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Hand Clin 22 (2006) 153–163

HAND
CLINICS

Trapeziometacarpal Arthroscopy: A Classification and Treatment Algorithm

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Osteoarthritis of the thumb trapeziometacarpal joint is a common clinical problem as well as a perplexing challenge, because of a myriad of treatment options. The fact that so many different surgical options exist for this condition attests to the fact that none of them has an optimal success rate. Or perhaps it may be that the majority of treatment options work to the satisfaction of the surgeon; hence the clinician continues to use his favorite technique, despite the fact that it may not be the most appropriate method for a particular stage of disease. One thing is indisputable: basal joint osteoarthritis of the thumb has many different clinical presentations, and one technique cannot be used for all of the different stages and all patients' individual needs. When conservative treatment has been exhausted, there are a wide range of surgical options to choose from. Treatment should be tailored to the individual patient.

The early stages of basal joint osteoarthritis are most commonly seen in middle-aged women. The literature discusses this in many instances, but rarely gives a solution to the management of these frequently active patients. The use of anti-inflammatories, splinting, and corticosteroid injections serve only as palliative measures, with none of them altering joint mechanics or affecting the articular surface itself in any manner. Moreover, the use of injectable steroids can accelerate cartilage loss and worsen capsular attenuation. Only the mildest cases of transient synovitis will escape the inevitable progressive loss of cartilage, and hence the need for surgical treatment if the patient indeed wants a definitive solution. After the relatively unimportant distal interphalangeal joint, the thumb carpometacarpal (CMC) joint remains the most common location for osteoarthritis in the hand. It is also the most critical for hand function. The argument has been made that man's evolution has been largely due to the increased range of motion and function as a consequence of the thumb basal joint, which has led to the progressive use of tools in hominid evolution. Treatment of this functionally important joint remains a priority for the hand surgeon, and it is important to use the wide variety of surgical techniques to optimally manage this condition.

Classically, the basal joint has been treated by surgical means only when conservative options have been exhausted. The principal option has been, and remains, some type of open resectional arthroplasty. Although the literature demonstrates good results in many different studies and using a variety of techniques, it remains clear that this is a surgically aggressive procedure, because resection of an entire carpal bone is required to achieve pain relief. This certainly makes good sense in the most advanced cases in which the trapezium is typically flattened or has severe deformity including marginal osteophytes, but earlier stages demand 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, as in any other joint in the body, has the added risk of failure of the implant, whether it be silicone or of metallic and plastic components. This is not

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doi:10.1016/j.hcl.2006.02.006

a good option for the younger, high-demand patients.

History

The advent of small-joint arthroscopic technology has allowed us to apply the concept of minimally invasive surgery to smaller joints, including the wrist, ankle, and now the smaller joints of the hand. Yung-Cheng Chen's classic paper in 1979 [1] on arthroscopy of the wrist and finger joints discussed the feasibility of performing small-joint arthroscopic procedures using the Watanabe No. 24 arthroscope as early as 1970; however, within that paper there was no mention of arthroscopy of the thumb trapeziometacarpal joint, despite the fact that this may be the arthroscope's greatest application. In Chen's paper there was a detailed description of arthroscopy of the wrist, metacarpophalangeal joints, and even the small interphalangeal joints. Nevertheless, the common applicability of this technology to such a ubiquitous clinical scenario may be its greatest contribution [1].

The first clinical paper in the literature on basal joint arthroscopy was written by J. Menon in the *Journal of Arthroscopic and Related Surgery* in 1996 [2]. This paper, "Arthroscopic Management of Trapeziometacarpal Joint Arthritis of the Thumb," described arthroscopic partial resection of trapezium as well as an interpositional arthroplasty using either autogenous tendon graft, Gore-Tex, or fascia lata allograft as interposed substances. In Menon's paper, it was obvious that the patients had a more advanced stage of arthritis, although his own clinical stages discussed the addition of metacarpal base subluxation as criteria for the stages, and he limited the indications to less than Stage IV disease. In his classification, this correlates to metacarpal base subluxation greater than one third of its diameter and adduction contracture. No mention was made as to whether very early stages of basal joint arthritis were treated with this innovative technique. In fact, the author's hope is to demonstrate that the utility of arthroscopy may be greatest in the earlier stages. The goal of Dr. Menon's groundbreaking technique was to avoid destabilizing the basal joint by avoiding an open arthrotomy to perform hemitrapeziectomy, which had already been described as an open procedure, and interposing the material with the assistance of an arthroscope. Three quarters of the patients had complete pain relief in Menon's series of 25 patients [2]. The results were comparable to the open technique, but he described several advantages with this minimally invasive technique. For one, it is simply less invasive, and hence has implicit advantages, such as a lesser chance of injuring the radial sensory nerve and decreasing postoperative pain. The less obvious advantage, however, is that arthroscopy of the trapeziometacarpal joint can allow detection of any articular changes long before they would be noted through routine radiographs. This simple fact enables us to treat basal joint osteoarthritis in much earlier stages, and the clinical indication for surgery could simply be pain, not the stage of radiographic disease. This presents a great advantage and allows us to use the arthroscope as a tool for treating younger and more active patients who are in the earliest stages of basal joint arthritis.

One year later in 1997, Richard Berger from the Mayo Clinic in Minnesota presented his experience with thumb CMC joint arthroscopy as a technique paper in the *Journal of Hand Surgery* [3]. Berger felt that small-joint arthroscopic technology presented several advantages over a standard open arthrotomy when joint visualization would be difficult because of the depth of the joint, and opined that one could avoid disruption of the critical ligamentous structures that he so aptly described. After his clear description, he briefly mentioned 12 arthroscopic procedures that he had performed since 1994 with a variety of clinical scenarios, including acute Bennett fractures of the thumb. Berger noted that there was excellent visualization and no complications with this procedure. At that time, the indications for first CMC joint arthroscopy were not clearly defined, but he noted that it was obviously an excellent alternative to arthrotomy for visualizing the anatomy [3]. This paper followed an instructional lecture and demonstration that Berger had performed at the Orthopaedic Learning Center (Rosemont, Illinois) during the wrist arthroscopy course, which the author had the pleasure of attending. Despite its infancy, it was obvious to me at that time that basal joint arthroscopy would have a wide range of application and clinical utility for this common condition. Soon after Berger's landmark paper was published, J. Menon presented a letter to the editor indicating the fact that he had actually published the clinical use of arthroscopy in the basal joint in a previous paper [4]. In Dr. Berger's reply [5], he noted that his technique was developed independently because it was presented as an instructional course in 1995, and the common delay in publication led to this overlap with Dr. Menon's publication. It is clear that both of these authors have made an invaluable contribution to our treatment armamentarium for the basal joint. Further clinical utility was validated in the paper by Osterman and Culp presented in *Arthroscopy* in 1997 [6], in which they defined two groups of patients—traumatic and degenerative—who would benefit from the use of this imaging technology. They, too, felt it had a promising place in the treatment of both acute and chronic conditions of the thumb CMC joint. They were the first to mention that arthroscopy may allow for appropriate staging of the degree of trapezial involvement and may have particular application in the younger patient.

Hence, it is obvious that arthroscopy of the thumb CMC joint allows us to appropriately stage the extent of cartilage degeneration and subsequently determine therapeutic options. The author maintains that the arthroscope can be used not only for treatment of earlier stages but also in advanced stages, as J. Menon so well described [2].

The goals of this article are to describe an arthroscopic classification of the thumb CMC joint and to present a treatment algorithm based upon this staging system. Whether the clinician decides to use arthroscopy definitively for treatment remains an option. Before we expand on the disease staging that arthroscopy allows, we must better understand the ligamentous anatomy and its functional significance as related to biomechanics; however, there can be no argument that the arthroscope gives us the true extent of basal joint disease for the first time.

Functional anatomy

Arthroscopy of the thumb CMC joint has little relevance if the treating surgeon does not understand the ligamentous anatomy. This has been described extensively through cadaver dissections, and over time we will be able to better correlate these open landmarks with the arthroscopic findings. The pioneering description of the trapeziometacarpal ligaments dates way back to 1742, when Weitbrecht described these ligaments in a rudimentary fashion in his book *Syndesmology* [7], reprinted in 1969. Since then, a variety of authors have further described the details of this anatomy, with the most detailed work coming from Bettinger and colleagues at the Mayo Clinic in their 1999 paper [8]. They described a total of 16 ligaments, including ligaments between the metacarpal and trapezium, as well as two ligaments attaching the trapezium to the second metacarpal, and separate stabilizers for the scaphotrapezial and trapezoidal joints. It was their conclusion that this complex of ligaments function as tension bands to prevent instability from cantilever bending forces placed upon the trapezium by the act of pinch [8]. This was a critical concept, because extremely large loads are transferred to the trapezium, and there is no fixed base of support because the scaphoid is an extremely mobile carpal bone. It is the attenuation and pathologic function of these ligaments that may indeed lead to the common scenario of basal joint arthritis. Based upon improved ligamentous understanding, Van Brenk and coworkers [9] suggested that the dorsoradial collateral ligament was in fact the most important ligament in the prevention of trapeziometacarpal subluxation. This was determined by a cadaveric study in which serial sectioning of four separate ligaments determined that the radial collateral ligament (RCL) was the most critical in preventing dorsoradial subluxation [9]. Zancolli and Cozzi, in their landmark *Atlas of Surgical Anatomy of the Hand* [10], supported this concept, but also added the controversial premise that aberrant slips of the abductor pollicis longus (APL) may cause an excessive compressive force of the dorsoradial aspect of trapeziometacarpal (TMC) joint, leading to arthrosis [10]. They felt that the underlying ligamentous laxity may be caused by underlying variations in an individual person's ligamentous laxity, or by a hormonal predisposition that may explain the increased incidence in the female gender. These theories lead to a greater understanding of the causes of basal joint arthritis, and in the future arthroscopic visualization may lend further credence to these theories. Xu and coworkers [11] indicated that the trapeziometacarpal joint is smaller and less congruous in women, and may also have a thinner layer of hyaline cartilage, suggesting that this is a cause for the higher incidence of basal joint osteoarthritis in women. This is the author's experience as well, and suggests that the greatest applicability of arthroscopy may be in younger women who present who have this disease at a much earlier age, and, for whom fewer surgical treatment options exist.

In 1979 in *Hand Clinics,* Pellegrini [12] continued to affirm the biomechanical role that the volar beak ligament plays in preventing dorsal translation of the metacarpal during common functional activities. This ligament and the dorsoradial ligament (DRL), are clearly visualized via arthroscopy, and direct intervention is now feasible. Pellegrini's hypothesis is that there are attritional changes in the beak ligament at the metacarpal insertion site, and that this insertion zone may be particularly sensitive to estrogen-type compounds [12]. This lends further support to the genetic predisposition of this condition. Arthroscopically, the author has also noted particular cartilage loss at the insertion of the volar beak ligament on the deep metacarpal base in the early stages, when the remainder of the hyaline cartilage appears normal. Many of these anatomic, clinical, and biomechanical concepts have been further defined by Bettinger and Berger in their work on the functional ligamentous anatomy of this joint [13]. They did note that the arthroscopic anatomy is much less complicated because only a limited number of structures are able to be seen from the interior perspective. For the first time, they outlined which of the two common portals would lead to clear visualization of what corresponding ligaments [13]. Although they discussed optimal viewing, the reader should note that the small size of this joint allows one to visualize the majority of the surface simply by a change in the viewing direction and the angulation that the arthroscope is held in. Recently other authors have described new portals to help further define the topographic anatomy of this joint. Orellana and Chow [14] described a radial portal that they found was safer because of its proximity to the radial artery and branch of the superficial radial nerve. For this reason, Walsh and colleagues [15] also described another portal, the thenar portal, which was much more volar, actually passing through the thenar muscles to allow for improved triangulation and visualization of the joint via a presumably safer location. These newer portals confirm that thumb CMC arthroscopic surgery is in a state of evolution, and hopefully will allow us to better understand arthritis at this level. A further advantage of this portal is that it does not violate the deep, anterior oblique ligament, which Walsh and colleagues, like Bettinger and Berger [13], feel serves as the major restraining structure against dorsal subluxation. This is in contrast to the biomechanical studies performed by Van Brenk and colleagues [9]. Again, careful documentation of these structures over time may allow arthroscopy to further elucidate the cause of dorsal subluxation as a factor in basal joint arthritis.

Culp and Rekant [16] were the first clinicians to suggest that arthroscopic evaluation, debridement, and synovectomy "offer an exciting alternative for patients who have Eaton and Littler Stages I and II arthritis." They described radiofrequency "painting" of the capsule of the TMC joint to stabilize the critical volar ligaments that may cause dorsal subluxation, and hence arthrosis of the basal joint. They also mention that if the majority of the trapezial surface is abnormal, then at least one-half of the distal trapezium should be resected with an arthroscopic burr [16]. This indicates that a more advanced stage of arthrosis is present, and does not necessarily support its use in the early stages. In fact, their short-term results described in this paper followed arthroscopic hemi- or complete trapeziectomy coupled with electrothermal shrinkage. They had nearly 90% excellent or good outcome in 22 patients with a moderate follow-up. They did make the critical point that no bridges had been burned, because patients who have the arthroscopic procedure can always serve as suitable future candidates for more aggressive complete excisional trapezial arthroplasty by open means. They concluded that debridement and thermal capsular shrinkage is a potentially good treatment for early arthritis of the basal joint [16]. These multiple papers describing the arthroscopic findings make it clear that a more comprehensive staging system is necessary to dictate treatment. All of the clinical results in the studies to date have focused upon more advanced osteoarthritis, and all have discussed the results after an arthroscopic-assisted hemitrapeziectomy. It is perhaps in the patient whose trapezium is largely spared that arthroscopy may find its greatest utility. The author therefore proposes a novel classification to be described herein.

Indications for basal joint arthroscopy

In the author's practice, the vast majority of patients who have the diagnosis of thumb basal joint arthritis who did not improve after conservative treatment underwent arthroscopy for further evaluation of the joint status and surgical treatment during the past 10 years. The disease was staged radiographically according to Eaton's criteria (Table 1) [17]. The notable exceptions were in patients who had advanced Eaton Stage IV arthritis, who then underwent a trapezial excisional suspensionplasty using a slip of abductor pollicus longus. Stage IV patients who had only mild scapho-trapezio-trapezoidal joint (STT) changes were still treated via arthroscopy. Another exception occurred in much older, low-demand patients

Table 1
Proposed Badia arthroscopic classification of thumb trapeziometacarpal osteoarthritis

Stage	Arthroscopic changes
I	Intact articular cartilage Disruption of the dorsoradial ligament and diffuse synovial hypertrophy Inconsistent attenuation of the anterior oblique ligament (AOL)
II	Frank eburnation of the articular cartilage on the ulnar third of the base of first metacarpal and central third of the distal surface of the trapezium Disruption of the dorsoradial ligament + more intense synovial hypertrophy Constant attenuation of the AOL
III	Widespread, full-thickness cartilage loss with or without a peripheral rim on both articular surfaces Less severe synovitis Frayed volar ligaments with laxity

who did well using a cemented total joint arthroplasty, because this required almost no immobilization and minimal therapy. Many of these patients displayed an adduction contracture, and the open arthroplasty permitted an adductor release and a metacarpophalangeal (MCP) joint volar capsulodesis was often needed in cases of severe swan-neck deformity. The last exception was the rare young, male laborer who underwent a TMC joint arthrodesis. This indication has been well-substantiated in the literature [18].

Surgical technique

The arthroscopic procedure is performed under regional anesthesia with tourniquet control. A single Chinese finger trap is used on the thumb with 5 to 8 lbs of longitudinal traction. A shoulder holder, rather than traction tower, is used to more easily facilitate fluoroscopic intervention. The TMC joint is then detected by palpation. The incision for the 1-R (radial) portal, which is used for proper assessment of the DRL, posterior oblique ligament (POL) and ulnar collateral ligament (UCL), is placed just radial to the APL tendon. The incision for the 1-U (ulnar) portal, which allows better evaluation of the anterior oblique ligament (AOL) and UCL, is made just ulnar to the extensor pollicis longus (EPL) tendon. Joint distension is achieved by injecting 2 to 5 mL of normal saline. A short-barrel, 1.9 mm, 30° inclination arthroscope is used for complete visualization of the TMC joint surfaces, capsule, and ligaments, and then appropriate management is performed as dictated by the pathology found. A full-radius mechanical shaver with suction is used in all cases, particularly for initial debridement and visualization. Many cases are augmented with radiofrequency ablation to perform a more thorough synovectomy. This technology and clinical applications are later expanded upon. Radiofrequency is also used to perform chondroplasty in cases with focal articular cartilage wear or fibrillation. Ligamentous laxity and capsular attenuation are treated with thermal capsulorraphy, also using a radiofrequency shrinkage probe. The author and colleagues are careful to avoid thermal necrosis, and therefore a striping technique is used to tighten the capsule of lax joints. Although the use of radiofrequency is relatively new, we can gain further understanding by prior basic science studies and the clinical application in other joints.

Radiofrequency effects on collagen

Orthopedic surgeons have benefited from the use of radiofrequency in a variety of procedures during the past decade. It is only now that we are realizing that there may be some detrimental effects, and it is important to look at this technology more critically. Nevertheless, as with any new technique, judicious use of this technology may allow for stabilization of the joint capsule in a variety of clinical scenarios. Shoulder instability has been treated by a variety of authors using radiofrequency to stabilize the joint, particularly in those patients who have global instability and who classically have not been considered good operative candidates. It has also been used extensively in the knee, but there has been minimal mention in the literature of its application in the joints of the hand. Obviously this is coupled with the fact that reports on arthroscopy of the TMC joint and the MCP joint have been scant in the literature.

Radiofrequency has had many medical applications since its initial use in the 1800s for creating lesions in brain tissue. It has also been used in cardiology, oncology, and colorectal surgery. Lopez and colleagues [19] first demonstrated the effect of radiofrequency energy on the ultrastructure of joint capsular collagen in a histologic study thus titled. They noted that similar applications had been used with a nonablative laser energy in orthopedics, but that radiofrequency offered several advantages over the use of a laser. Not only is it less expensive and safer, but these units are much smaller and easily maneuverable in their application to arthroscopic techniques. Initial studies on a sheep joint indicated that the thermal effect was characterized by the fusion of collagen fibers without tissue ablation, charring, or even crater formation. There was a linear relationship between the degree of collagen fiber fusion and increasing treatment temperature. This indicates that the technology must be treated with respect with avoidance of aggressive use. It was postulated that the coagulated tissue mediates a mild inflammatory reaction that leads to the degradation and replacement of the affected capsule with a denser tissue [19]. This would obviously help to stabilize the joint, and thus would have particular application in the TMC joint based upon previous discussions in this article. In a later study, Hecht and coworkers [20] also looked specifically at the monopolar radiofrequency energy on the joint capsular properties. They concluded that monopolar radiofrequency caused increased capsular damage in the immediate area and depth that correlated with the wattage used. The heat production increased linearly with the duration of application. The arthroscopic lavage could protect the synovial layer from permanent damage as seen in sheep [20]. These findings suggest that radiofrequency probes must be used with adequate fluid lavage as well as for short durations, and with the minimal wattage necessary to achieve the desired effect. The author refers specifically to monopolar radiofrequency because it is a common understanding amongst orthopedic surgeons that monopolar radiofrequency causes less heat production than bipolar modalities. This is particularly important to the hand surgeon, because there are close neurovascular structures directly overlying the joint capsule in the small joints as compared with the knee or shoulder. Further understanding may be gleaned in the future if a direct clinical comparison can be made with monopolar versus bipolar radiofrequency treatments in the small joints.

Arthroscopic staging

Arthroscopic Stage I patients are characterized by diffuse synovitis, but with minimal, if any, articular cartilage loss (Fig. 1). Ligamentous laxity, particularly the entire volar capsule, is a frequent finding. This presentation is relatively uncommon, because most patients present late, having suffered with symptoms for a long period; or are referred at a delayed time once conservative means have been exhausted. These patients undergo synovectomy, both mechanical and by radiofrequency, with occasional shrinkage capsulorraphy performed, depending on findings. The joint is then protected in a thumb spica cast from 1 to 4 weeks, depending on the extent of capsular laxity. More unstable joints required longer immobilization to achieve joint stability and presumably slow the progression of articular cartilage degeneration.

Fig. 1. Arthroscopic Stage I findings demonstrate synovitis around the volar oblique ligament, with intact articular cartilage on the trapezium.

Arthroscopic Stage II patients are characterized by focal wear of the articular surface on the central to dorsal aspect of the trapezium. In the author's mind, this represents an irreversible process, and requires a joint-modifying procedure to alter the vector force across the joint. After synovectomy, debridement, and occasional loose body removal, the joint is reassessed to determine the extent of instability and capsular attenuation (Fig. 2). A shrinkage thermal capsulorraphy is performed in many of the cases, with chondroplasty frequently performed to anneal the cartilage borders (Fig. 3). The arthroscope is then removed and the ulnar portal extended distally to expose the metacarpal base. A dorsoradial closing wedge osteotomy, similar to Wilson's original technique [21], is then performed to place the thumb in a more extended and abducted position. This is to minimize the tendency for metacarpal subluxation and to change the contact points of worn articular cartilage. The osteotomy is protected by a single oblique Kirschner wire that is also placed across the first CMC joint in a reduced position.

This allows for healing of the osteotomy in the correct position, and also a correction of the

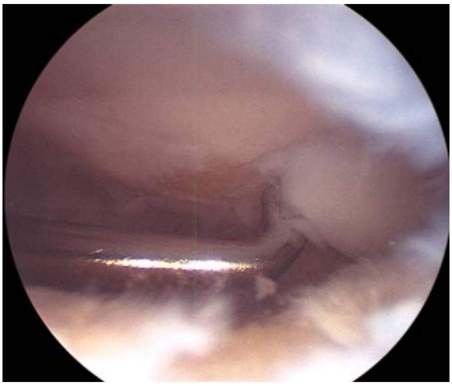

Fig. 2. Arthroscopic Stage II typical findings include small area of articular cartilage loss on deep aspect of metacarpal at insertion of volar beak ligament and central, focal loss of trapezial joint surface. This stage often demonstrates loose bodies as seen here during extrication.

metacarpal subluxation often seen in this stage. A thumb spica cast protects this during healing, and the wire is removed at 5 weeks postoperative. Only arthroscopy can determine the optimal indications for this osteotomy, which has demonstrated good results in the past, and in a more recent paper by Tomaino [22]. Late follow up on the author's patients has demonstrated that the metacarpal remains "centralized," and it is unclear if the capsular shrinkage plays a role versus the alteration of biomechanics by the use of osteotomy (Figs. 4 and 5).

Arthroscopic Stage III is characterized by much more diffuse trapezial articular cartilage

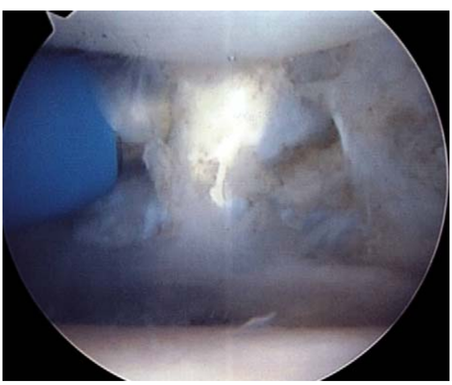

Fig. 3. Shrinkage capsulorraphy being performed on deep aspect of capsule noted to be attenuated because of chronic deposition of corticosteroid.

Fig. 4. Preoperative radiograph in middle-aged woman demonstrating metacarpal base subluxation free of osteophytes. Arthroscopy demonstrated focal trapezial wear indicative of Badia arthroscopic Stage II arthritis. Patient indicated for osteotomy of metacarpal base.

loss (Fig. 6). The metacarpal base can also be devoid of cartilage to varying degrees. Arthroscopic findings indicate that this is not a joint worth preserving, and a simple debridement or even accompanying osteotomy will not give a good long-term

Fig. 5. One-year postoperative radiograph after metacarpal osteotomy (and pin removal) demonstrating the persistent "centralization" of the metacarpal on the trapezium. This changes the joint contact points that may have led to progression of arthrosis and pain.

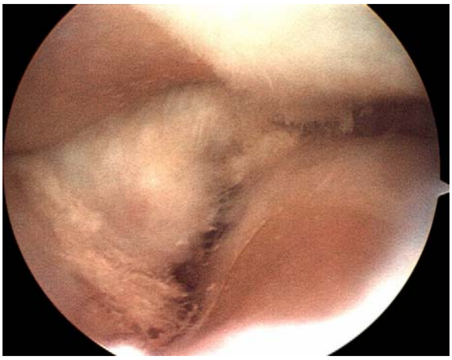

Fig. 6. Arthroscopic Stage III findings include diffuse articular cartilage loss on both trapezium and metacarpal base. Chronic inflammation leads to capsular fraying evident here.

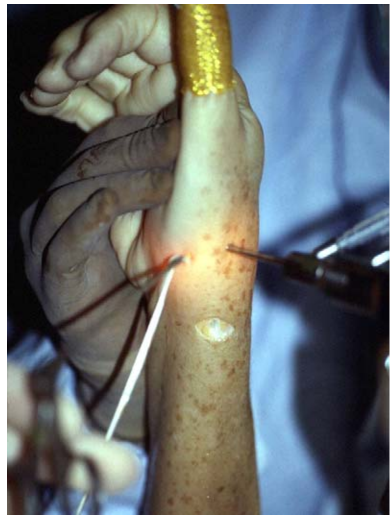

Fig. 7. External view of thumb base denoting the traction method and ulnar portal placement of the arthroscope with APL tendon slip insertion via the radial portal.

result in this case. An arthroscopic hemitrapeziectomy is then performed by burring away the remaining articular cartilage and also removing subchondral bone down to a bleeding surface. This serves to not only increase the joint space, but to allow for bleeding that will form an organized thrombus, which will adhere to an interposed tendon graft. This graft, either palmaris longus or the volar slip of APL, is inserted via a portal, similar to the technique as proposed by Menon [2] (Fig. 7). A thumb spica cast in an abducted position is then maintained for 4 weeks, followed by hand therapy to focus on pinch strengthening. Stage III can also be treated by a traditional open excisional arthroplasty [23–26], arthrodesis [18], or total joint replacement [27], depending on surgeon preference.

Arthroscopic/radiographic correlation

The most consistent arthroscopic findings in the group of patients who display radiographic changes compatible with Stage I of the disease include 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 (see Fig. 1). A less reliable discovery is attenuation of the POL.

Regular arthroscopic findings noted in patients classified as having Stage II arthritis include frank eburnation of the articular cartilage of the ulnar third of the metacarpal base and central third of the distal surface of the trapezium, disruption of the DRL, more noticeable attenuation of the POL, and more intense synovial hypertrophy (see Figs. 2 and 3). Most of the patients in this arthroscopic stage also presented radiographically as Stage II, but on occasion patients deemed Stage I may actually have more advanced findings once the joint is truly assessed. Herein lies one of the great advantages of this technology. Only the rare case demonstrates less cartilage wear than supposed on the plain film. Consequently, radiographic Stage III rarely is considered Stage II, but that does greatly influence and expand the treatment options. Because this stage may have the most clinical impact on our method of treatment, due to lack of good options, it is important to review the patient outcomes for arthroscopic Stage II disease.

Preliminary Stage II results

A retrospective assessment evaluated arthroscopic Stage II patients with adequate follow-up in a selected 3-year period. Forty-three patients (38 female and 5 male) were arthroscopically diagnosed as having Stage II basal joint osteoarthritis of the thumb between 1998 and 2001. All the procedures were performed by the author, with follow-up data generated by visiting fellows for objectivity. The average patient age was 51 (range: 31–69). 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 the author's direction. The surgical procedure consisted of arthroscopic synovectomy, debridement, and occasional thermal capsulorraphy, followed by an extension-abduction closing wedge osteotomy in all cases. A 0.045-inch Kirschner wire provided stability to the osteotomy site, and a short arm-thumb spica cast was used for 4 to 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 to 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 progression of arthritic changes in 42 patients. Average range of thumb MCP joint motion was 5° to 50°, and thumb opposition reached the base of the small finger in all cases. The average pinch strength was 9.5 lbs (73% from nonaffected side). At final follow-up, 37 patients had no pain, 3 had mild pain, 2 had moderate pain, and the only patient who complained of severe pain had undergone arthroscopic-assisted hemitrapeziectomy because of progressive arthritis. These preliminary results suggest that continued use of this technique is appropriate. A longer follow-up will be later obtained to better assess the long-term utility of this technique and to publish these findings specifically in Stage II patients.

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, severe synovitis; and frayed volar ligaments with laxity (see Figs. 4 and 5). 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, or as the author prefers in most cases, an arthroscopic interposition arthroplasty is undertaken.

Based on the above findings and clinical experience, the author proposes the arthroscopic classification and treatment algorithm delineated in Table 1 and Fig. 8.

Discussion

Clinical assessment and radiographic studies used to be the only tools available for the selection of treatment modalities for thumb CMC arthritis [28,29]. Eaton and Glickel proposed a staging system for this disease that has been widely applied [17]. Later, Bettinger and coworkers [30] described the trapezial tilt as an instrument to predict further progression of the disease. They found that in advanced Stages (Eaton III and IV) the trapezial tilt was high (50° $\pm$ 4°; normal: 42° $\pm$ 4°). Barron and Eaton [31] concluded that there appears to be no indication for MRI, tomography, or ultrasonography in the routine evaluation of basal joint disease .

Although the author believes 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 CMC joint, as previously discussed [3].

In early stages of thumb basal joint arthritis, in Eaton Stage I, for instance, it is very common to find essentially normal radiographic studies despite the presence of painful limitation of the thumb. In the experience of the author and coworkers, this group of patients displays mild to moderate synovitis that could benefit from a thorough joint debridement combined with thermal shrinkage of the ligaments to enhance the stability. This, of course, assumes that they have not responded well to conservative treatment, including splinting, use of nonsteroidal anti-inflammatory drugs (NSAIDs), and corticosteroid injection. This stage is typically seen in middle-aged women who tend not to be indicated for more aggressive open procedures [29]. Arthroscopic treatment provides a particularly good option for this ubiquitous subset of patients.

Tomaino [22] concluded that first metacarpal extension osteotomy is a good treatment option for Eaton Stage I. 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 capsulorraphy, may avoid progression of disease and the need for a mechanical intervention; however, the arthroscopic findings that the author previously described for arthroscopic Stage II of the disease

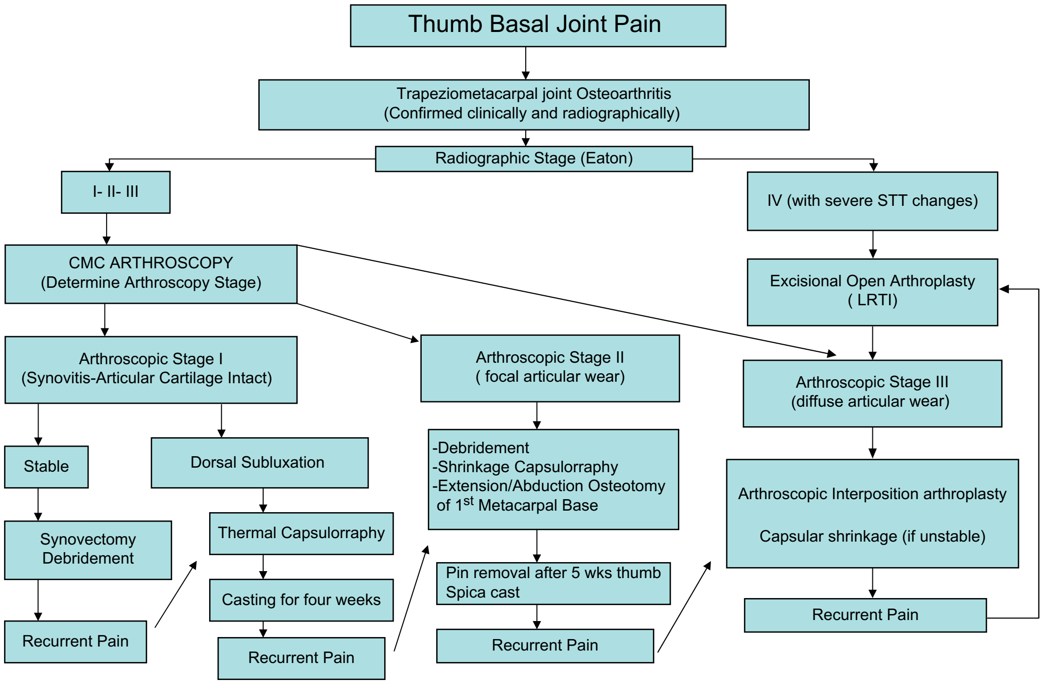

Fig. 8. Schematic for management of trapeziometacarpal arthritis, incorporating arthroscopic stages and subsequent treatment decision-making. LRTI, ligament reconstruction tendon interposition.

demand a joint modification such as osteotomy, 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 is no doubt that if complete articular cartilage loss is the arthroscopic scenario, then the logical further step is to perform some type of trapezium excision with interposition arthroplasty. This can include either a partial or complete excision or replacement. Menon [2] described a technique demonstrating arthroscopic debridement of the trapezial articular surface and interposition of autogenous tendon, fascia lata, or Gore-Tex patch into the CMC joint in patients who had Stage II and III, with excellent results. Newer techniques may allow the arthroscopic insertion of Artelon (Small Bone Innovations, New York, New York), which has proven successful with open techniques and confirmed histologically [32]. In either case, complete excision of the trapezium may not be desirable or even necessary, particularly in younger patients. This Stage III treatment needs to be further assessed by evaluating long-term clinical results.

According to the arthroscopic classification proposed, the author recommends arthroscopic synovectomy and debridement of the basal joint in patients who have Stage I arthritis. In patients who have Stage II disease, synovectomy and debridement is combined with 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.

Summary

Arthroscopic assessment of the CMC 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 made based on this information. The author recommends 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 using arthroscopy will likely ensure its place in the treatment armamentarium for trapeziometacarpal osteoarthritis.

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