

Thumb Basal Joint Arthritis

Dr. Bindesh Dadi – Fellow Hand Surgery- Ganga Hospital, Coimbatore

[bindesh.dadi@gmail.com]

Dr. Praveen Bhardwaj- Consultant Hand Surgery- Ganga Hospital, Coimbatore

[drpb23@gmail.com]

Introduction:

The thumb basal joint also called the “universal joint” is the osteoarticular foundation from which the opposable human thumb is able to perform its myriad functions and movements. The unique anatomic configuration allows arcs of movement in three planes to position the thumb for axial loads^{1,5}. The base of the thumb, primarily the trapeziometacarpal (TM) joint, is the second most common site affected by primary idiopathic arthritis in the hand, first being the distal joints of the fingers¹.

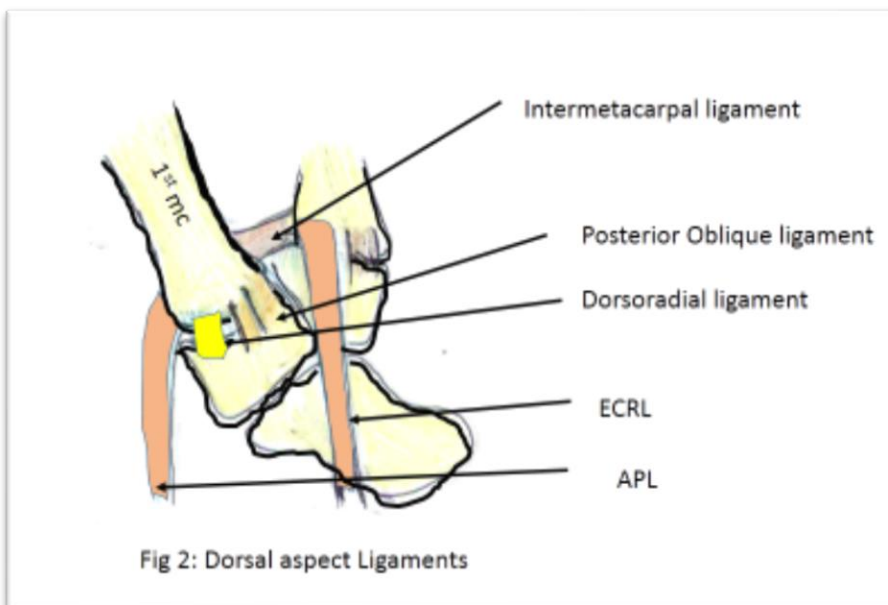
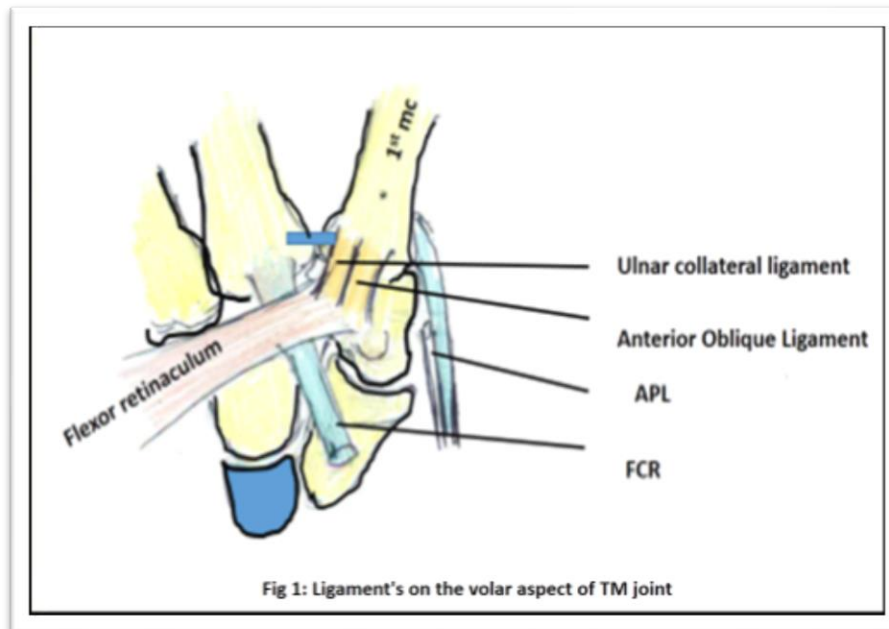
Symptomatic arthritis in this area can cause significant functional disability, due to the broad range of activities that become impaired. However, presentation and diagnosis may be delayed because patients try to adapt by adjusting their hand position, and adopting preferential hand use, to limit disability.^{1, 2, 3, 4, 5}

The primary treatment is non-operative which include rest, modifying activities, physiotherapy, anti-inflammatory medications, Intra-articular injection of corticosteroids and splinting. Patients with persistent symptoms despite conservative treatment may require surgery.

Pathophysiology:

The basal joint of the thumb consists of four trapezial articulations: the trapeziometacarpal (TM), trapezotrapezoid, scaphotrapezial (ST), and trapezium-index metacarpal articulations. Only the TM and ST joints lie along the longitudinal compression axis of the thumb⁵. The biomechanical design of the TM joint makes it unique to allow for the tremendous degree of motion at the joint with very little intrinsic osseous stability¹. It is a modified saddle joint permitting opposition of the thumb and

conferring the ability to hold and manipulate objects. The actions of 'pinch' grip, 'tripod' pinch and 'chuck' grip are specifically facilitated. Significant forces pass across and compress this joint as compared to the remaining CMCJs making it a kind of “axial load bearing” joint. The forces transmitted across this joint are amplified and can be as great as 13 times those at the tip of the thumb, particularly during strong pinching⁶.



Stability for pinching and grasping is provided by the complex arrangement of ligaments around the trapeziometacarpal joint [Fig 1 & 2] ⁶. The most important of these is the anterior oblique ligament or palmar beak ligament [Fig 1], an Intra-articular ligament running from the volar aspect of the base of the thumb metacarpal to the volar aspect of the trapezium. Attenuation or division of the palmar beak ligament results in a gradual dorsal shift in the contact area at the trapeziometacarpal joint. If the ligament is deficient, repetitive loading in combination with instability results in progressive osteoarthritis⁷. Others feel that the dorsoradial ligament is the primary restraint to dorsal translation, as evidenced by a cadaver study simulating acute dorsal TM joint dislocations and could be the starting point of the patho-mechanical events leading to arthritis¹³. If these ligaments are unable to stabilize the joint, it is felt that joint degeneration will follow a predictable pattern. The joint initially becomes painful due to synovitis. As the disease progresses, there is a loss of articular cartilage, first in the palmar regions of the joint and spreading to involve the entire joint. Osteophytes form in a futile attempt to increase the surface area so as to decrease the force per unit area. Lastly, in end stage disease, the thumb metacarpal base will subside and a thumb adduction contracture will occur.

Epidemiology:

Life time prevalence of this condition approaches to 10%. It is not clear why this site is mostly affected, but it may be related to the large forces that are repeatedly transmitted across the joints at the base of the thumb, particularly during pinch and grasping activities. Other causes of TM joint arthritis include primary osteoarthritis, trauma, inflammatory arthritis, hypermobile lax joints, connective tissue disorders and failed reconstruction. The reported age adjusted incidence of osteoarthritis at the base of the thumb is 7% for men and 15% for women, and 33% in older postmenopausal women¹. Several large observational studies have identified differences in epidemiology between men and women may be due to greater reciprocal curvature of the trapezium and metacarpal articular surfaces, lower degree of congruity and smaller surface areas leading to increased contact stresses⁶. Estrogen related collagen degradation through matrix metalloproteases, in postmenopausal women may result in laxity and instability of the ligaments at the base of the thumb.

Symptoms and signs:

Detailed history and clinical examination is all that is normally needed to clinch the diagnosis. Most often the patients present with pain localized to the base of thumb and radiating to the thenar eminence which is activity related, particularly during forceful pinching. As the disease progresses the pain becomes constant. At this stage, it may be accompanied with weakness and loss of motion of thumb as a protective mechanism to prevent excessive use of damaged joint. In the later stages, as the instability and subluxation sets in patient may present with inability to abduct, weakness of pinch strength and progressive deterioration of hand functions. Eventually the thumb collapses and producing a typical swan neck deformity of the thumb.

Inspection of the hand of a patient with advanced disease may show dorsoradial prominence of thumb base also called the “shoulder sign” [Fig 3 – (Arrow)] and swan neck deformity of thumb.

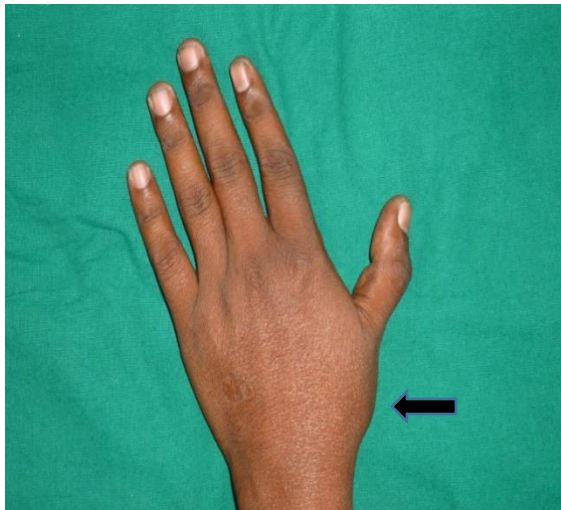


Fig 3: In late stages of arthritis there is abnormal prominence of dorsoradial aspect of TM joint which appears as a shoulder also known as “Shoulder sign” (Arrow)

Physical examination findings contribute to the diagnosis of basal joint arthritis, but it remains unknown whether symptoms and their severity correlates with specific physical findings¹¹. Focal tenderness is best elicited by using a single fingertip to accurately identify the TM joint. The TM joint is easily palpated as the joint just proximal to the metacarpal base which can be identified as the most proximal bone rotating while rotating the thumb at its tip. The STT joint can be palpated approximately 1 cm proximal to the TM joint^{5,7}. By palpating dorsal and volar to the abductor pollicis longus and extensor pollicis brevis tendons, the risk of mistaking de Quervain's tenosynovitis for basal joint

disease is minimized. An assessment of the STT joint is important because when symptoms originate from this joint rather than the trapeziometacarpal joint, standard treatment aimed solely at the trapeziometacarpal joint in form of arthrodesis or ligament reconstruction (without trapeziectomy) are unlikely to provide full relief. One comprehensive case series of 37 patients undergoing surgery for osteoarthritis at the base of the thumb established that plain radiographs have a low sensitivity for Scaphotrapeziotrapezoidal arthritis and may underestimate it. In the same study, skilled examination was poor at distinguishing between symptoms resulting from the trapeziometacarpal or the Scaphotrapeziotrapezoidal joints⁷. However, it is a general observation that patients with STT arthritis have more of a palmar-thenar pain whereas the patients with TM arthritis have more of a dorso-radial pain.

To identify the disease in early stages, the “distraction test” or the torque test is performed by rotating the thumb metacarpal base while applying gentle axial traction. A positive test is indicative of synovitis associated with milder disease, as a result of traction on an inflamed joint capsule¹⁰. This test could also be helpful in differentiating the TM arthritis from the STT arthritis [Fig 4].

The “grind test” is the most common referred diagnostic tool to evaluate and confirm arthritis [Fig 5]. To perform this test, the examiner applies axial compression along the plane of thumb metacarpal and simultaneously rotates the thumb metacarpal base which reproduces pain in the joint. Merritt et al have shown that grind test has a sensitivity of 42% - 53% and specificity of 80%- 93%¹².



Fig 4: Distraction test: The metacarpal is distracted and simultaneously rotated



Fig 5: Grind test: The metacarpal is compressed against trapezium and simultaneously rotated

Other tests described are the “lever test” where the examiner grasps the metacarpal base and shucks it back and forth in radial and ulnar directions, and the “metacarpophalangeal extension test, where the patient attempts to extend the thumb while the examiner provides resistance against extension on the proximal phalanx¹¹.

Active and passive range of motion of interphalangeal, metacarpophalangeal, and basal joint should be measured and documented. The basal joint range of movement is determined from the angle between the 1st and 2nd metacarpal with thumb in radial and palmar abduction and compared to the unaffected side. The MCP joint hyperextension both active and passive during pinch should be noted as it may need to be addressed at time of reconstructive surgery ¹⁴. A patient with hyperextension at the MCP joint would need a volar capsular plication or advancement to prevent the hyperextension. A patient with stiffness of the MCP joint and limited flexion would need the joint release to improve the flexion especially if the TM joint fusion is contemplated.

Radiographs are helpful in staging the disease, preoperative planning and for patient education. Three standard views including true AP, true lateral view, pronation oblique view and special basal joint stress view are enough to confirm the diagnosis¹⁵. The joint laxity and subluxation of early stage disease can often be demonstrated with a “basal joint stress” view [Fig 6].



Fig 6: **Basal joint stress view:** Note the abnormal lateral subluxation of base of metacarpal due to laxity in early arthritis, which appears only on lateral stress.

An additional view, the pinch lateral, can also be obtained preoperatively to allow later comparison with longitudinal follow-up radiographs.¹⁶ Late stage arthritis will often show complete loss of the joint space, subchondral cysts, osteophytes, and involvement of the scaphotrapezial joint. The degree of arthritis seen on the radiograph will determine the available treatment options, but should not be the sole determinate of any decision regarding surgery, which depends on the individual needs and intraoperative assessment.

Of the diagnostic classification methods, the radiographic staging method established by Eaton and Littler⁵ is the most popularly used. Eaton et al have described radiographic stages I to IV of OA of the thumb basal joint:

Stage I- normal articular cartilage with possible joint widening due to effusion and laxity of the beak ligament.

Stage II- narrowing of the joint space, with debris and osteophytes smaller than 2 mm in size, and more than one-third subluxation of the metacarpal.

Stage III- exhibits more severe joint narrowing, with osteophytes and debris greater than 2 mm in size.

Stage IV- begins when there is involvement of the scaphotrapezial joint.

Badia described arthroscopic stages I to III of the arthritic TM joint. He believes that arthroscopic evaluation of the joint enables earlier detection of arthritic changes than can be achieved with radiographic analysis. The earlier detection of joint pathology of the articular surfaces enables treatment of earlier stages of TM OA⁹.

Hand functions should be evaluated both by patient reported questionnaire and objective measurements. Measurements include range of motion, grip and pinch strength⁸.

Associated conditions and differential diagnosis:

Before embarking on to the treatment a clinician must always consider the conditions associated with basal joint arthritis. Surprisingly Florack *et al* noted that 43% of their patients who underwent surgery for arthritis of the base of thumb, also had carpal tunnel syndrome¹⁷. The prevalence was higher in women and in patients with diabetes mellitus.

Other conditions that are associated with TM joint arthritis are scaphotrapezial arthrosis, trigger digits, MCP hyperextension and tenosynovitis around wrist joint. Recognition of scaphotrapezial arthrosis is most essential as it influences the line of management. Pertinent findings to rule out other entities in the differential diagnosis, such as de Quervain's tenosynovitis, flexor carpi radialis tendonitis, extensor carpi radialis longus/extensor carpi radialis brevis tendonitis, scaphoid pathology, should be sought.

Treatment of 1st CMC Arthritis:

Various operative and non-operative treatment options are available for dealing with patient's symptoms and functional demands. Most of the patients are started on non-operative treatment primarily. Operative treatment are generally required for severe disease not responding to conservative treatment and in patients with high functional demands. With advent of arthroscopy operative intervention early in the disease is possible.

Conservative measures provide high level of patient satisfaction and good functional results. Berggren et al studied 33 patients with 1st CMC arthritis treated with hand therapy, splints, and analgesia while awaiting surgery. Symptoms were so much improved in 70% of these patients that they refused surgery after 7 months of non-operative treatment. At the end of seven years follow-up only 2 of them underwent surgery ⁴.

Activity modification and pain control:

The functional level of patient tends to be inversely related to their pain level. Improving levels of pain will significantly help the patient with activities of daily living. Learning to avoid painful activities of thumb, such as pinching, gripping, lifting and twisting may greatly improve the patient symptoms especially in acutely flared thumb. This is done by dividing stress between multiple joints or by using assistive devices. If there is good compliance, it has been shown that there is improved grip strength and pain relief. Switching to larger diameter writing instruments and grips and using a reading stand to hold books may be helpful⁵.

In early stages of disease strengthening and flexibility exercises are recommended if abduction with medial rotation and flexion of thumb CMC joint increases the stability at base of the joint. Exercises should be aimed at improving the range of motion of joint and prevent contracture of the 1st web and the MCP joint. Strengthening exercises should focus on strengthening the abductor pollicis brevis and the extensor pollicis to counter the flexion-adduction forces of the adductor pollicis muscle thus preventing adduction contracture and loss of first web. Exercises should not produce protracted pain or discomfort (lasting for hour or two).

Activity modification can be supplemented with simple analgesics or non-steroidal anti-inflammatory drugs. Simple analgesics have safer risk benefit profile, but non-steroidal anti-inflammatory drugs will also treat concurrent inflammation. In view of potential side effect NSAID's prescription should be on the basis of symptomatic relief, patient tolerance, and other health factors.

Splinting:

Positional splinting in a thumb brace with abduction can offload degenerated area of joint and stabilize the thumb in better functional position hence provide effective pain relief²². The splint reduces pain, decreases edema, decreases inflammation, improves function and reduces mechanical stress that may be causing the instability and delay the disease progression by encouraging the joint to stiffen or stabilize in the splinted functional position. It is widely used because it is non-invasive, simple, and cost effective. Swigart et al ¹⁹ reported that 76% of patients with stage I or stage II disease and 54% of those with stage III or stage IV disease obtained sufficient symptomatic relief to allow continued activities with intermittent time-limited splint use¹⁹.

A well applied splint should be acceptable to the patient with maximum adherence and without complications. It should incorporate palmar abduction, flexion, and pronation of thumb metacarpal. Careful assessment is needed while choosing a splint considering degree of support needed at CMC joint and wrist; whether splint is to be worn full time or for night time support only; whether metacarpophalangeal is symptomatic, unstable and needed to be included in the splint. Splinting helps to reduce pain and need for surgery

but objective measures, such as grip or pinch strength, have not been shown to improve after splinting, although functional outcome scores may improve.

Intra-articular Injections:

Injection of corticosteroid into the TM joint can be used in early to moderate disease. It can be performed in the outpatient setting. The primary goal of corticosteroid injection is to reduce inflammation and achieve pain relief. Though pain relief has been reported in early stages of arthritis but no significant benefit has been reported in moderate to severe arthritis. It can be used as a diagnostic tool, where the diagnosis is somewhat unclear. Water soluble corticosteroids are preferred as they don't leave any deposits. A cocktail with Lidocaine without epinephrine is often used to give immediate pain relief in acute cases¹⁸. Corticosteroid injection may accelerate cartilage loss and exacerbate capsular attenuation. Day et al investigated intra-articular steroid injections of the CMC joint in 30 thumbs in a prospective analysis, and found that at 18 months, 80% of Eaton stage I patients experienced pain relief. However, this was not true for patients with advanced stages of arthritis, in which only 25% of stage IV patients experienced pain relief¹⁸.

Injection of hyaluronic acid with their apparent benefit in knee joint, some investigators have attempted injecting hyaluronic acid into the thumb CMC joint, but there is no definitive evidence that hyaluronic acid preparation are as effective or superior to corticosteroid injections.

Platelet rich plasma (PRP) is an autologous blood product that contains an increased concentration of platelet and has emerged as a safe treatment modality to accelerate healing of musculoskeletal injuries. Platelet contain more than 5000 proteins of which more than 300 are released on activation, among these are bioactive proteins and growth factors which can modify the microenvironment inside the joint. It is believed to reduce the inflammatory process and alter the joint homeostasis of anabolism and catabolism in the cartilage. Leukocyte-reduced PRP has proven to be superior over leukocyte-rich PRP in the treatment of OA in vitro²⁴. Markus loibl *et al* reported in his randomized control trial of 10 patients, that intra-articular injections of PRP for TMC OA represent a safe conservative treatment modality. Patients with mild to moderate TMC OA experience persistent decreased pain at six-month follow-up after two intra-articular injections of

PRP²⁴. However, this methods have not gained universal acceptance and is only being used sporadically but it does hold promise for the future.

Operative treatments:

Numerous surgical techniques are available for the treatment of TM joint arthritis that are refractory to conservative non-surgical measures. Patients are selected for surgery on the basis of an assessment of symptoms, functional demands of patients and the results of non-operative treatment. The goals of surgery are symptom control where non-operative treatment have failed and to improve functional ability. It can be achieved by a tailored approach from the range of options available.

Abduction-Extension Osteotomy:

Forces across the thumb CMC joint lead to cantilever bending and result in high concentrations of shear forces across the volar half of the joint. These forces are believed to be causative in the preferential development of osteoarthritis of this segment of the thumb TM joint. Therefore, a 30-degree closing wedge, extension osteotomy of the thumb metacarpal has been theorized to unload the volar segment of the thumb CMC joint by redistributing the load through the more dorsal segment of the joint²¹. It places the thumb in a more extended and abducted position, to reduce the chance of subluxation, and it changes the contact points between the metacarpal and trapezium where cartilage is worn out. Badia performed a retrospective assessment of 43 Badia stage II TM OA patients who received extension-abduction closing wedge osteotomies at a mean follow-up of 43 months. He found the average pinch strength to be 73% of their non-affected hand, and 37 of his patients to be pain free. This procedure is only useful in patients who have cartilage wear restricted to the volar surface, with preservation of the remaining cartilage and is more useful in younger active patients ¹.

Trapeziectomy:

Since Greis described trapeziectomy 60 years back, it is one of the most commonly performed surgical procedure for osteoarthritis of TM joint. Though this operation relieves pain but has been associated with loss of thumb strength and stability as a result of

collapse and shortening of the thumb metacarpal into the space left by excised trapezium²⁰. The trapeziectomy procedure has been repeatedly modified since it was first described to try to resolve these problems. Modifications include haematoma arthroplasty or distraction pinning of the first metacarpal, tendon interposition, and palmar beak ligament reconstruction. Surgeons often use combinations of these procedures to augment simple trapeziectomy, with the aim of achieving reliable pain relief and a stable strong thumb. The large number of variations of trapeziectomy suggests that the best treatment is still not clear. A Cochrane review examined the evidence from several randomized trials, prospective series, and observational studies. It concluded that no commonly used surgical procedure was superior, although simple trapeziectomy resulted in fewer complications than other approaches³².

Resection Arthroplasty:

Removal of articular base of first metacarpal with ligament reconstruction and tendon interposition of autologous material described by Eaton and Littler and later modified by Burton and Pellegrini has emerged as good treatment option in cases of late stage III and stage IV arthritis. The procedure involves resection of trapezium and base of first metacarpal, along with stabilization procedure using distally based strip of flexor carpi radialis sling suspension interposition, to reconstruct the deep anterior oblique ligament and create an interposition arthroplasty by filling the void left by trapeziectomy, providing both support and resist subsidence of thumb metacarpal³⁰.

Authors have had good experience with technique described by Weiby and modified by Marc Garcia-Elias, involving passing the radial slip of FCR tendon around the APL tendon, making a suspension lattice in the void created by resection of trapezium. This procedure has theoretical benefit of avoiding late yielding of intermetacarpal link under tension and torque³¹.

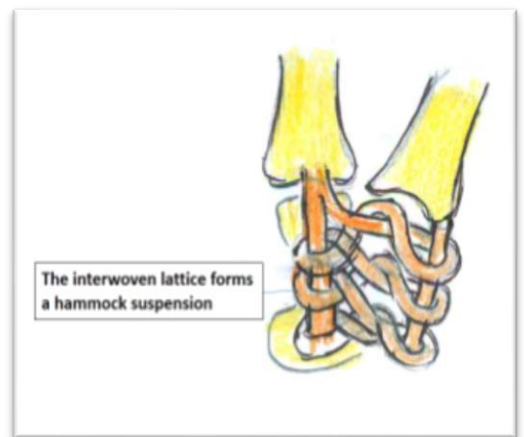
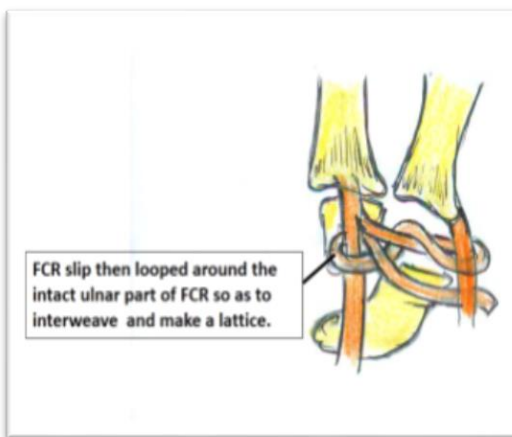
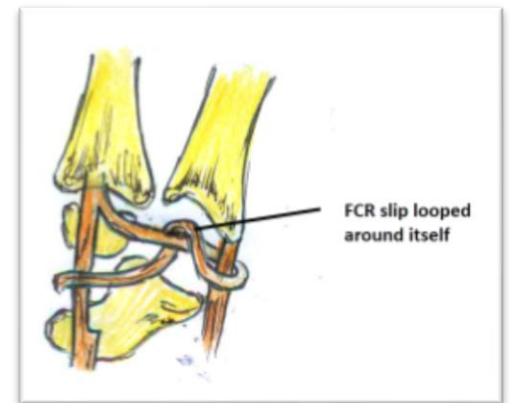
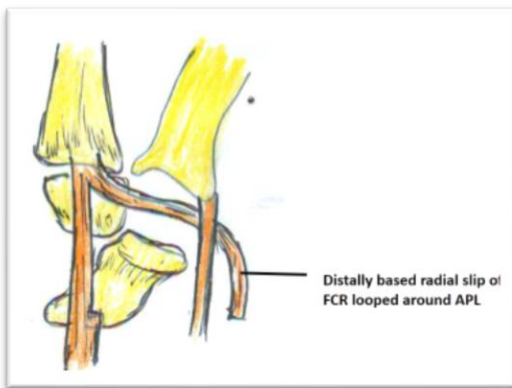
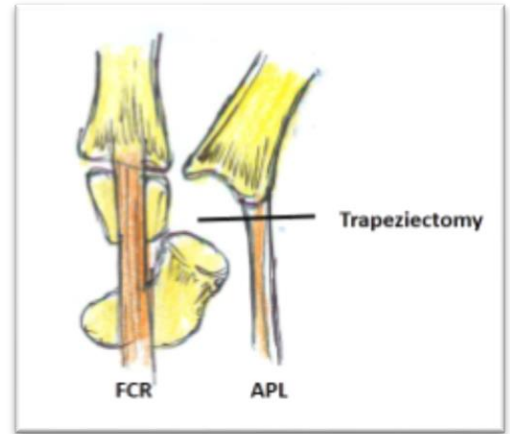
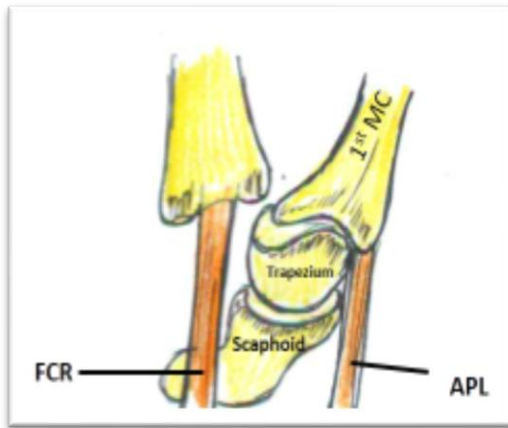


Fig 7: Steps of Trapeziectomy and suspension arthroplasty

Volar ligament reconstruction:

Initially reported by Eaton and Littler in 1973, reconstruction of the volar ligament alone, with a strip of autogenous flexor carpi radialis (FCR) tendon remains the standard procedure for stage I and II arthritis¹⁵. Pellegrini modified the procedure by splitting the FCR tendon as far distally as possible and using only one slip of it. Volar ligament reconstruction is indicated in early arthritis without eburnation⁵.

Arthrodesis:

Arthrodesis is considered for patients for whom strength, pain relief, and joint stability are a high priority than joint preservation. It is often preferred surgical option for young manual worker with high functional demand for whom loss of movement is offset by relief of pain and improved stability. Clinician must always make sure that degenerative changes are not extending beyond the 1st CMC joint where isolated CMC joint arthrodesis is unlikely to relieve symptoms.

The metacarpal is placed in a functional position of 30° palmar abduction, 35° of radial abduction, 15° of pronation and 10° of extension. Numerous methods of arthrodesis have been described including use of mini plates, screws, tension band wiring, staples, or compression screws. However, authors have found K-wire fixation to be sufficient and effective.

Potential complications include non-union, restricted movement, and progressive adjacent joint arthritis.

In well selected patients there is excellent pain relief, return to normal activities, and improvement of subjective strength.²⁹



Figure 8: A case series showing advanced TM arthritis treated by fusion of the joint using K-wires. The excellent functional result was achieved and patient reported good pain relief and functional restoration (Star indicates the involved side thumb).

1st CMC joint Arthroplasty:

Arthroplasty of 1st CMC joint has been available for more than 50 years but still not devoid of prosthesis related complications. Due to mechanical wear and poor long term results of observational studies, silicon prosthesis are no longer used. A long term study

by Van Cappelle HG *et al* of cemented metallic chaffiniere prosthesis showed that 72% of 77 implants survived at 16 years, with rate of loosening of 44%²⁵. It may be considered, particularly for older patients with low demands²⁶.

Newer synthetic interpositional materials may be more often used in future which are designed so as to act as simple spacer, than load bearing. Though the long term results of interpositional implants in past have been poor, early results of newer interpositional material are encouraging with excellent pain relief and good functional outcome²⁷. At present there is no evidence to support their use over trapeziectomy or arthrodesis

Arthroscopic surgery:

Arthroscopic debridement of trapeziometacarpal joint provides good pain relief, but option is limited to early stages of arthritic disease²⁵. Though with expertise partial or total trapeziectomy also can be performed arthroscopically, but as yet no evidence is available of the superiority of arthroscopy over open technique. Edwards SG *et al* in their small series of hemitrapeziectomy reported equivalent results as open trapeziectomy²⁸.

Treatment of Scaphotrapeziotrapezoidal joint arthritis:

Recognition of STT arthritis cannot be over emphasized. Treatment of isolated 1st CMC arthritis is doomed to fail in such conditions. It is clinically difficult to localize this joint hence injection under radiological guidance is preferred. If non-operative treatment has failed, STT arthritis is best treated with local fusion³⁴. However the surgery is associated with complications including progressive radio-carpal arthritis and may not necessarily halt the disease²⁹.

Thumb basal joint arthritis is common but there is poor correlation between the clinical symptoms and radiological findings. Hence, patient should be treated based on their symptomatology and disability rather than the radiology. Non-operative treatment and activity modification are effective and must be tried first. Failure of non-operative methods is the indication for surgical intervention. Arthroscopy and implant arthroplasty are there for some time now but have not dramatically influenced the outcome and as yet have not become universally acceptable. So, among the surgical techniques, the main discussion would revolve around choosing between a TM joint fusion or trapeziectomy

with or without suspension arthroplasty. Surgeon's preference vary, however in general in a young patient with heavy work demands a fusion is preferable. Whereas, in an elderly patient with lesser demand and preference for mobility, a trapeziectomy with or without suspension arthroplasty may be preferred. Though the literature review reveals doubtful advantage of suspension or ligament reconstruction and interposition over simple trapeziectomy authors (and many other surgeons) still believe that if carefully performed they would have an advantage over a simple trapeziectomy. At our center we routinely perform trapeziectomy with suspension arthroplasty (Fig 7). Arthritis of both the STT and TM joint is a contraindication for TM arthrodesis and excision of trapezium with or without suspension should be considered.

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