International Journal of Dental Sciences & Research
(A Peer- Reviewed Bi-Annual Journal)

TEMPOROMANDIBULAR DISORDERS AND ORTHODONTICS– A REVIEW

[1]Rajdeep Kaur, [2]Sahil, [3]Sahil Handa, [4]Arick, [5]Himani Chopra, [6]Sumit
[1]Reader, Department of Orthodontics & Dentofacial Orthopaedics,
Desh Bhagat Dental College & Hospital, Mandi Gobindgarh, Punjab, India.
[2]Post Graduate Student (3rd year), Department of Orthodontics & Dentofacial Orthopaedics,
Desh Bhagat Dental College & Hospital, Mandi Gobindgarh, Punjab, India.
[3]Bachelor of Dental Surgery, Punjab, India.
[4]Bachelor of Dental Surgery, Punjab, India.
[5]Bachelor of Dental Surgery, Punjab, India.
[6]Dental shadowing at Care Dental Centre, Surrey BC

Corresponding author
Dr. Rajdeep Kaur
Reader, department of Orthodontics & Dentofacial Orthopaedics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh, Punjab, India. Email id: dentistchahal@gmail.com, Contact No. 9750700057.

Abstract

The masticatory system is extremely complex, functional unit of the body primarily responsible for chewing, speaking, and swallowing. Temporomandibular Joint (TMJ), the articulation of the mandibular condyle with the glenoid fossa of the temporal bone, is a complex skeletal structure that is essential for jaw movement in mammals. TMJ is comprised of multiple tissues, including the mandibular condyle, glenoid fossa, a fibrocartilaginous articular disc located between these two bones that divides the joint cavity into two compartments, and a variety of associated tendons and muscles. The application of forces during certain orthodontic mechanics, especially orthopedic situations, can cause alterations in condylar growth and bone structures of the TMJ. The orthodontist must understand the functional anatomy of TMJ before they can effectively diagnose and treat disease of TMJ. This term Temporo-Mandibular Disorders (TMDs), does not merely suggest problems that are isolated to the joints but includes all disturbances associated with the function of the masticatory system.The aetiology of TMDs is complex and multi-factorial. Numerous factors can contribute to TMDs. Factors that increase the risk of TMDs are called predisposing factors. Factors that cause the onset of TMDs are called initiating factors and factors that interfere with healing or enhance the progression of TMDs are called perpetuating factors.

Key words: Temporo-Mandibular Disorders, Temporomandibular Joint, perpetuating factors, functional anatomy, predisposing factors.

Introduction

Over the years functional disturbances of the masticatory system have been identified by a variety of terms. In 1934 James Costen[1] described a group of symptoms that centered around the ear and Temporo-Mandibular Joint (TMJ). The term 'Costensyndrome' developed because of his work. Later the term 'Temporo-Mandibular Joint Disturbances' became popular and then in 1959 Shore introduced the term 'Temporo-Mandibular Joint Dysfunction Syndrome". Later came the term 'Functional Temporo-Mandibular Joint Disturbances, coined by Ramfjord and Ash.[2]

Some terms described the suggested etiologic factors, such as Occluso-Mandibular Disturbance and Myoarthropathy of the Temporo-Mandibular joint. Others stressed pain, such as Pain-Dysfunction Syndrome, Myofascial Pain-Dysfunction Syndrome and Temporo-MandibularPain-Dysfunction Syndrome. Because the symptoms are not always isolated to the TMJ, some authors believe that the previous terms are too limited and that a broader, more collective term should be used, such as Cranio-mandibular Disorders.[3]

Bell suggested the term Temporo-Mandibular Disorders (TMDs), which has gained popularity. This term does not merely suggest problems that are isolated to the joints but includes all disturbances associated with the function of the masticatory system.[4]

Aetiology

The aetiology of TMDs is complex and multi-factorial. Numerous factors can contribute to TMDs. Factors that increase the risk of TMDs are called predisposing factors. Factors that cause the onset of TMDs are called initiating factors and factors that interfere with healing or enhance the progression of TMDs are called perpetuating factors. In some instances, a single factor may serve one or all of these roles. Following factors play role in TMDs:

1. Relationship of Occlusion to Temporo-mandibular Disorders,
2. Trauma
3. Emotional stress
4. Deep pain input
5. Para-functional activities
6. Muscle activity and masticatory symptoms

Relationship of Occlusion to Temporo-mandibular Disorders

The occlusal condition can affect TMDs by way of two mechanisms. One mechanism relates to the introduction of acute changes in the occlusal condition. Although acute changes can create a protective muscle co-contraction response leading to a muscle pain condition, most often new muscle engrams are developed and the patient adapts with little consequence. The second manner in which the occlusal condition can affect TMDs is in the presence of orthopaedic instability.[5,6,7]

The orthopaedic instability must be considerable and it must be combined with significant loading forces. A simple way to remember these relationships is as follows: "Problemswith

bringing the teeth into occlusion are answered by the muscles.[8] However,oncethe teeth are in occlusion, problems with loading the masticatory structures are answered in the joints". The importance of these relationships is stressed throughout the remainder of this text. These relationships are, in fact, how dentistry relates to TMD. Therefore, if one of these two conditions exists, dental therapy is likely indicated. Conversely, if neither of these conditions exists, dental therapy is contraindicated.[9]

2. Trauma

Trauma to the facial structures can leadto functional disturbances in the masticatory system. Trauma seems to have a greater impact on Intra-Capsular Disorder than muscular disorders. Trauma can be divided into two general types: Macro-traumaand Micro-trauma. Macro-trauma is considered anysudden force that can result in structural alterations, such as a direct blow to the face. Micro-trauma refers to any small force that is repeatedly applied to the structures over a long period of time. Activities suchas bruxism or clenching can produce micro-traumato the tissues that are being loaded (i.e. teeth, joints or muscles).[10]

3. Emotional Stress

A common systemic event that can influence masticatory function is an increase in the level of emotional stress experienced by the patient. The emotional centres of the brain influence muscle function. The hypothalamus, the reticular system and particularly the limbic system are primarily responsible for the emotional state of the individual. These centres influence muscle activity in many ways, one of which is through the gamma efferent pathways.

Stress can affect the body by activating the hypothalamus, which in turn prepares the body to respond (the autonomic nervous system). The hypothalamus, through complex neural pathways, increases the activity of the gamma efferent, which cause the intrafusal fibres of the muscle spindles to contract. This sensitizes the spindle so that any slight stretching of the muscle will cause a reflex contraction. The overall effect is an increase in tonicity of the muscle.[11]

Circumstances or experiences that create stress are known as ''stressors". These can be unpleasant (e.g., losing one's job) or pleasant (e.g., leaving for a vacation). When a stressful situation is encountered, energy is generated within the body and must be released in some way.[2]

Two types of releasing mechanisms exist:

1. External and
2. Internal

The clinician should remember that the perception of the stressor, in both type and intensity, varies greatly from person to person. What may be stressful for one person quite possibly represents no stress for another.

Therefore, it is difficult to judge the intensity of a given stressor on a given patient. Increased levels of emotional stress experienced by the patient increase not only the tonicity of head and neck muscles but also the levels of non-functional muscle activity such as bruxism or tooth clenching.[4]

The sympathetic nervous system is closely related to the fight-or-flight reflex activated by stressors. Therefore, in the presence of stress the capillary blood flow in the outer tissues is constricted, permitting increased blood flow to the more important musculoskeletal structures and internal organs. The result is a cooling of the skin such as the hands. Prolonged activity of the sympathetic nervous system can affect certain tissues such as the muscles. It has been suggested that sympathetic activity can increase muscle tone, thereby producing a painful muscle condition.

Increased sympathetic activity or tone therefore represents an etiologic factor that can influence TMD symptoms. Emotional stress can also influence TMD symptoms by reducing the patient's physiologic tolerance. This is likely to occur because of increased sympathetic tone. This effect often represents the individual's learned response to various stressors.[4]

4. Deep Pain Input

The sources of deep pain input can cause altered muscle function they can centrally excite the brainstem, producing protective co-contraction. This represents a normal healthy manner in which the body responds to injury or threat of injury. Therefore, it is reasonable to find a patient who is suffering with pain, such as toothache (i.e., necrotic pulp), to have limited mouth opening. This represents the body's response to protect the injured part by limiting its use. This clinical finding is common in many toothache patients. Once the tooth pain is resolved, normal mouth opening returns. The limited mouth opening is merely a secondary response to the experience of the deep pain.

If this phenomenon is not recognized, we may conclude that the limited mouth opening is a primary TMD problem and treatment would be misdirected. Any source of constant deep pain input can represent an etiologic factor that may lead to limited mouth opening and therefore clinically present as TMD. Tooth pain, sinus pain and ear pain can create this response. Even pain sources remote to the face, such as cervical pain input, can lead to this condition.[9]

5. Para-functional Activities

Para-functional activity refers to any activity that is not considered functional (chewing, speaking and swallowing). This includes bruxing, clenching and certain oral habits.

Some of these activities may be responsible for creating TMD symptoms. Para-functional activity can be subdivided into two general types: (i) that which occurs through the day (diurnal); (ii) that which occurs at night (nocturnal).[9]

Diurnal Activity

Para-functional activity during the day consists of clenching and grinding, as well as many oral habits that are often performed without the individual even being aware of them (e.g., cheek and tongue biting; finger and thumb sucking; unusual postural habits; occupation related activities such as biting on pencils, pins, or nails or holding objects under the chin [a telephone or violin]). During daily activities, individuals commonly place their teeth together and apply force.

This type of diurnal activity may be seen in someone who is concentrating on a task or performing a strenuous physical chore. The masseter muscle contracts periodically in a manner that is totally irrelevant to the task at hand. Such irrelevant activity is commonly associated with many day time tasks (e.g. driving a car, reading, writing, typing, lifting heavy objects).[12]

Some diurnal activities are closely related to the task being accomplished, such as a skin diver biting on the mouth piece or a musician playing certain musical instruments. The clinician must recognize that most para-functional activities occur at a subconscious level. In other words, individuals are often not even aware of their clenching or cheek-biting habits.

Nocturnal Activity

Data from various sources have suggested that para-functional activity during sleep is quite common and seems to take the

form of single episodes (referred to as clenching) and rhythmic-contractions (known as bruxing). Whether these activities result from different etiologic factors or are the same phenomenon in two different presentations is not known. In many patients both activities occur and are sometimes difficult to separate. For that reason, clenching and bruxism are often referred to as bruxing events.[9]

Sleep: To best understand nocturnal bruxism, the clinician should first have an appreciation of the sleep process. Sleep is investigated by monitoring the brain wave activity (electroencephalogram) of an individual during sleep. This monitoring is called a polysomnogram. A polysomnogram reveals two basic types of brain wave activities that appear to cycle during a night of sleep: (A) alpha and (B) delta.[4]

(a) Alpha waves are relatively fast (about 10 waves per second) and are the predominant waves observed during the early stages of sleep or light sleep.

(b) Delta waves are slower waves (0.5 to 4 waves per second) and are observed during the deeper stages of sleep.

The sleep cyclic is divided into four stages that are free of rapid eye movement (non-REM) followed by a period of REM.

Stages 1 and 2 represent the early phases of light sleep and are made up of groups of fast alpha waves along with a few beta waves and "sleep spindles."

Stages 3 and 4 represent the deeper stages of sleep with the predominance of the slower beta waves.

When an individual is experimentally deprived of REM sleep, certain emotional states become predominant. Individuals show greater anxiety and irritability. They also have difficulty concentrating. It would appear that REM sleep is important for psychic rest. A different finding is revealed when an individual is deprived of non-REM sleep.

When a normal subject is experimentally deprived of non-REM sleep for several nights, the subject will often begin to complain of musculoskeletal tenderness, aching and stiffness.[9]

This may result from the individual's inability to restore metabolic requirements. In other words, non-REM sleep is important for physicalrest.

The clinician who treats TMDs must have an appreciation of the relationship between sleep and muscle pain.

Stages of sleep and bruxing events.Controversy surrounds the stages of sleep during which bruxing occurs. Some studies suggest that it takes place mainly during the REM stage, whereas others suggest that bruxism never occurs during REM sleep. Still other studies[13] report that bruxing events occur during both REM and non-REM sleep, but most events seem to be associated with the lighter stage 1 and 2 non-REM sleep.[4]

Bruxing events appear to be associated with a change from deeper to lighter sleep, as can be demonstrated by directing a flashing light toward a sleeping person's face. Such stimulation has been shown to induce tooth grinding. The same reaction was observed following sonic and tactical stimulation. Thus, this and other studies have indicated that bruxing may be closely associated with the arousal phases of sleep.

(a) Duration of bruxing events. Kydd and Daly[14] reported that a group of 10 bruxists rhythmically clenched their teeth for a total mean duration of 11.4 minutes per night. These clenches commonly occurred in single episodes lasting 20 to 40 seconds.

(b) Intensity of bruxing events. The intensity of bruxing events has not been studied well, but Clarke et al[1] demonstrated an interesting finding. They found that an average bruxing event involved 60% of the maximum clenching power before the person went to sleep. This is a significant amount of force because the maximum clench far exceeds the normal forces that are used during mastication or any other functional activity.

(c) Sleep position and bruxing events. In a few studies sleep position and bruxing events have been studied. Before these investigations, researchers speculated that subjects did more bruxing while sleeping on their sides compared with sleeping on their backs.[15]

(d) Bruxing events and masticatory symptoms. An important question regarding nocturnal bruxism that has not been adequately addressed is the type and duration of bruxing events that cause masticatory symptoms. Ware and Rugh suggested that there might be two types of bruxism patient: one bruxing more during REM sleep and one bruxing more during the non-REM phases. Other studies by these authors showed that the amount of sustained contraction occurring in bruxism was commonly much higher during REM than non-REM phases of sleep. [9]

6. Muscle activities and masticatory symptoms

As one begins to appreciate para-functional activity, one also begins to understand how this type of muscle activity can represent a cause of some types of TMDs. Functional activity, on the other hand, does not seem to have the same risk factors.[9]

Five common factors will illustrate why these different muscle activities pose different TMD risk factors (Table: 1)

Factor	Functional Activity	Para-Functional Activity
Forces of tooth contacts	17,200 lb/sec/day	56,600 lb/sec/day, possibly more
Direction of applied forces to teeth	Vertical (well tolerated)	Horizontal (not well tolerated)
Mandibular position	Centric occlusion (relatively stable)	Eccentric movements (relatively unstable)
Type of muscle contraction	Isotonic (physiologic)	Isometric (non-physiologic)
Influence of protective reflexes	Present	Bounded
Pathologic effects	Unlikely	Very likely

Table 1: Comparison of Functional and Para-functional Activities using Five common Factors

(a) Forces of Tooth Contacts. In evaluating the effect of tooth contacts on the structures of the masticatory system, two factors must be considered: the magnitude and duration of the contacts. A reasonable way to compare the effects of functional and para-functional contacts is to evaluate the amount of force placed on the teeth in pounds per second per day for each activity.[9]

Both chewing and swallowing activities must be evaluated (normally no tooth contacts occurduring speech). Estimates indicate that during each chewing stroke an average of 58.7 lb of forceis applied to the teeth for 115 ms. This yields[6]. 75 lb/sec/chew.[16]

In view of the fact that an estimated 1800 chews occur during an average day,one can see that the total occlusal force-time activity would be 12,150 lb/sec/day. The forces of swallowing must also be considered. Persons swallow some 146 times a day while eating.[9]

Because an estimated 66.5 lb of force is applied tothe teeth for 522 ms during each swallow, this comes to 5068 lb/sec/day. Thus, the total force time activity for chewing and swallowing is about 17,200 lb/sec/day.[9]

Tooth contacts during para-functional activity are more difficult to evaluate because little is known regarding the amount of forces applied to the teeth. A significant amount of force over a given period can be recorded during nocturnal bruxism.

(b) Direction of Applied Forces: During chewing and swallowing, the mandible is moving primarily in a vertical direction. As it closes and tooth contacts occur, the predominant forces applied to the teeth are also in a vertical direction. Vertical forces are accepted well by the supportive structures of the teeth. During para-functional activities, however (e.g.bruxism), heavy forces are applied to the teeth as the mandible shifts from side to side. This shifting causes horizontal forces, which are not well accepted and increase the likeli hood of damage to the teeth and/or supportive structures.[9]

(c) Mandibular Position. Most functional activity occurs at or near the Inter-Cuspal Position (ICP). Although the ICP may not always be the most Mesio Superior position for the condyles, it is stable for the occlusion because of the maximum number of tooth contacts it provides. Therefore, the forces of functional activity are distributed to many teeth, minimizing potential damage to an individual tooth. Tooth wear patterns suggest that most para-functional activity occurs in eccentric positions. Few tooth contacts occur during this activity and often the condyles are translated far from a stable position. Activity in this type of mandibular position places more strain on the masticatory system, rendering it more susceptible to breakdown. Such activity results in the application of heavy forces to a few teeth in an unstable joint position and thus there is an increased likelihood of pathologic effects to the teeth and joints.[16]

(d) Type of Muscle Contraction: Most functional activity consists of well-controlled and rhythmic contraction and relaxation of the muscles involved during jaw function. This isotonic activity permits adequate blood flow to oxygenate the tissues and eliminate by products accumulated at the cellular level. Therefore, functional activity is a physiologic muscle activity. Para-functional activity, by contrast, often results in sustained muscle contraction over long periods. This type of isometric activity inhibits normal blood flow within the muscle tissues. As a result, there is an increase in metabolic by-products within the muscle tissues, creating the symptoms of fatigue, pain and spasms.[17,18,19]

(e) Influences of Protective Reflexes: Neuromuscular reflexes are present during functional activities, protecting the dental structures from damage. During para-functional activities, however, the neuromuscular protecting mechanisms appear to be some what bounded, resulting in less influence over muscle activity. This allows para-functional activity to increase and eventually reach levels high enough to create breakdown of the structures involved. After considering these factors, it becomes apparent that para-functional activity is more likely to be responsible for structural breakdown of the masticatory system and TMDs than functional activity. This is an important concept to remember because many patients come to the dental office complaining of functional disturbances such as difficulty in eating or pain during speaking. The clinician should remember that functional activities often bring to the patient's awareness the symptoms that have been created by para-functional activities.

Another concept to remember is that para-functional activities occur almost entirely subconsciously. Much of this damaging activity occurs during sleep in the form of bruxism and clenching. Often patients awake with no awareness of the activity that has occurred during sleep. They may even awake with TMD symptoms but not relate this discomfort to any causative factor. When they are questioned regarding bruxism, most will deny such activity.

(E) Classification

Welden Bell presented a classification that logically categorizes these disorders and the American Dental Association adopted it with fewchanges. It has, in fact, become a "road map" helping-clinicians toward a precise and well-defineddiagnosis. The basic Classification of TMDs developed by Bell but incorporates someadditional modifications of Jeffrey Okeson. It begins byseparating all TMDs into four broad categories having similar clinical characteristics:

1. Masticatorymuscle disorders,
2. TMJ disorders,
3. Chronic Mandibular Hypomobility Disorders and
4. Growth disorders.

Each of these categories is further divided according to dissimilarities that are clinicallyi dentifiable. This classificationis important because treatment indicated foreach subcategory varies greatly. Each broad category can be described according to the symptoms that are common to it, where as each subdivision is characterized by the clinical characteristics that differentiate it from the others.[9]

Classification system used for diagnosing Temporo-Mandibular Disorders:

A. Masticatory muscle disorders

1. Protective co-contraction
2. Local muscle soreness
3. Myofascial pain
4. Myospasm
5. Centrally mediated myalgia

B. Temporo-Mandibular Joint (TMJ) disorders

1. Derangement of the condyle-disc complex

(i) Disc displacements
(ii) Disc dislocation with reduction
(iii) Disc dislocation without reduction

2. Structural incompatibility of the articular surfaces

(i) Deviation in form

a. Disc
b. Condyle
c. Fossa

(ii) Adhesions

a. Disc to condyle
b. Disc to fossa

(iii) Subluxation (hypermobility)
(iv) Spontaneous dislocation

3. Inflammatory disorders of the TMJ

(i) Synovitis/capsulitis
(ii) Retrodiscitis
(iii) Arthritides

a. Osteoarthritis
b. Osteoarthrosis
c. Polyarthritides

4. Inflammatory disorders of associated structures

(i) Temporal tendonitis
(ii) Stylomandibular ligament inflammation

(C) Chronic Mandibular Hypomobility

1. Ankylosis

(i) Fibrous

(ii) Bony

2. Muscle contracture

(i) Myostatic

(ii) Myofibrotic

3. Coronoid impedance

(D) Growth disorders

1. Congenital and developmental bone disorders

(i) Agenesis

(ii) Hypoplasia

(iii) Hyperplasia

(iv) Neoplasia

2. Congenital and developmental muscle disorders

(i) Hypotrophy

(ii) Hypertrophy

(iii) Neoplasia

(F) Sign and symptoms of temporo-mandibular joint disorders

Temporo-Mandibular Joint (TMJ) pain or arthralgia is usually due to capsulitis or synovitis, with associated joint inflammation, tenderness, pain and fluida ccumulation or effusion.Effusions and inflammation can be detected by MRI scans. The difficulty in diagnosing joint problems lies in determining whether pain in the area of the joint is due to muscle disorder,-joint disorder,or a systemic disorder. Most TMJ arthralgias cause pain anterior to the ear, with occasional referral to surrounding (e.g. temporal) regions; digital palpation and normal joint use are painful. Several joint conditions can be associated with arthralgia.

(i) Disk displacement with reduction is characterized by clicking of the TMJ on opening and closing. The opening click reflects thecondyle moving beneath the posterior band of the disk until it snaps into its normal relationship on the concave under surface of the disk.

The closing click reflects reversal of this process. The condyle moves under the posterior band of the disk until it snaps off the disk and onto the posterior attachment. The opening click occurs at a wider incisal opening than the closing clicks and at different points of incisal opening.[17]

Momentary dysfunction of the disk has been theorized to reflect articular surface irregularity, disk-articular surface adherence, synovial fluid degradation, disk-condyle incoordination as a result of abnormal muscle function, increased muscle activity around the joint, or disk deformation.

As the disk becomes more dysfunctional, it beginsto interfere with normal translation of the condyle and mayeven cause periodic jaw locking. An occasional patient has e xcessive-opening due to ligament laxity and joint hyper-mobilityand becomes at risk for open locking or sub-luxation of the joint.

(ii) Disk displacement without reduction is characterized by marked limited mouth opening due to interference with normal condylar sliding on the disk due to disk adhesion, deformation, or dystrophy. In this situation, the opening is usually restricted to 20-30mm with a deviation of the jaw to the affected side on opening. Joint noise is minimal because little joint translation occurs.

The masticatory muscles and joint frequently become tender and painful in response to the joint dysfunction. After the disk is permanently displaced, soft tissue remodelling of the disk and associated ligaments in the joint occurs.[20]

After a permanent locking occurs, routine daily jaw function encourages the posterior attachment and collateral ligaments to accommodate toallow normal jaw opening and abatement of pain. Further adaptation within the joint includes remodelling of the surfaces of thecondyle, fossa and articular eminence, with corresponding radio graphic changes.

Disk perforation may cause degenerative changes and coarse crepitus upon opening and closing. Successful remodelling allows patients to regain normal opening with minimal pain, but joint noise often persists. Sometimes, however, bony degenerative changes progress with severe erosion, Loss of vertical dimension, occlusal changes, worsened joint andmuscle pain and greatly compromised jaw function. The genesis of disk disorders and TMJ arthralgia has been at least partially attributed to abnormal biomechanical forces onthe condyle, which alter the shape, form and function of articulart issues. Friction due to abnormal jaw function and mal-position of the disk may exacerbate both jaw displacement and changes to the form and function of the disk. In other cases, ablow to the jaw, in advertent biting of a hard object or excessive chewingmay be inciting factors. Occasionally,whiplash injury contributes to TMJ arthralgia and disk displacement.

Disk displacements are common in the general population,but those affected generally function adequately without treatment. When a patient seeks help for asymptomatic TMJ noises, continued observation, education about the conditionand self-care are sufficient. Pain, intermittent lockingand difficulty using the jaw mandate closer observation and possible intervention.

(iii) TMJ subluxation or dislocation with or without a disk displacement is characterized by hypermobility of the joint due tolaxity of the ligaments. It may be provoked in the dental office when the mouth is held open for an extended period, particularlyin patients with systemic hypermobility.

The condyle is anteriorly dislocated with respect to the disk and articular eminence, unable to return to the closed position because normal posterior translation is blocked. In most cases, the condyle can be moved laterally or medially by the patient or clinician to disengage the locking and allow normal closure. If the lock cannot be immediately disengaged, jaw manipulation inferiorly and anteriorly may be required before the jaw can glide posteriorly.

(iv) Osteoarthrosis of the TMJ involves degenerative changes of the articular surfaces of the joint that cause crepitus, jawdys function and radiographic changes. In osteoarthritis, pain,inflammation and tenderness of the joint accompany the degenerative changes. Osteoarthrosis can occur at any stage of a disk displacement as well as after trauma, infection and other insults to the integrity of the joint, or with rheumatic or other conditions that cause poly-arthritis. The latter include disorders such assystemic osteoarthritis, rheumatoid arthritis, psoriasis, lupus erythematosus,scleroderma, Sjogren's syndrome and hyper-uricemia.

(v) Ankylosis or total lack of joint movement can be due to osseousor fibrous attachment of the condyle to fossa. Extra-capsularconditions such as coronoid process interference or muscle contracture can also cause significant jaw limitation.

(vi) Traumatic injuries usually result in either a contusion with joint haemorrhage,a sprain with tearing of the joint capsule and ligaments,or a fracture of the condylar neck or head or of the

external auditory canal. TMJ injuries are usually accompanied by pain and limited range of motion.

Developmental abnormalities, primary benign and malignant tumours, myxoma, fibrous dysplasia and metastasis or local extension of neighbouring malignancies to the TMJ can also occur but are rare.[20]

(G) Patient examination

The examination process includes a detailed clinical interview and a comprehensive physical inspection. Tempo-ro-Mandibular Joint (TMJ) imaging and additional tests (as serology and electromyography) are necessary only for very few specific cases. It has been stated that approximately 70% of the diagnostic process is based on the history review.

1. Amanesis: The following information should be part of acomprehensive history: (a) chief complaints, (b) history of presentillness, (c) past medical and dental history, (d) review of the systems(systemic conditions that can enhance or cause the painsensation) and (e) psychosocial history.

History review is the most important part of theexamination process. The first question to be done is aboutthe chief complaint, which is the main reason that made thepatient seek help. This information is of great importancebecause even if the patient has many complaints, theattenuation or resolution of the main problem may improvethe general status and quality of life.

Each complaint should be listed separately in order ofimportance to the patient and shall contain informationabout:

(a) Onset
(b) Location
(c) Intensity
(d) Frequency
(e) Quality
(f) History of the chief complaint
(g) Current and past medication
(h) Medical and surgical history
(i) Family history
(j) Dental history
(k) Presence of para-functional activity

2. Physical examination

A comprehensive physical examination will help to determine the source ofpain as well as the severity of the dysfunction. This part of assessment includes TMJ evaluation (joint range of motion,inspection of joint sounds and pain on palpation) and muscle palpation. Additional diagnostic tests can be necessary for some patients. Dental and occlusal evaluations are also performed.

(a) TMJ evaluation: TMJ clinical inspection is often based on joint range of motion, pain on palpation and presence of joint sounds during mandibular and opening movement. TMJ range of motion: some chief complaints include limitation of opening and difficulties in mandibular movement. The patient is requested to fully open the mouthand the sum of inter-incisal distance and overbite, measured with a millimetre rule is documented. The normal values to maximum opening range from 45 to 55mm, although smaller figures are frequently found inasymptomatic individuals. The mandibular opening andclosing movements may be accomplished in a straight line, to assess deviation or deflection. Measurements of protrusion, lateral right and left movements must also be performed (figure 1). For these measurements it is recommended the demarcation of two reference points, on the maxilla and mandible, close to the midline. These reference points will assist the measurements of the range of motion during mandibular excursion.

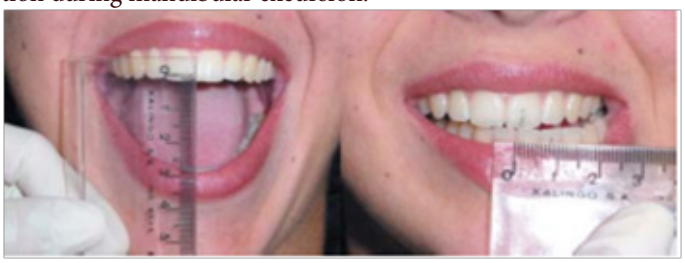

Fig. No 1: Measurement of maximum active opening and maximum lateral movement

• Detection of joint sounds (figure:2): The presence of joint soundsduring mouth opening and mandibular excursion can beuseful in the diagnosis of disc-condyle in-coordination. It isbelieved that the clinical registration by means of manualinspection or by using a stethoscope is very reliable in thedetection of articular sounds. Clicking,crepitation and terminal thud (related to hyper-translation)are the most common sounds in TMD patients.

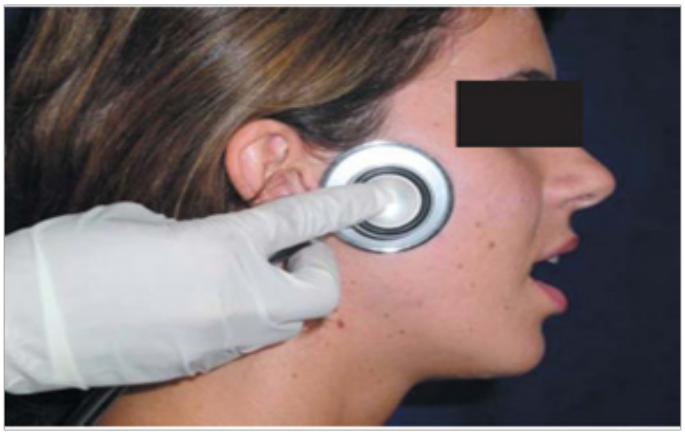

Fig. No. 2: Joint sound inspection with a stethoscope

• **TMJ Palpation (figure:3):** Tenderness to palpation is consideredone of the most important signs in the detection of intra-capsular pathologies. During repeated opening and closing movements the clinician should locate the lateral polo of mandibular condyle. After that, with the patient maintaining the mouth in a relaxed position, TMJ bilateral and simultaneous palpation of the lateral aspect of the joint should be done. This palpation should be performed with pressure of 1kg.in the lateral and posterior aspects of the joints. Reports of pain can lead to diagnosis of capsulitis and/or sinovitis. In order to graduate the patient's response to palpation, score ranging from 0 to 3 can be used: 0 - absence of pain on palpation; 1 - mild pain; 2 moderatepain; 3 - severe pain, palpebral reflex or "jumpsign".

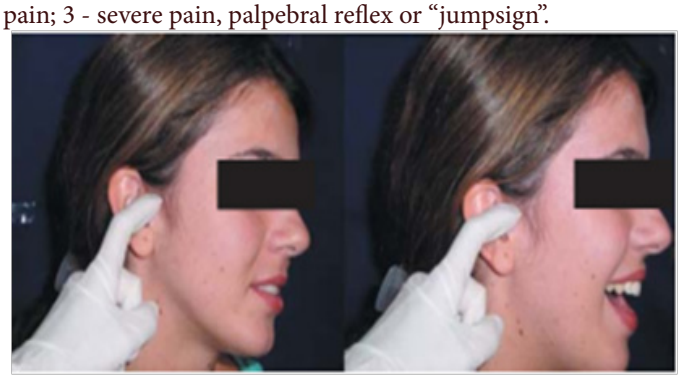

Fig. No. 3: Palpation of TMJ's lateral and posterior aspects

(b) Muscle Palpation (figure:4,5): Muscle palpation is a very important step in the diagnosis of TMD and myofascial pain syndromes. By means of mechanical stimuli caused by digital pressure, nociceptive neurons located in the muscular and myof as cial structures are stimulated to detect and transmit painmessages to the central nerve system. The graduation of patient's response to palpation allows evaluating the severity of pain and is used to measure the efficacy of a given treatment modality in follow-up visits. Palpation should be performed with a pressure of 1.5 kg. which is strongenough to elicit pain message in symptomatic patients and mild enough to not cause pain in asymptomatic control subjects.

The 3 portions of the temporalis (posterior, medialand anterior), superficial and deep masseter, as well as the insertion of the medial pterygoid muscle should be examined. The sternocleido astoid, superior trapezius and suboccipital are important cervical muscles to be also considered in this evaluation. Muscle palpation is also scored 0 to 3, according to the patient's response. The detection of trigger points in the myofascial structures is done during the examination. When the patient presents severe pain, this spot is continuously pressed from 8 to 10 seconds in order to stimulate referred pain.When referred pain zones are reproduced, a diagnosis of my of ascial pain is done, which requires specific management modalities.

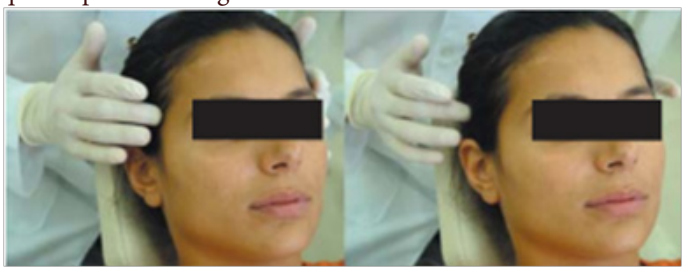

Fig. No. 4: Palpation of anterior and posterior temporalis Muscle

Fig. No. 5: Palpation of the superficial and deep masseter muscle

(c) Dental and Occlusal Evaluation (figure:6)

- Dental Examination: Dental and periodontal conditions, such as defective restorations, missing teeth or periodontal problems that could contribute to pain onset should be detected at this moment. Most orofacial pain conditions have a dental origin. The presence of incisal or occlusal dental attrition is also an indicator of possible para-functional habits.
- Occlusal Examination: The presence or absence of lateral and anterior guidesis recorded as the overbite and overjet. In thise valuation, the patient is asked to perform lateral mandibular movements in order to detected occlusal interferences in the non-working side, using a cellophane paper. The discrepancies between centric relation and inter-cuspalposition are also registered by means of the mental pressuretechnique. When large discrepancies are detected or theresults are uncertain, an articulator mounting can be indicated.

Fig. No.6:Anterior and lateral guide assessment

(d) Additional Diagnostic Tests: In case some doubt still persists, additional tests canhelp defining a diagnostic impression. Functional muscle manipulation, TMJ overloading, cryo-therapy and diagnostic nerve blockage are useful for this purpose.

(e) TMJ imaging Assessment: The real need and validity of TMJ images in the diagnosisof TMD is controversial, despite all technological apparatusa vailable in present days. Joint imaging should be indicatedbased on the dentist's good sense, but diagnosis and treatment techniques are still mainly elaborated based onclinical examination.

The general rule is that imaging exams are necessarywhen they might, somehow, change an initially established management strategy. The overestimation of image findings,followed by unnecessary irreversible treatment is a potential problem, especially for non-experienced clinicians. Panorex is helpful only to rule out dental and bone pathologies, with no validity on the diagnosis of TMJ position or anatomical form. Transcranial, lateral images and computed tomography can detect bone changes, condyledegeneration, mobility and fractures. Magnetic resonanceimage (MRI), on the other hand, is able to detect TMJ discposition and the presence of inflammatory processes. Again, the detection of small abnormalities in TMJimages is highly prevalent in asymptomatic individuals and does not mean that a treatment is mandatory. Flattening of the condyle in older subjects is an example of this statement.[21]

(H) Management

Management of all patients with Temporo-Mandibular Disordersaims to:

1. Reduce or Eliminate Pain
2. Restore Normal Jaw Function
3. Reduce the need for Future Health Care and
4. Restore Normal Lifestyle Functioning

Specific interventions and their sequencing parallel treatment of musculoskeletal disorders in general. A key determinant of success in chronicpain management is the success in educating the patient about the disorder to enhance adherence to the self-care aspects of management, including jaw exercises, habit change and properuse of the jaw.

The treatments included here are supported byRandomized Controlled Trials (RCTs).[20]

Self-Care

Most acute TMD symptoms are self-limited and resolve with minimal intervention. Most patients respond well to self-care in 4-6 weeks; if not, further assessment and treatment are indicated.[20]

1. **Apply moist heat or cold** to the joint or muscles that are sore, whichever feels better. Either can reduce joint or muscle pain and relax the muscles. Apply heat for 20 minutes to the painful area several times daily. For cold, use ice wrapped in a thin wash cloth for 10 minutes several times each day (apply it to the painful area just until the onset of numbness).

2. **Eat a softer diet.**
3. **Chew your food on both sides** at the same time or alternate sides to reduce strain on one side.
4. **Keep your tongue up, teeth apart and jaw relaxed.** Place your tongue lightly on the palate behind your upper front teeth, allowing the teeth to come apart and relax the jaw muscles. The upper and lower teeth should not touch at rest, except occasionally with swallowing. Monitor your jaw position during the day to keep it in a relaxed, comfortable position.
5. **Avoid caffeine.**
6. **Avoid oral habits that strain the jaw muscles and joints.** These include teeth clenching, teeth grinding (bruxism), teeth touching or resting together, biting the cheeks, pushing the tongue against the teeth, jaw tensing and biting objects.
7. **Avoid resting your jaw on your hand** to reduce strain on the TMJ and maintain jaw muscles in a rest position.
8. **Avoid activities that involve excessive or prolonged wide opening of the jaw** (yawning, prolonged dental treatments, etc.) for a period of time until the pain has been reduced.
9. **Avoid stomach sleeping**
10. **Use anti-inflammatory medications** such as ibuprofen and aspirin (without caffeine) to reduce TMJ and muscle pain

Pharmacotherapy

Common medications used for TMD pain are classified as Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), corticosteroids, opioids, muscle relaxants, anxiolytics, hypnotics andantidepressants. Analgesics are used to allay pain; musclerelaxants and anxiolytics for anxiety, fear and muscle tension; hypnotics for enhancing sleep and anti depressants for pain,depression and with certain agents, insomnia.[22]

For more severe joint inflammatory symptoms, corticosteroids are efficacious in TMJ synovitis, either as brief, tapering oral doses("dose packs"), injected, or given via iontophoresis.[20]

Injectionof hyaluronic acid is just as efficacious as corticosteroids without being associated with any risk of degenerative joint disease. Repeated injections of corticosteroids can lead tochondrocyte apoptosis and acceleration of the degenerative process.

For myalgia, especially with limited opening, NSAIDs and benzodiazepines are effective.Cyclobenzaprinehas also been shown, in clinical trials of muscle pain, to be efficacious in reducing pain and improving sleep and can be considered when benzodiazepines cause daytime sedation orother side effects.[23]

In patients with chronic TMD pain, tricyclic anti depressantssuch as amitriptyline and nortriptyline significantly ameliorateinsomnia, anxietyand pain. These medications can be used chronically. Selective serotonin reuptake inhibitors(SSRIs) should be used with caution with TMD patients because these agents may increase masticatory para-functional muscle tension and aggravate muscle pain [24]

Physical Medicine

Physical medicine interventions can be efficacious for patients with TMD pain and restricted motion. Jaw exerciseis the primary and often the only physical medicine treatment required. Jaw exercises include relaxation, rotation, stretching (range of motion), isometric exercise and postural exercise. Stretching exercises, together with cold or heat, are effective inreducing pain and improving range of motion. Their benefit is enhanced when they are incorporated into the patient's daily routine in conjunction with relaxation techniques and a relaxed posture to reduce strain from sustained jaw contraction.[20]

If exercises are ineffective or worsen pain, other physical modalities can be considered: ultrasound, short-wave diathermy, low-intensity laser, pulsed diathermy, iontophoresis, phonophoresis, superficial heat, cryotherapy (cold) and massage all have demonstratedefficacy. In the short term, such modalities can reduce jaw pain and increase range of motion, thereby allowing jaw exercises to proceed. When range of motion of the jaw is restricted by a TMJ disk displacement without reduction, short-termmanipulation of the jaw by a physical therapist or self-mobilization by the patient can help in remodelling the disk to improve joint translation, range of motion and pain.[20]

Orthopaedic Intra-oral Splints

The two most common splints include the anterior positionings plint and the stabilization splint. Theanterior repositioningsplintplaces a patient's mandible and TMJ into an anteriorpositionso as to reduce a TMJ click that occurs on opening and closing of the jaw.

The anterior repositioning splint is typically placed on the maxillary arch with an anterior ramp that first engages mandibular teeth on initial closure and shifts the jaw forward into final closure, when all mandibular teeth contact the splint. The stabilization splint provides a flat passive occlusal surface that is adjusted with contact on all posterior teeth to allow passive protection of the jaw and reduction of oral habits. Although both splints can reduce TMD symptoms, the indications for each differ some what.

Anterior repositioning splints can be efficacious for intermittentjaw locking with limited range of motion, especially upon awakening, or for persistent TMJ arthralgia not responsive to other therapy (including a stabilization splint). They are recommendedonly for short-term, part-time use, primarily during sleep,because they can cause occlusal changes if worn continuouslyor chronically. The stabilization splint is most efficacious for masticatory myalgia and TMJ arthralgia, especially if the pain is worse upon awakening. This type of splint can also be used during the day for oral habit management. Such splints are designed to provide postural stabilization and to protect the TMJ, muscles andteeth.

Partial coverage splints may cause occlusal changes in some patients. All splints should cover all of the mandibular ormaxillary teeth to prevent movement of uncovered teeth, with malocclusion. The splint's occlusal surface can be adjusted toprovide a stable occlusal posture by creating single contacts inall posterior teeth in the habitual closure position.[20]

Cognitive-Behavioural Therapy

Approaches to changing maladaptive habits and behaviours such as jaw tensing and clenching and grinding of the teeth are important in treating painful tissues. Cognitive-behavioural therapies such as habit reversal, bio feedback, relaxation techniques and stress management can be effective alone or inconjunctionwith other treatments.

Behaviour modification strategies such as habit reversal andover correction are the most common techniques used to change these habits. Although many simple habits are easily abandoned when the patient becomes aware of them, changing persistent habits requires a structured program that is facilitated by a clinician trained in behavioural strategies. Patients should be aware that habits do not change themselves and that they are responsiblefor initiating and maintaining behaviour changes. Habit correction can be accomplished by (i) becoming more aware

of the habit, (ii) knowing how to correct it (i.e.,what to do with the teeth and tongue) and (iii) knowing why tocorrect it. When this knowledge is combined with a commitment to conscientious self-monitoring and a focus upon the goal,most habits will change. Supplemental behavioural strategies such as biofeedback may also be helpful. Even when clenching is unconscious or nocturnal, correcting it during the day will help reduce it at night.[20]
Splints mayalsoincrease patients' awareness of oral habits. If muscle tensingis the inciting factor,biofeedback and relaxation techniquesmay be indicated. Another major issue to address is pacing orhurrying related to a hectic day.
For triggers such as depression and anxiety, psychological therapy can helpful. If the problem is a sleep disorder, sleep hygiene self-care can be instituted by the psychologist for non-pathological sleep disturbances, or the patient can be referred to a sleep laboratory for more detailed evaluation.[24]

TMJ Surgery

If persistent pain is localized to the TMJ and is associated with specific structural changes in the joint, surgical intervention can be considered if comprehensive non surgical care is unsuccessful. Muscle pain and associated contributing factors should be addressed and controlled prior to TMJ surgery.
In general, the less invasive surgeries are as efficacious as those thatare more invasive, so the health care provider should consideran arthrocentesis or arthroscopic procedure before more
Invasive interventions such as diskectomy or disk repair.[25]
Post operative management includes appropriate medications, physicaltherapy,splint therapy when indicated and continued-psychologicaltreatment as appropriate.[13]

Dental Treatment

There is no consistent evidence from RCTs that altering the occlusion through occlusal adjustment will benefit TMD. Likewise, other dental treatments such as prosthodontic andorthodontic treatments are not recommended as a primary treatment for the management or prevention of TD. However,patients with TMD may require these procedures as part of normal dental care. In these cases, care should be exercised inminimize additional strain to the muscles and joints and aggravation of an existing TMD during these procedures.[20]

Conclusion

The relationship between Orthodontics and patient with TMD is complex and controversial. Most of the studies revealed that Orthodontic treatment do not predispose to TMD. Orthodontic therapy in patients with TMD is beneficial only if orthopaedic instability contribute to TMD.[26]

References

1. Costen, JB 1934, 'A Syndrome of Ear and Sinus Symptoms Dependent upon Disturbed Function of the temporo-mandibular Joint', Annals of Otology, Rhinology & Laryngology.1934; 43(1): 1-15.
2. Byahatti, SM. Evolution, epidemiology and etiology of temporo-mandibular joint disorders', Journal of Indian Acadamy of Oral Medicine and Radioloy.2010:22(4): S13-18.
3. Griffiths, RH. Report of the president's conference on the examination, diagnosis and management of temporo-mandibular disorders', The Journal of American Dental Association.1983;106(1):55-57.
4. Okeson, JP, de Leeuw R.Differential diagnosis of temporo-mandibular disorders and other orofacial pain disorders', Dental Clinics of North America.2011;55,(1):105-120.
5. Harvey W. Investigation and survey of malocclusion and ear symptoms, with particular reference to otitic barotrauma; pain in ears due to change in altitude', British Dental Journal.1948;85(10):219.
6. Junemann, HR. Consequences of shortening the inter-maxillary distance. The Journal of the American Dental Association.1941;28(9):1427-1436.
7. Moyers RE. An electromyographic analysis of certain muscles involved in temporo-mandibular movement. American Journal of Orthodontics.1950; 36(7):481-515.
8. Brussell IJ. temporo-mandibular joint diseases: differential diagnosis and treatment. The Journal of the American Dental Association.1949;39(5):532-554.
9. ByahattiSM .Evolution, epidemiology and etiology of temporo-mandibular joint disorders.Journal of Indian Acadamy of Oral Medicine and Radioloy.2010;22(4): S13-18.
10. Carlson CR, Okeson JP, Falace DA, Nitz AJ, CurranSL, Anderson, D. Comparison of psychologic and physiologic functioning between patients with masticatory muscle pain and matched controls. Journal of Orofacial Pain.1993;7(1).
11. Castroflorio T, Bargellini A, Rossini G, Cugliari G, Deregibus A. Sleep bruxism in adolescents: a systematic literature review of related risk factors', European Journal of Orthodontics.2017;39(1):61-68.
12. Perry HT, Harris SC. Role of the neuromuscular system in functional activity of the mandible.The Journal of the American Dental Association, vol. 48, no. 6, pp. 665-673.
13. Colquitt, T 1987, 'The sleep-wear syndrome,' The Journal of Prosthetic Dentistry.1954; 57(1):33-41.
14. Conti A, Freitas M, Conti, P, Henriques, J, Janson, G. Relationship between signs and symptoms of temporo-mandibular disorders and orthodontic treatment: a cross-sectional study. The Angle Orthodontist.2003;73(4): 411-417.
15. Costen JB. Neuralgias and ear symptoms: associated with disturbed function of the temporo-mandibular Joint. Journal of the American Medical Association.1936;107(4):252-255.
16. Crider A, Glaros AG, Gevirtz, RN. Efficacy of biofeedback-based treatments for temporo-mandibular disorders. Applied Psychophysiology and Biofeedback.2005;30(4): 333-345.
17. Crompton AW, Parker P 1978, 'Evolution of mammalian masticatory apparatus.Am Sci.1978;66(2):192-201.
18. David CM, Elavarasi P. Functional anatomy and biomechanics of temporomandibular joint and the far-reaching effects of its disorders. Journal of Advanced Clinical & Research Insights.2016;3: 101-106.
19. de Souza Barbosa T, Miyakoda LS, de Liz Pocztaruk R, Rocha CP, Gaviao, MBD. Temporo-mandibular disorders and bruxism in childhood and adolescence: Review of the Literature. International Journal of Pediatric Otorhinolaryngology.2008;72(3):299-314.
20. Cairn BE. Pathophysiology of TMD pain-basic mechanisms and their implications for pharmacotherapy. Journal of Oral Rehabilitation.2010;37(6):391-410.
21. Calixtre LB, Gruninger BLDS, Chaves TC, Oliveira ABD. Is there an association between anxiety/depression and temporo-mandibular disorders in college students? Journal of Applied Oral Science.2014;22(1):15-21.
22. Kopp S. The influence of neuro peptides, serotonin and

interleukin 1B on temporo-mandibular joint pain and inflammation. Journal of Oral and Maxillofacial Surgery1998;56(2):189-191.

23. Kopp S, Carlsson GE, Haraldson T, Wenneberg B. Long-term effect of intra-articular injections of sodium hyaluronate and corticosteriod on temporo-mandibular joint arthritis. Journal of Oral and Maxillofacial Surgery.1987;45(11): 929-935.
24. Bertolami CN, Gay T, Clark GT, Rendell J, Shetty V, Liu C, Swann, DA. Use of sodium hyaluronate in treating temporo-mandibular joint disorders: a randomized, double-blind, placebo-controlled clinical trial. Journal of Oral and Maxillofacial Surgery.1993;51(3):232-242.
25. Sfondrini G, Reggiani C, Gandini P, Bovenzi R, Pellegrino, MA. Adaptations of masticatory muscles to a hyperpropulsive appliance in the rat.American Journal of Orthodontics and Dentofacial Orthopedics.1996;110(6): 612-617.
26. Kaur R, MunjalS,Singh S, Natt A, Singh H. Temporomandibular joint and Orthodontics.J applied Dent Med Sci.2018;4(6):128-35.