Direct Parasagittal Computed Tomography and Arthroscopic Surgery of the Temporomandibular Joint

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An overview of an interdisciplinary approach to TMJ problems, with preliminary findings on the application of CT scanning and arthroscopic surgery in cases that do not respond to conservative therapy.

KEY WORDS: • ARTHROSCOPY • COMPUTED TOMOGRAPHY • • FUNCTION • TEMPOROMANDIBULAR JOINT •

The temporomandibular joint seems to have always been a subject of ongoing controversy and conflict. Every professional concerned with this problem brings to it a unique background of education and experience that strongly influences their approach to diagnosis and treatment. This Author is no exception, so the following brief review of some of the most prominent influences are presented to provide a perspective for the studies reported here.

BOUCHER (1964) and many others have taught that centric relation for the mandibular condyle is the most posterior and superior position possible. However, many dental patients cannot tolerate that position, so I was among those dentists who found a need to create an occlusion with freedom to slide forward in a "long centric."

Beginning with a background in the concepts of gnathology, the views of RAMFJORD (1971) were found to be both enlightening and confusing. DAWSON (1974)

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presents the concept of a condylar centric relation being the most superior position, teaching the technique of "romancing" the mandible back, rather than forcing it back, to find the correct position.

For many years, THOMPSON (1954, AND PAGE 143), and others have taught that the normal position of the condyle in the fossa is in an upward and forward position, against the articular surface of the eminence.

Through all of this confusion, my father, Dr. Myer Alpern, who practiced dentistry in East Liverpool, Ohio, quietly professed that centric occlusion and centric relation coincided in a "comfortable position" for mandibular posture. He believed that occlusion should be adjusted with the patient upright, with the head tilted slightly down in a natural chewing position, as well as in the supine position to eliminate gravitational effects on the mandible. He could not understand why some dentists examine and adjust occlusion with the head tilted back in an unnatural posture that extends the submandibular and anterior neck muscles.

He also expressed concern over dependence on articulators, believing that each step between the appliance and the mouth introduces one more possibility for human and material error. Even the best articulator is a poor imitation of the joint; plaster can shift on setting; impressions can warp; operator error and patient input are a constant concern in the transfer process; and metal articulators can wear and the adjustments slip, to introduce other mechanical errors. His articulator served as an initial diagnostic and setup tool, and as a guide in construction, but the *real* articulator was always the mouth, with its many soft-tissue interfaces and multiple feedback paths not duplicated in rigid replications.

That was my background as I entered the advanced education course in orthodontics under Dr. Benjamin Williams at the Ohio State University. That education included an opportunity for original research in radiography that led to development of a head positioner for accurate replicable panoramic radiographs that could show the mandible with minimal distortion (ALPERN 1979). It also gave access to tomographic equipment, and the opportunity to explore TMJ tomography.

The submental→vertex technique for achieving an accurately oriented cross-sectional tomographic view of the TMJ was also developed in that period by WILSON AND WILLIAMSON (1976). For the first time, we began to see an accurate view of the TMJ, and this elicited more questions. While the oriented tomographs did accurately display the condyle/fossa relationship, we still could not see the articular disk.

The Temporomandibular Joint

We still face the question today of determining just where the condyle should be located in normal centric occlusion, and without that basic information on the normal condition it is impossible to recognize abnormality. We have an abundance of well-worn arbitrary rules, but they are more satisfying than informative, serving mostly to discourage any further search for the truth.

Of special concern are those patients who complain of pain, clicking or popping in the temporomandibular joint area even after orthodontic correction to such widely accepted criteria as the six keys to occlusion (ANDREWS 1972), or reconstruction to gnathologic standards. Some of these patients present apparently incurable TMJ symptoms.

Computerized Tomography

The increasing utility and precision of computerized tomographic (CT) scanning in recent years appeared to be approaching a level that could be of value

in TMJ diagnosis, so efforts were begun to seek access for application of this tool through local hospitals. This eventually led to Dr. John Ufema, a board-certified radiologist at St. Joseph's Hospital in Port Charlotte, Florida.

Dr. Ufema had just installed a new CT scanner *(Tomoscan)* which was specially equipped for ENT studies with a field enhancement upgrade consisting of hardware and software that enables visualization of structures as small as the inner ear ossicles. Given the correct technique, Ufema felt that we might also be able to visualize the TMJ disk.

A skull study followed, using the WILSON AND WILLIAMSON (1976) and WILLIAMS (1983) technique of beginning with what would be a submental→vertex view in conventional radiography, but is actually a coronal CT section, to first measure the condyle angles to a constructed sagittal line. Then, using a special table that permits placing the patient in the back of the CT gantry, the head is positioned to provide direct cross-sectional scans of the condyle area. The details of this technique are discussed by Ufema in the article that begins on page .

For the first time, we could visualize both aspects of the problem — the patient's teeth in centric occlusion position, *and* the condyle/disk/fossa complex. Several new keys became apparent. We noted that static condyle position in the fossa was only one of the important factors in our patient group. The condyle must also be *free to move* through its normal range of motion.

In most symptomatic patients, displacement of the disk may be involved in limiting the freedom of condyle movement and inducing pain and dysfunction. The position of the condyle in the fossa varied individually, as did the condyle/disk/fossa relationship.

We have found that restoration of unimpeded condyle mobility for our patients appears to relieve their symptoms.

These new visualizations of the condyle/disk/fossa complex caused us to question the diagnostic value of radiographs that only show the condyle in the fossa. This parallels Williams's concerns over excessive dependence on the "infallibility" of transcranial or sectographic radiographs for diagnosis.

Furthermore, Ufema expressed concern over the certainty of what we were really seeing in the CT scans, since interpretation of the scans is much more dependent on the technique of the radiologist than in conventional radiography.

A CT scan produces no image at all; only digital data describing density values in an unintelligible array. The creation of visible images is accomplished later, by computerized manipulation and reorganization of the recorded digitized x-ray data. This is accomplished by the radiologist, who must direct the image-creation process through the computer controls.

Many different images and different interpretations can result from variations in this analytical manipulation of the same data.

Several important new questions arose as these improved CT views of the TMJ emerged. Since this new technique enabled apparently much more accurate and complete viewing of the TMJ, we were faced with the task of learning how to interpret what we were seeing in these new images. While they are the result of x-rays, and bear a superficial resemblance to conventional radiographs, the differences are profound.

It is not acceptable to consider subjecting normal individuals to a CT scan for research purposes, so other approaches were needed in the search for normal standards. Applying the findings of arthroscopic viewing of the same structures has proved to be invaluable, and

answers to many of our questions began to emerge as we applied these new techniques in combination.

— Clinical Studies —

First, a few guidelines. Only patients complaining of pain or serious dysfunction are viewed as candidates for a CT scan. Mere clicks or noisy joint sounds in the absence of other symptoms are not considered to be a valid justification for invasive diagnosis or treatment.

The first group of patients had already been evaluated in the Author's orthodontic practice. These patients included some who presented with symptoms, and some who developed symptoms during or after orthodontic treatment.

All of these patients complete an extensive medical and dental history that includes questions about prior consultation with any doctor about head or neck pain or injury, or a blow or injury to the head, teeth or jaws. Clicking or popping or pain at the jaw joint, headaches or neckaches, pain or trouble chewing, talking or swallowing, are among the symptoms included in this history.

Responses are reviewed with patients and/or parents, and if answers are affirmative, additional questionnaires specific to TMJ are completed and reviewed.

If TMJ problems are present, a clinical examination evaluates dental and orthodontic factors. The TMJ area is palpated with fingers over the joint and the little fingers in the external auditory meati, pressing up and mostly forward. The muscles of mastication and adjacent musculature are also palpated. Additional diagnostic procedures are used as required to further evaluate head or TMJ pain.

Dentally-oriented treatment of head pain or joint dysfunction caused by tumor, arthritis, or other pathology, cannot succeed. Depending on the nature of the patient's history and clinical findings, orthodontic records and evaluation may be supplemented by referral to one or more of the following professionals (board-certified where applicable):

Neurologist
Psychiatrist or Psychologist
Endocrinologist
Internist
Nutritionist
Physical therapist
Opthalmalogist
Ear, Nose, and Throat
General Dentist
Endodontist
Periodontist
Oral Surgeon
Orthopedic Surgeon

If the patient history and clinical findings indicate possible joint pathology, further information is sought to gain as much information as possible about the condyle/disk/fossa complex and its condition. This is when a CT scan of the TMJ may be prescribed, giving specific history and concerns, and identifying the various views that are required.

A written report from each specialist referred to, including pertinent copies of the CT images, become part of the patient record.

Patient consultation begins with a 45-minute videotape of the Author explaining in detail what the TMJ syndrome is, and the various methods of treatment. The video also specifically explains that treatment involves no promises and no guarantees. TMJ dysfunction is explained as Gelb (1977) professes — a three-part problem involving heredity, stress, and function. It is carefully explained that dental measures address only one of those three components. Of course, no one can address heredity. However, the patient can have a major and very direct effect on stress. Diet, exercise, rest, psycholog-

ical or psychiatric counseling (and cooperation with that counseling), and all other areas of stress are explained in some detail. The patient is told that in many of the cases that fail, stress seems to be the central problem.

The videotape also covers various methods of treatment, and specifically explains that TMJ dysfunction is like a trick knee, bad back, chronic sinus problems, or chronic headaches. We cannot hope for a cure. Instead, the best that we can hope for is an improvement. They are told that the best state of the art is TMJ improvement. Furthermore, that improvement may be only temporary, depending on the hereditary predispositions and changes which may occur in stress and function over a period of time.

A personal consultation follows, with an explanation of the apparent problem and the proposed treatment plan. A letter repeating the key aspects of the consultation follows.

In light of the literature and many lecturers, we define a true TMJ problem as one involving the structures and function of condyle, disk, and fossa. Conservative therapy is always the first choice for a temporomandibular joint problem.

Splint Therapy

Splints are usually a first step. They can sometimes be combined with orthodontic treatment. The design and application of a corrective splint may be based on the CT scan, but the entire subject of splint therapy is too broad to consider here.

It is the Author's belief that therapeutic splints intended to alter joint relationships must be worn full-time to be effective. They are sometimes even cemented into place with orthodontic zinc phosphate cement. Based on the ways in which orthopedic surgeons treat other joint problems, one can hardly expect condyle/disk/fossa problems to respond adequately to intermittent correction.

Existing thinking suggests that one can "recapture" the TMJ disk, so initially it seemed reasonable to expect what so many current lecturers have claimed. However, the CT scan presented us with a visualization of the condyle/disk/fossa relationship that placed this interpretation in doubt.

Case 1
Figures 1 and 2

The pretreatment CT scan in Fig. 1 shows a picture that existing wisdom would probably interpret as an anteriorly-displaced disk. Arrows indicate the splint correction desired in this case.

The same joint is shown in Fig. 2 several months after repositioning splint therapy. Note the apparent dense soft tissue material in the condylar fossa. We now suspect, based on arthroscopic surgery on other patients, that this patient has adhesive capsulitis and that the splint merely held the condyle forward against the anterior band of the disk.

Our findings have differed from conventional thought on TMJ diagnosis and treatment. Many times, what has appeared to be an anteriorly- displaced disk was found on arthroscopic examination to have been physically changed. The disk may have crumpled or crumbled, or degenerated or changed in some other manner so that when it was repositioned in the apparently correct condyle/disk/fossa relationship, it was unusable. In many cases, not only was the repositioned disk unusable, but in some instances it traumatized the condyle and placed the patient in acute distress.

Any orthodontist utilizing splints must be prepared to deal with the problems that can arise even with such "conservative splint therapy" advocated by many experts. The answer to such problems

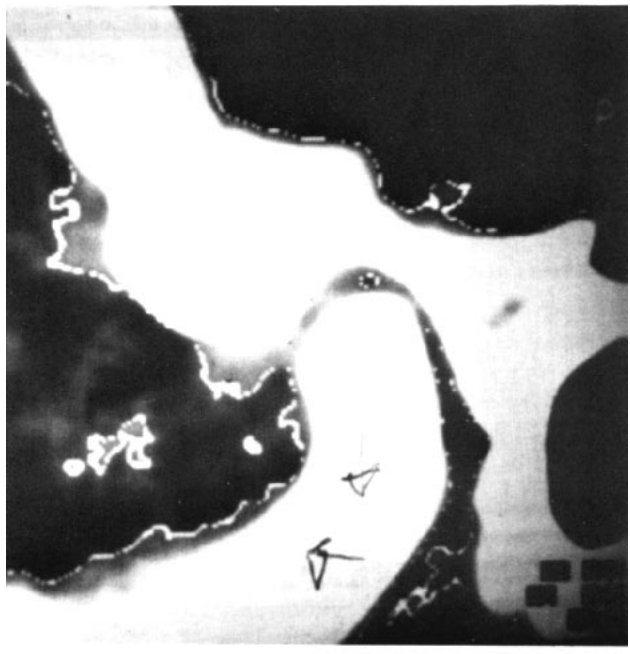

Fig. 1 Case 1 Pretreatment

Pretreatment CT scan showing a mass of cartilage-density tissue anterior to the joint, suggestive in conventional interpretation of an anteriorly-displaced disk. Arrows indicate the desired splint correction.

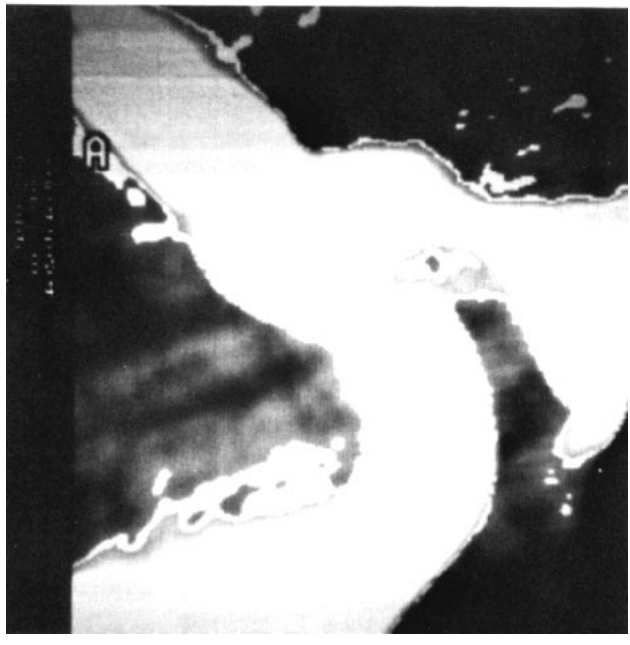

Fig. 2 Case 1 Posttreatment

The same joint, after several months of splint therapy. Note the tissue in the fossa. This may indicate an adhesive capsulitis, with the splint holding the condyle forward against the anterior band of the disk.

often appears to be arthroscopic surgery, so the patient starting on splint therapy should be advised that this does not preclude the need for surgery to relieve their symptoms.

Case 2
Figures 3 - 6

This patient presented with pain in the left joint, and initially experienced relief with a splint. However, after 3 months with the splint, a new acute TMJ pain appeared, this time in the *right* joint. Follow-up CT scans of the right TMJ revealed apparent erosion of the head of the condyle which required full-flap surgery.

Figures 3 and 5 show the CT scans of the left and right joints before treatment, and Figs. 4 and 6 show the same joints after repositioning. It is conjectured that the splint may have moved the right condyle into a position where it was functioning against a fragment of cartilage or bone that could have caused the condylar erosion.

This patient was treated prior to our arthroscopic surgical studies on patients who appeared to have what conventional wisdom has been regarding as "anteriorly displaced disks." At this time, we are still trying to determine whether that perception is actually correct. Thus far, our findings do not appear to support existing philosophies on the involvement of anterior disk displacement in clicking, painful, dysfunctional temporomandibular joints.

— Surgery —

Failed splint therapy, and new patients presenting with serious condyle/disk/fossa problems, often require TMJ surgery. The typical full-flap open surgical exposure and surgery of the TMJ present many problems and limitations. Such surgery surely is not a cure-all. A 50% improvement is a reasonable expectation in these cases, and most competent TMJ surgeons will operate only after the patient is almost begging them to do the surgery.

This discouraging outlook stimulated a search for a different surgical modality. Dr. Douglas Nuelle, a local board-certified orthopedic surgeon with an extensive background in arthroscopic surgery, had been operating knees, elbows, and various other joints in the body with the arthroscopic instrumentation.

This procedure has gained wide recognition from its applications in sports medicine, but it is not limited to those problems.

In discussing the idea of arthroscopic surgery of the TMJ, it became clear that the TMJ is not as fundamentally different from various other joints in the body as we may have believed. Nuelle felt that the 1.9mm arthroscope, originally designed for finger joints, could also be used to visualize the TMJ. More important, it might be possible to operate the joint in a manner similar to the arthroscopic procedures used on other body joints.

Together, we reviewed the literature on arthroscopic surgery of the TMJ, and found that visualization alone had been attempted in Japan and Sweden, and in Miami and Ann Arbor in the United States. At the time of our first arthroscopic procedure, there was no previous mention of any surgery of the TMJ beyond visualization, biopsy, and drainage.

After initial cadaver studies, the first live human joint was successfully visualized and surgically debrided through a second portal opening with a 2.4mm chondrotome. Since that time, a considerable number have been operated or are being prepared for the procedure, with encouraging results.

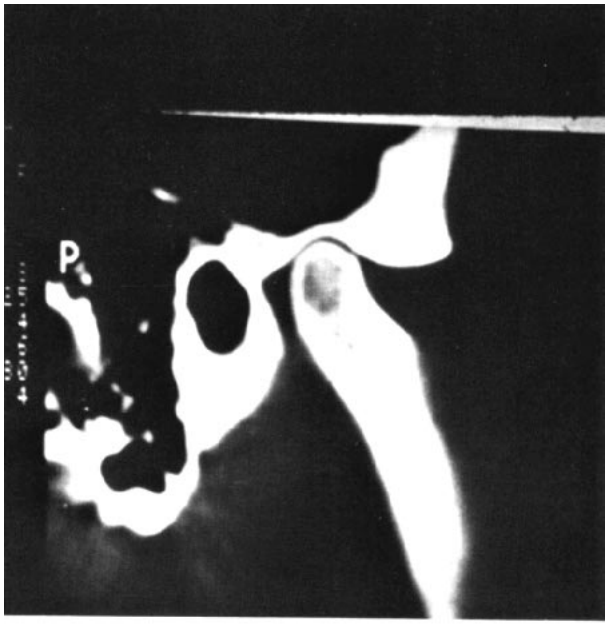

Fig. 3 Case 2, Left Joint

CT scan before treatment

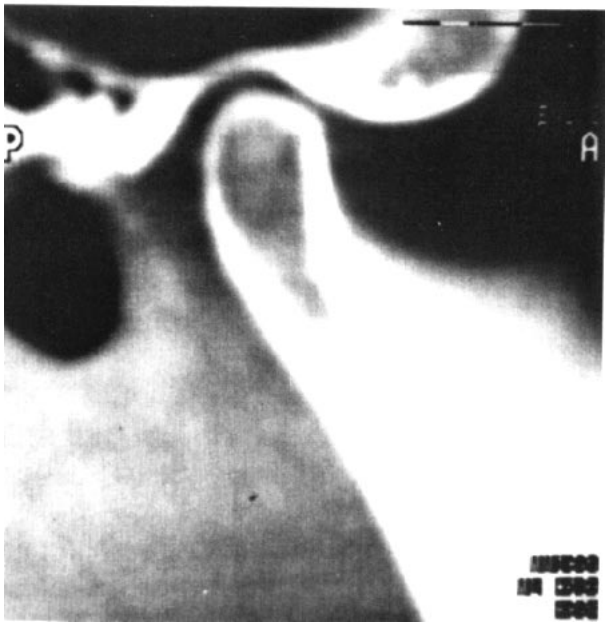

Fig. 4 Case 2, Left Joint

CT scan after repositioning splint therapy

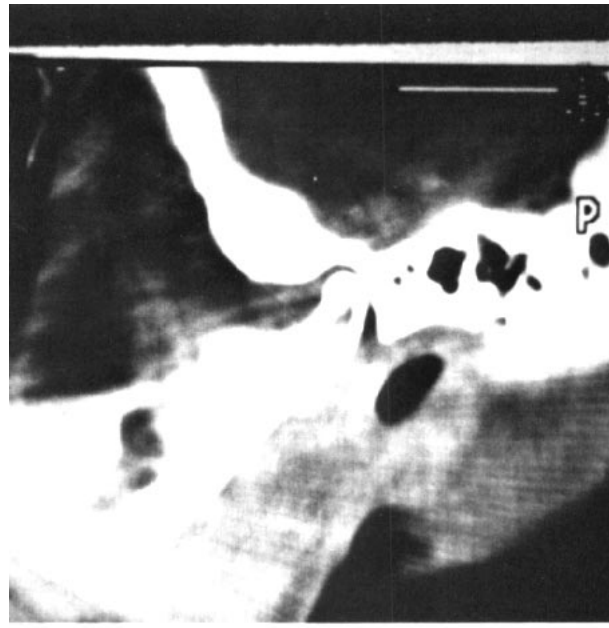

Fig. 5 Case 2, Right Joint

CT scan before treatment

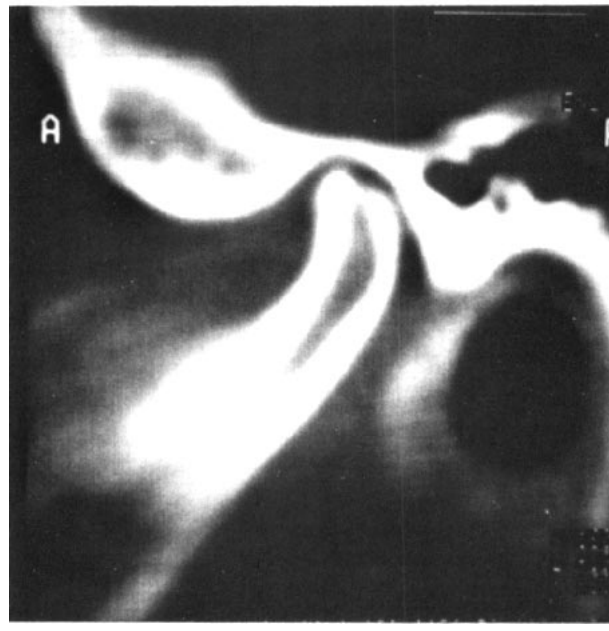

Fig. 6 Case 2, Right Joint

CT scan after repositioning splint therapy for left joint pain.
Note the apparent erosion or loss of cortical bone on the superior surface of the condyle.

We use an interdisciplinary team approach throughout, including the actual surgical procedure.

Everyone benefits by having the orthodontist in the operating room as a participant in the surgical procedure. The orthodontist manipulates the mandible as the surgeon works, while both watch the live enlarged video image of the joint. This gives the patient the benefits of a real-time team evaluation at every step.

The orthodontist can actually tell the surgeon when he has entered the joint, just by feeling the vibration of the entry of the arthroscope at the lower incisors. Our mutual perception of the joint from a functional occlusal standpoint, combined with the orthopedic surgeon's skill and knowledge of the joint itself, presents the best circumstances for TMJ improvement.

By videotaping the procedure, the team can meet afterward to discuss the CT findings in the light of the actual surgical arthroscopic visualization.

Our team has discovered new findings and developed new philosophies which have changed our anatomic, diagnostic, and therapeutic interpretations of the TMJ. These are discussed further in the two articles that follow.

— Conclusions —

Orthodontics stands at a crossroad. The enigma of the temporomandibular joint has troubled most sectors of the healing professions with its penchant for inflicting pain and discomfort in so many ways.

It is the Author's opinion that the orthodontist is the best-qualified specialist for the dental management of TMJ treatment. After all, we already assume responsibility for alignment, esthetics, and function of the teeth and jaws in conventional treatment. It seems a natural progression to treat from the incisal edges through the cuspids, bicuspids, and molars to the temporomandibular joint. Now that we can actually see the joint so much more clearly, the opportunities for effective treatment are greater than ever.

Nevertheless, neither orthodontists nor any other single profession or specialty can accomplish TMJ treatment alone. The orthodontist needs the full team of health care professionals in medicine and dentistry to completely evaluate and cope with a patient's total problem.

We need the help of board-certified radiologists with excellent CT scanners who are willing to spend the time, as John Ufema has, to become competent in CT radiology of the TMJ. Such competency requires untold hours of study, including the review of original diagnoses with video recordings of arthroscopic procedures.

We also need the help of highly skilled and competent arthroscopic surgeons who are willing to not only spend the time and effort to study the functional anatomy of the TMJ, but also willing to accept an orthodontist in the operating room for mandibular manipulation during arthroscopic surgery, and work in harmony with orthodontic treatment and philosophy.

Care is required in selecting members for such a team.

One does not just start taking and interpreting CT scans of the TMJ. Hands-on training is necessary in what Ufema calls the "knobology" of a good CT scan of the TMJ. This is adjusting the knobs and punching the keys that ultimately create the picture.

Similarly, arthroscopic surgery is a specialty in and of itself. It requires hands-on training in the form of additional courses, training and skill development, not only in manipulation of the instruments, but in interpreting where you are and what you are seeing and doing.

Finally, our team is very aware of the preliminary nature of this report. We have not solved all of the problems and riddles of the TMJ. As with any new development, with any new research, finding answers to some questions uncovers new ones that arise to challenge us. As orthodontists sharing in this quest, we must work with our colleagues as we accept these challenges. A/O

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