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Tempromandibular disorders and stress

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Department of Oral Diagnosis in Partial Fulfillment of the Requirements

for the Degree of B.D.S

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Certification of the Supervisor

I certify that this project entitled " Tempromandibular disorders and stress " was prepared by the fifth-year student Shahad Salam under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor's name:

Date:

Signature:

Dedication

To my great father, mother …

To my deceased grandmother…

To the sourse of my happiness and light in my life,

my sister , brother and best friends …

To all who supported me, I dedicate this work

Acknowledgment

To Dr. Raghad Alhashimi, the Dean of the college of Dentistry/Baghdad University

To Dr. Bashar Hamed, the Head of Oral diagnosis Department, college of Dentistry

To Dr. Rana Murthadha, The supervisor of this project. For all of your support we're thankful.

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Lists of Abbreviations

Symbol	Abbreviation
TMJ	Temporomandibular joint
TMDs	Temporomandibular disorders
DJD	Degenerative joint disease
SAM	Sympathetic-adreno-medullar
HPA	Hypothalamus-pituitary-adrenal
NE	Norepinephrine
E	epinephrine
CRH	Corticotropin-releasing hormone
ACTH	Adrenocorticotrophin hormone
PACAP	Pituitary adenylate cyclase-activating polypeptide
MFP	Myofacial pain
ADD	Anterior disc displacement
DDwR	Disc displacement with reduction
DC	Disc complex
RA	Rheumatoid arthritis
CT	Computerized tomography
CBCT	Cone beam Computerized tomography
RDC	Research diagnostic criteria
MRI	Magnetic resonance imaging
TENS	Transcutaneous electrical nerve stimulation

INTRODUCTION

The temporomandibular joint (TMJ) is one of the most complex joints in the human body and it is responsible for opening and closing movements of the mouth and also the protrusion, retraction and lateral deviation movements of the mandible on the temporal bone. It is an extremely important structure, because its function is directly related to a context that involves communication, emotional expression and feeding, i.e., a set of factors that affect the individual's quality of life. Any imbalance caused in TMJ, or close to it structures, can generate a disturbance in this joint called Temporomandibular Disorder (TMD) **(Mourão,2006).**

Temporomandibular joint disorders is a collective term embracing a number of clinical problems that involve the muscles of mastication and the temporomandibular joint (TMJ), and its associated structures **(Okeson,1996)**. Pain is the defining feature of TMJ disorders and is the most common reason why patients seek care; other complaints may involve joint noises or limited or asymmetrical jaw movement **(Dimitroulis,1998).**
Other common symptoms are sensitivity changes in the muscles responsible for chewing, noises during jaw movements, limitation or incoordination of movements and malposition of the jaw relative to the maxilla**(Tavares *et al,*2013).**

Among the risk factors for temporomandibular joint disorders (TMD) there are the deleterious habits that escape from normal and harm an organ or system. Among them are: chewing gum, biting pencils, nail biting, gnashing or clenching. These habits can represent a way to release emotional tension. Parafunctions decrease normal blood flow of muscle tissue, causing accumulation of metabolic waste products in the cells of these tissues, triggering fatigue, pain and spasm symptoms**(Figueiredo *et al,*2009).** In general, parafunctions cause morphological and functional impairment of bones, teeth and soft tissue of stomatognathic system.

The aetiology of a large number of TMJ disorders is still not clear, although the literature suggests parafunctional activity, or habitual movements such as bruxism or tooth clenching. Other factors include hormonal influences, stress, previous trauma to the joint, the shape of the TMJ and degenerative change within the joint **(Rigon *et al,* 2011).**

It is thought that the prevalence of TMJ problems may be up to 76% of the population, being more prevalent in patients between 20 and 40 years of age **(Shi *et al,* 2003)** and in women **(Luther *et al,* 2010).** Research shows that quality of life can be significantly impaired among patients suffering from TMJ dysfunction **(Dahlstrom and Carlsson, 2010).**

Review of Literature

1.1 Temporomandibular Joint

1.1.1 Defenition

Temporomandibular joint (TMJ) is one of the most complicated and active joints in the human body. It can be considered to be the first joint to start functioning after birth upon suckling. Then eating food continues throughout the life and the load of the joint increases gradually due to speech and other facial expressions and gestures**(Haghnegahdar A. A.,2018)**.

The temporomandibular joint is a unique bi-condylar joint involved in normal function of mouth. It plays a role in chewing, swallowing, speaking, oral health and nutrition **(Kitsoulis *et al.*,2011).** The TMJ is formed by the mandibular condyle fitting into the mandibular fossa of the temporal bone. The articular disk and synovial spaces are separating the two bones. The articular portion of the disc is comprised of dense fibrous connective tissue devoid of any nerves and vessels; conversely, the posterior attachment of the disc is richly vascularized and innervated. The disc is attached to the condyle both medially and laterally by collateral ligaments**(Wadhwa and Kapila,2008).**

1.1.2 Anatomy of tempromandibular joint

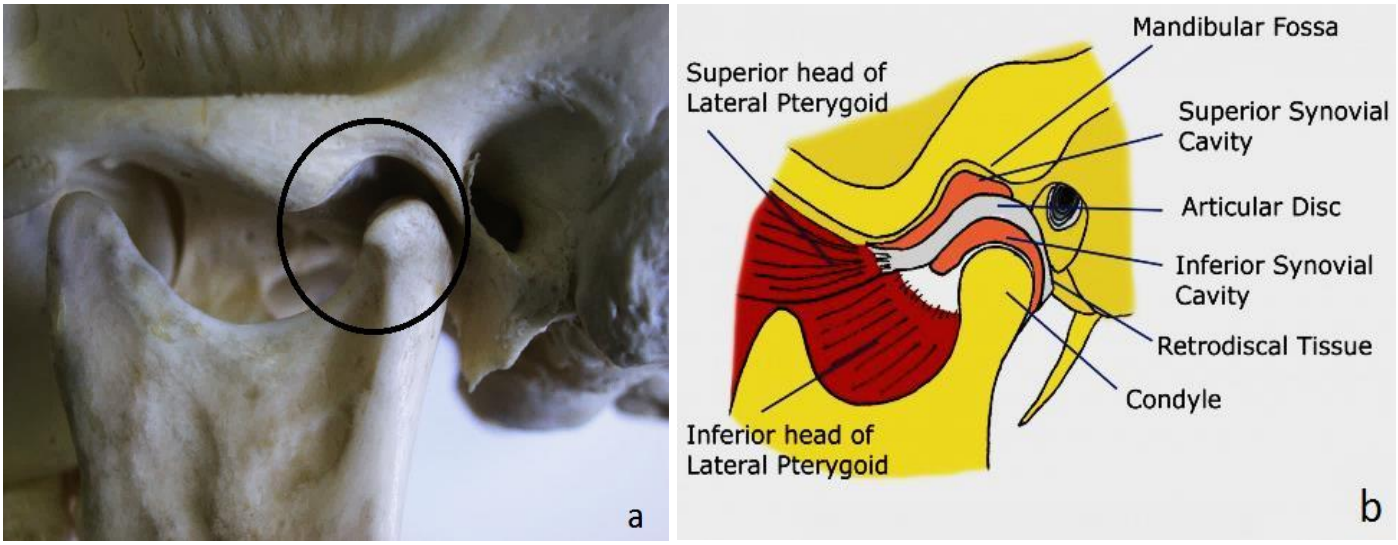
1.1.2.1 The primary components of the TMJ are:

The temporomandibular joint (TMJ) is a di-arthrodial joint consisting of the mandibular condyle, squamous portion of the temporal bone, fibrous capsule with reinforcement, and accessory ligaments and the synovial membrane**(Cuccia *et al.*,2013).**

The articular surfaces of the temporal bone

The articular squamous portion of the temporal bone is composed of three parts, the largest is the mandibular fossa , a concave structure extending from the posterior slope of the articular eminence to the post glenoid process. The second portion ,the articular eminence, is a transverse bony prominence that is continuous across the articular surface medio-laterally .

The third portion of the articular surface of the temporal bone is the pre-glenoid plane, a flattened area anterior to the eminence . The mandible is a u-shaped bone that articulate with the temporal bone by the means of the articular surface of its condyles,(figure 1-1). **(Mark *et al*.,2004).**



Figure(1-1) (a) The Temporomandibular joint sits just in front of the external auditory meatus **(Robin Gray,2011)** (b) Schematic diagram of the anatomy of the TMJ. **(Abreu MER,. 2009).**

The condyle

An elliptical projection forms the lower part of the bony joint **(Greenberg *et al.*, 2004).**

- presents an articular surface for articulation with the articular disk of the temporomandibular joint (TMJ)
- convex posteriorly and from side to side
- convexity extends further on the posterior than on the anterior surface

neck**:**

- flattened from front to back; lateral pterygoid muscle inserts into its medial surface ***(Breeland et al.*,2021).**

The articular disk

The articular disc is a fibrous extension of the capsule that runs between the two articular surfaces of the temporomandibular joint. The disc articulates with the mandibular fossa of the temporal bone above and the condyle of the mandible below.(figure 1-2). **(Miloro, M; Ghali ,2004).** The disk contains variable numbers of cartilage cells and is referred to as a fibrocartilage **(Greenberg *et al.*, 2004).** Fibrocartilage is better able to withstand sheer forces

than hyaline cartilage can, which makes it a superior material for enduring the large amount of occlusal load that is placed on the TMJ**(Milam, 2005).**

It has a biconcave shape, with the thinnest portion near its center. The posterior border is thicker than the anterior border, and the medial border is thicker than the lateral border. These thicker borders aid in keeping the disc in place atop the round condylar head**(Young ,2015)**. Its peaked cap shape divides the joint into a larger upper compartment and a smaller lower compartment **(Alomar *et al*,2007).**

The articular disc is considered to be the most important anatomic structure of the TMJ. As the hinging movements take place in the lower compartment and gliding movements take place in the upper compartment. The function of the disk is to accommodate both hinging as well as gliding actions between the temporal and mandibular articular bone**(Alomar *et al*,2007).**

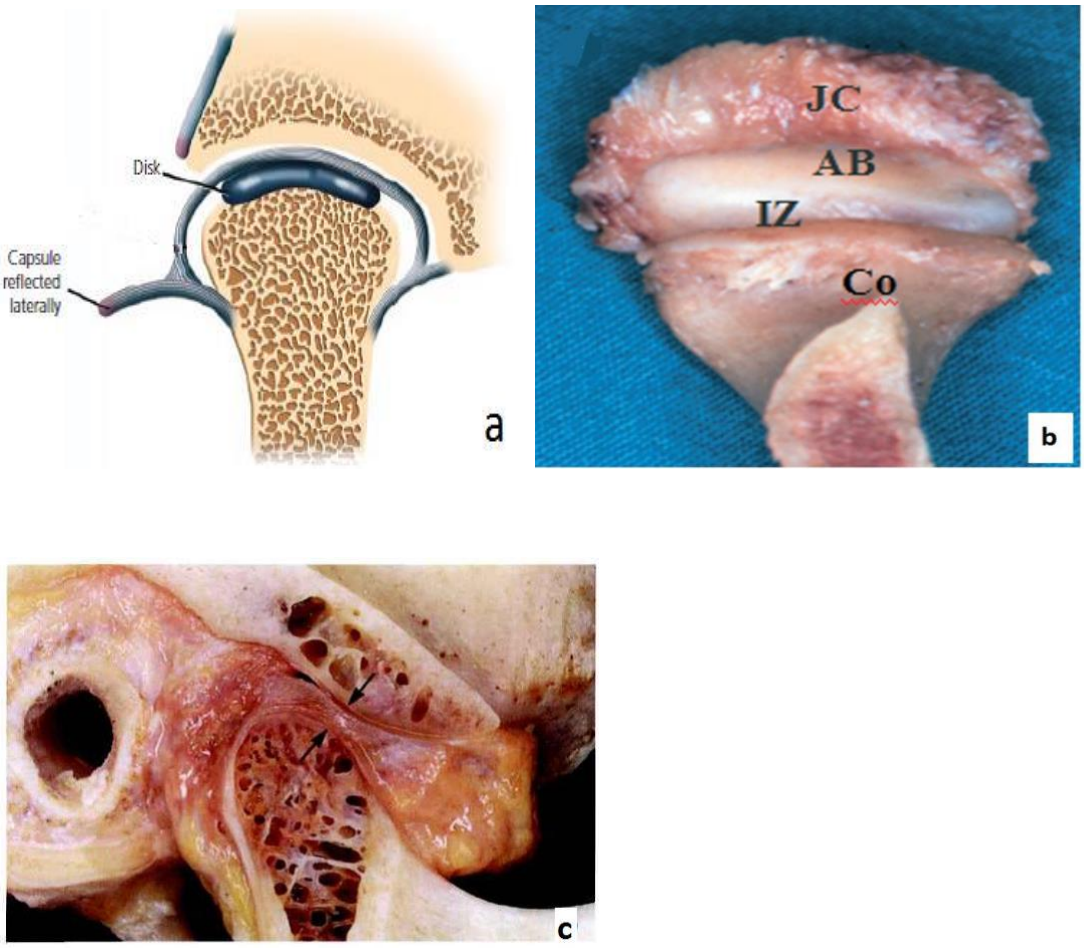


Figure (1-2) (a) the articular disk between the mandibular fossa of the temporal bone above and the condyle of the mandible below .(b) Components of the disk. AB: Anterior band; IZ: intermedius zone; JC: joint capsule; Co: condylar head of the mandible (c) Cadaver specimen showing lateral view of condyle, dissected disk between the two arrows ,and the mandibular fossa of the temporal bone. **(X. Alomar,2007),(John Wiley,2015)**

The anterior and posterior disc bands have predominantly transversal running fibers, while the thin intermediate zone has anteroposteriorly oriented fibers. Posteriorly, the bilaminar region consists of two layers of fibers separated by loose connective tissue. The upper layer or temporal lamina is composed of elastin and is attached to the postglenoid process, medially extended ridge, which is the true posterior boundary of the joint. It prevents slipping of the disc while yawning. The inferior layer of the fibers or inferior lamina curve down behind the condyle to fuse with the capsule and back of the condylar neck at the lowest limit of the joint space. It prevents excessive rotation of the disc over the condyle**(Alomar *et al*,2007).**

In between the two layers, an expansile, soft pad of blood vessels and nerves are sandwiched and wrapped in elastic fibers that aid in contracting vessels and retracting disc in recoil of closing movements**(Alomar M.,2007).**

The disc is composed of variable amounts of cells and an extracellular matrix. The matrix consists of macromolecules (15-35%) and fluid (65-85%). These macromolecules consist mainly of collagen (85-90%) and proteoglycans (10-15%)**(David *et al*,2016).**

The capsule

The capsule of the temporomandibular joint is a fibrous membrane that surrounds the joint and attaches to the articular eminence ,the articular disc and the neck of the mandibular condyle, (figure 1-3). **(Drake,2013).**

It is thin and loose in structure, its looseness prevent ruptures by excessive force of the mandibular movement. But when the capsule become below the disc as it attaches disc to the neck of the mandible ,it becomes tight**(Eren *et al,* 2015).**

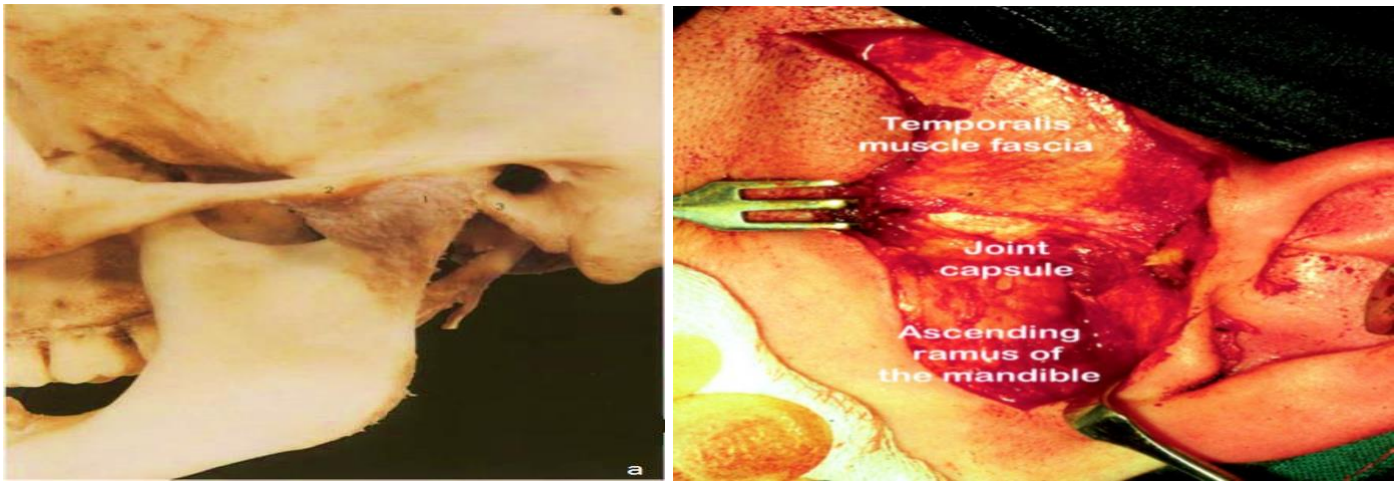


Figure (1-3) (a) the joint capsule lateral view (b) surgical approach to the joint capsule **(Neil S. Norton,2011)**

1.1.2.2 Ligaments of Temporomandibular joint

The TMJ ligaments help to limit their movements**(Okeson JeffreyP., 2008)**.

Temporomandibular joint ligaments figure (1-4) could be classified into two groups according to their relation to the joint capsule:

a. The extra-capsular ligaments which include the temporomandibular (lateral), sphenomandibular and styloomandibular ligaments **(Fuentes *et al.*, 2014)** (figure 1-5).

b. The intra-capsular and that connect the articular disc to the TMJ joint capsule which are the medial and lateral collateral ligaments**(Docherty,2012).**

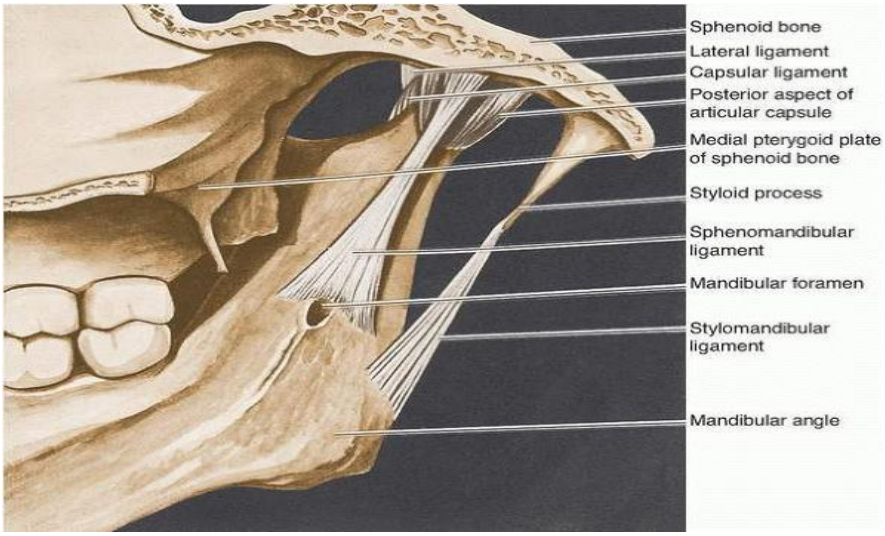


Figure (1-4) Ligaments of TMJ. (www.dentallecnotes.blogspot.com)

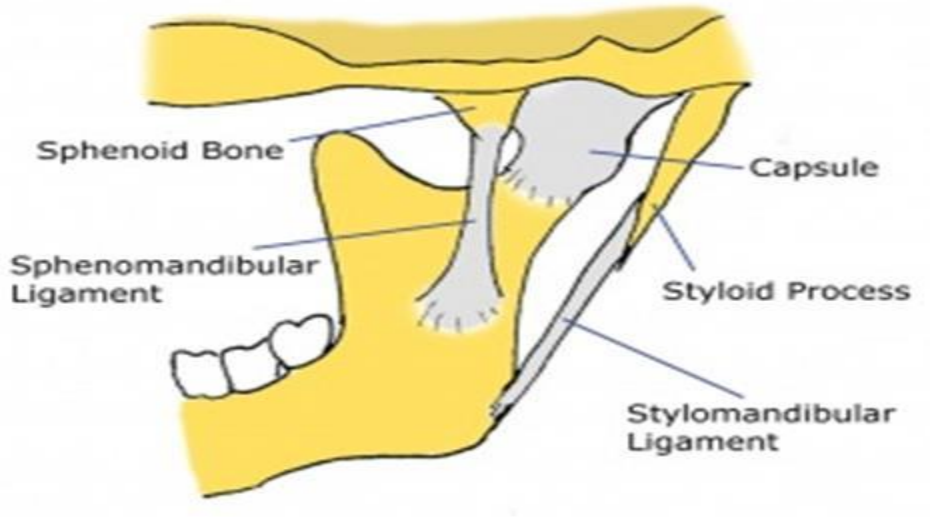


Figure (1-5) - the temporomandibular ligament and joint capsule (medial view), **(Cheynet,F,2003).**

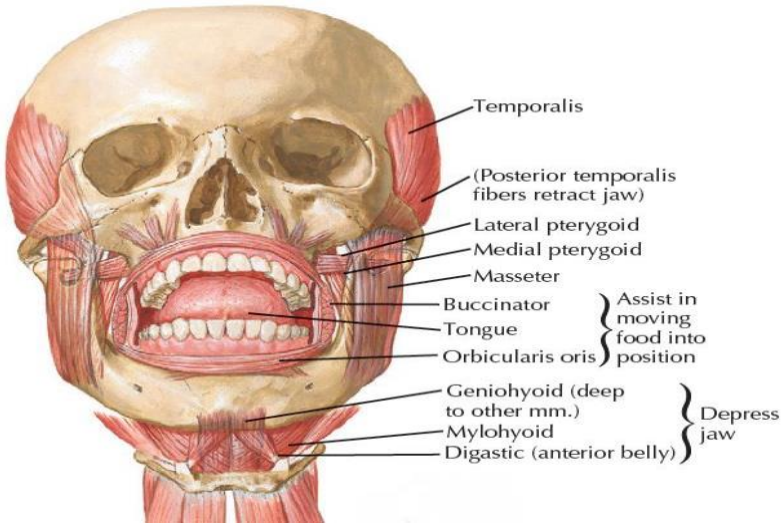
1.1.2.3 Muscles Associated with Mandibular Movement and Function

The jaw can move forward and back, side to side and can open and close. Each of these movements are performed by a number of muscles working together to perform the movement while controlling the position of the condyle within the mandibular fossa. Chewing and talking require a combination of jaw movements in a number of directions (figure 1-6). **(Cheynet *et al* ,2003).**

All muscles attached to the mandible influence its movement to some degree. Only the four large muscles that attach to the ramus of the mandible are considered the muscles of mastication ; however , a total of twelve muscles actually influence mandibular motion , all of which are bilateral muscles influencing the mandibular motion may be divided into two groups by anatomic position .

1. The supra-mandibular muscles group attaching primarily to the ramus and condylar neck of the mandible, consisting of the temporalis , masseter , medial pterygoid and lateral pterygoid muscles. this group function predominantly as the elevators of the mandible . the lateral pterygoid does have a depressor function as well**(Hupp *et al* ,2013).**

2. The infra mandibular group muscles attaching to the body and symphyseal area of the mandible and to the hyoid bone, which function as the depressors of the mandible and includes the four suprahyoid muscles (digastric, geniohyoid , mylohyoid and stylohyoid) and the four infrahyoid muscles (sternohyoid ,omohyoid , sternothyroid and thyrohyoid) **(Hupp *et al* ,2013).**



Figure(1-6) number of muscles working together to perform the movement of mandible **(Neil S. Norton,2011)**

1.1.2.4 Blood Supply of Temporomandibular Structures

The external carotid artery is the main blood supply for the temporomandibular structures. The artery leaves the neck and courses superiorly and posteriorly, embedded in the substance of the parotid gland. The artery sends two important branches, the lingual and facial arteries, to supply the region. At the level of the condylar neck, the external carotid bifurcates into the superficial temporal artery and the internal maxillary artery. These two arteries supply the muscles of mastication and the TMJ .Arteries within the temporal bone or mandible may also send branches to the capsule **(Greenberg *et al.*, 2004).**

1.1.2.5 Nerve Supply of Temporomandibular Structures

The masticatory structures are innervated primarily by the motor fibers of trigeminal nerve, but cranial nerves VII, IX, X and XI and cervical nerves 2 and 3 also contribute **(Martin *et al*, 2008).**

The nerve supply to the TMJ is predominantly from branches of the auriculotemporal nerve with anterior contributions from the massetric nerve and the posterior deep temporal nerve **(Mark *et al*,2004)**.

1.1.3 Temporomandibular Joint Muscle Control

A single bone joins both TMJs so movement in one joint cannot occur without either similar coordinating or dissimilar reactive movements in the other joint. Opening, closing,

protraction and retraction are bilateral symmetric movement. Lateral excursions are bilateral asymmetric movements.

Mandibular opening is produced by contraction of lateral pterygoid muscles with assistance from the digastric , geniohyoid, and mylohyoid muscles. The masseter, medial pterygoid, and anterior fibers of the temporalis muscles are involved in mandibular closing.

Protrusion of the mandible is accomplished by the lateral pterygoid muscles and less effectively, medial pterygoid and the superficial fibers of masseter which also prevent the lateral pterygoid opening the mouth. While retruded position is produced by contraction of the posterior fibers of the temporalis muscle.

Lateral movement of the mandible occurs when the lateral pterygoid muscle contract alternately **(Greenberg *et al.*, 2004).**

1.1.4 Normal Function of Temporomandibular Joint

The function of the TMJ is complex because the upper and lower joint compartments principally acts as two small joints within same joint capsule .this allows for proportionally greater movement of the TMJ in relation to the actual size of the joint. the principle function of the disc is to permit relatively large movement within a small joint while maintaining stability**(Docherty ,2012).**

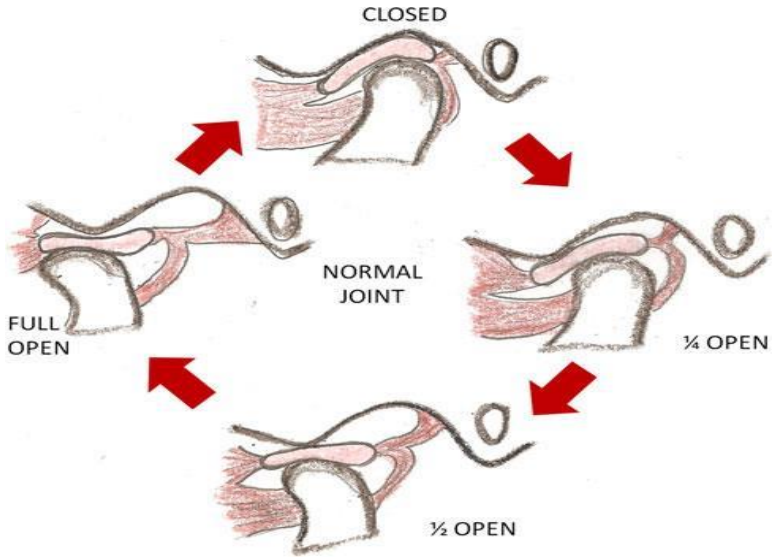
Rotation and translation occur in both the upper and lower joint spaces, however, translation occurs predominantly in the upper space and rotation is more evident in the lower joint space .in the initial phase of jaw opening , the condyle rotate in the lower joint compartment and after this initial rotation, translation occur in the upper and subsequently in the lower joint spaces together under the articular tubercle . during all mandibular movements , the central thin part of the disc is located between the condyle and the articular tubercle. This suggests that the thick periphery of the disk and the thick posterior and anterior bands act as a functional guides for the joint. This normal joint function can be identified in anatomic specimen of the TMJ (figure1-7). **(Coulthard *et al* ,2003).**

All these movements of mandible occur by two movements of the condyle. One is the gliding movement which takes place between the disc and temporal surface of articulation. The second is the rotator or hinge movement which takes place between the disc and head of

the condyle. These movements help in mastication and other functions of the mandible **(David *et al*,2016)**.

During normal functional movement of the condyle and disc in full range of opening and closing, the disc is rotated posteriorly on the condyle as the condyle is translated out of the fossa. The closing movement is the exact opposite of opening**(David *et al*,2016).**

The normal functioning of the TMJ is affected not only by several biological but also psychological factors; hence, a bio-psycho-social role is thought to be played out in temporomandibular disorders (TMD). **(David *et al*,2016)**



Figure(1-7) normal TMJ motion**.(Darpan Bhargava,2012)**

1.2 Temporomandibular Disorders (TMDs)

Temporomandibular disorder (TMD) is an umbrella term, embracing conditions which involve the temporomandibular joint (TMJ), masticatory muscles and/or associated structures. Disk displacement, TMJ sounds, congenital malformation, degenerative joint disease (DJD) are possible conditions affecting TMJ **(Hilgenberg-Sydney *et al* ,2018).**

Degenerative joint disease is characterized by deterioration and abrasion of TMJ hard and soft tissues and concomitant remodeling of the underlying sub chondral bone. A multifactorial etiology that presents some risk factors such As age , sex, genetics, trauma, muscle or joints disturbances, and systemic conditions. Clinical symptoms can include pain, joint sounds, such as crepitus, joint stiffness, and/ or restriction of mandibular movement **(Hilgenberg-Sydney *et al* ,2018)**.

After odontogenic pain, temporomandibular disorders (TMDs) are one of the most common causes of pain in the mouth and face and also have the potential to produce persisting (chronic)pain **(Sinisalu *et al* ,2016)**.

1.2.1 Epidermology

Prevalence and incidence are basic terms in epidemiology but are sometimes used incorrectly. Prevalence indicates the proportion of the population with the disease or condition at a given time **(Carlsson *et al* ,1995).** Incidence is the rate of onset of the condition over time (conventionally, 1 year).

Between 65 and 85% of people in the United States experience one or more symptoms of a TMD during their lives, but the symptoms are self-limiting for most individuals and resolve without professional intervention **(Dworkin *et al* ,1990).** Incidence of first lifetime onset of a painful TMD appears to be between 2–4% per annum **(Slade *et al* ,2013**). Although the prevalence of one or more signs of mandibular pain and dysfunction is high in the population, only about 5 to 7% have symptoms severe enough to require treatment**(Schiffman *et al* ,1990).**

Among those who develop a TMD, approximately 12% experience prolonged pain that results in disability**(Dworkin *et al* ,1990)**, and more recent estimates indicate that between 25–50% of individuals with acute painful TMD develop chronic pain in the absence of appropriate intervention **(Meloto *et al* ,2019).** In terms of symptom profile, individuals with a painful TMD are similar to those with headache and back pain with respect to pain intensity, frequency, chronicity, psychosocial distress, and pain-related disability **(Rudy *et al* ,1990)**. These profiles appear to be similar in individuals with TMDs across cultures; for example, Asian, Swedish, and American populations with TMDs share similar characteristics **(Yap *et al* ,2003).**

Between the ages of 20 and 40 years, and that prevalence then decreases by age 60, after which it decreases substantially **(Sharma *et al* ,2018)**. The lower prevalence of TMDs in older age groups suggests that the disease course in a significant proportion of individuals with TMDs is strongly influenced by situational factors that resolve with aging. TMDs in the community occur at about twice the rate in females vs. males, yet females are eight times

more common in the clinic population, compared to males. The reason why women make up the majority of patients presenting for treatment remains unclear.

Signs and symptoms of masticatory muscle and TMJ dysfunction are also commonly observed in children and adolescents **(Grosfeld *et al* ,1985)**. Among adolescents in Sweden between the ages of 12 and 19 years, 4.2% reported TMD pain, and girls reported TMD pain approximately twice more frequently than boys, 6% compared with 2.7%.57 Surprisingly, a wide variety of painful TMD characteristics observed in adults also occur to largely the same extent in children and adolescents.

1.2.2 Etiology

Temporomandibular disorders have multiple etiological factors **(Brecher *et al* ,2019).** There is insufficient evidence to reliably predict which patients will or will not develop TMD **(Howard,2013).** Predisposing (risk) factors, precipitating (initiating) factors, and perpetuating (or sustaining) factors contribute to the development of TMDs**(Howard,2013).** The available evidence base suggests a poor correlation between any single etiological factor and resulting signs (i.e., findings identified by the dentist during the examination) and symptoms (i.e., findings reported by the child or parent) **(Horswell *et al* ,2018)**. Alterations in any one or a combination of teeth, periodontal ligament, the TMJ, or the muscles of mastication may lead to TMD **(Horswell *et al* ,2018)**.

Etiologic factors suggested as contributing to the development of TMD are:

1-Macrotrauma: A common occurrence in patients because of falling, chin trauma is reported to be a factor in the development of TMD in patients **(Fischer *et al* ,2006).** Additional macrotraumatic injuries occur due to motor vehicle accidents, sports, physical abuse, forceful intubation, and third molar extraction **(Bae *et al* ,2018).**

2-Microtrauma from parafunctional habits: Bruxism, clenching, hyperextension, and other repetitive habitual behaviors are thought to contribute to the development of TMD by joint overloading that leads to cartilage breakdown, synovial fluid alterations, and other changes within the joint **(Dym *et al* ,2012).**

3- Anatomical factors (skeletal and occlusal) and orthodontic treatment: The association of skeletal and occlusal factors and the development of TMD is relatively weak **(deLeeuw *et al* ,2018).**

4-Psychosocial factors: Psychosocial factors may play a part in the etiology of TMD **(List *et al* ,2001).**Behavioral factors such as somatization, anxiety, obsessive-compulsive feelings, and psychologic stress were predictors of TMD onset **(Fillingim *et al* ,2011).**

5- Systemic and pathologic factors: Systemic factors contributing to TMD include connective tissue diseases such as rheumatoid arthritis, systemic lupus erythematosus, juvenile idiopathic arthritis, and psoriatic arthritis **(Granquist,2018)**.

6- Genetic and hormonal factors: There is little research regarding genetic susceptibility for development of TMD **(Fillingim *et al* ,2011).**

1.2.2.1 Stress

Stress is a feeling experienced by everyone, however it is perceived and explained from various aspects in different ways. There are three types of stress **(Barrón López de Roda,1997):**

- Stress as stimulus: stress is defined as any situation that provokes alteration in the homeostatic processes. This definition has been criticized since it does not consider individual differences in response to the same situation. Individuals are not passive and there are many situations that result in changes of the homeostatic processes but they are not stressful, for instance to breath.
- Stress as interaction: many authors suggest that stress should be understood as a relationship between individuals and their environment. In this specific relationship, the environment is perceived as threatening by individuals who experience that environment demands exceed their personal resources.
- Stress as response: stress is defined in terms of the reactions provoked in the organism. Some authors argue that this kind of definition of stress can be misunderstood since there are both emotional and physical responses that can fit in this definition of stress and they result from non stressful situation, for instance to practice sport.

1.2.2.2 Stress physiology

Any physical or psychological stimuli that disrupt homeostasis result in a stress response. The stimuli are called stressors and physiological and behavioral changes in response to exposure to stressors constitute the stress response. A stress response is mediated by a complex interplay of nervous, endocrine, and immune mechanisms that involves activation

of the sympathetic-adreno-medullar (SAM) axis, the hypothalamus-pituitary-adrenal (HPA) axis, and immune system**(Mifsud *et al*.,2018).** The stress response is adaptive, to begin with, that prepares the body to handle the challenges presented by an internal or external environmental challenge (stressor) e.g., the body's physiologic responses to trauma and invasive surgery serve to attenuate further tissue damage. But if the exposure to a stressor is actually or perceived as intense, repetitive (repeated acute stress), or prolonged (chronic stress), the stress response becomes maladaptive and detrimental to physiology e.g., exposure to chronic stressors can cause maladaptive reactions including depression, anxiety, cognitive impairment, and heart disease**(Ketchesin *et al*.,2017).**

The physiology of stress response has two components; a slow response, mediated by the HPA axis, and a fast response, mediated by the SAM axis. The fast response due to activation of SAM results in increased secretion of norepinephrine(NE) and epinephrine(E) from the adrenal medulla into the circulation and increased secretion of NE from the sympathetic nerves and thus result in elevated levels of NE in the brain.

The slow response is due to activation of the HPA axis resulting in the release of Corticotropin-releasing hormone (CRH) from the paraventricular nucleus of the hypothalamus into the circulation. The CRH released from the hypothalamus acts on two receptors; CRH-R1 and CRH-R2.CRH-R1 is widely expressed in the brain in mammals. It is the key receptor for the stress-induced ACTH release from the anterior pituitary. CRH-R2 is expressed primarily in peripheral tissues including skeletal muscles, gastrointestinal tract, and heart, as well as in subcortical structures of the brain**(Westphal *et al*.,2005).**

The released CRH then stimulates the anterior pituitary gland to release adrenocorticotrophin hormone (ACTH) into the bloodstream. ACTH stimulates the adrenal cortex to secrete glucocorticoid hormones, such as cortisol, into the circulation. Cortisol's inactive form, cortisone, is catalyzed to its active form, cortisol, by 11 beta-hydroxysteroid dehydrogenases. The HPA axis is regulated by pituitary adenylate cyclase-activating polypeptide (PACAP). PACAP may play a role in the production of CRH and have a modulatory role in multiple levels of the HPA axis**(King *et al*.,2017).**

The hypothalamic-pituitary adrenocortical (HPA) axis and its end product, cortisol, are thought to be important mediators of the relationship between stressful life experiences and health outcomes**(McEwen, 2003).**

1.2.2.3 The Value of Stressful Experiences Contribute to the Development of Temoporomandibular Disorders

Laskin 1969, was the first to suggest that the main factor responsible for TMD is the emotional instead of the physical aspect, he merge both biological and psychological aspects and according to this concept, people react to stress with different systems in the body, some react via the head and neck muscles and develop TMDs. There is currently considerable evidence that psychological factors are of importance in the understanding of TMDs, but there is less evidence that these factors are etiologic. Although there is strong evidence that some patients with TMDs are more anxious and/or depressed compared with asymptomatic controls **(Gamerio *et al,* 2006).**

DeLeeuw et al 1994, consider that muscle dysfunction and accompanying pain are very often the result of stress induced muscular hyperactivity. Stress induced muscular dysfunction may induce secondary changes in the TMJ. A proposed integrated biopsychological model of how stress may impact on TMD can be drawn figure (1-8), **(Gameiro *et al,* 2006).**

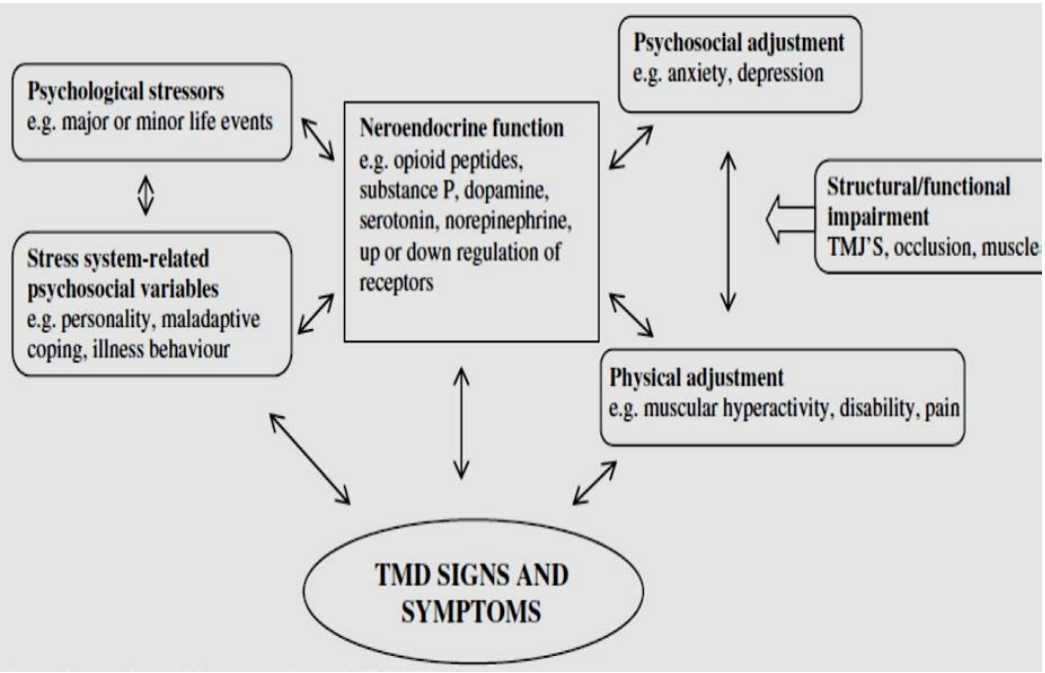


Figure (1-8) A range of psychosocial (central event) and physical variables(peripheral events) may modify or exacerbate the effects of stressors on disease related outcomes **(Gameiro *et al,* 2006).**

Most TMD patients show HPA axis hyperactivity. The facial region pain represents a greater stimulus to HPA axis activation than pain elsewhere in the body **(Gamerio *et al,* 2006).** Pain itself acts as a strong activation of the HPA axis **(Pacak and Palkovits, 2001).**

Most of the molecules mediating stress effects are the same as those associated with pain modulation, so the stress can profoundly affect the biological processes of pain transmission and perception **(Millan, 2002).** The inappropriate adaptational responses could be maladaptive and act as stressors themselves (orofacial pain is a strong stressor), feeding into a sustained vicious cycle, figure (1-9) **(Gameiro *et al,* 2006).**

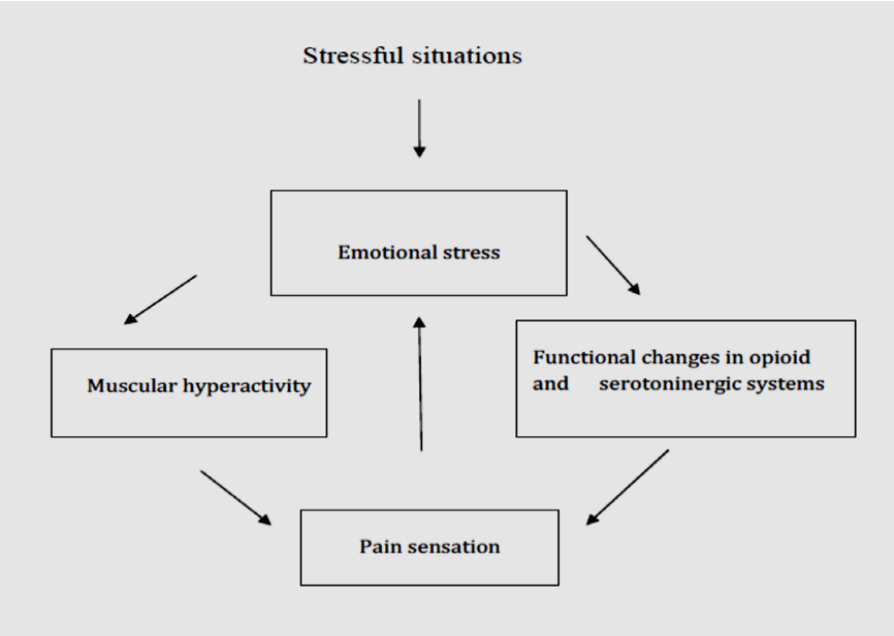


Figure (1-9) Diagram illustrating the cycle stress-pain-stress that can occur in TMD patients **(Gameiro *et al,* 2006).**

Geissler1985, used biochemical evidence (urinary cortisol:creatinine ratios) to show that patients with TMDs have higher urinary cortisol than normal individuals and therefore they are under greater emotional stress. It is possible that high levels of cortisol in TMDs patients represent a physiological response to chronic stress, with pain as a potential stressor, associated with chronically increased CRH or other HPA axis central mediators. Increased activation of the central components of stress system may result in hyperalgesia **(Lariviere and Melzack, 2000).**

The women showed more signs and symptoms of TMDs, and higher prevalence due to an interaction of a variety of factors ranging from biological and hormonal factors to psychological and social ones **(Kuttila *et al,*1998).** The diagnosis, assessment, and management of TMDs must include both physical (e.g., TMJ, occlusion, and muscles) and psychological (e.g., personality, affective states, and distress) factors **(Gamerio *et al,* 2006).**

1.2.3 Classification of tempromandibular disorders

According to the guidelines of the American Academy of Orofacial Pain TMJ disorders can be classified as follows:

Classification scheme adapted from the guidelines of the American Academy of Orofacial Pain. TMJ denotes temporomandibular joint. (Robert,2015)

Articular disorders

– **Congenital or developmental**

1. First and second branchial arch disorders: hemifacial microsomia,
2. Treacher Collins syndrome, bilateral facial microsomia
3. Condylar hyperplasia
4. diopathic condylar resorption (condylysis) **(Robert,2015)**

– **Disk derangement disorders**

1. Displacement with reduction
2. Displacement without reduction (closed lock)
3. Perforation **(Robert,2015)**

– **Degenerative joint disorders**

1. Inflammatory: capsulitis, synovitis, polyarthritis (rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, Reiter's syndrome, gout)
2. Noninflammatory: osteoarthritis **(Robert,2015)**

– **Trauma**

1. Contusion
2. Intracapsular hemorrhage
3. Fracture **(Robert,2015)**

– **TMJ hypermobility**

1. Joint laxity
2. Subluxation
3. Dislocation **(Robert,2015)**

– **TMJ hypomobility**

1. Trismus
2. Post-radiation therapy fibrosis

3. Ankylosis: true ankylosis (bony or fibro-osseous) and pseudoankylosis

– **Infection**

– **Neoplasia (Robert,2015)**

Masticatory muscle disorders

– **Myofascial pain disorder**

– **Local myalgia**

– **Myositis**

– **Myospasm**

– **Myofibrotic contracture**

– **Neoplasia (Robert,2015)**

1.2.4 Sings and Symptoms of Temporomandibular Disorders

It is important to identify both signs and symptoms clearly. A sign is an objective clinical finding that the clinician uncovers during clinical examination. A symptom is a description or complaint reported by the patient.

1.2.4.1 Myogenic Disorders

It has been reported that approximately 50% of all TMDs are masticatory **(Stohler, 2000).** The two major symptoms of myogenic disorders are pain and dysfunction so divided into myofacial pain(MFP) and myofacial pain and dysfunction syndrome when there is accompanying limitation in jaw opening **(Ogle and Hertz, 2000).**

The muscle pain range from slight tenderness to extreme discomfort and associated with a feeling of muscle fatigue and tightness. Patients will usually describe the location of the pain as broad or diffuse, and the pain is often bilateral. The severity of muscle pain is generally directly related to the amount of functional activity. If the patient does not report an increase in pain associated with jaw function, the disorder is not related to a masticatory muscle problem and other diagnoses should be considered **(Okeson and de Leeuw, 2011).**

Clinically, myofascial pain is characterized by the presence of localized, firm, hypersensitive bands of muscle tissue called trigger points. These areas create a source of deep pain input that can lead to central excitatory effects resulting in pain referral. This condition manifests

as pain on palpation with referral of pain to the surrounding or remote tissues **(Simons *et al,* 1999).**

While dysfunction, clinically may be seen as a decrease in the range of mandibular movement. When muscle tissues have been compromised by overuse, any contraction or stretching increases the pain, therefore the patient restricts movement within a range that does not increase pain. The restriction may be at any degree of opening depending on where discomfort is felt. In many myalgic disorders the patient is able to slowly open wider but this increases the pain **(Mense, 2003).**

MFP of the masticatory muscles is more frequently induced by stress related parafunctional habits (ie, clenching and grinding) and rarely by mechanical causes such as malocclusion or high dental restorations **(Herb *et al,* 2006).** The increase of muscle use by parafunction is causing muscle pain due to vasoconstriction of the relevant nutrient arteries and the accumulation of metabolic waste products in the muscle tissues **(Mense, 2003).** But parafunctions like daytime clenching or sleep related bruxing, chewing gums and biting lips, cheeks, fingers and nails are common and do not lead to pain in most individuals.

1.2.4.2 Articular Disorders

Temperomandibular joint displacement, also known as internal disc derangement, is an abnormal relationship between the articular disc, the mandibular condyle and the mandibular fossa **(Young,2015).** Anterior disc displacement (ADD) is the most common articular derangement, ADD is divided into:

1. **Anterior disk displacement with reduction.**

Many studies confirm that disc displacement with reduction (DDwR) is the most prevalent derangement of the condyle-disc complex ,the DC/TMD defines DDwR as an intracapsular biomechanical disorder when, in closed mouth position, the disc is in an anterior position relative to the condylar head, and the disc reduces upon opening of the mouth (medial and lateral displacement of the disc may also be present; clicking, popping, or snapping noises may occur with disc reduction). **(Pihut *et al* ,2018)**

DDwR could be the result of masticatory muscle contracture. Clicking occurs when the condylar head of the mandible skips the rear edge of the displaced articular disc during mouth opening and/or closing. Afterwards, the disc does not return to the correct position in relation to the condyle when the mandible is again, upon closure, in the central position.

Clicking may occur in the initial, middle, and final phase of the mandible opening movement. Different studies have reported that pain is a comorbid symptom of temporomandibular joint (TMJ) disc displacement. When the disc is anteriorly displaced, the ligaments of the rear disc are elongated, stretched, and damaged, and acoustic symptoms are accompanied by pain located in the area of the temporomandibular joints and surrounding tissues, intensifying when the patient opens their mouth and chews food **(Pihut *et al* ,2018).**

2. Anterior disk displacement without reduction

The main symptoms of closed lock are pain in affected joint and decreased range of mouth opening (≤ 35 mm), which deteriorate the function of the stomatognathic system and force the patient to look for professional help. The symptoms of closed lock are usually related to disc displacement without reduction. The etiology of disc displacement is not clear, but there are a few possible reasons playing a key role in changes of the TMJ structure, such as parafunctions (e.g. bruxism), anatomical factors, trauma or general hypermobility of the joints **(Mlernik,2015) .**

In the majority of cases the disc is displaced anteriorly, blocking mechanically translating movement of the condyle, resulting in restricted mouth opening. In addition the bilaminar zone becomes overloaded by direct contact with the condyle, which is the main reason of pain in the TMJ **(Mlernik,2015).**

• Inflammatory Joint Disorders

Inflammatory joint disorders are a group of disorders in which various tissues that make up the joint structure become inflamed as a result of insult or breakdown. Any or all joint structures may be involved. Unlike disc derangement disorders, in which pain is often momentary and associated with joint movement, inflammatory disorders are characterized by constant, dull, aching pain that is accentuated by joint movement **(Jeffrey, 2008).**

Rheumatoid Arthritis

Rheumatoid arthritis (RA) is a chronic, systemic inflammatory disorder that may affect many tissues and organs, but principally the synovial joints. The TMJs are involved in approximately half of cases **(Coulthard *et al,* 2003).** The disease process starts as a vasculitis of the synovial membrane, progresses to chronic inflammation marked by an intense round cell infiltrate and subsequent formation of granulation tissue. The cellular

infiltrate spreads from the articular surfaces to cause an erosion of the underlying bone **(Greenberg *et al,* 2004).** RA is usually involved the TMJs bilaterally. The most common symptoms include pain and limitation of mandibular opening. Pain is usually associated with the early acute phases of the disease but is not a common in later stages. Morning stiffness, joint sounds, tenderness and swelling over the joint area are often experienced by the patients **(Stabrun *et al,* 1989).** symptoms are usually temporary, and only some of patients with RA of the TMJs will experience permanent clinically significant disability **(Greenberg *et al,* 2004).**

Septic Arthritis

Septic arthritis of the TMJ most commonly occurs in patients with previously existing joint disease, such as RA or underlying medical disorders—particularly diabetes. Patients receiving immunosuppressive drugs or long-term corticosteroids also have an increased incidence of septic arthritis. The infection of the TMJ may result from blood-borne bacterial infection or by extension of infection from adjacent sites, such as the middle ear, tonsils, maxillary molars, and parotid gland **(Hincapie *et al,* 1999)**.

Symptoms of septic arthritis include trismus, deviation of the mandible to the affected side, severe pain on movement, and inability to occlude the teeth due to the presence of inflammation in the joint space.

Examination reveals redness and swelling in the region of the involved joint, the swelling may be fluctuant and extend beyond the region of the joint **(Hincapie *et al,* 1999).** Large tender cervical lymph nodes are frequently observed on the side of the infection and this helps in diagnosis of septic arthritis from other types of TMJ disorders **(Greenberg *et al,* 2004).**

1.2.4.3 Truama

Trauma is subdivided into:

1-Microtruama

Microtrauma refers to any small force that is repeatedly applied to the joint structures over a long period of time such as bruxism and high spots. If loading exceeds the functional limit of the tissue, irreversible changes or damage can result. When the functional limitation has been exceeded, the collagen fibrils become fragmented, resulting in a decrease in the stiffness of the collagen network. This allows the proteoglycan-water gel to swell and flow out into the joint space, leading to a softening of the articular surface. This softening is called chondromalacia **(Stegenga, 1991).** The early stage of chondromalacia is reversible if the excessive loading is reduced. If the loading continues to exceed the capacity of the articular tissues, irreversible changes can occur. Regions of fibrillation can begin to develop, resulting in focal roughening of the articular surfaces **(Dijkgraaf *et al,* 1995).**

2-Macrotruama

Macrotruama leads either to fracture of the condyle head and neck or to less commonly dislocation of the mandible when the condyle is positioned anterior to the articular eminence and cannot return to its normal position without assistance, and may be unilateral or bilateral. The patient with a condylar fracture usually presents with pain and edema over the joint area and limitation and deviation of the mandible to the injured side on opening. Bilateral condylar fractures may result in an anterior open bite. While the typical complaints of the patient with dislocation are an inability to close the jaws and pain related to muscle spasm. On clinical examination, a deep depression may be observed in the pretragus region corresponding to the condyle being positioned anterior to the eminence **(Greenberg *et al,* 2004).**

1.2.5 Diagnosis of Temporomandibular Disorders

Diagnosis could be achieved by two steps

1.2.5.1 Clinical Examination

1- History

The patient history may be the most important part of evaluation .the history begins with the chief complaint, which is a statement of the patients reasons for seeking treatment **(Hupp *et al*,2013)** .The history of the present illness should be comprehensive ,including an accurate description of the patients symptoms ,chronology of the symptoms ,description of how the problem affect the patient, exacerbating and relieving factors and information about any previous treatments (including patients response to those treatment) **(Hupp *et al*,2013)**.

2-Physical Examination

Physical examination findings that support the diagnosis of TMD may include—but are not limited to—abnormal mandibular movement, decreased range of motion, tenderness of masticatory muscles, pain with dynamic loading, signs of bruxism, and neck or shoulder muscle tenderness. Clinicians should assess for malocclusion (e.g., acquired edentulism, hemifacial asymmetries, restorative occlusal rehabilitation), which can contribute to the manifestation of TMD. Cranial nerve abnormalities should not be attributed to TMD **(Scrivani *et al*,2014) .** A clicking, crepitus, or locking of the TMJ may accompany joint dysfunction. A single click during opening of the mouth may be associated with an anterior disk displacement. A second click during closure of the mouth results in recapture of the displaced disk; this condition is referred to as disk displacement with reduction. When disk displacement progresses and the patient is unable to fully open the mouth (i.e., the disk is blocking translation of the condyle), this condition is referred to as closed lock. Crepitus is related to articular surface disruption, which often occurs in patients with osteoarthritis **(Okeson *et al*,2011)** .

Reproducible tenderness to palpation of the TMJ is suggestive of intra-articular derangement. Tenderness of the masseter, temporalis, and surrounding neck muscles may distinguish myalgia, myofascial trigger points, or referred pain syndrome. Deviation of the

mandible toward the affected side during mouth opening may indicate anterior articular disk displacement **(Emshoff *et al*,2002) .**

Assessment of range of mandibular movement by measuring the maximum mouth opening with comfort, with pain and with clinician assistance, thus to differentiate the restrictions due to muscle or joint, also evaluate the maximum lateral and protrusive movements **(Greenberg *et al*, 2004)**

Palpation of the TMJ palpated on both sides of the face with mouth open and close to reveal pain and irregularities during condylar movement, and joints sounds like clicking and crepitus. The lateral pole of the condyle is most accessible for palpation during mandibular movements. In addition to joint noises and pain, there may be palpable differences in the form of the condyle when comparing right and left. Assessment of parafunctional habits by the examination of tooth wear, multiple fracture of enamel and restorations, and soft-tissue changes like lip or cheek chewing, a hyperplastic occlusal line, and scalloped tongue borders **(Greenberg *et al*, 2004).**

1.2.5. 2 Imaging

There are many imaging modalities to investigate TMJ, such as CT, cone beam CT (CBCT), MRI, plain radiography, ultrasound, pantomograph (commonly named "panoramic"), arthrography, among others **(Bag *et al* ,2014).**

The RDC(research diagnostic criteria/TMD has a protocol of examination that suggests three types of images: pantomograph, MRI, and CT/CBCT. Using the RDC/TMD as the reference standard, **(Ahmad *et al*,2009)** found that while CT images detected 75% of OA, MRI detected 40% (figure 1-10)and panoramic radiographs 0%.**(Ahmad *et al*,2009)** , The use of CT/CBCT was thought to be the image reference standard to evaluate DJD **(Larheim *et al*,2014)** .

Despite the advancement in MRI imaging quality, the examiners' evaluation of TMJ disc derangement remains inconsistent. The new technique that co-register both MRI and CBCT images improved the visualization of the TMJ's soft and hard tissues and the examiners' consistency compared to MRI alone **(Al-Saleh *et al* ,2016).**

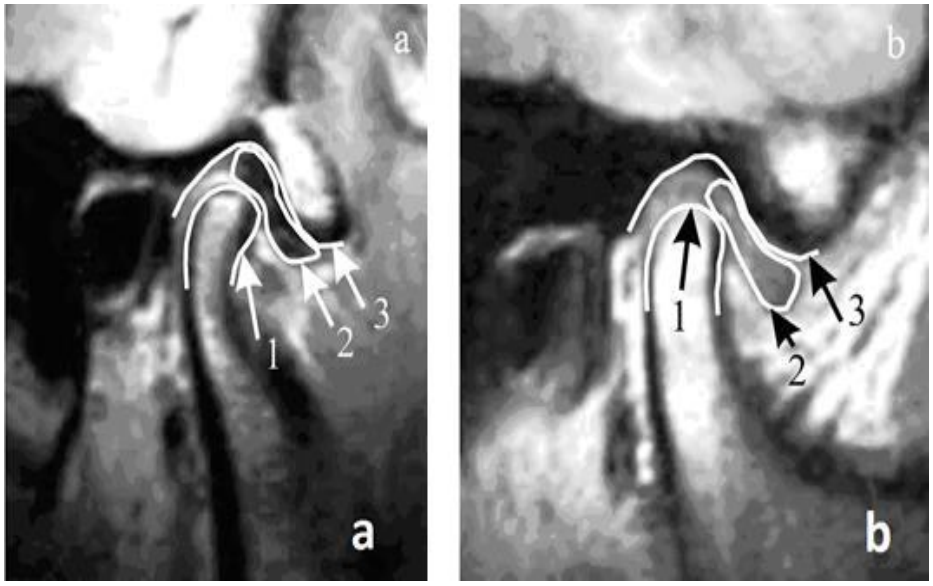


Figure (1-10) MRI image of the temporomandibular joint : (a) disk is in normal position; (b) anterior displacement of the disc (pathology) (1 is condyle; 2 is disk; 3 are glenoid fossa and tubercle of the temporal bone) **(V Nikitin,2016)**

While the Temporomandibular joint (TMJ) arthroscopy is a minimally invasive surgical approach for intra-articular TMJ diseases , it can be used for TMJ imaging . Office-based arthroscopy using the smallest TMJ scope allows for good visualization, as well as the ability to lavage the joint in an office setting **(Hossameldin *et al,*2018)** .

1.2.6 Treatment of Temporomandibular Disorders

The variations in types of treatment recommended by dentists have been explained by the gap between published information in the medical and dental literature and individual dentist's beliefs and attitudes **(Le Resche *et al,*1993).** Yet, because the different types of TMD treatment appear to have more or less equivalent efficacy, the treatment effect may be nonspecific and related more to the therapeutic relationship established between therapist and patient than to the specific attributes of the treatment **(Goodman *et al,*1976).**
Treatment is aimed towards symptomatic relief and not cures, since most of the conditions that affect the temporomandibular system are untreatable. It should be conservative and reversible , and if this failed, irreversible treatment such as surgery should be offered but only in extreme conditions **(Jerjes *et al,*2008).**

(G Dimitroulis,2018) puts a general skeleton for TMD management strategies :

1- **Education and self-care**

a. Soft diet

b. Jaw rest (especially during long dental appointments)

c. Avoid extreme jaw movements (i.e. yawning)

d. Topical heat (e.g. wheat packs)

e. Protect face and jaws from cold weather

f. Avoid stress and anxiety**(Dimitroulis,2018)**

2- Jaw physiotherapy

a. Massage and stretching

b. Dry needling

c. TENS – transcutaneous electrical nerve stimulation

d. Pulsed ultrasound therapy**(Dimitroulis,2018)**

3- Occlusal appliance therapy

4- Medications

a. Anti-inflammatories

b. Anxiolytics

c. Muscle relaxants

d. Antidepressants**(Dimitroulis,2018)**

5- Behavioral therapy

a. Lifestyle counseling

b. Relaxation therapy

c. Hypnosis

d. Biofeedback**(Dimitroulis,2018)**

6- Psychotherapy

7- Other

a. Acupuncture

b. Botox injections

c. Chiropractic manipulation**(Dimitroulis,2018)**

8- TMJ surgery

a. Closed procedures

i. TMJ arthrocentesis

ii. TMJ arthroscopy

b. Open procedures

i. TMJ arthrotomy / arthroplasty

ii. TMJ joint replacements. **(Dimitroulis,2018)**

2.1 Conclusions

According to the information gathered from previously cited studies ,this study concluded the following:

1- Temporomandibular disorder (TMD) is defined by the American Academy of Orofacial Pain as “a collective term which includes a number of clinical problems that involves the masticatory muscles, the temporomandibular joint (TMJ) and associated structures”.

2- Among the most common signs and symptoms in TMDs there is limiting of mouth opening because of pain, TMJ sounds, and asymmetrical jaw movements .

3- As TMD’s etiology is considered to be multifactorial, different treatment modalities are available, including occlusal equilibration, medication, and physical therapy. Physical therapies refer to several treatment options such as occlusal splints, low-level laser therapy, acupuncture, ultrasound, etc. The aim of physical therapies is to re-establish the muscle physiology by increasing the local blood and lymphatic flow **.**

4- With respect to the significant increase of sings and symptoms during specific period , stress is possibly capable of arising TMJ disorders. It can be concluded that considering psychological factors including stress is necessary during the examination of patients with TMJ disorders and dentists have an excellent social relationship with the patients in performing complete evaluation of the TMJ during their visits.

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