THE VALIDITY OF TEMPOROMANDIBULAR JOINT RADIOGRAPHS USING THE HEAD POSITIONER

by

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ABSTRACT

The aim of the study is to examine the validity of temporomandibular joint radiographs using the head positioner. For the study three groups of patients are examined:

1) Patients with myofascial pain dysfunction syndrome.

2) A random sample.

3) Patients who had undergone occlusal rehabilitation.

Each group is analysed to determine if a relationship exists between the radiographic findings and the clinical conditions that are observed.

The conclusions are as follows:

A) T.M.J. radiographs using the head positioner provide a valuable adjunct to diagnosis and treatment planning for patients with M.P.D. syndrome.

B) Where extensive restorative procedures are anticipated T.M.J. radiographs can be useful before embarking on a treatment plan as well as to document the postoperative results.

C) Bilateral symmetry seems like a reasonable objective of extensive restorative dentistry.

D) Retrusion is more frequently accompanied by signs and symptoms than bilateral symmetry and protrusion.

RESUME

Le but de cette étude est d'examiner la validité de la radiographie de la jointure temporomandibulaire en utilisant le positionneur de la tête.

Pour l'étude, trois groupes de patients ont été examinés:

1) Patients souffrant de l'incidence du syndrome de dysfonction myofaciale.

2) Un échantillon pris au hasard.

3) Patients qui ont reçu un traitement pour la réhabilitation occlusale.

Chaque groupe est analysé pour s'assurer si une relation existe entre les résultats de la radiographie et les conditions cliniques observées.

La conclusion est comme suit:

A) Les radiographies de la J.T.M. utilisant le positionneur de la tête nous fournissent une aide pour diagnostiquer et planifier un traitement pour les patients souffrant de l'incidence du syndrome de dysfunction myofaciale.

B) Quand des procédés restoratifs compliqués sont anticipés, les radiographies de la J.T.M. peuvent être valables avant de planifier un traitement et d'anticiper les resultats postopératoires.

C) La symétrie bilatérale est un objectif raisonnable pour une dentisterie operatoire avancée.

D) La rétrusion est plus souvent accompagnée par des signes et symptomes que la symétrie bilatérale et la protrusion en présentent.

To the great incentives in my life:

my parents with love

my teachers with gratitude.

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INTRODUCTION

The myofascial pain dysfunction syndrome appears to be a fairly common occurrence, and is comprehensively documented in the dental literature. Routine radiographic techniques have not demonstrated that a relationship exists between M.P.D. syndrome and condylar position.

In 1972 Weinberg introduced a technique for taking T.M.J. radiographs using the head positioner, and subsequently in a series of publications he drew attention to the extreme importance of T.M.J. radiographs in diagnosis and treatment planning. He concluded that a relationship exists between M.P.D. syndrome and condylar position. Controversy exists about this conclusion. The purpose of the study is to examine the validity of T.M.J. radiographs using the head positioner.

For the study three groups of patients are examined:

1) Patients with myofascial pain dysfunction syndrome.

2) A random sample.

3) Patients who had undergone occlusal rehabilitation.

Each group is analysed to determine if a relationship exists between the radiographic findings and the clinical conditions that are observed.

REVIEW OF LITERATURE

HISTORY OF MYOFASCIAL PAIN DYSFUNCTION

The phrase temporomandibular joint pain dysfunction syndrome is an umbrella term covering a variety of problems. These problems may include the entire classification of temporomandibular joint disorders, whether intra-articular or extra-articular. However, the greatest common denominator of temporomandibular joint disorders is known as the myofascial pain dysfunction syndrome.[1]

Dental diseases are not only the product of modern times. In 5 B.C. Hippocrates described a method of reducing dislocation of the mandible very much like present techniques and similar to that used by ancient Egyptians 2,500 years earlier. This points out historically the early recognition of the special problem with mandibular dislocations.

Early concepts were not well developed until anatomical studies on articulation of the mandible and cranium were more refined. Certain figures stand out for their efforts here: Leonardo da Vinci (15th century), Andreas Vesalius (16th century) and John Hunter (18th century).[2]

Prentiss,[3] in 1918 recognized that loss of molars and premolars produced a distal condylar movement. This movement, he felt, resulted in direct pressure on the Eustachian tube and the ear structures, or impingement of the auriculotemporal nerve. Thus he felt a vertical collapse of the bite was responsible for the T.M.J. syndrome. This was the birth of the mechanical displacement theory.

Wright,[4] in 1920 agreed, stating that the retrusion of the condyle could cause resorption of the tympanic plate, constriction of the canals and irritation of the tympanic structures including the tympanic artery and the chorda tympani nerve causing partial or total loss of hearing.

Brown,[5] in 1921 and McCrane,[6] in 1925 supported this concept of deafness being caused by posterior displacement of the condyles: it did so by causing compression of the Eustachian tube.

Goodfriend,[7] in 1933 suggested that the alteration of the articular relationship was primarily a superior-posterior displacement which resulted in the relaxation of the articular ligaments and muscles, eventually causing atrophy of the disc and articular surfaces, and finally resorption of bone, which is part of a degenerative process. Cracking noises, he believed, were probably caused by loosening of the attachments of the disc to the condyle and ear symptoms were caused directly by reflex nerve pressure.

The basis of Costen's syndrome[8] was that loss of posterior teeth resulted in overclosure of the mandible and consequently pressure of the condyle on the retrocondylar structures. Pressure on these structures, mainly the auriculotemporal vessels and nerve and the external auditory meatus, resulted in a range of symptoms including impaired hearing, tinnitus, dull pain in and around the ears, dizziness and alleged sinus symptoms.

In 1936 Costen[9] published a second report. The following symptoms were added to his original syndrome: herpes and glossodynia, glossopharyngeal neuralgia and trismus. Those symptoms were present at different times and in different combinations with varying emphasis.

Many authors supported Costen's theories, others disagreed. They felt that certain aspects of Costen's syndrome had been invalidated, e.g. Zimmerman[10] in 1951 wrote "It is evident that from an anatomic and functional point of view there is only one group of symptoms in Costen's syndrome of mandibular overclosure that has a basis of acceptable fact: trigeminal and occipital neuralgias. All other symptoms are questionable."

Sicher,[11] questioned tympanic irritation with mandibular overclosure. He believed that the tympanic nerve lies protected in the pterygotympanic fissure. Sicher concluded that the only way to irritate the tympanic nerve was to fracture the surrounding bone. He proposed that the pain arose from spasm of the muscles secondary to malocclusion. He believed that the dental malocclusion was the key factor and that the edentulous patient would not have this problem. He did not discuss the patient with poorly occluded dentures.

Costen's syndrome has fallen into disrepute in recent years because his theories of its etiology have been completely disproved. The syndrome does exist but the etiology is different from that offered by Costen.

Zimmerman and Sicher[10, 11] respectively could find no anatomical basis for relating the retropositioned condyle with the complex of symptoms known as Costen's syndrome.

In 1937 Schultz[12] introduced the concept of hypermobility caused by 'lax ligaments'. He concerned himself with clinically observable joint disorders such as clicking and dislocation. He believed that an excessive range of condylar movement was responsible for the symptoms of pain and clicking. In contrast to Costen, Schultz directed his attention to the joint itself and emphasized treating the joint rather than the occlusion.

Painful areas within muscles of 'trigger areas' were described by Travell and Rinzler.[13] They pointed out the existence of syndromes associated with trigger areas within the muscles coupled with pain, spasm, tenderness and dysfunction.

Schwartz[14] felt that predisposition, psychologically or physiologically, was more important than the precipitating factors themselves. According to Schwartz's study, the pain-dysfunction syndrome first appeared in patients predisposed by constitution and temperament, as a result of sudden or prolonged stretching or proprioceptive changes following rapid or extensive changes in the occlusion of the teeth. In the explanation of this syndrome, abnormalities of the occlusion are considered to be only contributing factors.

In 1969 Laskin[15] proposed a revised view of Schwartz's T;M.J. pain-dysfunction syndrome. "Although mechanical factors related to occlusion may sometimes cause this condition by producing muscular overextension or overcontraction, our investigations support the role of muscle fatigue as the most frequently encountered cause of such spasm. The fatigue appears related predominantly to psychologically motivated, persistent, tension relieving oral habits. Thus we have come to consider the pain-dysfunction syndrome as essentially a functional psycho-physiologic disease with organic changes that later may be noted in the teeth and joints as secondary rather than primary phenomena. To stress the role played by muscles, it is suggested that the term 'myofascial pain dysfunction (M.P.D.) syndrome' is a more accurate term to describe the condition than T.M.J. pain dysfunction syndrome."

CURRENT VIEWS ON ETIOLOGIES

The myofascial pain dysfunction syndrome appears to be a fairly common occurrence, and is comprehensively documented in the dental literature. Several authors maintain that inadequate dentitions and unsatisfactory occlusion[7,8,16,17,21] are the most frequent causes of M.P.D. Other investigators, noting that hyper-function may provoke myofascial pain, assert that T.M.J. disturbances are usually related to dysfunction of the masticatory muscles and/or emotional disorders.[18,20,21]

Laskin et al[15,19] point out the key elements of the theory of the myofascial pain dysfunction (Table I). They believe that the masticatory muscle spasm is the primary factor responsible for the signs and symptoms of the pain dysfunction syndrome.

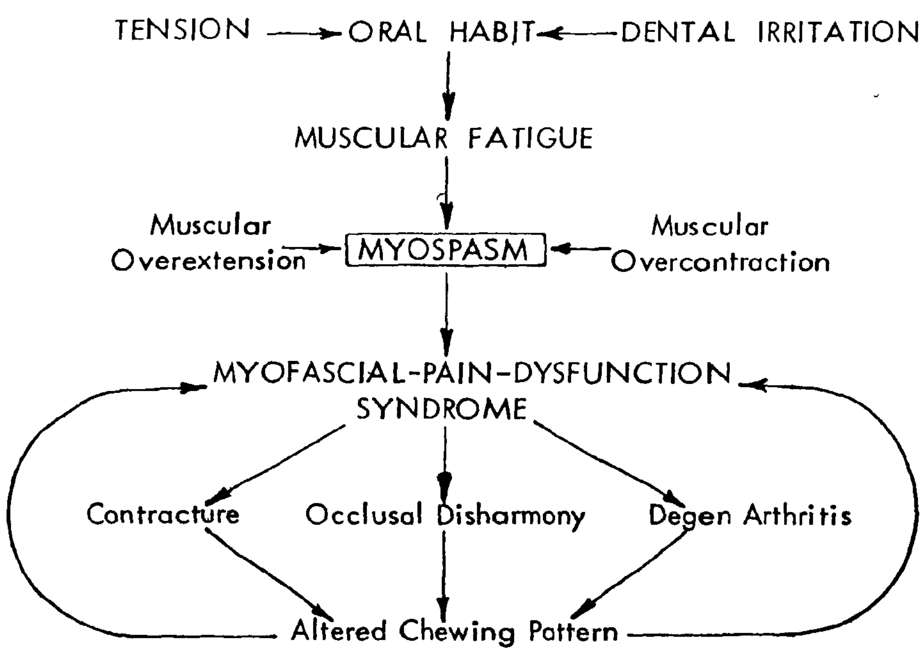


Table I

The key elements of the theory of the myofascial pain dysfunction syndrome

Spasm can be initiated in one of three ways: muscular overextension, muscular overcontraction or muscle fatigue. Examples of some of the factors that can produce overextension of the various masticatory muscles are dental restorations or fixed and removable prostheses that encroach on the intermaxillary space. Over-contraction, on the other hand, can be caused by overclosure resulting from such things as bilateral loss of posterior teeth, settling of partial dentures, etc. Although adverse mechanical factors leading either to muscle overextension or overcontraction may cause some instances of M.P.D. syndrome, Laskin et al[15, 19] believe that the most common cause of muscle fatigue is produced by chronic oral habits such as clenching or grinding of the teeth. These habits can be initiated by an annoying dental irritation such as an improperly occluding restoration or an overhanging margin. Generally, however, Laskin et al believe that they are an involuntary tension-relieving mechanism.

The development of spasm in one or more of the masticatory muscles not only leads to pain and limitation but also may produce a slight change in jaw position so that the teeth do not occlude properly. If this abnormal jaw relationship persists for several days, the teeth then may gradually shift to accommodate to the new position. In addition to producing possible alterations in occlusion, persistent myospasm also can cause two other organic changes - either (1) degenerative changes in the T.M.J. or (2) contracture of the muscle which is a manifestation of long-term spasm. These organic changes result in an altered chewing pattern with attendant reinforcement of the original spasm and pain.

According to the psychophysiologic theory, Laskin points out that masticatory muscle spasm is the primary factor responsible for the symptoms of the pain dysfunction syndrome. Organic changes such as occlusal disharmonies, degenerative arthritis and contracture which may result, tend to make the condition self-perpetuating.

Studies to support muscular fatigue as the direct cause of pain have been performed by Christenson[22] who found that prolonged voluntary loading can produce the signs and symptoms of the M.P.D. syndrome. Yemm[23] found that individuals within a control group were able to relax their muscles between successive attempts at a task, whereas patients with M.P.D. could not relax their muscles between tasks.

Histopathologic investigations have attempted to correlate myofascial pain and dysfunction with the direct overloading of muscles or with indirect disturbances of the blood supply. Yavelow[1] hypothesizes that prolonged isometric contraction interferes with local circulation and thus ionic interchange across cell membranes, depriving cells of glycogen and oxygen and increasing the lactic acid concentration.

Newton[24] adds that intense gamma firing, related to increased reticular stimulation by stress initiates the excessive isometric contraction rendering protective reflexes ineffective in correcting motor activity upon sensory input. The alpha and gamma systems are further abused by prolonged isometric contraction which in turn cuts off circulation to the muscles and the spindles become unresponsive to further stretching. Once stretching is inhibited, limitation of mandibular opening will result. Since a muscle in spasm cannot be in synchrony with the complex masticatory muscle system an asynchronous muscle activity resulting in deviation of midlines at maximal opening is produced.

Travell[25] points out that "when the muscles are subjected to noxious stimulation of various sorts (mechanical, emotional, metabolic.....) they act in one way - they develop spasm and shorten. A muscle in spasm is unable to relax voluntarily and it resists passive lengthening: this condition results in poor neuromuscular coordination." The change in muscle length of one or more of the masticatory muscles causes a change in the opening and closing movements of the jaws; it also changes the position of the mandibular condyles and restricts the degree of active vertical opening. Spasticity of the external pterygoid muscles, specifically, causes firm bracing of the condyle against the articular eminence, which causes the clicking and grating associated with T.M.J. disturbances. When only one external pterygoid is spastically involved, it will cause a shift of the mandible deviation on opening.

Patients with premature occlusal contacts feed back noxious stimuli to the masticatory muscles, causing these muscles to undergo spasm. Upon correction of the occlusal prematurity the muscle returns to a relaxed, resting state. Bruno[26] added that should the spasm be allowed to continue, the activity within the muscles will build up; the resulting pain in the muscles will be concentrated in the areas of the fascia which upon palpation demonstrate tenderness and pain. These areas are referred to as 'trigger areas'.

Bruno[26] notes that neuromuscular function is most efficient when centric relation coincides with maximum intercuspation. Deflective, interceptive contacts introduce noxious impulses into some or all of the mandibular muscles causing changes or disharmony in the neuromuscular control of mandibular motion.

Dawson[27] hypothesizes that muscle function changes in the presence of interferences to protect the interfering tooth or teeth from absorbing the entire force of the closing musculature if the mandible is not deviated away from its terminal axis. The deviation is initiated by the proprioceptive nerve endings in the periodontal fibers around the roots of the interfering teeth. These nerve endings are so sensitive to pressure that even minute interferences can trigger the external pterygoid muscles to pull one or both condyles forward. Thus, the mandible can be deviated by the muscles to accommodate almost any occlusion. Because of constant repetition of the proprioceptive trigger to the muscles, these muscles become patterned to the devious closure. Such memorized patterns of muscle activity are called 'engrams'; the physiology of muscle engrams has been described by Sicher, Ramfjord and Ash.[28] Dawson[27] added that no study of occlusion is complete without a thorough understanding of the role that engrams play.

Thomson[29] states that the type of occlusion and the number of teeth missing does not contribute to M.P.D. He added that this condition is of neuromuscular origin. Evidence in support of this is given by Schwartz and Chayes,[30] who found that a hyperexcitable central reflex mechanism triggers myospasm rather than abnormal stimuli originating from dental malocclusion.

Banasik and Laskin,[31] in their experimental induction of bruxism by electrical stimulation of major muscles of mastication concluded that muscle fatigue rather than occlusal disharmony was responsible for producing a situation akin to the M.P.D. syndrome.

While Greene and Laskin's[32] hypotheses have been offered to answer the question of why occluding splints are clinically effective, generally the hypotheses can be grouped into one of two categories: those that attribute success to an improvement in skull mandibular relationship and those that explain success in terms of improved muscular relaxation or balance. Advocates of each category usually regard occlusal disharmonies or irregularities as the primary etiologic factors responsible for the mandibular displacement or muscular imbalance. Thus the positive results that are obtained with the use of such splints are explained by improving the craniomandibular relations, allowing muscle relaxation by disengaging the teeth.

Posselt[17] suggested treatment of patients with severe symptoms of M.P.D. by selective grinding according to the following sequence:

a) adjustment of the occlusion to remove interfering tooth contacts in the retruded position
b) elimination of tooth contacts on the balancing side
c) adjustment of contacts on the working sides to increase distribution of the occlusal load.

He noted that selective grinding resulted in improvement followed by remission of symptoms in 50% of his experimental group, while an additional 45% improved. Only 5% of his patients showed no improvement.

Rosenthal and Burch[33] show the direct relationship between a patient's occlusal interferences, lack of stable contacts in centric occlusion, retrusive occlusal interferences and non-working contacts, and his neuromuscular or temporomandibular articulation dysfunction.

In a study by Ramfjord,[28] 32 patients with T.M.J. dysfunction and pain were 'cured' by occlusal adjustment of the retruded contact position and by obtaining harmony in excursive movements.

Dawson[27] states that the pain of M.P.D. is almost always resolvable in a matter of minutes once the occlusion has been refined, except if the pain comes from the traumatized joint surfaces or from tendonitis or damage to the muscle. If the pain persists after occlusal adjustment Dawson believes that it comes as a result of the dentist not correctly manipulating the mandible to locate the interferences or by not refining the occlusion precisely enough. A 'pretty good' centric occlusion is not good enough.

Winter and Yavelow[34] believe that the neuromuscular adaptation enables most patients to tolerate or adapt to interceptive contacts which do not necessarily traumatize the supporting investiture.

Zarb and Thompson[16] write that the human masticatory system is rarely in harmony, but the components exhibit an extraordinary adaptive range. Once the adaptive range is exceeded, the weakest part of the system breaks down, be it the periodontium, the teeth, the muscles or the T.M.J. That is why there are millions of people with severe malocclusions, without the slightest indications of muscle or joint problems.

Celenza[87] states that all parts in the positional guidance system have the capacity to adapt. The joint can give, the teeth can wear, the periodontal structure can stretch, the neuromuscular complex can alter in dynamics, all of which give a wide range of adaptation.

Celenza added that adaptation is a normal process. It remains normal as long as the limit of adaptation is not exceeded. If exceeded, pathology will occur in many possible forms:

a) loss of periodontal support

b) recession of attachment apparatus

c) bone loss

d) wear of teeth. If highly resistant to wear, the joint will be forced into non-centric position by musculature in spite of neuromuscular control, and trauma to the joint will occur

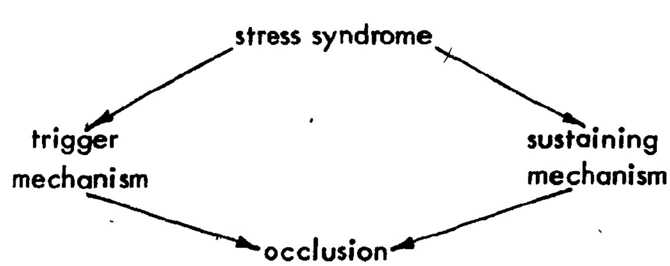
e) muscle spasm.

Celenza believes that the temporomandibular joints are the last structures to show pathology. They are so designed that they are the top structures of the system. Restoration of harmony between positional guidance components within the adaptive range of that individual is the objective of oral rehabilitation.

Whereas a school emphasizes the occlusal disharmony as the major etiological factor for the development of M.P.D., it cannot explain why masticatory pain and dysfunction are comparatively uncommon when occlusal disharmony is so prevalent in the general population. It is now recognized that the hyperactivity of muscles leading to myalgia and myospasm is triggered by emotional tension and may be due to a combination of psychological stress and muscle incoordination secondary to malocclusion. The resulting pain and dysfunction may then exacerbate the stress and anxiety already present to set up a myospasm pain cycle leading to continued masticatory dysfunction.

Ramfjord and Ash[28] note that occlusal discrepancies together with psychogenic factors can trigger abnormal muscle action. The key factor is the patient's ability to adapt to the occlusal disturbances as determined by the individual's psychological state. Thus the pain dysfunction depends on the intensity of the initiating factor (occlusion) and the state of resistance or adaptation as determined by psychological parameters.

The diametrically opposing etiologic concepts, namely occlusion and emotional stress are both misused, Weinberg[35] says, when a patient must be rigidly type cast into one or the other group depending on the views of the clinician. The problem is not to decide which single factor caused the symptoms but rather to understand the interrelationship of the many factors operating simultaneously and/or their timing. In a given patient, an occlusal interference may trigger the patient's acute symptoms while another factor, such as emotional stress, may sustain them. The converse may also be true where a given long-standing malocclusion will serve as a sustaining mechanism to the acute symptoms which were triggered by the patient's response to an acute stress syndrome. Thus the concept of the 'etiologic circle' is useful to understand the mechanism of T.M.J. dysfunction.



Weinberg[35] avoids using the terms 'psychosomatic' or 'emotional tension' as these terms imply that T.M.J. dysfunction is an emotional disorder which can only be cured by psychiatry. The term 'stress syndrome' is preferred for many patients undergoing the emotional stress of life for which psychiatry is not indicated, such as sudden change of a patient's circumstances. The patient may be able to adjust to this emotional crisis without professional help, but the body chemistry changes take place nonetheless. Selye[36] described the 'fight-flight' reaction to stress over twenty years ago. Physical and emotional stress no matter what the cause, produce body chemistry changes.

Goss[37] believes that the psychological aspect of M.P.D. is an important one and indeed it has been asserted that without emotional tension M.P.D. does not develop. This assertion is supported by the work of Lupton[20] who showed that there was no statistically significant difference between a randomly selected group of patients with M.P.D. who were treated with psychotherapy alone as compared to a similar group treated with dental therapy alone. In selected groups of patients, that is those with a strong non-organic component to M.P.D., it is possible that dental treatment alone without psychotherapy will do positive harm.

Moulton,[38] has described her attempts to treat several M.P.D. patients through psychotherapy. She reported that precipitating factors affecting the psychological balance of the patient included strong anger requiring inordinate efforts to repress and control, the death of a relative or marital partner on whom the patient was dependent, and exacting perfectionism that covered secret hostility. Thirty one of the thirty five patients she interview presented significant emotional factors.

Thomas et al[39] studied the effects of anxiety and frustration on muscular tension. Electromyogram recordings were taken from the masseter and temporal muscles for each subject during the condition of relaxation, anxiety and frustration. The results leave no doubt that psychologic stress plays a significant role in the etiology of M.P.D.

Nally and Moore[40] mentioned emotions that cannot be consciously expressed to relieve tension may be converted into somatic symptoms, including pain. Though the seat of the emotions is the psyche, the mouth is used subconsciously to express a wide range of emotional reactions including love, rage, hate, anger, worry and fear. Consequently the T.M.J. structures and related muscles of mastication can become deranged because of emotional distress. The development of this pain syndrome can occur as the result of an unbearable environmental situation especially if the patient feels trapped between two opposing forces.

Lupton[20] stated that as a result of past and present studies there are reasonable grounds for recognizing a significant relationship between psychological factors and non-organic T.M.J. dysfunction. Treatment of the psychological factors also results in relief of the symptoms.

Lerman[41] presents a good explanation for the emotional aspect: some individuals are psychologically predisposed to magnify the stress-generating potentials of their life situation. Consequently those individuals actually experience excessive degrees of psychological stress. The body responds physiologically to this by generating energy and liberating it internally. Instead of venting and discharging the resulting tension during the coping process, potential M.P.D. patients turn them inward, and channel them through the stomatognathic system. Increased clenching and bruxing activity results.

The 'gnashing of teeth' or the common term bruxism is a manifestation of hostility which occurs when conscious controls are relaxed.[88] Vernallis[89] studied forty persons who ground their teeth to determine the extent to which this dental syndrome is related to psychological factors of anxiety, hostility and hyper-activity. Through psychological testing of these subjects, he found that the three psychological factors are significantly and positively related to bruxism. The pre-disposition of a patient to bruxism may be due to environmental tension, and the trigger may be the occlusal and proprioceptive disturbance of unrestored loss of teeth, the result in this situation being a tendency towards muscular hyperactivity, tooth faceting and joint dysfunction.[18]

To complete the screening for the etiology of M.P.D. it is essential to eliminate the possibility of medically-linked factors, recent major surgical operations, trauma to the head and neck such as a blow to the jaw or whiplash of the head as could result from automobile accidents or recent airplane trips, which can give signs and symptoms of M.P.D.

There are still some gaps in total understanding of the etiology of the M.P.D. syndrome and there is no agreement between the 'pro and con' schools of thought.

DIAGNOSIS

There are a wide variety of factors which must be considered when attempting to establish a correct diagnosis of any disease entity. From the moment the patient presents, a logical step by step procedure should be carried out in the diagnosis of the presenting problem. Primarily, an accurate medical history should be taken, noting the last physical examination, recent laboratory test findings such as urinalysis, blood analysis, etc. The patient's sex, age, race, as well as previous illnesses, disabilities, hospitalization periods; cause, nature and treatment of any such occurrence in the patient's life should be recorded. Next, an accurate dental history should be compiled considering experience with other dentists, previous work done, previous extractions, histories of dental and/or head and neck pain (cause and treatment). Medication for a medical and/or dental problem should be noted as this may affect the treatment or may contribute to the subconscious disease process.

Having been satisfied with such a history, we should now turn our attention to recording the patient's objective symptoms, i.e., the reasons why he/she presented for treatment. Upon questioning, any complaint of pain, muscle tenderness, joint crepitation and limitation or alteration of mandibular movement should be recorded. The patient should be asked about his social life, his work, whether stress plays a large role in his daily living - anything which may give us any insight into the subject's psychological profile.

Dentally, we should discover whether the patient has any complaints about the health of his soft and hard oral tissues. At this stage, the patient should be examined for subjective symptoms or complaints.

A. Subjective symptoms

1. Pain

Goss[42] believes that the most common features of the pain of M.P.D. are location (unilateral in the preauricular region); duration (increasing severity over a period of months); time (worse on waking, eating and times of stress); radiation (to the infraorbital, ramus and temporal regions) and referred (to the occipital and cervical regions). Lerman[41] explains that the most frequently sore muscles are the lateral pterygoid, masseter and temporalis. Dawson[27] hypothesized that the muscle pain is due to build up of toxins due to prolonged contraction causing prolonged chemical changes within the muscle fiber.

2. Muscle tenderness

Dawson[27] and Goss[42] believe that checking the pterygoid muscles for tenderness to palpation is the first clinical step in making a diagnosis.

Goss[42] believes that the muscles of mastication should be firmly palpated to detect tender areas of muscle spasm. Common sites are over the anterior fibers of the temporalis, the attachment of masseter to the zygoma and the insertion of the medial pterygoid to the medial aspect of the angle of the mandible. In the facial and neck areas, the insertion of the sternomastoid muscle, as well as the body of trapezious can be affected. In fact, Goss[42] went on to state that "..... myofascial pain dysfunction is only a variant of muscle tension headache, affecting the masticatory muscles." Therefore, during the examination procedures, palpation not only of the joint but also the entire head and neck muscular apparatus is essential.

3. Joint clicking

Clicking and noises of the T.M.J. are not a disease but a symptom, usually alarming and annoying in nature and frequently followed by limitation of movement and pain.[90] It has been described by patients as a 'click', a 'crack' or a 'pop'. The sound may be minor and heard only with the use of a stethoscope or it may be so loud as to be easily heard across a room. At other times there are variations of loudness between these two extremes. Many people exhibit this sign of masticatory apparatus dysfunction but apparently live with it and never seek treatment.[30] Weinberg's[35] opinion is that disc derangement may precede muscle spasm and is nature's warning device of a malfunctioning joint mechanism, while Goss[42] believes that there is no correlation between joint sounds and articular pathology.

Sicher hypothesized that if the muscles of the mandible fall into spastic contractions or contracture, the unilateral muscle contractions eventually will cause a displacement of the disc with relation to the condyle. In the 'fight' of the irritated muscles against each other, the disc may be held in place while the mandible is displaced posteriorly, the mandible may be stabilized while the disc is displaced anteriorly, or more probably a combination of these possibilities becomes a reality.[91]

Sabin and Laskin believed that during unharmonious movement of the condyles sound occured during opening.When the condyle on one side reached its position of sound occurrence there was a time delay before the contra-lateral condyle reached this same position. This time delay in movement was measured and taken to mean asynchronous movement.[91]

Yavelow and Arnold[91] emphasize the importance of desynchronization of masticatory muscles and their associated moving parts as predisposing factors to clicking and they believe that the synovial fluid being confined under pressure instead of acting as a lubricant plays a part in producing the click.

4. Limitation of jaw movement or alteration of mandibular opening

Limitation of movement or dysfunction of masticatory muscles is the least common major feature and it also tends to occur late in the M.P.D. syndrome; usually the patient complains of an inability to bite or insert food into his mouth or to yawn or deviation on opening.

This is explained by the fact that the muscles are programmed to produce mandibular positions. When these muscles are stretched beyond their optimal length, deviation or limitation of opening occurs.

Other minor symptoms have been noted by Posselt[17] which he lists as ear symptoms (tinnitus, feeling of a stuffy sensation in the ear or about the ear), head (headache, neuralgia) and nasopharyngeal symptoms (causalgia of the tongue, nose or throat).

Having evaluated the subjective signs and symptoms (those provided by the patient) attention is now focused on the objective examination (information obtained by the dentist).

B. Objective signs

Oral habits such as clenching or bruxing have been implicated with M.P.D. patients. Agerberg[51] found that clenching occurred twice as often in the M.P.D. individuals when compared to the general population surveyed (1,215 people).

Helkimo[52] also found clenching and grinding habits most common in the thirty five to forty four year group which had M.P.D. symptoms.

Schwartz[14] refers to dislocation of the condyle as a possible sign of muscle spasm. This is due to a sudden change in muscular tension when the condyles are on or anterior to the articulator eminence. Subluxation has also been recognized as a manifestation of the dysfunction syndrome.

Zarb and Thompson[16] noted that ten patients complained of swelling over the joint region.

Stallard[43] noted typical signs of occlusal trauma, resorption of alveolar bone and thickened periodontal ligaments in individuals with T.M.J. dysfunction, while Winter et al[34] believe that the periodontal health of patients with the M.P.D. syndrome appears to be better than anticipated.

Travell[25] found that areas of hypersensitivity located in muscle or fascia could induce pain at specific sites distant from the initial site of stimulation. He found that referred pain patterns did not necessarily follow a 'neurosegmental distribution' but rather had fixed anatomic pathways. As well as the referral of pain, trigger areas could also give rise to nonpainful responses such as localized sweating, lacrimation, salivation, dizziness and tinnitus.

C. Psychological findings

During examination a diagnosis of the patient's psychological status will become the most important area for further investigation. Kydd[44] states that in such a phase of diagnosis, the following tests are of the utmost benefit:

1) subject's written history of original and progress of pain

2) an interview or series of interviews to determine if there are any emotional stressful incidents which might correlate with the initial onset of pain

3) the Cornel Medical Index, the Minnesota Multiphasic Personality Index and the Edward's Personality Profile.

Kydd[44] reported that if there was any indication of emotional disturbance with one of the three methods of emotional evaluation, it usually appeared with the other methods as well.

Of the subjects evaluated in Kydd's study, it was found that seventy six percent were emotionally disturbed and twenty four percent were considered emotionally normal. Goss[42] amongst others has supported the above by concluding that most patients with M.P.D. have significant psychological problems and require psychological and/or psychiatric consultation.

D. Electromyography

It has been recently discovered that measurement of muscle activity of facial origin by electromyography is now thought to be essential in determining the function of masticatory muscles in the etiology of M.P.D. syndrome. Electromyographic measurements of the 'masseteric silent period' after jaw-jerk reflex during a voluntary clenching of the teeth disclosed various interesting results. Normally, in pain-free individuals the 'silent period' following the jaw-jerk reflex measures approximately 20 - 24 msec's followed by resumption of asychronous activity.[45] In myofascial pain dysfunction patients the electromyographic reading is similar in all instances to that of a normal, pain-free subject except that the duration of the masseteric silent period is approximately 60 msec's. Therefore, it has been suggested by several authors that a silent period of greater than 33 msec's is associated with myofascial pain dysfunction and may indicate muscle spasm.

Furthermore, it was suggested that in a great majority of cases, M.P.D. patients did not manifest chronic hyperfunction of the masseter and temporal muscles when they were comfortable and discussing emotionally neutral topics. These subjects could produce a 'resting state' in their musculature.[44] Therefore, electromyographic measurement of the duration of the masseteric silent period is useful in diagnosis of M.P.D. patients. Bessette[45] tried to explain the abnormally long masseteric silent period in M.P.D. patients by rationalizing that they exhibit an additional inhibition of the trigeminal motor pool in some manner. Muscle spasm presented and increased the output from Golgi tendon organs which in turn caused an abnormally lengthened silent period. Although this rationale is still purely conjecture, it does pose interesting implications. Spasm in muscles of mastication may, therefore, be responsible for altered position of the condyles in the glenoid fossae.

An electromyographic study[46] of the masseter and anterior part of the temporalis muscles was performed on ten patients presenting temporomandibular joint dysfunction symptoms. The electromyographic silent periods (Sp) produced in the open-close-clench cycle and jaw-jerk reflex were compared for duration before and after treatment with an occlusal bite plane. Following use of the splint, there was a shortening of Sp indicating the possible use of the duration of Sp as a diagnostic measurement, and also as an indication of treatment effectiveness. Ramfjord[28] also believes that electromyography is a sensitive, helpful tool for diagnosing muscle spasm.

Moller[47] and Yemm[23] hypothesize that electromyography reflects the activity in a muscle and the relative time of activation of different muscles. Electromyography has been used as an aid to diagnose muscle dysfunction.

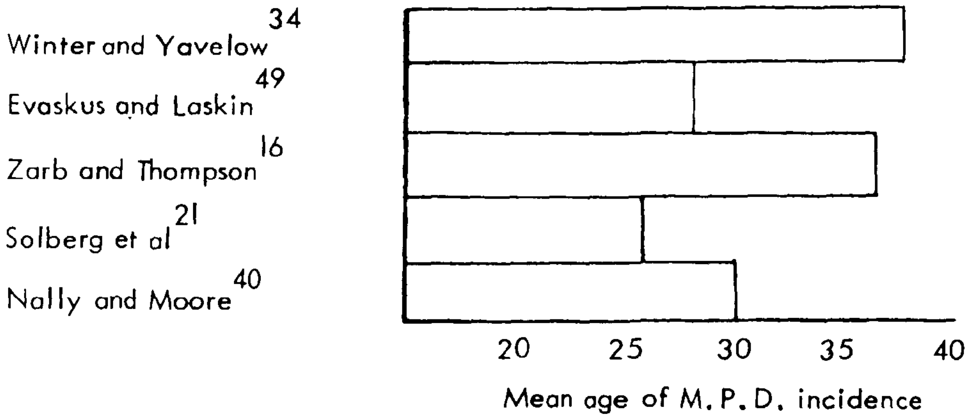
Finally, Bessette et al[45] think that measurement of the duration of the masseteric silent period may be more reliable diagnostically than radiography of the temporomandibular joint because it permits quantification of the amount of muscle spasm.

E. Pantographic records

Roura and Clayton[48] in their study concluded that reproducible mandibular border movements can be recorded graphically by means of a pantograph on subjects with apparently 'normal' muscle and temporomandibular joint function. If a subject cannot reproduce the border movements, one cause might be T.M.J. dysfunction. One month of occlusal splint therapy relieved most signs and symptoms of T.M.J. dysfunction. When studied clinically and electromyographically, complete relief of muscle dysfunction was not evident. In a subject with T.M.J. dysfunction, one month of occlusal bite-splint therapy alone may not insure relief of symptoms to the point where the subject can trace reproducible mandibular border movements.

F. Physical findings

Age: There appear to be two predominant age groups which are predisposed to the syndrome. Most cases occur between twenty and forty years of age in one study while the other group reports a predominant incidence in the late middle to early old age period (forty five to seventy years). Refer to Graph I and Table 2 for a summary of findings.



Graph I

Carrars et al[50]	(763)	33.3% were 21 to 30 years
Thomson[29]	(100)	23.0% were 31 to 40 years
		39.0% were under 30 years
		38.0% were over 40 years
Agerberg and Carlsson[51]	(82)	41.0% were 50 to 74 years
Helkimo[52]	(321)	over 50% were 45 to 54 years

N.B. The numbers in brackets refer to the number of patients seen in the study.

Table 2

Sex: The predominant M.P.D. subject is a female at the ratio of 4:1, but two studies surveyed have differed from this generalized view, showing equal involvement of males and females. Refer to Table 3 for a summary of findings.

	Female to Male Ratio
Agerberg,[51] Helkimo[52]	1:1
Winter[34]	2:1
Solberg,[21] Carraro[50]	3:1
Thomson[29]	4:1
Butler,[53] Evaskus,[49] Nally[40]	5:1
Zarb[16]	8:1

Table 3

Female to Male Ratio of M.P.D. Patients

Reasons for the female majority are based mainly on psychological differences. Some of these reasons include:

a) Women have a higher tendency to demonstrate anxieties.

b) Women have less opportunity to release aggression through other means, thus this release is manifested through muscular contraction.

c) Women have been shown to be prone to emotional instability.[44]

d) Women seek more attention for oral problems in general.[50]

G. Radiographic evaluation

It is not surprising to find that the number of dentists who routinely make complete intraoral roentgenographic examination for all patients is continually growing. Lateral jaw and sinus examination also are being made more frequently; but examination of the temporomandibular joint is usually avoided, regardless of the evidence demanding a roentgenographic study of this structure. The reasons most commonly given for this apathetic attitude are:

1) The infrequent demand for roentogenography of the joint does not warrant the installation of the complicated and costly equipment required to produce the desired results.

2) The information gained from a roentgenogram of the temporomandibular joint is often questionable and inconclusive.[54]

Zech[55] and Yune[56] believe that roentgenography is one of the most important diagnostic aids in studying diseases of the temporomandibular joint. Zech believes that clearly defined roentgenograms are difficult to obtain and even an investigator with a conscientious technique is bound to become discouraged. Many factors are involved in obtaining accurate films of this joint. Of first consideration is the large amount of structure which must be penetrated by the roentgen rays before they arrive at the site being examined, for the rays must pass obliquely through the entire head before arriving at the joint. This produces considerable scattered radiation which causes fogging of the film. Furthermore, the central ray must avoid the dense petrous portion of the temporal bone in order to prevent superimposition of the joint being examined and subsequent obliteration of contrast. In addition there is a lot of variation in the cranial size, form and bony density of individuals. Also, Amer[57] points out the anatomic variations of the temporomandibular structures in the same individual. With these thoughts in mind, the operator readily appreciates the difficulties in establishing a standardized technique of film placement and exposure time which is expected to produce excellent results in all applications. Yale[58] in his study of 1,700 mandibular condyles believes that correct radiographic evaluation of the temporomandibular joint requires specialized procedures and thorough knowledge of the range of variation in condylar forms.

Greene et al[59] believe that too often the roentgenographic examination is incomplete and it is erroneously concluded that the patient's problem is functional or psychosomatic.

Dawson[27, 86] believes that when we realize that severe symptoms can be triggered by tooth interferences which deviate the condyle position less than the thickness of thin cellophane it is unrealistic to think that such minute deviation can be detected by any existing radiographic technique.

Dawson[27, 86] added that while it is unusual for T.M.J. radiographs to affect the choice of treatment, they should nevertheless be a part of the differential diagnosis of any T.M.J. syndrome. In some patients, radiographs are the only source of needed information.

Taylor et al[60] believe that the diagnosis and treatment of the symptomatic temporomandibular joint continues to be a challenge. Roentgenographic architecture of the joint has not been well delineated, a situation which contributes to confusion in the interpretation of these symptoms.

Rozencweig[61] concludes that radiographic examination of the temporomandibular joint often becomes an essential diagnostic tool, particularly in obscure and difficult problems of pain and dysfunction in the area of the articulation. Many individuals performing extensive prosthetic reconstruction utilize T.M.J. X-ray as an adjunctive aid in establishing or verifying the harmony of the condylar position of the jaws.

The theoretical and technical difficulties of obtaining detailed and diagnostically helpful radiographs of the T.M.J. are numerous, owing to the depth and position of the anatomic structures being studied. This is dramatically shown by the extent of distortion of the bony structures involved when standard radiographic technique for viewing the T.M.J. is employed. Practically all of the techniques commonly used are designed to avoid anatomical superimpositions by utilizing an oblique projection, thus resulting in a less than accurate X-ray image of the bones and adjacent joint spaces.

DIFFERENT T.M.J. RADIOGRAPHIC TECHNIQUES

During 1916 to 1920 the roentgenographic examination of the temporomandibular joint was the subject of many European investigators' interest.[62] In the developing stage the technique consisted of conventional roentgenographs of the joints in lateral oblique projections. Because of the problem of superimposition of image of various structures on a roentgenograph, angulation and rotation of the patient's head or the source of the radiation (X-ray tube) were tried. Soon the significance of a graphic demonstration of the joint function made possible by an additional roentgenograph obtained in an open mouth position was realized. The morphology and the function of the temporomandibular joint were also studied in different (frontal) projections. Later further efforts were made to improve the visualization of smaller structural details on a roentgenographic image by using such special examination techniques as tomography and arthrography.

Some portions of the temporomandibular joint are radiopaque and therefore readily demonstrable on radiographs. Other parts which are radiolucent can be evaluated only be deduction. The integrity of these radiolucent structures is evaluated by implication, observations on the adjacent image-forming structures or in the function of the joint. The complete temporomandibular joint evaluation should consist of 1) static morphological evaluation and 2) the functional aspect of the joint.

Some of the techniques introduced to the medical and dental professions in the past half-century emphasize one aspect or the other. Regardless of how meticulously an examination is conducted, the study in one aspect alone would not be considered as a complete evaluation.

Lateral Projections

In the lateral projection, to avoid image superimposition, the beam of radiation can be directed in either one of two ways. The first way is to enter through the cranium on the opposite side (transcranial lateral oblique projection) and the other way is to enter through below or behind the opposite mandible (infracranial-transfacial transpharyngeal projection). In either way, the joint to be examined is placed against the film and the central beam of the radiation exist through this joint. The angulation which is necessary to eliminate the superimposition of images of other structures on that of the temporomandibular joint may distort the appearance of the joint structures on the roentgenograph.[64] There are several minor modifications in both groups. The transpharyngeal approach is a modification of the conventional lateral view of the ascending ramus of the mandible. Various views are named after the author who advocates different ways of positioning the patient and/or the tube in relation to the film and the use of certain accessories and attachments to the roentgenographic unit. In the transcranial lateral projection, either the patient's head or the

X-ray tube is tilted to produce anywhere from a 1° to 30° angle to the axis of central radiation beam in relation to the sagittal plane of the skull. In some views, tilt of the axis of the central beam of radiation toward the face is also added. In transpharyngeal lateral projection, the head or the X-ray tube is tilted in such a way that the central beam of radiation may be directed towards the face or the occiput by additional rotation of the head or tilt of the X-ray tube. The cephalad elaborate angulation ranges from 10° to 30°. If facial or occipital tilt is added, this is usually about 10°.

The outlines of the mandibular condyle shown on transcranial and transfacial projections are similar, but the transcranial view is actually delineating a slightly more lateral aspect. The transpharyngeal view delineates a more medial aspect of the head of the mandibular condyle.

Since the translation of the head of the mandibular condyle is to the anterior direction, nearly perpendicular to the axis of the radiation beam, the lateral projection will demonstrate the range of mobility of the condyle to its full extent. Therefore, any of the lateral projections may be obtained in closed and open mouth positions for the assessment of the condyle's degree of translation. Some of the authors (Updegrave) recommend an additional view with the teeth in terminal occlusion to see if there is any alteration of the positional relationship of the mandibular condyle to the mandibular fossa by an acquired centric occlusion of the teeth which would not be demonstrated with the mandible in rest position.

Frontal projections

The temporomandibular joint may be visualized from a frontal projection such as Water, submentovertex and transorbital views. These frontal projections are added to the lateral projection as a supplementary study for the evaluation of the morphology of the temporomandibular joint. Since the motion of the temporomandibular joint is in an anterior posterior direction, this movement cannot be appreciated readily on these frontal projections. An open mouth view will provide a clearer outline of the mandibular condyles on Towne and transorbital views by bringing the head of the mandibular condyle below the articular eminence.

Both temporomandibular joints may be visualized on single exposure on the same film on Towne, Water, and submentovertex views. Furthermore, if one should wish to evaluate the other parts of the mandible away from the temporomandibular joint, the frontal projections which will include the entire mandible as well as the facial bones will provide such an opportunity. For this reason and also for reducing the time of examination the single exposure method is more desirable than tightly coned down views over the temporomandibular joint area which some authors advocate for the reasons of slightly improved clarity of the image and reduced tissue radiation dose. Transorbital views cannot be obtained on a single exposure because of the rotation of the head necessary to visualize the mandibular condyle through the center of the orbit. This is accomplished by aligning the axis of the central beam of radiation on the canto-meatal line and turning the head approximately 20^{o} to the side of the joint being examined.

Other techniques

In the last quarter-century, more sophisticated and specialized examination techniques have been introduced. These include panoramic view, tomography, arthrography and cinefluorography. Of these, the arthrography and cinefluorography have not gained popular clinical acceptance because the additional information that may be gained by these specialized examination techniques does not justify the expense in time and material. The panoramic technique and the tomography, on the other hand, are gaining wider support by clinicians as time goes on due to the fact that improved image quality by these examinations enables the detection of smaller and frequently earlier changes in small structures of the temporomandibular joint. Both the panoramic and the tomographic techniques may be obtained in open and closed mouth series to gain an insight in the functional aspect of the joint.

The panoramic view is in a sense the lateral and frontal views combined into one as far as the jaws are concerned, except the temporomandibular joint, which is a straight lateral view. Both sides of the face are recorded on single film, and lateral views of the temporomandibular joint are easily compared on the same film. Provided that there is no gross asymmetry of two sides of the mandible and the positioning of the head was properly done, geometric relationship of temporomandibular joints to the midline of the face should be symmetrical, therefore a direct comparison of two sides is more accurate than any other technique. The orth-axial sweel of the tube and the curved film results in a tomographic image of structures placed on the arc of the changing axis, eliminating the problem of superimposition of structures.

In the earlier period, when the tomographic technique was applied to the examination of the temporomandibular joint, the objective seems to have been only in eliminating superimposed images. The routine for the recommended technique was to obtain laminagraphic views at every 5 mm. distance, from l to 2.5 or 3 cm. depth from the skin surface in an open and closed mouth position at each depth. With later years, the use of the multidirectional thin section tomography technique opened a new frontier for investigators whose interest was in the study of ultrafine structural details in various parts of the body, resulting in a further contribution from the tomographic technique in the areas of the temporomandibular joint. The multi-directional tomography is a highly sophisticated technique which allows up to l mm. thin sectional image of a structure of interest. The most lucid example of the use of this technique is in the study of the middle and the inner ear structures. The same modality applied to the examination of the temporomandibular joint has added the perspective of depth by making it possible to see finer morphological details of only a few millimetres in dimension.[65]

Multiple exposures to radiation during tomographic series were considered by some as an undesirable risk and cause for them to hesitate accepting this technique as a part of a routine examination.

These special examination techniques such as panoramic and tomographic techniques cannot be obtained without proper equipment. The investment in the equipment and the expense in time and material for the performance of the examination are considerable.

Yune and Updegrave[63] added that although the multidirectional thin section tomography technique is an essential element of the modern investigation method of the temporomandibular joint, it would be unwise to consider that this technique can replace all previously established conventional techniques and it is also empirical and wasteful to study the functional aspect of the temporomandibular joint on thin section tomography.

Markovic and Rosenberg[66] in their study of tomographic evaluation of one hundred patients with temporomandibular joint symptoms, conclude that all radiographic techniques will produce radiographs showing a series of shadow shapes of the bony structures of the area of interest, but relating bony changes or morphologic changes of the complex temporomandibular joint requires a technique that positions the skull so as to allow the central X-ray beam to penetrate the long axis of the condyle, considering the horizontal and vertical angulations of each condyle.

Rosenberg[67] in his study used the laminagraphy for examining the temporomandibular joint. He believed that laminagraphy is a technique which minimizes the superimposition over the joint region.

Buhner[69] used a headholder which attached to a standard dental X-ray machine to produce properly oriented radiographs of the temporomandibular joint region and to permit the patient to be in an unstrained and natural vertical position. He obtained a series of radiographic views that are reproducible, oriented in character and traceable. Buhner added that the individual anatomic anomolies and variations (such as a large and prominent sella turcica, an extreme roof angle of the glenoid fossa, and the depth and direction of the external auditory meatus or ear canal in relation to the external auditory meatus on the cranium) are some factors that adversely affect film clarity and the actual relationship of the condyle to the glenoid fossa.

Considering this instrument as a clinical tool, the errors introduced by fixation are, to a large degree, offset by improved orientation. The degree of individual error should remain the same.

Weinberg[69] concluded that the anterior and posterior 'poles' of the condyle can sometimes be observed to change shape in repeated X-rays of the same joint. Before one draws premature conclusions, Weinberg feels that two questions should be evaluated. First, does the superior part of the condyle undergo the same degree of distortion as the poles, in successive radiographs? Secondly, does the fossa undergo similar and proportional change, between duplicate radiographs, so that the dimension of the joint space remains the same? If the joint space remains constant on successive radiographs then the T.M.J. radiograph is indeed an accurate tool for diagnosis and treatment.

Weinberg[69] used a standard X-ray machine and a 5 x 7 inch cassette and a film holder for obtaining T.M.J. radiographs. He called it a simplified T.M.J. radiographic technique. A flat surface was used to hold the cassette. The patient's body position was adjusted so that it was comfortable to him to place his head on the cassette with his ear resting flat against it. Centric occlusion was confirmed and the cassette was placed against the side of the head with the patient in an upright position. The central lines of the cassette were placed about one half an inch below the location of the condyle in order to center the X-ray on the film. The cassette was held against the head while both were positioned on a flat table. The ala tragus line of the patient was aligned parallel to the top of the cassette and the head of the X-ray tube. A cardboard template was used to position the cone of the X-ray. The template was placed even with the middle of the tragus of the ear and along the line where the ear attaches to the side of the head.

Weinberg[69] in his clinical experiment on twenty eight pairs of T.M.J. radiographs of patients, showed that the maximum difference in means between pairs of radiographs was only 0.05 mm. more than the control group. Clinical discrepancies between centric relation and centric occlusion could be correlated by means of T.M.J. radiographs. Changes in the occlusion of as little as 1.0 mm. can be observed in temporomandibular joint radiographs. Weinberg[69] added that his study provides evidence supporting the view that the T.M.J. space can be duplicated with radiographic techniques, and therefore the routine use of T.M.J. radiographs is strongly recommended in diagnosis and treatment.

Limitations of Weinberg's simplified technique

The T.M.J. space is duplicable, but the superimposition of cranial structures into the joint space is not controllable with ordinary techniques. This statement may seem to be contradictory at first glance, but the duplicability of the T.M.J. space is due to the high ratio (14:1) of the X-ray source-to-film distance and the object-to-film distance. The superimposition of bony structure changes in position from one film to another, because these structures move a proportionately greater distance as the head is rotated about the T.M.J. that is being radiographed. Since these skeletal structures are closer to the X-ray source, their slight change in position relative to the T.M.J. is magnified by their projection onto the film. For these reasons, control of the head position becomes a practical necessity if continued good diagnostic quality is to be expected.

A most important consideration is the amount of radiation the patient receives. With a controlled head position, the area that is exposed to the X-rays can be reduced greatly. This has the significant benefit of increasing the contrast and quality of the resultant radiograph. A more controlled technique will also permit basic research into the factors that affect the resultant T.M.J. radiograph. With this information, a controlled technique can be developed which will insure improved results and will permit the correction of heretofore nondiagnostic T.M.J. radiographs.

Head Positioner*

A device developed by Weinberg in 1972 was constructed to record the three-dimensional position of the patient's head. It consists of a raised plastic table, to permit the insertion of an X-ray cassette, with a small plastic projection (fixed auditory guide) which fits into the auditory meatus. Another plastic sheet was hinged to fit over the head, and a grid of small holes (6mm. apart) was prepared and labeled. The grid is made up of 17 holes in the X and Y axes covering an area of 102 mm. by 102 mm. Another plastic earpiece (movable auditory guide) is attached to a small rod which fits into the holes of the grid. The top cover has an adjustable guide on the side which is marked so that its position can be recorded and later duplicated.

The patient's 'lower' ear is positioned on the plastic table to fit over the fixed auditory guide. The rod of the movable auditory guide can be seen extending beyond the grid. The ala tragus line of the patient is made parallel with the back part of the positioner. An angulation of 75 degrees is used with the X-ray tube parallel

*T.M.J. Head Positioner, A-B Tool & Manufacturing Company, High Bridge, N.J.

to the back of the positioner. The tip of the cone is positioned at the selected point on the grid which will place the T.M.J. image in the middle of the radiated area. The location of the movable auditory guide and X-ray tube and position of the top cover are recorded. (See Figure I)

Figure I

Whether the head is vertical, horizontal, or tilted somewhere between, the central X-ray will have to be adjusted to accommodate the head position in order to pass through the 'window of bone' to avoid superimposition of the petrous portion of the temporal bone and the posterior clinoid process on the T.M.J. space. Every technique must make this narrow pathway available to produce good results. Even if the head is positioned three-dimensionally and the narrow pathway through the 'window of bone' is assured, every T.M.J. radiograph will not necessarily be diagnostic. Occasionally a patient's atypical anatomy of the temporomandibular joint cannot be successfully reproduced on a radiograph because of the limitations of the narrow pathway through the 'window of bone' through which the beam of radiation must pass.

Weinberg mentioned the following advantages of the previously described head positioner:

1) Correction of superimposition of cranial structure in the T.M.J. space.
2) Reduction of radiation.
3) Improvement of the diagnostic quality of the resulting radiographs.

Weinberg also offers suggestions for:

1) Correction of nondiagnostic T.M.J. radiographs;[70] due to the individual anatomic variations of the patient, the resultant T.M.J. radiograph may not be diagnostic.

When the T.M.J. radiograph is nondiagnostic, the location of the petrous portion of the temporal bone will indicate what corrective measures should be taken. When this bony structure is located in a much more inferior direction than it usually is the head position should be corrected by rotating the auditory axis superiorly which will cause the petrous portion of the temporal bone to move superiorly on the T.M.J. radiograph. The conclusion can be drawn that major distortion of the anterior joint space and exaggerated inferior location of the petrous portion of the temporal bone can be corrected by superior rotation,of the auditory axis.

When the anterior joint space is completely obliterated by bony superimposition and when the posterior joint space is extremely well defined, it usually means that the auditory axis has been rotated too far posteriorly. The auditory axis must be rotated anteriorly a great distance (about 7 holes) to accomplish correction.

The same condition exists on the opposite side with the auditory axis located in a posterior inclination. Again, the posterior joint space is clearly delineated with complete obliteration of the anterior joint space. Exaggerated anterior rotation of the auditory axis (7 holes) should produce a diagnostic T.M.J. radiograph with the petrous portion of the temporal bone in its normal place.

Exaggerated anterior rotation of the auditory axis may not be comfortable or possible with a patient in whom obliteration of the anterior joint space may be corrected by combining anterior rotation (2 holes) with superior rotation of the auditory axis (2 holes).

2) Reduction of radiation exposure.

The standard dental X-ray unit has a lead diaphragm and an aluminum filter. The diameter of the lead diaphragm is 17 mm. If this unmodified cone were used for T.M.J. radiographs, an unnecessarily large area would be exposed to radiation. A lead diaphragm containing a much smaller hole (9 mm. for an S.S. White dental X-ray unit) is fitted to an extra cone, which should be labeled to prevent accidental use for routine radiographs. This lead diaphragm should produce a $2\frac{1}{2}$" diameter exposure on a T.M.J. film rather than the usual 8" diameter with standard equipment. (See Figure 2) There is a dual reason for the reduction of the area of exposure. The first is the obvious beneficial reduction in radiation given to the

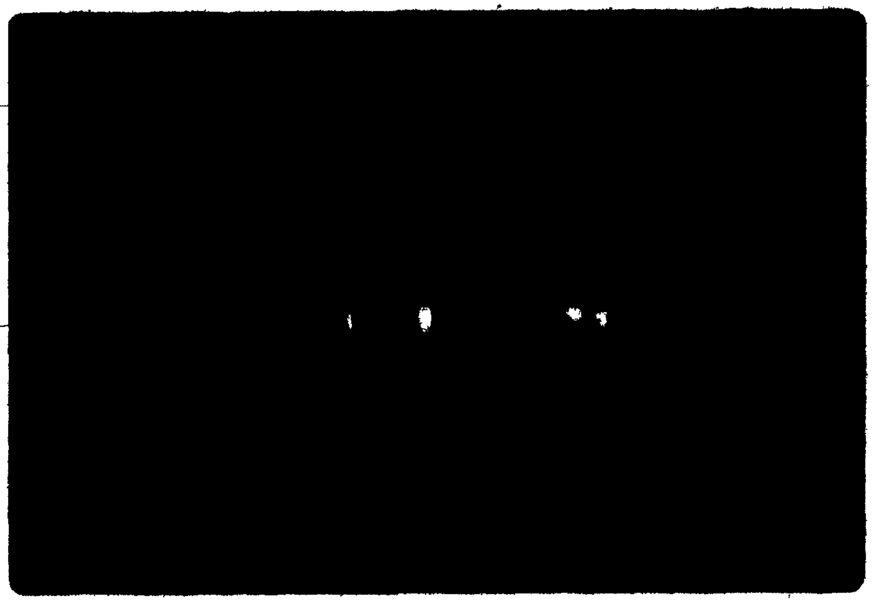


Figure 2

patient by the use of the narrow lead diaphragm with the head positioner. This permits a reduction in the area of radiation for each radiograph by a factor of 4. The second is that the reduction in exposure area increases the contrast and quality of the resultant T.M.J. radiograph, because when X-rays pass through dense bone, they tend to scatter. This scatter causes a background 'fogging' of the radiograph which is observable as reduced contrast.

Klein, Blatterfein and Miglino[65] reported on the comparison of tomographic radiographs with single-plane conventional T.M.J. radiographs. They found that, even though the tomographic radiographs "..... are not as sharp and clear as conventional radiographs, variations in condylar morphology cannot be observed on one-plane radiographs."

Weinberg[71] concluded that the three dimensional head position that is required for a T.M.J. radiograph accommodates for condylar asymmetry allowing the condyle to be almost perpendicular to the film in two planes.

Weinberg[69-71] added that "The lateral third cross-sectional view of the T.M.J. radiograph is consistently reproducible and should be used as a reference of condylar position within the fossa and as an aid in establishing the correct diagnosis and treatment of the occlusion."

The diagnostic significance of a T.M.J. radiograph[69] lies in the interpretation of the condylar position within the fossa. This is determined by the character of the joint space or more specifically by the relative dimensions of the joint space at various points.

A diagnostic T.M.J. radiograph usually will have a clearly defined auditory meatus which immediately indicates the posterior portion for orientation. The articular eminence forms the anterior boundary of the temporomandibular fossa while the posterior wall of the fossa is usually irregular. For diagnostic purposes, the superior part of the condyle must be clearly observed in its relation to the fossa, superiorly, posteriorly and anteriorly.

The evaluation of the T.M.J. space can be used to determine the condylar position in the fossa.[72] The superior portion of the temporomandibular fossa is usually symmetrical. The anterior and posterior portions are used for orientation of the radiograph. Condylar position is determined by the relative dimensions of the anterior and posterior joint spaces between the fossa and the condylar surface. For example, condylar concentricity exists when the anterior and posterior joint spaces are equal.

When the posterior joint space is less than the anterior space, the condyle is retruded. Conversely, condylar protrusion is demonstrated when the posterior joint space is larger than the anterior joint space.

Since the condyle is the movable part it is obvious that the fossa must be used for orientation and measurement of the T.M.J. radiograph. Examination of many radiographs under high magnification revealed that the superior portion of the fossa is consistently symmetrical[69] and this area is most accurately duplicated and is easily freed from the superimposition of cranial structures on the T.M.J. radiograph itself.[70]

Weinberg[72] suggests that T.M.J. radiographs should be evaluated bilaterally because both temporomandibular joints must function in harmony with each other and with the associated neuromuscular complex. When the anterior and posterior joint spaces are equal to each other on both sides, the patient is classified as having bilateral symmetric T.M.J. spaces. If the posterior or the anterior joint spaces are not equal to their counterparts on the opposite side, the patient has bilateral asymmetric T.M.J. spaces.

Weinberg believes that the condyles can be displaced anteriorly, posteriorly or superiorly. This requires the development of new concepts of functional and dysfunctional centric relation as well as specific treatment procedures to suit the individual type of condylar displacements.[73]

CONFLICTING CONCEPTS

Dentistry, like other fields, has its share of unproven hypotheses which, if repeated often enough, are accepted without question. Our favorite cliché is that "the most retruded position (i.e. centric relation) is the only position that can be duplicated." Clinical duplicability, of itself, is not necessarily a proof of correctness. The conclusion can be drawn that "the most retruded position" and clinical duplicability should no longer be the only factors in evaluating or defining centric relation. Weinberg[74] suggests that the condylar position in the glenoid fossae, as revealed by T.M.J. radiographs, is a factor that should be brought into the definition of centric relation.

In recent years, the concept of 'long centric' as advocated by Schuyler and by Mann and Pankey[75] has sharpened the conflict with those who believe that centric relation should be a precise position which is duplicable with needle-sharp accuracy.[76] Indeed, clinical methods for obtaining centric relation records or adjusting the occlusion have been described as having the benefit of "seating the condyle upward and backward in the glenoid fossae." Since temporomandibular radiographs have not been published to verify these results, the unsupported assumption is made:

1) that the most retruded position is always desirable, and
2) that the specific techniques do in fact what the clinician says they do.

Weinberg[74] defines <u>functional centric relation</u> as the most retruded clinical relation of the mandible to the maxillae when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movements can be made, at any given degree of jaw separation. When no deflective slide is present, the left and right T.M.J. spaces are symmetrical, with each condyle concentrically positioned in the glenoid fossae. If a defective slide exists, the direction and magnitude can be correlated with the degree of condylar displacement as revealed in T.M.J. radiographs. The correction of the deflective contacts would result in bilateral condyle concentricity. This clinical retruded position should be used for reconstructive procedures.

Weinberg's[74] definition of dysfunctional centric relation also includes many criteria. He states that "A dysfunctional centric relation is the most retruded clinical relation of the mandible to the maxillae when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movement can be made, at any given degree of jaw separation. When no deflective slide is present, the left and right joint spaces are asymmetrical, with one or both condyles protruded or retruded. If a deflective slide is present, the direction and magnitude cannot be correlated with the degree of condylar displacement as revealed in the T.M.J. radiographs. This clinical retruded position should not be used for reconstructive procedures." Weinberg believes that the dentist should establish a "treatment" centric occlusion with T.M.J. radiographs used as a guide in order to establish optimum condylar position in the glenoid fossae (bilateral concentricity).

Wilkie, Hurst and Mitchell[77] concluded that the definition of centric relation may lead one to the incorrect assumption that the centric relation method places the condyles in a posterior position. The finding of their study that the condyles were centered in the fossae in 80 percent of the subjects, indicates that in general, the most physiologic retruded position is actually an anatomic centering of the condyle in the fossa.

Their study revealed that a high percentage of condyles were located in the anterior part of the fossae when muscular stimulation was used for maxillo-mandibular registrations. Whether or not the anterior position of the condyle is desirable would have to be determined by long-term studies evaluating physiologic and other effects. It is possible that the forward position might define the anterior limit of freedom when the objective of occlusal treatment is anterior freedom from centric relation.

In an article by Ricketts[78] on occlusion he was asked "You do not like to register rest position for reconstruction, even though you admit to using it in the rehabilitation and in treatment of occlusion and temporomandibular relations. However, you also object to using the terminal hinge axis even though you admit it exists and can be located, and it is a point that can be found repeatedly. If you do not like either of these positions, what is left that can be registered?"[78]

Ricketts' answer was that you must always return to the musculature and to the condyle in a normal juxtaposition with the eminence through the medium of the disc or to a position of physiologic centric relation. This mandibular position is located by producing normal contractions of musculature. It is determined by the use of mild physiologic resistance to the normal closure from a position of natural upright posture. It results in a centered-condyle position away from the posterior terminal condyle location but not sufficiently forward to be on the slope of the eminence.

In a series of recently published articles Weinberg[73] drew attention to the extreme importance of T.M.J. radiographs. He suggests treatment procedures to suit the individual type of condylar displacement. However the technique required for each type is totally different, e.g. in bilateral posterior condylar displacement, the occlusion is adjusted to permit protrusion without increasing the vertical dimension of occlusion, and a repositioning prosthesis is constructed to retain muscle programming and to maintain the anterior mandibular position.[81]

In posterior unilateral condylar displacement, the occlusion is adjusted to permit lateral movements towards the opposite side without increasing the vertical dimension of occlusion. After the acute symptoms have been eliminated, a repositioning prosthesis is not usually constructed to retain the muscle programming or to maintain the corrected mandibular position. The patient's physiologic adaptation process, over a long period of time (one year) repositions the unilateral posteriorly displaced condyle into the middle of the fossa.[80] Muscle reprogramming with repositioning prosthesis is easier when a bilateral symmetrical protrusive mandibular adaptation is required. Posterior bilateral condylar displacement also requires an anterior repositioning prosthesis. The posterior unilateral condylar displacement has an opposite condylar suspension system that is essentially healthy and does not require a repositioning prosthesis.

Weinberg believes that when dealing with dysfunctional centric relation, a therapeutic centric occlusion should be established by the dentist in conjunction with T.M.J. radiographs and patient function.[82] The patient is now functioning in the planned therapeutic centric occlusion rather than the original dysfunction centric relation. The corrective change in condylar position is a physiologic T.M.J. adaptation which is the result of a mandibular reposition, not "T.M.J. remodeling" by histologic changes. This is fundamental to the understanding of the condylar repositioning process accomplished by occlusal correction.[80]

THE AIM OF THE STUDY

The aim of the study was to determine whether a correlation existed between the signs and symptoms of M.P.D. and the location of the condyle within the glenoid fossa by measuring temporomandibular joint space on radiographs taken with the head positioner. This was achieved by examining three groups:

1) Patients with myofascial pain dysfunction syndrome.

2) A random sample, consisting of patients who presented to the clinic without T.M.J. dysfunction syndrome, also includes hospital and university staff and dental students.

3) Patients who had undergone occlusal rehabilitation. This group was further subdivided into the following:

   a) patients that had signs and symptoms before occlusal rehabilitation and whose signs and symptoms disappeared or improved subsequent to treatment

   b) patients without signs and symptoms before and after treatment

   c) patients with signs and symptoms before occlusal rehabilitation who demonstrated signs and symptoms after rehabilitation

   d) patients without signs and symptoms before occlusal rehabilitation who demonstrated signs and symptoms after rehabilitation.

MATERIALS AND METHODS

THE CLINICAL EXAMINATION

The clinical examination begins when the patient enters the consultation room and seats himself. His appearance, posture and the character of his bodily movements should be noted, since his gait and general attitude may contribute important information about his personality and general health. Facial expression is also an important source of information.

Close observation of the patient determines whether he demonstrates any obvious signs of stress or emotional disturbance. Some patients who consult dentists regarding T.M.J. problems may be much more in need of psychotherapy than dental therapy. Others may require both dental therapy and psychotherapy. Still others who consult a psychiatrist for T.M.J. as well as head and neck pain may in fact only require dental therapy. Since a relationship exists between bruxism and the patient's psychic status, a determination of the patient's psychic status is significant at this time. This is done with full realization that an emotional or behavioral assessment is very difficult to make even by a highly trained psychiatrist.

The subjective part of the examination consisted of asking the patient the following questions on a form which was developed for this study:

Have you ever had orthodontic treatment?

Do you have extensive dental crowns and bridges?

Do you wear a removable partial denture?

Have you ever been treated for problems of your jaw joint spasm?

Are you aware of clenching your teeth during the day?

Have you ever been told that you grind your teeth during sleep?

Do you have any pain or soreness around your eyes, ears or other parts of your face?

Do you have 'tension' headaches?

Do you frequently have stiff neck muscles?

Do your jaw muscles become tired frequently?

Do you have difficulty in opening your mouth widely?

Have you ever had arthritis?

Do you ever hear grating sounds from your jaw joint?

Are you presently in any pain from your jaw joint or muscles?

Do you have a problem with insomnia?

Do you take aspirin frequently?

Are you taking any tranquilizers, muscle relaxants or anti-depressants?

Do you smoke cigarettes or cigars?

Do you bite your nails, tongue or lips?

Medical history

When the opportunity present itself, questioning should be guided towards a consideration of the patient's general health. Any organic disorders are noted, with particular care being taken to note any information about rheumatic disease, non-rheumatic musculoskeletal difficulties and disorders associated with tension. Information regarding disorders associated with tension is valuable since it may provide insight into the emotional state of the patient at a time when a frank discussion is not possible.

Dental history

Because the patient, as a rule, feels less constrained in talking about dental difficulties, discussion along these lines may yield important facts regarding the emotional state of the patient suffering from facial pain and mandibular dysfunction. The frequency of dental treatment, its nature and the reaction of the patient to it will provide information about significance of the oral area to the particular patient. The intensity or agitation of some patients during this phase of the history will suggest that there is more in the dental situation than meets the eye.

The patient must be permitted to tell his own story: he may be guided but should not be influenced by leading questions. The doctor should know clearly the information he seeks but should carefully avoid putting words into the patient's mouth.

The chief complaint

Patients with symptoms of long duration may wish to recall their entire history chronologically and in great detail, including previous therapy and its results. Gentle insistence that the chief or present complaint be discussed first will expedite the history taking, and the patient's reaction to this approach may provide valuable information about his personality.

Once the chief complaint is clear, description of any secondary or associated symptoms should be obtained. It is then desirable to elicit information about the onset, duration and course of the disorder. One should note whether the onset was sudden or gradual, whether the patient associates the onset with any event such as yawning, awakening, a dental appointment or whether the symptoms first appeared in a time of great emotional stress. Information about the course of the disorder and circumstances that aggravate or relieve the symptoms is helpful.

The patient is asked to point to the site of the pain. It may be the area of a temporomandibular joint or a portion of a muscle such as the temporal, the superficial portion of the masseter, the internal and external pterygoid muscle. During the actual muscle palpation the site of the pain can be established more accurately.

Then the patient should be asked if he uses any medication to relieve the pain and whether he was treated for this condition previously and what was done.

Many painful symptoms diagnosed as trigeminal neuralgia, arthritis of the spine, migraine and tension headaches[26] might be due to myofascial pain resulting from spasticity of the masticatory muscles. It is imperative to recognize the subjective symptoms as well as the clinical symptoms of neuromuscular disturbances. That is why it is essential to ask the patient about headaches, their location, duration, and medication used for relief.

In the early stages of Meniere's disease tinnitus may be the only symptom present, and it may then be confused with the tinnitus which supposedly can occur in association with traumatic temporomandibular joint arthritis.[28] This emphasizes the importance of asking about ear infections and earache.

Mandibular dysfunction as a result of direct trauma to bone and/or masticatory muscles is readily diagnosed in most cases by asking about the history of trauma.

The examiner should look at the patient full face and in profile. Swellings, hypertrophy or marked asymmetry may often be detected in the full face view. If swellings are seen, gentle palpation will tell whether they are hot or cold, hard or soft, fluctuating or rigid. Such infomation, coupled with facts obtained in the history, will influence the direction of further examination, if needed.

Tenderness to palpation

1. The temporomandibular joint

The joints are examined for pain and degree of movement. Sound should be noted. The temporomandibular joint is palpated on its lateral aspect just anterior to the tragus of the ear and on its posterior aspect through the external auditory meatus. The patient is instructed to open and close the jaws. The dentist should note the degree of movements of condyles and whether they move symmetrically in respect to each other. The presence of any periarticular tenderness, clicking or crepitus should be noted.[83-85]

2. Muscle palpation

By palpating bilaterally, the dentist allows the patient to compare relative tenderness of each functioning pair of muscles. A muscle with increased tone may not be tender, but the higher the degree of asymptomatic tonus, the less the increase in physiologic or psychic tension required to produce pain. An abnormal degree of muscle tone may be noted by an unusual firmness of the fibres.[84]

Trigger areas of zones of hypersensitivity located in the fascia, or in muscles in spasm: These areas have a lowered pain threshold upon palpation. Stimulation of these areas can result in referred pain. A trigger area in a particular site gives rise to essentially the same distribution of referred pain in one person as in another.[25]

The muscles are palpated in a designated sequence. The sequence is divided into extraoral and intraoral palpation.[83-84] The most practical order begins with the extraoral regions and finishes with the intraoral regions.

(a) Extraoral regions

1. The deep portion of the masseter muscle:

The patient is instructed to let his lower jaw relax. About 10 to 12 mm. in front of the temporomandibular articulation, the dentist can note the small depression which corresponds to the palpable triangular section of the deep part of the masseter muscle. The deep part of the masseter muscle courses the entire length of the zygomatic arch to the lateral surface of the angle of the mandible. The fibre's function is retracting the mandible in closure. As an example, these fibres are frequently painful in the patient with bruxism with deflective contacts in the centric relation position of the mandible.

2. Anterior border of the masseter muscle:

The superficial part of the masseter muscle courses from the lower border of the zygomatic arch to the lateral surface of the angle of the mandible. The anterior border of the masseter muscle is examined with the mandible at rest and with the teeth in centric occlusion to determine the presence of painful regions. This part of the masseter muscle may be tender if the patient is a bruxer or has other dysfunctional joint disturbances. The patient is also asked to squeeze his teeth together and relax, then squeeze and relax. With digital examination, the dentist notes the bilateral sequence of contraction and strength of contraction of the anterior border of the masseter muscle.

3. The attachment of the masseter muscle at the mandibular angle:

The large attachment of the masseter muscle to the lower one third to one fourth of the ramus of the mandible is inspected using the same procedure as that for the anterior border of the masseter muscle. The strength and timing of contraction are also evaluated by again asking the patient to squeeze his teeth together in centric occlusion and relax. The dentist would expect to observe forceful, simultaneous, bilateral contractions of the musculature, since the masseter muscle is considered the most powerful mandibular elevator.

4. The anterior and middle parts of the temporal muscle:

The temporal muscle attaches to the lateral surface of the skull by thin, radiating fibres. The fibres converge and course inferiorly to attach to the surface of the coronoid process by a superficial and deep tendon. The anterior part is examined for painful regions, and the strength and sequence of contraction are determined. The anterior fibres of the temporal muscle are elevators of the mandible and are very sensitive to occlusal interferences.

5. The posterior part of the temporal muscle:

The posterior part of the temporal muscle has a retracting component because of the downward and forward direction of its fibres. This region is examined for pain in the manner used for the anterior part and strength and sequence of contraction are noted.

6. The medial pterygoid muscle:

The fibres of the medial pterygoid muscle course from the pterygoid fossa to the medial surface of the angle of the mandible. The medial pterygoid muscle is palpated extraorally at its attachment on the mandible. The patient is asked to tip his head back and the dentist gently palpates the inner aspect of the angle of the mandible with the palmar surface of his index, middle and ring finger. Hard digital palpation may cause a false positive response to pain. The dentist may also evaluate the strength and sequence of contraction if the anatomy permits. Intraoral palpation of the internal pterygoid muscle is complicated by the presence of several soft tissue structures and is impractical for routine examination.

7. Posterior belly of the digastric muscle:

The posterior belly of the digastric muscle attaches to the mastoid notch, medial to the mastoid process. The muscle fibres course anteriorly and are attached to the hyoid bone by a common tendon of the anterior belly of the digastric muscle. The posterior belly may be palpated by directing the fingers upward and inward between the angle of the mandible and the mastoid process.

8. The sternocleidomastoid muscle:

The sternocleidomastoid muscle courses from the mastoid process to the clavicle and the sternum. This muscle should be palpated along its entire course for the presence of painful regions.

9. Occipital muscles:

Pressure is exerted on the deep neck muscles which attach just below the superior nuchal line. Any painful regions are noted.

10. Trapezius muscle fibres:

The trapezius muscle fibres are palpated from the base of the skull down to the base of the neck and then to the shoulders with downward pressure on the superior aspect and with forward pressure from the dorsal aspect.

(b) Intraoral palpation

1. The insertion of the temporal muscle:

The dentist places his index finger in the retromolar fossa area of the mandible. The retromolar fossa is bordered on its medial and lateral aspects by the tendinous attachments of the temporal muscle on the coronoid process. Movement of the finger medially allows palpation of the deep tendinous attachment of the temporal muscle. Movement laterally allows palpation of the superficial tendinous attachment. The temporal muscle is considered to be the positioner of the mandible and tenderness is related to gross discrepancies between centric occlusion and centric relation.

2. The inferior head of the lateral pterygoid muscle:

The larger inferior head of the lateral pterygoid muscle arises from the lateral surface of the lateral pterygoid plate. The smaller superior heads arise from the infratemporal surfaces of the greater wing of the sphenoid bone. The fibres of the inferior head course posteriorly where they fuse with the fibres of the smaller superior head and attach to the anterior surface of the condyle.

The larger inferior head of the lateral pterygoid muscle can be palpated introorally. This muscle is the only one that cannot be palpated simultaneously on both sides. The dentist places his index finger on the lateral aspect of the alveolar ridge in the region of the maxillary molars. Then, the index finger in this position permits inspection of the attachment to the inferior head of the lateral pterygoid muscle. The lateral pterygoid muscle may be tender if the patient:

a) has a lateral deviation of the mandible from the first contact of opposing teeth in the retruded position to the fully intercuspated position

b) has a deflective occlusal contact on the balancing side

or c) has limited ability to open the jaws.

<u>Maximum, voluntary interincisal opening</u>

The average jaw opening is between 45 and 73 mm. Anything less than 37 mm. should be considered restrictive.[25] The measurement is made from the incisal edge of the maxillary central to the incisal edge of the mandibular centric incisor without forcing the mandible. Muscle spasm associated with occlusal disharmony may be responsible for the restricted opening.[84] In patients with clicking of the temporomandibular joints there is usually incoordination of the mandibular muscles. This causes asymmetric movements of the condylar heads, which results in irregular opening and closing mandibular paths.[30]

A visual examination should be made along the occlusal plane of the teeth for detection of malposed teeth, over-erupted teeth, prominent cusps or plunger cusps.

Clinical centric relation

Bilateral posterior stimulation is used to obtain hinge closure. It is usually helpful to have the patient place the tongue as far back on the roof of the mouth as possible. This will break the muscle programming which tends to return the mandible to the acquired centric occlusion. Forceful retrusion of the mandible with the thumb on the chin produces reflex contraction of the external pterygoid muscles, and a more anterior mandibular position may be recorded.[74] The patient is instructed to close the jaws together, "wherever the mandible wants to go"; with very light closure, he should stop when he feels the first tooth touch. Within a few minutes, the patient can be trained to close in a relaxed fashion to the most retruded unstrained centric relation position.

Deflective slide into centric occlusion[74]

It is of the utmost diagnostic importance to record the direction and magnitude of the deflective slide of the mandible from centric relation to the acquired centric occlusion, as well as the relative degree of anterior and vertical component.

The patient is requested to close very lightly (in guided centric relation as above) until one tooth touches another. He should maintain that position while the dentist observes one of the mandibular teeth such as the second bicuspid. The mandible will slide from centric relation deflective contact to the maximum contact of teeth (acquired centric occlusion). The direction and magnitude of the deflection is recorded. Lateral components of the deflective slide are best observed by comparing the relative positions of the upper and lower midlines during the deflective slide. This information is then related to the T.M.J. radiographs to determine whether this clinical centric relation is functional or dysfunctional.[74]

Premature contacts in centric relation

Teeth that are making premature contacts in centric relation can be detected by using evenly heated thin strips of green occlusal indicator wax placed on the occlusal surfaces of either the maxillary or mandibular teeth. The operator taps the patient's jaw together in centric relation. The wax is then removed with a cotton plier, then by holding the wax against a light source and studying the pattern of perforations or near perforations, the initial occlusal contact in centric relation can be located.

Articulating paper can also be used for location of occlusal contacts; the marking is enhanced by drying the occlusal surfaces of the teeth and making the tapping jaw movements sharp and distinct. Light palpation with the fingertips on the buccal aspect ofthe teeth that are in contact when the patient taps or bites together also helps to locate premature contacts in centric occlusion.

Examination for occlusal interferences in lateral and protrusive excursions

Occlusal interferences in lateral excursions can best be located by guiding the patient's mandible in a manner similar to a Gothic arch tracing, while light occlusal contact is maintained. The common practice of asking the patient to do lateral movements himself is completely unreliable for detection of occlusal interferences since the patient most often will move along his preferential path of occlusal wear and thereby avoid the most severe interferences. There is also a tendency to overlook heavy balancing side contacts if the patient moves his mandible in lateral excursion with heavy occlusal contact since under such circumstances it is extremely difficult to observe a slight tipping of the jaw associated with the maintenance of working side occlusal contact. The protrusive and combinations between protrusive and lateral excursions can usually be performed by training the patient.

Occlusal interferences in the lateral and protrusive movements can also be revealed by palpation. Observations can be made by holding a fingertip very lightly against the buccal surface of a tooth during a combination of various occlusal jaw movements.

The chart used for the clinical examination follows.

T.M.J. ANALYSIS

History

1. Patient's statement of history: (onset, nature and course).

2. Pain: ☐ None ☐ Right ☐ Left

sharp pain	when yawning
dull pain	acute
during eating	when tense
starts suddenly	recurrent
starts slowly	chronic

	Right	Left		Right	Left
T.M.J.			Lateral pterygoid		
Masseter			Medial pterygoid		
Temporal			Digastric		
Occipital			Hyoid areas		
Sterno-mastoid			Shoulders		

3. Does anything seem to bring on the pain?

Yes
Specify

Does anything you take (medication) relieve the pain?
Specify

4. Do you have difficulty

	yes	no
a) opening wide		
b) swallowing		
c) chewing food		

5. Have you ever been treated for this condition before? Yes No

If so, what was done?

6. Headaches·

Location

None	Hours
Mid	Constant
Moderate	Times per month
Minutes	Type and amount of medication

7. Had the patient had·

Ear infections	Trauma to the jaw
Earache	Lower 3rd molar extractions
General anaesthetic	

Clinical Examination

1. Hypertrophy: Yes No Muscles (specify)

2. Asymmetry: Yes No

3. Tenderness to palpation:

	Right	Left		Right	Left
( ) T.M.J. joint	____	____	( ) Lateral (Ext) Pterygoid	____	____
( ) Masseter	____	____	( ) Medial (Int) Pterygoid	____	____
( ) Temporal	____	____	( ) Digastric	____	____
( ) Sterno-mastoid	____	____	( ) Hyoid area	____	____
( ) Occipital	____	____	( ) Shoulders	____	____

Tenderness (x)
Pain flow ( )

4. Palpate temporomandibular joints while patient opens normal range and closes:

   (a) Clicking or crepitus: ( ) No ( ) Yes ( ) Right ( ) Left ( ) Both
   (b) Movement: ( ) Equal ( ) Greater on right ( ) Left

5. Mandibular opening movement:

   ( ) Normal ( ) Painful ( ) Clicking ( ) Deviated to Right
   ( ) Deviated to Left

6. Look along occlusal line of teeth. Malposed teeth, prominent cusps

   ____

7. While back teeth are tapped together vigorously·

   (a) Sound clear ( ) Dull ( )
   (b) Tooth displacement (circle)

By sight:	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
By touch:	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8

8. Centric occlusion:

   (a) Same as habitual occlusion Yes ( ) No ( )

   (b) Premature contact:

8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8

   (c) The shift is: straight forward ______ mm.
   to the right ______ mm.
   to the left ______ mm.

   (d) Correction indicated Yes ( ) No ( )

   Grinding ( )
   Ortho ( )
   Prosth ( )

9. Right lateral mandibular movement ( ) Normal ( ) Restricted ( ) Painful
   ( ) Clicking

Static Contacts	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
(Working and balancing)	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8

10. Left lateral mandibular movement. ( ) Normal ( ) Restricted ( ) Painful
( ) Clicking

Static Contacts	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
(Working and Balancing)	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8

11. Protrusive mandibular movement

Static Contacts	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8
(Including Posterior)	8 7 6 5 4 3 2 1	1 2 3 4 5 6 7 8

12. Correction of eccentric dynamic occlusion: Indicated ( ) Yes ( ) No
By grinding ( ) Ortho ( ) Prosth ( )

The history and clinical examination provide a diagnosis. The T.M.J. radiographs using the head positioner are now taken to determine whether a correlation exists between these findings and the position of the condyle within the glenoid fossae. The technique employed is that which has been recommended by the manufacturer for use with the head positioner.

DESCRIPTION OF THE X-RAY TECHNIQUE

Use of cassette

A metal marker is attached two inches from the lower right hand corner with Scotch tape. This marks the left T.M.J. radiograph. For the left T.M.J., the left half of the cassette is covered with a lead shield and the cassette is moved as far to the left as possible in the slot. A white plastic block is placed in the space on the right side of the slot to prevent shifting of the cassette. (See Figure 3)

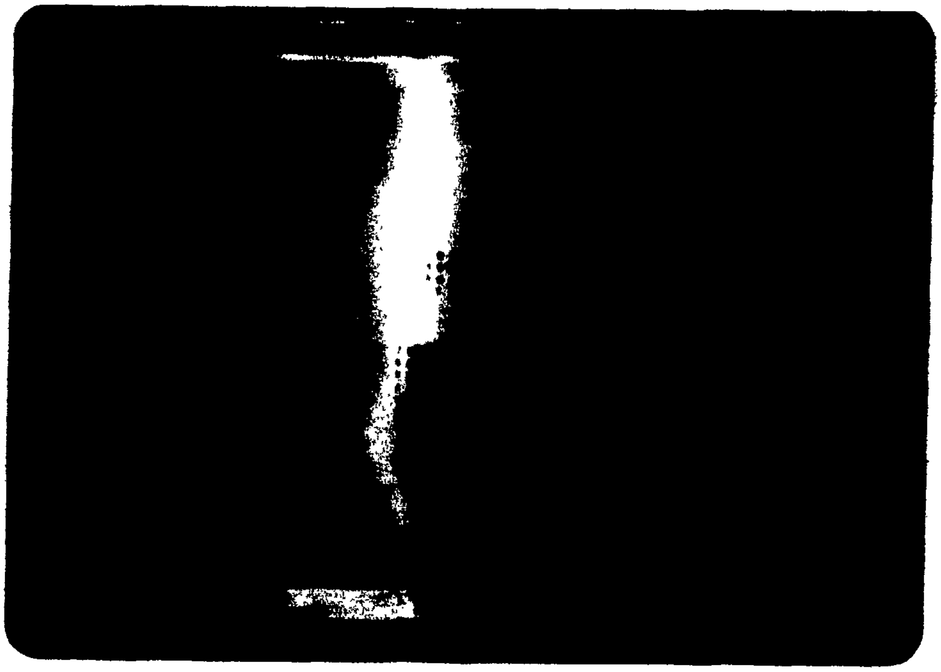


Figure 3

Head position for the left T.M.J. Radiograph

The tragus ala line is marked on the patient's face with a soft graphite pencil on both sides. The left auditory meatus is positioned over a stationary auditory guide attached to the base of the head board above the cassette slot. The pin of the movable auditory guide is placed into the hole circled in red, (4J) in the movable cover of the instrument. The cover is placed over the head and the seat of the dental chair is raised or lowered until the movable auditory guide fits into the right auditory meatus and the rod is perpendicular through the hole in the cover (4J). The positioning will require anterior posterior rotational movements of the head as well. The tragus ala line should be parallel to the steel back of the instrument. (See Figure 4)

Figure 4

Cassette position for the right T.M.J.

The right half of the cassette is covered with a lead shield and the cassette is moved as far to the right as possible in the slot. The white plastic block is placed in the space on the left side of the slot to prevent shifting of the cassette.

Head position for the right T.M.J. radiograph

The right auditory meatus is positioned over the stationary auditory guide. The pin of the movable auditory guide is placed into the hole circled in red (4D) in the cover of the instrument. The tragus ala line should be parallel to the steel back of the head positioner.

Occlusion

The patient should have his teeth in maximum intercuspation.

X-ray cone position

The angle of the X-ray head is 75 degrees. The tip of the cone is placed at 9J for the left T.M.J. and 9D for the right T.M.J. Each is circled in red for convenience. (Figure 5) The head of the X-ray unit is made exactly parallel to the steel back of the T.M.J. head positioner.

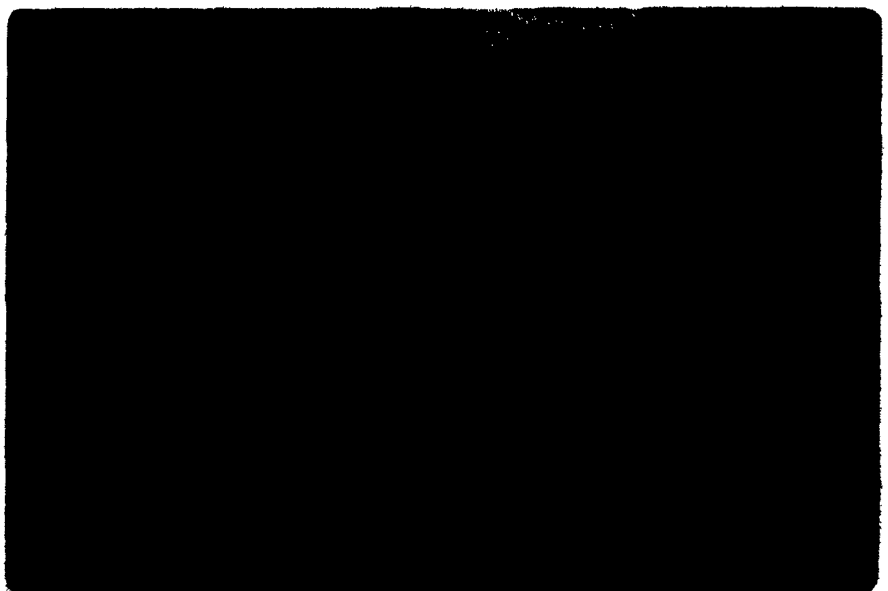


Figure 5

Exposure

The KVP depends on the face width. Thin patients will require 68KVP, while average patients require 70KVP and wide-faced patients require 72 KVP .15 milliampers and 2 seconds exposure is required.

Dark room exposure

T.M.J. film is much more light sensitive than ordinary oral dental film. An absolute light tight X-ray room is essential. Only a Wratten 6B filter can be used as a safe light with a 10 watt bulb. This should be placed in the ceiling if possible or a minimum of 4 feet from the working area.

Chemistry

Kodak chemistry should be used with a replenishing system. For every T.M.J. film developed (or full series) 25 cc. of undiluted developer should be added to the developer tanks and 10 cc. of fixer to fixer tanks. This should be done before each development and the solutions mixed thoroughly with large mixing spoons. The replenishing process is necessary because of the chemicals that are removed from the solutions during proccessing. Without the addition of chemicals subsequent T.M.J. films become lighter and lighter.

Developing time

$5\frac{1}{2}$ minutes at 65 degrees F.

Photoenlargement technique

A basic engineering approach for the measurement of small parts is with photoenlargement. The image is measured on the enlargement, which is later reduced mathematically by the degree of magnification.

The T.M.J. radiographs can be cut to fit into cardboard mounts and projected onto a white cardboard screen 14 times the normal size.

A measurement template was drawn in order to precisely orient each T.M.J. tracing to the superior part of the fossa and to record the same four measuring points. (Figure 6) An outer arc of 115 mm. and an inner arc of 97 mm. were drawn. Five radii were drawn, each 48 mm. apart, measured as chords, on the outer arc.

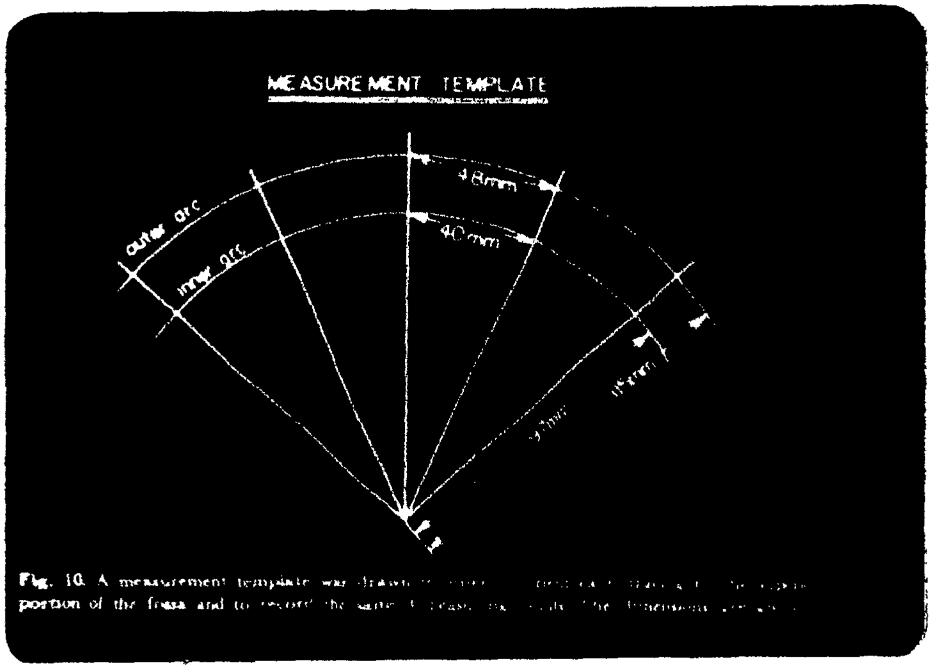


Figure 6

Positioning the tracings on the measurement template

The center of the superior part of the temporomandibular fossa is located where the anterior and posterior symmetrical curves of the fossa meet. This was placed over the central radius of the measurement template on the outer arc. The tracing was rotated around this point (C) until the anterior and posterior curves of the superior part of the fossa were equidistant from the outer arc of the measurement template. (Figure 7) This oriented the measurement template to the superior part of the fossa. The anterior wall of the fossa did not extend below the inner arc and it remained between the inner and outer arcs.

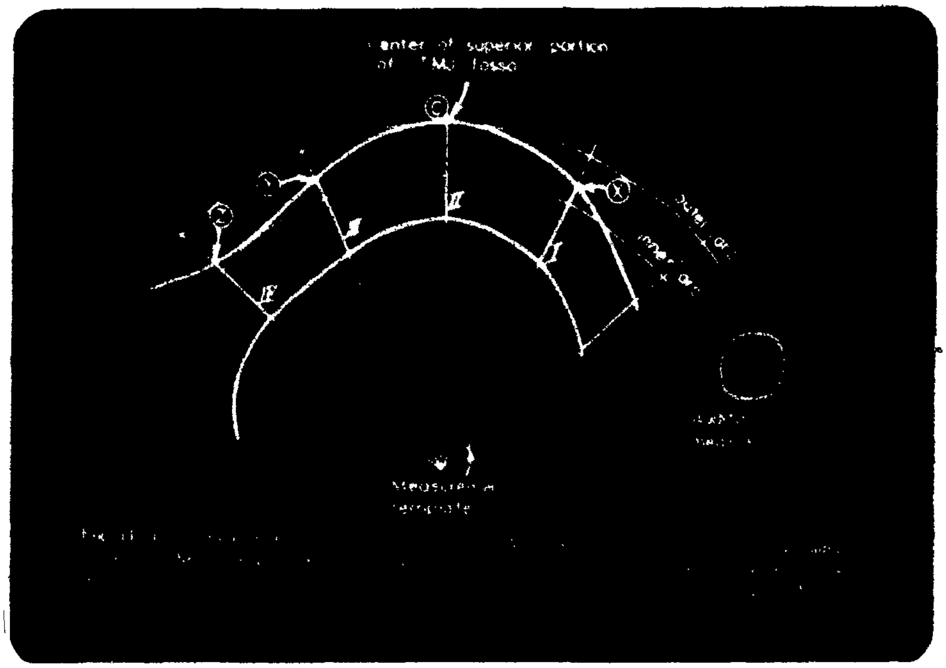


Figure 7

Measuring points

Four lines were drawn on the tracing of the temporomandibular joint corresponding to the radii of the measurement template as they pass through the condyle and fossa. The four measuring points were the posterior (I), mid-fossa (II) and two anterior points (III, IV). The distances were measured in millimeters and recorded; later they were reduced mathematically by a factor of 14 to produce accurate measurements of the joint space.[69]

RESULTS

1. Analysis of the patients with M.P.D.

Sixty three patients were examined; for each patient the history was recorded, the muscles associated with jaw movement were palpated, the existence of a deflective contact in centric relation and the direction and magnitude of the slide into the acquired centric occlusion were recorded and crepitus or disc derangement was also noted.

T.M.J. radiographs were obtained with the method previously described, while the patients' teeth were in the acquired centric occlusion.

23 patients had a bilateral condylar retrusion - 36.5% (Figures 8-9)

14 patients had a unilateral condylar retrusion - 22.2% (Figures 10-11)

9 patients had a bilateral condylar protrusion - 14.2% (Figures 12-13)

6 patients had a unilateral condylar protrusion - 9.5% (Figures 14-15)

5 patients had bilateral asymmetric T.M.J. spaces - 7.9% (Figure 16)

4 patients had bilateral symmetrical T.M.J. spaces - 6.3% (Figure 17)

2 patients had bilateral symmetrical T.M.J. spaces (extremely narrow) - 3.1% (Figure 18)

One patient had the condyle ankylosed with the glenoid fossa.

From a total of 63 patients with signs and symptoms, 54 patients had asymmetric T.M.J. spaces. Six patients had bilateral symmetrical T.M.J. spaces. Two had extremely narrow T.M.J. spaces representing possible changes in disc morphology or disc perforations.[72]

2. Analysis of the random sample of patients

Of the 50 patients examined, 12 had crepitus, clicking, and/or deviation during opening and closing of which they were unaware. The remaining 38 patients had no signs and symptoms. Of the 12 patients

2 had a bilateral condylar retrusion - 16.6%

7 had a unilateral condylar retrusion - 58.3%

1 had a bilateral condylar protrusion - 8.3%

1 had a unilateral condylar protrusion - 8.3%

1 had bilateral symmetrical T.M.J. spaces - 8.3%

Of the other 38 patients:

10 had bilateral condylar retrusion - 26.3%

3 had unilateral condylar retrusion - 7.8%

11 had bilateral condylar protrusion - 28.9%

3 had unilateral condylar protrusion - 7.8%

7 had bilateral asymmetric joint spaces - 18.4%

4 had bilateral symmetrical joint spaces - 10.5%

3. Analysis of the patients who had undergone occlusal rehabilitation

(a) Patients with signs and symptoms before rehabilitation who improved after the treatment (16)

3 patients had bilateral asymmetrical joint spaces - 18.7% (Figure 19)

13 patients had bilateral symmetrical joint spaces - 81.3% (Figures 20-23)

(b) Patients without signs and symptoms before and after treatment (16)

3 had bilateral retrusion - 18.75% (Figure 24)

3 had bilateral protrusion - 18.75%

10 had bilateral symmetrical joint spaces - 62.5%

(c) Patients who had signs and symptoms before with no improvement after treatment (11)

7 had bilateral retrusion - 63.6%

1 had unilateral retrusion - 9.0%

2 had bilateral protrusion - 18.0%

1 had bilateral symmetrical joint spaces - 9.0%

(d) One patient presented with signs and symptoms after occlusal rehabilitation who had no signs and symptoms before. She had a unilateral condylar retrusion.

Figure 8

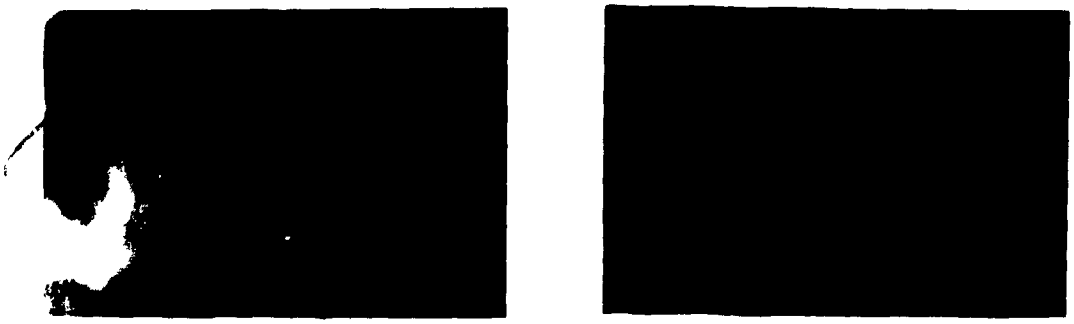


Figure 9

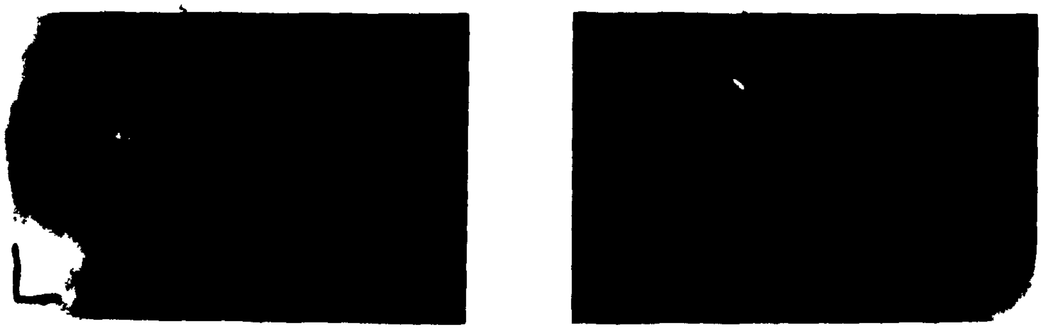


Figure 10

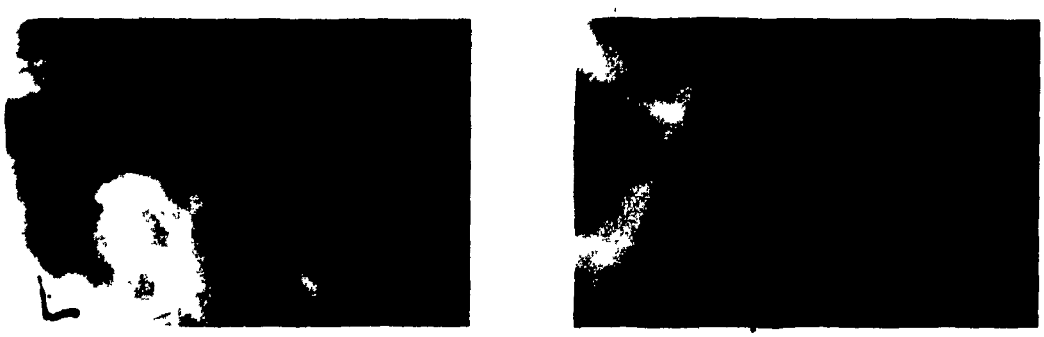


Figure 11

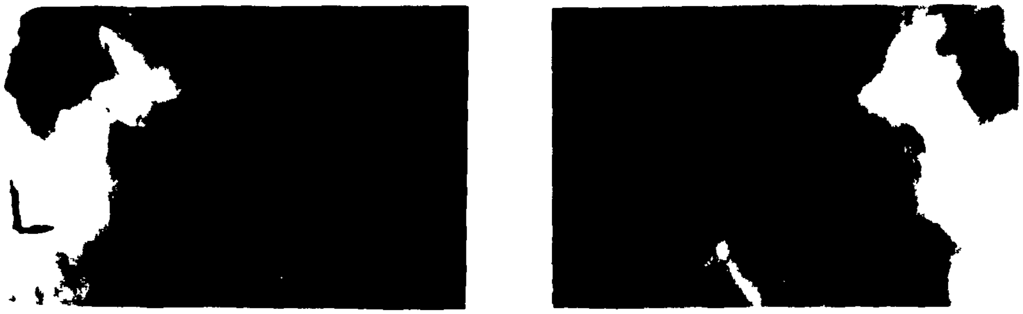


Figure 12

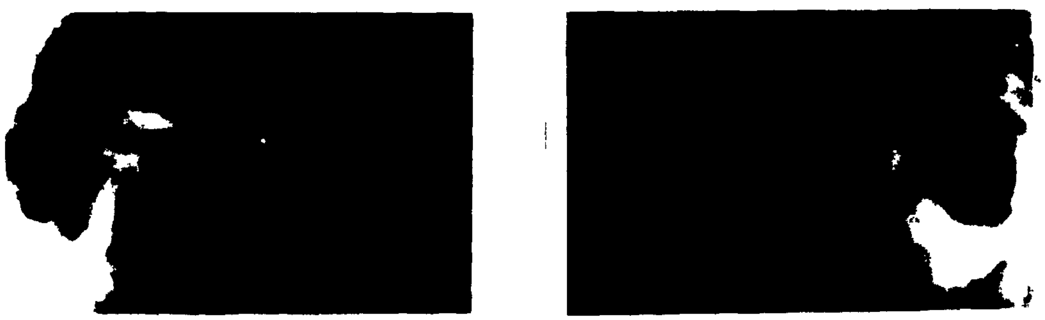


Figure 13

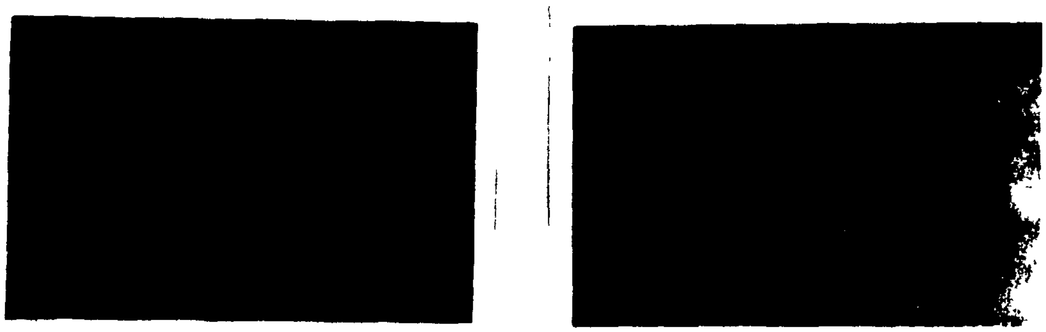


Figure 14

Figure 15

Figure 16

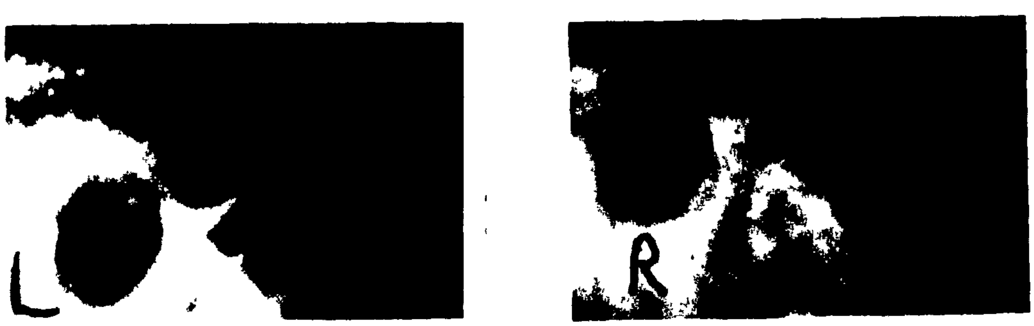


Figure 17

Figure 18

Figure 19

Figure 20

Figure 21

Figure 22

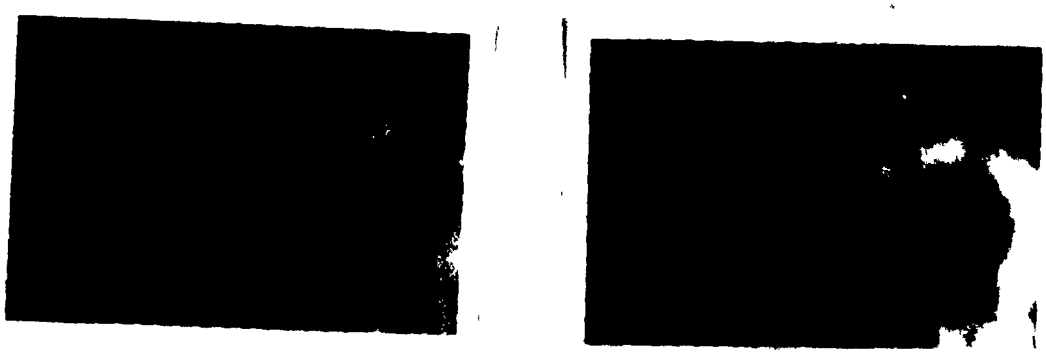


Figure 23

Figure 24

SUMMARY

1. (a) 88.8% of the patients with M.P.D. had asymmetric joint spaces.

   (b) 58.7% of the patients with M.P.D. had retrusion.

   (c) 23.7% of the patients with M.P.D. had protrusion.

2. (a) Of the random sample 25.0% had some signs and symptoms of which they were unaware. 89.5% had asymmetric joint spaces.

   (b) 34.1% of the random sample had retrusion.

   (c) 36.7% of the random sample had protrusion.

3. (a) 81.3% of the patients who had undergone occlusal rehabilitation with signs and symptoms before rehabilitation who improved after treatment had bilateral symmetrical joint spaces and 18.7% had bilateral asymmetric joint spaces. This information leads to the conclusion that for most of the cases which had been occlusally rehabilitated and improved after treatment, the condyles were concentrically placed within the glenoid fossae.

   (b) Of the patients who had undergone occlusal rehabilitation without signs and symptoms before and after, 62.5% had bilateral symmetry, 18.75% had bilateral protrusion and 18.75% had bilateral retrusion.

   (c) For those patients who had signs and symptoms before with no improvement after treatment, 91.0% had asymmetric joint spaces and of this group, 72.6% had retrusion.

   (d) The only patient who developed symptoms after the occlusal rehabilitation who had not demonstrated symptoms before had a unilateral condylar retrusion.

DISCUSSION

A comparison of M.P.D. patients and random sample patients reveals that no statistically significant relationship exists between M.P.D. and condylar symmetry. However a statistical significant relationship exists between M.P.D. and condylar retrusion.

Bilateral symmetrical joint spaces became apparent in the analysis of the patients who had undergone occlusal rehabilitation, where the majority of patients who displayed no signs and symptoms or who demonstrated an improvement after treatment had bilateral symmetrical joint spaces. The disparity between these groups of patients and the first two groups examined is explained by the fact that all the treated patients had had their deflective contacts eliminated through occlusal adjustment by selective grinding and restorative procedures.

Among the patients who had been rehabilitated without demonstrating improvement in signs and symptoms, a statistically significant percentage (72.5%) demonstrated retrusion. Furthermore, the one patient who had no signs and symptoms before rehabilitation but developed signs and symptoms after had a unilateral condylar retrusion.

CONCLUSIONS

1. T.M.J. radiographs using the head positioner provide a valuable adjunct to diagnosis and treatment planning for patients with M.P.D. syndrome.
2. Where extensive restorative procedures are anticipated, T.M.J. radiographs can be useful before embarking on a treatment plan as well as to document the postoperative results.
3. Bilateral symmetry seems like a reasonable objective of extensive restorative dentistry.
4. Retrusion is more frequently accompanied by signs and symptoms than bilateral symmetry and protrusion.

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