Small Joint Arthroscopy

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Abstract	The development of small and micro-arthroscopes has ushered in an era of small joint arthroscopy that remains in a state of progression. Despite these technological advances, clinical indications for small joint arthroscopy in the hand remain scant and underutilized. This is mainly due to a scarcity of papers utilizing this technique in the literature, as well as rare hands on training in the technical aspects of small joint arthroscopy. Despite the fact that these small joint arthroscopes have been readily available for decades, hand surgeons have been slow to adopt this methodology within their treatment protocols of both traumatic and degenerative conditions involving small joints. This discussion will focus on small joints within the hand, namely the trapeziometacarpal, scaphotrapezial-trapezoidal, metacarpophalangeal, fifth carpometacarpal (CMC), proximal (PIP), and even distal (DIP) interphalangeal joints. Similar instrumentation is used in the temporomandibular joints and small foot articulations but is beyond the "scope" of this chapter. Both traumatic and degenerative afflictions in the hand are ideally suited for use of small joint arthroscopy. Basic arthroscopic techniques such as synovectomy, debridement, chondroplasty, capsulorrhaphy, joint resurfacing, and arthroscopic-assisted internal fixation or soft tissue repairs are all ideally suited for the small joints. Further advances in fiberoptic technologies, and particularly in small joint instrumentation, will help contribute to expanding treatment options in articular pathology within the small joints.	

Small Joint Arthroscopy

27

Alejandro Badia

Introduction

Advances in fiberoptic technology and small joint instrumentation have opened up a new world in the area of arthroscopy. However, indications for small joint arthroscopy in the hand remain poorly understood and underutilized. This is mainly due to a scarcity of papers utilizing this technique in the literature, as well as scarce hands on training in the technical aspects of small joint arthroscopy. Despite the fact that these small joint arthroscopes have been readily available for decades, hand surgeons have been slow to adopt this to include this methodology within their treatment protocols of both traumatic and degenerative conditions involving small joints.

Small joints to be discussed include the trapeziometacarpal, scaphotrapezial-trapezoidal, metacarpophalangeal, fifth carpometacarpal (CMC), proximal (PIP), and even distal (DIP) interphalangeal joints. Similar instrumentation is used in the temporomandibular joints and small foot articulations but is beyond the "scope" of this chapter.

Perhaps the most common indication for small joint arthroscopy is its use in the thumb trapeziometacarpal or first CMC joint and is simply due to the ubiquitous nature of thumb basal joint arthritis and the myriad of treatment options that continue to be offered. Small joint arthroscopy offers a minimally invasive manner to achieve similar treatment goals and a previously described arthroscopic classification for basal joint osteoarthritis helps direct specific treatment depending on the stage of disease. This chapter will also review the brief history of trapeziometacarpal arthroscopy and provide insight as to how this technique can be incorporated into a treatment algorithm in managing this extremely common condition.

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Metacarpophalangeal joint arthroscopy is even less commonly used, while traumatic and overuse injuries are frequently seen in the thumb, and present an ideal indication in certain scenarios. Painful conditions affecting the metacarpophalangeal joints of the fingers are less commonly seen, yet the small joint arthroscope presents a much clearer picture of the present pathology compared to other imaging techniques or even open, and potentially harmful, surgery due to excess capsular scarring.

Proximal interphalangeal arthroscopy remains a novel technique and few papers have outlined the indications or utilization of this in PIP pathology. Rheumatoid arthritis may be the best indication as the soft tissue pathology itself permits introduction of the scope into a small space due to capsular laxity. Treatment is best suited for earlier stages.

Distal interphalangeal arthroscopy remains anecdotal as does that of the fifth carpometacarpal joint, only possible since it is quite mobile.

The application of this technology to the smaller joints will soon make the treating surgeon realize that a myriad of pathologies are readily visible and can augment treatment as well as diagnosis. Similar to the wrist, small joint arthroscopy may one day supplant imaging techniques such as MRI or CT in establishing an accurate diagnosis.

Thumb First Carpometacarpal (CMC) Arthroscopy

Osteoarthritis of the thumb trapeziometacarpal (TM) joint remains the most common indication for small joint arthroscopy and perhaps the only small joint technique that is now consistently mentioned in academic symposia and scientific articles. There is a plethora of different surgical options for the basal joint suggesting that none of them has an optimal success rate, or conversely, it may be that many treatment options lead to satisfactory results; therefore, the clinician continues to use his favorite technique. However, this "one operation fits all" approach may not be optimal since different

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stages of basal joint arthritis are clearly recognized. Furthermore, first CMC osteoarthritis of the thumb has many different clinical presentations and one technique cannot be used for all of the different stages and a patient's individual needs. When conservative treatment has failed, there are many surgical options, and should be individualized to the particular patient.

The early stages of basal joint osteoarthritis are frequently seen in middle-aged women and can be frustrating since current open surgical options may be deemed too aggressive for this patient population. These patients often fail conservative treatment and are searching for a solution to provide definitive pain relief while allowing them to be active. The use of anti-inflammatories, splinting, corticosteroids, and even hyaluronic injections serves only as palliative measures with none of these affecting a permanent change in the joint pathophysiology or mechanics. Furthermore, the use of injectable corticosteroids can hasten cartilage degradation and lead to further capsular attenuation/instability. The rare cases of transient synovitis may experience some relief, but the inevitable progressive loss of cartilage demands a more aggressive intervention. Second to the DIP joint, the thumb basal joint remains the most common, but most symptomatic location for osteoarthritis in the hand. Ironically, it is also the most critical for hand function and perhaps the increased motion and demands this joint experiences lead to the condition itself. The ascent of mankind has been largely attributed to the unique function of the human thumb basal joint and likely led to the progression of tool use in hominid evolution. Treatment of this functionally important joint remains a priority for the hand surgeon, and it is important to utilize the wide variety of surgical technique to optimally manage this condition.

Traditionally, the basal joint has been treated by surgical means only when conservative options have been exhausted and patient demands more aggressive treatment. The primary option has been, and still remains, some type of open trapezial resection arthroplasty. This explains why the procedure is not often offered to younger patients, and why high demand patients will forego operative treatment, even when symptoms are quite severe. While the literature demonstrates good results in a multitude of studies and using a variety of techniques, it nevertheless is a surgically aggressive procedure since removal of a complete carpal bone is required in order to achieve pain relief. This is understandable in the most advanced cases where the trapezium is typically flattened, has pan-trapezial disease, or has severe deformity including marginal osteophytes. However, earlier stages warrant a more conservative option that allows for future interventions if the primary treatment is not successful. Other options, perhaps less aggressive, include arthrodesis, which can provide excellent pain relief but has the obvious limitation of loss of motion, or joint replacement. Joint arthroplasty, like in any other joint in the body, has the added risk of failure of the implant, whether this be silicone or of metallic and plastic components and is still not accepted by many clinicians. This is also not a good alternative for the younger, high-demand patients.

Evolution of Basal Joint Arthroscopy

The refinement of fiberoptic technology has allowed us to apply the ideals of minimally invasive surgery to small joints including the wrist, foot, temporomandibular, and now the small joints of the foot and hand. Yung-Cheng Chen's classic treatise on arthroscopy of the wrist and finger joints in 1979 reviewed the technique and indication of performing small joint arthroscopic procedures using the Watanabe No. 24 arthroscope as early as 1970 [1]. Surprisingly, within that paper there was no mention of arthroscopy of the thumb trapeziometacarpal joint, perhaps the small joint arthroscope's broadest clinical indication. In his review, there was a detailed description of arthroscopy of the wrist, metacarpophalangeal joints, and the proximal interphalangeal joints. While wrist arthroscopy has been universally accepted [2] as a critical tool for management of pathology in this small joint, the smaller joints remain underutilized regarding this methodology. This author reviewed the extensive clinical applications of both MCP and first CMC joint arthroscopy 7 years ago [3] but only recently has the latter gained acceptance and even been discussed in academic presentations as yet another option for treatment of thumb arthritis.

Jay Menon published the first important clinical paper on basal joint arthroscopy in the *Journal of Arthroscopic and Related Surgery* in 1996 [4]. This clinical series, "Arthroscopic Management of Trapeziometacarpal Joint Arthritis of the Thumb" reviewed patients undergoing arthroscopic hemitrapeziectomy and interpositional arthroplasty using either autogenous tendon graft, Gore-Tex, or fascia lata allograft. It was not clear what extent of arthritis was involved in the series, but it appeared the technique was reserved for more advanced stages. This early paper did not present the possibility of performing arthroscopy on less advanced stages but rather avoid destabilizing the basal joint by not performing an open arthrotomy on advanced cases which otherwise would have had an open complete trapeziectomy. More than 80 % of the patients had complete pain relief in his series of 25 patients, perhaps akin to results utilizing the open technique. However, he clearly outlined the advantages of doing this arthroscopically including the minimally invasive nature with less risk of injuring the radial sensory nerve coupled with less post-op pain. He did not comment on one obvious advantage, namely that arthroscopy of the trapeziometacarpal joint can assess the true articular changes providing more accurate joint assessment than routine radiographs.

This encourages us to treat basal joint osteoarthritis in much earlier stages and the clinical indication for surgery could be failure of conservative treatment, not simply patients with advanced X-ray changes. Herein lies the major advantage of small joint arthroscopy as it provides a new option for treating patients with the earliest stages of basal joint arthritis.

One year after Menon's clinical study paper, Berger from the Mayo Clinic presented a technical discussion of first carpometacarpal joint arthroscopy as a technique paper in the *Journal of Hand Surgery* (JHS American) in 1997 [5]. The clear advantages of arthroscopy in assessing the anatomy, as opposed to a standard open arthrotomy, were presented. He reasoned that open joint visualization would be difficult due to the depth and constraint of the joint, while the arthroscope could avoid disruption of the multiple ligaments that he described with Bettinger in a separate anatomic review [6]. Berger's paper also reviewed 12 cases that he had performed from 1994 in diverse clinical indications including several Bennett fractures of the metacarpal base. He further commented that there was excellent visualization and no complication with this procedure, yet clear indications for first CMC joint arthroscopy were not outlined, but this did present a viable alternative to the more invasive open surgery. This paper was followed by an interesting barrage of letters to the editor arguing over whether Berger or Menon had presented the index article on this new technique for the thumb. The next clinical paper on thumb arthroscopy was not until 1997, by Osterman and Culp in the journal *Arthroscopy*, wherein two groups of patients were described: traumatic and degenerative [7]. Their paper validated the use of arthroscopy for the thumb carpometacarpal joint also suggesting that arthroscopy may determine the degree of trapezial surface involvement and even promoted its usage in younger patients. This led this author to use arthroscopy of the thumb carpometacarpal joint to accurately stage the degree of cartilage wear and determine specific treatment based upon this information [8]. While Jay Menon and others may have introduced the use of arthroscopy to limit the invasive nature of partial trapezial excision, I believe the technique may be uniquely suited to manage those patients who, until now, were not candidates for any surgical option.

Like any other joint, arthroscopy of the thumb carpometacarpal joint is only helpful if the operating surgeon clearly understands the anatomy, particularly the functional ligaments so critical to function and perhaps implicated in development of arthrosis. The first description of the trapeziometacarpal ligaments occurred in 1742 in a treatise by Weitbrecht, entitled Syndesmology, where these ligaments were mentioned in a cursory manner [9]. A variety of authors have since further described the details of this anatomy with the pinnacle, as mentioned, coming from Bettinger, Berger, and others from the Mayo Clinic 1999 [6]. They described a total of 16 ligaments including ligaments between the metacarpal and trapezium and two ligaments attaching the trapezium to the second metacarpal apart from separate stabilizers for the scaphotrapezial and trapezoidal joints. They determined that this complex of ligaments act as tension bands to prevent instability from cantilever bending forces exerted on the trapezium by the mechanics of pinch. This was a very important concept since large loads are transferred to the trapezium, and there is no fixed base of support since the underlying scaphoid is a mobile carpal bone. Therefore, it is the dysfunction and weakening of these key ligaments that may lead to the condition of basal joint arthritis. It was later surmised by Van Brenk that the dorsoradial collateral ligament was the critical ligament preventing trapeziometacarpal subluxation [10]. He calculated this based upon a cadaveric study where serial sectioning of four key ligaments ultimately determined that the RCL was the key structure in preventing dorsoradial subluxation. Furthermore, Zancolli, known for his thorough knowledge of functional hand anatomy, also supported this concept, although he added a controversial theory that aberrant, redundant slips of the abductor pollicis longus may cause a compressive force of the dorsoradial aspect of trapeziometacarpal joint possibly leading to arthrosis [11]. He surmised that the underlying ligamentous laxity is due to underlying variations in an individual person's ligamentous laxity or a hormonal predilection that could perhaps explain the increased prevalence amongst women. My personal discussions with him ultimately led to my developing an arthroscopic classification since the articular findings may help determine which ligaments are most commonly afflicted in the arthritic process. An intrinsic cause for basal joint arthritis was suggested by Xu and Strauch, who indicated that the trapeziometacarpal joint is smaller and less congruous in women and might also have a thinner layer of hyaline cartilage, adding an additional etiology explain the increased incidence of basal joint osteoarthritis in women [12]. This, too, is my experience and suggests that the greatest applicability of arthroscopy may be in younger women who present with this disease at a much earlier age and have, implicitly, less surgical treatment options.

In 1979, Pellegrini in Hand Clinics, reaffirmed the functional role that the volar beak ligament plays in limiting dorsal translation of the metacarpal during pinch function [13]. The volar oblique ligament and the dorsoradial ligament are well visualized during arthroscopy and can allow for therapeutic intervention as well. Pellegrini proposed that the attritional changes in the volar oblique ligament seen at its metacarpal insertion site may be related to increased estrogen receptors at this site. This is consistent with a gender predilection for this affliction. I have indeed noted consistent full thickness cartilage loss at the insertion of the volar beak ligament on the deep metacarpal base while the rest of the metacarpal appears normal via arthroscopic evaluation.

More detailed anatomic, clinical, and even biomechanical concepts have been described by Bettinger and Berger in their study emphasizing the functional ligamentous anatomy of this joint [14]. It was noted that the arthroscopic anatomy is less complicated due to limited number of structures seen from intra-articular vantage point. It was a pioneering technique article as well, outlining which of the two main portals provides visualization of which corresponding ligaments. Further portals were later described to further define the surface anatomy of this joint but predominantly to assist in performing triangulation during arthroscopic interventions. For example, Orellana and Chow described a radial portal which they suggested was safer due to its position relative to the radial artery and branches of the superficial radial nerve [15]. Later, Walsh and Akelman described the thenar portal, which was much more palmar, passing through the thenar musculature, allowing for improved triangulation and more "birds eye" visualization of the joint [16]. Slutsky later described a more distal portal, at the first webspace, allowing better exam of the dorsal structures and better access to the deep trapezial osteophyte typically seen [17]. These newer portals confirm that thumb CMC arthroscopic surgery is now in a state of evolution and hopefully will allow us to better understand arthritis at this level. Arthroscopic assessment of these structures over time may allow us to elucidate the cause of dorsal subluxation as a factor in basal joint arthritis.

An early clinical series by Culp and Rekant first suggested that arthroscopic evaluation, debridement, and synovectomy "offer an exciting alternative for patients with Eaton and Littler stages I and II arthritis" [18]. They were the first to discuss radiofrequency (RF) at the basal joint, describing radiofrequency "painting" of the volar capsule of the trapeziometacarpal joint, in order to stabilize the critical palmar ligaments that may cause dorsal subluxation and subsequent basal joint arthrosis. They recommended that if the majority of the trapezial surface is arthritic, then at least one-half of the distal trapezium should be resected via arthroscopic burr. The short-term results described in this paper followed arthroscopic hemi- or complete trapeziectomy in conjunction with electrothermal shrinkage reporting nearly 90 % excellent or good results in 22 patients with a relatively short follow-up. They were the first to indicate that no "bridges had been burned" since patients who have the arthroscopic procedure can always undergo a more aggressive open and complete excisional trapezial arthroplasty. They conclude that debridement and thermal capsular shrinkage is a good treatment option for early arthritis of the basal joint although the paper does seem to focus on a more advanced stage.

It is important to understand the role of RF in this new indication since orthopedic surgeons have benefited from the use of radiofrequency in multiple joints during the past two decades. In recent years, we are realizing that it may have some detrimental effects, and it is important to look at this technology more critically. As with any new technique, selective use of this technology and careful adherence to certain principles may allow for safe use of RF in a variety of clinical scenarios. Shoulder instability had been commonly treated using radiofrequency to stabilize the joint, particularly in those patients with global instability who traditionally had not been considered good operative candidates [19]. More recently, this technique has been largely abandoned in shoulder capsulorrhaphy due to poor results and even potential complications [20]. One must scrutinize the literature as perhaps the technology was applied in an overaggressive manner or even poor patient selection. While it has also been used in the knee and some other joints, there has been minimal mention in the literature of its application to the wrist, let alone small joints of the hand. This is largely due to the fact that arthroscopy of the small joints has had only cursory discussion in the literature.

Radiofrequency has had many medical applications since the late nineteenth century including creating lesions in brain tissue and has been used in cardiology, oncology, and colorectal surgery. Markel and colleagues first demonstrated the effect of radiofrequency energy on the ultrastructure histology of the joint capsular collagen in a basic science study [21]. They noted that similar clinical applications had been performed with a non-ablative laser in orthopedics but offered alternative that radiofrequency provided several advantages over the use of a laser. RF is less expensive and safer than laser technology, while the devices are much smaller and easily maneuverable in its application to arthroscopic techniques. Early basic science studies on a sheep joint first demonstrated that the thermal effect was characterized by the fusion of collagen fibers without tissue ablation, charring, or even crater formation. They described a linear relationship between the degree of collagen fiber fusion and increasing treatment temperature. This indicates that the technology must be judiciously utilized with avoidance of aggressive use. It was determined that the coagulated tissue mediates a mild inflammatory reaction leading to the degradation and replacement of the affected capsule with stronger, fibrous tissue. This could potentially help to stabilize a joint and might have specific application in the trapeziometacarpal joint since instability is part of the clinical spectrum in many cases. Later, Markel and Hecht looked specifically at monopolar radiofrequency energy on the joint capsular properties and determined that monopolar radiofrequency caused increased capsular damage in the immediate area and depth correlating with the wattage used [22]. Of note was that heat production increased linearly with the duration of application. Arthroscopic lavage could protect the synovial layer from permanent damage as demonstrated in sheep. These findings all indicate that radiofrequency probes must be used with adequate fluid lavage as well as for short durations and with the minimal wattage necessary to

Table 27.1 Badia arthroscopic classification for thumb CMC arthritis

Stage I	Diffuse synovitis, intact articular cartilage, volar capsular laxity
Stage II	Central focal articular cartilage loss of trapezium, deep metacarpal base loss, and synovitis
Stage III	Widespread articular cartilage loss, deep osteophyte on trapezium

achieve the desired effect. We are referring here to monopolar radiofrequency since it is commonly accepted amongst orthopedic surgeons that monopolar radiofrequency causes less heat production than bipolar modalities. This is critical to the hand surgeon since small joints have correspondingly thinner capsules and are in close continuity to neurovascular structures. This is a completely different scenario as compared to the knee or shoulder. Future studies might specifically compare monopolar versus bipolar radiofrequency treatments in these small joints.

Based upon the early clinical papers, while taking full advantage of the technologies available, it soon became clear that a thorough staging system would be beneficial, utilizing these arthroscopic findings to actually dictate treatment. First, the clinical studies discussed have primarily focused upon more advanced osteoarthritis, discussing results after some manner of arthroscopic-assisted hemitrapeziectomy. Second, there was little mention of the degrees of arthritis noted during arthroscopy and how that might influence treatment. Furthermore, it is likely that the patient whose joint is less affected might benefit most from an arthroscopic treatment method. This author therefore developed an arthroscopic classification which could dictate treatment for the respective stages herein delineated (Table 27.1).

The arthroscopic staging was gradually developed as a result of nearly 20 years of performing an arthroscopic assessment for recalcitrant basal joint arthritis which did not improve after often extensive conservative treatment. The condition is, of course, staged radiographically as per Eaton's criteria [23]. Obvious exceptions were in patients with advanced (Eaton stage IV) arthritis with significant scaphotrapezial-trapezoidal (STT) arthrosis or trapezial collapse who then underwent a trapezial excisional suspensionplasty using a slip of abductor pollicis longus similar to Thompson's description [24]. The advanced stage of disease really required excision of the entire trapezium, while stage IV patients with mild STT changes were still often treated via arthroscopy. Cobb describes a technique where both trapeziometacarpal and STT joints can simultaneously undergo arthroscopic treatment although I did not consider that in my treatment algorithm here described [25]. An additional exception was for older, low demand patients who did well using a cemented total joint arthroplasty as this required almost no immobilization and minimal therapy [26, 27]. This open surgery also allowed me to correct z-deformities by performing intrinsic releases of the adduction contracture coupled with an MCP volar capsulodesis. The last exception to arthroscopic management was the occasional young, usually male laborer who underwent a trapeziometacarpal joint fusion in good position of function for heavy pinch and grip. This indication for arthrodesis has been amply described in the literature and remains a good option, although arthroscopic hemitrapeziectomies may soon obviate even that procedure in some cases [28].

Except in clear-cut radiographic stages, where one can predict the arthroscopic stage, one performs the procedure with understanding that several therapeutic options are available once the arthroscopic stage is defined. These stages will later be delineated. The arthroscopic surgery is performed under wrist block regional anesthesia, usually only requiring several cc's of lidocaine at median and radial sensory nerves of the wrist, 2–3 cm proximal to volar wrist crease. It is performed with tourniquet control and the upper arm is secured to arm board over this tourniquet via either wide tape or a Velcro strap. A single large Chinese finger trap is used on the thumb with 5–8 lbs. of longitudinal traction using a shoulder holder directly in line with the elbow flexed at 90° so that the thumb tip points to the ceiling. One can utilize the specialized wrist arthroscopy traction tower but is superfluous and more costly, since easy unencumbered access to the thumb is later necessary to drive a K-wire and fluoroscopy can be more easily introduced into the field. The trapeziometacarpal (TM) joint is then identified by palpating the more prominent metacarpal base. The joint is best localized by using an 18 gauge needle on a small syringe containing either lidocaine or lactated ringer's solution so that the joint can be insufflated and distended. The needle needs to be introduced a bit more distal than expected and aimed cephalad since the metacarpal dorsal flare/lip needs to be cleared (Fig. 27.1). One can usually only introduce 1–2 cc due to small nature of the joint and the degree of laxity and joint swelling will influence this. Caution must be used to ensure the STT joint is not actually distended and less experienced surgeons should use fluoroscopy when the needle is in the joint to both confirm precise location and help determine trajectory of the soon to be placed trochar/sheath assembly. The location for this initial distention will often vary based upon which hand (left or right), and location of occasional large, interfering prominent osteophytes. The longitudinal portal stab wound incision is then made in line with the needle penetration and will likely be at either the 1-R or 1-U portal as described by Berger [5]. The incision for the 1-R (radial) portal is placed just volar to the abductor pollicis longus (APL) tendon and is typically used for clear assessment of the dorsoradial ligament (DRL), posterior oblique ligament (POL), and ulnar collateral ligament (UCL). The incision for the 1-U (ulnar) portal, which allows better evaluation of the anterior oblique ligament (AOL-volar/oblique) and UCL, is made just ulnar

Fig. 27.1 Joint insufflation of the thumb basal joint in preparation for arthroscopic exploration. Note the needle trajectory which follows course of thumb metacarpal base flare and helps orient for correct arthroscope insertion angle

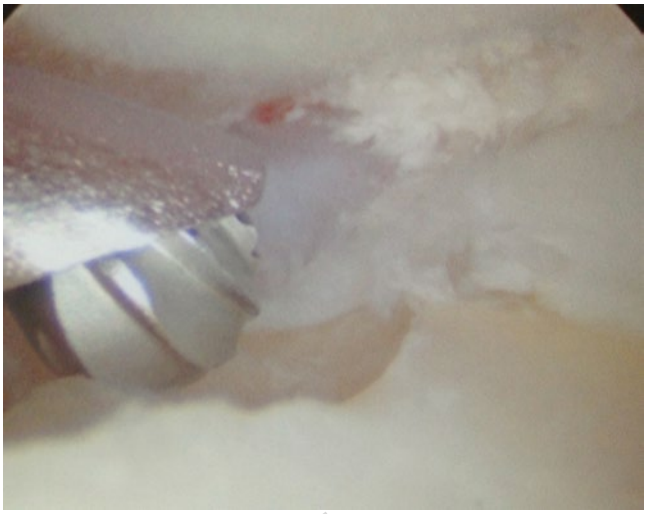

Fig. 27.2 Arthroscopic view of thumb trapeziometacarpal joint demonstrating dorsoradial resection of trapezial surface using a 2.9 mm burr in a Badia stage III arthritic joint

to the extensor pollicis brevis (EPB) tendon but palmar to the extensor pollicis brevis (EPL). The portals should be just distal to the dorsal branch of radial artery which lies across the ST joint, and should avoid any sensory radial nerve branches since the portals are, again, longitudinal, but one should always enter the capsule and spread with a straight small mosquito clamp. This will push the sensory nerves away from the portal sites. A short-barrel 1.9 mm 30° inclination arthroscope is usually used for complete visualization of the TM joint articular surfaces, capsule, and intrinsic ligaments. A 2.7 mm scope may be preferred when a more advanced Eaton stage is indicated since the larger scope may scuff the articular cartilage but is irrelevant in that scenario. The larger scope will actually assist in distracting the joint and provide a better field of view, while not risking the more delicate, and costly, 1.9 scope. A 2.0 mm full radius mechanical shaver with suction is used in most cases, particularly for initial debridement and visualization. Again, the larger 2.9 mm more aggressive shaver or cutter may be used in advanced cases where a hemitrapeziectomy is fully expected to be undertaken. The larger shavers allow for much better suction and evacuation of debrided joint material. Many cases utilize radiofrequency, for either ablation or thermal shrinkage as discussed, so need to be available per surgeon's choice. Radiofrequency can also be used to perform chondroplasty in less advanced cases demonstrating focal articular cartilage wear or fibrillation. Ligamentous laxity and capsular attenuation are treated with thermal capsulorrhaphy also using the same RF shrinkage probe. One must be careful to avoid thermal necrosis and consequently, a striping technique is used to tighten the capsule of redundant or lax joints. Ample joint irrigation fluid is necessary during this treatment in order to minimize any thermal injury. In lesser stages of arthrosis, the arthroscopic treatment is completed once the joint synovectomy is performed, arthroscopic stage has been assigned, and the joint adequately debrided. Decision to use RF is made at this point but no further arthroscopic procedure is done in the early stages. Decision will have been made if adjunctive corrective metacarpal osteotomy is to be performed. In advanced cases, the shaver is now substituted for a mechanical shaver in order to proceed with partial trapeziectomy. A 2.9 mm long barrel type burr is then used to remove the distal 3–5 mm of remaining articular cartilage and subchondral bone. This is preferable to the round burrs due to speed and ease of use while some surgeons (Berner, Cobb etc.) try to utilize a larger, 3.5 mm burr since this will quickly remove the necessary trapezial surface. A strategic plan of joint resection is needed in order to avoid leaving significant prominent ridges or sections of the trapezium that may cause later impingement and persistence of pain. My strategy has usually been to divide the trapezial surface into four quadrants, two dorsal and two volar, or radial and ulnar. One begins at the area of shaver entry since the bone to resection is directly afoot, and this will create space to easier approach the other quadrants (Fig. 27.2). If the scope is in 1-R portal of a right thumb, then the burr would be in the 1-U portal facilitating subchondral resection of the dorsoulnar quadrant first. Once that side of the joint is cleared, the arthroscope can be changed to the opposite portal allowing the resecting burr to now enter the opposite portal, namely

the 1-R portal in the previous example delineated. The radial palmar/dorsal quadrants can now be better approached for resection. At this point, several options are possible in order to encourage fibrous tissue ingrowth to create a new pseudo-joint. Menon described a variety of materials including gore-tex, graft jacket, or tendon to interpose [4]. In my early experience, spanning nearly 10 years, I used a tendon graft which would serve as an "arthroscopic anchovy" and function as a biologic, albeit now inert, material to encourage fibrous ingrowth. This was quite successful and was even utilized in Ehlers-Danlos patients, notoriously known for poor results in basal joint reconstruction due to their extreme underlying joint laxity, the proposed cause for the current arthritic process. Several patients did well enough to request the opposite thumb be similarly addressed, and my first experience in handling this challenging clinical scenario was published as a case report [29]. However, the dead tissue being pushed into the joint was not easily controllable via portals and I did not feel the complete joint surface was well lined by this flimsy material, despite being autogenous. Around 2004, a synthetic but biologically compatible material known as artelon began to be used for open thumb CMC joint stabilization. This material degraded into lactic acid chains and CO_2 over time, and there were basic science studies suggesting the neoformation of fibrocartilage in animals [30]. This material demonstrated good clinical results in several early studies, particularly showing improved pinch strength recovery as opposed to classic complete trapezial resection procedures [31]. While I too utilized it in a number of open cases, it soon became apparent that the material could naturally be used for an arthroscopic interposition (Fig. 27.3). The material "wings" did not need to be secured as the joint capsule itself would keep the material in place and it would serve as a scaffold for fibrous tissue ingrowth.

Fig. 27.3 Arthroscopic view of artelon polyurethane urea sheet lining the trapezium after arthroscopic limited hemiresection

This was described in a technique journal article but after many years, was largely abandoned by this author due to cost issues and other unrelated matters [32]. It should be noted that in my experience, and that of many others, there was never an adverse reaction clinically seen. However, a recent trend to simplifying the trapezial resection procedures led me to consider not interposing any material at all. Meals gave rebirth to the simple concept that resection of the trapezium alone would suffice and he added simple k-wire pinning of the joint in a distracted position soon termed "hematoma distraction arthroplasty" or HDA. He demonstrated very comparable results to much more complex procedures traditionally utilized [33]. This was simply a fancier delineation of complete trapeziectomy published by Gervin a half century ago [34]. However, it appears that the pinning provides several beneficial effects, including keeping the joint distracted so ample fibrous tissue can form within a maintained biologic cavity. The other advantage for the arthroscopic technique is that little joint stabilization is provided in this minimally invasive surgery; therefore, pinning of the metacarpal base over the trapezium keeps the joint well reduced and the metacarpal "centralized" over the functional center of the trapezium (Fig. 27.4). A thumb spica cast is typically worn for 5–6 weeks to allow for hematoma maturation and fibrous tissue ingrowth; hence any decrease in swelling, or unopposed pull of the APL tendon, might allow for dorsal re-subluxation of the metacarpal base, possibly hindering the formation of this stabilizing tissue. New techniques, including suture/bone button stabilization devices, allow for "suspension" of the metacarpal base without the

Fig. 27.4 X-ray demonstrating transfixing pin of the thumb trapezio-metacarpal joint in palmar abduction after arthroscopic hemiresection of the trapezium in a Badia stage III joint. The immobilization allows for fibrous tissue ingrowth in the new space created and now maintained by the temporary pin fixation

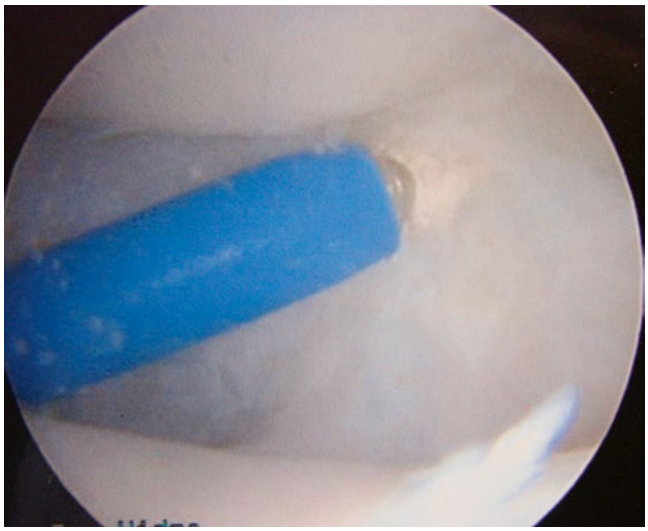

Fig. 27.5 Arthroscopic view of Badia stage I basal joint arthritis illustrating the synovitis but intact articular cartilage surface on both trapezium and metacarpal base

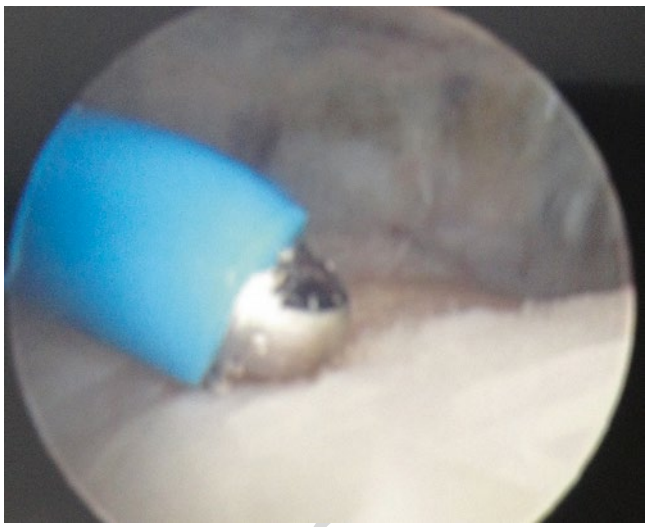

Fig. 27.6 Radiofrequency stabilization of the edge of a focal cartilage defect in a thumb Badia arthroscopic stage II. The joint contact points will subsequently be altered by a dorsoradial closing wedge osteotomy during same procedure

need for pinning. However, complications such as impingement against the second metacarpal base, or bone fracture at the tunnel location, must be taken into account [35].

These arthroscopic interposition arthroplasties are obviously indicated for more advanced arthritis, but a joint modification might only be needed if the joint can be debrided and stabilized; hence a discussion on arthroscopic staging [8] is necessary to delineate when and how metacarpal base osteotomy is performed.

Staging by arthroscopy (Badia) is critical in order to indicate what further joint procedure, articular or extra-articular, is performed once the assessment has been made after synovectomy and appropriate debridement. Arthroscopic stage I patients are characterized by diffuse synovitis but with minimal, or no, articular cartilage loss (Fig. 27.5). Capsular or specific ligamentous laxity is a typical finding at this stage. This arthroscopic appearance is not commonly seen, since most patients present late, having dealt with symptoms for a prolonged period, or referred at a delayed time, once conservative means have been exhausted. Primary care physicians, orthopedic surgeons, and even hand specialists typically feel there are few options available to these patients failing traditional nonoperative treatment. These patients will undergo synovectomy, by both mechanical shaving and radiofrequency, with frequent shrinkage capsulorrhaphy performed depending on findings. The joint is then stabilized in a thumb spica cast from 1 to 4 weeks depending on the extent of capsular laxity. More unstable joints required longer immobilization in order to achieve joint stability and might also be pinned in a reduced position with thumb in palmar abduction. Stabilization of the capsule and aggressive synovectomy is hoped to slow the progression of articular cartilage degeneration.

Arthroscopic stage II patients are typified by focal articular wear on the central to dorsal aspect of the trapezium. It can be argued that this likely represents an irreversible degenerative process and demands a joint modifying procedure in order to alter joint deforming forces and progression of subluxation. Once synovectomy, debridement, and any loose bodies are removed, the joint is evaluated to determine the degree of instability and extent of capsular incompetence. A thermal shrinkage capsulorrhaphy is then often performed, with thermal chondroplasty occasionally done to anneal the cartilage borders (Fig. 27.6). The scope is then removed and an open incision usually extended from the ulnar portal is performed in order to identify the metacarpal base and metaphyseal-diaphyseal junction. A dorsoradial closing wedge osteotomy, according to Wilson's original technique [36], is then performed in order to place the thumb in a more extended and abducted position altering the joint force vector (Fig. 27.7). Usually, only a 2–3 mm wide dorsoradially based wedge of bone is excised by combination of oscillating saw/osteotome. The idea is to minimize the tendency for metacarpal subluxation as well as change the contact points of degenerative articular cartilage. The osteotomy is stabilized usually by a single oblique Kirschner wire, also placed across the TM joint in a reduced position so that the metacarpal base sits squarely over the trapezium. This fixation allows for healing of the osteotomy in the reduced position and hopefully leads to a correction of the metacarpal subluxation, typically seen in this stage. A thumb spica short arm cast is worn during osteotomy bone healing and the wire is removed at 5–6 weeks post-op. While the osteotomy has been published as solely an open surgery by multiple authors, only arthroscopy can truly determine which patients should

Fig. 27.7 X-ray showing centralized metacarpal base and pin fixation after dorsoradial closing wedge osteotomy in order to alter joint force vector and minimize further cartilage wear

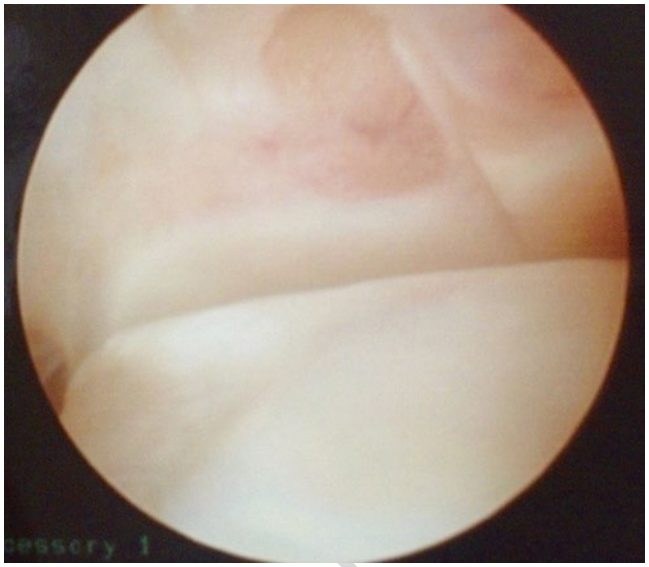

Fig. 27.8 Arthroscopic view of the scaphotrapezial-trapezoidal (STT) joint showing scaphoid distal pole to be burred down limiting painful impingement from overlying trapezium and trapezoid

undergo this osteotomy. This has demonstrated good results in the past, including a more recent paper by Tomaino [37], but we can surmise that perhaps any poor results achieved were due to a poor indication; namely that only patients with a moderate stage of arthritis should undergo osteotomy, and this can now be determined arthroscopically. I published a modest series of patients having undergone this technique of combined arthroscopic debridement with metacarpal osteotomy while further outlining specifics of the technique [38]. This represented only a fraction of the potential patient series that underwent this surgery and, interestingly, even late follow-up on my patients has demonstrated that the metacarpal remains "centralized." It is frankly unclear if the capsular shrinkage played a major role versus the alteration of joint mechanics by the osteotomy but suffice it to say that I have yet to convert any of these arthroscopic-assisted joint modifying procedures into any type of trapeziectomy or salvage procedure.

Arthroscopic stage III is characterized by nearly complete trapezial articular cartilage loss (Fig. 27.8). The metacarpal base can also demonstrate loss of cartilage to varying degrees. Arthroscopic findings indicate that this is not an articulation that can be salvaged and a simple debridement or even joint modifying osteotomy would not provide a good result in this scenario. At this point, an arthroscopic hemitrapeziectomy, as earlier described, is performed by burring away the remaining articular cartilage and subchondral bone to achieve a bleeding surface. This acts to not only increase the joint space, but provides the key bleeding which creates the so-called hematomaplasty. Whether interposition material is placed or not, an oblique transfixing K-wire is used, coupled with a thumb spica cast in an abducted position, and maintained for about 6 weeks in order to encourage fibrous tissue ingrowth within the interposition space. This is followed by generally a minimal period of hand therapy to focus on pinch strengthening as joint motion is rapidly restored no matter what therapy is done. While Artelon material for interposition represents a good option obviating tendon procurement, it has become increasingly apparent that generous resection of the trapezial surface without specific interposition material should suffice.

It should always be noted that arthroscopic stage III can also be treated by any traditional open technique such as excisional arthroplasty, arthrodesis, or even total joint replacement. This will largely depend on surgeon preference as well as patient needs and wishes.

Since arthroscopy remains underutilized and joint images are not readily available to study, we must take note of the correlations between arthroscopic and radiographic staging in order to better understand the role of arthroscopy and the typical findings at each stage. The most consistent arthroscopic findings in the group of patients who displayed radiographic changes compatible with stage I of the disease included fibrillation of the articular cartilage on the ulnar third of the base of the first metacarpal, disruption of the dorsoradial ligament, and diffuse synovial hypertrophy. We also noted attenuation of the anterior oblique or beak ligament (AOL) often being able to visualize the thenar muscles below the capsule, almost as a veil. The frequent injection of

steroids likely influences this factor and a future study correlating frequency/amount of corticosteroids with joint findings would be quite valuable.

Typical arthroscopic findings seen in patients determined to be stage II arthritis were significant but focal wear of the distal surface of the trapezium, loss of metacarpal base cartilage near insertion of the AOL ligament, disruption of the dorsoradial ligament, and more significant attenuation of the AOL. We typically would also see more intense synovial hypertrophy. Most of the patients with this arthroscopic stage also presented as stage II radiographically, but it is not uncommon to discover patients deemed stage I may actually have more advanced findings once the joint is accurately assessed. This represents the great advantage of this technology since there is little other way to see what the true joint status is. Only rarely did we find less cartilage wear than was supposed or predicted on the plain X-rays. Therefore, radiographic stage III is only rarely considered stage II arthroscopically, but that finding would greatly influence and expand the treatment options. Since arthroscopic findings in early disease may have the most clinical impact on our decision making for definitive treatment, due to lack of good options for conservative treatment, it is important to review the patient outcomes for arthroscopic stage II disease.

In 2003, a retrospective assessment evaluated arthroscopic stage II patients with adequate follow-up in the prior 3-year period [38]. Forty-three patients (38 female and 5 male) had been arthroscopically diagnosed as having stage II basal joint osteoarthritis of the thumb between 1998 and 2001. All the procedures were performed by me with follow-up data generated by visiting fellows for objectivity. The average age was 51 with range of 31–69 years of age. The right thumb was involved in 23 patients and the left in 20. There was no improvement after a minimum 6 weeks of conservative treatment under my direction although most patients had been failing conservative measures by referring doctors for over a year. The surgical procedure consisted of arthroscopic synovectomy, debridement, frequent thermal capsulorrhaphy followed by an extension-abduction closing wedge osteotomy in all cases. A .045-in. Kirschner wire provided stability to the osteotomy site while a short arm thumb spica cast was maintained for 4–6 weeks until pin removal. The average follow-up was 43 months (range: 24–64 months).

Consistent arthroscopic findings in the selected group were frank eburnation of the articular cartilage of the ulnar third of the base of the first metacarpal and central third of the distal surface of the trapezium, disruption of the dorsoradial ligament, attenuation of the anterior oblique ligament, and synovial hypertrophy. The osteotomy healed within 4–6 weeks in all the cases. Radiographic studies at final follow-up depicted maintenance of centralization of the metacarpal base over the trapezium and no appreciable progression of arthritic changes in almost all 42 patients. Average range of thumb metacarpophalangeal (MP) joint motion was 5–50° and thumb opposition reached the base of the small finger in all cases. The average pinch strength was 9.5 lbs (73 % from non-affected side). At final follow-up patients were evaluated by Buck-Gramcko score, which takes into account both the subjective as well as objective outcomes [39]. The mean total Buck-Gramcko score in our series was 48.4 representing a "good outcome." The constant pain in one of the patients was due to progressive osteoarthritis after the procedure. She did not respond to steroid injections and finally had to undergo arthroscopic-assisted hemitrapeziectomy due to progressive arthritis. A long-term follow-up should be obtained in future to better assess the utility of this technique and publish these findings specifically in stage II patients after minimum 10-year follow-up.

Arthroscopy in patients who had radiographic features of stage III and IV generally displays widespread full thickness cartilage loss with or without a peripheral rim on both articular surfaces, paradoxically less severe synovitis although we do note more frayed volar ligaments and often less laxity. This clearly constitutes arthroscopic stage III and the treatment options here are quite varied. The arthroscope can be removed and the most appropriate open procedure performed. I prefer the arthroscopic interposition arthroplasty in most of the cases. Based on the above findings and clinical experience, I proposed the arthroscopic classification and treatment algorithm as outlined in Table 27.1.

Trapeziometacarpal Arthroscopy: Clinical Utility

Clinical assessment and radiographic studies used to be the only tools available for the selection of treatment modalities for thumb CMC arthritis. Eaton and Glickel proposed a staging system for this disease that has been widely applied [20]. Later, Bettinger et al. [40] described the trapezial tilt as a parameter to predict further progression of the disease. They found that in advanced stages (Eaton III and IV) the trapezial tilt was high (50° ± 4°; normal: 42° ± 4°). Barron et al. concluded that there appears to be no indication for magnetic resonance imaging (MRI), tomography, or ultrasonography in the routine evaluation of basal joint disease [41].

While I believe that a radiographic classification is important for a stepwise interpretation of the progression of this entity, my experience has demonstrated instances when it is very difficult to make an accurate diagnosis of the extent of disease based solely on radiographic studies. Recent advances in arthroscopic technology have allowed complete examination of smaller joints throughout the body with minimal morbidity [1]. Moreover, arthroscopy has already proved

to be reliable for direct evaluation of the first carpometacarpal joint as previously discussed [5].

In early stages of thumb basal joint arthritis, for instance, in Eaton stage I, it is very common to find essentially normal radiographic studies despite the presence of painful limitation of the thumb. In our experience, we have found that this group of patients displays mild to moderate synovitis which could benefit from a thorough joint debridement combined with thermal shrinkage of the ligaments to enhance the stability. This, of course, after assuming they have not responded well to conservative treatment including splinting, NSAID use, and corticosteroid injection. This stage is typically seen in middle-aged women who are not suitable candidates for more aggressive procedures. Arthroscopic treatment provides a particularly good option for this ubiquitous subset of the patients.

Tomaino concluded that first metacarpal extension osteotomy is a good indication for Eaton stage I [37]. This may not be necessary in the occasional patient who undergoes arthroscopy at an early time and demonstrates no focal cartilage loss. Future studies may indicate that synovectomy, and perhaps thermal capsulorrhaphy, may avoid progression of disease and the need for a mechanical intervention. However, the arthroscopic findings that I previously described for arthroscopic stage II of the disease demand a joint modification such as osteotomy, in order to minimize the chance of further articular degeneration. My retrospective study indicates that this approach is efficacious with only one out of 43 thumbs developing progressive arthritis requiring further surgery.

There remains little doubt that if complete articular cartilage loss is the arthroscopic scenario; the logical further step is to perform some type of trapezium excision with interposition arthroplasty. Menon described a technique demonstrating arthroscopic debridement of the trapezial articular surface and interposition of autogenous tendon, fascia lata, or Gortex patch into the CMC joint in patients with stage II and III with excellent results [2]. I have demonstrated that this arthroscopic technique is even effective in patients with underlying severe ligamentous laxity, as in Ehrler-Danlos syndrome [33]. Newer techniques may allow the arthroscopic insertion of Artelon, which has proven successful with open techniques and confirmed histologically [30]. In either case, complete excision of the trapezium may not be desirable, particularly in younger patients. The stage III treatment needs to be further assessed by evaluating long-term clinical results.

According to the arthroscopic classification proposed, I recommend arthroscopic synovectomy and debridement of the basal joint in patients with stage I arthritis. In patients with stage II disease, synovectomy and debridement is combined with dorsoradial osteotomy of the first metacarpal. In both these stages, thermal shrinkage is used to manage ligamentous laxity. Finally, for stage III of the disease, arthroscopic interposition arthroplasty is my treatment of choice, although other factors must be considered in making this determination.

Arthroscopic assessment of the trapeziometacarpal joint allows direct visualization of all components of the joint including synovium, articular surfaces, ligaments, and the joint capsule. It also allows for the extent of joint pathology to be evaluated and staged with intraoperative management decisions making based on this information. I recommend this arthroscopic staging to ensure better judgment of this condition in order to provide the most adequate treatment option to patients who have this disabling condition.

Future studies assessing the clinical long-term results utilizing arthroscopy will likely ensure its place in the treatment armamentarium for trapeziometacarpal osteoarthritis.

STT Arthroscopy (Scaphotrapezial-Trapezoidal)

Arthroscopy of the STT joint was a natural offshoot to the thumb CMC joint since the former is frequently involved when advanced basal joint arthritis is present. While Cobb reported simultaneous arthroscopic management of both TM and STT joints [42], the role of arthroscopy for the STT joint is likely best suited for focal disease where a minimally invasive option is sought. Ashwood and Bain described simple arthroscopic debridement for isolated STT arthritis demonstrating 90 % good and excellent results in their small series [43]. Fontes also described simple resection of the distal pole of the scaphoid as a useful technique for painful STT arthrosis [44].

The technique is relatively simple since instability is not an issue and the goal is to increase the joint space and avoid painful impingement. The joint is localized by ascending the scaphoid from the radial midcarpal portal, followed by creating a working portal that can be volar [44] or more recently, a radial portal has been described by Carro et al. [45]. Simple debridement is done using a 2.0 mm full radius shaver and then limited resection of the distal pole of the scaphoid is performed using burr (Fig. 27.9). The joint space is markedly widened but one must be careful to not resect the critical volar ST ligaments, one advantage of this procedure as opposed to open techniques.

Minimal post-op immobilization is another surgical advantage of this methodology, and pain relief is generally excellent assuming patient selection was properly performed.

A long-term study is necessary to determine the late outcomes and secure the role of STT arthroscopy amongst the various techniques used for treatment of this common arthritic malady.

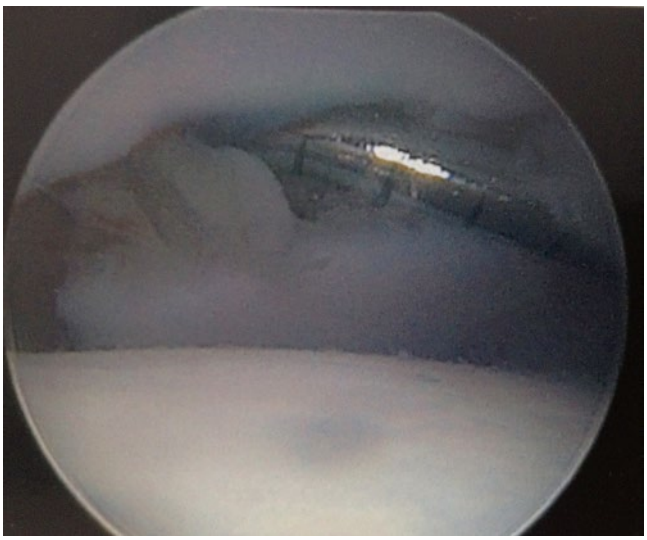

Fig. 27.9 Arthroscopic view of the thumb MCP joint illustrating how a hook probe can derotate an avulsed bony gamekeeper fragment, obviating the need for joint arthrotomy to reduce

Metacarpophalangeal Arthroscopy

While arthroscopy of the metacarpophalangeal joints of the hand was first described almost three decades ago, the clinical utility and indications remain poorly understood. Many orthopedic surgeons are unfamiliar with this possibility, hence unable to offer it to their patients as an option. Furthermore, hand surgeons rarely utilize this technology despite the fact that both acute injury and chronic pain are commonly found in the MCP joint, thumb, and digits alike. It seems that minimal exposure within the literature as well little hands on training has contributed to the underutilization of what is a very useful technique to manage certain pathology in the hand.

Dr. Chen first described arthroscopy of the metacarpophalangeal (MCP) joints, amongst other small joints of the hand as previously mentioned, in his 1979 paper in *Orthopedic Clinics of North America* representing a paradigm shift in arthroscopy indications [1]. Despite a cursory review, this paper first described the use of the Watanabe #24 arthroscope within the wrist, metacarpophalangeal joints, and even interphalangeal joints of the hand. Although he described both PIP and DIP joints being scoped, there was surprisingly no mention of the trapeziometacarpal joint. However, he did first introduce the concept of placing a small arthroscope into the metacarpophalangeal joint of several digits including the thumb. He went on to describe the anatomy followed by several clinical case reports where he described the arthroscopic findings and clinical utility. Overall, he described 90 arthroscopies performed in multiple joints encompassing 34 clinical cases as well as two cadaveric arms. Despite this broad introduction to small joint arthroscopy, the idea of MCP joint treatment was not truly developed until much later.

Ironically, it was sports medicine arthroscopists, Vaupel and Andrews, who first described a report using arthroscopic treatment of the metacarpophalangeal joint about 6 years after Chen's report [46]. They described a professional golfer who was severely limited due to a 1-year history of chronic painful synovitis within the thumb MCP joint. They performed a synovectomy and also an arthroscopic burring of a small chondral defect that had been identified at the time of procedure. The patient did so well that he was able to return to his sport within a 6-month period and was remained pain free at his 2-year follow-up. While this was a tremendous clinical advance, it was published in the *American Journal of Sports Medicine* where hand surgeons would likely not take note of this paper. Furthermore, despite an excellent outcome and a positive response to a new technique, no clinical indications were recommended for future usage and this remained an isolated case report until 2 years later when Wilkes presented the first clinical series of an MCP joint problem treated with arthroscopic means [47]. He reported on 13 cases of arthroscopic rheumatoid synovectomy in five patients suffering from advanced rheumatoid arthritis. While these patients lacked the usual joint subluxation or advanced destruction, they did have marked synovitis found in the joint space and within the recesses of the collateral ligament origins. Despite an adequate follow-up of nearly 4 years, the patients did demonstrate recurrence of pain and this treatment did not seem to alter the natural history of RA at the MCP joint. This series was also published in a low profile journal, the *Journal of the Medical Association of Georgia*, and therefore gave limited exposure to hand surgeons or even arthroscopic surgeons. A clinical paper exposed to hand surgeons was not seen until 1994 where it finally reached the *Journal of Hand Surgery—British Volume* in another case report [48]. The subject was a young male presenting with swelling and recalcitrant locking of the metacarpophalangeal joints of both index and middle fingers, bilaterally, and represents a typical presentation for hemochromatosis. Until then, the treatment of arthropathy was osteotomy and arthroplasty or even a joint arthrodesis for more advanced cases. Hemochromatosis is a rarely seen hematologic condition that is actually treated with phlebotomy and the joint manifestations are not well understood. Nevertheless, it was apparent to these surgeons that arthroscopy presented a superior alternative to open surgery with better visualization of the joint and subsequent treatment of the synovitis with faster recovery due to its minimally invasive approach. The focus, however, of the case report was on the disease itself and gave no further recommendations regarding arthroscopy besides stating that arthroscopic surgery is "of value." Since the arthroscopic treatment was downplayed by the

unusual pathology being treated, the common clinical application of this technology was not clearly apparent or yet elucidated.

In 1995, Ryu and Fagan presented a small series on the treatment of the ulnar collateral ligament Stener lesion arthroscopically, which represented the first time that we could see a common clinical application for this new minimally invasive approach [49]. They described an arthroscopic reduction of a Stener lesion in eight thumbs, with average follow-up period of just over 3 years, showing how simple reduction of the Stener lesion into the joint can place the avulsed ligament alongside its insertion site on the debrided base of the proximal phalanx. Prior to reduction, the ligament had been sitting outside the adductor aponeurosis and could therefore not heal in the necessary position. Once the reduction was performed, the ligament insertion site was aggressively debrided and the joint pinned to immobilize and allow healing. Upon removing the cast, a brief course of therapy was introduced and at follow-up no patient reported any pain or functional limitation. There was an excellent range of motion with strength parameters equal to or often greater than the thumb on the unaffected side. The only reported complication was an isolated simple pin tract infection. These results demonstrated that an all arthroscopic reduction of a Stener lesion obviated the need for open repair and subsequent complications such as prolonged recovery and stiffness. This was a clear clinical advantage and represented the first common clinical application that could encourage arthroscopic treatment of MCP joint pathology. Surprisingly, there was no mention of bony gamekeeper's lesions, and there was not a comparative study with the open method. Nevertheless, the primary triumph of this paper was that it was published in a widely read journal, first exposing hand surgeons to this minimally invasive technique and opening the door to other utilizations. In reality, this paper first introduced the concept of arthroscopic surgery in small joints to the greater hand surgery community. Nevertheless, despite the fact that this paper was published nearly 20 years ago, the technique remains minimally utilized and there have been few clinical series since then.

About 5 years later, in 1999, Rozmaryn and Wei presented the first broad paper on the technical aspects of metacarpophalangeal arthroscopy with elaboration on the possible indications and advantages of this still unknown technique [50]. They commented that there may be a misconception that the MCP joint is too small to perform any arthroscopic procedures in a useful or relevant manner. Although no clinical series was presented, they discussed the wider indications that might be addressed with this procedure. They discussed joint synovectomies and biopsies as previously mentioned and reaffirmed the concept of collateral ligament debridement while mentioning the possibility of ligament repair. They also introduced removal of loose bodies, treatment of osteochondral lesions, management of juxta-articular lesions, and treatment of intra-articular fractures and other possible clinical applications. They also noted that only a few case reports were present in the literature, and they surmised why this technique perhaps was not yet expanded upon. We must be cognizant, however, that this ample review was published in the journal *Arthroscopy: The Journal of Arthroscopic-Related Surgery*, and this would have created little exposure to dedicated hand surgeons, the clinicians most apt to utilize the technique. This report discussed some technical aspects and reviewed the anatomic landmarks for the first time since Dr. Chen's simplistic description with a rudimentary arthroscope nearly 20 years before. They stated that the advantages of arthroscopic versus open techniques were similar to those enjoyed in larger joints and that over time, more indications would emerge.

During the same year of Rozmaryn and Wei's technical paper, a broad review paper was published in *Hand Clinics* and entitled, "Arthroscopy of the Metacarpophalangeal Joint," by Slade and Gutow [51]. This represented the initial thorough analysis of the technique, including detailed technical explanations followed by some representative cases, including brief mention of minor complications and how to avoid them. However, the mantra "triumph of technology over reason" was also mentioned, suggesting arthroscopy of this small joint may not have been seen as practical or even useful. They explained that small joint arthroscopy required not only specialized instrumentation but also a working understanding of the anatomy within these joints. Their broad review soon revealed that there were a wide variety of indications that could greatly benefit from this technology. Detailed treatment techniques were described illustrated by case examples, particularly in the topic of intra-articular fracture treatment. A new method was also described where arthroscopy could be combined with small bone anchor application for reattachment of collateral ligament injuries. This may represent a difficult technique, but the authors clearly outlined the relative advantages of this method. In a discussion comparing arthroscopic synovectomies in rheumatoid patients with other joints treated in the same patient with open means, both surgeons and the patients alike clearly noted the decreased post-op swelling and the expedited rehab leading to faster return to activity. This represents a clear advantage of the arthroscopic technique as opposed to open means and in that same year, there was an obscure paper in the rheumatology literature that discussed the use of "mini-arthroscopy" of metacarpophalangeal joints in staging a synovitis and using this as an effective biopsy tool. The paper was written by rheumatologists in Germany and the paper focused on the scoring system of synovitis within rheumatoid patients with minimal elaboration of the operative technique [52]. They simply used this as a tool for assessing the degree of disease involvement

but again emphasized its clinical utility. The authors, non-surgeons, noted that micro-arthroscopy provided an objective technique for joint evaluation allowing visual guided synovial biopsy with improved accuracy and diminished the risk of any sampling errors. They performed this under local anesthesia, showing that general anesthesia was not necessary and, of course, could be done as an ambulatory procedure. Therefore, if the rheumatologists could see the great benefit of this technique, hand as well as arthroscopic surgeons could further develop its clinical application. In that same year Wei, who had coauthored the first technical description of metacarpophalangeal joint arthroscopy [50], presented an ample clinical series of arthroscopic synovectomies in rheumatoid arthritis describing 21 patients treated with arthroscopic synovectomy with good short-term results [52]. Although his intent was for this to be a technique article, he noted that the early results were promising and that this procedure would be useful in other types of arthritis or orthopedic maladies. He questioned the long-term outcomes and theorized what might be the ideal timing for this surgery in arthritic patients. This remains an unanswered question although Sekiya et al. elaborated on previous surgeons' descriptions by assessing 21 patients with rheumatoid arthritis in 27 proximal interphalangeal joints and 16 metacarpophalangeal joints. This represented the first clinical use of PIP joint arthroscopy and lent further support for metacarpophalangeal joint arthroscopic synovectomy [53]. He supported the concept that arthroscopic assessment of the joint surface and synovial lining was an optimal indication for arthroscopy including diagnostic biopsies under direct visualization. He also reasoned that arthroscopy for the small joints in the hands "will become a standard procedure in the near future." Their study did not assess other pathologies. Their study, also published in an arthroscopy journal, represents the last clinical series of arthroscopic surgery within the MCP joint. It is apparent that there is a paucity of clinical papers in the literature and that further discussion regarding the indications and clinical application of this tool is necessary in order to stimulate the hand surgeon to include this option in his realm of treatment possibilities. While the arthroscopic surgeon, typically known as a "sports medicine" specialist, may consider this option, it certainly remains for the hand surgeon to develop the clinical indications since we typically assess the more complex injuries, particularly the recalcitrant few. Therefore, it is up to hand surgeons to expand the applications of this still vastly underused methodology and this might include hand specialists who commonly do not perform wrist arthroscopy since the technique is much less daunting as later to be outlined. It is important to understand the indications and what role arthroscopy has in both detecting and treating these pathologies.

MCP Arthroscopy Indications

Traumatic and degenerative problems of the metacarpophalangeal joint are commonly encountered by hand specialists. Acute injury can involve any one of these joints and the thumb is the most commonly affected due to its relatively unprotected position. The Thumb MCP ulnar collateral ligament (UCL) tear is a frequently seen injury and is often erroneously termed "gamekeeper's thumb" when this should really be coined "skier's thumb" as the former refers more to a chronic attritional lesion. Acute trauma can also affect the finger MCPs with both ligamentous injuries and articular fractures presenting as a painful, swollen joint after injury. The term "overuse syndromes" may actually represent a previously occult acute injury that was not addressed or a chronic synovitis of unknown etiology. Plain X-rays will rarely shed light on chronic pain issues unless advanced degenerative disease or arthropathy is present, and imaging studies such as MRI are notoriously nonspecific in such small joints. Ultrasound presents a newer, more cost-effective modality that can determine if effusion is present, but not allow for anatomic diagnosis. Therefore, arthroscopy of the involved MCP joint will clarify the diagnosis, and also allow for potential treatment in a wide variety of indications of both thumb and digit MCP joints (Table 27.2).

Surgical indications to perform MCP arthroscopy will usually involve chronic conditions as opposed to acute injury since the latter can often be managed conservatively with appropriate immobilization. The thumb UCL avulsion is a common exception where open repair of a stener lesion is often required and simple immobilization may not suffice. In fact, an arthroscopic repair has been described in the literature as previously outlined [31]. With increasing familiarity of small joint arthroscopy, more acute indications may develop allowing accurate assessment of the precise injury and subsequent specific treatment.

Table 27.2 Indications for MCP arthroscopy

Acute	Chronic
Recent thumb ulnar collateral stener	Persistent MCP pain after trauma
Bony displaced gamekeeper's thumb	MCP OA—early/moderate grade
Septic MCP joint	Rheumatoid arthritis w/o ulnar drift
Articular die-punch fracture phalangeal base	Chronic synovitis

Fig. 27.10 External view of MCP arthroscopic treatment of an ulnar collateral bony avulsion where k-wire fixation will maintain reduction of the arthroscopically reduced fragment

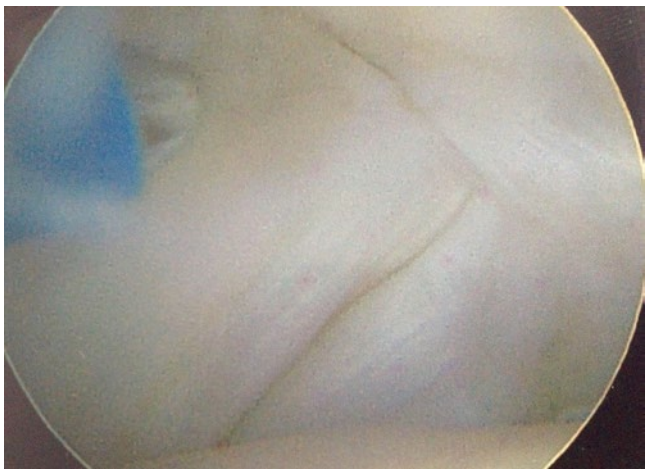

Fig. 27.11 Thermal shrinkage capsulorrhaphy in a chronically painful MCP joint stabilizes the capsule and collateral ligament minimizing the chance of recurrent painful synovitis. A period of post-op immobilization is necessary and dictated by the severity of the collateral ligament fraying

Acute indications generally involve an associated fracture that will need synovectomy, fracture debridement followed by articular reduction. This is likely true since the majority of ligamentous injuries will adequately heal with conservative immobilization, or are so severe that the resultant instability will lead to open management and repair. Perhaps the ideal acute indication for MCP arthroscopy is reduction of a collateral ligament avulsion fracture with a rotated fragment sitting within the joint. Once arthroscopic debridement at the fracture site has been performed, a small hook probe is used to simply derotate the bony fragment via arthroscopic visualization (Fig. 27.9). Kirschner wire fixation can then be performed with combination of arthroscopic control and fluoroscopic confirmation as published by this author [54] (Fig. 27.10). Additionally, another acute, albeit less common, indication would be a die-punch articular fracture, usually of the proximal phalanx base, where the scope can be used to control for the best articular reduction possible while facilitating the reduction itself. Besides a thorough synovectomy, the complete removal of any floating loose osteochondral fragments can be performed. This helps reduce the post-trauma inflammatory process in addition to reducing the fracture more anatomically. This arthroscopic method has the intrinsic advantage of a more exact articular reduction with the minimally invasive perk of limiting capsular adhesions, therefore faster recovery of an improved range of motion. Furthermore, like in any other arthroscopic acute indication, thorough assessment of associated soft tissue lesions can be performed and treated as needed. This may include MCP dislocations, where the acute capsule and ligamentous avulsions can be debrided after reduction, minimizing the scarring and expediting the healing process, even without actual soft tissue repair.

Chronic processes affecting the MCP joint, however, tend to be the most common indications for arthroscopy of these small joints. This is a welcome alternative since few options exist in a persistently painful "knuckle" joint. As discussed, most acute injuries heal with appropriate rehabilitation and/or immobilization with more severe trauma being managed by open repairs. Therefore, persistent pain and disability despite prolonged conservative treatment in both thumb and finger MCP trauma may represent the most common indication for MCP arthroscopy. It is not infrequent to encounter persistent symptoms after cast treatment for a skier's thumb or perhaps a border digit hyperabduction injury. This is likely due to a more severe ligamentous injury than originally assessed, or perhaps a concomitant articular cartilage injury associated with persistent synovitis. Oftentimes the contralateral ligament is injured as well and was not fully addressed at time of initial treatment. An arthroscopic evaluation, whether in acute or chronic setting of injury, can accurately determine the location and extent of injury and can lead to concomitant treatment, whether by simple debridement and/or thermal radiofrequency capsulorrhaphy (Fig. 27.11). Typically, these types of ongoing complaints are managed by a prolonged course of NSAIDs, therapy, or a number of cortisone injections. In the setting of more substantial pathology, these treatments only provide temporary relief, if any, and cannot be sustained indefinitely. Herein lies the optimal value of arthroscopic treatment, since it provides a relatively simple option to both make a definitive diagnosis and provide treatment based on these findings.

Persistent, occult pain, often associated with chronic swelling and stiffness, also represents a clear indication to offer arthroscopic evaluation as well. These symptoms may stem from an unrecognized injury, initial presentation of

osteoarthritis, or even an idiopathic synovitis that is occasionally seen and remains a diagnostic and even therapeutic dilemma Open synovectomy has been mostly indicated for rheumatoid indications, but until now, this has been the sole option for any patient presenting with a swollen, painful MCP joint that has failed conservative measures [55]. Steroid injections are frequently effective here, but can classically lead to acceleration of cartilage and capsular degeneration. These repeat injections to one joint must be recognized as a catabolic process and must be diminished. Arthroscopic debridement will avoid this complication and even possibly retard the degenerative and arthritic process. This benefit greatly outweighs the minimal complications that we might rarely see while the recovery is rapid.

Although not as common a location as other hand joints, degenerative arthritis of the MCP joints may represent a new frontier for arthroscopic assessment and treatment in managing this frustrating condition. The earliest stages of osteoarthritis are not clearly seen on plain radiographs and the diagnosis is often a clinical one. After adequate conservative treatment with NSAIDs and perhaps a course of therapy, the logical next step for treatment remains an intra-articular corticosteroid injection. If symptoms recur despite several injections, clinicians are often at a dead end since surgery is not usually offered to early stages of arthrosis or even younger patients. In this scenario, arthroscopic debridement becomes the best option short of joint replacement. Open arthrotomies with synovectomy are difficult due to limited visualization and poor access to certain regions of the joint. Furthermore, the approach itself can lead to marked post-op stiffness simply due to the arthrotomy itself. In rheumatoid disease, silicone arthroplasty remains the gold standard for MCP joints while post-traumatic arthrosis and osteoarthritis are not typically good indications for replacement arthroplasty [56]. Arthroscopy provides a minimally invasive alternative before offering arthroplasty, which in this indication would consist of the newer metallic or pyrocarbon non-constrained replacement options now available [57].

Inflammatory arthritides, such as rheumatoid arthritis, are typically managed with systemic pharmacotherapy, the newer disease modifying agents, and perhaps in later stages, replacement arthroplasty for MCP involvement. Rarely, a mono- or pauci-articular form is identified and a biopsy can be taken during arthroscopic rheumatoid synovectomy, confirming the diagnosis. Therefore, early stage involvement of these joints may warrant an arthroscopic synovectomy and capsular shrinkage as shown by Sekiya [53]. However, this approach is best suited when only a few joints are involved perhaps retarding the joint destruction and is impractical for severe, diffuse involvement. Furthermore, long-term results of arthroscopic rheumatoid synovectomy are necessary. Until more surgeons become adept at this technique, it will be difficult to collect sufficient data to justify its use in these advanced indications. Therefore, to break this vicious cycle, hand surgeons must learn this minimally invasive approach and begin to frequently apply it in the more ubiquitous pathologies.

MCP Arthroscopic Technique

Metacarpophalangeal arthroscopy demands use of an arthroscope 1.9 mm in diameter or less due to the narrow, relatively constrained anatomy of these small joints. A 1.9 mm 30° arthroscope as described by maxillofacial surgeons for temporomandibular (TMJ) pathology is utilized [58]. While newer arthroscopes are becoming available, even as small as 1 mm, the 1.9 scope should suffice for the described indications herein. The use of a 2.0 mm shaver is critical for synovectomy and most debridements, while small radiofrequency probes, including ablation and shrinkage applications, are often useful.

Small joint arthroscopy, including MCP joints, only requires local anesthesia and light IV sedation. The portal sites are both injected with minimal local anesthesia, followed by several cc's of lidocaine, or similar short acting agents, introduced into the joint once the hand is vertically suspended using a single Chinese fingertrap on the involved digit. Intravenous sedation may be needed only to control tourniquet discomfort depending on the planned time of procedure or patient/anesthesiologist preference. The use of lidocaine with epinephrine may even obviate the need for a tourniquet since these are typically short lasting procedures.

Once 3–4 kg (5–8 lbs) of traction is applied, the joint-line is typically palpable and more local might be introduced into the joint, typically with the 18 gauge needle in order to determine the locations site for the portals. Longitudinal portal small incisions (stab wounds) are made with a small scalpel in the site of visible capsular bulging. This orientation is used since the patients MCP joint is typically immobilized in flexion and the incision direction is orientated parallel to the plane of motion. It is crucial to introduce the trocar into the joint in atraumatic fashion since most indications are for otherwise pristine joints and one must minimize iatrogenic injury within the narrow interval. The space between metacarpal head and proximal phalanx base is very narrow and one should find the appropriate position and insertion angle by inserting a small curved clamp once the joint is adequately distended with lidocaine or lactated ringer's solution. The arthroscope is then inserted at this exact same angle and a thorough cursory joint examination is now performed. Portal anatomy is relatively simple as radial and ulnar portals lie on either side of the visible or palpable extensor tendon. Rarely, a third portal is for outflow, or better instrument direction, and is created by palpating the capsule, identifying area moving due to external pressure, and then inserting an 18

gauge needle to mark the area and possible portal site. A thorough synovectomy is usually performed at the outset, since this allows thorough inspection of the joint and to localize the pathology. As this is done with a small full radius shaver, the articular structures including capsule and collateral ligaments will soon be more apparent. A radiofrequency ablator probe can also make this ablation process more precise and rapid. It is important to use RF judiciously, as the joint capsule is relatively thin and subcutaneous, and thermal injury can result to either capsule or articular surface. Once synovectomy is underway, the surgeon can now begin to identify any pathology or anatomic variations and should be done in a reproducible systematic manner in order to avoid overlooking pathology. For example, one may begin on the radial collateral ligament, then assess the volar plate, look for sesamoids, then the ulnar collateral ligament and finally followed by dorsal capsule and extensor. The articular surface of both proximal phalanx and metacarpal head is then evaluated including the synovial recesses and the collateral ligament origins. Once specific pathology is identified and treated, the arthroscope is retired and portals are closed with benzoin and steri-strips only, obviating any stitches which is where dorsal hand scarring may result and can easily be avoided. Any pins utilized are cut underneath the skin and the thumb MCP is usually protected with a short arm thumb spica plaster intra-op splint in MCP extension and thumb palmar abduction/opposition. Conversely, arthroscopy of any of the digits will necessitate a dorsal metacarpophalangeal block splint, usually in full MCP flexion in order to allow the collateral ligaments to heal in their most taut position and to minimize any resultant loss in motion, usually flexion. The period of immobilization is determined by the type and extent of pathology found during the arthroscopic intervention and can be determined intraoperatively. Post-op therapy often plays a crucial role, although only after the appropriate period of immobilization.

MCP arthroscopy remains a vastly underutilized but very useful technique for both diagnosing and treating acute and chronic injuries afflicting that joint. While the indications expand amongst the few utilizers, the majority of hand surgeons would benefit from the minimal training needed to include this in their treatment armamentarium [59, 60].

Proximal Interphalangeal Arthroscopy

Arthroscopy of the Proximal interphalangeal (PIP) joints should still be viewed as an emerging procedure and very little has been written in the literature. Despite this, Chen's hallmark paper in *Orthopedic Clinics of North America* did present one clinical case and eight cadaveric studies utilizing small joint arthroscopy of the PIP joint [1]. The only clinical case was in a rheumatoid patient which foreshadowed future attempts since only RA has been studied as an indication in this rarely performed procedure.

The initial paper devoted solely to PIP joint arthroscopy was published by Thomsen et al. in a 2002 volume of the *Journal of Hand Surgery* [61]. They focused on anatomic findings, including portal anatomy, in eight cadaveric PIP joints followed by two clinical cases. The only firm conclusion was that the technique was possible, although technically demanding and limited by instrumentation, and that indications needed to be delineated while commenting that synovitis, infection, and loose body excision would be the main indications. In this early clinical description, one of the patients was rheumatoid while the other was a removal of a loose body coupled with synovectomy.

In the same year, Sekiya and his group presented a thorough analysis of both MCP and PIP arthroscopy in 21 rheumatoid patients as previously mentioned in the MCP arthroscopy discussion [53]. Twenty-seven PIP joints and 16 MCP joints underwent rheumatoid synovectomy although most reportedly had only "joint irrigation." They determined it was a promising procedure allowing biopsies and concluding that synovectomies led to early clinical improvement. There was no mention of the results longevity but it was felt that small joint arthroscopy, including PIP, could become a standard procedure in the future. They did warn that technique was very limited, both by joint configuration/morphology and largely by the equipment utilized. The rigidity and relative size of the arthroscope would not permit exploration of the volar half of the middle phalanx base and even the proximal phalangeal condyles could only be seen by significant flexion of the joint. Therefore, this is the only hand joint where vertical traction is not utilized and the finger is held horizontally while the small scope is introduced in the interval between central slip and lateral band in his modified portal from Thomsen's description. While this study focused on rheumatoid disease we must recall that the PIP joint is more commonly involved in routine osteoarthritis. No clinical study reviewing this very common pathology has been published. It should also be noted that this work was published in the journal *Arthroscopy* where, again, few hand surgeons might see a technique reviewed that likely only they would utilize. This can now be seen as a recurring theme that perhaps has slowed the advent of small joint arthroscopy of the hand.

Sekiya did publish a follow-up study, now in a hand techniques journal, where he expanded modestly upon his experience in RA PIP arthroscopy but did now conclude that the results tend to be long lasting, and that no patients had required reoperation, a notable finding [62]. His follow-up study also included one thumb interphalangeal joint, perhaps the first clinical mention of arthroscopy in a distal interphalangeal joint (DIP). Actually, the true DIP joint of a digit was first scoped in order to realize an arthroscopic-assisted

arthrodesis as described by Cobb in his chapter on "Frontiers in Small Joint Arthroscopy" with coauthors, Berner, Badia, and Topper in 2011 Hand Clinics [60]. The topic of DIP arthroscopy is so novel and currently limited that it warrants no further discussion. Suffice it to say that when microarthroscopes, in range of 1–1.2 mm, become widely available in the future, we may then see indications develop for this innovative approach. Arthroscopic debridement for early OA, truncation of mucous cysts with evacuation, and synovectomy may all be routine procedures in future as the technology emerges.

Indications do remain narrow for PIP arthroscopy largely due to the relative large size and rigidity of the scope in this bicondylar joint, which is anything but a flat surface. Although similar to the knee in bony architecture, the small size of the joint does not permit the same visualization at the current time.

Therefore, the technique remains limited to dorsal compartment synovectomy, mainly in rheumatoid, and perhaps larger osteoarthritic patients. Removal of loose bodies, infection lavage, and now joint arthrodesis might be possible as well. Joint debridement and synovectomy should be performed solely with mechanical shaving since the joint is subcutaneous where application of RF (radiofrequency) could be problematic.

PIP Arthroscopic Technique

The anatomic nuances of the PIP joint necessitate that this arthroscopy be performed horizontally, allowing free motion of the digit during the scope permitting visualization of most elements of the joint, although the entire volar compartment is essentially inaccessible. Traction in a vertical position would hamper that visualization and would not permit joint flexion.

The PIP joint should be insufflated with 1–2 cc of lidocaine once adequate digital block anesthesia is achieved. This joint distention is performed dorsally allowing the dorsal recesses to become prominent and facilitate 1.9, or perhaps 1.5 mm, arthroscope insertion. The portals are simply on either side of the central slip, easily found between that key landmark and the lateral bands. In his initial paper, Sekiya described a more volar and lateral portal, essentially traversing the transverse retinacular ligament, about 1–2 mm dorsal to the mid-axial line [53]. It must again be emphasized that the palmar aspect of the joint is not visualized sufficiently which happens to be the predominant location for synovitis at the PIP joint, in addition to the dorsal recess, currently amenable to excision. This technical issue could be overcome if perhaps flexible micro-arthroscopes can pass over and around the proximal phalangeal condyles, hence providing more visualization. The procedure would also require smaller shavers that can also follow the contours of the joint. An additional problem is that inadequate suction power currently limits the efficacy of shavers this small in diameter. Even today's 2 mm suction shavers are somewhat limited when trying to aggressively debride and aspirate a dense amount of scarred capsule. Therefore, there are currently both optical and mechanical limitations in technically being able to realize an optimal PIP joint arthroscopic procedure. Once these issues are resolved, the indications should quickly expand although it may be some decades before this becomes an everyday procedure for the hand surgeon.

CMC Arthroscopy of Ulnar Digits

The fourth and fifth carpometacarpal joints are also amenable to arthroscopic intervention due the flexible nature of these joints. Pathology, however, is relatively rare here and the indication is primarily for traumatic related condition. It is relatively common to have post-traumatic issues at this joint, either arthrosis and/or synovitis, that would benefit from synovectomy and debridement [60]. Articular fractures of either the hamate or corresponding metacarpal base often lead to later degenerative changes that can cause pain. Insertion of a 1.9 mm arthroscope and concomitant debridement with a shaver and/or RF probe (Fig. 27.12) can provide good pain relief and perhaps avoid fusion of the CMC joint which is currently a necessary procedure in cases of post-traumatic arthrosis not responding to conservative treatment such as corticosteroid injection. The fusion itself might be able to be done arthroscopically as currently seen in limited carpal fusions by colleagues such as Ho [63].

Fig. 27.12 Arthroscopic debridement of the fifth CMC joint in patient with persistent pain after an articular fracture of the small finger metacarpal base

Conclusion

Small joint arthroscopy of the hand is currently limited by a combination of technical considerations that are improving continuously, and a lack of clear indications and surgeon utilization likely due to scarce arthroscopy training and scant literature on the topic. The latter reason is self-imposed, and hand surgery organizations must provide more opportunities for "hands-on" training in the usage of the small arthroscope to emerging surgeons who might not be exposed to this in their fellowship training. EWAS (European Wrist Arthroscopy Association) has made major strides in training hand surgeons to push the envelope when it comes to wrist arthroscopic procedures even publishing entire textbooks covering a single indication for its usage [64]. There have been some courses (AANA, Miami, Strasbourg) that have covered the topic to some degree, largely in the area of the thumb basal joint, enabling colleagues to now consider this as a viable alternative for treatment in their patients. Much more needs to be done to expose surgeons to all the small joint procedures possible in the hand, ultimately to benefit their patients who are increasingly looking towards minimally invasive options.

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Queries	Details Required	Author's Response
AU1	Please check whether affiliation and correspondence details are okay.	
AU2	There is a mixed usage of "K-wire" in the chapter. Please check and make consistent if appropriate.	
AU3	Please check the phrase "…easier approach the other quadrants" for clarity	
AU4	"CO^{2}" has been changed to "CO_2" in the sentence "This material degraded...." Please check if appropriate.	
AU5	Should "hematomaplasty" be "hematoma plasty"? Please check.	
AU6	Please check whether edits made to journal title and volume number in references are okay.	
AU7	Please check reference [43] and amend accordingly.	