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REVIEW ARTICLE

TMJ AND TMDs IN ORTHODONTICS - AN UNSEEN FACTOR

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ABSTRACT

Orthodontists are constantly being challenged with the task of providing their patients with acceptable esthetics and masticatory function. Although esthetics is often the patient's immediate and primary goal, function becomes far more important over the lifetime. So developing a sound, functional masticatory system is the primary goal of all orthodontic therapy. The frequency of TMJ complaints has multiplied in the last few years. This may have been brought about by the increased stresses of our fast paced world, or at least we now recognize that there is a stress strain tension release syndrome that often manifests itself with nocturnal parafunctional activity. Orthodontist, through many accepted treatment procedures may inadvertently exert distal pressure on the mandibular complex, which can be the beginning of a TMJ disorder.

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INTRODUCTION

The area where the mandible articulates with the cranium, the TMJ, is one of the most complex joints in the body. It provides for hinging movement in one plane and therefore can be considered aging lymoid joint. However, at the same time it also provides for gliding movements, which classifies it as an arthrodial joint. Thus it has been technically considered a ginglymoarthrodial joint. Temporomandibular disorders (TMD) are a collection of pathologic and functional conditions affecting the temporomandibular joint (TMJ) and the muscles of mastication as well as contiguous tissue components The term temporomandibular joint disorders (TMD) describes a condition characterized by pain in the preauricular area, the temporomandibular joint (TMJ) or the muscles of mastication, by a limitation of the range of mandibular motion, and by the presence of joint sounds during jaw function.

Temporomandibular joint: The area where the mandible articulates with the cranium, the TMJ, is one of the most complex joints in the body. It provides for hinging movement in one plane and therefore can be considered aginglymoid joint. However, at the same time it also provides for gliding movements, which classifies it as an arthrodial joint. Thus it has been technically considered a ginglymoarthrodialjoint.The TMJ is formed by the mandibular condyle fitting into the mandibular fossa of the temporal bone. Separating these two bones from direct articulation is the articular disc. The TMJ is classified as a compound joint. By definition, a compound joint requires the presence of at least three bones, yet the TMJ is made up of only two bones.

Functionally, the articular disc serves as anonossified bone that permits the complex movements of the joint. Because the articular discfunctions as a third bone, the craniomandibular articulation is considered a compound joint The articular disc is composed of dense fibrous connective tissue, for the most part devoid of any blood vessels or nerve fibers. The extreme periphery of the disc, however, is slightly innervated.

Innervation of the Temporomandibular Joint: As with all joints, the TMJ is innervated by the same nerve that provides motor and sensory innervation to the muscles that control it (the trigeminal nerve). Branches of the mandibular nerve provide the afferent innervation. Most innervation is provided by the auriculotemporal nerve as it leaves the mandibular nerve behind the joint and ascends laterally and superiorly to wrap around the posterior region of the joint. Additional innervation is provided by the deep temporal and masseteric nerves.

Vascularization of the Temporomandibular Joint: The TMJ is richly supplied by a variety of vessels that surround it. The predominant vessels are the superficial temporal artery from the posterior; the middle meningeal artery from the anterior; and the internal maxillary artery from the inferior. Other important arteries are the deep auricular, anterior tympanic, and ascending pharyngeal arteries.

Ligaments: As with any joint system, ligaments play an important role in protecting the structures. The ligaments of the joint are composed of collagenous connective tissues that have particular lengths.

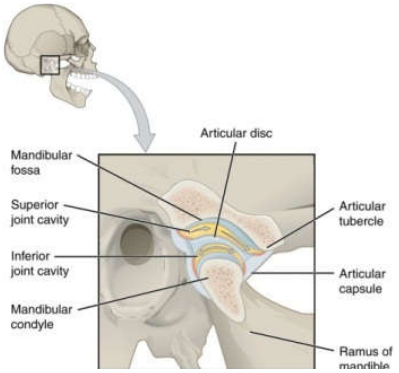

Fig 1 ; Articular Disc, Fossa, And Condyle

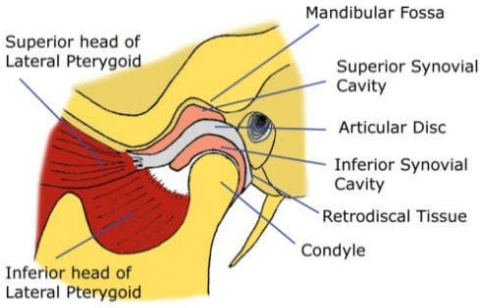

Fig 2. Temporomandibularjoint

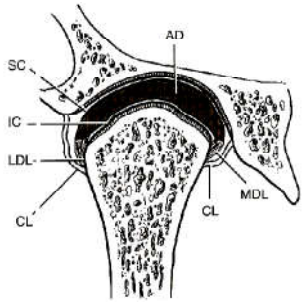

Fig. 3. Temporomandibular joint (anterior view).

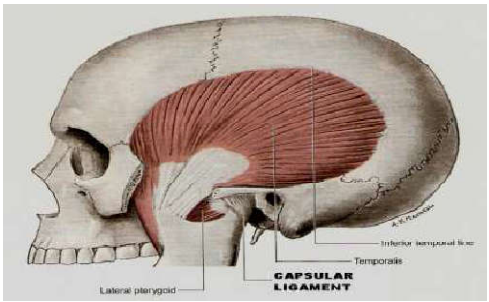

Fig. 4. Capsular ligament

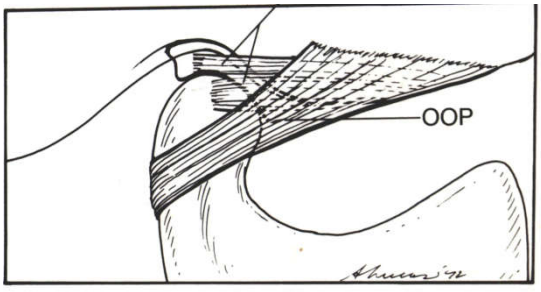

Fig. 5. Temporomandibular Ligament Ligament (Lateral view

They do not stretch. However, if extensive forces are applied to a ligament, whether suddenly or over a prolonged period of time, the ligament can be elongated. When this occurs, the function of the ligament is compromised, thereby altering joint function. Ligaments do not enter actively into joint function but instead act as passive restraining devices to limit and restrict border movements. Three functional ligaments support the TMJ: (1) the collateral ligaments, (2) the capsular ligament, and (3) the temporomandibular (TM) ligament. Two accessory ligaments also exist: (4) the sphenomandibular and (5) the stylomandibular.

Capsular Ligament

Capsular ligament (lateral view): Note that it extends anteriorly to include the articular eminence and encompass the entirearticular surface of the joint. A significant function of the capsular ligament is to encompass the joint, thus retaining the synovial fluid. The capsular ligament is well innervated and provides proprioceptive feedback regarding position and movement of the joint.

Temporomandibular Ligament: The lateral aspect of the capsular ligament is reinforced by strong, tight libers that make up the lateral ligament, or TM ligament. The TM ligament is composed of two parts," an outer oblique portion and an inner horizontal portion. The outer portion extends from the outer surface of the articular tubercle and zygomatic process posteroinferiorly to the outer surface of the condylar neck. This unique feature of the TM ligament, which limits rotational opening, is found only in humans

Sphenomandibular Ligament: The sphenomandibular ligament is one of two TMJ accessory ligaments. It arises from the spine of the sphenoid bone and extends downward to a small bony prominence on the medial surface of the ramus of the mandible, which is called the lingula. It does not have any significant limiting effects on mandibular movement.

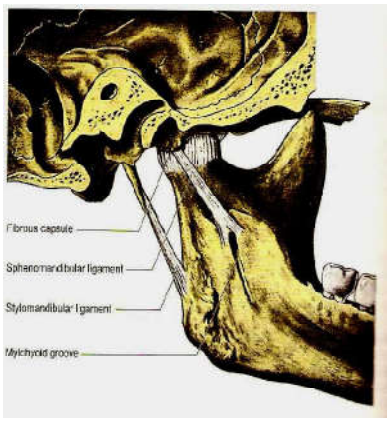

Fig. 6. Mandible, tempero mandibular joint, capsular ligament

Stylomandibular Ligament: The second accessory ligament is the stylomandibular ligament . It arises from the styloid process and extends downward and forward to the angle and posterior border of the ramus of the mandible. It becomes taut when the mandible is protruded but is most relaxed when the mandible is opened. The stylomandibular ligament therefore limits excessive protrusive movements of the mandible.

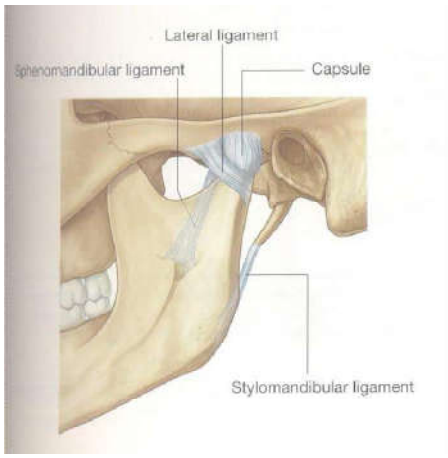

Fig. 7. Stylomandibular ligament

TMD'S IN DETAIL

Signs and Symptoms of Temporomandibular Disorders: Etiologic factors such as trauma, emotional stress, orthopaedic instability, and sources of deep pain and muscle hyperactivity were implicated as significant components. The clinical signs and symptoms of masticatory dysfunction can be grouped into categories according to structures that are affected: (1) the muscles, (2) the temporomandibular joints (TMJs), and (3) the dentition. Muscle and TMJ disorders make up the group of conditions known as temporomandibular disorders (TMDs). Included with the signs and symptoms of each are the etiologic factors that either cause or contribute to the disorder.When evaluating a patient, it is important to identify both signs and symptoms clearly. A sign is an objective clinical finding that the clinician uncovers during a clinical examination. A symptom is a description or complaint reported by the patient. Patients are acutely aware of their symptoms, yet they may not be aware of their clinical signs. For example, a person reports muscle tenderness during mandibular opening yet is totally unaware of the joint sounds that are also present. Both the muscle tenderness and the joint sounds are clinical signs, but only the muscle tenderness is considered a symptom. To avoid overlooking subclinical signs, the examiner must be acutely aware of the common signs and symptoms for each specificdisorder.

Functional Disorders of The Muscles: Functional disorders of masticatory muscles are probably the most common TMD complaint of patients seeking treatment in the dental office. With regard to pain, they are second only to odontalgia (i.e., tooth or periodontal pain) in terms of frequency. They are generally grouped in a large category known as masticatory muscle disorders. As with any pathologic state, two major symptoms can be observed: (1) pain and (2) dysfunction . Certainly the most common complaint of patients with masticatory muscle disorders is muscle pain, which may range from slight tenderness to extreme discomfort Pain felt in muscle tissue is called myalgia.

Dysfunction: Dysfunction is a common clinical symptom associated with masticatory muscle disorders. Usually it is seen as a decrease in the range of mandibular movement. When muscle tissues have been compromised by overuse, any contraction or stretching increases the pain. Therefore to maintain comfort, the patient restricts movement within a range that does not increase pain levels. Acute malocclusion is another type of dysfunction.

Acute malocclusion refers to any sudden change in the occlusal condition that has been created by a disorder. An acute malocclusion may result from a sudden change in the resting length of a muscle that controls jaw position. When this occurs the patient describes a change in the occlusal contact of the teeth. The mandibular position and resultant alteration in occlusal relationships depend on the muscles involved.

Regional myalgic disorders

Myofascial Pain (Trigger Point Myalgia): Myofascial pain is a regional myogenous pain condition characterized] bands of muscle tissue known as"'trigger points. This condition is sometimes referred to as myofascial trigger point pain. It is a type of muscle disorder that is not widely appreciated or completely understood, yet it commonly occurs in patients with myalgic complaints. In one study more than 50% of the patients reporting to a university pain center were diagnosed as having this type of pain. Myofascial pain was first described by Travell and Rinzlerin 1952, yet the dental and medical communities have been slow to appreciate its significance. In 1969 Laskin described the myofascial pain dysfunction (MPD) syndrome as having certain clinical characteristics. Although Laskin borrowed the term myofascial, he was not describing myofascial trigger point pain. Instead MPD syndrome has been used in dentistry as a general term to denote any muscle disorder (not an intracapsular disorder). Because the term is so broad and general, it is not useful in the specific diagnosis and management of masticatory muscle disorders.

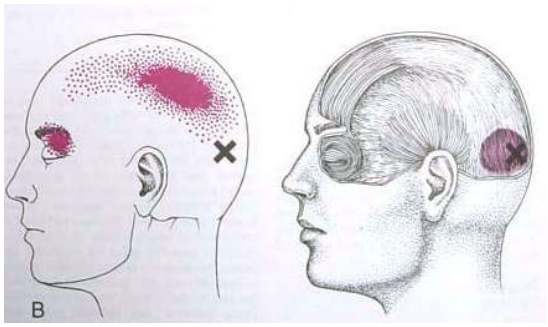

Fig 8; A trigger point (marked with x) in the occipital belly of the occipitofrontalis muscle produces referred headache pain behind the eye. (From Travell JG, Simons DG: myofascial pain and dysfunction. The trigger point manual, Baltimore, 1983, Williams & Wilkins, p 291)

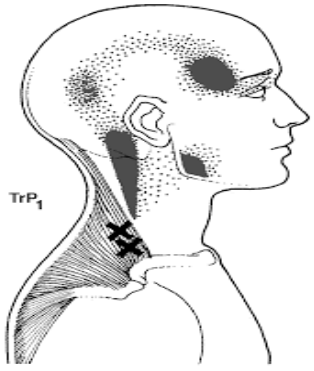

Fig. 9. The trigger points locate din the trapezius muscles (marked with x) refer pain to behind the ear, the temple, and the angle of the jaw (From Travell JG, Simons DG:Myofascial pain and dysfunction. The trigger point manual, Baltimore,!983,Williams & Wilkins, p 184.)

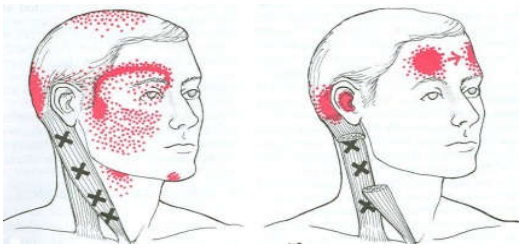

Fig 10; Trigger points located in the stemocleidomastoideus refer pain to the temple area (i.e., typical temporal headache). (From Travail JG, Simons DG: myofascial pain and dysfunction. The trigger point manual, Baltimore, 1983, Williams & Wilkins, p 203.)

Macrotrauma: Macrotrauma is considered any sudden force to the joint that can result in structural alterations. The most common structural alteration affecting the TMJ is elongation of the discal ligaments. Macrotrauma can be subdivided into two types: direct trauma or indirect trauma.
Direct trauma. Significant direct trauma to the mandible, such as a blow to the chin, can instantly create an intracapsular disorder. If this trauma occurs when the teeth are separated(open mouth trauma) the condyle can be suddenly displaced from the fossa. This sudden movement of the condyle is resisted by the ligaments.

Microtrauma: Microtrauma refers to any small force that is repeatedly applied to the joint structures over a long period of time. The dense fibrous connective tissues that cover the articular surfaces of the joints can well tolerate loading forces. In fact, these tissueneed a certain amount of loading to survive because loading forces drive synovialfluid in and out of the articular surfaces, passing with it nutrients coming in and waste products going out. If, however, loading exceeds the functional limit of the tissue, irreversible changes or damage can result.

Orthodontics and Disc Derangement Disorders: In recent years concern has arisen regarding the effect of orthodontic treatment on disc derangement disorders. Some authors have suggested that certain orthodontic treatments can lead to disc derangement disorders. Long-term studies of orthodontically treated populations, however, do not support these concerns. These studies report that the incidence of TMD symptoms in a population of orthodontically treated patients is no greater than that of the untreated general population Furthermore, studies that looked at the specific type of orthodontic mechanisms used, such as Begg technique versus various functional techniques, also failed to show a relationship between intracapsular disorders (or any TMD symptoms) and orthodontic treatment. Even the extraction of teeth for orthodontic purposes did not reveal a greater incident of TMD symptoms post treatment. Although these studies are comforting to the orthodontist, one should also note that the incidence of TMD symptoms in the orthodontically treated populations was generally no lower than that of the untreated population. Therefore these findings suggest that orthodontic treatment is not effective in preventing TMDs.

Spontaneous Dislocation: On occasion the mouth is opened beyond its normal limit, and the mandible locks. This is called spontaneous dislocation or an open lock. Most dentists will eventually experience this condition in a patient following a wide opening dental procedure. It should not be confused with the closed lock, which occurs with a functionally dislocated disc without reduction.

With spontaneous dislocation, the patient cannot close the mouth. This condition is almost always produced by wide opening (e.g., an extended yawn or a long dental procedure). Spontaneous dislocation typically occurs in a patient who has the fossa anatomy that permits subluxation. Aswith subluxation, the disc becomes maximally rotated on the condyle before full translation of the condyle occurs. The end of translation therefore represents a sudden movement of the condyle-disc complex as a unit. If, in the maximally open position of the mouth, pressure is applied to force it open wider, the tight attachment of the anterior capsular ligament can cause a bodily rotation of the condyle and disc, moving the disc farther anteriorly through the discal space.

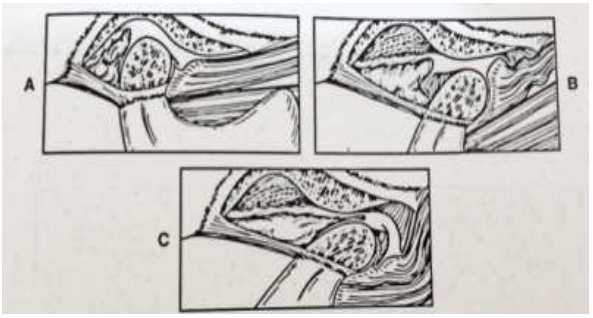

Fig 12. Spontaneous dislocation (with disc anteriorly dislocated)

Treatment of tmd's general considerations in treatment of temperomandibular joint disorders interrelationships of various temporomandibular disorders. Accurately diagnosing and treating temporomandibular disorders (TMI)s) can be a difficult and confusing task. This is often true primarily because patients' symptoms do not always fit into one classification. In many instances several classifications seem to be appropriate because in reality the patient is suffering from more than one disorder. In many patients one disorder contributes to another. The interrelationship of the various TMDs must always be considered in the evaluation and treatment of patients. Sometimes it is nearly impossible to identify which disorder preceded the other. Often the evidence to determine such an order can be obtained only from a thorough history.

Definitive therapy considerations for occlusal factors

Occlusal therapy is considered to be any treatment that is directed toward altering the mandibular position and/or occlusal contact pattern of the teeth. It can be of two types: reversible and irreversible.

Reversible occlusal therapy: Reversible occlusal therapy alters the patient's occlusal condition only temporarily and is best accomplished with an occlusal appliance. This is an acrylic device worn over the teeth of one arch that has an opposing surface that creates and alters the mandibular position and contact pattern of the teeth. Full-arch maxillaryocclusal appliance, a type of reversible occlusaltherapy.

Irreversible occlusal therapy: Irreversible occlusal therapy is any treatment that permanently alters the occlusal condition and/or mandibular position. Examples are selective grinding of teeth and restorative procedures that modify the occlusal condition.

Fig 13. Full arch maxillary occlusal appliance, a type of reversible occlusal therapy

Other examples are orthodontic treatment and surgical procedures aimed at altering the occlusion and/or mandibular position.Appliances that are designed to alter growth or permanently reposition the mandible are also considered irreversible occlusal therapies.

Definitive Therapy Considerations for Trauma: Trauma is one of the five etiologic factors that can lead to a TMD. As previously discussed, trauma can occur in two forms: macrotrauma and microtrauma. In the case of macrotrauma, definitive therapy has little meaning because the trauma is usually no longer present. Once macrotrauma has produced tissue injury, the only therapy that will help resolve the tissue response is supportive therapy. However, in the case of macrotrauma, preventive measures should always be considered. When macrotrauma is likely, such as when participating in a sporting event, proper protection of the masticatory structures should be considered. A simple and effective manner to minimize injury associated with macrotrauma is to wear a soft occlusal appliance or mouth guard. when this appliance is in place, the mandible is stabilized with the maxilla, which minimizes injury to the masticatory structures.

Physical Therapy: Physical therapy represents a group of supportive actions that is usually instituted in conjunction with definitive treatment. It can be an important part of the successful management of many TMDs. Although physical therapy has been used to reduce the symptoms associated with TMD, the evidence that supports each specific type of treatment has yet to be established.Because physical therapy techniques are normally quite conservative, the profession feels relatively comfortable using them without evidence-based data. Most physical therapy fits into one of two general categories: modalities and manual techniques.

Physical therapy modalities: Physical therapy modalities represent the physical treatments that can be applied to the patient. They can be divided into the following types: thermotherapy, coolant therapy, ultrasound, phonophoresis, iontophoresis, electrogalvanic stimulation (EGS) therapy, transcutaneous electrical nerve stimulation (TENS), acupuncture, and laser.

Thermotherapy: Moist heat applied to the symptomatie muscle can often reduce levels of pain and discomfort. A commercially available moist heat pad can be moistened and heated in a microwave. A warm, moist towel can also be used.

Fig14. Thermo therapy

Coolant Therapy: An ice pack is applied to the painful area for 2 to 4 minutes or until the tissue feels numb. Then the tissue is allowed to slowly warm again. This can be repeated as needed. Ice should not be left on the face for longer than 5 to 7 minutes or tissue injury may result. Fluoromethane spray is applied to the painful areas for approximately 5 seconds. The muscle is then gently stretched. This is repeated several times during each visit. The eyes, nose, and ears are protected from the spray.Two of the most common sprays used are ethyl chloride and fluoromethane. In early studies ethyl chloride was generally used, but it was found to be both flammable and a cardiac depressant if inhaled. Thus fluoromethane has been more recently suggested because it does not pose these risks.

Fig. Coolant therapy

Ultrasound Therapy: Ultrasound is a method of producing an increase in temperature at the interface of the tissues and therefore affects deeper tissues than does surface heat. Not only does ultra sound increase the blood flow in deep tissues, it also seems to separate collagen fibers. This improves the flexibility and extensibility of connective tissues. Ultrasound has also been used to administer drugs through the skin by a process known as phonophoresis. For example, 10% hydrocortisone cream is applied to an inflamed joint and the ultrasound transducer is then directed at the joint. The effects of salicylates and other topical anesthetics can also be enhanced in this manner. Iontophoresis, like phonophoresis, is a technique by which certain medications can be introduced into the tissues without affecting any other organs. With iontophoresis the medication is placed in a pad and the pad is placed on the desired tissue area.

Fig 15. Coolant Therapy

Fig. 16. Ultrasound therapyiontophoresis

Fig 17. Iontophoresis treatment

Medication is placed in a pad, and then a low electrical current is passed through the pad, driving the medication into the tissue. Local anesthetics and anti¬inflammatories are common medications used with iontophoresis.

Electrogalvanic Stimulation Therapy: EGS uses the principle that electrical stimulation of a muscle causes it to contract. EGS uses a high-voltage, low-amperage, monophasic current of varied frequency. Arhythmic electrical impulse is applied to the muscle, creating repeated involuntary contractions and relaxations. The intensity and frequency of these can be varied according to the desired effect, and they may help to break up myospasms, aswell as increase blood flow to the muscles. Both effects lead to a reduction of pain in compromised muscle tissues. If, however, significant motor stimulation occurs concurrently, this may impair the analgesic effect and actually exacerbate acute muscle pain.

Transcutaneous Electrical Nerve Stimulation: TENS, is produced by a continuous stimulation of cutaneous nerve fibers at a subpainful level.

When a TENS unit is placed over the tissues of a painful area, the electrical activity decreases pain perception. TENS uses a low-voltage, low-amperage, biphasic current of varied frequency and is designed primarily for sensory counter stimulation in painful disorders. When the intensity of a TENS unit is increased to the point that motor fibers are activated, the TENS unit becomes an EGS unit that is no longer used for pain control but instead for muscle relaxation, as mentioned earlier. Frequent interchange of these terms confuses some professionals. Portable TENS units have been developed for long-term use by patients with chronic pain and can be effectivewith various TMDs.

Fig. 18. Transcutaneous electrical nerve stimulation (tens)

Acupuncture: Another technique of modulating pain, acupuncture, uses the body's own antinociceptive system to reduce the levels of pain felt. Stimulation of certain areas (or acupuncture points) appears to cause the release of endorphins, which reduce painful sensations by flooding the afferent interneurons with subthreshold stimuli.These effectively block the transmission of noxious impulses and thus reduce the sensations of pain.

Fig 19. Accupucture

Cold Laser: In recent years the cold or soft laser has been investigated for wound healing and pain relief. Currently, it is not considered to be a routine physical therapy modality but is included in this section for completeness. Most studies on the cold laser report on its use in chronic musculoskeletal, rheumatic, and neurologic pain conditions. A cold laser is thought to accelerate collagen synthesis, increase vascularity of healing tissues, decrease the number of microorganisms, and decrease pain.

Fig 20. Cold laser

Fig 21. Massage Therapy

Fig. 22. Joint distraction of the temporomandibular joint

Fig. 23. Passive exercises

Manual Techniques: Manual techniques are the "hands-on" therapies provided by the physical therapist for the reduction of pain and dysfunction. Manual techniques are divided into three categories: soft tissue mobilization, joint mobilization, and muscle conditioning.

Soft Tissue Mobilization: Physical therapy can be helpful in regaining normal function and mobility of injured or painful tissues. Soft tissue mobilization is useful for muscle pain conditions and is accomplished by superficial and deep massage. As discussed previously, mild stimulation of cutaneous sensory nerves exerts an inhibitory influence on pain. Thus gentle massage of the tissues overlying a painful area can often reduce pain perception. The patient can be taught gentle self-massage techniques and is encouraged to do this as needed for reduction of pain.

This technique along with painless stretching of the muscles can be quite helpful in reducing pain. When muscle pain is the major complaint, massage can be helpful. The patient is encouraged to apply gentle massage to the painful areas regularly throughout the day. This can stimulate cutaneous Sensory nerves to exert an inhibitory influence on the pain. If it increases the pain, it should be stopped.

Joint Mobilization: Mobilization of the TMJ is useful in decreasing intcrarticular pressure, as well as increasing range of joint movement. Gentle distraction of the joint can assist in reducing temporary adhesions and perhaps even mobilize the disc. In some instances distraction of the joint is useful in managing an acute disc dislocation without reduction. Passive distraction is thought to inhibit the activity of muscles that pull across the joint. Distraction of the TMJ is accomplished by placing the thumb in the patient's mouth over the lower second molar area on the side to be distracted. With the cranium stabilized by the other hand, the thumb places downward force on the molar as the rest of the same hand pulls upon theanterior portion of the mandible (chin). Distraction for relaxing muscles does not require translation of the joint but merelyunloading in the closed joint position. The distraction is maintained for several seconds and then released. It can be repeated several times. When joint immobility is the problem, distraction is combined with manual translation of the joint. This can be accomplished by placing the thumb in the patient's mouth over the mandibular second molar area on the side to be distracted. While the cranium is stabilized with the other hand, the thumb exerts downward force on the molar.

Muscle Conditioning: Patients who experience TMD symptoms often decrease the use of their jaw because of pain. If this is prolonged, the muscles can become shorted and atrophied. The patient should be instructed in self-administering exercises that can help restore normal function and range of movement. Four types of exercises programs can be instituted by the physical therapist or the dentist: passive muscle stretching, assisted muscle stretching, resistance exercises, and postural training. Resistance exercises use the concept of reflex relaxation to provide an increase inmandibular opening. A, The patient is instructed to open against gentle resistance provided by the lingers. This will promote relaxation in the elevator muscles, thus allowing increased mandibular opening. B, When eccentric movement is limited, the patient can be asked to move in the eccentric position with gentle resistance from the fingers. These exercises are repeated 10 times each session, six sessions a day.

Correlation between orthodontics and tmd's: The relationship between orthodontic treatment and temporomandibular disorders (TMDs) has long been of interest to the practicing orthodontist, but only during the past decade have a significant number of clinical studies been conducted that have investigated this association. This interest in orthodontics and TMD in part was prompted in the late 1980s after litigation that alleged that orthodontic treatment was the proximal cause of TMD in orthodontic patients. This litigious climate resulted in an increased understanding of the need for risk management as well as for methodologically sound clinical studies. Temporomandibular joint disorder (TMD) is a collective tenn embracing several clinical problems that involve the masticatory musculature, the temporomandibular joint and associated structures, or both.

Disk displacement (DD) and osteoarthritis(OA) or degenerative joint diseases (DJDs) are often associated with TMJ pain. DD with reduction (DDR) is frequently associated with a clicking sound, and DD without reduction (DDN) is often associated with limitation of jaw opening. After the "Michigan Case," orthodontists became interested in documenting the relationship between orthodontic therapy and TMD. Infact, three significant studies (Larsson and Ronnerman, 1981; Sadowsky and Poison, 1984; Sadowsky et al, 1988) already had been published but seemed to be ignored in the courtroom. Since thesestudies, seven more studies (Dahl et al, 1988; Smith and Freer, 1989; Hirata et al., 1992;Kremenake/ al, 19926; Rendell et al, 1992; Wadhwa et al, 1993; Henrikson and Nilner, 2000) have attempted to investigate this relationship.

These studies suggest that subjects who received orthodontic therapy have no greater incidence of developing TMD than a group of control subjects who never received orthodontictherapy. Females are more commonly affected. It has been suggested that DD alters mandibular growth, sometimes resulting in a retrognathic facial profile. Some authors suggest that the prevalence of TMD begins to rise in late adolescence and increases through middle age and is associated with female sex, facial trauma, and specific anatomical and occlusal relationships. For example, abnormal mandibular morphology or increased horizontal overlap are potential correlates with mandibular morphology. In fact, subjects with TMD with horizontal overlap >4mm significantly differ from controls. It is not clear whether the disharmony of the facial skeletal structure is caused by the TMJ disorder or vice versa. Another argument that has been made is that the extraction of the premolars leads to a posterior displacement of the condyles in the fossa.

Conclusion

Consequently one would have to conclude that:

- We still await the "perfect study" to assess the relationships between malocclusion and TMD; more steps should be taken to eliminate bias
- Confusion has sometimes risen because of assumptions that correlation implies casualty; this needs to be avoided in future.
- More information with respect to aetiology, diagnosis, and assessment of TMD is still needed, this may have repercussions for study designs
- Based on currently available evidence, it seems that neither the possession of a malocclusion nor orthodontic treatment can be said to cause or cure TMD.

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