MENTORS IN ORTHOPEDICS

VALUE OF TRAPEZIOMETACARPAL JOINT IMAGING IN THE SURGICAL MANAGEMENT OF BASAL THUMB ARTHRITIS

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SUMMARY

Background: Management of trapeziometacarpal (TMC) joint degeneration requires precise imaging to assess the extent of osteoarthritis and guide clinical decision-making. Despite its importance, obtaining high-quality radiographs of the thumb base is technically demanding and often complicated by inconsistent positioning or a lack of specialized training among radiology staff.

Objective: This article describes the clinical utility of static and dynamic radiographic views, advanced imaging modalities such as cone-beam computed tomography (CBCT), and diagnostic arthroscopy in evaluating TMC joint morphology, dysplasia, and degenerative changes.

Key Points: Radiological assessment relies on standardized classifications, including the Eaton, Dell, and Allieu systems, which categorize joint space narrowing, subluxation, and peritrapezial involvement. Essential projections include Kapandji's frontal and lateral views, Robert's anteroposterior view, and stress views to evaluate joint stability. Specialized views, such as Gedda's (Bett's) and dynamic radial/ulnar deviation images, are necessary to visualize the scaphotrapeziotrapezoid (STT) joint. Quantitative measures of trapezial dysplasia include the trapezial tilt (Dévers angle) and trapezial inclination. While CBCT provides high-resolution cartilage evaluation with lower radiation doses, arthroscopy remains the most definitive method for assessing the topography of chondral damage. Notably, radiographic severity does not always correlate with clinical pain levels.

Conclusion: Accurate diagnosis of basal thumb arthritis necessitates a comprehensive radiographic protocol and specialized technician training. Integrating dynamic views and advanced imaging ensures a precise anatomical assessment, though clinical symptoms must remain the primary indication for surgical intervention.

KEYWORDS

Osteoarthritis; Carpometacarpal Joint; Trapezium Bone; Radiography; Cone-Beam Computed Tomography

INTRODUCTION

When managing patients with trapeziometacarpal (TMC) joint pain, imaging will be a useful tool to understand the extent of joint degeneration, and consequently provide the patient with accurate information.

Radiology is often the only technical instrument needed for appropriate management of basal thumb arthritis [1]. Traditional radiology of the thumb base presents challenges as it is complex to perform, but this is sometimes not appreciated by either radiologists or referring doctors

The aim of this article is to offer a thorough description of the importance of static and dynamic radiology [2], the usefulness of additional examinations such as Cone Beam CT [3] with or without contrast material and finally the value of diagnostic arthroscopy. It will set out the angles that can be used to define trapezial dysplasia and current descriptions of trapezial morphology.

The end goal of a radiology examination is to obtain good quality imaging through the lowest number of images. To achieve this, it is crucial to follow thumb positioning criteria to obtain the right views so that the most accurate diagnosis can be made. This requires a motivated radiology department who have had specific training in this type of radiology so that the best possible imaging of the trapeziometacarpal joint can be obtained [1]. Often, a lack of interest on the part of many radiologists when it comes to taking these views will prompt the hand surgeon to thoroughly master the different positions that are important, so that reference images can be obtained to assess the state of the trapeziometacarpal joint, as well as the joints proximal and distal to it. This is why it is useful for radiology technicians to be well-trained and to take the initiative as a hand surgeon by training them in this topic [2].

THE TRAPEZIOMETACARPAL JOINT

Radiological classifications of basal thumb arthritis

There are three classifications in use today: Eaton is more commonly used in English-speaking countries [4],[5], while Dell is more common in Europe and France [6]. In 2011, Allieu developed a further, more accurate classification [7]. All of these classifications are based on measurements of frontal views of the joint. It is worth mentioning that a lateral view of the TMC joint initially allows for a better appreciation of the extent of joint space degeneration as long as the projection has been set up perfectly.

Dell classification

This is the most popular classification in France.

It is divided into four stages. The first stage consists of mild sclerosis. In the second, there is subluxation with the first metacarpal shifting by less than one third of the base and osteophyte formation at the ulnar border, although this is all said to be reducible. In stage 3 subluxation exceeds one third of the thumb base, there is increased osteophyte formation, and hyperextension of the metacarpophalangeal (MCP) joint of the thumb will result if the metacarpal head shape allows. Stage 4 involves almost total immobility due to the joint degeneration.

Stage I	Joint space narrowing, mild sclerosis, no subluxation
Stage II	Osteophyte formation on the ulnar border of the trapezium - < 1/3 subluxation – reducible
Stage III	More significant osteophytes – 1/3 subluxation or more – non-reducible – Hyperextension of the MCP – adductus of the first metacarpal
Stage IV	Total loss of joint space – joint is stiff

Table 1 : Dell Classifiction. JHS, 1978; 3: 243-9 [4]

Eaton classification

This is also divided into four stages, with normal joint space preserved in the first stage, combined with joint swelling and presumed preservation of joint cartilage. The second stage shows slight joint space narrowing with the joint contour preserved. Bone debris, if present, measures under 2mm. It is assumed that there is moderate joint cartilage degeneration. At stage 3 joint involvement is already very marked. Sclerosis is seen as well as subchondral cystic changes. Osteophytes are larger than 2mm. The triscaphoid joint, however, seems normal. At stage 4, very pronounced joint involvement is seen at both the TMC joint and the triscaphoid joint. This fourth part of the classification was added to the initial classification dating from 1973 [4] on Eaton's second publication in 1984 [5].

Stage I	Synovitis – capsule swelling – slight subluxation
Stage II	Slight pinching of the joint space. Subchondral sclerosis. Any osteophytes and periarticular bone debris does not exceed 2mm
Stage III	Joint space narrowing and subluxation – osteophytes and fragments around the joint >2mm. No triscaphoid involvement
Stage IV	Advanced joint degeneration – Triscaphoid OA

Table 2 : Eaton Classification. JBJS A , 1973; 55:1655-1666[4]

Allieu classification

This last classification is the most complete. It looks at the extent of TMC joint degeneration, primary instability and triscaphoid involvement.

It grades TMA (trapeziometacarpal osteoarthritis) – joint space involvement – from 0 to 3 starting from a preserved joint space (TMA 0), joint space narrowing under 50% (TMA 1), joint space narrowing over 50% (TMA 2) and finally disappearance of the joint space (TMA 3). TMI (trapeziometacarpal instability) looks at the extent of instability, with TMI 0 being reducible subluxation at the base of the first metacarpal, and TMI 1 also being reducible subluxation although the first metacarpal does not fully reintegrate into the saddle-shaped trapezium. At TMI 2 subluxation is no longer reducible but affects less than 1/3 of the joint surface. At TMI 3, subluxation of the first metacarpal exceeds 1/3 of the base.

Finally, the STT part of the classification looks at the triscaphoid joint (also known as the scaphotrapeziotrapezoid, STT) and the extent of OA: STT 0 means no joint change. At stage STT 1 there is joint space narrowing of under 50%, while at STT 2 the joint space is narrowed by more than half. Stage STT 3 shows erosions, sclerosis and irregularities. This classification has greater intra-observer reproducibility that is better

than its inter-observer reproducibility. However, the TMI aspect is less reproducible, and potentially insufficient [8].

TMA 0	No joint space narrowing (painful and unstable joint)
TMA 1	Joint space narrowing, under 50%
TMA 2	Joint space narrowing, over 50%
TMA 3	Joint space disappeared, bone erosion

TMI 0	Reducible subluxation, painful and unstable joint
TMI 1	Reducible subluxation although reintegration into saddle-shaped trapezium is incomplete
TMI 2	Non-reducible subluxation of under 1/3 of the joint surface of the base of the first metacarpal
TMI 3	Subluxation exceeding 1/3 of the joint surface of the base of the first metacarpal

Table 3 : Allieu Classification. Hand Surg Rehab 2021 ; 40 :S15 – S20 TMA: Trapeziometacarpal joint space TMI : Trapeziometacarpal instability/subluxation StT : Condition of the triscaphoid jointTMA: Trapeziometacarpal joint spaceTMI : Trapeziometacarpal instability/subluxationStT : Condition of the triscaphoid joint

RADIOGRAPHY

View and positioning

The standard frontal and lateral projections required to achieve good visualisation of the joint have been thoroughly described by Kapandji [9],[10] and these are still an excellent reference. A posteroanterior projection (Figure 1) is used for the frontal view otherwise the metacarpophalangeal and interphalangeal joints would be visualised first (Figure 1). The lateral view is achieved through an ulnar to radial projection (Figure 2). Across the Atlantic, variations to these projections exist and some useful additions are made. Robert's view [11] is a variant of the Kapandji frontal view that uses an AP rather than PA projection and is very popular in the English-speaking world. We should not forget comparative images, such as the Eaton view with and without stress. To assess the triscaphoid it is important to include Gedda's view [12], also known as Bett's view [13], among dynamic views in ulnar and radial deviation. We will move on to a detailed discussion of the key views and their positioning.

Figure 1 : Comparative frontal images of IP and MCP joints (Courtesy Dirk Carette).

Figure 2 : Kapandji's lateral view offers excellent visualisation of the TMC, MCP and IP. Note how the concave first metacarpal base fits perfectly into the convexity of the trapezium. (Courtesy Dirk Carette)

Radiography of the distal interphalangeal

(DIP) and metacarpophalangeal (MCP) joints of the thumb.

Frontal views : This radiography is performed using dorsopalmar and lateral projections. For the frontal view it is crucial for the sesamoids to project over the first metacarpal head. (Figure 1). These frontal images clearly show the IP and thumb MCP joint spaces. The TMC joint space, however, cannot be visualised simultaneously.

Lateral views : These are carried out in the exact same way as Kapandji's lateral views: it is key to make sure the sesamoids are superimposed on lateral views as this will demonstrate the concave base of the first metacarpal and the convexity of the trapezium while enabling the base of the second metacarpal to be slightly superimposed. (Figure 2) This view allows for a very good appreciation of the involvement of the MCP and IP joints.

Trapeziometacarpal joint

Kapandji's frontal view equates to the Eaton view without stress, and involves placing the thumb in extension while moving the wrist into slight ulnar deviation (Figure 3). This offers good visualisation of the trapeziometacarpal joint.

Figure 3 : Kapandji's frontal view (Courtesy Filip Van Den Bossche)

Eaton's views are the same as Kapandji's frontal view, except that in the Eaton series the images are comparative (Figure 4), which means that a stress view (Figure 5) is taken so that the joint space can be assessed for any collapse when put under stress.

Figure 4 : Eaton's frontal view (Courtesy Dirk Carette)

Figure 5 : Eaton's stress view (Courtesy Dirk Carette)

In 1936 the French radiologist Robert [8] (Figure 6) described an anteroposterior view of the TMC performed in maximum anteroposterior pronation that it is useful to be familiar with. This view is very popular in the USA. It is taken with the patient's back facing, avoiding irradiating the lower limbs.

Figure 6: Positioning for anteroposterior view according to Robert (Courtesy of Filip Van Den Bossche)

Proximal joints: the scaphotrapezial and scaphotrapezoid joints

Finally, we must not overlook visualisation all of the peritrapezial joints, better known as the view described by Gedda [9] and popularised by Taleisnik as Bett's view [10], which frees up the trapezium perimeter to offer very good visualisation of the whole area (Figure 7). To obtain good quality visualisation of the triscaphoid joint it is useful to take frontal views in ulnar and radial deviation. Some triscaphoid joints appear 'normal' on imaging at rest and collapse completely in radial deviation (Figure 8).

Figure 7 : Gedda's view (Bett's view) offering a good view of the trapezium perimeter (Courtesy Dirk Carette)

Figure 8 : Frontal views in radial and ulnar deviation (Courtesy Dirk Carette)

View and pathological cases

From a perspective of pathology, it is useful to order comparative imaging from the start.

Radiological assessment of painful basal thumb arthritis will consist of Kapandji's frontal and lateral views, an Eaton frontal view (which can replace Kapandji's frontal view if necessary) and stress view of the TMC, a dynamic triscaphoid view and a Gedda's (Bett's) view **[12],[13]** (Figure 9).

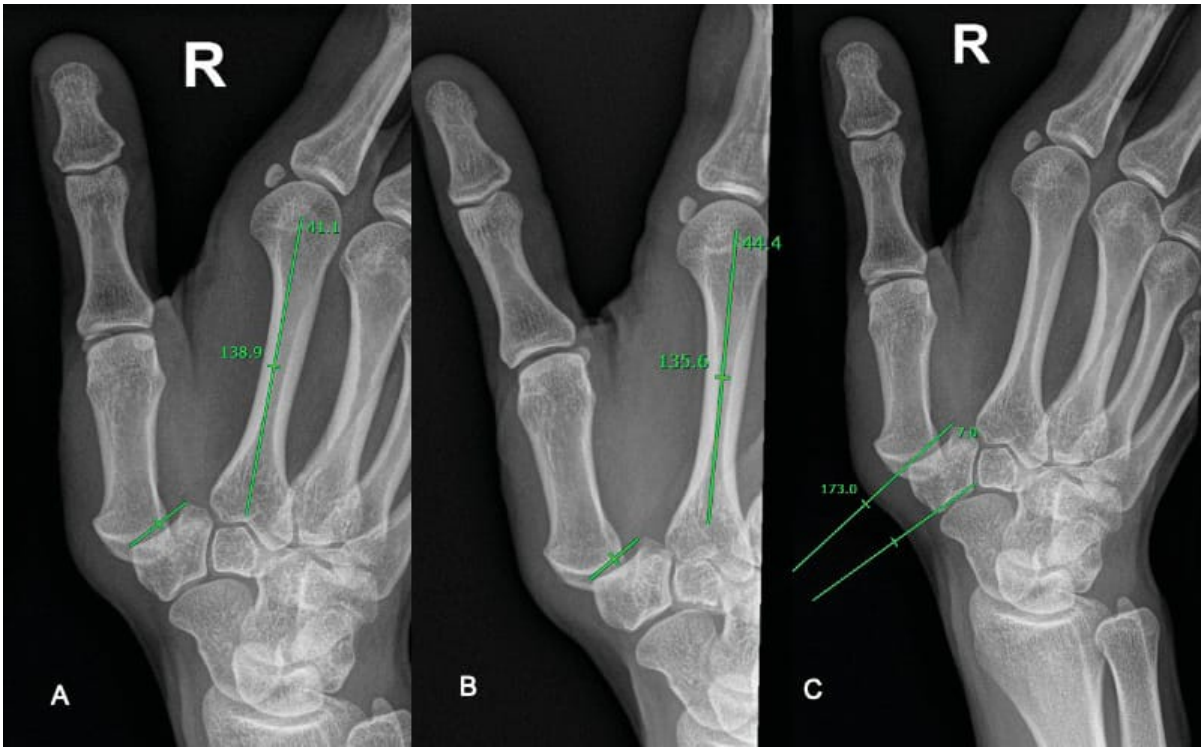

Figure 9 : Variability of the trapezial tilt (Dévers angle) in A and B Kapandji views, compared with trapezial inclination in C.

The aim here is not to describe all pathological cases, but to use specific examples to show how easy and sometimes how difficult positioning and radiography can be in very advanced cases.

When a young patient presents with pain at the thumb base, we can expect concern over instability due to laxity or often further to dysplasia. This can be measured by using either the trapezial tilt (Dévers angle) as described by Kapandji and Heim [13], or the trapezial inclination, more recently described by Van Royen [15]. The trapezial tilt is measured from the distal joint surface of the trapezium on a Kapandji frontal view and the axis of the second metacarpal. It measures 129° +/- 6° on average. The trapezial inclination, which its authors believe to be more consistent [15], is measured between the proximal articular surface of the trapezium (PAST) and the distal articular surface of the trapezium (DAST). It measures 10° +/- 5° on average. The inconsistency of the trapezial tilt is illustrated in figure 9. This can be explained by the 'cantilever' bending of the trapezium, as described by Van Royen et al. [15].

It is important to reiterate that radiology of the thumb base is not capable of reflecting patient pain (Figure 11). A patient showing Dell stage 1 (or Eaton stage 1 or a TMA1, TMI 0 and STT 0) may be in very significant pain, which may make them a candidate for joint replacement surgery (Figure 10).

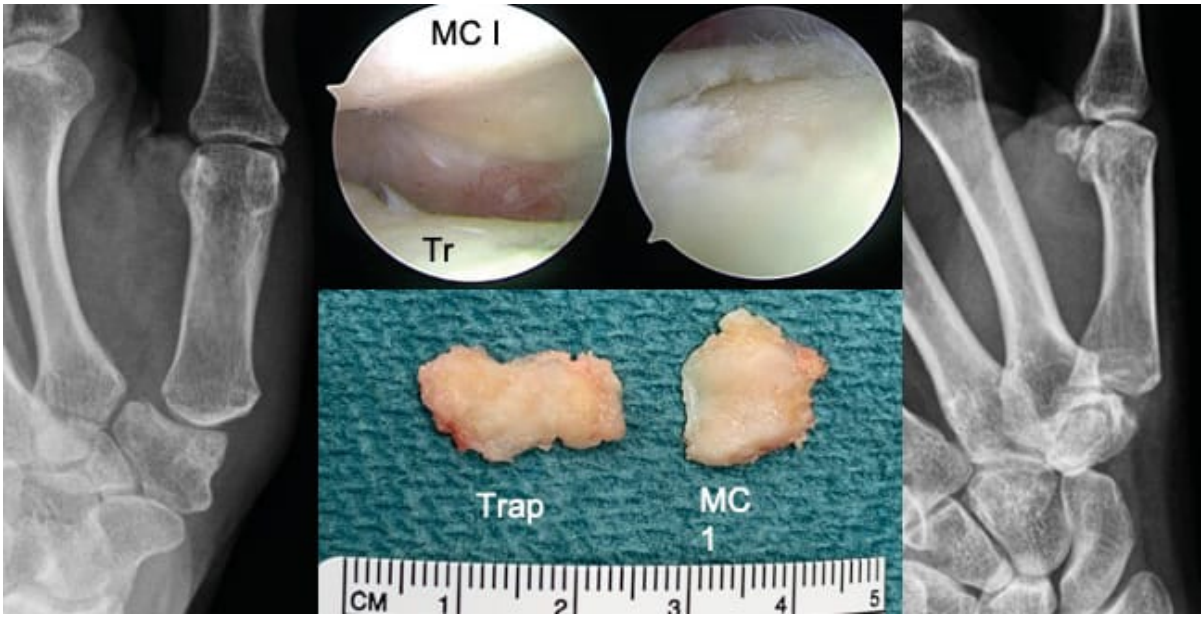

Figure 10 : Radiograph showing a joint with very minimal involvement, but experienced by the patient as very painful. Arthroscopy shows very advanced joint involvement. Photo of the resected joint surfaces following fitting of a prosthesis.

Figure 11 : Peritrapezial osteoarthritis in a patient presenting minimal pain on a day-to-day basis.

The value of dynamic views is illustrated very clearly in Fig. 12, showing a Dell stage II, Eaton stage 3, TMA 1, TMI 1, STT 0 joint, which, when seen under stress, suddenly becomes Dell stage II (unchanged) Eaton stage 3 and TMA 3, TMI 1, STT 0 (Figure 13). This demonstrates that Allieu's classification has greater precision for the TMA [8].

Figure 12 : Degenerative TMC joint on the left, with the Kapandji lateral view showing clear subluxation and disappearance of the joint space (see text).

Figure 13 : Same patient as in Fig. 12, but under stress: Total disappearance of the joint space on frontal views.

ADDITIONAL EXAMINATIONS

CBCT (Cone Beam Computed Tomography)

If there is any uncertainty, a CT scan will be carried out, preferably CBCT (3) as it offers greater detail and delivers lower radiation with contrast (Figure 14). This will allow an evaluation of cartilage quality. A trapeziometacarpal arthroscopy is better still (Figure 15).

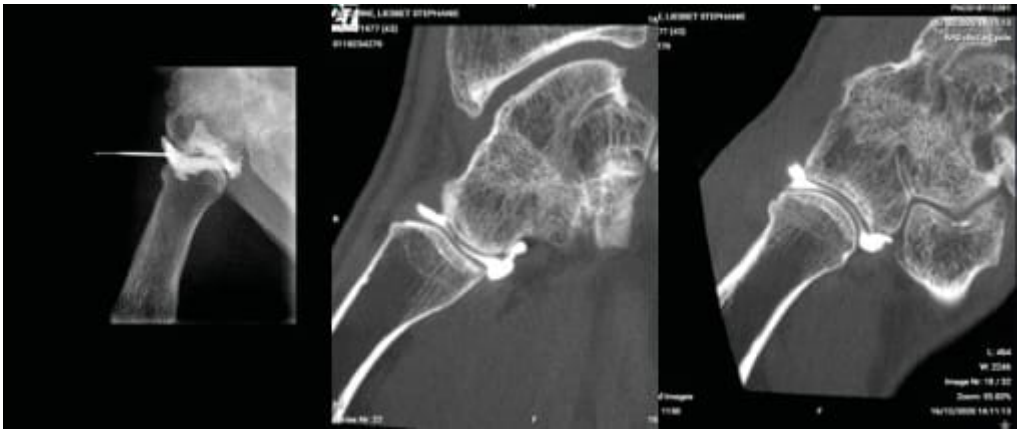

Figure 14 : CBCT arthrogram of the TMC joint showing perfectly intact cartilage in a patient who was nonetheless in significant pain.

Arthroscopy

An arthroscopy offers improved assessment of damage if conventional radiology is not conclusive. It replaces CT arthrogram and provides a better insight into the variability (Figure 15) of cartilage involvement at the trapezium and the articulating surface of the first metacarpal.

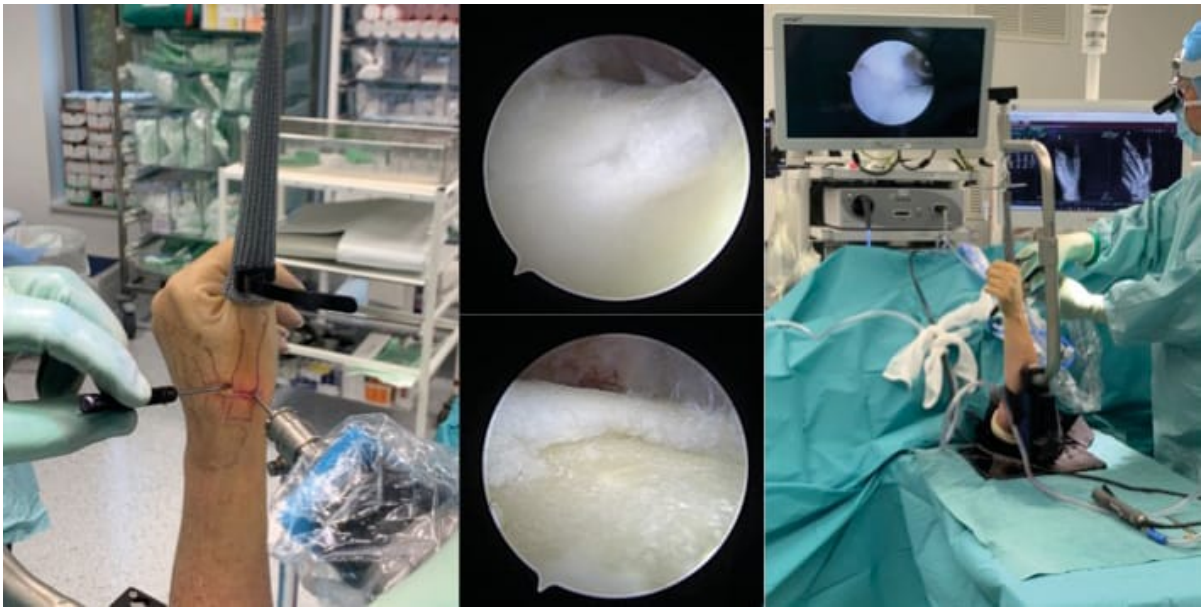

Figure 15 : Arthroscopy is useful to demonstrate the topography of cartilage damage in the TMC joint.

CONCLUSION

The importance of choosing the right views in the diagnosis of trapeziometacarpal osteoarthritis, or basal thumb arthritis, cannot be overstated [1]. If the radiology technician has had high quality training, this will lead to a clear and correct diagnosis, which in turn often means non-surgical management for patients with this pathology. By following the adage 'Don't treat the pictures, treat the patient' we ensure that we offer, through radiology that is performed well, treatment that is useful to our patients. It is important to remember that sometimes patients with radiographs showing minimal TMC involvement can be in more pain (Figure 10) than patients at the most

advanced stage of degene18ration (Figure 13). Finally, history has shown us that of the radiological views that are useful in imaging the degenerative TMC joint, they may not all be French, but they originate almost exclusively from Europe.

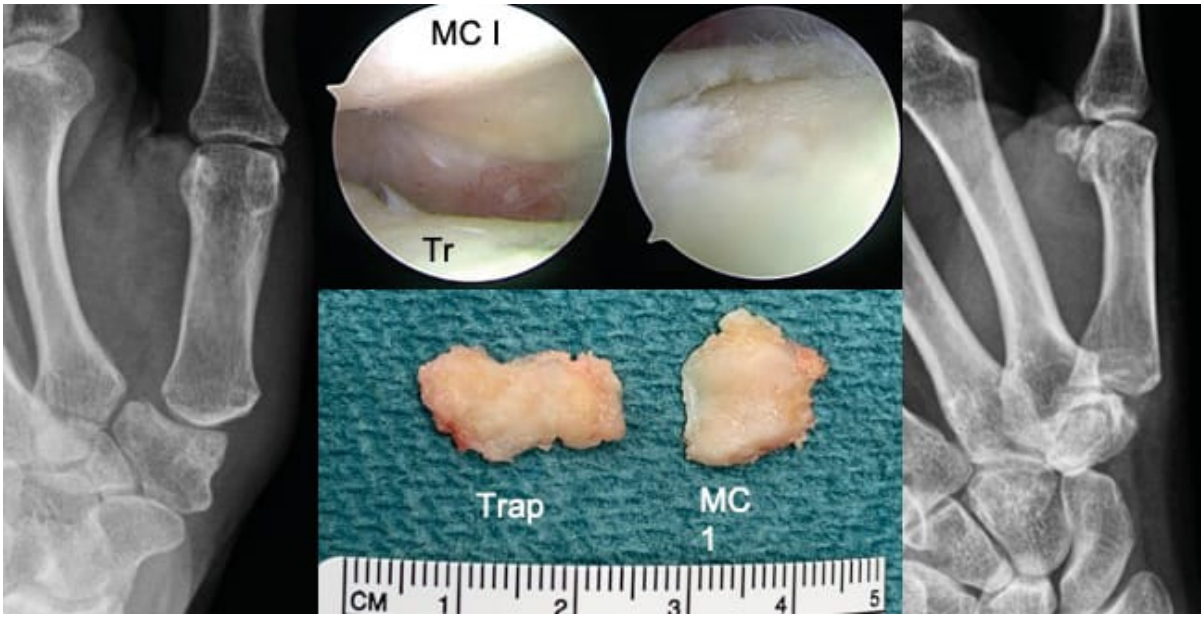

Figure 10 : Radiograph showing a joint with very minimal involvement, but experienced by the patient as very painful. Arthroscopy shows very advanced joint involvement. Photo of the resected joint surfaces following fitting of a prosthesis.

Figure 13 : Same patient as in Fig. 12, but under stress: Total disappearance of the joint space on frontal views.

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