumb and index of one hand while the other thumb applies a dorsal pressure to its base.[37,370] (Fig. 2.7b). This attempt at reduction of the dorsal subluxation is particularly painful in advanced stages of the disease.

Two other pathologies may also co-exist with TMJ arthritis: carpal tunnel syndrome and flexor carpi radialis tendinitis. This is confirmed by the presence of tenderness on palpation of the tendon at the level of the distal wrist crease which is intensified by active flexion of the wrist.

Imaging Studies

Kapandji has described a complete radiographic assessment of the TMJ in six views.[44] It is critical to obtain a true lateral X-ray which is the only way to stage the disease according to Eaton's classification

Figure 2.6.

Four stage classification of Eaton-Littler based on a lateral X-ray of the thumb centered on the trapezium and with the sesamoids superimposed.

Stage	Criteria
I	Normal articular surface with possible widening of CMC joint indicating synovitis.
II	Joint space narrowing, osteophytes < 2 mm scaphotrapezial joint is normal.
III	Severe trapeziometacarpal destruction with subchondral sclerosis, loose bodies and osteophytes > 2 mm. Scaphotrapezial joint is normal.
IV	Both the scaphotrapezial and trapeziometacarpal joints are affected.

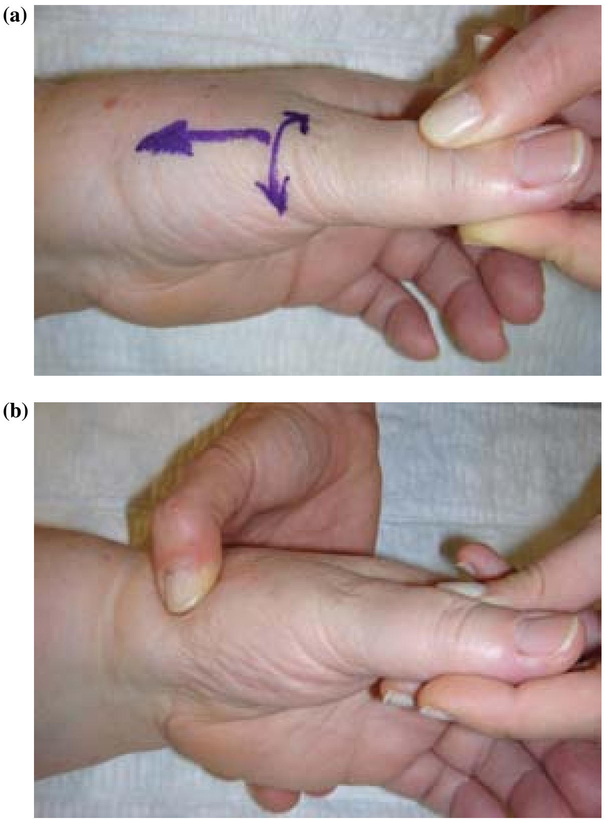


Figure 2.7.

(**a**) The Grind Test:
The examiner subjects the thumb to an axial compression accompanied by circumduction. There is crepitus of the affected joint.
(**b**) Glickel test:
The examiner puts into extension the head of the first metacarpal and applies a dorsal pressure to its base. This is particularly painful when the joint is inflamed and when the dorsal subluxation of the trapeziometacarpal joint is reduced.

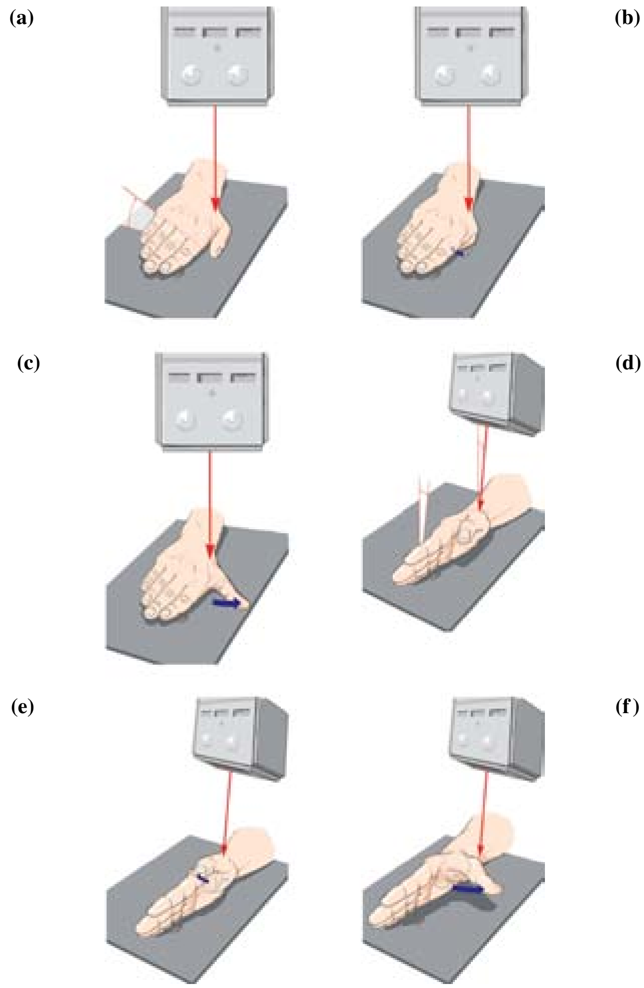


Figure 2.8.

Kapandji radiographic assessment.
(**a**) Lateral view of the thumb: The thumb is in the axis of the radius, the hand in pronation at 30º rests on the X-ray plate, X-ray beam centered on the MP joint.
(**b**) Lateral view with complete flexion of the thumb into the palm on the X-ray plate.
(**c**) Lateral view with maximum extension of the thumb resting on the X-ray plate.
(**d**) Posteroanterior view with the forearm lying on its ulnar border and in 15° of pronation and 15° of extension of the wrist. The plane of the thumb nail is parallel to the X-ray plate, the X-ray beam centered on the MCPJ is angled 30° to the vertical.
(**e**) Frontal view of the thumb in adduction: The thumb is close to the second metacarpal, the nail being kept parallel to the X-ray plate.
(**f**) Frontal view in abduction: The thumb in maximum extension away from the second metacarpal, the X-ray beam equally centered on the MCPJ.

(Fig. 2.8). The wrist is placed in 20° of extension and ulnar deviation. The pronated forearm and hand rest on the table. The hand is hyperpronated until the thumb is completely lateral with respect to a vertical X-ray beam centered on the metacarpophalangeal joint. According to Kapandji, a true lateral thus taken should show: true laterals of both thumb phalanges; superimposed sesamoids; and the base of the metacarpal which should appear concave and correspond to the convexity of the trapezial surface.

Table 2.2.

Normal Range of Motion of TMJ as measured Radiographically by Kapandji

	In Flexion-Extension		In Forward and Retropulsion
Neutral position: angle M1–M2	20°	Neutral	35°
Flexion	20 to 25°	Antepulsion	25 to 35°
Extension	30 to 35°	Retropulsion	15 to 25°
Total ROM	60 +/− 10°	Total ROM	50 +/− 10°

With the hand and the forearm in the same position, two more views are performed, one with flexion of the thumb into the palm and the other with maximal extension. Thus, flexion-extension arcs can be documented: 53+/−11° according to Cooney and 60+/−10° according to Kapandji.

Posteroanterior views are carried out with the forearm lying on its ulnar border and in 15° of pronation and 15° of extension of the wrist. The plane of the thumb nail should be parallel to the X-ray plate. The X-ray beam centered on the trapeziometacarpal joint is inclined 30° to the vertical to view distally. In this view, the trapezial saddle should appear concave and the metacarpal base convex. The sesamoids should be symmetrically aligned on the metacarpal head and the scaphotrapezial joint completely visualized. Two more views are carried out, one in adduction and one in abduction, with the thumb kept parallel to the X-ray plate.

It is also useful to X-ray the wrist-PA neutral, PA clenched fist and lateral views. This is to exclude any carpal instability that could be worsened after trapeziectomy. Herren *et al*. have shown that while a normal wrist is not destabilized after trapeziectomy, one in which a scapholunate rupture exists does so.[40] In these cases, it is better to keep and fuse the proximal part of the trapezium with the trapezoid.

Differential Diagnosis

There are a few pathologies that can cause confusion. De Quervain's tenosynovitis is easily confirmed by Finkelstein's maneuver, i.e. ulnar deviation of the wrist with the thumb clasped in the hand producing pain over the first extensor compartment. Wrist arthritis or chondrocalcinosis can produce joint line tenderness. Tenderness in the anatomical snuffbox signifies scaphotrapezial arthritis. Scaphoid views are necessary to exclude any scaphoid pathology.

Management

Conservative Management

TMJ arthritis should be managed in the initial stages with non-steroidal anti-inflammatory drugs and splints. During the day a short thumb spica splint immobilizing the thumb column in neutral (45° of abduction and antepulsion) with the metacarpophalangeal joint in 30° of flexion is fitted (Fig. 2.9). This flexion significantly relieves the forces on the TM joint.[54] At night, a long splint immobilizing the wrist in slight extension is used (Fig. 2.10). When worn for a period of six weeks, there is an improvement in symptoms in 76% of cases, when the arthritis is Eaton stage I or II, and improvement in 54% for stages III and IV.[68] Intra-articular steroid injection should not be done routinely and should be reserved for management of inflammatory flare-ups. Repeated injections weaken the capsuloligamentous apparatus and this will complicate any future surgery. Day *et al*. have, however, reported that for Eaton I arthritis, wearing of a splint for three weeks and intra-articular steroids give relief in 83% of cases over a period of 23 months.[22]

(a)

(b)

Figure 2.9.

Short thumb-spica day-splint.
The splint immobilizes the thumb column in neutral (45º of abduction and antepulsion), with the metacarpophalangeal joint in 30º of flexion. This flexion relieves the forces on the TM joint.

(a)

(b)

Figure 2.10.

Long thumb-spica night-splint.
The splint extends from the middle third of the forearm to the IPJ of the thumb. The wrist is stabilized at 20º of dorsiflexion. The thumb column is immobilized in the same way as for the short splint to allow relaxation of the intrinsic and extrinsic musculature.

Surgical Management

There has been an abundance of surgical options since the 1970s. Most of them are based on the anatomic and biomechanical studies that have been cited above. In advanced Eaton stages, III and IV, there is no technique that can restore durably mobility, comfort and strength. At this stage, the ligamentous apparatus is degenerated and trapeziectomy further reduces its mechanical ability. Functional results are, however, acceptable because the intrinsic and extrinsic musculature contribute to the stability of the neo-articulation. Much hope has been placed on ligament reconstruction with tendon interposition (LRTI). The goal of LRTI is to reconstruct the anterior oblique ligament (AOL) or beak ligament using half of the FCR or the APL. The elegance of these procedures is not matched by their efficacy in preventing proximal migration of the thumb, which is always under strong axial forces. One must also remember that a tendon does not have the same mechanical qualities as a ligament.

After trapeziectomy, though most techniques (tendon interpositions, ligament reconstructions,[21] implants,[69] total prostheses) reliably give a painless joint, they do not restore strength. Implants and prostheses do fulfill this requirement for a period of time, but the complications are numerous and most designs inspired by the concept of de la Caffinière have not weathered the test of time.[15] The biomechanics of the TMJ has defied the durability of total prostheses. They have found their place, however, in Eaton III and IV stages, where the shape of the trapezium is altered by osteophyte formation and when the scapho-trapezial articulation is affected. A metal cup is inserted into a pathologic trapezium which has to bear large axial loads (13 times the force of pinch). It is not surprising, then, to observe loosening of the cup, trapezial fracture and subluxation of the cephalic prosthesis. The revision surgery to salvage these failed prostheses is difficult. A complete trapeziectomy is required and the first metacarpal that was shortened for placement of the prosthesis must be managed. So, paradoxically, while Swanson implants have been criticized for their instability (25% subluxation or dislocation), they have an indication for use in the salvage of failed prostheses or LRTI that has resulted in severe proximal migration of the thumb.[66] More recently, the Silastic Tie implant has been found to decrease the risk of displacement with a ligamentoplasty that nooses the head of the implant. We have thought this preamble necessary to justify our choices of treatment options for Eaton stage II, III and IV arthritis. For stage I, we think that consensus has just about been achieved.

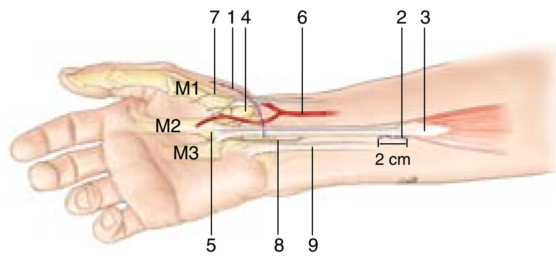
Stage I

Eaton-Littler ligamentoplasty

Failure of conservative treatment leads to the management of the TMJ instability with a ligamentoplasty as described by Eaton and Littler.[26] Half of the FCR is used. The distal attachment is preserved and the tendon slip is passed through a bony channel at the base of the metacarpal to be sutured on itself after being passed around the APL. This has the objective of recreating the anterior oblique ligament (AOL or beak ligament). Wagner's approach is used, prolonged proximally to the wrist crease overlying the FCR (Fig. 2.11a). The thenar muscles are reflected, the superficial branch of the radial nerve is preserved, and the radial artery is identified with a vessel loop. On the dorsum of the first metacarpal, the EPL is reflected ulnarly. The distal FCR tendon is liberated from its fibro-osseous tunnel, especially where it passes in the groove of the trapezium. A 2-cm longitudinal incision is made in the middle third of the forearm at the level of the musculotendinous junction of the FCR. The radial half of the tendon is cut transversely and the longitudinal division is initiated with the scalpel along with a release of the antebrachial fascia. With a long hemostat, the proximal end of the hemitendon is brought out through the wrist incision and separated until its insertion on the base of the second metacarpal (Fig. 2.11b).

The trapeziometacarpal joint line is identified with the aid of a needle and the bone tunnel through the metacarpal base is prepared with an awl and completed with a 2.7 mm drill. It is made parallel to the joint line and is 5 mm distant in an anteroposterior direction. The hemitendon is pulled out with the use of a looped wire, introduced through the anterior hole. Extracted through the dorsal surface, it is looped around the APL at its metacarpal insertion and is weaved back into the remaining intact FCR tendon. The trapeziometacarpal articulation is placed in neutral and the hemitendon is sutured to the periosteum of the first metacarpal at its dorsal exit point with PDS 2/0, then again to the base after crossing the APL. It is

(a)



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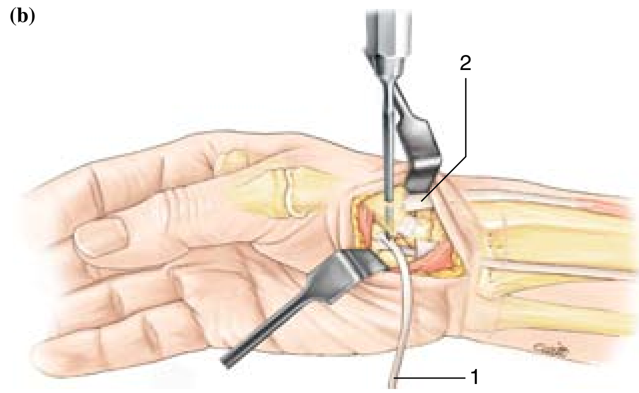


(c)

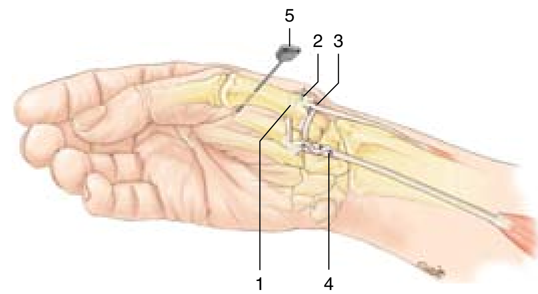


Figure 2.11.

Eaton-Litter ligamentoplasty.
(**a**) (1) A 3-cm dorsoradial incision at the base of the first metacarpal is extended in a "J" shape to the proximal wrist crease at the level of the FCR. (2) A 2-cm longitudinal incision is made at the level of the musculotendinous junction of the FCR. (3) FCR. (4) Trapezium. (5) Insertion of the FCR at the base of the second metacarpal. (6) Radial artery. (7) Radial nerve superficial branch. (8) Palmar cutaneous branch of the median nerve. (9) Palmaris longus. (**b**) The thenar musculature which is partially released from the first metacarpal and from the trapezium is reflected. (1) Half of the FCR is extracted *at the level of the wrist distal crease*; its osteofibrous sheath is split distally with a Mayo scissor. *The hemitendon is brought out through the wrist incision and divided until its insertion on the base of the second metacarpal.* The radial artery is dissected and protected in the vicinity of the TMJ. (2) Abductor pollicis longus. *The TM joint line is identified with the aid of a needle and the bone tunnel is prepared with an awl and completed with a 2.7 mm drill. It is made parallel to the joint and 5 mm distal in an anteroposterior direction.* (**c**) The hemitendon is introduced into the transosseous tunnel with a wire (1) then put under moderate tension. It is either sutured to the periosteum or fixed with a *Mitek-Minilock* anchor (2). After crossing the APL, the ligamentoplasty is then sutured again to the capsular base of the first metacarpal (3). It is then sutured to the tendon of the remaining FCR using a Pulvertaft weave (4). The thumb is kept in antepulsion from the neck of the first metacarpal to the neck of the second with a K-wire (5).

then put under moderate tension and sutured to itself through a Pulvertaft weave. The thenar muscles are then reattached with the use of *Vicryl* 3/0 sutures. The thumb is kept in antepulsion with a Kirschner wire from the neck of the first metacarpal to the neck of the second. It is removed after four weeks. This ligamentoplasty is effective for Eaton stage I disease. In a series of 23 patients with a 15-year follow-up, Freedman demonstrated that 65% of operated cases were pain-free and had not developed arthritis.[33]

First metacarpal osteotomy (Wilson[75]). It is designed to achieve a unicortical extension osteotomy of 30° with respect to the base of the first metacarpal. It modifies the biomechanics of the thumb, shifting the palmar and ulnar loading, which affects the anterior oblique ligament (AOL) to the posterolateral quadrant.[60] It reduces the risk of dorsal subluxation of the TMJ and allows the first web space to open. The approach is longitudinal on the radial border of the first metacarpal (Fig. 2.12a). A 3-cm long incision starting from the TMJ, previously identified with a needle, is made. The superficial branch of the radial nerve is protected and the EPL is retracted ulnarly. The thenar muscles are partially reflected. A closing wedge osteotomy is made in the metaphysis 1 cm from the joint (Fig. 2.12b). The transverse proximal cut and the distal oblique cut should be about 5 mm apart to give an angle of 30°. It is made with an oscillating saw on the dorsal surface, part of the anterior cortex being preserved to facilitate osteosynthesis and provide stability.

A 1.4 mm Kirschner wire is introduced obliquely from proximal to distal to close the osteotomy. A

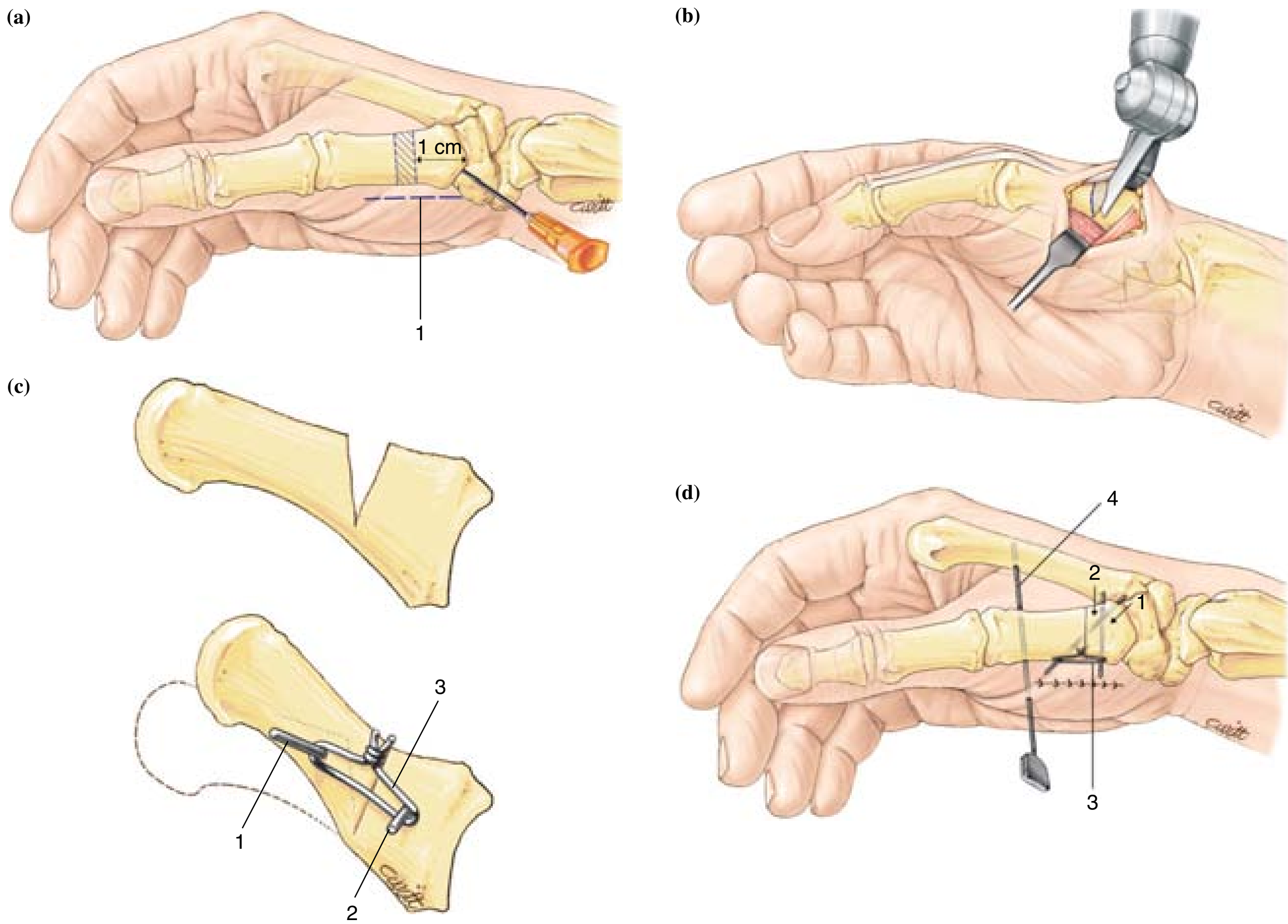


Figure 2.12.

Wilson first metacarpal osteotomy.
(**a**) (**b**) A 3-cm incision is made on the radial border of the first metacarpal (1). The trapeziometacarpal joint line is identified with the aid of a needle; the thenar muscles are partially reflected to expose the proximal part of the first metacarpal. The anteroposterior unicortical osteotomy of 30º is made with an oscillating saw 1-cm from the joint line.
(**c**) (**d**) The osteotomy site is stabilized with two K-wires (1 and 2) of 1.4 mm, and forced together by a 22-gauge cerclage wire (3). An intermetacarpal of 1.5 mm (4) protects the osteotomy site for four weeks.

second similar wire is introduced transversely into the base of the metacarpal some distance from the osteotomy site. The two protruding ends of the wires are forced together by a 22-gauge cerclage wire which compresses the bone ends (Figs. 2.12c–d). This stable construct limits the time of immobilization of the thumb to three weeks. We prefer an intermetacarpal wire to plaster immobilization. While allowing the metacarpophalangeal and interphalangeal joints to be free, it keeps the first web open and prevents contractures of the thenar muscles around the osteotomy site. In a series of 41 osteotomies done on 33 patients, Holly *et al*. observed the absence of pain or pain only on heavy work in 80% of cases.[41] With a follow-up of six years, there were 74% good or excellent results.

Trapeziometacarpal denervation

This joint is innervated by the branches of the radial nerve which emerge at the level of the radial styloid. In 30% of cases, the articulation is innervated by the nerve of Lejars.[20] Foucher *et al*.,[32] in a series of 36 denervations with a follow-up of 17 months, observed that 81% of patients improved in terms of pain. Our experience (11 cases) is less encouraging, with the effect of denervation receding at 13 months. We consider denervation to be indicated as an interim procedure in young women at Eaton stage I for whom conservative management has failed.

Stages II, III, IV

If the articular surface is still adequate, the Eaton-Littler ligamentoplasty can still be applied to stage II. Pellegrini[61] proposes an extension osteotomy of the first metacarpal if there is still cartilage in the dorsal aspect of the joint. These indications are limited because they wager on a non-evolution of an already present arthritic process. We have, on numerous occasions, regretted these seemingly more conservative options in patients who developed painful arthritis in the following year and who scarcely appreciated having to subsequently undergo a complete trapeziectomy with tendon interposition. In these cases, it is preferable to manage the condition conservatively with eventually a denervation procedure (not requiring postoperative immobilization). This allows the gain of a few years in relative comfort before trapeziectomy which must be done. There are two principal additions to the original total trapeziectomy as described by Gervis in 1949[35]: tendon interposition or ligament reconstruction with tendon interposition.

Trapeziectomy with tendon interposition

In our practice, the most commonly performed technique is complete trapeziectomy with tendon interposition using the palmar half of the abductor pollicis longus which is weaved to the palmaris longus. Unlike the original "anchovy" technique proposed by Froimson in 1970, which utilizes half of the flexor carpi radialis, our technique does not include any suspension or transosseous ligamentoplasty. It is best reserved for stages II and III, where the joint capsule retains sufficient material for a capsuloplasty and the intrinsic muscles are good enough to motorize the new joint. A mean loss of 40% of joint height is not detrimental to functional restoration and, in fact, allows deepening of the first commissure and reduces the action of the extensor pollicis brevis on the metacarpophalangeal joint.[12]

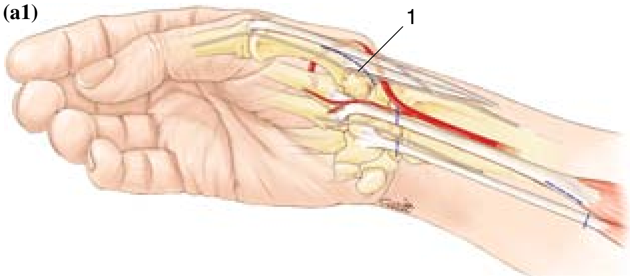
Approach

A 3-cm dorsoradial incision is made at the base of the first metacarpal. It can be extended in a "J" shaped manner to the proximal wrist crease if the FCR needs to be harvested (Fig. 2.13a). We prefer this approach to an "S" shaped incision across the anatomic snuffbox, as it is more convenient for the surgeon. The disadvantage is that it leaves an ugly scar. A venous plexus appears as soon as the dermis is incised; only the smallest collaterals are cauterized with a bipolar diathermy. The radial nerve, which is dorsal and ulnar, is identified. It is not necessary to isolate it along its length and it is retracted along with the main vein and surrounding fat on the same loop (Fig. 2.13b). The APL and EPB are also isolated on a loop. A retractor is placed proximally to allow visualization of the first extensor compartment, which is released using Metzenbaum scissors. A tendon hook helps to separate the 2 or 3 slips of the APL and one of these is divided at the musculotendinous junction (Fig. 2.13c). This slip will eventually be used along with the palmaris longus tendon to fashion the tendon interposition after total trapeziectomy.

Trapeziectomy

Before starting trapeziectomy, it is preferable to identify the radial artery, coagulate the fine arterial branches and put a loop to retract it ulnarly. The TMJ capsule is incised in an "H" fashion (Fig. 2.13d) with the distal limb at the trapeziometacarpal joint and the proximal one at the scaphotrapezial joint. The horizontal limb is parallel to and close to the thenar aponeurosis. This incision is designed to preserve a strong dorsal capsular flap which will augment the stability of the capsuloplasty. A periosteal stripper is used to separate the different facets of the trapezium from

(a1)

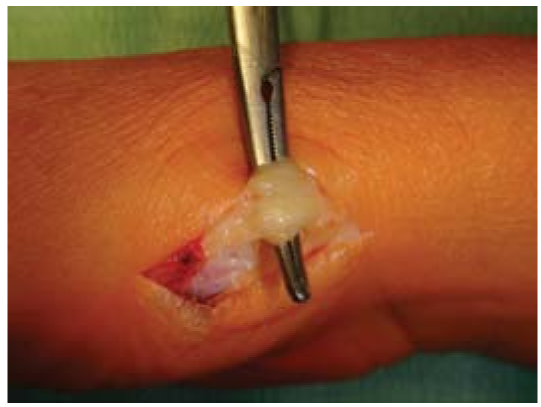


(a2)

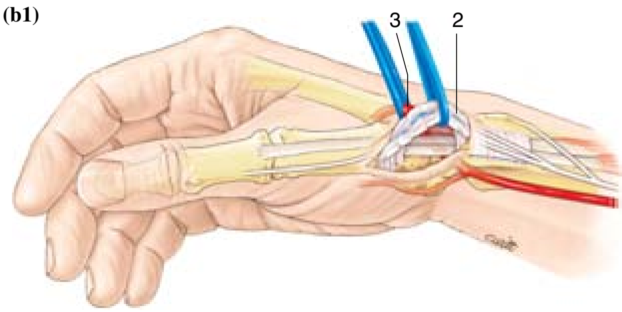
Figure 2.13.

Total trapeziectomy with tendon interposition.
(**a1**) a) A 3-cm dorsoradial incision is made at the base of the first metacarpal and the trapezium (1).
(**a2**) Short tiered incisions to remove the palmaris longus.

(b2)



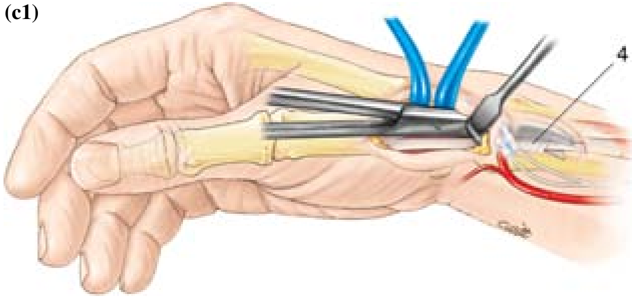
(b1)



(**b1**) (**b2**) b) The radial nerve (2) and venous branches are isolated on a loop. The APL and EPB are also isolated. The radial artery (3) is identified and retracted from the trapezium.

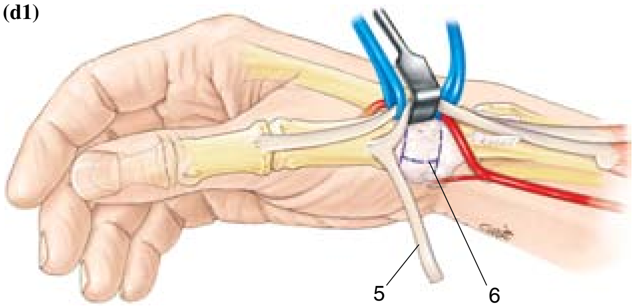
(c2)

(c1)



(**c1**) (**c2**) c) The Morel-Fatio retractor retracts the overlying skin and the radial nerve from the APL (4).

(d1)



(d2)

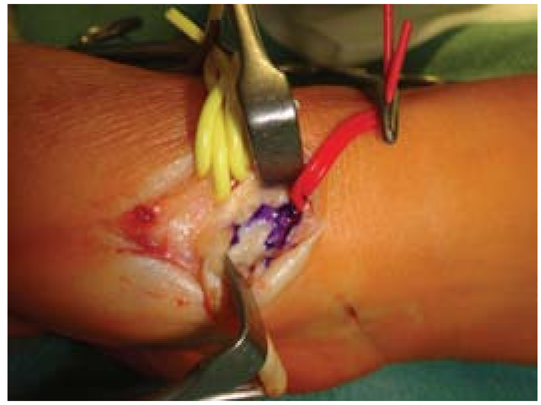
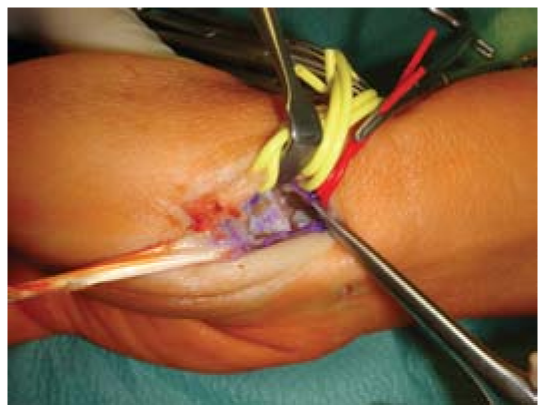


Figure 2.13. (*Continued*)

(**d1**) (**d2**) d) Half or a third of the APL is split longitudinally, then divided at the musculotendinous junction (5) using Metzenbaum scissors. An H-shaped incision is made over the TMJ capsule (6). Care should be taken to preserve the surrounding capsuloligamentous insertions on the first metacarpal, the trapezoid and the scaphoid.

(e1)

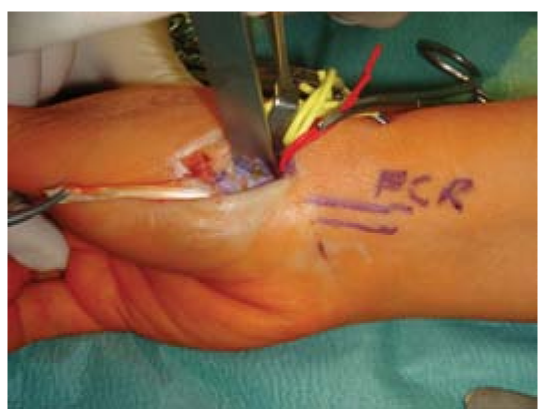
(e2)



(**e1**) (**e2**) e) A periosteal stripper is used to separate the different facets of the trapezium from their attachments (7).

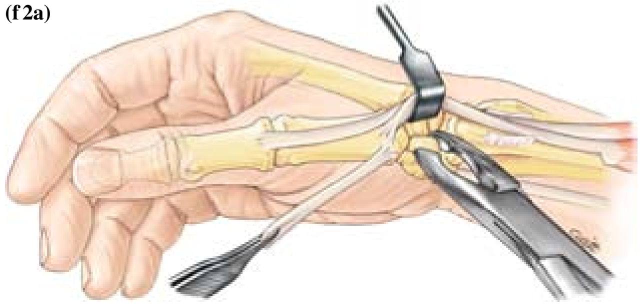
(f1a)

(f1b)



(**f1a**) (**f1b**) f) Trapeziectomy: An 8–10 mm osteotome in the axis of the FCR is used to split the trapezium into radial and ulnar fragments (f1a and b). Longitudinal fragmentation may be continued with an osteotome or preferably a rongeur (f2a and b).

(f2a)



(f2b)

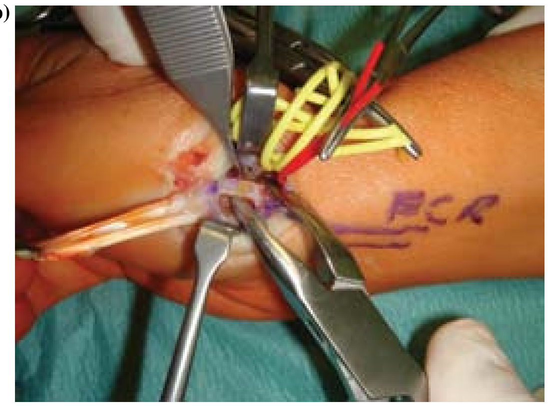
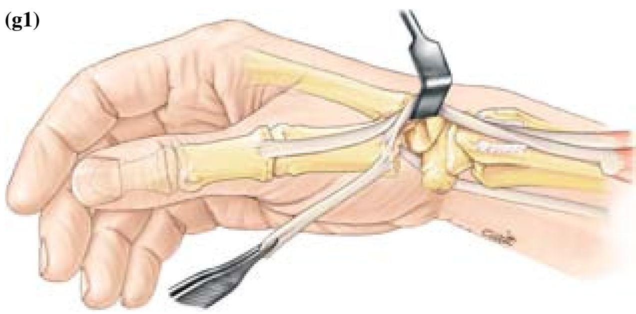


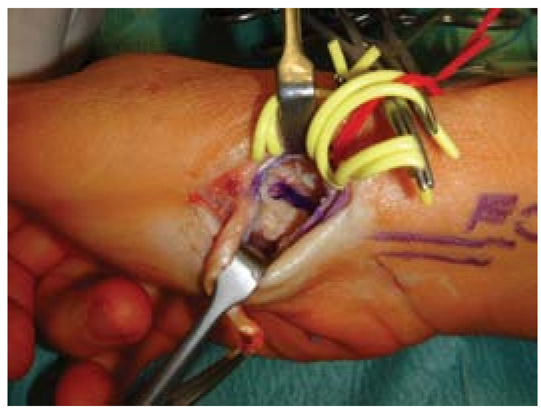
Figure 2.13. (*Continued*)

(**f2a**) (**f2b**) f) Trapeziectomy: An 8–10 mm osteotome is used to split the trapezium into radial and ulnar fragments (f1a and b). Longitudinal fragmentation may be continued with an osteotome or a rongeur.

(g1)

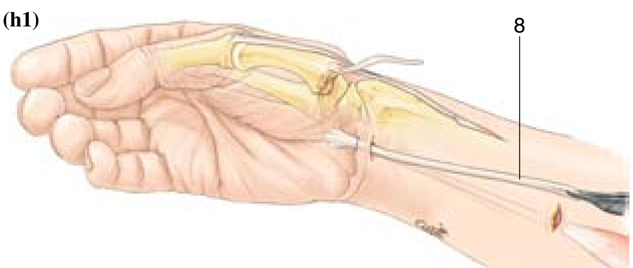


(g2)

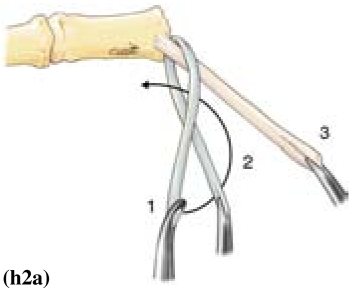


(**g1**) (**g2**) g) The trapeziectomy must be complete with the complete removal of osteophytes and synovitis from the inter-metacarpal space.

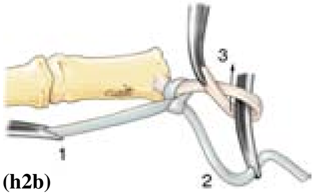
(h1)



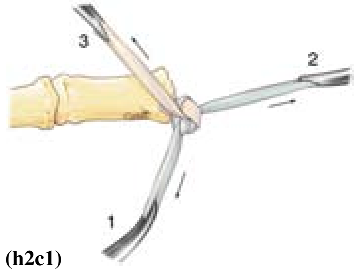
(**h1**) h1) The palmaris longus is harvested with two 1 cm incisions 12 cm apart.



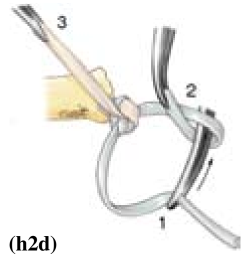
(h2a)



(h2b)



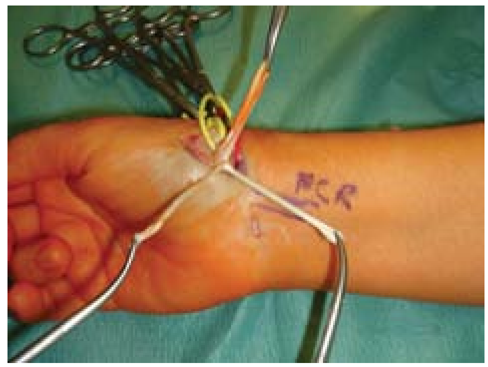
(h2c1)



(h2d)

Figure 2.13. (*Continued*)

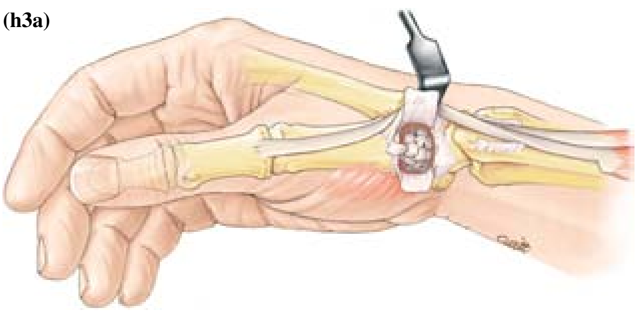
(**h2**) abcd. The palmaris longus (1, 2) is weaved to the APL (3) to obtain a tendinous sphere of 8–10 mm in diameter (h3a and b).



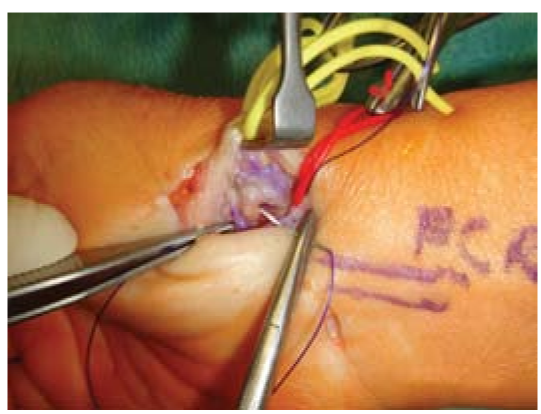
(h2c2)

(h3b)

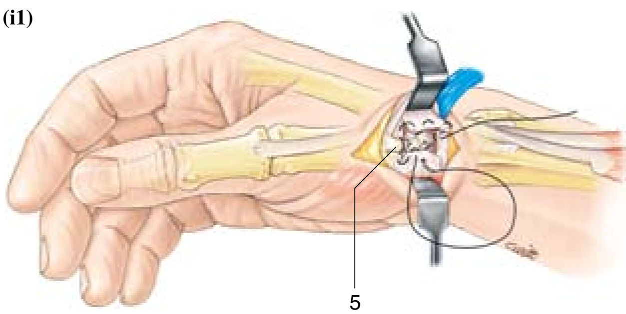
(h3a)



(i2)

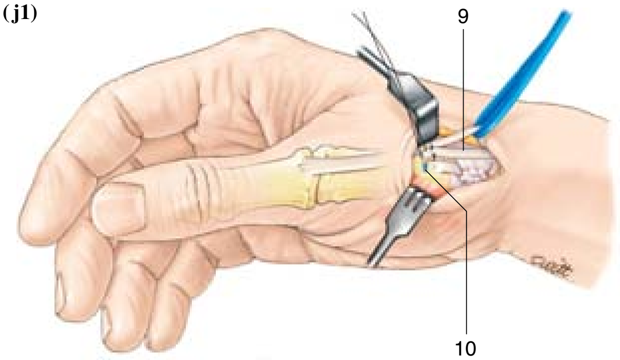


(i1)



(**i1**) (**i2**) Capsuloplasty: the flaps of the capsuloligamentous structures are sutured with a purse string suture with 2/0 PDS. The tendon interposition plasty remains at the base of the first metacarpal because of the APL (5).

(j1)



(j2)

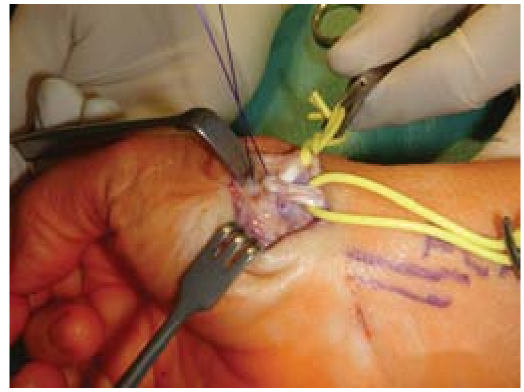


Figure 2.13. (*Continued*)

(**j1**) (**j2**) Transfer or shortening of the APL: The motorized APL is either shortened by 6–8 mm by plication to remedy the collapse of the thumb and to aid retropulsion, or is transferred distally and fixed with a resorbable *Mitek-Minilock* anchor (10).

their attachments (Fig. 2.13e). The trapeziectomy is achieved with fragmentation so as to best preserve the surrounding capsuloligamentous insertions and the FCR which travels in close proximity. An 8–10 mm osteotome in the axis of the FCR is used to split the trapezium into radial and ulnar fragments (Fig. 2.13f). Longitudinal fragmentation may be continued with the osteotome or with a rongeur. This last instrument is preferred to avoid damage to the FCR. The trapeziectomy must be complete. Osteophytes may form and synovitis may develop in the intermetacarpal space and these must be removed diligently. The trapezoid is left intact. This part of the operation may be tedious, but it must be done without brutality to best preserve the integrity of the capsuloligamentous apparatus which is the key to the success of this surgery. After the trapeziectomy is done, the base of the first metacarpal is not touched unless there is an osteophyte that may impinge on the second metacarpal or trapezoid (Fig. 2.13g). The base of the first metacarpal should be completely free in this space, where in addition, the base of the second metacarpal, the trapezoid, the scaphoid and the FCR can also be visualized.

Tendon interposition

The palmaris longus is harvested using two short incisions, one at the level of the distal wrist crease and the other 12-cm proximal in the forearm (Fig. 2.13h1). The exact position of the latter incision is determined after traction on the palmaris tendon with a hemostat. It is divided at the musculotendinous junctions. If it is absent (13% of the population), half of the FCR can be harvested. A short distal wrist crease incision is made bearing in mind that the palmar cutaneous branch of the median nerve lies on the ulnar side of the tendon. A second, 2-cm longitudinal incision is made in the forearm at the level of the musculotendinous junction where the tendon is divided and held in a hemostat; and the antebrachial fascia is released for a distance of a few centimeters to allow introduction of the hemitendon and its traction until its emergence at the distal wrist crease. This technique leaves very little scarring. The previously harvested slip of the APL is knit to the palmaris longus or the FCR graft (Fig. 2.13h2–3). A tendinous sphere is obtained, 8–10 mm in diameter; it is stabilized with 2/0 PDS sutures in the form of a cross. The sphere is inserted into the cavity and left free, the distal end still attached to the base of the metacarpal.

Capsuloplasty

It is the quality of the capsuloplasty that determines the final functional result. It is done by making a purse string suture using 2/0 PDS (Fig. 2.13i). Starting at the base of the metacarpal, the capsule and the neighboring thenar aponeurosis are seized in the first suture, which continues on the dorsal border of the metacarpal catching the capsuloligamentous insertions, dorsal capsular flap and insertion of the APL. The PDS suture turns to include the distal scaphoid pole and passes palmarly to once again catch the thenar aponeurosis whereupon the purse string is closed with the first metacarpal in abduction. It is useful, at this stage, to evaluate the mechanical quality of the capsuloplasty by directing an anteroposterior force to the first metacarpal; if adequate, the base of the metacarpal stays stable without subluxation. If not, a few "U" shaped 2/0 PDS sutures may be placed to reinforce the capsuloplasty. Circumduction of the metacarpal is then performed to test for any catching. If this phenomenon exists, there are three possible causes: Remaining osteophytes, weak capsuloplasty or first metacarpal collapse. While the first two are easily rectified, the last requires an Eaton-Littler type ligamentoplasty of the anterior oblique ligament for correction. Exceptionally, the surgeon may opt for a Swanson or Tie Silastic arthroplasty. To aid abduction and retropulsion of the thumb, the APL is shortened by 6–8 mm by plication at the base of the first metacarpal or with an absorbable Mitek-Minilock absorbable suture (Fig. 2.13j). The inevitable collapse of the thumb column by a few millimeters relaxes the EPB and thus has the positive effect of limiting the hyperextension deformity of the first metacarpophalangeal joint.

Correction of the hyperextension deformity of the first metacarpophalangeal joint (MCPJ)

Where the deformity is less than 30°, we perform a simple temporary arthrodesis in 20° of flexion held with a 1.2-mm oblique Kirschner wire introduced obliquely from the radial aspect of the proximal phalanx. Where the deformity is more than 30°, a capsulodesis of the volar plate with the sesamoids is required. A Bruner incision is centered on the palmar MCPJ crease. The digital nerves are identified and retracted with loops and the oblique pulley incised, releasing the FPL. The neck of the metacarpal is rawed and the volar plate with the sesamoids is mobilized with a scalpel and fixed to the neck with a Mitek-Minilock resorbable anchor. This capsulodesis is protected for four weeks with a 1.2 -mm Kirschner wire that immobilizes the MCPJ in 20° of flexion (Fig. 2.14).

Immobilization

The neoarticulation is immobilized for four weeks with a 1.5-mm intermetacarpal wire that passes through both the cortices of the first and second metacarpals. It is left protruding through the skin at the level of the neck of the first metacarpal (Fig. 2.15). This wire provides for strict immobilization of the arthroplasty while leaving the wrist and interphalangeal joints free.

Closure and dressings

Before closure with Vicryl rapide 3/0, the radial nerve is placed away from the scar so as to avoid any future dysesthesiae. A drain in such a restrained space is of no use. Postoperative pain (about 7/10 on the visual analogue scale) must be managed aggressively. A compressive dressing without a splint is applied for 48 hours, then lightened while protecting the temporary arthrodesis wires. The sutures fall away by the 15th day. The intermetacarpal wire is removed without anesthesia at the 4th week.

Results

In a series of 52 patients with 69 surgeries, Stussi compared our personal series of 34 arthroplasties with 37 done by another surgeon who performed, in addition, a ligament reconstruction utilizing part of the APL interlaced with the FCR.[66] He observed that the reprise of daily activities is earlier with the first group (92% vs. 73%). Proximal migration of the thumb column is less by one mm with ligament reconstruction, but this technique causes more residual pain (30%) than a simple tendon interposition (20%). Mobility and strength are identical in both series, but it is the persistence of hyperextension of the MCPJ that affects pinch the most.

More recently, a review of 286 arthroplasties with simple tendon interposition done in our practice has

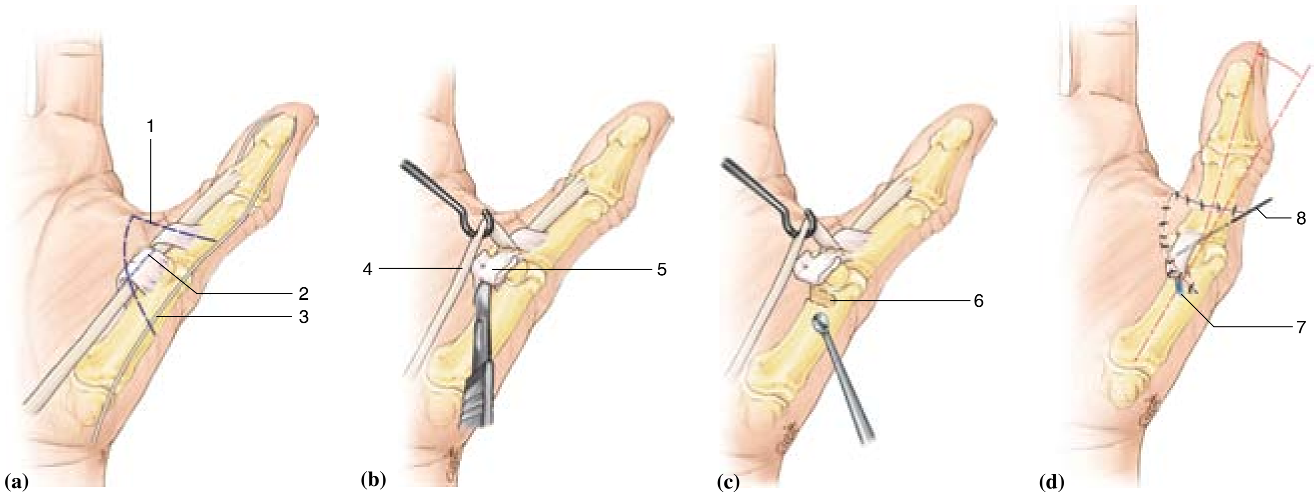


Figure 2.14.

Correction of hyperextension of the MCPJ.

(**a**) A Bruner incision is centered on the palmar MCPJ crease. The digital nerves are identified and retracted and the oblique pulley A1 incised longitudinally (2).

(**b**) The FPL is retracted (4); the palmar plate is released with a scalpel (5).

(**c**) The neck of the metacarpal is rawed with a curette (6).

(**d**) A *Mitek-Minilock* resorbable anchor is fixed perpendicularly in the neck of the metacarpal (7). This capsulodesis is protected for four weeks with a 1.2-mm K-wire (8) that immobilizes the MCPJ in 20º of flexion.

shown that 93% of patients with bilateral TMJ arthritis requested for the procedure in the contralateral hand, on an average of 16 months after the first procedure.

Ligament reconstruction with tendon interposition (LRTI) arthroplasty

There is a consensus among American teams for combining a reconstruction of the anterior oblique ligament with an arthroplasty by tendon interposition (LRTI). The ligament reconstruction is transosseous and this guarantees a durable efficacy despite the shear stresses developed by the thumb column during work. We have abandoned suspension ligamentoplasties like that recommended by Weilby,[73] who passes the FCR three times around the APL, or that recommended by Atroshi,[4] who uses half of the ECRL around the APL, and FCR. These suspension ligamentoplasties all end up stretching and do not limit proximal migration of the thumb. We continue to use the technique described by Burton[12] to perform a transosseous ligamentoplasty quite similar to that of Eaton and Littler, but we now use the entire FCR, loss of which does not create any functional deficit at the wrist. We use this technique for advanced stages of the disease, in particular Eaton IV with an adducted thumb. At this stage, the quality of the capsuloligamentous apparatus is severely affected and the intrinsics are atrophied. It is thus essential to stabilize the first metacarpal by reconstructing the anterior oblique ligament.

Approach

A 3-cm dorsoradial incision at the base of the first metacarpal is extended in a "J" shaped manner to the proximal wrist to harvest the FCR (Fig. 2.16a). The smaller branches of the venous plexus which appears after the skin incision are coagulated. The radial

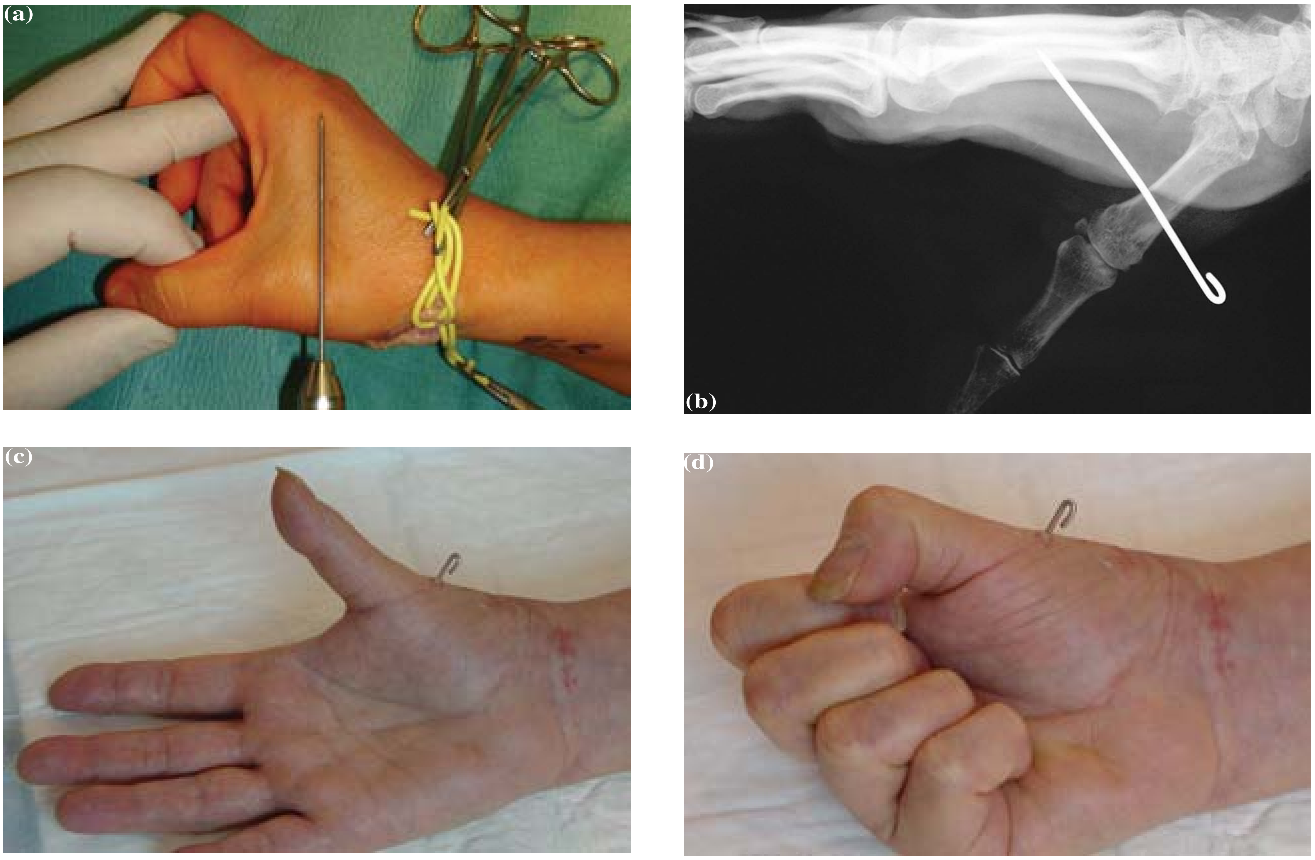


Figure 2.15.

Immobilization of the arthroplasty.
This is done with a 1.5-mm intermetacarpal K-wire that passes through both the first and second metacarpals, holding the thumb in antepulsion for four weeks. The patient exercises the digital chains.

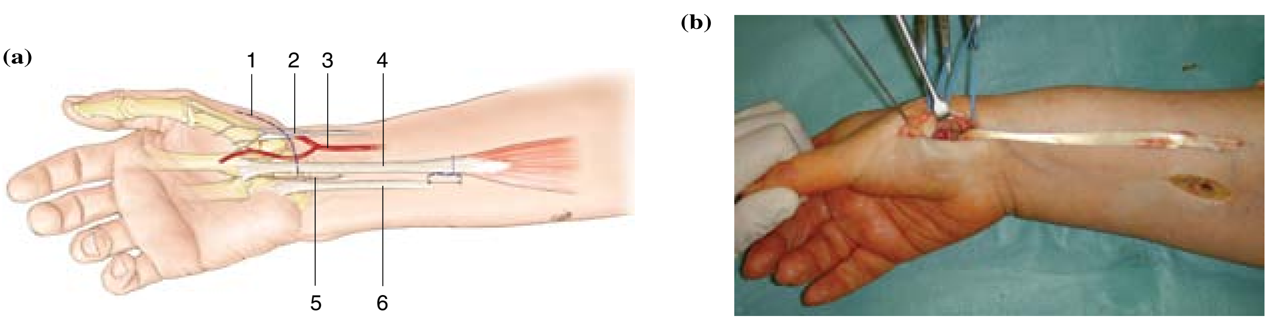


Figure 2.16.

Total trapeziectomy with LRTI.
(**a**) Approach: A 3-cm dorsoradial incision at the base of the first metacarpal is extended in a "J" shape to the proximal wrist crease to the level of the FCR (1)). (2) Superficial branch of the radial nerve. (3) Radial artery. (4) FCR. (5) Palmar cutaneous branch of the median nerve. (6) Palmaris longus.
(**b**) Total release of the FCR till its distal insertion. A 2-cm proximal longitudinal incision allows for separation of the tendon from the musculotendinous junction and splitting of the antebrachial fascia to facilitate its distal extraction.

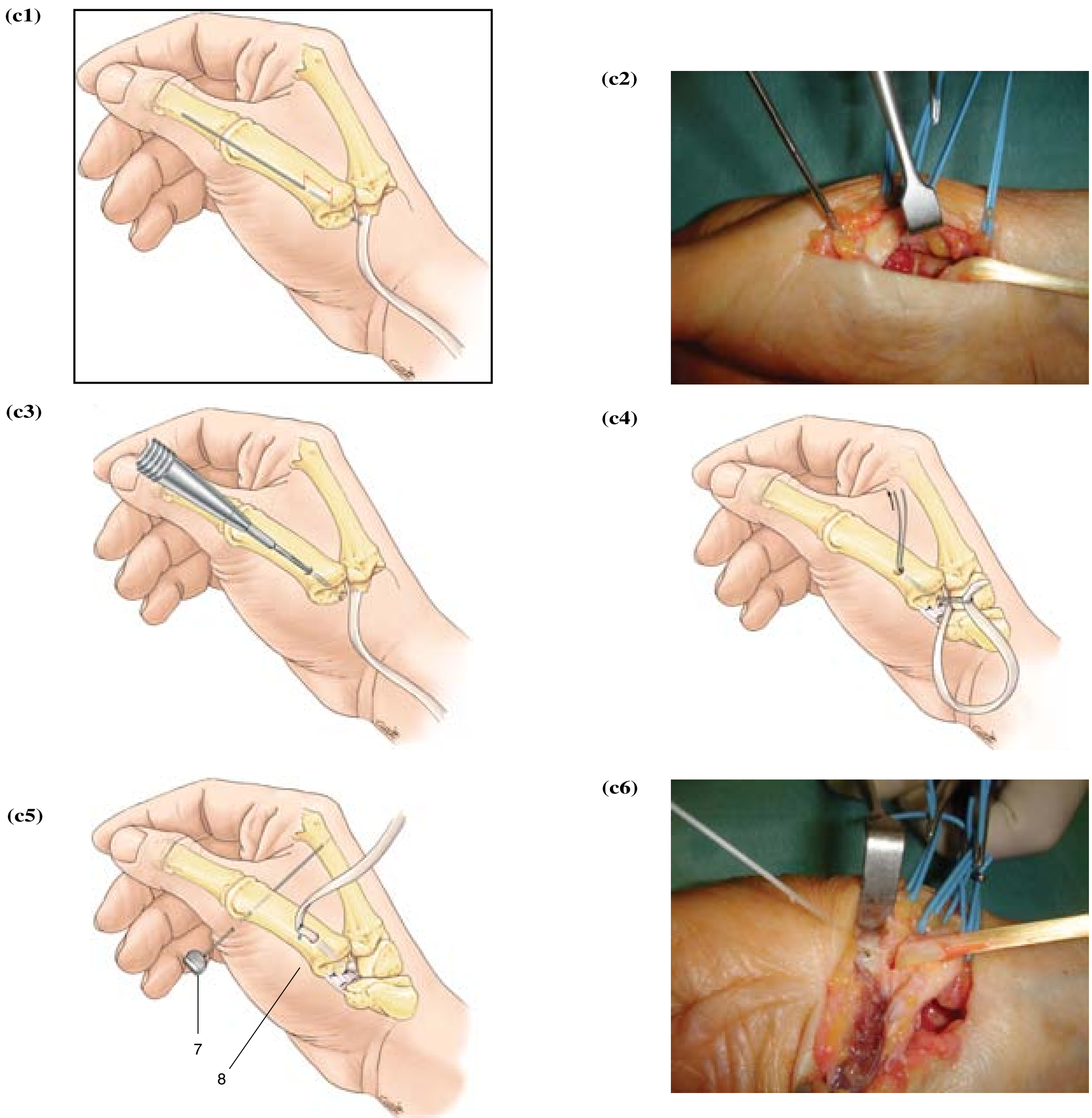


Figure 2.16. (*Continued*)

(**c**) Transosseous tunnel.

(1) A 1.5-mm K-wire is inserted obliquely on the dorsal surface of the first metacarpal M1, 1 cm distal to the TM joint line. It exits at the point of insertion of the palmar oblique ligament (AOL).

(2) (*photo*) After completing the total trapeziectomy the FCR has been removed, the postero-anterior oblique tunnel is prepared with a K-wire.

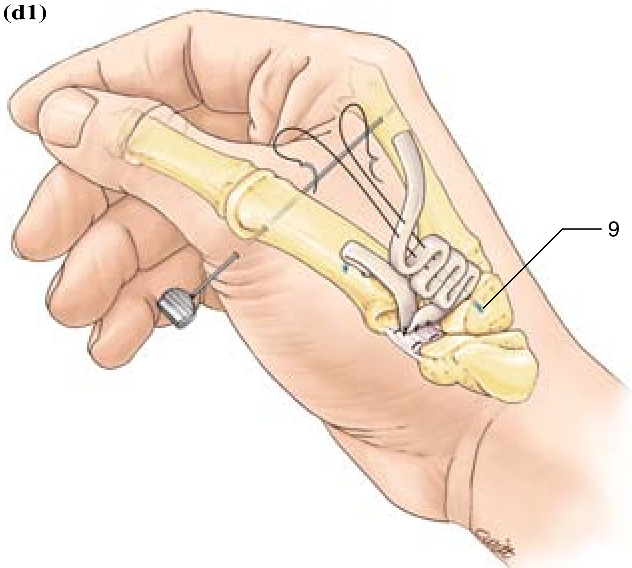
(3) A 3 mm drill is then used to enlarge the tunnel.

(4) The anterior caspsule is reinforced with a few PDS 2/o sutures. A 22 gauge looped wire is used to pull out the tendon.

(5) When the first metacarpal is level with the second, the first metacarpal is fixed in antepulsion (7) to the second using a transcommissural 1.5-mm K-wire. The tendinous plasty of the FCR is fixed to the dorsum of the first metacarpal with a resorbable *Mitek-Minilock anchor* (8).

(6) (*photo*) Dorsal extraction of the FCR from the first metacarpal; the sutures are attached to the bone anchor.

(d1)

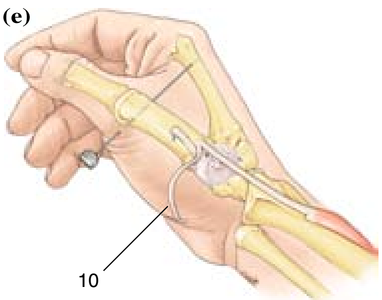


(d2)

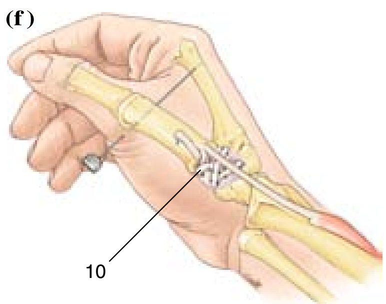
Figure 2.16. (*Continued*)

(**d1**) (**d2**) The tendon is folded on itself on the base of the first metacarpal. It is sutured with 2 PDS 2/0 sutures to the palmar aspect of the metacarpal. The tendinoplasty is held in the trapezial cavity with a resorbable anchor inserted into the trapezoid (9). The tendinoplasty can be folded into an accordeon (b1) or rolled upon itself like a snail (*photo d*2).

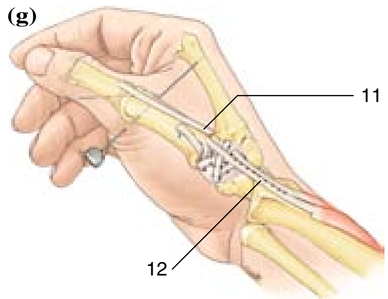
(e)



(f)

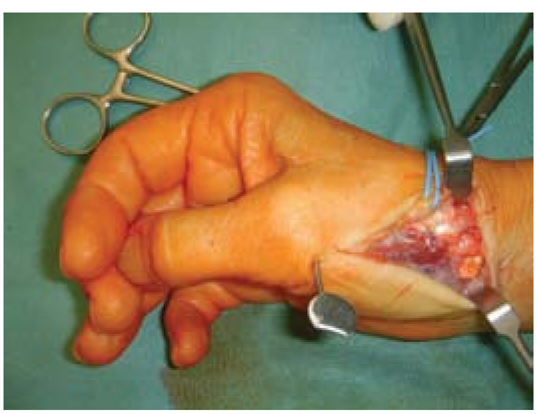


(g)



(**e**) The capsuloligamentous tissue is gathered with a PDS 2/0 purse string (2). If necessary, this repair can be reinforced with a tendon slip harvested from the APL (10).
(**f**) Reinforcement of the capsuloligamentous apparatus using half of the APL (10).
(**g**) The extensor pollicis brevis EPB (11) is divided at the base of the first metacarpal and transferred to the abductor pollicis longus APL (12) to improve thumb abduction and reduce hyperextension of the metacarpophalangeal joint. If hyperextension is <30°, temporary arthrodesis with a 1.2-mm K-wire is sufficient.

(h)



(**h**) (*photo*) View of the capsuloplasty and temporary arthrodesis of the first and second metacarpals. When closing the wound, care must be taken to avoid superimposing the scar on the course of the radial nerve (blue loops).

(i)

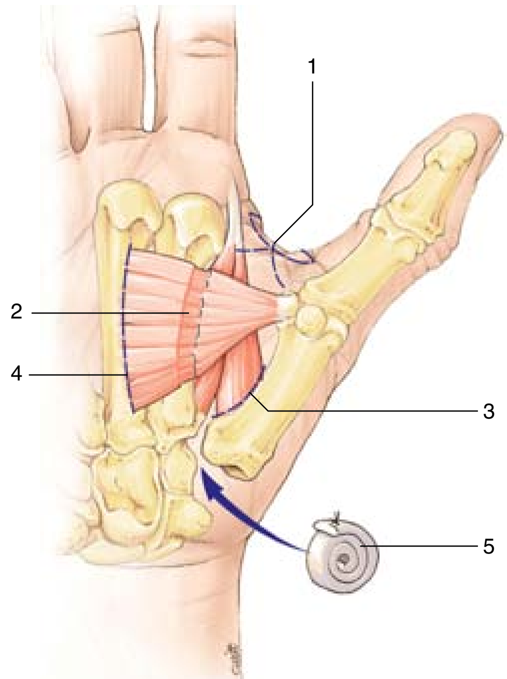


Figure 2.16. (*Continued*)

(**i**) Opening the first web
(1) Z-plasty.
(2) Release of the adductor.
(3) Disinsertion of the first interosseous dorsal on the first metacarpal.
(4) Arthroplasty by tendon interposition.

nerve, which is to be found dorsal and ulnar, is identified and to avoid injury and dessication, the adipose tissue around it is not disturbed (see Fig. 2.13b; the approach is the same). It is retracted with a loop and the assistant takes great care to protect it throughout the procedure. These precautions prevent the advent of neuralgic pain on the dorsum of the thumb which may take months to improve. The APL and EPB are isolated with a loop and the first extensor compartment is released under direct vision provided by a retractor under the skin (Fig. 2.13c). The radial artery is freed via coagulation of the fine branches and mobilized ulnarly away from the peritrapezial complex.

Complete trapeziectomy

The technique is the same as for a simple tendon interposition, but it is often more tedious because at stage IV, the capsular degradation and osteophyte formation are more marked. A No. 15 scalpel blade is used to free the capsuloligamentous apparatus subperiosteally from the trapezium. The most difficult part is freeing the palmar structures and the FCR, which is often very adherent to the scaphoid and trapezium. All osteophytes and inflamed synovium must be removed, especially in the intermetacarpal space (Figs. 2.16d–g).

Harvesting of the FCR

The tendon is easily isolated in the distal palmar crease and freed distally from the scaphoid. Tension on the tendon with a hemostat reveals its course in the forearm. A longitudinal incision about 12-cm proximal allows identification of the musculotendinous junction. The entire tendon is cut and gripped with a hemostat. The antebrachial fascia is released to allow the passage of the tendon into the wrist wound. A tendon hook passed around the tendon in the trapezoid cavity brings the proximal end in and facilitates complete extraction. The distal end should be freed of all palmar attachments (Fig. 2.16b).

Tunneling the FCR through the base of the first metacarpal

This requires precision. The tunnel is oblique, starting on the dorsal surface of the metacarpal, 1 cm distal to the TM joint line, and exits at the insertion of the deep anterior oblique ligament (dAOL). A 1.5-mm K-wire should first be inserted to verify the positioning of the tunnel (Figs. 2.16c1–c2). A 3-mm drill is then used, hand powered on a Jacob's chuck and not powered so as to avoid damage to the surrounding structures and to the base of the metacarpal itself (Fig. 2.16c3). A 22-gauge looped wire is used to pull out the tendon from anteriorly (Fig. 2.16c4). The tendon is progressively extracted until the base of the first metacarpal is about 2 to 3 mm from the second. Tensioning too tight would cause pain and lead to an adducted thumb. Too loose a tension would cause instability and a weak pinch. At this stage, the anterior capsule is reinforced with a few PDS 2/0 sutures and the tendon is fixed to the dorsum of the metacarpal with a Mitek-Minilock bone anchor (Fig. 2.16c5–c6). The first metacarpal must be situated in the axis of the scaphoid and at the level of the second metacarpal; the space of the trapeziectomy must be preserved and the thumb pronated to achieve a thumb pulp to index radial pulp pinch. At this juncture, Burton recommends the insertion of a temporary Kirschner wire to fix the metacarpal to the trapezoid and capitates.[13] We do not find this step necessary and instead, fix the first metacarpal to the second using a 1.5-mm wire. This wire is introduced at the level of the metacarpal neck, and we find that it gives enough stability to complete the capsuloplasty and ligamentoplasty.

Tendon interposition

The tendon is folded on itself on the base of the first metacarpal so as to resurface it and to cover the intraosseous tunnel. Two 2/0 PDS sutures fix the tendon to itself, and to the palmar aspect of the metacarpal (Fig. 2.16d1). The volume of the interpositional tendon should occupy the entire trapeziectomy space but without excess so as to allow a good closure of the dorsal capsule. Depending on its form and consistency, it can be rolled on itself like a snail (Fig. 2.16d2) and fixed with PDS 2/0 sutures, or it can be folded into the shape of an accordion 8–10 times (Fig. 2.16d1). This tendinoplasty should behave like a real interface between the first metacarpal and scaphoid and reduce shear stresses at the ligamentoplasty. With this in mind, we hold the tendinoplasty in the trapezial cavity with another Mitek-Minilock resorbable anchor inserted into the trapezoid (Fig. 2.16d1).

Capsuloplasty

It is the quality of the capsuloplasty that will determine the stability of the neoarticulation. At a stage IV Eaton, the capsuloligamentous substance is greatly attenuated and a mechanically competent and water-tight closure is difficult. A PDS 2/0 purse string is first used to close the capsule (Fig. 2.16e). If this repair is insufficient, it can be reinforced with a tendon slip harvested from the APL which can be sutured in a to- and fro fashion from the dorsal aspect of the metacarpal to the distal scaphoid (Fig. 2.16f).

Transfer of the EPB and correction of metacarpophalangeal joint hyperextension

In the advanced stages of TM arthritis, metacarpophalangeal joint hyperextension is common. Where it is less than 30°, temporary arthrodesis with a 1.2-mm K wire is sufficient. Where the hyperextension is greater than 30°, a palmar plate capsulodesis, as described above, is required (see Fig. 2.14). We have never performed a primary arthrodesis. To improve thumb abduction, the EPB is transferred to the APL; this has the additional effect of reducing the hyperextension of the metacarpophalangeal joint (Fig. 2.16g).

Correction of the adducted thumb

This is difficult, as in stage IV, the articular degeneration is accompanied by considerable atrophy of the thenar muscles. Contracture of the adductor and the first dorsal interosseous are usually accompanied by contracture of the first web, placing the thumb column parallel to the index (see Figs. 2.5 and 2.16i). If aponeurotomy alone of the adductor does not open up the first web, the first dorsal interosseous must be released from the first metacarpal and the thumb adductor from the third metacarpal. A butterfly or trident plasty opens up the web without deepening it.[53] In all the cases, metacarpophalangeal joint hyperextension more than 30° is corrected with a capsulodesis (see Fig. 2.14).

Closure and dressings

Closure is done with Vicryl rapide 3/0, care being taken to avoid superimposing the scar on the course of the radial nerve, a source of neuralgic pain which may last weeks to months (Fig. 2.16h). No drain is necessary. The exposed K wires should be protected with Chiroclips or bent to form a loop. A bulky dressing is applied for 48 hours as well as a palmar splint which keeps the wrist in mild extension. Once the dressings are lightened, active mobilization of the fingers can begin, and only the trapezial neoarticulation and the ligamentoplasty are immobilized and protected for four weeks by the intermetacarpal wire.

Results

Even if recovery in not very spectacular in the first few months, three series with more than three years follow up document an increase in grip strength of 13, 50 and 93% and an increase in lateral pinch of 27, 34 and 43%.[51,63,70] Tomaino reported subluxation in 11% and proximal migration in 13% of cases, but affirmed that there is no correlation between radiologic and functional result.[70] Lins observed in his series that 89% patients of patients were satisfied with the relief of pain provided by the arthroplasty.[51] He also noted functional improvement even beyond the 6th postoperative year. Tomaino stated that the rare failures were due to a mechanical incompetence of the ligament reconstruction.[70]

Failures and their treatment

Trapeziectomy followed by tendon interposition with or without ligament reconstruction can be complicated by a proximal migration of the thumb column, with return of pain, loss of strength and subluxation. In this case, priority must be given to restoring the length of the thumb using a Silastic implant, Tie or Swanson. The implants are routinely stabilized with what is left of the surrounding tendons, either half of the FCR or more often, the radial half of the ECRL. The technique is described below.

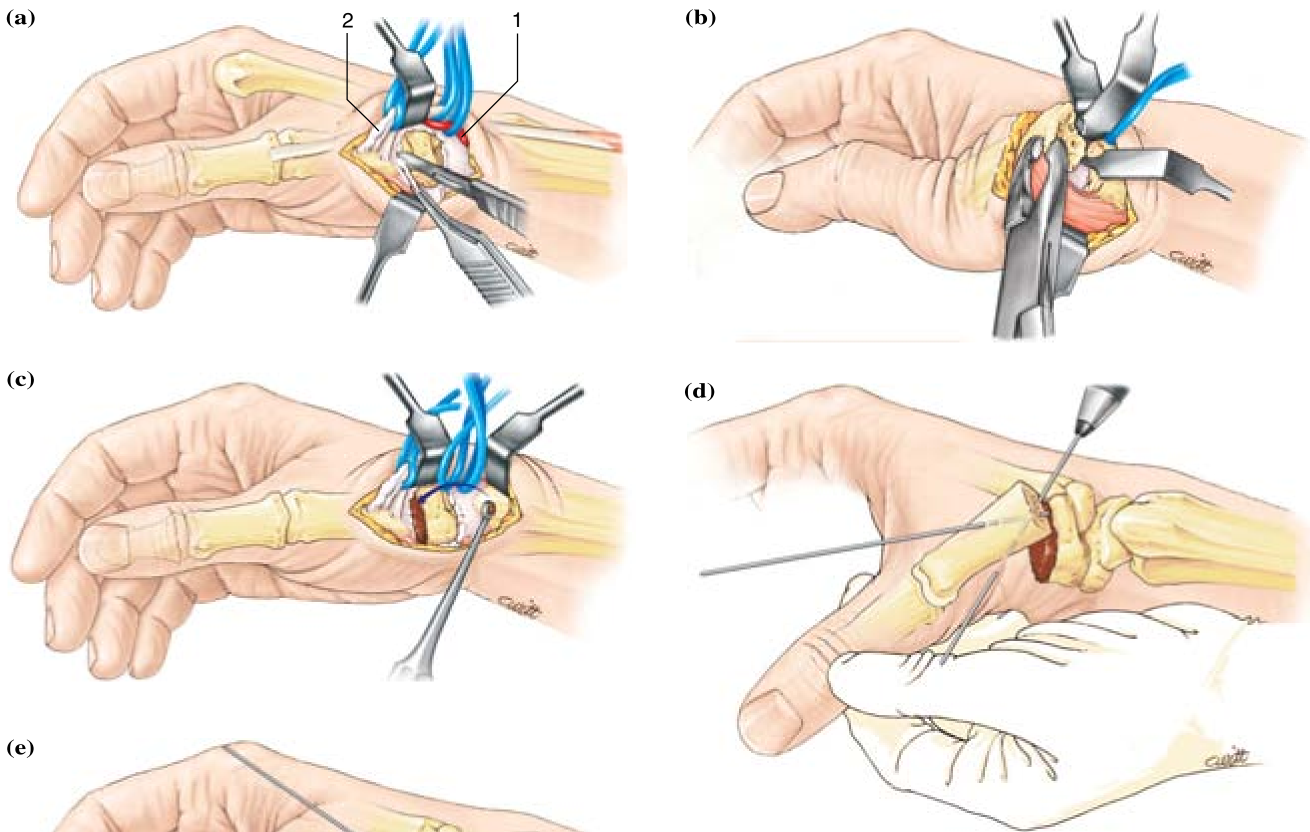
Persistence of paresthesiae in the area of distribution of the radial nerve is frequent; the nerve is often trapped in scarring around the wound. This problem usually disappears after a few weeks with massages and therapy. To prevent this neuritis, the nerve must never be dissected out bare and the surrounding adipofascial tissue must be kept. In 272 patients, we have had to intervene in two to neurolyze the nerve and to envelop it in fatty tissue.

Other surgical techniques and the treatment of their failures

Arthrodesis

This technique should not be considered in the first instance; it is only indicated if the osteoarthritis is limited to the TM joint. The technique has numerous disadvantages, for example, inability of the palm to be flattened, causing difficulty in the wearing of gloves or putting the hand into the pocket. Stresses transferred to the adjacent joints leads to arthritis in 25% of cases within six- and a-half years, according to Chamay.[18] Overuse of the metacarpophalangeal joint leads to hyperextension and a painful lateral instability. Technically, union takes a long time and non-union rates are high, up to 13%, depending on the method used.[9] Ever since Muller[55] proposed an inlay graft, many techniques have been recommended such as cerclage wiring, staples, wires, Herbert screws. Our experience is that the cup and cone arthrodesis as described by Carroll[17] with cancellous autograft obtained from the distal radius is the most reliable. Fixation is done with three K-wires and a cerclage compression wire (Fig. 2.17). The construct is protected from flexion forces with an intermetacarpal wire for four weeks. The classic position for arthrodesis is 45° of abduction and antepulsion with mild pronation of the thumb. When a fist is made, the thumb should come to rest on the middle phalanx.

Revision of arthrodesis. Apart from non-union which is managed with bone grafting and a solid fixation, we have revised a TMJ arthrodesis and converted it into an arthroplasty. Because of the disadvantages of a fused TM joint, some patients might ask for a return of motion to this joint. This must only be acceded to with caution, as an arthroplasty cannot guarantee a return of strength, dependent as it is on the quality of the intrinsic and to a lesser degree, the extrinsic musculature. In addition, an arthrodesis completely destroys the TM capsuloligamentous structures and thus FCR, APL or ECRL are required to restore the stability of the neo-articulation.



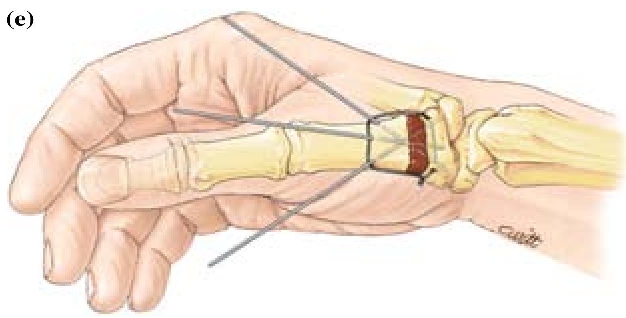
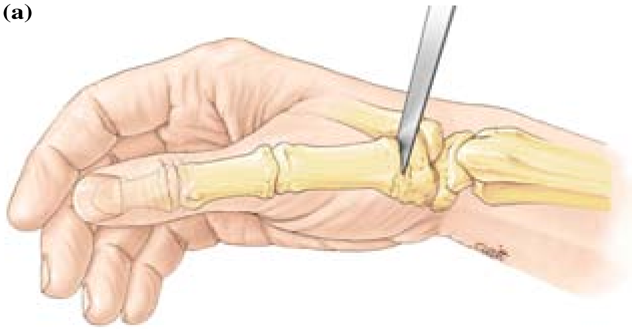


Figure 2.17.

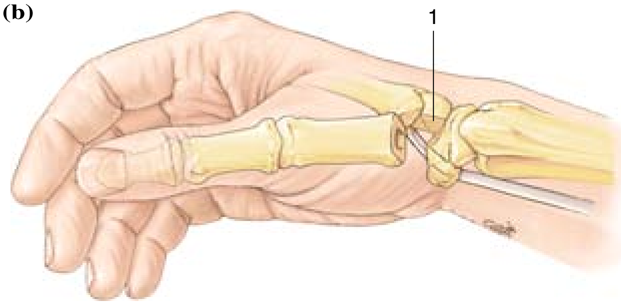
Cup and cone trapeziometacarpal arthrodesis.
(**a**) Dorsoradial approach centered on the TM joint; the artery (1) and radial nerve (2) are protected; the APL is retracted laterally and the EPB medially; and the capsuloligamentous apparatus is excised with a scalpel (15).
(**b**) A periosteal *elevator frees the base of the first metacarpal and any osteophytes are removed with a rongeur.* The base of the first metacarpal is retracted out of the joint cavity and is decorticated and trimmed with rongeur.
(**c**) The trapezium is also decorticated and trimmed. Cancellous autograft is obtained from the distal radius.
(**d**) Fixation is done with 3 K-wires from the base of the first metacarpal.
(**e**) After the interposition of the autogenous bone graft into the arthodesis, the K-wires are inserted into the trapezium. A cerclage wire ensures compression of the arthrodesis site. The classic position is 45° of abduction and antepulsion with mild pronation.

Mobility and comfort can be re-established with a silicone spacer (Tie implant) which, with its diabolo shape, allows stabilization with the FCR or half the ECRL (Fig. 2.18d). The arthrodesis is taken down with an osteotome and the trapeziectomy is total, care being taken not to damage the FCR. A periosteal elevator frees the base of the first metacarpal and any osteophytes are removed with a rongeur (Fig. 2.18). The first metacarpal must regain freedom of movement in all axes. An awl is used to penetrate the base of the metacarpal and this is followed by calibrated rasps to form a cavity to receive the tail of the Tie prosthesis. To secure the implant, it is necessary to partially resect part of the trapezoid so that it makes a right angle with the distal scaphoid. The implant is sized so as to cover the entire surface of the scaphoid but not in excess. The ligament stabilization utilizes

(a)



(b)

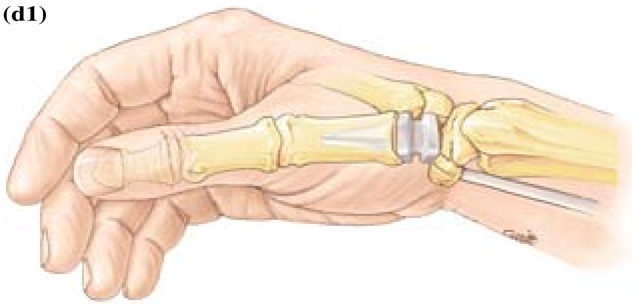


(c)

Figure 2.18.

Revision of a failed arthrodesis with a *Tie* implant.
(**a**) The same incision is used as for arthrodesis. The non-union site is rawed in order to obtain a flat surface at the base of the first metacarpal.
(**b**) A total trapeziectomy is performed and the trapezoid is partially resected so that the bone cuts are perpendicular to the base of the scaphoid (1).
(**c**) The rasp of the *Tie* implant shapes the intramedullary cavity of the first metacarpal. There are 3 sizes available. The shape of this implant facilitates its stabilization by ligamentoplasty.

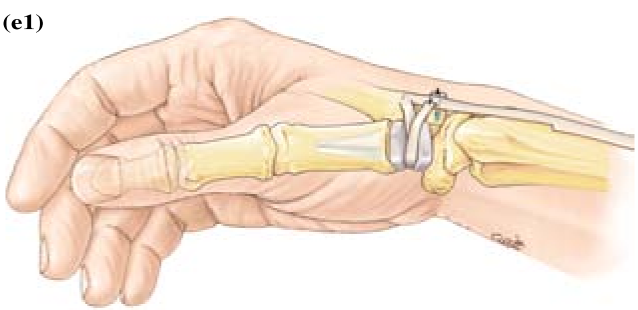
(d1)



(d2)

(**d1**) (**d2**) The rasp of the *Tie* implant shapes the intramedullar cavity of the first metacarpal. Three sizes are available. The shape of the implant facilitates its stabilization by ligamentoplasty.

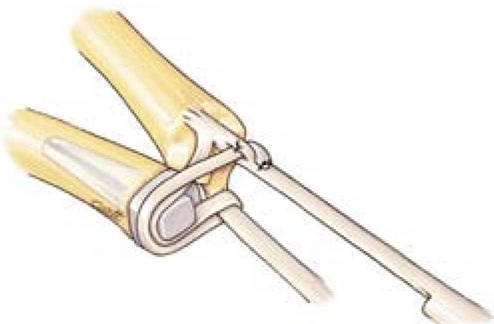
(e1)



(e2)

(**e1**) (**e2**) The ECRL hemitendon is sutured to itself after both the implant and the FCR having been lassoed.

(f1)



(f2)

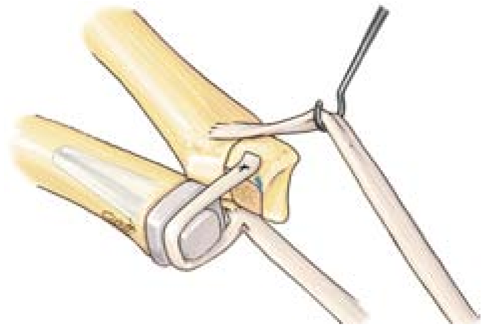


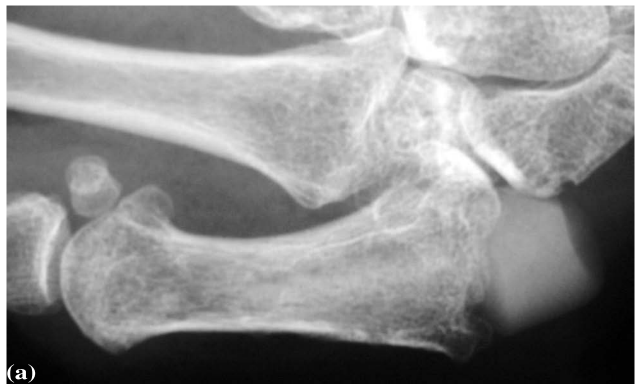
Figure 2.18. (*Continued*)

(**f1**) (**f2**) Detailed view of the plasty of the ECRL which twice encircles the *Tie* implant. The FCR can also be used to perform the arthroplasty. It is fixed to the trapezoid with a *Minitek-Minilock* bone anchor.

half of the ECRL or the FCR. The ECRL hemitendon is sutured to itself after both the implant and the FCR have been lassoed. If the FCR is used, it is fixed with a Mitek-Minilock bone anchor to either the trapezoid or the base of the second metacarpal (Fig. 2.18g–h). The implant is further stabilized by a slip of the APL zigzagging from the base of the first metacarpal to the scaphoid. Immobilization is assured with a 1.5-mm intermetacarpal wire holding the thumb in abduction and antepulsion for four weeks. This preserves the length of the thumb column and alleviates pain. Like all trapezial silicone prostheses, movement occurs at the junction of the head and tail. This is also where fractures may occur over time.

Arthroplasty

Swanson Silastic implant and Tie implant. Though this implant was used with success over the past two decades, at one point it was rejected, perhaps prematurely, as it was thought to cause silicone synovitis. This is actually uncommon and in our series of 150 cases, we have observed the occurrence only twice. If radiologic evidence of instability is seen in 25% of cases, there is no correlation with the clinical result; most subluxations do not affect pain or mobility (Fig. 2.19). We no longer use the Swanson implant primarily, but only for revision surgery as in the salvage of failed arthroplasties or failed total prostheses. A ligament reconstruction is routinely required. The Tie implant is the implant of choice as it comes in three sizes and this allows the resolution of most cases.



(a)

(b)

Figure 2.19.

Complications arising from a Swanson *Silastic* implant.

(**a**) Implant subluxation and breakage.

(**b**) The implant more often breaks at the junction of the head and tail, at the level where the first metacarpal is subjected to stress. Note the wearing out of the implant which was not stabilized on the scaphoid.

Other spacers. The Ashworth-Blatt Silastic implant has been used for treating isolated TM osteoarthritis.[3] In a series of 52 cases, fragmentation has been consistently observed in the three years after implantation.[31] Most revisions were done with total trapeziectomy followed by a Swanson implant or tendon interposition. Dacron anchovy interpositions were initially thought to be reliable,[72] but more recently, Voulliaume *et al*. have reported inflammatory reactions induced by the Dacron which was poorly tolerated by the patients. We have observed a similar phenomenon in composite silicone-Dacron implants where the latter substance is supposed to stabilize the tail of the implant in the metacarpal. We quickly abandoned the use of the Eaton-Littler silicone implant[57] as the FCR, which is used to stabilize the prosthesis, undergoes necrosis as it passes through the head of the implant. Titanium and pyrocarbon implants have the problem of wearing out the surrounding bone.

Total prostheses. In 1973, de la Caffinière developed a total joint arthroplasty which was an assembly of a ball and socket cemented into the metacarpal and trapezium.[15] In 1991, he published a series of more than 100 cases with an 18-year follow up which revealed a complication rate of 7%.[16] Most problems arose due to loosening of the socket in the trapezium. Numerous reasons have been proposed to promote this concept of a total prosthesis: preservation of thumb length, early rehabilitation (three weeks), speedy recuperation and restoration of strength and mobility, and absence of pain. The indications remain limited to TM arthritis and de la Caffinière does not recommend the implant for manual workers, adducted thumbs or marked metacarpophalangeal joint abduction. Much criticism has been leveled against the long term outcome for this arthroplasty. As a result, many teams have tried to improve it by changing the shape of the implant, and using osteointegrated implants instead of cemented implants. The metal-polyethylene coupling has been replaced with a metal-on-metal implant. Each new prosthesis is initially received with enthusiastic publications involving small series with short-term follow-up.[10] The complications include subluxations, cup loosening, proximal migration and trapezial fracture (Fig. 2.20a) and the rate hovers around 10%.

Our experience with total joints, which we implant regularly, is generally negative because of the complications described above. We have noticed that surgeons mostly have difficulty centering the cup in the trapezium without damaging the bone. With the additional difficulty of maneuvering in the small TM space, excessive bone is removed from the metacarpal base, making any future revision surgery more difficult. While authors agree that there is no difference between trapeziectomy with tendon interposition and total joint replacement with regards to comfort and mobility, they emphasize that the prostheses improve strength significantly despite stating that they are not indicated for manual workers. Nonetheless the population that we operated on has an average age of 60 years and they want above all, comfort and mobility. Finally, patients who are already disappointed after a painful surgery that required rehabilitation, are disheartened at the need to go for a difficult revision surgery.

Revision of total prosthesis

Following the removal of the cup, a total trapeziectomy is carried out, care being taken not to injure the FCR (Fig. 2.20b). The extraction of the cemented or osseointegrated metacarpal is more difficult. If the head and neck of the implant can be separated from a well-osseointegrated stem, then the latter piece can be left *in situ*. More often, a specific extractor and mallet are required. In the most challenging cases, a longitudinal corticotomy must be done along the proximal two thirds of the metacarpal (Fig. 2.20c). There are a few ways to perform the arthroplasty but the choice is governed by the condition of the first metacarpal (length and size of medullary cavity). If the resection of the metacarpal has been extensive (more than 7 mm), its length must be restored or even overcorrected with an iliac crest bicortical bone graft (Fig. 2.20d). This overcorrection

(a)

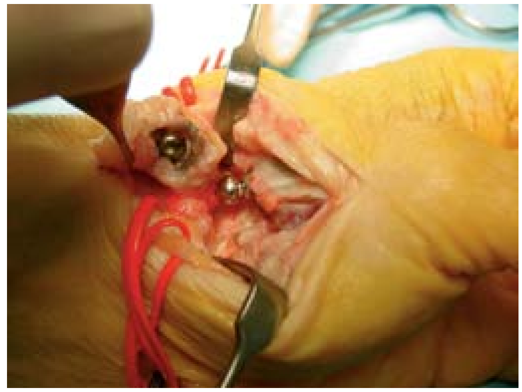
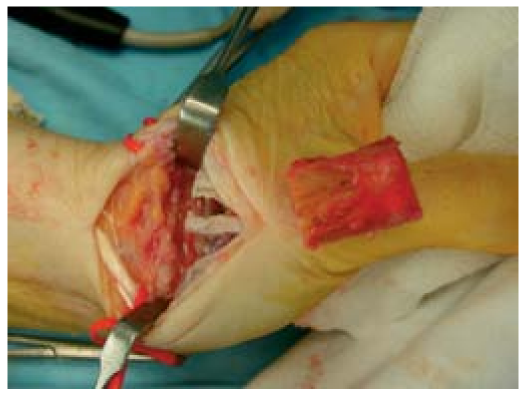

(b)


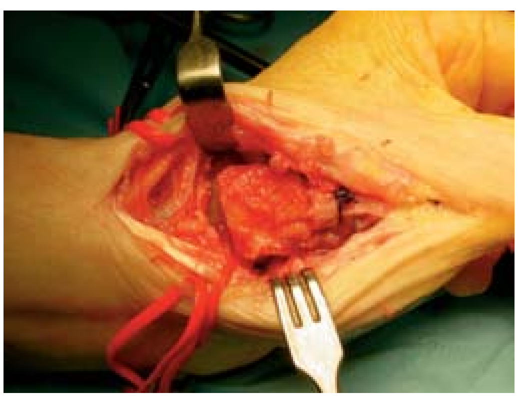
Figure 2.20.

(**a**) Failure of a total arthroplasty caused by proximal migration of the implant and synovitis caused by metallosis.
(**b**) The total trapeziectomy allows visualization of the implant and metallosis.

(c1)


(c2)


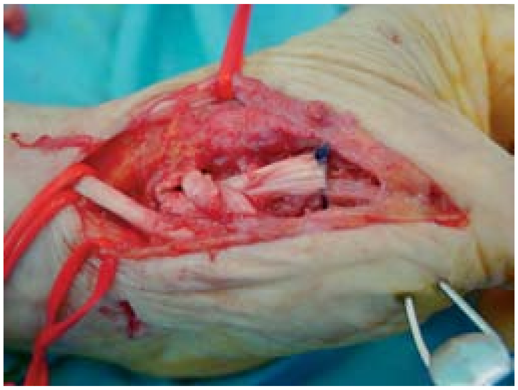
(**c1**) The extraction of the osseointegrated metacarpal stem requires a longitudinal osteotomy.
(**c2**) The excessive resection of the first metacarpal during the implantation of the total prosthesis requires correction with an iliac crest bicortical or tricortical graft bicortical bone graft.

(d)


(e)


(**d**) The iliac crest graft sculpted with a rongeur is inserted into the medullary cavity and fixed with 3 K-wires. The longitudinal osteotomy of the first metacarpal has been closed with a cerclage of PDS 2/0 suture. The iliac graft is oversized in length as it will resorb partially over a period of time.
(**e**) The tendinoplasty of scaphoidotrapezial interposition uses half of the FCR tendon. Half of the 1st radial tendon (ECRL) is used for the capsuloligamentous apparatus; it is fixed with 2 *Minitek-Minilock anchors* inserted into the iliac crest graft.

(f1)



(f2)

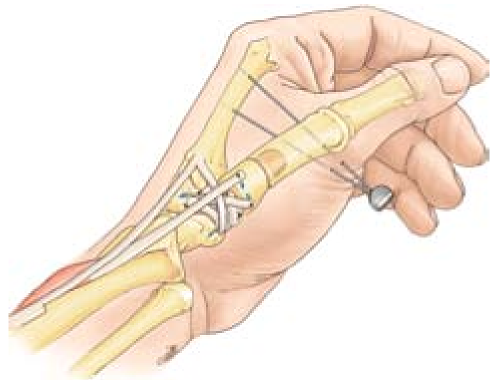
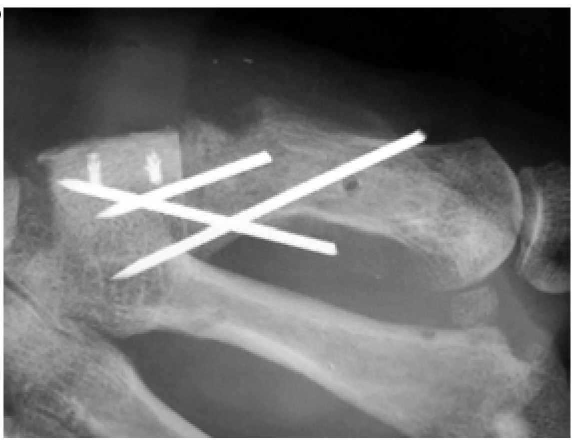


Figure 2.20. (*Continued*)

(**f1–2**) View of the ligamentous reconstruction using half of the FCR; two commissural divergent pins stabilize the first metacarpal for six weeks.

(g)



(h)

(**g**) Radiological aspect 5 mth later: Note the good intergration of the iliac graft to the first metacarpal.
(**h**) Functional outcome with a Kapandji score of 9/10.

is necessary because the bone graft resorbs over a period of a few months and with a tendon interposition, there is a loss of height of about 40% of the thumb column. Cancellous bone graft fills the medullary cavity which will have been curetted clean of cement debris. The bicortical graft is sculpted with a rongeur so as to wedge it into the proximal few millimeters of the medullary cavity. Fixation is done with two crossed 1.2-mm K wires.

The interposition tendinoplasty is done according to the volume to be replaced; the whole FCR or FCR with palmaris longus can be used. The most difficult aspect of the procedure is to achieve good stabilization of the new TM joint. The capsuloligamentous apparatus is usually severely attenuated. It is preferable to use the radial half of the ECRL and to fix it in a zigzag manner from the proximal border of the graft to the distal border of the scaphoid (Fig. 2.20f). This is facilitated by the use of bone anchors. The APL, often altered by the resection of the base of the first metacarpal, is then reinserted on the dorsum of the graft with a bone anchor. The thumb is placed in abduction and antepulsion and a 1.5-mm intermetacarpal wire is introduced. Active mobilization is allowed after six weeks, the shortest possible time for integration of the graft (Figs. 2.20g–h). When the resection of the metacarpal has been limited (a few millimeters), it is easier to perform the reconstruction using a Tie Silastic implant. The intramedullary cavity receives, without difficulty, the tail of the implant and stability is assured using half of the FCR, ECRL or a band of the APL. Immobilization is with the thumb in abduction and antepulsion using a 1.5-mm intermetacarpal wire for four weeks. If the patient does not want a silicone implant, the medullary cavity must be filled with graft from the distal radius or a bone substitute. This is to prevent migration of the tendinoplasty. A ligament reconstruction can also be performed.

Selection of Appropriate Surgical Procedure

In the young patient, medications and splints are used so as to defer surgery for as long as possible. Although denervation of the trapezium is believed to delay the need for trapeziectomy for a few years, this is only speculative as the natural history of TMJ arthritis escapes any radiologic or clinical criteria. It is the development of permanent pain that precipitates the indication for surgery (Table 2.1).

Eaton Stage I

Ligament reconstruction using half of the FCR to stabilize the TM joint is a reliable technique. The biomechanical approach of Wilson consisting of an extension osteotomy is also effective. Trapezial denervation is a complementary technique which in our experience lasts only about 13 months.

Eaton Stage II

We do not recommend the extension of stage I techniques to stage II. It is a wager that can be rapidly lost especially where pain is concerned and patients are far from delighted at being told one year later that they need a trapeziectomy and an associated procedure.

Eaton Stages III and IV

Our first choice is a trapeziectomy and tendon interposition especially if the capsuloligamentous apparatus and in particular the anterior oblique ligaments are of good quality. If, after trapeziectomy, the first metacarpal base is unstable, we add a FCR ligament reconstruction. The adducted thumb is also addressed.

Revision Surgery

Stage I. The reappearance of pain is an indication for trapeziectomy with tendon interposition with or without a ligament reconstruction as described by Burton.

Stage II, III, IV. Proximal migration of the thumb column associated with pain and loss of strength requires revision with a Swanson or Tie implant and a stabilizing ligamentoplasty.

Failed arthrodesis. The arthrodesis is taken down and after trapeziectomy, a Swanson or Tie arthroplasty with a stabilizing ligamentoplasty is added.

Failed total prosthesis. With significant metacarpal bone loss, length must be restored with a bicortical iliac crest graft. A tendon interposition with a stabilization capsuloplasty gives a useful and comfortable functional outcome. Without significant bone loss, it is preferable, after having removed the prosthesis, to place a Swanson or Tie implant and associate it with a stabilizing ligamentoplasty.

Splints and Rehabilitation

M. Isel, S. Célérier

Rehabilitation from the first to the 30th postoperative day has the aim of maintaining the mobility of the fingers so as to minimize edema. The hand is elevated in an arm sling and cold therapy is also used. Active range of motion of the thumb IPJ is critical to prevent adhesions of the EPL. On the other hand, mobilization of the metacarpophalangeal joint should be restrained so as to avoid micromotion of the intermetacarpal wire and any capsuloligamentous repair of the neo-articulation. Thumb to index pinch can be performed, but without force. The position of the wrist, which has a tendency to go into mild flexion and ulnar deviation, must be monitored. If the patient cannot control this tendency, a forearm based splint must be worn (Fig. 2.21). At the 30th day, after removal of the wire, a long thumb spica is applied. The first metacarpal is placed in abduction and 45° of antepulsion, the metacarpophalangeal joint in 30° of flexion, the interphalangeal joint free and the wrist in 10° of extension. The splint keeps the thumb in its original position and aids in the management of pain.[1] Rehabilitation starts

Figure 2.21.

Postoperative long thumb spica.
IP joints of the index and middle fingers have been fused.

with a global thumb massage and scar massage with the aim of reducing pain.

Passive range of motion exercises are progressively increased within painless limits, to restore abduction, antepulsion and opposition. The first metacarpal is held while the metacarpophalangeal joint is immobilized and only the neo-articulation is moved. Active mobilization follows the protocol of Boutan *et al.* The first dorsal interosseous and opponens are strengthened, stabilizing the dorsoradial aspect of the neo-articulation.[8] The exercise starts with training of the abductor pollicis brevis, which may have atrophied during the disease process. The thumb is abducted maximally while the hand is held flat; if there is wasting, an isometric contraction is sufficient. This is followed by training of the opponens to compose pulp to pulp pinches, with emphasis on abduction and antepulsion. The most frequent error is to allow adduction, which should also be exercised but with a different regime. Active axial lengthening exercises recruit the opponens and first dorsal interosseous.

Retropulsion is painful and has a protracted recovery. The metacarpal needs to be extended by the APL, which may have been atrophied by the disease process and may also have been caught in the scar. For this movement to be efficient, EPB and EPL have to be neutralized. Thus, retropulsion of the first metacarpal is done with the thumb interphalangeal joint and metacarpophalangeal joints in flexion. The final aim of this program is to restore a stable and efficient pinch. Metacarpophalangeal joint flexion is important so as to avoid a thumb adduction deformity; a short thumb spica may be required. It has been proven that even in such a splint, the thenar muscles are active when a pinch is made (isometric contraction). The spica holds the first metacarpal in abduction and antepulsion while preventing opposition. The metacarpophalangeal joint is in 30° of flexion and the interphalangeal joint is free.

Resisted exercises start in the 8th week and the patient may be demoralized by the atrophy of the thenar muscles occurring during the time that the TM arthritis developed. Pinch exercises are continued long term, and it is important to verify, all the while, that metacarpophalangeal hyperextension does not occur. Advice is given for daily activities, like opening a jar or cutting vegetables. It is recommended that patients wear the long splint after prolonged exercises that stress the entire thumb column, so as to rest the articular and muscular complex. The scar is managed with massage and ultrasound after the 5th week. It is sometimes painful and is associated with paresthesiae on the dorsum of the thumb and index, in which case, the radial nerve would have been caught in the scar process. Management of this problem consists of scar massage, desensitization with Vibralgic and a silicone sheet. Kapandji's functional score is used to measure progress[45] (Fig. 2.22).

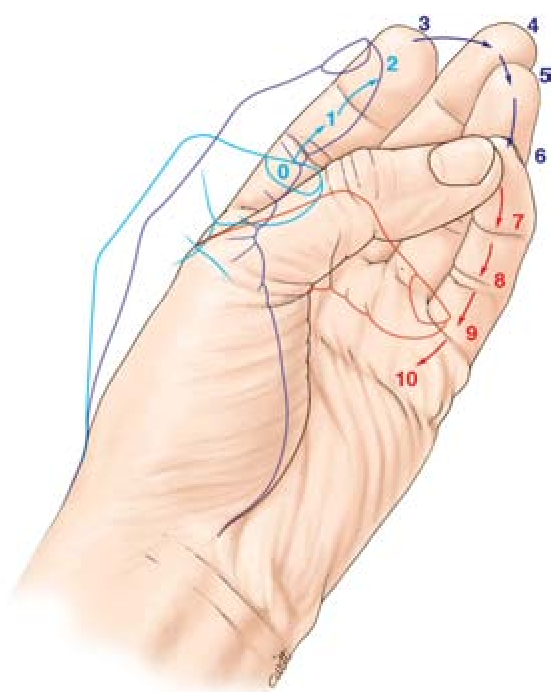


Figure 2.22.

Kapandji Functional Score, based on a 10-point system, provides a simple, rapid and objective assessment of the functional status of the thumb joints (TMJ, MCPJ, IPJ).
0 – thumb pulp opposition to radial aspect of index proximal phalanx; 1 – thumb pulp opposition to radial aspect of index middle phalanx; 2 – thumb pulp opposition to radial aspect of index distal phalanx; 3 – thumb pulp opposition to index finger tip; 4 – thumb pulp opposition to middle finger pulp; 5 – thumb pulp opposition to ring finger pulp; 6 – thumb pulp opposition to little finger pulp; 7 – thumb pulp opposition to little finger DIPJ crease; 8 – thumb pulp opposition to little finger PIPJ crease; 9 – thumb pulp opposition to little finger MCPJ crease; 10 – thumb pulp opposition to ulnar edge of distal palmar crease.

References

1. Andre JM, Gable C, Xenard J, *et al*. (1994) *Atlas pratique des ortheses de la main.* Springer Verlag, Paris.
2. Armstrong AL, Hunter JB, Davis TR. (1994) The prevalence of degenerative arthritis of the base of the thumb in post-menopausal women. *J Hand Surg* **19B**: 340–341.
3. Ashworth CR, Blatt G, Chuinard RG, Stark HH. (1977) Silicone rubber interposition arthroplasty of the carpometacarpal joint of the thumb. *J Hand Surg* (Am) **2**: 345–357.
4. Atroshi I, Axelsson G. (1997) Extensor carpi radialis longus tendon arthroplasty in the treatment of primary trapeziometacarpal arthrosis. *J Hand Surg* **22A**: 419–427.
5. Bettinger PC, Smutz W, Linscheid R, Berger RA. (1999) An anatomic study of the stabilizing ligaments of the trapezium and trapeziometacarpal joint. *J Hand Surg* **24A**: 786–798.
6. Bettinger PC, Berger AB. (2001) Functional ligamentous anatomy of the trapezium and trapeziometacarpal joint (gross and arthroscopic). *Hand Clinics* **17**: 151–168.
7. Bonnel F, Bellan N. (1990) L'articulation trapezometacarpienne du pouce. In: Ph Saffar (ed.), *La Rhizarthrose.* Expansion scientifique française, Paris, pp. 9–17.
8. Boutan M, Genin-Etcheberry T, Peres JM, Ribiere J. (2003) Le protocole de reeducation posoperatoire de rhizarthrose. *Ann Kinesitherapie* **20–21**: 36–41.
9. Bramberger HB, Stern PJ, Kiefhaber TR, *et al*. (1992) Trapeziometacarpal joint arthrodesis: a functional evaluation. *J Hand Surg* **17A**: 605–611.
10. Brutus JP, Kinnen L. (2004) Remplacement prothetique total de la trapezometacarpienne au moyen de la prothese ARPE dans le traitement de la rhizarthrose: notre experience a court terme dans une serie personnel le de 63 cas consecutifs. *Chir Main* **23**: 224–228.
11. Burton RI. (1973) Basal joint arthrosis of the thumb. *Orthop Clin North Am* **4**: 347–348.

12. Burton RI, Pellegrini VD. (1986) Surgical management of basal joint arthritis of the thumb: II. Ligament reconstruction with tendon interposition arthroplasty. *J Hand Surg* **11A**: 324–332.
13. Burton RI. (1997) Ligament reconstruction tendon interposition arthroplasty. *Atlas Hand Clinics* **2**: 77–99.
14. Caffiniere (de la) JY. (1970) L'articulation trapezometacarpienne approche biomecanique et appareil ligamentaire. *Arch Anat Pathol* **18**: 277–284.
15. Caffiniere (de la) JY, Aucouturier P. (1979) Trapeziometacarpal arthroplasty by total prothesis. *Hand* **11**: 41–46.
16. Caffiniere (de la) JY. (1991) Resultat a long terme de la prothese totale trapezometacarpienne dans la rhizarthrose. *Rev Chir Orthop* **77**: 312–321.
17. Carroll RE, Hill NA. (1973) Arthrodesis of the carpometacarpal joint of the thumb. A clinical and cinerocentographic study. *J Bone Joint Surg* **55B**: 292–294.
18. Chamay A, Piaget-Morerod F. (1994) Arthrodesis of the trapeziometacarpal joint. *J Hand Surg* **55B**: 489–497.
19. Cooney WP, Chao EY. (1977) Biomechanical analysis of static forces in the thumb during hand function. *J Bone Joint Surg* **59A**: 27–36.
20. Cozzi EP. (1991) Denervation des articulations du poignet et de la main. In: R Tubiana, *Traile de chirurgie de la main.* Masson, Paris, Vol. 4, pp. 781–787.
21. Davis TRC, Brady 0, Dias JJ. (2004) Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint: a study of the benefit of ligament reconstruction or tendon interposition. *J Hand Surg* (Am) **29**: 1069–1077.
22. Day CS, Gelberman R, Patel AA, *et al*. (2004) Basal joint osteoarthritis of the thumb: A prospective trial of steroid injection and splinting. *J Hand Surg* (Am) **29**: 247–251.
23. Dell PC, Brushart TM, Smith RJ. (1978) Treatment of trapeziometacarpal arthritis: results of resection arthroplasty. *J Hand Surg* **3A**: 243–249.
24. Drewniany J, Palmer A, Flatt A. (1985) The scaphotrapezial-ligament complex: an anatomic and biomechanical study. *J Hand* Surg **10A**: 492–498.
25. Eaton RG, Littler JW. (1969) A study of the basal joint of the thumb, treatment of its disabilities by fusion. *J Bone Joint Surg* **51A**: 661–668.
26. Eaton RG, Littler JW. (1973) Ligament reconstruction of the painful thumb carpometacarpal joint. *J Bone Joint Surg* **55A**: 1655–1666.
27. Eaton RG, Lane LB, Littler WJ, Keiser JJ. (1984) Ligament reconstruction for the painful thumb carpometacarpal joint: a long term assessement. *J Hand Surg* **9A**: 692–699.
28. Eaton RG, Floyd WE Ill. (1988) Thumb metacarpophalangealcapsulodesis: an adjunct procedure to basal joint arthroplasty for collapse deformity of the first ray. *J Hand Surg* **13A**: 449–453.
29. Felson DT. (1990) The epidemiology of knee osteoarthritis: Results from the Framingham osteoarthritis study. *Semin Arthritis Rheum* **20**: 42–50.
30. Forestier J. (1937) L'osteoarthrite seche trapezometacarpienne (rhizarthrose du pouce). *Presse Med* **45**: 315–317.
31. Foucher G, Merle M, Girot J, Lemarechal P. (1990) La « punaise» d'Ashworth-Blatt dans le traitement de la rhizarthrose. In: Ph Saffar (ed.), *La Rhizarthrose*. L'Expansion scientifique française, Paris, « Monographie du GEM », pp. 126–128.
32. Foucher G, Pretz PL, Ehrard L. (1988) La denervation articulaire, une reponse simple a des problemes complexes de chirurgie de la main. *Chirurgie* **123**: 183–188.
33. Freedman DM, Eaton RG, Glickel SZ. (2000) Long term results of volar ligament reconstruction for symptomatic basal joint laxity. *J Hand Surg* **25A**: 297–304.
34. Froimson AI. (1970) Tendon arthroplasty of trapeziometacarpal joint. *Clin Orthop Re Res* **70**: 191–199.
35. Gervis WH, Wells T. (1949) Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint. *J Bone Joint Surg* **31B**: 537–539.
36. Glickel SZ, Kornstein AN, Eaton RG. (1992) Long term follow-up of trapeziometacarpal arthroplasty with coexisting scaphotrapezial disease. *J Hand Surg* **17A**: 612–620.
37. Glickel SZ. (2001) Clinical assessment of the thumb trapeziometacarpal joint. *Hand Clinics* **17**: 185–195.
38. Guyot-Drouot MH, Fontaine C, Delcambre B. (1997) Arthrose de la main et du poignet. *Encycl Med Chir*, Elsevier, Paris Appareil locomoteur, 14-066-A-10, p. 7.
39. Haynes R. (1944) The mechanism of rotation of the first carpo-metacarpal joint. *J Anat* **78**: 44–46.
40. Herren DB, Lehmann O, Simmen BR. (1998) Does trapeziectomy destabilize the carpus? *J Hand Surg* **23B**: 676–679.
41. Hobby JL, Lyall HA, Megitt BT. (1998) First metacarpal for trapeziometacarpal osteoarthritis. *J Bone Joint Surg* **80B**: 508–512.
42. Imaeda T, An K, Cooney WI, Lindsheid R. (1993) Anatomy of trapeziometacarpal ligaments. *J Hand Surg* **18A**: 226–231.
43. Imaeda T, Niebur G, Cooney WP, *et al*. (1994) Kinematics of the normal trapeziometacarpal joint. *J Orthop Res* **12**: 197–204.
44. Kapandji AI, Matti E, Raab C. (1980) La radiographie specifique de l'articulation trapezometacarpienne, Sa technique, Son interet. *Ann Chir* **34**: 9719–9726.

45. Kapandji AI. (1986) Cotati on clinique de l'opposition et de la contre-opposition du pouce. *Ann Chir Main* **5**: 67–73.
46. Kapandji AI. (1990) Biomecanique des articulations trapezo-metacarpienne et scapho'idotrapezienne. In: Ph Saffar (ed.), *La Rhizarthrose.* Expansion scientifique française, Paris, pp. 33–48.
47. Kaplan E. (1965) *Functional and Surgical Anatomy of the Hand*, 2nd edn. Lippincott, Philadelphie.
48. Koff MF, Ugwonalli OF, Strauch RJ, *et al*. (2003) Sequential wear patterns of the articular cartilage of the thumb carpometacarpal joint in osteoarthritis. *J Hand Surg* **28**: 597–604.
49. Kuhlmann JN. (2001) Importance du complexe ligamentaire posteromedial trapezometacarpien. *Chir Main* **20**: 31–47.
50. Lanz TV, Wachsmuth W. (1959) Praktische *anatomie*; *ein lehr und helfsbuch der anatomischen grundlagen artzlichen Handelns.* Springer Verlag, Berlin, p. 261.
51. Lins RE, Gelberman RH, Me Keown L, *et al*. (1996) Basal joint arthritis: trapeziectomy with ligament reconstruction and tendon interposition arthroplasty. *J Hand Surg* **21A**: 202–209.
52. Martinet X, Belfkira F, Corcella D, *et al*. (2004) Reaction a corps etranger dans les rhizarthroses traitees par trapezectomie et interposition d'un anchois en *Dacron*. A propos de 5 cas. *Chir Main* **23**: 27–31.
53. Michon J. (1990) La premiere commissure dans la rhizarthrose. In: Ph Saffar (ed.), *La Rhizarthrose*. Paris, Expansion scientifique française, pp. 163–166.
54. Moulton MJ, Parentis MA, Kelly MJ, *et al*. (2001) Influence of metacarpophalangeal joint position on basal joint loading in the thumb. *J Bone Joint Surg* (Am) **83**: 709–716.
55. Muller GM. (1949) Arthrodesis of the trapeziometacarpal joint for osteoarthritis. *J Bone Joint Surg* **318**: 540–542.
56. Napier J. (1955) The form and function of the carpo-metacarpal joint of the thumb. *J Anat* **89**: 362–369.
57. Ny JE, Eaton RG. (1990) Arthroplastie par implant de trapeze stabilise par un tendon. In: Ph Saffar (ed.), *La Rhizarthrose*. Paris, Expansion scientifique française, pp. 140–143.
58. Pellegrini VD Jr. (1991) Osteoarthritis of the thumb trapeziometacarpal joint: a study of the pathophysiology of articular cartilage degeneration, I. Anatomy and pathology of the aging joint. *J Hand Surg* **16A**: 967–974.
59. Pellegrini VD Jr. (1991) Osteoarthritis of the thumb trapeziometacarpal joint: a study of the pathophysiology of articular cartilage degeneration, II. Articular wear patterns in the osteoarthritic joint. *J Hand Surg* **16A**: 975–982.
60. Pellegrini VD, Parentis M, Judkins A, *et al*. (1996) Extension metacarpal osteotomy in the treatment of trapeziometacarpal osteoarthritis: a biomechanical study. *J Hand Surg* **21A**: 16–23.
61. Pellegrini VD Jr. (1997) Extension metacarpal osteotomy in the treatment of trapeziometacarpal osteoarthritis, Atlas of the Hand Clinics, Carpometacarpal. *Joint* **2**: 183–202.
62. Pieron A. (1973) The mechanism of the first carpometacarpal (CMC) joint. An anatomical and mechanical analysis. *Acta Orthop Scand Suppl* **148**: 1–104.
63. Rayan GM, Young BT. (1997) Ligament reconstruction arthroplasty for trapeziometacarpal arthrosis. *J Hand Surg* **22A**: 1067–1076.
64. Rongieres M. (2004) Anatomie et physiologie de l'articulation trapezometacarpienne humaine. *Chir Main* **23**: 263–269.
65. Rouviere H. (1924) *Anatomie humaine descriptive et topogr-aphique*, Tome 2 Membres, Systeme nerveux central, Paris.
66. Stussi JD, Dap F, Merle M. (2000) Etude retrospective de 69 rhizarthroses primitives operees par trapezectomie totale suivie dans 34 cas de tendinoplastie d'interposition et dans 35 cas de suspensioplastie. *Chir Main* **19**: 116–127.
67. Swanson AB, de Groot SG, Watermeier JJ. (1981) Trapezium implant arthroplasty, long-term evaluation of 150 cases. *J Hand Surg* (Am) 125–141.
68. Swigart CR, Eaton RG, Glickel SZ, Johnson C. (1999) Splinting in the treatment of arthritis of the first carpometacarpal joint. *J Hand Surg* **24A**: 86–91.
69. Taylor EJ, Desari K, D'Arcy JC, Bonnici AV. (2005) Comparison of fusion, trapeziectomy and Silastic replacement for the treatment of osteoarthritis of the trapeziometacarpal joint. *J Hand Surg* (Br) **30**: 45–49.
70. Tomaino MM, Pellegrini VD Jr, Burton RI. (1995) Arthroplasty of the basal joint of the thumb. *J Bone Joint Surg* **77A**: 346–355.
71. Van Wetter P. (1974) Le champ d'action du pouce et ses limites. *Ann Chir* **28/10**: 851–853.
72. Voulliaume, Forli A, Guinard D, *et al*. (2003) Les arthroplasties par nterposition par anchois en *Dacron* dans le traitement des rhizarthroses essentielles: resultats a distance. *Chir Main* **22**: 197–202.
73. Weilby A. (1988) Tendon interposition arthroplasty of the first carpo-metacarpal joint. *J Hand Surg* **13B**: 421–425.
74. Weitbrecht J, *Syndesmology* (1742), W8 Saunders, Philadelphie, 1969, [75] Wilson JN Basal osteotomy of the first metacarpal in the treatment of arthritis of carpometacarpal joint of the thumb. *Br J Surg* **60**: 854–858.
75. Zancolli EA, Ziadenberg C, Zancolli E Jr. (1987) Biomechanics of the trapeziometacarpal joint. *Clin Orthop* **220**: 14–26.

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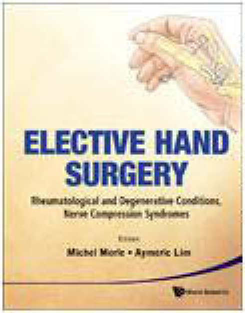

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