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The use of botilinium toxin in treatment of TMJ disorder

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of oral surgery in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled "....." was prepared by the fifth-year student ..... 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

Dedication

To our beloved families, who have always been our pillars of support and inspiration. our fathers and mothers, who have instilled in us the values of perseverance, dedication, and hard work, and who have never ceased to believe in us even in the face of the most difficult challenges. Without their unwavering love and guidance, we would not have been able to reach this milestone in our academic journey.

we also dedicate this research to the brave martyrs who have sacrificed their lives for the sake of our beloved country, Iraq. Their selflessness, courage, and sacrifice will always be remembered and honored, and their legacy will continue to inspire future generations to pursue peace, justice, and progress.

May this research serve as a small tribute to their memory and a humble contribution to the advancement of knowledge and the betterment of society

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Abbreviation	Meaning
TMDs	Temporomandibular disorders
BoNT	Botulinum toxin
TMJ	temporomandibular joint
DML	discomalleolar ligament
AML	anterior malleolar ligament
OPG	Orthopantomagram
(RDC/TMD)	Research Diagnostic Criteria for Temporomandibular Disorders

Chapter one
Review of Literature

1.1 Introduction :

Temporomandibular disorders (TMDs) are multi-factorial and polysymptomatic pathologies and their management must be customized for every patient. Numerous therapy techniques are available to treat temporomandibular disorders-related muscular discomfort and persistent orofacial pain. Botulinum toxin (BoNT) has emerged as a popular option for patients with myofascial TMD who do not completely recover from their condition after receiving conservative care and medication **(Al-Sabbagh, 2006).**

The temporomandibular joint (TMJ) is structured by the mandibular condyle inserted into the mandibular fossa of the temporal bone .Mastication muscles are primarily involved in the movement of this joint .Temporomandibular disorders (TMDs) have been described by the American Association for Dental Research (AADR) as 'a cluster of musculoskeletal and neuromuscular conditions that involve the TMJ, the masticatory muscles, and all associated tissues .In general, TMDs are divided into myofascial TMDs or arthrogenic TMDs. The myofascial temporomandibular disorder is associated with pain arising from hyperfunctioning muscles of mastication that leads myositis .In contrast, arthrogenic temporomandibular **(Jivraj & Chee, 2006)**.

Up to 25% of the population seeks professional care for TMD treatment, with the prevalence of TMDs ranging from 30 to 44 percent.They are thought to be the third most prevalent cause of chronic pain overall, behind headache and backache .and the most frequent cause of chronic pain in the orofacial region. TMDs have a complex etiology that involves biological, environmental, social, emotional, and cognitive causes. Other pain-related illnesses, such as fibromyalgia, immunological disorders, sleep apnea, and psychiatric illness are also regularly linked to TMDs (e.g., chronic headaches) .As a result, the degree of discomfort and dysfunction, as well as the course of symptoms, determines the necessity for treatment **(D'Addona et al., 2012)**.

2. Anatomy and Physiology of the TMJ

TMJ is a synovial, condylar and hinge-type joint. The joint involves fibrocartilaginous surfaces and an articular disc which divides the joint into two cavities. These superior and inferior articular cavities are lined by separate superior and inferior synovial membranes **(Dhir et al., 2013; Räisänen et al.,2000).**

2.1 Joint

2.1 1 Capsule - The capsule is a fibrous membrane that surrounds the joint and attaches to the articular eminence, the articular disc and the neck of the mandibular condyle **(Dhir et al., 2013; Räisänen et al., 2000).**

2.2.2 Articular disc - 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. The disc divides the joint into two sections, each with its own synovial membrane. The disc is also attached to the condyle medially and laterally by the collateral ligaments. The anterior disc attaches to the joint capsule and the superior head of the lateral pterygoid. The posterior portion attaches to the mandibular fossa and is referred to as the retrodiscal tissue **(Ivanovski & Lee, 2018)**.

2.3.3 Retrodiscal tissue - Unlike the disc itself, the retrodiscal tissue is vascular and highly innervated. As a result, the retrodiscal tissue is often a major contributor to the pain of Temporomandibular Disorder (TMD), particularly when there is inflammation or compression within the joint **(Ivanovski & Lee, 2018)**.

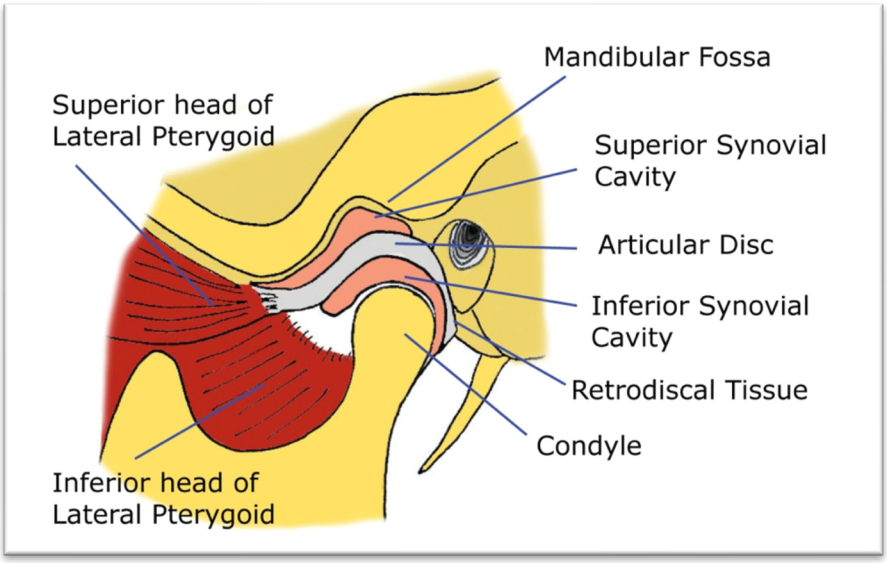

Fig.1 The Temporomandibular Joint(**Michael et al., 2011)**.

2.2 Ligaments

The ligaments give passive stability to the TMJ. **1.2.2.1 The temporomandibular ligament** is the thickened lateral portion of the capsule, and it has two parts, an outer oblique portion and an inner horizontal portion **(Michael et al., 2011)**.

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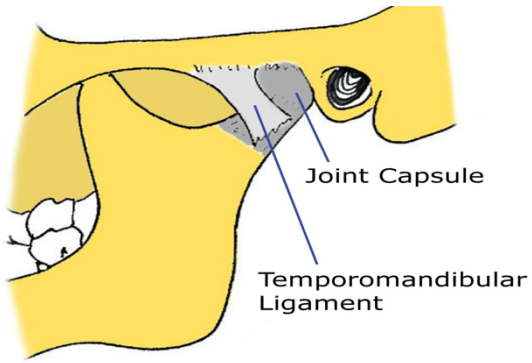

Fig.2 The Temporomandibular Ligament and Joint capsule (lateral view) **(Michael et al., 2011)**.

2.2.2 The stylomandibular ligament

runs from the styloid process to the angle of the mandible. **The sphenomandibular ligament** runs from the spine of the sphenoid bone to the lingula of mandible **(Michael et 2011)**.

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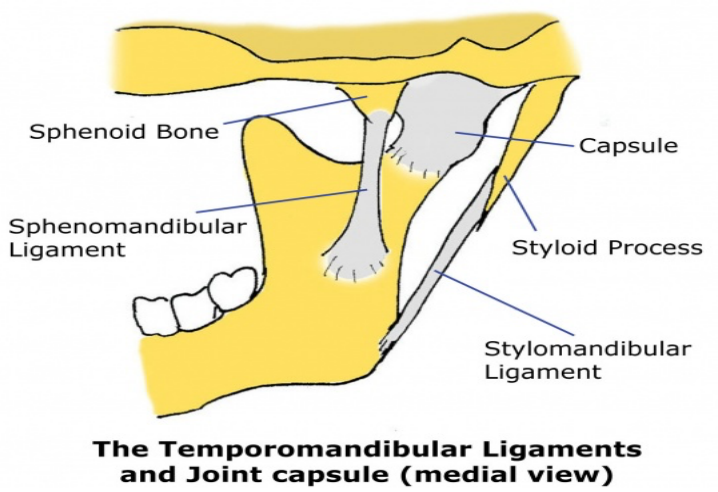

Fig.3 TheTemporomandibular Ligamentsand Joint capsule (medial view) **(Michael et al., 2011)**.

2.2.3 The oto-mandibular ligaments

are the **discomalleolar ligament** (DML), which arises from the malleus (one of the ossicles of the middle ear) and runs to the medial retrodiscal tissue of the TMJ, and the **anterior malleolar ligament** (AML), which arises from the malleus and connects with the lingula of the mandible via the sphenomandibular ligament The oto-mandibular ligaments may be implicated in tinnitus associated with TMD. A positive correlation has been found between tinnitus and ipsilateral TMJ disorder It has been proposed that a TMJ disorder may stretch the DML and AML, thereby affecting middle ear structure equilibrium. “It thus seems that otic symptoms (tinnitus, otalgia (ear pain), dizziness and hypoacusis) corresponding to altered ossicular spatial relationships (such as conductive

middle ear pathologies) can also be produced from masticatory system pathologies **(Michael et al., 2011)**.

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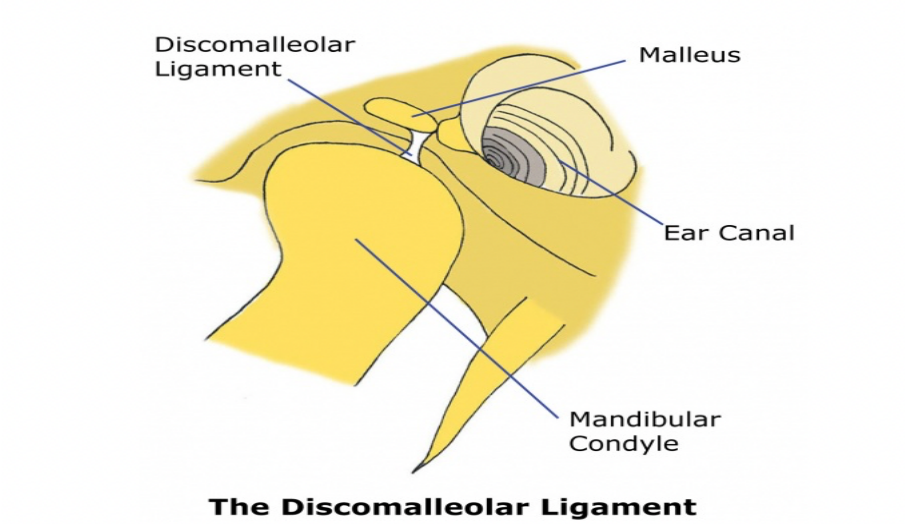

Fig.4 The Discomalleolar Ligament**(Michael et al., 2011)**.

2.3 Movements

A variety of movements occur at the TMJ. These movements are mandibular depression, elevation, lateral deviation (which occurs to both the right and left sides), retrusion and protrusion.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 **(Dijkgraaf, Milam, 2001)**

2.3.1 Hysiology of the Jaw-Opening Movement

Jaw opening is accomplished through the action of the suprahyoid muscles (rotation) and the lateral pterygoi muscles (translation). In centric condylar position the elastic fibers in the temporomandibular joint are in equilibrium The initial phase of an opening movement is primarily rotation that always progresses with a translational compo. (**Merlini and Palla 1988, Maeda et al. 1992, Ferrario e al. 1996**). The opening rotation of the condyle always causes the disk to lie against a more posterior region of the condyle where it is more stable. During translation the dis is passively carried along in an anterior direction **(Roth et al 1984, Osborn 1985**). During jaw opening. on increases in the superior stratum and in the lower for wall of the joint capsule. While the superior stratum restrict anterior movement of the disk, it cannot restrict jaw opening. This is limited by the t capsule and the lateral ligament. During jaw opening genu vasculosum expands to approximately four or fine es its original volume (**Rees 1954, Wilkinson et al 1994),** that during excursions a negative pressure arises within **(Finlay 1964, Ward et al. 1990).**

2.3.1.1 Jaw-opening movemen

2.3.1.1.1 Initial phase

Illustration of the structural loading during the initial opening movement. The condyle makes a rotational movement with a small translational component, changing its position relative to the fossa only slightly. Because of the condylar rotation, the disk moves posteriorly relative to the condyle. The only part of the lateral pterygoid muscle that is active is its lower head .The elastic fibers are brought out of equilibrium only minimally **(Dijkgraaf, Milam, 2001**).

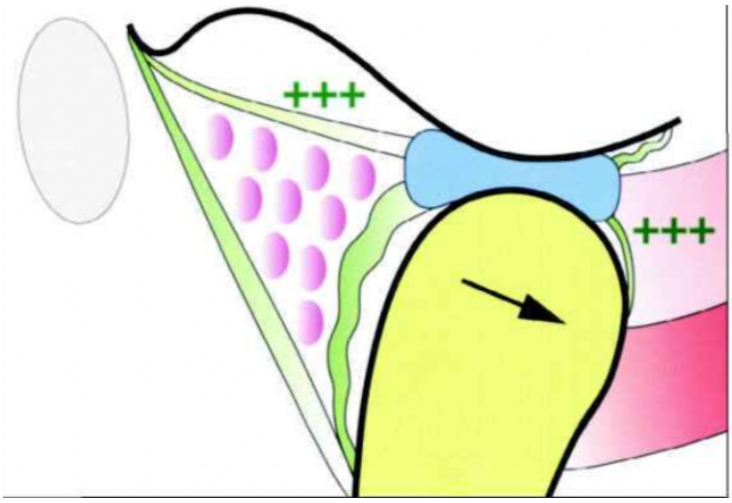

Fig.5 initial phase of jaw movement **(Axel and Ulrich, 2002)**

2.3.1.1.2 Intermediate phase

In this phase the condyle executes a definite translation. The disk moves anteriorly relative to the fossa, but posteriorly in relation to the condyle. Tension becomes steadily increased in the superior stratum of the bilaminar zone and in the lower anterior wall of the joint capsule.The inferior stratum relaxes to the same extent. The venous plexus of the genu vasculosum expands, creating a negative pressure, and fills with blood **(Dijkgraaf, Milam, 2001)**.

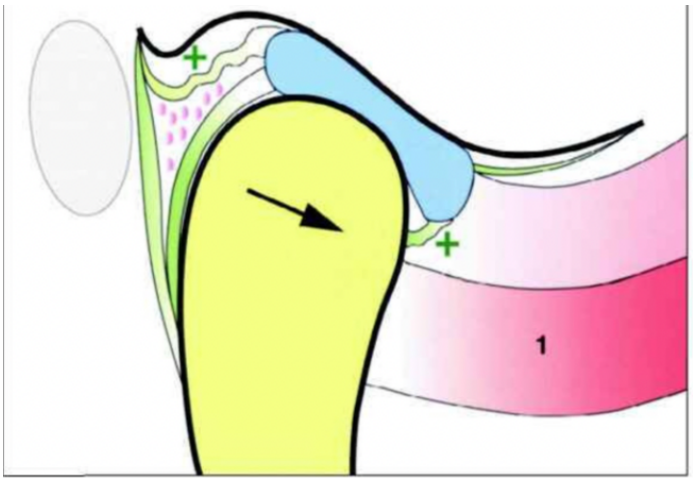

Fig.6 Intermediate phase of jaw movement **(Axel and Ulrich, 2002)**

2.3.1.1.3 Terminal phase

In this phase the condyle reaches the maximum extent of its rotation and translation. The translational component passively moves the disk farther forward, while the rotation makes it lie farther posteriorly on the condyle. The superior stratum and the lower anterior capsule wall are now stretched to their max-imum. The retrocondylar space is filled by the blood flowing into the genu vasculosum. The inferior stratum is completely relaxed.

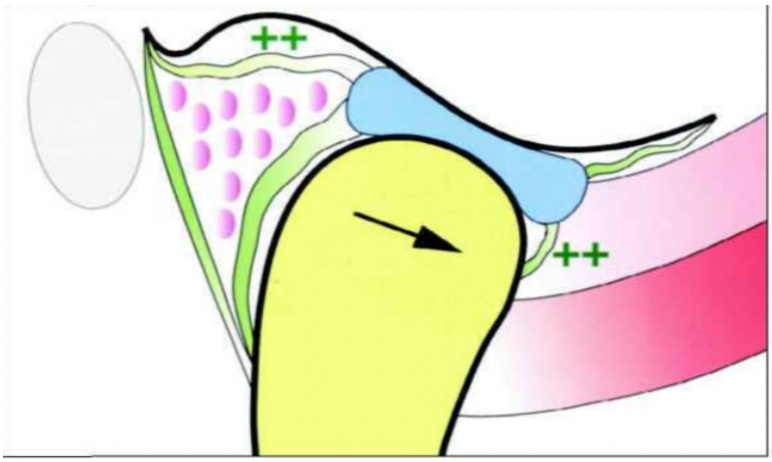

Fig.7 terminal phase of jaw movement **(Axel and Ulrich, 2002**

2.4 Musculature

Only the four large muscles that attach to the ramus of the mandible are considered the muscles of mastication; however, a total of 12 muscles actually influence mandibular motion, all of which are bilateral **(DuBrul, 1980)**. Muscle pairs may function together for symmetrical movements or unilaterally for asymmetrical movement. For example, contraction of both lateral pterygoid muscles results in protrusion and depression of the mandible without deviation, whereas contraction of one of the lateral pterygoid muscles results in protrusion and opening with deviation to the opposite side. Muscles influencing mandibular motion may be divided into two groups by anatomic position. Attaching primarily to the ramus and condylar

neck of the mandible is the supramandibular muscle group, consisting of the temporalis, masseter, medial pterygoid, and lateral pterygoid muscles. This group functions predominantly as the elevators of the mandible. The lateral pterygoid does have a depressor function as well **(Blackwood, 1979)**. Attaching to the body and symphyseal area of the mandible and to the hyoid bone is the inframandibular group, which functions as the depressors of the mandible. The inframandibular group includes the four suprahyoid muscles (digastric, geniohyoid, mylohyoid, and stylohyoid) and the four infrahyoid muscles (sternohyoid, omohyoid, sternothyroid, and thyrohyoid). The suprahyoid muscles attach to both the hyoid bone and the mandible and serve to depress the mandible when the hyoid bone is fixed in place. They also elevate the hyoid bone when the mandible is fixed in place. The infrahyoid muscles serve to fix the hyoid bone during depressive movements of the mandible**(Blackwood, 1979)**.

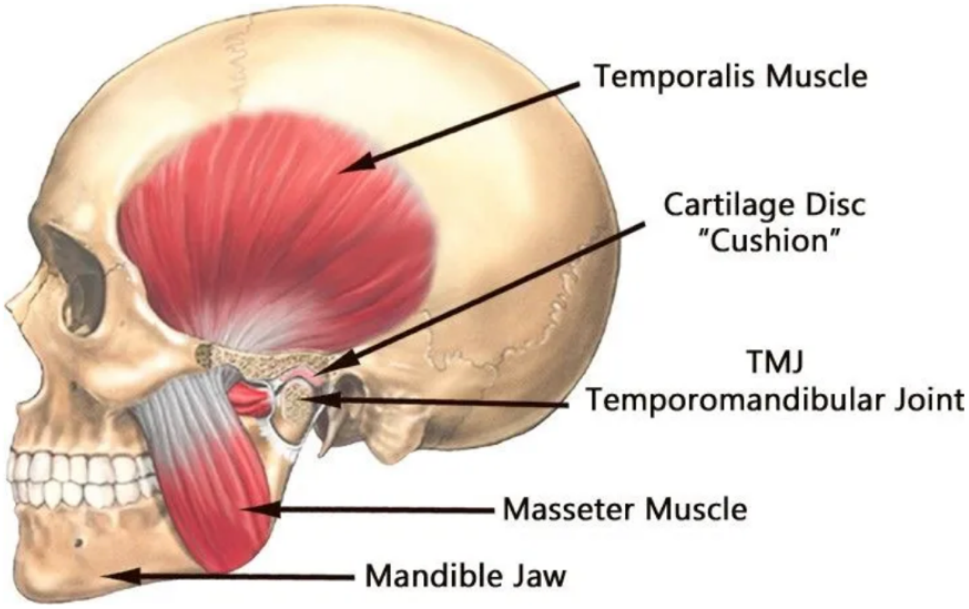

Fig.8 muscles of TMJ **Blackwood, 1979)**.

2.5 Vascular Supply and Innervation

The vascular supply of the TMJ arises primarily from branches of the superficial temporal and maxillary arteries posteriorly and the masseteric artery anteriorly. There is a rich plexus of veins in the posterior aspect of the joint associated with the retrodiscal tissues, which alternately fill and empty with protrusive and retrusive movements, respectively, of the condyle-disc complex and which also function in the production of synovial fluid. The nerve supply to the TMJ is predominantly from branches of the auriculotemporal nerve with anterior contributions from the masseteric nerve and the posterior deep temporal nerve **(DuBrul, 1980)**.

3.Temporomandibular Disorder (TMD)

Temporomandibular Disorder (TMD) is a broad term that encompasses disorders of the temporomandibular joint and its associated anatomical structures.The disorder may be intra-articular, due to inflammation, internal structural changes (internal derangement) or degeneration, or it may be extra- articular due to imbalance or over-activity of the jaw muscles, commonly the muscles of mastication or the cervical muscles. There is a strong correlation between postural dysfunction of the cervical spine and TMD. There are numerous other conditions that can cause pain in the TMJ region. It is important to make an accurate diagnosis to ensure that the correct treatment is given and that potentially serious problems are not overlooked **(Mujakperuo et al., 2010) .**

3.1 Causes of TMD

3.1.1 Intra-Articular Causes

3.1.1.1 Inflammatory conditions within the joint are often caused by direct trauma, such as a blow to the chin or jaw, indirect trauma, such as a whiplash injury, heavy chewing, grinding (bruxism), clenching of the jaw or loss of dental height due to worn down or missing teeth. **(Manfredini et al., 2011; Wright, 2010)**

Synovitis - The synovium or the capsule may be inflamed. There is often pain at rest and limited range of motion or pain at the end of range **(Manfredini et al., 2011; Wright, 2010)**

Retrodiscitis The retrodiscal tissue (the posterior attachment of the articular disc to the mandibular fossa) is highly vascular and innervated and if inflamed, can cause severe pain. The jaw may deviate away from the painful side at rest and with opening. **(Manfredini et al., 2011; Wright, 2010)**

3.1.1.2. Internal derangement describes conditions where there are structural changes within the joint. This can be caused by direct trauma, such as a blow to the jaw or falling on the chin, indirect trauma, such as a whiplash injury, long term clenching or grinding, heavy or hard chewing or prolonged periods of mouth opening, such as a dental procedure or a general anaesthetic **(Manfredini et al., 2011; Wright, 2010)**

-**Disc displacement with reduction** The articular disc can become displaced in any direction, but will most commonly displace anteriorly. The disc will be pushed forward during opening and will bunch up. At a certain point in range the disc will reposition or reduce itself causing an audible or palpable click. The jaw will often deviate towards the affected side. **Neville et al., 2002)**

-Disc displacement without reduction In this more severe version the disc will not reduce causing pain and a loss of range. This is called closed lock. The jaw will often deviate towards the affected side. There will be no click but the patient may report that there was a click at the time when their jaw locked. **Neville et al., 2002)**

3. 1.1. 3 Arthritis

Degenerative Arthritis can occur in the TMJ. It can often be seen on plain x-ray or Orthopantomagram (OPG) as a flattening of the condylar head, often with some osteophytic formation MRI gives more information with views done in open and closed positions. This shows the position of the joint and disc at the start and end of range. Crepitus can often be felt or can be heard with a stethoscope. It can be age related degeneration, usually seen in the over 50s, or secondary to trauma occurring at a younger age **(Anderson et al., 2010).** Inflammatory Joint Diseases can affect the TMJ, including rheumatoid arthritis, ankylosing spondylitis, infectious arthritis, Reiter's syndrome .

3.1.1.4. Hyper mobility

It can result in excessive anterior movement of the jaw and the articular disc. This will result in deviation of the jaw away from the affected side. There are usually some clicking sounds in the TMJ and there may or may not be pain. Hyper mobility may be related to connective tissue disorders such as Marfan syndrome or conditions such as Down Syndrome and Cerebral Palsy. Long term hyper mobility can cause the articular disc to elongate and degenerate **(Anderson et al., 2010).** The disc can then fail to reduce on closing, causing the TMJ to become stuck in an open position (Open Lock). This can often occur after opening the mouth to an extreme position, such as when singing or yawning or after a prolonged dental procedure **(Wassell et al., 2008).**

3.1.2 Extra-Articular Causes

3.1.2.1 Muscle Spasm can cause significant pain and limitation of movement of the jaw. This is referred to as trismus. It often affects one or more muscles, commonly the muscles of mastication, especially masseter, temporalis and the pterygoid muscles. Causes include

prolonged dental procedures or anaesthetics where the mouth has been held open for extended periods of time, stress, bruxism and postural dysfunction. **(Nitzan et al., 2004)**.

3.1.2.2 Cervical Postural Disorders can cause jaw pain. The anterior belly of the digastric muscle runs from the point of the chin to hyoid bone. This attachment means that when the head is protracted forward digastric will exert a posterior force on the mandible. With prolonged cervical protraction as occurs with poor posture or stress-related posture the mandibular condyle is pushed back against the retrodiscal tissue, eventually causing swelling, pain and gradual degeneration of the disc. **(Nitzan et al., 2004)**.

3.1.2.3. Temporal Tendinopathy is caused by excessive contraction of the temporalis muscle usually as a result of bruxism. There is tenderness and swelling of the anterior portion of the temporalis tendon palpable just above the zygomatic arch. There may also be tenderness of the temporalis tendon where it inserts onto the coronoid process, palpable just below the zygomatic arch when the jaw is slightly open. **(Emshoff and Rudisch, 2007)**.

3.1.2.4. Fractures of the mandible often occur at the mandibular symphysis or the condylar neck. Commonly there will be a fracture of the mandibular symphysis combined with a fracture/dislocation of one or both condyles. The mechanism of injury can be a blow to the jaw or a fall onto the chin. Treatment can usually begin within a week or two of surgery to begin early mobilisation of the TMJ and to restore function. **(Emshoff and Rudisch, 2007)**.

3.2 diagnosis

The diagnosis of TMD is based largely on history and physical examination findings. The symptoms of TMD are often associated with jaw movement (e.g., opening and closing the mouth, chewing) and pain in the preauricular, masseter, or temple region. Another source of orofacial pain should be suspected if pain is not affected by jaw movement. Adventitious sounds of the jaw (e.g., clicking, popping, grating, crepitus) may occur with TMD, but also

occur in up to 50% of asymptomatic patients **(Stohler, 2007).** A large retrospective study (n = 4,528) conducted by a single examiner over 25 years noted that the most common presenting signs and symptoms were facial pain (96%), ear discomfort (82%), headache (79%), and jaw discomfort or dysfunction (75%). Other symptoms may include dizziness or neck, eye, arm, or back pain. Chronic TMD is defined by pain of more than three months' duration **(Kubota et al., 2009).** 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 **(Zarb et al., 2003).**

Table.1 Common diagnoses of temporomandibular disorders (TMD) and their clinical findings **(Schiffman et al., 2014).**

Painful Conditions	**Clinical Findings**
Myalgia	Familiar pain in the masseter or temporalis upon palpation or mouth opening
Local Myalgia	Familiar pain in the masseter or temporalis localized to the site of palpation
Myofascial pain	Pain in the masseter or temporalis spreading beyond the site of palpation but within the confines of the muscle
Myofascial pain with referral	Pain in the masseter or temporalis beyond the confines of the muscle being palpated
Arthralgia	Familiar pain in the TMJ upon palpation or during function
Headache attributed to TMD	Headache in the temple upon palpation of the temporalis muscle or during function
Non-Painful Conditions	**Clinical Findings**
Disc displacement with reduction	Clicking in the TMJ upon function
Disc displacement with reduction with intermittent locking	Clicking in the TMJ with reported episodes of limited mouth opening
Disc displacement without reduction with limited opening	Limited mouth opening affecting function, with maximum assisted opening < 40mm
Disc displacement without reduction without limited opening	Limited mouth opening affecting function, with maximum assisted opening of ≥ 40mm
Degenerative joint disease	Crepitus of the TMJ upon function
Subluxation	History of jaw locking in an open mouth position, cannot close without a self-maneuver

3.2.1.RDC/TMD criteria

The DC/TMD may include the following :

Pain-related TMD and headache (Kubota et al., 2006).

- Local myalgia (per subject)
- Myofascial pain with referral (per subject)
- Myalgia (local myalgia and myofascial pain with referral; per subject)
- Arthralgia (per joint)
- Headache attributed to TMD (per subject)

Intra-articular joint disorders and Degenerative joint disorder (Kubota et al., 2006)

- Disc displacement with reduction (per joint)
- Disc displacement with reduction with intermittent locking (per joint)
- Disc displacement without reduction (per joint)
- Disc displacement without reduction without limited opening (per joint)
- Degenerative joint disease (per joint)

4.Internal Derangement of the Temporomandibular Joint

Internal derangement of a synovial joint is not a disease. The biomechanical joint dysfunction that is associated with internal derangement represents a failure of the intra-articular tissues caused by the loss of the structure and function. Identifying the cause of the breakdown of the tissues within a synovial joint that leads to internal derangement is an important component of suc- cessful treatment. **(Okeson, 1998; Rayne, 2008)**

4.1.Clinical Stages

Anatomical, epidemiological and clinical studies have shed some light upon the ultimate fate of the displaced disc **(Kaplan, 1991)**. Traditionally, internal derangement of the TMJ has been described as a progressive disorder with a natural history that may be classified into four consecutive clinical stages **(Dolwick et al., 1983; Kaplan, 1991; Heffez, 2009)**: stage one has been described as disc displacement with reduction (ability of the disc to assume a normal position in relation to the condyle during mouth opening), stage two as disc displacement with reduction and intermittent locking, stage three as disc displacement without reduction(closed lock) in which mandibular condyle fail to pass over the posterior band of the articular disc, and

stage four as disc displacement without reduction and with perforation of the disc or posterior attachment tissue (degenerative joint disease).

4.1.1.Stage One

Stage one is characterized clinically by reciprocal clicking ,occurring both during mouth opening and during mouth closing, as a result of anterior disc displacement with reduction. It has been stated that the later the opening click occurs, the more advanced the disc displacement **(Stohler, 2001)**.

The clinical hallmark of disc displacement with reduction is limited mouth opening, usually accompanied by deviation of the mandible to the involved side, until a pop or click (reduction) occurs. After the pop, the patient is able to open the mouth fully with a midline position of the mandible. Arthrographic show anterior disc displacement in centric occlusion, but the disc is normally located in the open-mouth position **(Fig. 9)**

4.1.2.Stage Two

Stage two features all the aforementioned characteristics, plus additional episodes of limited mouth opening, which can last for various lengths of time. The obstruction may disappear spontaneously. Arthrographically, stage two is similar to stage one.

4.1.3.Stage Three

Closed lock (disc displacement without reduction) occurs when clicking noises disappear but limited opening persists. The patient complains of TMJ pain and chronic limited opening, with the opening usually less than 30 mm. Examination will reveal preauricular tenderness and deviation of the mandible to the affected side with mouth opening and protrusive movements. TMJ pain may accompany border movement. Arthrographic examination and magnetic resonance imaging show anterior disc displacement in both centric occlusion and maximal mouth open positions. Limited condylar translation may also be evident. In chronic closed lock episodes, if the condition progresses, the condyle may steadily push the disc forward to achieve almost normal ranges of mouth opening, in spite of the presence of a non-reducing disc.

The anchored disc phenomenon, or acute disc displacement without reduction, is characterized by a sudden, severe and persistent limited mouth opening that is considerably more decreased than disc displacement without reduction (10-30mm). Since the disc is not anatomically displaced, the highly innervated retrodiscal tissue is not compressed, and pain is only experienced when the patient attempts forced mouth opening. Research has suggested that a suction-cup effect occurs, in which the disc is adherent to the articular eminence due to a

vacuum effect in the joint space, and well as the presence of increased joint viscosity and decreased synovial fluid volume **(Kubota et al., 2008)**.

4.1.4.Stage Four

With continued mandibular function, the stretched posterior attachment slowly loses its elasticity, and the patient begins to regain some of the lost range of motion. As retrodiscal tissue continues to be stretched and loaded, it becomes subject to thinning and perforation. Joint crepitus suggested to be but not pathognomic of disc perforation.

Although often classified as characteristic of a separate final stage, hard tissue remodelling probably occurs throughout all stages. Clinically, osteoarthrosis may be diagnosed because the remodelling often occurs unilaterally, the symptoms appear to worsen as the day goes on, crepitation as distinct from clicking is often present and radiographic evidence is frequent (e.g., flattening, sclerosis, osteophytes, erosion) **(Zarb et al., 2006)**.

The general term "degenerative joint disease" refers to arthritis (both osteoarthritis and rheumatoid arthritis) and arthrosis. In the specialized literature that has evolved around TMD research, arthrosis is differentiated from arthritis by the presence of low and no inflammation respectively. Both are however

equally degenerative. Over time, either with normal use or with parafunctional use of the joint, wear and degeneration can occur, termed osteoarthritis ***(*Cairns, 2010*)***. Suggesting that impaired joint lubrication may be involved in the pathogenesis of inflammatory-degenerative changes **(Nitzan et al., 2004)**. Rheumatoid arthritis, an autoimmune joint disease, can also affect the TMJs. Degenerative joint diseases may lead to defects in the shape of the tissues of the joint, limitation of function, and joint pain ***(*Cairns, 2010*)***.

5.Arthrocentesis

Arthrocentesis, also known as joint aspiration, is a medical procedure in which a needle is inserted into a joint space to remove fluid for diagnostic or therapeutic purposes. The joint can be any joint in the body, including the knee, hip, shoulder, or wrist. Arthrocentesis is usually performed to relieve pain, swelling, or stiffness in the joint caused by an excess buildup of fluid. It can also be done to diagnose the cause of joint inflammation or infection, such as gout, septic arthritis, or rheumatoid arthritis. During the procedure, the area around the joint is cleaned with antiseptic solution, and a local anesthetic may be used to numb the area. A sterile needle is then inserted into the joint space and the fluid is withdrawn using a syringe. The fluid

is then sent to a laboratory for analysis, which can help diagnose the underlying cause of the joint problem. Arthrocentesis is generally a safe and minimally invasive procedure, but it can carry some risks, such as infection, bleeding, or damage to nearby nerves or blood vessels. Therefore, it is important to discuss the risks and benefits of the procedure with your healthcare provider before undergoing it **(Nitzan et al., 2004)**. Arthrocentesis and TMJ arthroscopy have been found to be minimally invasive effective treatments for articular TMD by decreasing pain and increasing mandibular range of motion. The term temporomandibular joint arthrocentesis defines the lavage of the upper joint compartment by the use of saline solution, using needles for the inflow and the outflow **(Nitzan et al., 2002)**. The under pressure flow of a liquid through the joint should allow by itself the removal of the catabolytes, the distension of the joint with breakages of some adherences, and the mobilization of the disc **(Emshoff and Rudisch, 2007)**.

5.1. common classifications of arthrocentesis:

5.1.1 Diagnostic arthrocentesis: This is a procedure in which fluid is withdrawn from a joint to diagnose the underlying cause of joint inflammation or infection. The fluid is sent to a laboratory for analysis, which can help identify the type of arthritis, infection, or other joint condition.

5.1.2 Therapeutic arthrocentesis: This is a procedure in which fluid is withdrawn from a joint to relieve pain, swelling, or stiffness. The removal of the excess fluid can help improve joint mobility and reduce discomfort (**Guarda-Nardini et al., 2007)**

5.1.3 Prophylactic arthrocentesis: This is a preventive procedure in which fluid is withdrawn from a joint to prevent the development of joint infections or to reduce the risk of joint damage **(Ziccardi, 2009)**

5.1.4 Site-specific arthrocentesis: This is a procedure in which a specific joint is aspirated, such as knee arthrocentesis, hip arthrocentesis, shoulder arthrocentesis, or wrist arthrocentesis **(Sharma et al., 2013)**

5.1.5 Fluid-specific arthrocentesis: This is a procedure in which a specific type of fluid is aspirated from a joint, such as synovial fluid, blood, or pus.

The classification of arthrocentesis may vary depending on the medical setting and the specific needs of the patient. Your healthcare provider can recommend the most appropriate classification of arthrocentesis for your individual case **(Guarda-Nardini et al., 2007) .**

6.botilinium toxin

(BTX) is a biologic agent manufactured in a laboratory in the form of a crys- talline stable substance, freeze-dried in human albumin, and supplied in a sterile, vacuum-dried vial to be reconstituted in a saline solution. It is naturally produced by *Clostridium botulinum*, a gram-positive anaerobic bacterium that produces several distinct serotypes of BTX (Box 1-1).[1–3] In terms of cosmeceutical therapy, type A is the only one that shows a clinically important biologic activity, and hence it is the most often studied and used serotype of BTX.[4] Type B is also commer- cially available to treat cervical dystonia and for patients resistant to BTX-A,[5–8] but it is generally associated with a higher incidence of pain when injected and a short-lasting effect, although it has a faster onset than type A[9–13]. Botulinum toxin (BTX) has been widely used in the management of Temporomandibular Disorders (TMD) due to its analgesic and relaxing abilities, and its relatively fast disposal of poor compliance. In this systematic review, we aim to discuss the effectiveness of BTX in the management of TMD, including its effect on pain, maximum mouth opening, and adverse effects. A systematic electronic database search was conducted in seven databases for relevant studies published prior to 7 July 2020. Generally, pain relief improved over time in most of the included studies. Both slight and significant improvements in mouth opening following BTX injection were observed. No serious adverse effects or complications were reported by the included studies. Adverse effects reported were headaches, weakness, increased pain, flu-like symptoms, chewing discomfort, and unilateral paralysis of the zygomaticus major muscle. However, adverse effects caused by BTX local infusion may be dose dependant, and this aspect should be considered in future investigations. This study demonstrates that it is difficult to determine the effect of BTX on TMD patients, and it is essential that more research is conducted in this field with proper populations and fewer limitations. However, we can conclude that the administration of BTX is almost free of severe complications and may only cause minimal adverse effects. **(Sharma et al., 2013).**

.6.1 General Indications for BTX

BTX (Botulinum toxin) is a neurotoxin protein that comes in two types, type A and type B. Here are some general indications for BTX: **(Kubota et al., 2006)**.

1-Muscle Spasms: BTX is often used to treat muscle spasms and contractions caused by conditions such as cerebral palsy, multiple sclerosis, and spinal cord injuries.

2-Migraines: BTX injections can help reduce the frequency and severity of chronic migraines.

3-Hyperhidrosis: BTX can be used to treat excessive sweating, a condition called hyperhidrosis.

4-Strabismus: BTX can help correct eye muscle imbalances that cause crossed or misaligned eyes (strabismus).

5-Blepharospasm: BTX can be used to treat uncontrollable eye twitching (blepharospasm) or spasms of the eyelids.

6-Cervical Dystonia: BTX can help reduce the muscle spasms and neck pain associated with cervical dystonia.

7-Movement Disorders: BTX can be used to treat movement disorders such as tremors and tics.

8-Spasticity: BTX can help reduce spasticity in muscles after stroke, traumatic brain injury, or spinal cord injury.

9-Overactive Bladder: BTX can be used to treat overactive bladder by relaxing the muscles of the bladder.

It is important to note that BTX should only be administered by a trained medical professional and in appropriate doses for each indication.

6.2 Mechanism of Action of BTX

BTX-A should be injected in the muscle so that it disperses and diffuses to cholinergic nerve endings, where its mechanism of action takes place. BTX essentially breaks down fusion proteins (synaptosomal-associated protein 25 [SNAP-25]) responsible for the release of the neurotransmit- ter acetylcholine (ACh), thereby inhibiting muscle contraction in the fibers that receive the BTX injection**(Nitzan et al., 2002)**.

Once injected, BTX dissociates from the accessory proteins through the action of proteases. Immediately afterward, it is irreversibly bound to high-affinity specific receptors in the neuromus- cular junction (NMJ). This is phase 1: binding.Once the BTX molecule is bound to the receptor at the nerve cell membrane surface, the heavy chain allows the toxin to enter the cell through a membrane invagination, resulting in the forma- tion of a vesicle that will surround the two chains of BTX. This process takes 20 minutes and is called *receptor-mediated endocytosis*. This is phase 2: internalization.

The light chain is then separated from the heavy chain by the dissociation of disulfide bridges through the action of proteases. Under an acidification condition, it is released from the vesicle to the neuronal cytoplasm. Once at the cytosol, the light chain performs its metalloproteinase activity at the intracellular targets that regulate the exocytosis of ACh vesicles. Such targets are part of the SNARE complex (soluble N-ethylmaleimide-sensitive factor attachment receptor) responsible for the binding and coupling of ACh vesicles. This complex is formed by the fusion of three proteins: SNAP-25, VAMP (vesicle-associated membrane protein), and syntaxin 1a **(Guarda-Nardini et al., 2007)**.

The light chain of BTX-A, through a zinc-dependent endopeptidase and under an acidic pH, cleaves SNAP-25. (VAMP is cleaved by BTX-B, -D, and -F, and syntaxin 1a is cleaved by BTX-C.) This cleavage prevents the release of the neurotransmitter ACh. This is phase 3: blockage or pro- teolytic cleavage.

By inhibiting release of ACh from synaptic vesicles, BTX chemically denervates muscles and glands; this process is known as *chemodenervation*. This mechanism is specific to BTX-A and has wide clinical applications, including the modulation of muscle contraction, whose effect is clini- cally observed for 3 to 4 months. It may also be used to reduce hyperhidrosis for up to 12 months and excessive salivation for up to 6 months **(Guarda-Nardini et al., 200**

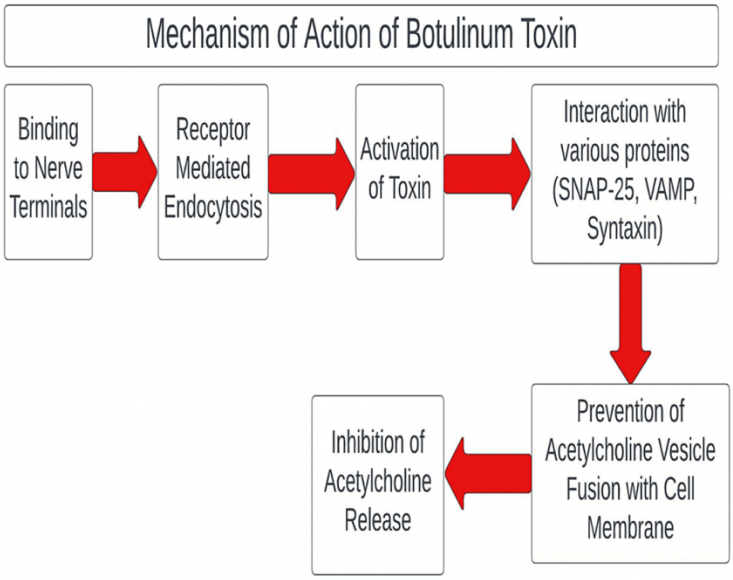

Fig.9 : Mechanism of action of botulinum toxin . **(Nitzan et al., 2004)**

6.3 Characteristics of BTX (Stohler, 2007)

ABTX-A (Botulinum Toxin Type A) is a neurotoxic protein produced by the bacterium Clostridium botulinum. It is used medically in very small doses to temporarily paralyze or weaken specific muscles by blocking nerve signals to them. Here are some of the characteristics of BTX-A:

1-Potency: BTX-A is a highly potent neurotoxin, which means that it can cause paralysis or weakness in very small amounts.

2-Mechanism of action: BTX-A works by blocking the release of a neurotransmitter called acetylcholine, which is responsible for triggering muscle contractions.

3-Duration of action: The effects of BTX-A can last for several months, but the exact duration varies depending on the individual and the specific area being treated.

4-Specificity: BTX-A is very specific in its action, meaning that it only affects the muscles that it is injected into, leaving surrounding muscles unaffected.

5-Safety: BTX-A is generally considered safe when used in appropriate doses by a qualified medical professional. However, there are potential risks and side effects associated with its use, such as muscle weakness, pain, and allergic reactions.

6-Medical applications: BTX-A is commonly used in cosmetic treatments to reduce wrinkles and fine lines, as well as in medical treatments for conditions such as muscle spasms, migraines, and excessive sweating.

6.4 the use of BTX in the treatment of TMD

Kim et al29 point out that successful TMD treatment starts from correctly differentiating the origin of symptoms. Because myofascial pain and limited mouth opening are the most frequent symptoms of masticatory muscle disorders, directing treatment at the muscular components of TMD could yield therapeutic gains.31 Therefore, noninvasive conservative treatments such as counseling, a soft diet, behavioral medicine, physiotherapy, oral appliances, pharmacotherapy, and BTX injections are reported to be effective as first-line therapies for extra-articular pathologic conditions. ***(*Cairns, 2010)**

Intra-articular pathologic conditions such as internal derangement and osteoarthritis could also benefit from the reversible interventions used to treat myofascial pain. Patients with acute pain, however, may require intra-articular injection of lidocaine, hyaluronic acid, or even a cortico-steroid.33 When the symptoms and pain surpass the effectiveness of these techniques, surgical approaches such as arthrocentesis, arthroscopy, and arthroplasty may be performed to treat ana- tomical pathology. **(Kubota et al., 2008)**.

After the introduction of commercial brands of BTX-A (Botox, Dysport [Ipsen]), its injection therapy on orofacial muscles became a valuable adjunct in managing myofascial components of TMD. Supporting literature dates back three decades, with successes reported in various therapeutic applications since the 1980s. While clinical injection of BTX-A in the masticatory musculature of TMD patients can be considered a useful supportive treatment option for con-trolling complex TMD and alleviating its associated symptoms, more randomized controlled stud- ies with larger sample sizes and longer follow-up periods are necessary in order to scrutinize and evaluate the full effects of BTX-A injections. **(Kubota et al., 2008)**.

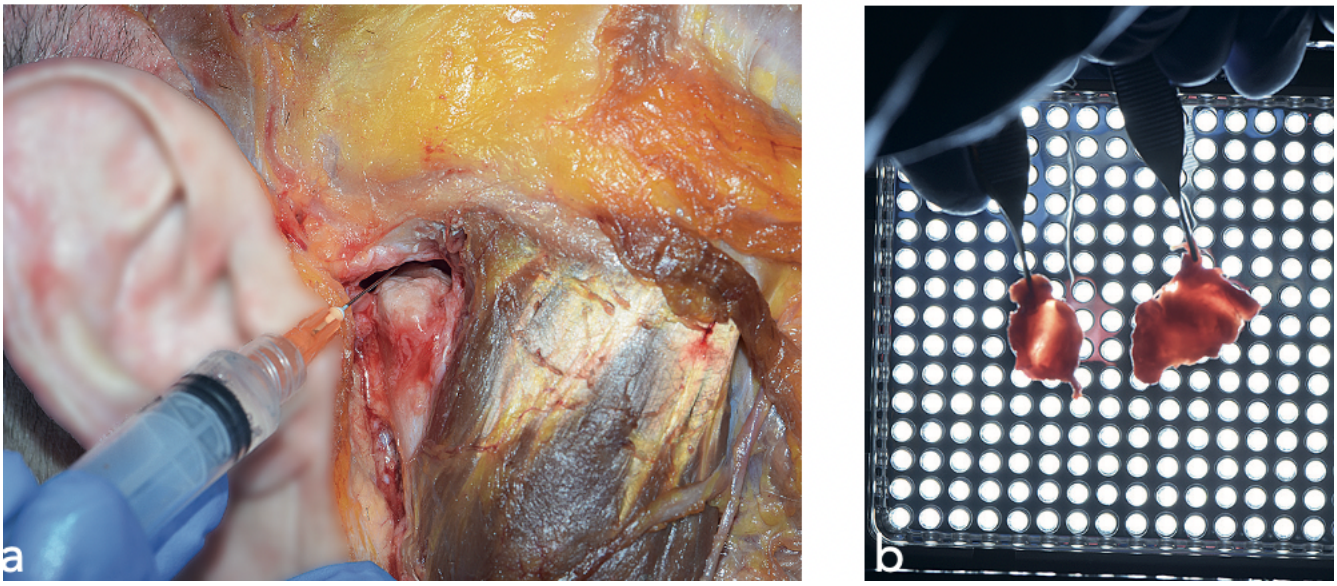

Fig 10 . *(a)* Cadaver showing TMJ after synovium aspiration. *(b)* The artic- ular disc on the left belonged to a cadaver whose teeth were worn out by attrition. The disc on the right was from a patient with preserved teeth. . ***(*Cairns, 2010)**

6.5 limitation of the use of BTX in the treatment of TMD

While botulinum toxin type A (BTX-A) can be effective in the treatment of muscular temporomandibular joint disorders (TMD), there are several limitations to its use. These limitations include.

1-Short-term Relief: The effects of BTX-A typically last for 3-6 months, after which the treatment may need to be repeated. This means that patients may need to receive multiple injections over time to maintain the benefits of the treatment.

2-Limited Evidence: While there is some evidence to support the use of BTX-A in the treatment of TMD, the quality of the evidence is generally low. Most studies have been small and have not compared BTX-A to a placebo or alternative treatments.

3-Risk of Adverse Effects: BTX-A can cause muscle weakness and other adverse effects in some patients, particularly when injected into the wrong muscle or in excessive doses.

Additionally, there is a risk of developing antibodies to BTX-A, which can reduce its effectiveness over time.

4-Cost: BTX-A injections can be expensive, and many insurance plans do not cover the cost of the treatment. This can make the treatment inaccessible to some patients.

5-Limited Applicability: BTX-A may not be effective for all patients with TMD. Patients with structural abnormalities or other underlying medical conditions may not benefit from the treatment.

6.6 technique for the use of BTX-A in the treatment of muscular TMD:

1-Patient evaluation: The first step is to evaluate the patient to determine if they are a good candidate for BTX-A treatment. This may involve a thorough medical history, physical examination, and imaging studies.

2-Injection Site Selection: The next step is to identify the specific muscles that are causing the patient's TMD symptoms. This may involve palpation of the jaw muscles or imaging studies such as ultrasound.

3-Injection Preparation: Once the injection sites have been identified, the BTX-A is prepared for injection. This may involve reconstituting the toxin with saline and preparing the syringe and needle.

4-Injection Technique: The injection technique may vary depending on the specific muscles being targeted. However, in general, the needle is inserted into the muscle belly and the toxin is injected slowly.

5-Post-Injection Care: After the injection, the patient may be instructed to avoid strenuous activity or jaw movement for a period of time. The patient may also be given pain medication or anti-inflammatory drugs to manage any discomfort.

6.7 Local Anatomy for Safe Injection

The maxillary artery, the larger terminal branch of the external carotid artery, arises behind the neck of the mandible and is initially embedded in the parotid gland. The maxillary artery passes lateral to the inferior head of the lateral pterygoid muscle or medial to the muscle .

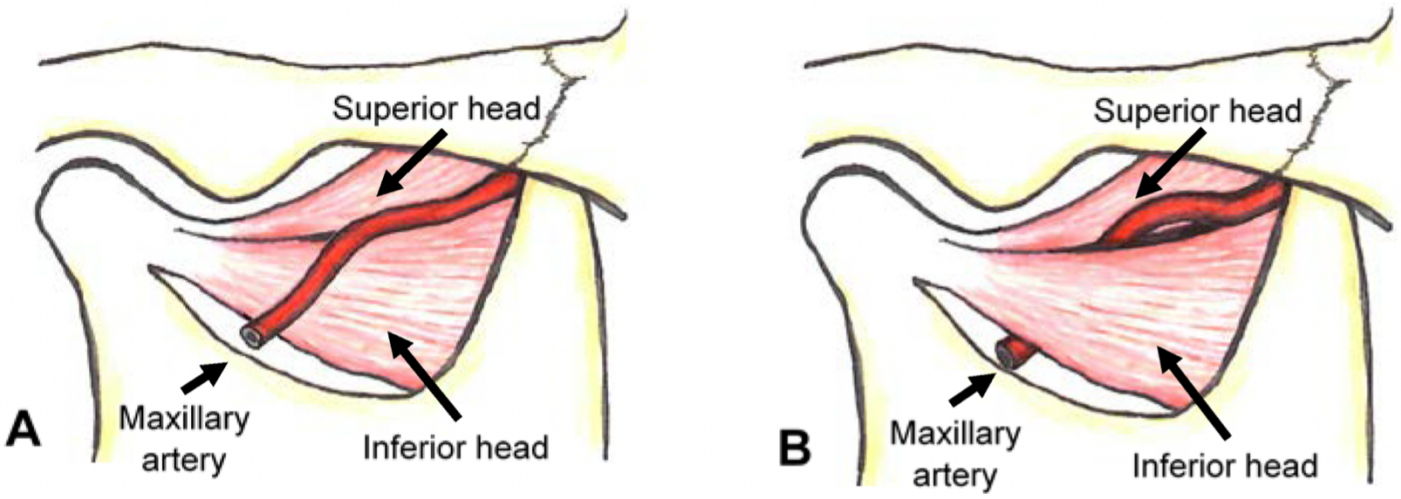

Figure 9. The lateral and medial courses of the maxillary artery to the lateral pterygoid muscle. The two main courses of the maxillary artery are lateral (**A**) and medial (**B**). In the lateral course, the maxillary artery passes lateral to the inferior head of the lateral pterygoid muscle (**A**). In the medial course, the artery passes medial to the muscle (**B**).

6.8. Injection Methods into the Lateral Pterygoid Muscle

The inferior head of the lateral pterygoid muscle can be accessed via intraoral and extraoral transcutaneous routes Various methods used for inserting electromyographic electrodes into the inferior and superior heads of the lateral pterygoid muscle have been reported However, the intraoral approach is preferable for several reasons .First, this approach leads to less patient anxiety as it is similar to the approach employed during routine intraoral injections in dental treatment. Second, it reduces the risk of damage to the maxillary artery, and third, during the extraoral preauricular transcutaneous approach, the needle electrode could be bent or broken if the patient bites down forcefully.

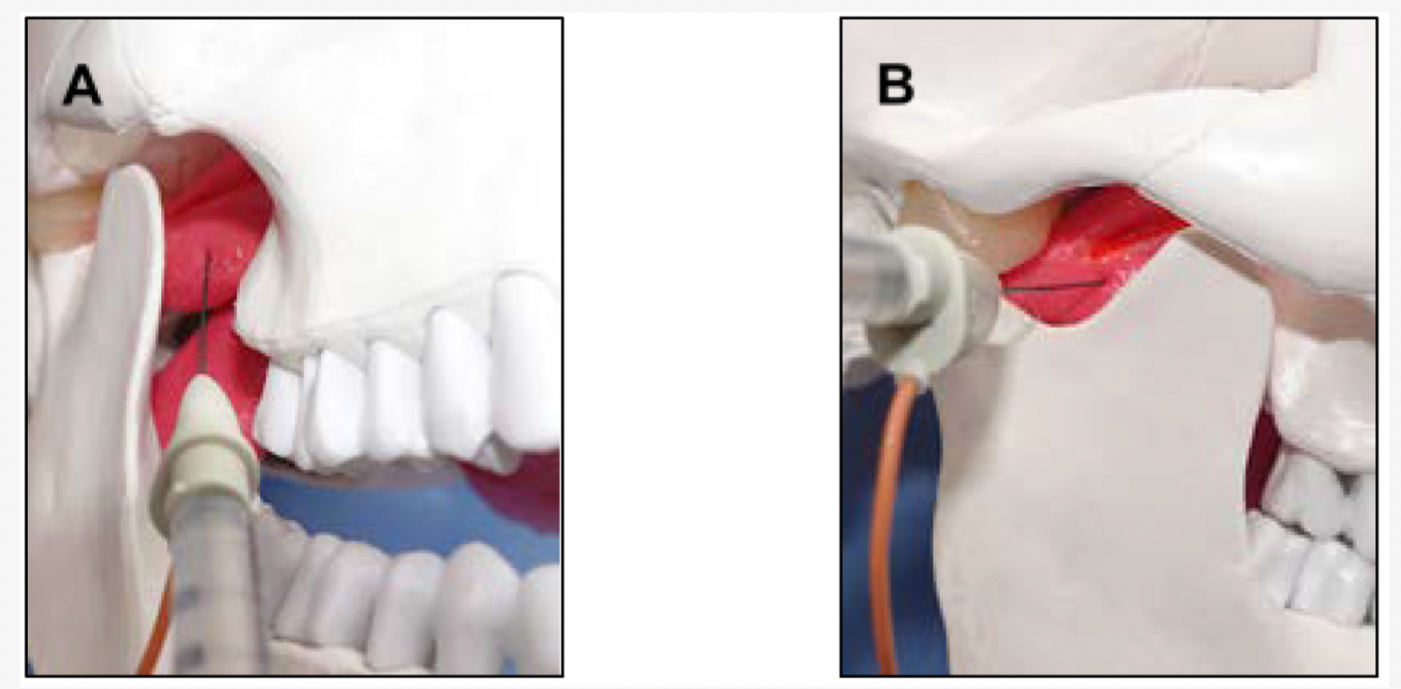

Figure 10. The intraoral (**A**) and extraoral (**B**) approaches for lateral pterygoid muscle injection.

Conclusion

the use of Botulinum toxin (BTX) in the treatment of temporomandibular joint (TMJ) disorder is a promising therapy that has shown positive results in reducing pain and muscle tension in patients with TMJ disorders. The main mechanism of BTX action is the inhibition of acetylcholine release at the neuromuscular junction, resulting in muscle relaxation and reduced pain.Several studies have shown that BTX injections can effectively reduce pain and muscle tension associated with TMJ disorders. BTX has also been shown to improve the quality of life of patients with TMJ disorders by reducing pain, improving jaw mobility, and decreasing the need for pain medication.However, it is important to note that BTX treatment for TMJ disorders is not a cure but a temporary solution to manage symptoms. Also, there are potential side effects such as temporary weakness of surrounding muscles, difficulty chewing, and difficulty speaking. Therefore, the use of BTX should be carefully considered and evaluated by a trained medical professional.

In conclusion, BTX injections can be a useful treatment option for TMJ disorders, but more research is needed to determine the long-term efficacy and safety of this therapy.

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