Occlusal factors among tempromandibular joint Dysfunction syndrome patients

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Dedication

To those who love dentistry, and those who care about me.
To the soul of my father.
To my mothers Shama, Saida, and Alawicea
Who had taught me that whoever did a work he or she must do it perfect or leave it.
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Appreviations
Acknowledgment

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I did not find any suitable words to express my thanks to professor Yahia Altyieb the head of the conservative department for the so many helpful things that he had offer to us since we are undergraduate students.

Special thanks also go to my dear twin engineer Mohammed Abdelgadir who assisted me in all the steps of my life.

To my sister Kawther all the best wishes in the world for her helpfulness not for me only but for the whole family she took the responsibility of us sincerely Allah bless her.

Last but not least, my thanks go to my sons Mahmoud, Osman, Rania and Rawaa who help me to put the thesis in its final layout.
Abstract

This comparative study was carried out to study the pattern of occlusal discrepancies in fifty patients with myofacial pain dysfunction syndrome attending Khartoum Teaching Dental Hospital and in another fifty control subjects who were free from any sign or symptom of the disease.

The examination of occlusion was done both clinically using a plain mirror and an articulating paper and on the laboratory using study models mounted on a (Hanau) type articulator with the bite fork and an ear piece face bow.

Analysis of both static and functional occlusal factor was done.

The data was analyzed using the Statistical Package for the Social Sciences SPSS and the Chi Square test was applied.

The results of the study showed there was a significant relation between the occurrence of Myofacial Pain Dysfunction Syndrome and class II div I with \( P = 0.049 \). Neither class I nor class III malocclusion with \( P \) value = 0.114, \( P \) value = 0.646 respectively, showed significant relationship with the disease.

On function it appeared that occlusial interferences on the non-working side has a significant role in the occurrence of TMJD (\( P \) value of 0.001). Contrary to the occlusal interferences on the working side which were found to play no role in the disease (\( P = 0.52 \)).

Both altered occlusal surface by wear or caries as well as loss of molar teeth was found to have a significant relation to TMJD. Also premature contact in centric relation and the slide of centric relation to
Centric occlusion were found to play role in TMJD, with p-value = 0.016 and p-value = 0.041.

Recent dental intervention either with restoration or with prosthesis, show insignificant relations with a P–value=0.52 and 0.67 respectively.

Studying some of the habits such as clenching and bruxing shows that clenching had a positive impact (P = 0.06), as well as bruxism (P = 0.24).

**Conclusion:**

Although the sample of the study was small the results of the study showed there is some relation between the TMJD syndrome and the pattern of occlusion.
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class II div  

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عة 0.001 = 0.001

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Chapter One

Introduction

According to the Guidelines of the American Academy of Orofacial Pain, temporomandibular disorders (TMDs) are a collective term embraces a number of clinical problems that involves the masticatory musculature, the temporomandibular joints and/or associated structures, or both\(^1\).

The temporomandibular joint pain dysfuntion syndrome(TMJDs) comprises a constellation of signs and symptoms including joint tenderness and pain on function, restricted jaw movement, clicking jaw locking and tenderness in the muscles of mastication\(^2\).

TMD is a fairly common condition where symptoms has been reported in 12-59 % of the population in industrialized countries and its signs were reported by 28 – 86 % of the same population\(^3\). Similar finding of high prevalence of TMD signs and symptoms has subsequently been reported by epidemiological studies from developing countries\(^4\).

Despite the high prevalence of this condition its aetiology remains obscure. The aetiology of TMD has been considered to be one
of the most controversial issues in clinical dentistry and a number of adumbrated hypotheses about the primary causes of TMD has been suggested but, generally all such concepts reflect the heterogenous multifactorial aetiological factors$^5$.

One of the conflicts that has attracted most attention has been the role of occlusal factors in the development of TMD. Several recent studies have not found any strong support for an occlusal aetiology$^6$. Nevertheless, these studies did not completely excluded the role of occlusal factors in the aetiology of this condition. In addition the majority of dental practitioners believe that occlusal disturbances can cause or are closely related to TMD and may therefore also include occlusal adjustment as an initial treatment to TMD, a concept strongly opposed by many TMD experts$^7$.

In view of these conflicting findings and opposing ideas the aim of the present study is to investigate the possible role of the occlusal factors in the aetiology of TMD by studying the prevalence, pattern and distribution of occlusal discrepancies among a group of TMD patients and a control group of heathly individuals.
Literature Review

1) The Anatomy and Physiology of the temporo-mandibular joint

Knowledge of the functional anatomy of the tempromandibular joint is essential to understand not only the function of the articulatory system but also to appreciate what abnormalities can occur.

The tempromandibular joint is a diarthroidal synovial paired joint. This means that there are two joint movements. These movements occur in separate compartments of this synovial joint, and that one joint cannot operate without the other.

The major components of TMJs are the cranial base, the mandible, and the muscles of mastication with their innervation and vascular supply.

Interposed between the condyle and temporal bone is the articular disc. The interarticular disk consists of fibrous tissue shaped to accommodate the shape of the condyle and concavity of the mandibular fossa. It consists of dense collagenous connective tissue which in the central zone, is relatively avascular, hyalinized, and devoid of nerves. The disk divides the articulating surfaces into upper and lower compartments that provide smooth gliding function. As the jaw opens and moves
forward, the intermediate zone of the disk is interposed between the anterior slope of the articular eminence and the condyle and the bilaminar region of the disk fills in the mandibular fossa. The relationship of the disk to the eminence is stabilized by the upper head to the lateral pterygoid muscle, which does not appear to be active during mandibular opening movement. The disk always move back with the condyle unless it is held forward with a force that is counter to the retrusive movement. The backward pull of the elastic fibre is constant, and the only way the disk can be displaced anteriorly is through the contraction of the superior lateral pterygoid muscle. The displacement cannot occur until the connective tissues that bind the disk are torn, stretched, or displaced enough to permit the disk to be pulled off the condyle. The most common type of disk derangement is anterior displacement meaning that the condyle has slipped distally past the superior band of the disk, or the disk has become forward of the condyle. When this occurs, the condyle loads against the innervated, vascular tissues behind the disk i.e the bilaminar zone.

Anterior displacement of the disk with the posterior band in an anterior position with the jaw closed can prevent the jaw from opening normally “locking”. The cause of the disk derangement is multifactorial, and include acute and chronic trauma with ischemic necrosis.
The temporomandibular joint is enclosed in a capsule that is attached to the borders of the articulating surfaces of the mandibular fossa and eminence of the temporal bone and to the neck of the mandible. The capsule consists of an internal synovial layer and an outer fibrous layer. The anterolateral side of the capsule may be thickened to form a band referred to as the “tempromandibular ligament”\(^\text{10}\).

There are accessory ligaments considered as part of the masticatory apparatus, including the stylomandibular and sphenomandibular ligaments. These ligaments do not have a direct relationship with mandibular articulation, although they may stabilize the articular system during jaw movements. There are otomandibular ligaments which connect the middle ear and the tempromandibular joint. These small ligaments e.g. discomalleolar and tympanomandibular (sphenomandibular), have been described as connecting the malleus to the TMJ disk and to the sphenomandibular ligaments. The role of these ligaments as causal factors in the TMJ mediated auditory symptoms remains to be substantiated\(^\text{11}\).

2) Musculature:-

Several muscles are responsible for mandibular movement and the movements of the mandibular muscles are well coordinated complex events. These muscles can be grouped into the muscles of mastication and
the suprahyoid muscles\textsuperscript{12}. There are four pairs of muscles of mastication namely temporalis, masseter, medial, and lateral pterygoids muscles. The bulk of temporalis muscle originates from an area bounded by the inferior temporal line above infratemporal crest and inserted into the medial aspect of the anterior border of the ramus as far as the retromolar fossa. The anterior fibers are those most commonly tender to palpation as they are the main elevators of the jaw. In addition to jaw elevation, the posterior fibers retract the mandible and close the jaw. The masseter originates from the anterior two-thirds of the zygomatic arch and inserts into the outer aspect of the angle of the mandible, it elevates and protracts the jaw. The lateral pterygoid muscle originates from the lateral surface of the lateral pterygoid plate and inserts into the anterior border of the condyle and the intra-articular disk via two independent heads. The superior and inferior heads of the lateral pterygoid muscle both inserted into the pterygoid fovea of the mandible with a part of the superior head inserting into the disk and capsule. It is, therefore, should be considered as two separate muscles, function horizontally during opening and closing; the inferior belly (inferior lateral pterygoid) is active during protrusion, depression, and lateral movement, and the superior lateral pterygoid active during closure\textsuperscript{13}. Medial pterygoid muscle originates from the surfaces between the medial and lateral pterygoid plates and inserts into the medial aspect of the angle of the mandible. Elevation of
the mandible is produced by the masseter, temporalis and medial pterygoid muscles of both sides acting together. Depression is produced by the digastric, geniohyoid and lateral pterygoid muscles of both sides acting together, and by the mylohyoid muscle. Protrusion is effected by the medial and lateral pterygoid muscles of both sides acting together, and retraction by the posterior fibers of the two temporal muscles. Lateral movement is effected by the medial pterygoid muscle of one side acting in conjunction with the lateral pterygoid muscle of the opposite side. On the side to which the jaw moves the condyle remains stationary; on the opposite side the condyle and disc move downward and forward on the articular slope of the glenoid fossa as a protrusion. This arrangement assist in maintaining the integrity of the condyle - disk assembly by pulling the condylar process firmly against the disc. The muscles of the suprathyoid group have a dual function. They can elevate the hyoid bone or depress the mandible; which movement occurs depends on the state of contraction of the other muscles of the neck and jaw region.

Muscles must always be involved at some stage, whenever there is incoordination of diskal movement with the condyle. Coordination of muscle function depend on precise timing between antagonistic muscles. The timing is necessary to coordinate a smoothly controled release of contraction to allow a muscle to lengthen as its opposing muscle shortens.
Incoordination occur when the timing of contraction and release is disturbed\textsuperscript{9}.

Recent experimental study suggest that masticatory muscle pain may also influence the intra individual position of Centric Relation (CR)\textsuperscript{15}. Because pain often changes its intensity, it is expected that static and dynamic positional relationship between the maxilla and mandible will vary with changes in pain level\textsuperscript{15}. In the natural dentition, Centric Occlusion (CO) is in a majority of people, anterior to centric relation contact and on the average approximately 1 mm\textsuperscript{10}. The retrusive range, as measured from centric occlusion to centric relation, is referred to as a discrepancy between CO and CR, and therefore centric relation can be classified clinically as functional and dysfunctional. When there is no deflective slide and the centric relation and centric occlusion are coincident that is CR=CO, the clinical CR is classified as functional, this occurs when the joint spaces are symmetrical and both condyles are concentrically positioned in the superior portion of the glenoid fossa. The clinical CR is said to be dysfunctional when one or both condyles are retruded or protruded and there is a deflective slide to the acquired CO. On radiographic images, the clinical CR can be classified as functional if the condylar displacement in the TMJ radioigraph correlates with the direction and magnitude of mandibular deflection. The correction of
deflective contacts must result in bilateral condylar concentricity. When the condylar position in the TMJ radiographs does not correlate with the mandibular deflection, the clinical CR is dysfunctional\textsuperscript{16}.

3) Mandibular movements:

The function of joints in general is to facilitate and to mediate movement of the skeleton. The function of the TMJ is to permit not only movement of the mandible but also the masticatory strokes demanded by the dentition and the movements required by speech and deglutition. Joints have various degrees of freedom of motion. This depends on the ability of a joint to rotate around a central axis i.e angular movement and the second type is its ability to change its position in space i.e linear movement\textsuperscript{17}.

The basic movements at the TMJs are hinge (rotation), and translation. These are combined in various ways to produce the functional movements of depressing, elevating, protruding, retracting and laterally deviating the mandible. In the sagittal plane the head of the condyle rotates about a transverse axis resulting in a purely rotational movement up to 12 mm of incisors separation\textsuperscript{14}. This rotational movement occurs in the inferior compartment of the joint cavity. Then the TMJ ligaments, and structures anterior to the mastoid process force the mandible to translate anteriorly. The translation involves the mandibular head and disk sliding
together forwards and downwards out of the mandibular fossa on to the articular tubercle, taking place in the upper compartment of the joint cavity\textsuperscript{12}.

In the horizontal plane the mandible is capable of rotation around several vertical axes. For example, the lateral movement consists of rotation around an axis, situated in the working (laterotrusive) condylar process with relatively little translation. A slight lateral translation known as Bennett movement, mandibular side shift, or laterotrusion is also frequently present. This may be slightly forward or slightly backward (lateroprotrusion or lateroretrusion), and the orbiting (nonworking) condyle travels forward and medially as limited by the medial aspect of the mandibular fossa and the temporomandibular ligament. Finally, the mandible can make a straight protrusive movement\textsuperscript{18}.

When the lateral movement is observed in the frontal plane, the mediotrusive (or nonworking) condyle moves down and medially while the laterotrusive (or working) condyle rotates around the sagittal axis perpendicular to this plane. Again, as determined by the anatomy of the medial wall of the mandibular fossa on the mediotrusive side, transtrusion may be observed; and, as determined by the anatomy of the mandibular fossa on the laterotrusive side, this may be lateral and upward or lateral and downward, "(laterortrusin and laterodetrusion). A straight protrusive
movement observed in the frontal plane, with both condylar processes moving downward as the side along the tubercular eminences \(^{18}\).

### 3.1 Functional movement:

Much of the functional movement of the mandible which occurs during mastication and speech takes place inside the physiologic limits established by the teeth, the TMJs, and the muscles and ligaments of mastication\(^{14}\). There is evidence that periodontal pressoreceptors provide positive feedback to jaw closing muscles during mastication\(^{19}\). Posselt was the first to describe the extremes of mandibular movement, which he termed border movements\(^{20}\).

The complexity of the actual patterns of jaw movements in both feeding and speech, which depend on the shifting axes of rotation at the tempromandibular joints, led Posselt to develop the concept of an ‘envelope of motion’

The envelope is the volume of space within which all movements of a point on the lower jaw take place. The limits or borders of the envelope are anatomical. Once the teeth have occluded, the jaws cannot be closed further but the teeth can slide across each other in both the anteroposterior and transverse planes. These contact or gliding movements have a vertical component, which depends on the cuspal profile of the posterior teeth and the extent of the incisor overbite.
Normal jaw movements utilize very little of the possible range of movement in each plane and so little of the envelope. There have been attempts to classify the forms of cycle profile found in chewing and to correlate them with occlusal and facial types in the hope of establishing anormal against which disturbances can be assessed. Profiles have usually been obtained by filming the head of the subjec whilst chewing from in front. The position of a marker point on the lower jaw is then plotted against a reference point on the upper jaw in each frame of film. There is, however, evidence that in individuals with the tempromandibular joint syndrome the movement become jerky and the profile jagged21.

4) **Mandibular positions:**

Basic jaw positions are usually described as centric occlusion \(\text{CO}\) or the (intercuspal position \(\text{ICP}\)) and centric relation (CR).

Centric occlusion is the way in which the teeth fit together i.e it is a tooth to tooth relationship. Centric relation, is a jaw-to-jaw relationship, rather than occlusion relationship, it is the position attained by the disc condyle assembly when it is against the most superior part of the distal facing incline of the eminence22.

In the first edition of the Glossary of Prothodontic Terms (GPT-1) centric relation is defined as "The most retruded relation of the mandible to the maxilla with its condyles in the most posterior restrained position
in the glenoid fossae from which lateral mandibular movements could be made"23.

In other words centric relation is the position of the mandible relative to skull when the muscles are at their most relaxed and least strained position and the disk is in place. This is, however, an anatomical definition which cannot be clinically verified. Centric relation is a concept because it cannot be proved to exist, nor is there any easy scientific way of establishing where it is. However, there does exist a clinically significant jaw relationship (CR) that is reproducible irrespective of tooth contact. The term (CR) is preferred to retruded contact position because this jaw relation is not inevitably retruded22.

The definition currently in use defines mandibular centric relation as "the maxillomandibular relationship in which the condyles articulates with the thinnest avascular portion of their respective disks in an anterior – superior position against the posterior slope of the articular eminence23.

The vertical dimension of rest - is also known as the physiologic rest position or mandibular rest position - is referred to the mandibular position assumed when the head is in upright position and the involved muscles particularly the elevator and depressor groups ,are in equilibrium with respect to their tonic contraction, while the condyles are in a neutral unstrained position23. The tonicity of muscles may be influenced by the
central nervous system as a result of such factors as emotional stress and by local peripheral factor such as a sore tooth.

Under physiologic condition of the masticatory system, centric relation is used to transfer the position of the mandible in relation to the maxilla to an articulator\textsuperscript{24}.

Despite the fact that CR is described as a reference mandibular position, it is not fixed in space its position may change over the course of time\textsuperscript{25}. The clinical rest position (CRP) is considered as range because there is a variable space referred to as interocclusal distance what means the space between maxillary and mandibular teeth. This is affected by a number of factors rather than an absolute one factor\textsuperscript{26}. The CRP of the edentulous is considered an unreliable means of re–establishing the Occlusal Vertical Dimention (OVD)\textsuperscript{27, 28}, but is still commonly used to determine a clinically acceptable interocclusal distance for these patients. The treatment of dentate patients with tooth wear often employs management techniques which require an assessment of the original OVD\textsuperscript{29, 30}.

The amount of tooth wear is, however, not easily equitable with loss of OVD as compensatory mechanism may operate to maintain the status\textsuperscript{31}. The most superior position of the mandible assumed during speech has long been advocated for the establishment of OVD\textsuperscript{32, 33}. More
recent reports by Rivera – Morales & Goldman 1997 suggest that techniques based on speech sounds are not reliable as they are generally regarded in the evaluation of OVD$^{34}$.

5) Disorders of the tempromandibular joint:

The Temporomandibular Joint Disorders (TMJD) are considered to be a heterogeneous cluster of conditions affecting the masticatory muscles and/or, the temporomandibular joints. It had been generally defined or identified in terms of a set of symptoms rather than through its etiology or by specifying the exact diagnosis.

5.1 Classification of TM disorders:

There are a multitude of classifications based upon the aetiology, clinical signs and symptoms or anatomy but all have their weaknesses. As diagnostic criteria vary the classification vary. In 1982 a conference on temporomandibular joint disorders held by the American Dental Association had proposed guidelines for classifying temporomandibular disorders. These guide lines are based on the classification developed by Bell. Use of such simple & logical classification improving the diagnostic capability as well as allowing the communication within the profession. The classification is described in table (1-1).

5.2 Pain dysfunction syndrome
The majority of patients with a temporomandibular disorder suffer from pain dysfunction syndrome. This syndrome incorporates more than one of five signs and/or symptoms in any combination or number. These are pain on palpation of associated muscles, limitation or deviation of mandibular movement, joint sounds and headache. Headache alone and joint sound alone are not diagnostic of pain dysfunction syndrome. 

There is a multiplicity of terms which had been used to describe this syndrome, some of these are: Masticatory myalgia, Cranio mandibular dysfunction, Cranio cervical mandibular syndrome, mandibular stress syndrome and Facial arthromyalgia.

Recently the American Academy of Orofacial pain had defined TMD as" a collective term embracing a number of clinical problems that involves the masticatory musculature, the temporomandibular joints and associated structures, or both,". 

Solberg, 1985 had defined tempromandibular joint disorders as musculoskeletal discomfort or dysfunction in the masticatory system aggravated by chewing or other jaw use, but independent of local disease involving the teeth and mouth. The clinical features of TMDs include pain that is provoked by function.

It presents as a uni, or bilateral pain in the TMJ and its associated craniofacial musculature. Additional symptoms may include clicking and
sticking of the joint, limitation of opening of the mandible with deviation to the affected side. There may also be a sense of fullness, popping or tinnitus in the ear\textsuperscript{36}.

It often emerges that such patients have experienced other orofacial and general pains. Such pains include atypical facial pain neuralgia and idiopathic facial pain, which is a continuous ache with intermittent excruciation episodes, localized to the non-muscular, non-joint areas of the face\textsuperscript{36}.

5.3 Prevalence of the syndrome:

A number of studies have investigated the prevalence of craniomandibular disorders (CMD) in industrialized countries. In a review by Rugh and Solberg\textsuperscript{37} of studies conducted in Scandinavia and U.S.A demonstrated a prevalence of symptoms of 12-59\%, and a prevalence of signs of 28-86\%\textsuperscript{4}.

6) Aetiology of pain dysfunction syndrome:

A number of adumbrated hypotheses about the primary causes of TMD have been suggested, but generally all such concepts reflect a heterogenous, multifactorial aetiology\textsuperscript{5} and indeed reflect the extent of the controversy of this issue. David Robert, 1974 stated that the pathosis
of TMD is unlikely to be the result of a primary dysfunction of the joint but is probably a secondary result arising from a primary dysfunction of some other part of the masticatory apparatus\textsuperscript{38}.

6.1 Historical Background:

Earlier attempts to establish a specific aetiology for TMD go back to 1934 when Costen proposed the mandibular overclosure theory. This concept was then expanded in the 1970s by Gerber 1971 who proposed the mechanical displacement theory which claimed that deflective occlusal contacts and lack of molar support were directly responsible for the eccentric position of the condyles in the fossa\textsuperscript{39,40} and that these eccentric positions caused pain and dysfunction. However this theory has been challenged by many investigators who had demonstrated eccentric condylar positions in many asymptomatic patients\textsuperscript{41,42}. In late 70s another theory based on the assumption that occlusal interferences and loss of molar support cause hyperactivity in the masticatory muscles\textsuperscript{43}. The patients tried to remove the interferences by parafunctional muscular activity (grinding) or to stabilize the jaw in cases where occlusal stability was not present with subsequent jaw muscular pain joint overload and, dysfunction\textsuperscript{44,45}. This concept was never been found to be applicable for all TMDs patients and the attention of the dental profession was then drawn to the close relationship between different morphological parts of
the articulatory, (the joints, occlusion and muscles) and the psychological and behavioral characteristics of patients.

6.2 Current concept:

Since the aetiological factors for TMD subclasses are not well known, the current concept considers the factors contributing to the development of TMDs as either predisposing, initiating and/or perpetuating factors.

The predisposing factors are usually systematic, they could be psychological (personality, behavioural) or structural (occlusal features, extensive overbite. Loss of molars, open bite, joint laxity) these factors increasing the risk for TMD. The initiating factors are trauma, parafunctional habits and adverse or overloading factors, while the perpetuating factors are considered to be mechanical and muscular stress, metabolic problems, social and emotional difficulties.

It is however important to recognise that these groups of factors may influence each other and/or act together. GJ Huang and his colleagues in 2002 have investigated some risk factors associated with subgroups of painful TMD, distinguishing between muscular (myofacial) pain and joint pain (arthralgia). However, they found that: Facial trauma, clenching, somatization and female gender are common risk factors. A potential role of third molar surgery had also been implicated to these risk factors.
Solberg\textsuperscript{35} claims that TMJDs result from adverse loading of the jaw system, differentially generated by repetitive loadings due to stress and postural loading due to biomechanical factors, and microtrauma. While Harris\textsuperscript{36} claimed that the 'facial pain patient' is biochemically vulnerable and can be identified by a reduced urinary excretion of conjugated tyramine sulphate which is also found in patients with endogenous depression. However, this tyramine trait marker occurs in facial pain patients without any evidence of depression, and may explain why this tricyclic antidepressants relieve pain in non-depressed patients. The tricyclic medication is thought to increase midbrain serotonin levels, which are concerned with central analgesia. It is assumed that physical stress in biochemically vulnerable subjects promotes the release of neuropeptides, such as substance P and calcitonin gene-related peptide (CGRP) in the joint capsule, muscles or such sites as the periodental membrane and dental pulp. These neuro peptides can induce vasodilation and an inflammatory response generating free radicals from leukocytes. Localized free radical damage of cell membranes can then produce eicosanoids algiesic agents such as PGE\textsubscript{2} and 15 HPETE. Although the non-steroidal anti-inflammatory agents such as aspirin can block the pain producing prostaglandins such as PGE\textsubscript{2}, they do not affect the neuropeptides or the leukotrines such as 15 HETE. This may explain why simple analgesics offer little relief in these
conditions. Such a mechanism would account for the intermittently chronic painful TMJ, capsulitis and synovitis initially impairs joint lubrication and movement, the well recognised 'clicking and sticking phase'. But with free radical damage to the fibrocartilage, meniscus translation becomes increasingly impaird and adhesions can be seen readily on arthroscopy.

6.3 The Psychological concept:

This proposed that masticatory muscle spasm was responsible for the signs and symptoms of pain dysfunction syndrome. The muscle spasm was believed to be caused by chronic parafunctional habits which were presumed to be induced by anxiety.

Parafunctional movements may be described as sustained activities that occur beyond the normal functions of mastications, swallowing, and speech. Typically, parafunction is manifested by long periods of increased muscle contraction and hyperactivity. Concurrently, excessive occlusal pressure and prolonged tooth contact occurs, which is inconsistent with normal chewing cycle. Over a protracted period this phenomenon may result in excessive or retrograde wear, widening of the periodontal ligament, and mobility, migration or fracture of the teeth. Muscle dysfunction such as myospasm, myositis, myalgia, and referred pain (headache) from trigger point tenderness may also be seen.
The suggested mechanism involves stress-induced oral parafunction such as clenching and or bruxism. These parafunctions may lead to overstrain of the TMJ, which in turn may lead to TMJ sounds\textsuperscript{48}. Despite the investigation of the relevant factors, the relationship remains unclear, possibly because different factors are likely to contribute in different individuals and there is unlikely to be one simple cause\textsuperscript{22}. Psychological factors that may be associated with TMJ sounds centre around stress levels and stress coping. Stress levels are related to the work situation and stress coping is related to various personality characteristics and to the social support system\textsuperscript{48}.

The majority of patients with pain dysfunction syndrome do not have a mental illness and the few that do are not necessarily those with the most severe pain. In those patients with a mental illness, the signs and symptoms of pain dysfunction syndrome may be either manifestations of psychosocial distress or alternatively they may represent a co-existent pathology\textsuperscript{22}.

When a mental disorder co-exists in patient with a temporomandibular disorder it is commonly of a depressive nature. The prevalence of depressive illness in patients with TMDs is about five times greater than is found in the general population but is similar to that reported in many other groups of patients with chronic pain such as
backache or irritable bowel syndrome. There is little evidence to suggest that depression causes pain directly but when people become depressed they often become more aware of pre-existing physical symptoms, whatever their origin. Khalid.M.A. and colleagues 2002 using an Abridged Psychological Self-rating Questionnaire (APSQ). Found that depression and anxiety were the primary focus of attention among many psychological factors contributing to TMD.

Depressive illnesses usually respond well to treatment. Therefore, the psychosocial factors that may have contributed should be considered in order to plan treatment. Unfortunately, depressive illnesses in patient with TMDs are often unrecognised and are therefore untreated or treated inappropriately.

7) The Occlusion concept:

Occlusion Literally means closing while in dentistry it refers to contact of teeth in the opposing dental arches when the jaws are closed. Collectively occlusion can be defined as the functional and dysfunctional relationship between an integrated system of teeth, supporting structures, joints and neuromuscular components.

A normal mouth is a mouth in which all of the teeth are present and occluding in a heathy, stable and pleasing manner but with variations in position within measurable normal limits. Such concept implies that
adaptive mechanisms are present and necessary and that there are feedback mechanisms from the occlusal system that provide occlusal hemostasis. In the adult this adaptive mechanism has been lost except for wear, extrusion of teeth, and drifting. “Adapted centric posture” is used to distinguish from TMJs that have remodeled or adapted to a conformation that can comfortably accept maximal loading. This classification is necessary because deformed but adapted joints may within certain conditions function with the same degree of comfort as intact, properly aligned condyle disk assemblies in centric relation.

The requirements for an occlusion to function with optimum stability according to Dawson⁹ are:

- Stable stops on all teeth when the condyle disk assembly on both side is properly aligned in its most superior position against the eminence i.e CR.

- An anterior guidance that is in harmony with the border movement

- Disclusion of all posterior teeth in protrusive movement.

- Disclusion of all posterior teeth on the non-working side.

- Non-interference of all posterior teeth on the working side with either the lateral anterior guidance or the border movements of the condyle
7.1 Static occlusal relationships and TMDs:

The static occlusion is the end point of normal closure and pertains to be the relationship of the jaws at that position.

Seligman and Pullinger\textsuperscript{50} considered five identifiable factors related to the static occlusion. On reviewing the literature they concluded that posterior crossbites, loss of posterior occlusal support, and asymmetrical tooth contact in the retruded intercuspal position did not show significant association with TMD symptoms while significant vertical open bites and significant horizontal overlaps (horizontal overjet), did reveal a significant correlation with TMD symptoms and this relationship was specific for patients with evidence of osteoarthritic changes in the tempromandibular joints. The authors however questioned whether the occlusal changes caused the symptoms or were actually the results of the osteoarthritic changes in the TMJs.

7.2 Functional occlusal relationships and TMDs:

The term functional occlusion refers to a state of the occlusion in which the occlusal interfaces are free from interferences on smooth gliding movements of the mandible and there is freedom for the mandible to close or to be guided into maximum intercuspation in centric occlusion and centric relation in which occlusal contact relations contribute to occlusal stability. From a practical standpoint functional occlusion refers
to a state of harmonious function obtainable by an occlusal adjustment or by properly designed individual or multiple restorations or by both adjustment and restoration orthodontic therapy could be added as well.24

Further to their review on TMDS and static occlusion, Silgman and Pullinger51 assessed the published research literature concerning the relationship of functional movements of the mandible to TMD, they reported that most controlled surveys fail to demonstrate any association between working and nonworking contacts and TMD signs and symptoms. These types of eccentric occlusal contacts are so common and variable that they lack the sensitivity and specificity for defining a present or potential TMD population. They found that even RCP/ICP slide does not appear to differentiate symptomatic from asymptomatic populations. However the author stated that many of these studies were based in inadequate study designs and they emphasised the need for further research in this field.

7.3 Occlusal interferences:

Occlusal interferences have been defined differently in the literature over the years and can generally be defined as contacts that interfere with smooth gliding movement, or cause displacement or heavy contacts in individual teeth.24 Examples of occlusal interferences include:
• Premature contacts in centric relation: This can be defined as an interference to jaw closure into a stable intercuspal position.

• Working side interferences: are contacts that interfere with smooth gliding movements, cause displacement or heavy contact on individual teeth, or cause disclusion when working side contacts should be present.

• Balancing side interferences: are contacts in the balancing side that cause disclusion of the teeth on the working side or displacement of teeth on the balancing side.

• Aprotrusive interference: is any interference to smooth gliding protrusive movements. Such an interference may cause anterior disclusion or displacement of teeth as well as interfere with straight forward movement with the teeth in contact.

A number of studies have tried to clarify the role of occlusal interferences in jaw function, muscle contraction and the development of TMDs, by inserting occlusal interference in healthy, symptoms-free subjects. In order to simulate the ‘classically detrimental occlusal interference’ small restorations were placed in maximal intercuspal position on the non-working or working side. The inference remained in place on average for 1-2 weeks and the studies investigated changes in electromyography (EMG), in the jaw movement and the development of
any signs or symptoms of pain dysfunction. In most studies an immediate
effect in the EMG was observed: asymmetry in the contraction pattern, a
change in velocity of jaw movements, an increase in the number of silent
periods per chewing stroke and changes in the co-ordination of
contraction patterns. A few subjects developed signs of dysfunction. The
results showed a markedly different response between individuals not
only in degree but also over time.

There is currently no universal agreement on the type of
interference that is considered detrimental to function and with a causal
role in the aetiology of TMDs. The ‘classical types’ of occlusal
interferences are extremely common according to epidemiological
surveys. In most studies on occlusal adjustment, non-working side
interferences are removed as being considered the most detrimental and
some authors have advocated to eliminate possible risk of occlusal
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interferencess are removed as being considered the most detrimental and
some authors have advocated to eliminate possible risk of occlusal
interferences. The correlations found between such interferences and TMDs signs
and symptoms in epidemiological and clinical studies, including
longitudinal ones, have been too weak to provide any clinically relevant
conclusions. In studying mandibular forces generated during
simulated clenching in a finite element analysis, Kikuchi, Korioth &
Haunnam found that non-working side contacts decreased the non-working side condylar load, supporting the clinical concept of Minagi and colleges. The distinction between non-working side contacts and interference has not always been clear in studies on occlusion. In a small sample of nine healthy asymptomatic subjects, those without non-working side contacts showed a more symmetrical patterns of the masticatory muscle electromyography EMG. than those with such contacts. It is not known if such EMG a synnetry has any negative consequences.

Observations of temporarily increased tooth grinding have been reported in some of these studies. However, in a controlled study, experimental occlusal interferences did not provoke nocturnal bruxism. Although many of the studies have been well planned and performed, they have not been adequate for a realistic insight into the consequences of occlusal disturbances for the long-term health of the masticatory system. These studies have shown that artificially introduced occlusal interferences can provoke immediate responses in the contraction pattern of jaw muscles and they may induce jaw muscle hyperactivity and pain in some subjects. However, due to the short time frame of the experiments, the small sample size, the different responses in time and degree, the adaptation that will inevitably occur, no certain conclusions can be drawn.
from these studies on the aetiological link between interferences and TMDs.

In an attempt to clarify the relation between occlusal interferences and muscles disorders, Williamson and Lundquist, studying the effect of various occlusal contact pattern on the temporal and the masseter muscle, reported that when subject with bilateral occlusal contact during a laterotrusive excursion where asked to move in that direction, all four muscle remain active. However, when the mediotrusive contacts were eliminated only the working side muscle remained active. This demonstrated that when the mediotrusive contact is eliminated the masseter and temporal muscle on the mediotrusive side are not active during the mediotrusive movement. The study further demonstrated that if group function guidance exists, both the masseter and the temporal muscle in the working side are active during a laterotrusive movement. If however just the canines make contact during a laterotrusive movement {canine guidance}, then only the temporal muscle is active during the laterotrusive movement. This study pointed out the merits of the canine guidance over group function in mediotrusive tooth contact. It also along with others demonstrated that certain occlusal conditions can affect the muscle group that are activated during a particular mandibular movement. In other words, certain posterior occlusal contact can increase activity of
the elevator muscle. Thus, the study substantiated the concept that the occlusal condition can increase muscle activity.

Rugh and associate decided to challenge the concept that a premature occlusal contact could cause bruxism. They deliberately placed a high crown in ten subjects and observes its effect on nocturnal bruxism. Although much of the dental profession was certain that this would lead to increase the level of bruxism, it did not. In fact, most of the subjects had a significant reduction in bruxism during the first two to four nights followed by a return to normal bruxing levels. The conclusion from this study and from others would suggest that premature occlusal contact does not increase bruxing activity. In other words, a high posterior occlusal contact does not necessarily increase muscle activity. At first, it might appear that these studies lead to opposite conclusions. But both studies are sound and their results have been duplicated, demonstrating their reliability and accuracy. Therefore, one should examine them more closely to appreciate how they contribute to the understanding of TMDs. Careful evaluation will reveal that these two studies actually investigate two different muscle activities. The first study assessed the effect of occlusal contact on conscious and controlled voluntary, mandibular movement. The other study assessed the effect on subconscious and uncontrolled, involuntary, muscle activity (nocturnal bruxism). These activities are
quite different. Whereas the first is generated for functional use at a peripheral level {outside the Central Nervous System (CNS) } the second is initiated and regulated at the CNS level. Muscle activity generated at the peripheral level has the benefit of the nociceptive reflex. In other words, influence from the peripheral structures {i.e. the teeth} has an inhibitory effect on the muscle activity. In contrast nocturnal bruxing seems to be generated at the CNS level and stimulation of the CNS has an excitatory effect on this activity {i.e.sleep stage,emotional stress}. Thus the former study suggests that tooth contact greatly influence the muscle response during functional activities of the masticatory system, but the latter study implies that tooth contacts have little effect on nocturnal bruxism.

Perhaps this type of muscle response explain why in the study by Rugh and associates there was a significant reduction of nocturnal bruxism during the first 2 to 4 nights of wearing the crown. As the subjects went to sleep and began bruxing events, their teeth came together and contacted the poorly fitting crown. This resulted in significant peripheral input to the CNS that was inhibitory and initially seemed to shut down the CNS induced bruxing activity. After a few days of accommodation, the high crown no longer was perceived as damaging to the system and the inhibitory effect was reduced. Then the bruxing
began again. This same phenomenon, altering peripheral sensory input causing decreased CNS activity, is likely to occur in other instances (e.g., orthodontics). If the bruxing activity of a patient undergoing orthodontic treatment is monitored at night it will almost always be found that immediately after an arch wire is activated, bruxism decreases or even stops. This is likely to occur because the teeth become so sensitive that any tooth contacts initiate a painful sensory peripheral input, which in turn decreases bruxing events. As the patient accommodates to the tooth movement and tooth sensation decreases, the bruxing events resume. Therefore, changes in peripheral input have the effect of inhibiting CNS induced activity. It is likely that this inhibitory effect is the mechanism by which occlusal appliances therapy decreases bruxism\(^1\). Closer evaluation of the study by Rugh and colleagues\(^6^0\), also revealed that a significant percentage of the subjects wearing the poorly fitting crown reported an increase in muscle pain. This was not associated with increased bruxing, as many would have been predicted, it was more likely produced by increased tonus of the elevator muscles in their attempt to protect the mandible from closing on the poorly fitting crown. In other words a sudden occlusal change that disrupts the intercuspal position can lead to protective response of the elevator muscles, resulting in pain.
Studies that have been recently reviewed suggested that tooth contacts affect different muscle function in different ways. It is important to recognize that there are two different type of muscle activities that might be affected by an occlusal interference; functional or parafunctional. Functional activity is greatly influenced by peripheral input (inhibitory), Whereas parafunctional activity is predominantly influenced by CNS input (excitatory). Another factor that influences the muscle response is the acuteness or chronicity of the interference. In other words, an acute change in the occlusal condition will precipitate a protective response of the muscle during functional activity. At the same time, the acute change in the occlusal condition has an inhibitory effect on parafunctional activity. As an occlusal interference becomes chronic, the muscles response is altered. A chronic occlusal interference may affect functional activity in one of two ways. The most common is to alter muscle engrams so as to avoid the potentially damaging contact and get on with the task of function. This alteration is likely to be controlled by the central pattern generator found in the brain stem and represents an adaptive response. If altered muscle engrams are not created, a significant muscle pain disorder can develop. Chronic occlusal interferences seem to have little effect, however on parafunctional activity. Although the acute interference seems to inhibit bruxing events, bruxing returns once the individual has accommodated to the change.
The type of the occlusal interference is also an important feature. The traditional types of interferences that were thought to create TMD symptoms were the mediotrusive (non-working), posterior laterotrusive (working), and the posterior protrusive contacts. As discussed earlier these contacts are present in TMD patients, and as well, as in controls and are not strongly related to TMD symptoms. A significant centric relation slide, however may be related if it adversely affects orthopedic stability of the masticatory system. As previously discussed this slide must be significant, such as or greater than 3 to 4 mm. The contacts that seem to have the major impact on muscle function are those that significantly alter the intercuspal position. It has been experimentally demonstrated that introducing an occlusal contact that interferes with closure into the intercuspal position often produces symptoms(1).

The significance of these responses is paramount to diagnosis and treatment of TMDs. For example, if a patient presents with early morning muscle tightness and pain, bruxism should be suspected. The treatment of choice is likely to be one that alters CNS activity such as an occlusal appliance. Alteration of the occlusal condition is not generally indicated unless an occlusal aetiology is suspected. On other words if a patient reports that the pain problem began immediately following an alteration in the occlusion and is present much of the time, the occlusal condition
should be suspected as a potential aetiologic factor. Proper assessment should be made to determine the most appropriate therapy. In this situation the clinician should appreciate that the history reported by the patient may be more important than examination. The examination is likely to reveal occlusal interferences in both these patients, yet in only one of these patients is the occlusal condition related to the symptoms. The importance of taking a thorough history and examination is paramount in the diagnosis and management of TMD. Fujii\textsuperscript{62} studied the relationship between the occlusal interference side and the symptomatic side in TMD patients. The occlusal conditions were investigated after the relieve of pain or clicking by means of bite plane therapy. The frequencies of occlusal interferences in relation to the symptomatic side was not identified.

In summary, a good, sound occlusal condition is fundamental for healthy muscle function during chewing, swallowing, speaking and mandibular posture. Disturbances in the occlusal condition can lead to increased muscle tonus (hyperactivity) and symptoms. Nocturnal bruxism, however appears to be relatively unrelated to tooth contacts and is more closely related to changes in levels of emotional stress and sleep stages (CNS activity). Therefore, it is vital to understand these differences
when establishing a diagnosis and developing an appropriate treatment plan for the patient.

7.4 Tempromandibular disorders and loss of molar support:

The teeth perform two functions; they, comminute food particles and maintain the vertical distance between the mandible and the maxilla. When the posterior teeth are either lost or worn down, occlusal vertical dimension (OVD) is decreased. Patients who have lost the OVD are said to be suffering from posterior bite collapse.

Loss of molar support has been considered an important aetiiological factor for TMDs. Several studies analysing skull and autopsy material have shown that gross joint changes and signs of TMJ osteoarthritis (OA) were correlated with the lack of molar support. It was concluded that the lack of molar support subjected the joint to unfavorable loading, more wear and more strain; these conclusions, have been challenged by the fact that there are several limitations in autopsy and skull studies as they cannot be correlated with the clinical situations, as any of the observed
joint changes. These changes might well be interpreted as remodelling and adaptation to changes in function\textsuperscript{64}.

The work of Hylander\textsuperscript{65} is often cited to emphasize the fact that biting on incisors and chewing in the anterior part of the mouth leads to more load on the joints. Theoretically, chewing in the anterior part of the mouth is likely to occur after loss of molars without replacement.

However, Hylander\textsuperscript{65} also stressed that the magnitude and direction of reaction forces acting on the TMJ are adjusted continuously by the muscles preventing joint instability.

The complex aspects of loading in the TMJ and the biomechanics of the masticatory system have recently been discussed in review papers\textsuperscript{66, 67}. It can be concluded from these reviews that loss of molars does not necessarily lead to overload in the joints.

Few follow-up studies have been conducted on the treatment outcome in TMDs following the replacement of missing teeth, especially the replacement of missing molar teeth. In most clinical studies on the outcome of conservative treatment, a combination of treatment modalities has been used. In these studies, a large percentage of patients have either significantly improved or have been rendered asymptomatic\textsuperscript{68-75}. Details of the number of patients receiving prosthetic treatment have often not been presented. In the study by Mejersjo\textsuperscript{86}, 18\% of patients had received
some form of permanent prosthetic treatment, whereas only 8% of the patients in the study by Wedel\textsuperscript{71} received such treatment. In these studies, however, prosthetic treatment was usually carried out after conservative TMDs management and on prothetic indications. Rausitia\textsuperscript{76} and associates indicated that 9% of their TMDs patients received prosthetic work, combined with other methods. It is now acknowledged that an interocclusal appliance need not necessarily be classified as occlusal therapy, because it has been shown that appliances that do not influence the occlusion may also lead to the reduction of TMJ signs and symptoms\textsuperscript{77}.

8) The management of tempromandibular joint dysfunction syndrome:

The large number and variety of treatment modalities used for the management of TMJ and muscle dysfunction indicate its complexity with respect to both diagnosis and treatment\textsuperscript{78}.

The diagnosis Once has been made, the management of the patient can be done putting in mind different patients need different treatment. Patients with the same signs and symptoms but different history and personal circumstances may need different managements.

The initial treatment should be reversible and directed towards the management of symptoms and towards behavioural modification
when indicated to control stress or cope with pain. Pain management can be accomplished with either medication or physiotherapy. Behavioural modification on other hand can be achieved through counselling and biofeedback.

The initial phase could also include splint therapy. Currently several types of occlusal splints are used in the treatment of TMJ / muscle dysfunction. Splints increase vertical dimension to varying degrees hence, prevent teeth from coming into occlusal contact and to a certain extent disengage the teeth from the masticatory system. Most tend to have an influence on the affective state, emotive and/or emotional aspects of the patient.

The occlusal bite plane splint is a stabilization type splint and when properly designed and adjusted is effective as a diagnostic device as well as an active form of treatment. It allows the mandible to position itself in response to reduction of muscle hyperactivity and allow healing of joints provided that the splint is properly adjusted. The adjustment of the splint should be done as often as necessary to accommodate for vertical as well as horizontal changes in condyar position.

The design of the splint is related to clicking, crepitus, locking, bruxing and malocclusion. It can be used for long periods of time if supervised and adjusted periodically by a dentist. An occlusal bite plane
Splint is particularly useful during periods of stress and it is generally accepted as an optimal form of therapy. It is often used in non-contact sports, including jogging, weight lifting, and tennis or any procedure in which clenching or bruxing occurs.

Treatment of the occlusion was for a long time considered to be the most important and most efficient strategy to alleviate the pain and to restore function. However, because of the change in understanding of aetiological concepts, this strategy has become more and more criticized and doubtful. Even if TMDs experts, have developed a relatively uniform opinion, de-emphasizing the relationship of TMDs and occlusion, a majority of general practitioners continue to treat TMDs patients with occlusal adjustment and prosthetic restoration of lost teeth.

There are many irreversible procedures for treatment of TMD syndrome which include Mandibular orthopaedic repositioning appliances, comprehensive orthodontics, occlusal adjustment, occlusal reconstruction and surgery. Irreversible treatment should not be the initial treatment, specially in view of the success of reversible form of therapy.

Mandibular orthopaedic repositioning appliances (MORA) are essentially bite raising appliances which have been modified functionally to attempt to recapture the disc when the disc is considered to be
anteriorly displaced\textsuperscript{80}. Although the device may give spectacular relief of pain in some patients, prediction is highly questionable and the end result is frequently severe malocclusion \textsuperscript{81}. Even if not used as an anterior repositioning device intrusion of posterior teeth and extrusion of anterior teeth often occurs, especially in patients who clench and brux. Unfortunately such patients often demand periodic increases in vertical dimension to remain free of symptoms. A posterior open bite resulting from the use of MORA may only take 1-2 weeks to develop. The amount of open bite is dependent upon the amount of anterior positioning, path of condyle and vertical and horizontal overlap of the anterior teeth. A high percentage of patients require comprehensive restorative treatment to make it possible for them to have intercuspal position and chew properly. In some instances the orthodontic result relapses so that the posterior open bite develop in a matter of months and symptoms reappear as well. The effect of condylar repositioning on the temporomandibular joint is far from clear, whether the appliance is used for the treatment of clicking or intracapsular derangement\textsuperscript{82} or an attempt to induce remodelling and reverse degeneration of the joint\textsuperscript{83} is not yet known. Adaptation of the human temporomandibular joint to such repositioning in the adult many be ever more complex than that reported previously \textsuperscript{84, 85,86}. 
Unfortunatly MORA devices are being used virtually for all categories of TMJ and muscle dysfunction. They are used very frequently as an initial treatment and too often without informing the patient of the potential adverse consequences and the frequent need for further treatment. Finalization of occlusion\textsuperscript{81} is almost a routine part of the treatment plan for some practitioners. It is not unusual to see a patient who continues to have severe pain and dysfunction after the use of a MORA device; and it is not unusual to see severe malocclusion and pain develop after it's use.

A partial occlusal adjustment is an initial form of treatment for TMJ /muscle dysfunction when occlusal interferences have precipitated the dysfunction, i.e. adjustment of gross interferences, especially those related to new restorations that interfere with function or parafunction.

The occlusal adjustment may be required during occlusal splint therapy to facilitate the resolution of TMJ and muscle dysfunction. The occlusal adjustment should be done to eliminate a meaningful occlusal interference, i.e. contact relations which involve mobile teeth, trauma from occlusion that interference with function and aggravating parafunction. Although such relationships did not necessarily demonstrate cause and effect, an occlusal adjustment to specially correct such
problems is often beneficial for the patient however in no case should complete occlusal adjustment be done as a routine procedure.

Painless clicking should not be used as the rationale for a full mouth reconstruction. The painful symptoms of TMJ muscle dysfunction should be eliminated prior committing the patient who is in distress and under duress to a full mouth reconstruction. Unless reversible forms of treatment have been given a reasonable chance to succeed, irreversible treatment should not be presented to the patient who is under duress of pain.

Surgical procedures may be required for a small percentage of patients whose primary disorder involves the temporomandibular joint. Surgery should be considered only for patients who have had a reasonable application of conservative treatment but can no longer cope with chronic pain. However, the patient should be made aware of the possibility of failure and additional problems, viz, continued pain in the operated joint and development of pain in the other joint. Orthognathic surgery may be necessary to correct a severe malocclusion resulting from mandibular advancement therapy (MORA). However, mandibular entrapment (condyles placed too far posteriorly and incisors too anteriorly) may occur with exacerbation of the symptoms of TMJ and muscle dysfunction even when the maxilla as well as the mandible is included in the surgery.
Orthodontics is not recommended as primary treatment for TMJ and muscles dysfunction; although comprehensive orthodontics and orthognathic surgery is being used occasionally to reduce a difference between the intercuspal position and the retruded position of the mandible. However, there is no body of scientific evidence to substantiate a broad application of the concept that a reduction of the difference constitutes effective treatment for, or effectively prevents TMJ and muscles dysfunction.

Treatment outcome has often been used as proof for an aetiological concept. The treatment outcome after occlusal discrepancies have some aetiological importance in TMD and in bruxism. However, seligman\(^{(50)}\) stressed after a careful study analysis that most studies investigate signs and isolated symptoms, which is not the same as studying the disease; many studies group the most divergent types of orofacial pain and dysfunction patients in analysing treatment outcome; the definition of occlusal factor is often not clearly defined and terms such as “malocclusion” are too vague to be of any value.

Most studies, with few exceptions, are case series without any control group or placebo-treatment, leaving the only measure of efficacy, the pre-versus the post-treatment status of the subject. Such studies lack a properly defined treatment effect to be obtained, which is necessary in
randomized clinical trials. As a results of the small sample size, a number of controlled studies on follow-up of occlusal adjustment and prosthetic treatment are likely to be inconclusive, regardless of the efficacy of the treatment.

**Objectives:**

This study was designed to achieve the following:

1/ Determine the prevalence of occlusal discrepancies among TMD patients and the control group.

2/ Determine the type and pattern of occlusal discrepancies among TMD patients and the control group and relate that to the prevalence of signs and symptoms of TMD.

3/ Investigates the incidence of bruxism and clenching among patient and control group.
Chapter Two
Material and Methods

Study population:

The sample size for this study was one hundred cases. Fifty of them were patients seeking treatment for temporomandibular joint dysfunction syndrome 2000-2003. at the department of Oral and Maxillofacial Surgery in Khartoum Teaching Dental Hospital, which is a tertiary Hospital and referral centre for Oral and Maxillofaial surgery patients in the Sudan. The other fifty cases were normal individuals not complaining of any sign or symptom of TMD. The study was conducted at both dept. of the Oral Maxillofacial surgery in Khartoum Teaching Dental Hospital and the department of Operative dentistry at the University of Khartoum Faculty of dentistry.

The aim of the study was to investigate the role of occlusal factors in the development of TMDs. The objectives were to:

- estimate the prevalence of occlusal discrepancies among patients and control groups
- determine the type and pattern of occlusal discrepancies among patient and control group
• investigate the incidence of parrfunctional habits in patients and control group.

**Patient group selection criteria:**

The criteria adopted by TMDs specialist clinic at khartoum dental hospital was used for selection of patients with TMDS. The criteria include presence of the following sign and/or symptoms of TMDs

- pain in preauricular TMJ area
- clicking, cripitation and joint sounds
- limitation and deviation of mandibular movement

**Control group:**

The control group consist of fifty subjects who were examined and found to be virtually free from any of the previously described sign or symptoms of TMJD.

**Methods of data collection:**

The data was collected by means of questionaire, clinical and labrotary examination.

Although the patient group is already diagnosed in the consultation clinic as having TMDs, the diagnosis was further confirmed by history taking in form of questionare and clinical examination. The control group
has undergone the same evaluation procedure to exclude the presence of the disease.

The clinical examination sheet (Appendix) was designed in such a way that both the patient and the control will be directly interviewed and asked questions to elicit and quantify the symptoms related to TMDS. In addition, the questionnaire is also used to establish the demographic data, report the history of parafunctional activities, and update patient medical and dental history.

**Questionnaire:**

Divided into three parts:

Part I: includes questions that identify the patient with probable TMD:

All patients were asked and interrogated using this questionnaire (FIG) which is designed to elicit and quantify the complaints and symptoms for evaluation of mandibular function by recognizing function-related symptoms.

Part II questions are directed to habits and other factors that may provoked the symptoms such as clenching, grinding, bruxing.

Part III general factors associated with a worsening prognosis.
The clinical examination:

involved both extra and intra oral examinations.

A- Extra-oral examination confined mainly to the examination of the TMJs and the muscles of mastications.

1) The joints were palpated for tenderness and pain on palpation was recorded as present or absent. The joints were palpated in the immediate preauricular area by pressing gently over the lateral aspect of the joint.

2) Joint sounds were also recorded by direct audiable means as present or absent and the timing of the clicking during opening movement was also recorded.

3) The range of mouth opening was recorded as well as the presence or absence of deviation of the mandible on opening and closure. Incisal opening was measured using a ruler from the upper incisal tip to the lower incisal tip with the patient opening to the limit of their pain free range. The lower limit for the normal range of opening is 35mm for females and 40mm for males.

4) The muscles of mastication namely, masseter, temporalis, medial and lateral pterygoids were also examined for tenderness and pain.
The Masseter muscle was palpated bimanually by placing one finger intra-orally and the other on the cheek. Both attachments i.e origin and insertion were palpated separately. The temporalis muscle was palpated extra-orally between the superior and inferior temporal lines while the patient was clenching, and intra-orally by running the finger up the anterior border of the ascending ramus where the tendon is inserted into the coronoid process. The lateral pterygoid muscle on the other hand was examined by recording its response to resisted movement by placing the hand under the patient chin and the patient was asked to open against resistance and pain will be reported in the preauricular region. Medial pterygoid muscle was palpated medial to the ramus.

B) Intra-oral examination was carried out using plain mouth mirror and explorer

The dental hard tissues were examined for presence of caries that alters the tooth morphology, restorations with premature contact in centric relation or wear. The number and type of missing teeth were recorded loss of molar support was also assessed when the arch is reduced to six anterior teeth.
C) The occlusion was examined from both static and functional aspects.

1) Statically the occlusal relationship was assessed horizontally and vertically.

Occlusal relationship was classified according to Angle’s classification into:

- **Class I** or neutro-occlusion where the triangular ridge of the mesiobuccal cusp of the maxillary molar articulate in the buccal groove of the mandibular molar.

- **Class II** or disto-occlusion the articulation of the mesiobuccal cusp took place distal to the mesial groove of mandibular first molar. Class II is further subdivided according to the position of upper anterior teeth into division I where incisors are proclined and division 2 for retroclined.

- **Class III** is mesial occlusion where articulation of cusps took place mesial to the mesial groove of the mandibular first molar.

Other static occlusal features such as overjet, overbite, cross bite and open bite were assessed and abnormality was recorded.

a/Overjet: When the horizontal relationship between the upper and lower incisors is 4mm or more i.e positive overjet. Negative overjet when the lower teeth occlude in front of the upper teeth.
b/ Overbite: When the upper incisors overlap two thirds or more of the lower incisors.

c/ Crossbite when the lower arch is wider than the upper and the buccal cusps of the lower teeth occlude outside the buccal cusps of the corresponding upper teeth.

d/ Edge-to-edge bite when the incisal edges of the upper and lower anterior teeth occlude together.

e/ Anterior openbite: The lower incisors neither overlapped in the vertical plane by the upper incisors nor occlude with them.

2) The functional occlusion was assessed both clinically and laboratory on the articulator. Clinically centric occlusion was checked by asking the patients to close their teeth normally or close onto their back teeth. Recording the central relation did however involve bimannual manipulation of the mandible to deprogramme the muscle and guide the mandible to the upper most posterior superior position in the glenoid fossa. Articulating papers were used to record the occlusal contact. The presence and degree of occlusal interferences between centric relation and centric occlusion was then recorded. The same was applied to lateral and protrusive excursion where later working and non-working side contacts were checked and interferences were recorded when present.
To study these functional occlusion relationship on the laboratory on an articulator an upper and a lower alginate impressions were taken to make study models. Bite registration procedure using (cavex modelling wax tropical) was carried out to register centric relation, centric occlusion, right and left lateral excursions and protrusive movement.

A semi adjustable articulator (Hanau) type was used in the study

Face bow (ear piece) was used to mount the maxillary cast to the articulator and the above bite registrations were used to adjust the articulator and relate the mandibular to the maxillary casts in these functional positions. The functional occlusal relationships were then examined in the articulator and presence or absence of occlusal interferences was recorded.

**Data analysis:**

The data was analysed using the statistic programme SPSS version 10 and the difference between the groups was tested using Chi square test and the level of significance was set at p< 0.05.
Chapter Three

RESULTS

The demographic data for the study groups. (Table 4-1) and was found to be as follows:-

1) The age: The subject were divided into two groups, the first one with age ranging from 20-30 years, the other one with an age ranging from 30-40 years. Out of the 50 patients with TMJD syndrome 40 patients were in the age group 30-40 and the remaining 10 patients were in the age group 20-30 years.

In the control group 28 cases were in the age group ranging from 20-30 years while the remaining 22 cases were in the age ranging from 30-40 years.

2) The Gender: Among the TMJD syndrome patients group male to female raito was found 11 (22%) to 39 (78%) i.e there were 39 females and 11 males. While among the control cases there were 35 females and 15males.

3) The Occlusion: The differences for the occlusion were examined in fifty patients and fifty control subjects and was divided into

A) Static occlusal factors: (Table 4-2)
1/ Class I Angle classification was seen in 33 cases from the patient group and in 40 cases of the control group. the control group P value = 0.115.

2/ Angle class 11div1 was seen in 11 in the patients group compared to 4 in the healthy comparative group with a P-value =0.05.

3/ Angle class 11div2 in the case group they were 3 while in the control group it was found to be 4subjects with a P-value = 0.7.

4/ Class 111Angle classification were found in 3 cases in the patients group while in the control group it was seen in 2 subjects with a P-value = 0.645.

5/ The overjet was divided into +ve overjet which was seen in 11 cases of the patients group and in 4 cases in the control with a P value =0.049 and the –ve overjet was seen in 3 cases in the patient group and in 4 in the control group with P value =0.695

6/ Deep bite was seen in 3 subjects in the patients group and 2 subjects in the control group with P value =0.646

7/ Cross bite was seen in 3 subjects in the patients and in 2 subjects in the control group with P value =0.646

8/ Edge-to-edge bite was seen in 5 subjects in the patient group and in 3 subjects of the control group with P value =0.460

9/ Anterior open bite was seen in one subject in the patient group and it was not found in the comparative group with P value =0.015
B) Functional occlusal factors:

Occlusal interferences during the functional mandibular movements were examined in both patients and control groups (Table 4-3).

1) Premature contacts in centric relations were found in 16 subjects in the patients group and in 6 subjects in the control group with P value =0.016

2) Slide in centric relation to centric occlusion, was found in 25 cases in the patients group and in 15 subjects in the control with P value 0.041

3) Working side interferencies were found in 2 subjects of the patients and one in the control group with P value 0.52

4) Non-working side interferencies were found in 9 cases of the patient group, but were not found in any subject in the control with P value 0.001

5) Occlusion of posterior teeth in protrusive movement was found in 6 subjects in the patients group and in only 4 cases in the control group with P value =0.503

6) Loss of molar support was seen in 9 subjects in the patients group and in 2 subjects in the control group with P value =0.025
7) Altered occlusal surface (Table 4-4) was found in 28 cases in the patient group and in 14 cases in the control with P value =0.0045.

8) The prevalence of prosthetic intervention (Table-4-5) was divided into:

  - Recent dental intervention was found in 9 cases in the patient group and in 8 subjects in the control group with P value =0.79
  - Prostheses was found in 6 subjects in patient group and 3 subject in control group with P value =0.295.

Confounding Factors :-

In addition confounding factors such as educational and marital status were also examined

a) Education (Fig. 4-1)

Illiteracy found in 2 of the patients group, in the control was not found in any subject with P value=0.153

5 cases in the patient group was found to have a primary education while 8 cases in the control group with P value =0.372

13 cases in the patient group and nine in the control group were found in secondary education with P value = 9 p=0.334
University in the patient group 27 and in the control 32.

Postgraduate in the patients and control was one subject $P=1$.

b) Marital status (Fig. 4-2) Single 19 subjects in the patient group while in the control were 44 subjects. Married 22 subjects in the patient group while in the control were only 5 subjects. Divorced 6 subjects in the patient group while in the control were only 1 subjects. Separated in the patient group 2 none was in the control.

c) Parafunctional activities such as bruxism and clenching (Table 4-6) on the other hand has been reported by both patients and control.

1-Bruxism was found to be in 5 cases in the patient group and in 2 cases in the control group with $P$ value = 0.24

2-Clenching 23 subjects from the patient group while 14 cases in the control group with $P$ value 0.062.
Table (4-1) Demographic data of the study and control group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Case</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
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<tr>
<td>Female</td>
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<tr>
<td>Age</td>
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<td>Range</td>
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</tr>
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<td>&gt;30</td>
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<tr>
<td>&lt;30</td>
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Table (4-2) Prevalence of static occlusal factors in the case and control group

<table>
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<tr>
<th>Angle's classification</th>
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<th>Total</th>
<th>P.value</th>
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<tbody>
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<td>I</td>
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<td>73</td>
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<tr>
<td>II₁</td>
<td>11</td>
<td>4</td>
<td>15</td>
<td>0.04995</td>
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<tr>
<td>II₂</td>
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<td>7</td>
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<tr>
<td>III</td>
<td>3</td>
<td>2</td>
<td>5</td>
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<tr>
<td>Overjet</td>
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</tr>
<tr>
<td>+ve</td>
<td>11</td>
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<td>15</td>
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<tr>
<td>-ve</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>0.69511</td>
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<tr>
<td>Deep bite</td>
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<td>5</td>
<td>0.64636</td>
</tr>
<tr>
<td>Cross bite</td>
<td>5</td>
<td>8</td>
<td>13</td>
<td>0.37237</td>
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<tr>
<td>Edge-to-edge bite</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>0.46099</td>
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<tr>
<td>Anterior open bite</td>
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* significant P-value
Table (4-3) Prevalence of functional occlusal relationship in study and control group

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<th>Case</th>
<th>Control</th>
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<th>Pvalue</th>
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<tbody>
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<td>Premature contact in centric relation</td>
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<td>Slide in centric relation to centric occlusion</td>
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<td>15</td>
<td>40</td>
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</tr>
<tr>
<td>Working side interferences</td>
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<td>1</td>
<td>3</td>
<td>0.52</td>
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<tr>
<td>Non–working side interferences</td>
<td>9</td>
<td>0</td>
<td>9</td>
<td>0.001*</td>
</tr>
<tr>
<td>Occlusion of posterior teeth in protrusive movement</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>0.503</td>
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<tr>
<td>Loss of molar support</td>
<td>9</td>
<td>2</td>
<td>11</td>
<td>0.025*</td>
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<tr>
<td>Altered occlusal surfase**</td>
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<td>14</td>
<td>42</td>
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* significant P-value

* see table 4-6
Table (4-4) factors associated with altered occlusal surfaces in study and control group

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<td>Restoration</td>
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* significant P-value
Table (4-5) The prevalence of prosthetic intervention in study and control group

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<tr>
<td>Recent dental intervention</td>
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<td>8</td>
<td>17</td>
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<tr>
<td>Prosthesis</td>
<td>6</td>
<td>3</td>
<td>9</td>
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Table (4-6) prevalence of parafunctional habits in study and control group

<table>
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<th>P-value</th>
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<tr>
<td>Bruxism</td>
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<td>Clench*</td>
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### Table (4-2) Education

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<td>0.153</td>
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### Table (4-3) Marital Status

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<td>0.000</td>
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<td>Marrird*</td>
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<td>0.153</td>
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* significant
Chapter Four
Discussion

Through the years the dental professionals have debated the significance of occlusion in some dental therapies. These debates have not centered on the importance of occlusion in restoring function but in the role of occlusal conditions as an etiological factor in the development of the masticatory dysfunction. Opinions concerning the importance of the occlusal condition has shifted between the sole reason for masticatory dysfunction to no relationship at all. This present study was designed to investigate the possible role of occlusal factors in the causation of TMJD. The cases selected for this study were patients diagnosed as having TMDs in the specialist clinic at the department of Oral and Maxillofacial Surgery, Khartoum Dental Teaching Hospital. For ease of description the occlusal factors worked at were divided into static occlusal relationship and functional occlusal relationship.

Static occlusal relationship

The findings of the present study about the static occlusal relationship and TMD are not far from that reported previously in the literature demonstrating that there is a significant association between class II and
TMD in accordance with many investigators. Nesbitt and associates\textsuperscript{89}, in a case control study similar to this study, showed in his patients a significant association between class II and TMD. His sample size was comparable to that of the present study. Pullinger and associates\textsuperscript{90} has also reported similar finding in a study of risk factor of TMD among dental students. In a typical case control study conducted by Seligman and associates\textsuperscript{50} 1989 and using the same age group as those used in the present study a significant association between class II division 1 and TMD had been demonstrated, which is the same as those shown by the present study. A number of other studies Gazit et al\textsuperscript{91} 1984 and Egermark – Erikson\textsuperscript{92} et al 1987 has also shown such association, but their study sample was for preschool and school children that were not compatible to the adult study sample of the present study.

An association between Class III and TMD has also been demonstrated in the previously discussed study. The present study did not however show such association. This difference in presentation of the results was probable due to the fact that in the previous studies a larger sample size was used compared to the present study.

On the other hand, there are also different investigators, who investigated the role of static occlusal factors and TMD etiology and did not find any associations\textsuperscript{92}.
In the present study, the positive overjet and anterior open bite were found to be significantly associated with TMJD. Pullinger and associates\textsuperscript{90} reported that an overjet of 6 mm or larger is needed for a subject to be significantly associated with one of TMD subclasses.

**Functional Occlusal Relationship and TMD:**

As the case in static occlusal relationship not all the functional occlusal factors were found to have an association with TMD. The most reported functional occlusal factors to be associated with TMD were interferences in centric relations and non working side interferences. These factors are found to have an association with TMD in the present study reported by many different investigators. Nihler\textsuperscript{94} in across–sectional study has reported that centric slides and non working side interferences were significantly associated with TMD. The same results has also been reported by Pullinger and associates\textsuperscript{90}, and Wanman and colleages\textsuperscript{95}. Small occlusal slides less than 1mm were common in all patients and controls but significant slides longer than 2mm were found in the diseased group only. Pullinger and colleages\textsuperscript{92} found that large slides were associated with degenerative changes within TMJ. It is widely accepted in dentistry that the mandibular position and occlusal contact pattern of the teeth can influence the amount and type of the muscle activity\textsuperscript{95}. The normal functional activities of chewing, swallowing speaking are not thought to
create problems for most patients. There is some question that other
activities among the so called parafunctional activities contribute in the
causation of TMD symptoms. The present study showed that clenching
and not bruxism are more prevalent in patients rather than in the control
group is in agreement with the previous finding of Graham and colleagues
and Kirves Kari and associates. However, Bruxism in many studies was
found not to have no association with TMJD syndrome and the occlusal
contact pattern of teeth was found to have no relation with it. more
reported by patients than control group is in agreement with the previous
finding of Graham and associates and Kirves Kari. It is obvious that
the precise effect of the occlusal condition on the dynamic function of the
masticatory system such as muscle hyperactivity and bruxism has not yet
been clearly established and further investigation is needed.

Loss of molar support was found to be considered an aetiological
factor for TMD. In this study loss of molar support was found to be
associated with TMJD syndrome. In elderly patients Budtz – Jovgensen
and Pederge found an association between tooth loss and TMD from a
clinical point of view it seems that the dental arch of the patients was
reduce to six anterior teeth and the masticatory system has been lacking the
necessary occlusal stability. However the epidemiological findings
showed no or weak association between loss of molar support and TMD. In a clinical longitudinal study of non TMD patients Witter Dettaan and Kayger found no evidence of signs and symptoms of TMD over the years in individuals with a standardized dental arch provided that the bicuspid were present. Clinical follow up studies on the treatment outcome in TMD following replacement of missing teeth has shown significant improvement in patient condition. However the contribution of the prothetic treatment solely was not been possible to determine as combination of treatment modalities has been used.

Alteration of the occlusal surfaces by wear, caries, or restorations could be responsible for the development of occlusal interferences specially those of centric relation. The demonstration by the present study that were induced alteration of occlusal surfaces is significantly associated with TMD can be explained by the fact that loss of tooth surface by wear caries and restoration may lead to loss of occlusal contact and hence to the development of occlusal interferences that may lead to masticatory muscle dysfunction.

From the above discussion it is clear that among the many studied occlusal variables only a limited number of them was found to show a significant association with TMD and that those variables have been previously been the focus of debate on occlusion and its relation to TMD.
The answer to this consensus on this issue might be resolved more research and investigation on the exact role of occlusal condition on TMD.

The findings of the present study are therefore supporting the current concept that occlusion is not the sole aetiological factor for TMD but it does contribute to the development of TMD to some extent. Further evidence-based research on the TMD by occlusal therapy is needed to clarify the existing controversy regarding its etiology.
Intercuspal positions (ICP or centric occlusion position of maximum interdigitation.

Retruded contact position (RCP) or ligamentous or centric relation. Occurs when condyles are fully retruded in the glenoid fossa in approximately 20% patients. RCP and ICP are coincident, remainder have forward side from RCP to ICP.

Rest position: the habitual postural position of the mandible when the patient is relaxed with the condyles in a neutral position.

Interferences: Are contacts that hinder smooth excursive movements of mandible.

Occlusal vertical dimension (OVD): Relationship between maxilla and mandible in ICP, i.e. face height.

Balanced occlusion used for stability of F/F denture, not applicable to natural dentition.
References


38. David


