Clinical and Radiographic Evaluation of
Arthroscopic lysis and lavage Versus Arthrocentesis
for Treatment of Temporomandibular Joint Closed
Lock

Thesis submitted for Partial Fulfillment of Requirements for the
Doctor Degree in Oral and Maxillofacial Surgery

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DEDICATION

To the candles who lightened my life....

To my Family

Your love, encouragement, support and understanding
made all things possible.

Usama Taema


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LIST OF ABBREVIATIONS

TMJ: Temporomandibular joint.

TMD: Temporomandibular disorders.

ID: Internal derangement.

MRI: Magnetic resonance imaging.

SF: Synovial fluid.

CL: Closed lock.

MIO: Maximum interincisal opening.

MMO: Maximum mouth opening.

NRS: Numerical Rating score.

UJC: upper joint compartment.

ml: milliliter.

mm: millimeter.

cm: centimeter.

DDwR: Disc displacement with reduction.

DDnR: Disc displacement without reduction.

LP: Lateral Pterygoid.

ALL: Arthroscopic Lysis and Lavage.

RDC: Research Diagnostic Criteria.
INTRODUCTION
Introduction

Internal derangement (ID) of the temporomandibular joint (TMJ) has been established as a therapeutic challenge in the oral and maxillofacial clinics. This could be attributed to the lack of complete knowledge regarding their definite causes and pathogenesis with the subsequent evolution of numerous concepts, theories and treatment methods leading to confusion in an already complicated field of study.\(^{(1)}\)

Being a painful and incapacitating condition, ID requires early diagnosis and treatment. A wide variety of conservative and surgical approaches for its treatment have been proposed \(^{(2-6)}\). The adoption of conservative treatment modalities is based on the assumption that irreversible and invasive therapies are not indicated to treat symptoms in the absence of a well identified pathogenesis pathway.\(^{(7,8)}\) For this reason, surgical interventions are reserved for a minority of cases, and are usually used with caution as well.

Considering these premises, in the case that non-surgical treatments fail to alleviate the symptoms, minimally invasive surgical procedures were proposed with encouraging results.\(^{(9-11)}\)

The introduction of TMJ \textit{Arthroscopy} was a turning point in the treatment of ID. Numerous studies have since proved the value of arthroscopy for the management of symptomatic TMJs with ID.\(^{(12-16)}\)

Arthroscopy was first described by Ohnishi in 1975.\(^{(17)}\) Holmlund et al \(^{(18)}\) improved it in 1986 by establishing standardized techniques for local anesthesia, puncture and photometric documentation. It is a minimally invasive surgical approach used for diagnosis and treatment of patients with
Introduction

persistent, refractory symptoms related to TMJ pathology. Operative arthroscopy permits surgical management of the pathology that is seen, such as the removal of adhesions, direct injection of drugs into inflamed synovial tissues, disc mobilization, and debridement and shaving of osteoarthritic fibrillation tissue.\(^{(19-21)}\) In contrast to open surgery technique, arthroscopy offers the surgeon several advantages in investigating and thereby improving the diagnosis and treatment in patients with TMJ disorders more effectively. Arthroscopy has proven to be an effective tool for exploration of the joint, in addition blunt instruments can be used in order to lyse adhesions within the joint.

*Arthrocentesis* is a natural consequence to arthroscopic lysis and Lavage. The physical action of this technique was thought to be responsible for its success.\(^{(22,23)}\) It has been proved to be simple and relatively less invasive alternative.\(^{(12-14)}\)

Nitzan et al.\(^{(24)}\) were the first to describe arthrocentesis of TMJ as a treatment concept for severe closed lock symptoms. Orthopedic arthrocentesis, by definition, refers to needle puncture of a joint space, aspiration of fluid from that space and injection of a therapeutic substance.\(^{(25,26)}\) Arthrocentesis has proved to be a minimally invasive treatment modality, relatively safe, reversible and it can be done on outpatients under local anesthesia which significantly revert the mouth opening to a normal range. It is an effective method for the re-establishment of normal disc-condyle-fossa relationship.
Magnetic resonance imaging (MRI) has replaced other imaging methods for evaluation of soft-tissue abnormalities of the joint and surrounding region. The anatomy of the joint and the position and structure of the intra-articular disc can be accurately visualized both at rest and in motion.\textsuperscript{(27)} MRI is considered one of the best and most commonly used modality in TMJ imaging, Nevertheless, poor correlation exists between signs and symptoms and displacement of the articular disc when determined on the basis of imaging studies alone.\textsuperscript{(28)}
REVIEW
Of
LITERATURE
REVIEW OF LITERATURE

The challenges posed by temporomandibular disorders (TMDs) span the research spectrum, from causes to diagnosis through treatment and prevention. Researchers throughout the health sciences are working together not only to gain a better understanding of the temporomandibular joint (TMJ) and muscle disease process, but also to improve quality of life for people affected by these disorders.

Anatomy of the TMJ

The masticator system is the functional unit of the body primarily responsible for chewing, speaking, and swallowing. The system is made up of bones, joints, ligaments, and muscles. In addition, a complex neurologic controlling system regulates and coordinates all these components together. The TMJ is an integral part of the masticatory system and is one of the most complex joints in the body. TMJ is the site of articulation between the cranial base and mandible. It is the most active joint in the body as it needs to open and close up to 2000 times/day to account for a full day’s worth of chewing, talking, swallowing, yawning, and snoring. It is composed of articular disc, condyle, glenoid fossa, articular eminence, articular capsule and temporomandibular ligaments. The TMJ differs from other joints by having the articular surfaces as well as the central portion of the articular disk composed of fibro cartilage instead of hyaline cartilage.

Laskin has described the functional condyle disc relationship as follows: when the mandible is at rest, the disc is located between the antrosuperior aspect of the condyle and the posterior aspect of the eminence with the posterior region of the disc is at twelve o'clock position. The disc
is an oval fibrous plate between the condyle and glenoid fossa. It divides the intrarticular space into an upper and a lower joint compartment. It is a firm but flexible structure that changes in position during condylar movement. The shape of the superior surface of the disc is congruent to the glenoid fossa while its inferior surface is congruent to the surface of the mandibular condyle.

Anatomically the disc is biconcave and can be divided into three regions as viewed from the sagittal plane: the anterior band, the central intermediate zone, and the posterior band. The intermediate zone is thinnest and is generally the area of function between the mandibular condyle and the temporal bone.\textsuperscript{(33)} Posteriorly the disc continues into a thick double layer of vascularized connecting tissue called the bilaminar zone (the retrodiscal tissue). Laterally and medially the disc is not directly attached to the capsule but fused to the medial and lateral poles of the condyle.

Both the superior and inferior joint compartments drop inferiorly around the condyle to reach its lateral and medial poles. Thus they have a semilunar shape, both in an antero-posterior and medio-lateral aspect. The disc is believed to have several roles, such as, cushioning and distributing joint loads, promoting joint stability during chewing.\textsuperscript{(34)} The disc, fossa and condyle are surrounded by an articular fibrous capsule and ligaments. The capsule limits the movement in the joint during mandibular articulation and thus prevents luxation.\textsuperscript{(35,36)}

TMJ ligaments can be classified into main and accessory ligaments. The capsular and temporomandibular ligaments are considered to be the main or principle TMJ ligaments which protect the joint by maintaining stability and spatial relationship between the different intrarticular
components which is needed for optimum function. The capsule is attached superiorly to the circumference of the glenoid fossa and the articular eminence and inferiorly to the condylar neck separating the TMJ into two compartments. The capsule has two components: an outer fibrous layer and inner synovial layer. Laterally, the capsule is reinforced by another main ligament called lateral temporomandibular ligament which is made of outer oblique fibers and inner horizontal ones. \(^{(37)}\)

Two additional, accessory ligaments play a role in the function of the TMJ: the sphenomandibular ligament and the stylo mandibular ligament. These ligaments prevent excessive protrusive movements of the TMJ, even though they are not closely associated with articulation. \(^{(38)}\)

The synovial membrane is composed of a thin layer of vascularized connective tissue. It lines the inner surfaces of the joint capsule and all the surfaces not under shearing or compressive load. Its main function is to produce synovial fluid. This fluid is composed of a plasma ultra filtrate, sodium-hyaluronate and a few cells. Synovial fluid participates in the nutrition of the avascular articular tissue and also lubricates the components within the joint during movement.\(^{(31)}\)

**Biomechanics of the TMJ**

This unique construction of the TMJ facilitates a mouth opening of range from 40-60 mm as measured between the upper and lower incisors where the free rotation of the condyle enables a mouth opening of 15-25 mm as measured between upper and lower incisors. Then, in the upper compartment, the free sliding of the condyle with the disc along affords a mouth opening of 40-60 mm as well as lateral movements of up to 10 mm, protrusive movements of up to 9mm and retrusive movements of 1mm. \(^{(39)}\)
This wide range of different mandibular movements can only be achieved by healthy strong muscles controlled by intricate neural system. Thus, a proper neuromuscular coordination is needed to facilitate all the mandibular movements in an accurate way without any aberration.\(^{(38,40)}\)

The TMJ is the only joint with a rigid end point of closure, which is defined by the occlusal surfaces of the teeth. The mandible connects the left and right TMJs into one functional unit.\(^{(40)}\) It is generally considered to be load-bearing during masticatory function.\(^{(42)}\)

Three motions occur at the mandible, depression (during mouth opening), protrusion/retrusion (or protraction/retraction) and lateral excursion (right and left).\(^{(43)}\) TMJ provides for hinging movement in one plane which occurs in the inferior joint compartment and therefore can be considered a ginglymoid joint. It also provides for gliding movements which occurs in the superior joint compartment and classifies it as an arthrodial joint. Thus it has been technically considered a ginglymoarthrodial joint.\(^{(44)}\)

The positioning of the condyle and disc within the fossa, as well as the constant contact between the condyle, disc, and eminence, is maintained by continuous activity of the muscles of mastication, particularly the supranandibular group.\(^{(33)}\)

To conclude, TMJ is a complex highly adaptive organ which constantly adjusts to the functional demands by remodeling and it is really difficult to comprehend every fine detail in it. That's why it is not strange to accept that the diseases that affect the TMJ are difficult to diagnose and thus to treat.\(^{(45)}\)
Temporomandibular disorders (TMDs):

TMDs, a medical term, was first proposed by Bell in 1982 and has rapidly gained popularity. This term does not suggest merely problems that are isolated to the joints but includes all disturbances associated with the masticatory system.

The term TMD is an umbrella term that actually encompasses two groups of patients: those with true pathology of the TMJ i.e arthrogenic or (TMJ problems) and those with primary involvement of the masticatory muscles i.e. myogenic or (myofascial pain-dysfunction syndrome (MPDS)). Much of the difficulty encountered in the treatment of TMDs relates to the physician's failure to distinguish between these two groups because of the similarity of their signs and symptoms.

The masticatory muscle disorders include myofascial pain dysfunction syndrome, myospasm, protective muscle co-contraction, and local muscle soreness. The TMJ disorders include internal derangement (ID), structural incompatibility of the articular surfaces as adhesions, subluxation, dislocation as well as inflammatory TMJ disorders as arthritis, capsulitis, retrodiscitis and osteoarthritis.

However, we are going to focus on only ID in our study. ID is now a worldwide accepted and a well known anatomic disorder which may cause functional disturbance.

ID is one of the most frequent disorders of TMJ. The term is generally used to denote a mechanical fault in the joint interfering with its smooth movement. The term therefore includes all types of intracapsular interferences that obstruct smooth functional joint movements such as disc
derangements, disc adherences, disc adhesions, subluxations, and dislocations of the disc–condyle complex.

ID of the TMJ is not a new pathological entity, the first reported article describing displacement of the disc of the TMJ as a cause of TMJ dysfunction was in 1887.\(^{(54)}\)

Farrar, in 1972, has rebrought attention of the world to this interesting disease which was helped by the re-introduction of TMJ arthrography by Wilkes in 1978.\(^{(54)}\)

Nevertheless, with regard to the TMJ, the term is typically used interchangeably with disc displacement.\(^{(55)}\) It has been reported that up to 70% of persons with TMJ disorders suffer from displacement of the articular disc.\(^{(56)}\)

**Joint disc alterations**

ID has been associated with characteristic clinical findings, including pain, joint sounds, and irregular or deviated jaw functions.\(^{(51-53)}\) However, because a displaced disc does not always lead to clinical symptoms, Stegenga and de Bont\(^{(57)}\) proposed to replace the word ‘‘displacement’’ with ‘‘derangement.’’ which would indicate that the displaced disc actually interferes with smooth joint movement and causes some type of dysfunction to the individual.

A disc derangement is defined as a malpositioning of the articular disc relative to the condyle and eminence. In a normal TMJ, the disc is positioned over the condylar head with the posterior band situated in the 12 o’clock (superior to the condyle) position. Theoretically, a disc may be displaced to varying degrees and in any direction (ie, anterior, posterior, lateral, or medial).\(^{(58,59)}\)
Disc displacement is usually anteromedial; as a result, in oblique sagittal Magnetic resonance imaging (MRI) projections, the posterior margin of the disc is seen to lie more anterior than the 12 o’clock position. In coronal projections, it is seen that the meniscus does not completely cover the upper margin of the head of the condyle; instead, it appears displaced towards the internal zone of the joint. Posterior displacements have been described but are infrequent.\((60,61)\) However, posterior disc displacement was believed to be retrodiscal tissues which behave and function as a joint disc and this was attributed to articulation of the condyle on the retrodiscal tissues, which undergo adaptation and repair processes and become fibrotic and avascular \((62,63)\) With regard to clinical diagnosis and treatment, two predominant stages of disc derangements are distinguished. The respective conditions are called disc derangement with reduction and disc derangement without reduction.

**Disc derangement with reduction** is typically defined as a condition in which the articular disc of the TMJ is (most often anteriorly) displaced while the mouth is closed and the teeth are together in maximal occlusion.\((59,64)\) On opening, the condyle must surpass the posterior margin of the displaced disc, in order to secure a more anterior position. This process is referred to as reduction which produces a sound (click) as a result of the impact of the condyle against the central (and thinner) portion of the disc. On closing the mouth, the disc stays behind and slips off the condyle, which may be accompanied by a clicking sound.\((59,65)\) In this situation, when a click is produced both on opening and closing the mouth, the phenomenon is referred to as a reciprocal click.\((65)\)

**Disc derangement without reduction** is defined as a condition in which the condyle is unable to slide or snap back underneath the disc. The (anteriorly) displaced disc thus does not reduce to its position on top of the
condyle during the opening movement. The disc is obstructing further translation of the condyle and consequently the opening and contralateral movements are impaired.\(^{(59,65)}\) A particular form of disc displacement without reduction is acute lock on closing the mouth, defined as the sudden inability to open the mouth.\(^{(66)}\) In many cases these situations resolve spontaneously. The signs and symptoms of disc displacement without reduction are in no way specific of the disc disorder.\(^{(67)}\)

**Prevalence:**

The literature reports great variability in the prevalence of the clinical signs and symptoms of TMJ-ID with a peak age ranges between 20 and 40 years. It has been estimated between 4 - 28% of the adult population.\(^{(68)}\) Females are predominantly affected by these disorders. The reported female-to-male ratio is about 3-4:1 in patients’ populations.\(^{(69)}\) Women also comprise about 80% of patients seeking treatment for joint pain.\(^{(70)}\) Female hormones such as oestrogen and prolactin were thought to adversely affect the adaptive capacity of the TMJ by tipping the balance of molecular events in favor of catabolic or destructive tissue degradation.\(^{(71)}\)

Disc displacement was not found in 30 infants or young children imaged by MRI.\(^{(72)}\) However, asymptomatic disc displacement was documented in 8% of juveniles with a mean age of 11 years\(^{(73)}\) and about 30% of adult volunteers.\(^{(74)}\) TMJ sounds and deviation on opening the jaw occur in approximately 50% of otherwise asymptomatic persons; these were considered within the range of normal and do not require treatment.\(^{(75)}\) Symptomatic ID of the TMJ is found in about 20% of the population.\(^{(76)}\) This could be due to the observation that patients have more advanced pathology and more disc interference on opening than asymptomatic volunteers.\(^{(77)}\) Despite the high incidence of ID among patients referred for surgical
Consultation because of symptoms, only a small and yet-to-be determined fraction of persons with ID become sufficiently symptomatic to seek treatment.

**Etiology/Pathogenesis**

Various hypotheses have been proposed for the etiology of ID. Failure to find disc displacement in infants and very young children suggests an acquired nature of the condition.\(^{(78)}\) Nevertheless, genetic and metabolic factors may contribute by lowering the threshold for tissue damage from overloads (relative) or trauma and therefore may also be an important factor in the development of ID.\(^{(79)}\)

The pathophysiology of disc displacement is multifactorial and complex. Under normal physiologic conditions, a balance exists in synovial joints between tissue breakdown and repair. When the balance is disturbed by a mechanical, biomechanical, or inflammatory insult the internal cartilaginous remodeling system may fail, resulting in accelerated tissue breakdown.\(^{(80)}\) A wide variety of insult has been implicated as etiologic factors of ID.

It was believed that Trauma is the most common etiologic factor in the development of disc derangement.\(^{(59)}\) Various forms of trauma to the TMJ structures have been related to symptoms of ID, many theories discuss this predicament.

The first theory suggests that Macrotrauma, such as a hit or blow to the face, may result in direct tissue injury and immediate derangements of the TMJ components.\(^{(81)}\) Oral intubation and dental/surgical procedures that involve prolonged mouth opening or excessive forces, such as difficult extractions, also have the propensity to cause direct tissue injury.\(^{(59)}\) Indirect trauma, such as flexion-extension (whiplash) neck injuries\(^{(82)}\) may cause or aggravate ID.
The second theory suggested **functional overloading (microtrauma)** to be the underlying cause responsible for disc displacement. The articular components of the TMJ are constructed to withstand and adapt to the shearing forces that accompany translatory movements. However, these tissues are not constructed in such a way that they can cope with persistent compressive loading as, for example, that associated with chronic clenching. Such loading can impair the integrity of the articular TMJ components, directly or indirectly, by stimulating the generation of harmful reactive oxidative species (ROS), which enter into rapid chemical reaction in various tissues and destroy important molecules, such as hyaluronic acid, collagens, and proteoglycans, an action that is claimed to predispose to disc displacement. However, the nature of the damage and the manner by which it affects disc displacement has not been sufficiently explained.\(^{(83)}\)

Microtrauma such as the repetitive loading of clenching and bruxism possibly are etiologic factors, but a clear relationship has not been established.\(^{(84)}\) Bruxism is considered to be a combination of parafunctional clenching and grinding activities exerted both during sleep and while awake, because both phenomena are not adequately differentiated in most scientific articles, bruxism appears to be regulated mainly centrally, not peripherally. Up till now, repetitive activities or microtraumas, like sleep bruxism, are considered to be important factors in the onset and perpetuation of pain in TMD.\(^{(85)}\)

Occlusal interferences were initially postulated as a cause of bruxism; though at present emotional stress is considered to be the principal triggering factor. Other factors that have been related to the origin of bruxism are certain drugs, central nervous system disorders, and a certain genetic and/or familial predisposition.\(^{(86)}\)
Also alterations in occlusion have been identified as predisposing, triggering or perpetuating factors \(^{(87)}\). Comparisons were made of a group of women with internal TMJ derangement versus asymptomatic control women.\(^{(87)}\) The patients with disc displacement were mainly characterized by unilateral posterior cross bite and long displacement of centric relation to the position of maximum intercuspidation. The patients with osteoarthrosis in turn associated an increased distance between centric relation and maximum intercuspidation, greater over jet and a reduction in overbite. Therefore, it was proposed that occlusal alterations may act as cofactors in the identification of patients with ID, and that some occlusal variables may be a consequence rather than a cause of ID.

Another theory depended on increased friction and impaired lubrication in the TMJ as a possible cause for disc displacement. \(^{(88)}\) Intermittent clicking has been claimed to be connected to chronic or intermittent severe clenching, a disturbance that increases friction and eventually leads to disc displacement. This implies that increasing TMJ loading may cause elevation in the friction coefficient within the TMJ. But, how does excessive loading affects friction within the joint? It has been argued that detrimental forces may cause elevation in the concentrations of hyaluronic acid (gelation phenomenon) and this might induce increased friction. Conversely, degradation of hyaluronic acid, which is associated with a decrease in viscosity, has also been proposed as a condition that increases friction.\(^{(89)}\) However, it should be noted that it is impossible to decide by what means friction increases and how it then induces disc displacement from the published material. In short, although it is generally agreed that displacement of the TMJ disc may be associated with its inability to glide smoothly because of increased friction or degenerative changes, the mechanism involved in the process of increasing friction and how this causes
displacement of the disc remain unclear. The most accepted and appraised theory was proposed by Nitzan in 2001\(^{40}\) where she claims that collapse of the lubrication system does play a pivotal role in a chain of events leading up to increasing friction coefficient within the TMJ and this might cause disc displacement.

In synovial joints, both boundary lubrication and fluid film lubrication are required. Boundary lubricants can be explained as those molecules which are attached to, and cover, each articular surface within the TMJ reducing the surface energy. While, full fluid film is the component that keeps the articular surfaces apart.\(^{40,90}\)

Thus the problem seems to be in the boundary lubricants rather in the fluid film lubricants. A vast amount of literature is available concerning boundary lubrication within the TMJ and from the proffered information it emerges that surface-active phospholipids, in association with lubricin (a glycoprotein), act as extremely efficient boundary lubricants and as protectors of the articular surfaces.\(^{91}\)

Now, it is mandatory to explain how does the breakdown of the lubrication system is caused by detrimental loads on the TMJ and how does this affect the disc position? Lubrication of the joint remains normal as long as loading does not exceed the functional limits and its adaptive capacity is not compromised. The major cause of collapse of the lubrication system is overloading, which has various effects on synovial joints one of them being a change in the continuous blood supply. On overloading of a joint, the intra-articular pressure increases. In alert humans, voluntary clenching has produced high intra-articular pressures in the TMJ, reaching the range of -8 to -200 mm Hg \(^{92}\). When above -40 mm Hg, the intra-articular pressure surpasses the peripheral arteriolar pressure and which will cause temporary hypoxia, which is corrected by re oxygenation on cessation of the
overloading. Such a hypoxic-reperfusion cycle has been reported to evoke non enzymatic release of reactive oxidative species (superoxide anions and hydroxyl anions). Because of their very high reactivity, these reactive oxidative species may enter into rapid chemical reactions in various tissues or destroy important molecules. Among other effects of reactive oxidative species in joints is inhibition of the biosynthesis of hyaluronic acid and its degradation, causing marked reduction in synovial fluid viscosity.\(^{(93)}\)

In its degraded form hyaluronic acid has an indirect effect on joint lubrication. This is expressed in its inability to protect the continuity of the surface active phospholipid layer, which is the major boundary lubricant of the joint. The problem is exacerbated by the fact that the articular surfaces are of high surface energy, large surface contact and increase surface elasticity which causes an even greater friction.\(^{(94)}\)

The next pertinent question is, “Which qualities inherent in increased friction promote disc displacement? The increased friction in the upper compartment then prevents the disc from sliding in conjunction with the condyle. On opening of the jaw, the condyle is pulled forward by the inferior head of the lateral pterygoid muscle, away from the slowed down disc. As a result, the ligaments fastening the disc to the condyle are gradually stretched. The now mobile disc gravitates slightly downward and forward. It also has been proposed that the superior belly of the lateral pterygoid muscle contributes to the pull of the disc anteriorly on mouth closure. Once the disc is anteriorly displaced, during mouth opening, the condyle, which is now located posterior to the loose disc, will gradually push it down the slope of the eminence, displacing it further forward.\(^{(40)}\)

The role of lateral pterygoid (LP) muscle in disc displacement is still questionable as reflected by the contradiction of the findings and the
conclusions derived from the studies on the insertion of LP muscle inspite of being based on cadaver dissections.\(^{(95)}\) Since a number of procedural problems have been encountered that may disturb the anatomy of the examined joint. This muscle was also found to be the most difficult masticatory muscle to assess.\(^{(95)}\) It has been proposed that clicking and/or locking conditions arise in the TMJ through some form of lack of co-ordination between the superior head of lateral pterygoid (SHLP) and inferior head of lateral pterygoid (IHLP).\(^{(96)}\) The lack of co-ordination between the two heads of the muscle necessitates an important role for the SHLP in horizontal disc position, an idea that was based on the erroneous view that the SHLP inserts entirely into the disc.

Manual traction on the SHLP in cadavers has been reported to bring both disc and condyle forward together.\(^{(97)}\) However, recent evidence points to the possibility that those SHLP fibers inserting into the disc could activate independently of other SHLP fibres and could possibly exert forces on the disc that are not directed simultaneously to the condyle. The possibility that selective activation within SHLP might occur comes from data suggesting that the SHLP is functionally heterogeneous.\(^{(98)}\)

**Local and general hypermobility** were believed to play a role in the etiology of TMD. However, the studies investigated this hypothesis were quiet contradictory. Conti et al.\(^{(99)}\) found no association found between the intra-articular disorders and systemic hyperlaxity, or between TMJ mobility and systemic hypermobility.

While Kavuncu et al.\(^{(100)}\) reported that both local and general hypermobility were more frequently detected in patients with TMD than in the controls, and that the risk of TMJ dysfunction was greater if the patient presents both alterations simultaneously.
In conclusion, there is not any illegible, worldwide accepted, evidence based explanation for how does disc displacement occurs and what are the causes of pain and limitation in these patients.

Classification of ID

The diagnostic process for TMDs is complicated by the multifactorial etiology and multiplicity of clinical signs and symptoms characterizing such disorders. Several attempts were adopted to classify different subtypes of TMDs in trial to reach a consensus among clinicians which may impact positively TMJ research. One of the most commonly used classifications is that of Helkimo. Helkimo\(^{(101-104)}\) published an epidemiologic index, with five commonly observed physical signs and symptoms, to score "functional disturbance of the masticatory system". The primary concept of Helkimo’s index was that it developed specifically as an epidemiologic survey examination for investigating the prevalence of "global" TMDs and the need for treatment. Applying this index to one of the few probability-based study samples, Helkimo reported that only 18% of the population he studied was free of all signs and symptoms, and that as many as 47% had at least one severe TMD symptom. Since the percentage of the population which voluntarily seeks treatment for TMD is much lower \(i.e.,\) closer to 5\%, many challenged the above figures as overestimating the prevalence of TMD in the general population.

Wilkes\(^{(105,106)}\) classified ID based on clinical, radiographic and surgical findings (Table 2). Wilkes divided ID into five stages, the first stage is disc displacement with reduction (DDwR), the second stage is DDwR and intermittent locking, and the third stage is acute disc displacement without reduction (DDnR), the fourth stage is chronic DDnR and the fifth stage is DDnR with degenerative arthritis.
The clinical hallmark of stage one DDwR 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 full with a midline positioning of the mandible.

Stage two features all the aforementioned characteristics, plus additional episodes of limited mouth opening or even transient subluxation, which can last for various lengths of time. Patients may describe it as “hitting an obstruction” when opening is attempted. The “obstruction” may disappear spontaneously or the patient may be able to manipulate the mandible beyond the interference. In this stage, few episodes of pain, occasional joint tenderness and related temporal headaches, increase in intensity of joint sounds start to be obvious. Closed lock (DDnR or the third stage) occurs when clicking noises disappear but limited opening persists. The patient complains of TMJ pain and chronic limited opening. Examination will reveal deviation of the mandible to the affected side with mouth opening and protrusive movements in unilateral cases. Stage four or chronic closed lock is characterized by chronicity with variable episodic pain, headaches, variable restriction of motion, and undulating course. This undulating course can be explained as that 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. 107-109

In the last stage, the condition becomes very severe where 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 but as the retrodiscal tissue continues to be stretched and loaded, it becomes subject to thinning and perforation. This is the real problem since this means that there will be bony contact between the two articulating
surfaces with its subsequent detrimental intraarticular effects. Stage five can be termed osteoarthrosis (OA) which is best defined as non inflammatory pathological process caused by increase mechanical loading of the TMJ which causes degeneration of the articular cartilage and remodeling of the underlying bone.110 Clinically, these patients suffer from restricted motion with difficulty in different mandibular functions as yawing, biting and chewing, and pain both at rest and during different mandibular movements. Different joint sounds can also be detected as crepitus, scraping, grating and grinding sounds which all are signs of bone to bone contact between the two articulating surfaces of the TMJ. In severe terminal cases, the pathologic osteolysis decreases the height of the condyle and the mandibular ramus leading to joint instability, malocclusion and facial deformity as apertognathia.112

Wilkes classification widespread adoption may be attributed to its simplicity; however it is not without flaws. Wilkes classification depends on the hypothesis that ID is a progressive disorder which is still not yet proved. In fact, longitudinal epidemiological studies do not seem to support the idea of progression. For ten years, Magnusson and others studied 293 subjects with clicking. At the five-year follow-up, clicking had not changed to locking in any of the subjects. At the 10-year follow-up, only one of the 293 subjects reported intermittent locking.113

Additionally, de Bont observed histologically "osteoarthritic changes" affecting the articular surfaces of the TMJ in 4 of 8 joints with normal disk condyle relationships. These results support the idea that osteoarthritic changes may precede disk displacement.114
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| Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD): | 115 |

Considering the defects in the previously mentioned TMDs classifications, a group of American researchers published the RDC/TMD in 1992 aiming to critically revise the TMD diagnostic systems in use at that time, standardize TMD examination procedures, establish new research diagnostic criteria for TMDs and assess pain related disability and the psychological status of TMD patients. The data used to develop RDC/TMD came from longitudinal epidemiological research supported by the national institute for dental research (NIDR) which was conducted at the university of Washington.116,117

RDC/TMD is a dual axis diagnostic system for TMDs supported by a well-designed history and clinical examination protocol which provide specific reliable, reproducible and valid criteria with high sensitivity and specificity to define the most common types of TMDs.

The Axis I clinical assessment protocol is designed to render TMD diagnoses, and the Axis II screening instruments assess psychological status and pain-related disability. Together, Axis I and Axis II assessments constitute a comprehensive evaluation of the TMD patient.118 (Table 3).

Dolwick119 proposed a classification of ID of TMJ based on the disc morphology as an important feature of ID which may contribute to functional impairment of the TMJ. But some categories have been deliberately omitted because of the infrequency of occurrence; these would include posterior and lateral disc displacements. This classification categorized ID into four groups:

1. Deviation in form
   a) Frictional disc in-coordination.
   b) Articular surface defects.
c) Disc thinning and perforation.

2. **Disc displacement**
   
a) Partial anteromedial disc displacement.

b) Anteromedial disc displacement with reduction (partial – complete)

c) Anteromedial disc displacement with intermittent locking.

  d) Anteromedial disc displacement without reduction (acute – chronic)

  e) Anteromedial disc displacement with perforation of retrodiscal tissue.

3. **Adhesive disc hypo-mobility.**

4. **Displacement of disc-condyle complex.** (subluxation-dislocation)
### Table 1: Helkimo dysfunction index

<table>
<thead>
<tr>
<th>A. Mobility of the mandible</th>
<th>&gt;40 mm</th>
<th>0 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum mouth opening</td>
<td>31-39 mm</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>&lt; 30 mm</td>
<td>5 points</td>
</tr>
<tr>
<td>Maximum laterotrusion right left each</td>
<td>7 mm</td>
<td>0 points</td>
</tr>
<tr>
<td>Maximum protrusion</td>
<td>4 – 6 mm</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>0 – 3 mm</td>
<td>5 points</td>
</tr>
</tbody>
</table>

Degree of limitation of mobility
0 point: clinically normal mobility
1-4 points: moderate dysfunction
5-20 points: serious dysfunction

<table>
<thead>
<tr>
<th>B – TMJ function</th>
<th>No noises, mandibular deviation up to 2 mm on opening and closing</th>
<th>0 points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Noises and deviation greater than 2 mm</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>Dysfunction and/or lock jaw</td>
<td>5 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C- Muscular system</th>
<th>No tenderness at palpation</th>
<th>0 points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tenderness at palpation of 1 – 3 muscles</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>Tenderness of more than 3 muscles</td>
<td>5 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D – TMJ arthralgia</th>
<th>No tenderness at palpation</th>
<th>0 points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tenderness laterally</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>Tenderness dorsally</td>
<td>5 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E – Pain with motion of the mandible</th>
<th>Painless motion, opening, laterotrusion and mediotrusion</th>
<th>0 points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pain at one movement</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>Pain at more than one movement</td>
<td>5 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sum of A, B, C, D and E: Dysfunction index Di</th>
<th>Di 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – point: clinically symptoms</td>
<td>Di 0</td>
</tr>
<tr>
<td>1-4 points: slight dysfunction</td>
<td>Di 1</td>
</tr>
<tr>
<td>5 – 9 points: moderate dysfunction</td>
<td>Di 2</td>
</tr>
<tr>
<td>10 – 20 points: severe dysfunction</td>
<td>Di 3</td>
</tr>
</tbody>
</table>
Table 2: Wilkes Classification of ID

<table>
<thead>
<tr>
<th>Stage</th>
<th>Clinical</th>
<th>Radiologic</th>
<th>Surgical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early stage</td>
<td>No significant mechanical symptoms, other than reciprocal clicking (early in opening movement, late in closing movement, and soft in intensity); No pain or limitation on opening motion.</td>
<td>Slight forward displacement, good anatomic contour of disc, normal tomograms.</td>
<td>Normal anatomic forms, slight anterior displacement, passive in coordinate (clicking) demonstrable.</td>
</tr>
<tr>
<td>Early / intermediate stage</td>
<td>First few episodes of pain, occasional joint tenderness and related temporal headaches, beginning major mechanical problems, increase in intensity of clicking sounds, joint sounds later in opening movement, and beginning transient subluxation or joint catching and locking.</td>
<td>Slight forward displacement, slight thickening of posterior edge or beginning anatomic deformity of disc, normal tomograms.</td>
<td>Anterior displacement, early anatomic deformity (slight to mid thickening of posterior edge), and well-defined central articular area.</td>
</tr>
<tr>
<td>Intermediate stage</td>
<td>Multiple episodes of pain, joint tenderness, temporal headaches, major mechanical symptoms, transient catching, locking, and sustained locking (closed locks), restriction of motion, and difficulty (pain) with function.</td>
<td>Anterior displacement with significant anatomic deformity/prolapses of disc (moderate to marked thickening of posterior edge), normal tomograms.</td>
<td>Marked anatomic deformity with displacement, variable adhesions (anterior, lateral, and posterior recesses), and no hard tissue changes.</td>
</tr>
<tr>
<td>Intermediate / late stage</td>
<td>Characterized by chronicity with variable and episodic pain, headaches, variable restriction of motion, and undulating course.</td>
<td>Increase in severity over intermediate stage, abnormal tomograms, and early to moderate degenerative remodeling hard tissue changes.</td>
<td>Increase in severity over intermediate stage, hard tissue degenerative remodeling changes of both bearing surfaces, osteophytic projections, multiple adhesions (lateral, posterior recesses), and no perforation of disc or attachment.</td>
</tr>
<tr>
<td>Late stage</td>
<td>Characterized by crepitus on examination; scraping, grating, grinding symptoms; variable and episodic pain; chronic restriction of motion; and difficulty with function.</td>
<td>Increase in severity over intermediate stage, hard tissue degenerative remodeling changes of both bearing surfaces, osteophytic projections, multiple adhesions (lateral, posterior recesses), and no perforation of disc or attachment.</td>
<td>Gross degenerative changes of disc and hard tissues, perforation of posterior attachment. Erosions of bearing surfaces, and multiple adhesions equivalent to degenerative arthritis (sclerosis, flattening and anvil shaped condyle, osteophytic projections, and sub cortical cystic formation).</td>
</tr>
</tbody>
</table>

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### Table 3: TMD Research Diagnostic Criteria

<table>
<thead>
<tr>
<th>AXIS I Diagnostic Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Muscle Diagnoses</strong></td>
</tr>
<tr>
<td>a. Myofascial pain.</td>
</tr>
<tr>
<td>b. Myofascial pain with limited opening.</td>
</tr>
<tr>
<td><strong>II. Disc Displacements</strong></td>
</tr>
<tr>
<td>a. Disc displacement with reduction.</td>
</tr>
<tr>
<td>b. Disc displacement without reduction, with limited opening.</td>
</tr>
<tr>
<td>c. Disc displacement without reduction, without limited opening.</td>
</tr>
<tr>
<td><strong>III. Arthralgia, Arthritis, Arthosis</strong></td>
</tr>
<tr>
<td>a. Arthralgia.</td>
</tr>
<tr>
<td>b. Osteoarthritis of the TMJ.</td>
</tr>
<tr>
<td>c. Osteoarthrosis of the TMJ.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AXIS II Disability measures.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Pain intensity and disability.</td>
</tr>
<tr>
<td>b. Depression (depression and vegetative symptom scales)</td>
</tr>
<tr>
<td>c. Limitations related to mandibular functioning.</td>
</tr>
</tbody>
</table>
**Clinical manifestations:**

ID has been associated with characteristic clinical findings, including pain, joint sounds, and irregular or deviated jaw functions.\(^{(51-53)}\) However, pain is the most important symptom of ID for both the patient and the clinician, and is the main reason why patients with ID seek medical help.

- **Joint pain**

  The diagnosis of TMJ pain is challenging because the close proximity to other anatomic structures makes it difficult to pinpoint the origin of the pain. The joint cartilage lacks nerve endings, and is therefore unable to cause pain. The nerve endings are found in the periarticular soft tissues, specifically in the disc and capsular ligaments, and in the retrodiscal tissues (bilaminar zone of Rees). These are mostly free nerve endings, though some receptors with a more complex structure believed to correspond to mechanoreceptors have been identified in the lateral portion of the capsule and stylomandibular ligament.\(^{(50)}\)

  The most common symptom reported by patients with ID is unilateral facial pain. The pain may radiate into the ears, to the temporal and periorbital regions, to the angle of the mandible, and frequently to the posterior neck. The pain is usually reported as a dull, constant ache that is worse at certain times of the day. There can be bouts of more severe, sharp pain typically triggered by movements of the mandible. The pain may be present daily or intermittently, but many patients have pain-free intervals.\(^{(120)}\)

- **Muscle pain**

  Muscle tenderness, producing pain or discomfort, is generally found on both extraoral and intraoral palpation of the masticatory muscles. Tenderness may also be present in the anterior neck muscles (suprahyoid muscles and sternocleidomastoid muscles), posterior cervical paraspinal
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muscles (semispinalis capitus, splenius capitus, and suboccipital muscles), and the upper shoulder muscles (trapezius and levator scapulae).\(^{121}\)

- **TMJ Dysfunction**

  The mandibular movements usually evaluated in clinical practice are maximum aperture, forced maximum aperture, lateralization towards either side, or protrusion. They provide significant information for diagnosing ID. The normal amplitude of oral aperture is 40-60 mm.\(^{65}\) However, there is no universally accepted standard value beyond which limited oral aperture is considered to exist. The most widely accepted limit is 40 mm of interincisal maximum aperture.\(^{65}\) Mandibular lateralization in turn is determined by measuring the displacement of the interincisal line on one and the other side. Displacements of less than 7 mm are considered to be below the normal limit.\(^{122}\) The limitation of lateral movements is usually due to disc problems (displacement towards the affected side being normal, while lateralization to the healthy side is limited).\(^{65}\) It was proposed that continuous lateralization may have deleterious effect upon the TMJ disc as it could perforate disc and damage lateral anchoring of the disc to the condyle.\(^{123}\)

  Cases with disc displacement with reduction show varying degrees of limitation in mouth opening. This could be attributed to protective muscle contraction to protect the affected joint, or muscle spasm as the result of an increase in metabolic degradation products induced by parafunctional activity, both limit aperture with the purpose of avoiding pain.\(^{44}\) Although with difficulty, the patient is able to open the mouth a little beyond unforced maximum aperture.\(^{124}\)

  In the case of a patient with chronic and progressive limitation of oral aperture preceded by one or more episodes of acute lock, the first suspected diagnosis should be disc displacement without reduction.\(^{65}\) When disc displacement without reduction is bilateral, the lateralization and protrusion
movements are limited. In unilateral presentations deviation is seen towards the affected side at oral aperture. In some cases metaplastic phenomena develop in the retrodiscal tissues, which can behave as a pseudo disc thus allowing patients to recover oral aperture of up to 40-45 mm.\textsuperscript{(125)}

Normally, the mandibular path in maximum aperture follows a vertical line. Alterations in the path may comprise deviations, when at the end of the opening movement the mandible is once again centered, or deflections, when at the end of opening the midline remains deviated. Deviations are usually caused by disc alterations, and are a consequence of condylar movements to overcome the disc obstacle. Deflections in turn are usually caused by limitations in the mobility of one of the two joints. In cases where the origin of deflection is of a muscular nature secondary to unilateral spasm, protrusion movements can help clarify the diagnosis, since they show no lateralization when the underlying cause is muscular.\textsuperscript{(44)}

\textit{Joint sounds}

TMJ clicking generally indicates discal dislocation. The presence of joint sounds supports the diagnosis of ID of the TMJ though it also must be taken into account that the absence of such sounds does not necessarily imply joint normality. Clicks are brief sounds produced by mandibular movements associated to disc displacement with reduction, though click-like sounds can also be produced by joint remodeling or joint hypermobility.\textsuperscript{(44)}

It was reported that ID of the TMJ is a progressive disorder which usually starts with clicking associated with normal mouth opening (anterior disc displacement with reduction), to a stage where clicking gradually ceases but restricted mouth opening ensues (closed lock). This was attributed to a non-reducible anteriorly displaced articular disc acting as an obstacle to the gliding condyle.\textsuperscript{(126)}
A reciprocal click is usually generated in the more advanced phases of disc derangement with reduction. Typically, the opening click occurs later during the opening movement, whereas the closing click often occurs close to maximal occlusion.\(^{(59)}\) The further away the closing click is produced from the closed mouth position, the greater the degree of disc dislocation \(^{(65)}\) The joint clicks disappear as the disc becomes non-reducible and a limitation of maximum interincisal aperture to about 25 mm or less may develop.\(^{(127)}\)

Crepitants or friction sounds in turn are longer-lasting than clicks, and may accompany part of the mandibular movement cycle. They are the result of direct friction of one bone surface against another. Friction sounds are considered to be a manifestation of osteoarthrosis. Joint sounds are highly variable in one same individual – a fact that limits the reliability of sound assessment. Joint sounds are detected by palpation, auscultation or sonography.\(^{(44)}\)

Palpation is less sensitive, since some sounds go undetected. In contrast, auscultation and sonography offer low specificity, since many accessory sounds such as friction of the hair or skin, or even blood flow in the exploratory zone, can induce false positive readings.\(^{(128)}\)
**Imaging studies**

The most important diagnostic advances in TMDs during the past 30 years have occurred in imaging techniques for the TMJ. Imaging of the TMJ and associated structures is necessary to establish the presence or absence of pathology and stage of disease in order to select the appropriate treatment, assist in prognosis, and assess patient response to therapy. Imaging results will influence treatment strategy. Generally, it is recommended that imaging studies be bilateral because of the high incidence of bilateral joint disease.\(^{(129)}\)

Radiographs which can provide this information include plain films, panoramic films, and tomograms.\(^{(130)}\) In instances where more information is required, tomography is recommended.\(^{(130)}\) Plain radiographs have been almost completely replaced by computed tomography (CT) for evaluation of bony morphology and pathology of the joint, mandibular ramus, and condyle.\(^{(129)}\)

The disc and associated soft tissue structures should be imaged. Magnetic resonance imaging (MRI)\(^{(131)}\) or arthrography\(^{(132)}\) can provide this information.

Schiffman et al\(^{(133)}\) found that mandibular dysfunction indices produced values which were unrelated to the position of the disk in the TMJ as determined by arthrographic evaluation. Therefore, they suggested that the clinical significance of a positive arthrogram should not be overemphasized. However, Manfredini et al\(^{(134)}\) reported that imaging techniques should be used to gain a better insight within the TMJ.

*Magnetic resonance imaging (MRI)* has replaced other imaging methods for evaluation of soft-tissue abnormalities of the joint and
surrounding region. The anatomy of the joint and the position and structure of the intra-articular disk can be accurately visualized both at rest and in motion. MRI is considered one of the best and most commonly used modality in TMJ imaging.

Kinematic MRI allows for depicting sequential positions of the disc during mandibular movement. Nevertheless, poor correlation exists between signs and symptoms and displacement of the articular disk when determined on the basis of imaging studies alone. Other head and neck imaging studies may be necessary such as transcranial views for general determinations of condylar morphology and position in the fossa.

**TMJ Arthroscopy** was first described in the 1970s. Arthroscopy is both a therapeutic and mini-invasive endoscopic method for TMJ space examination. As a diagnostic tool, arthroscopy permits the surgeon to identify significant intra-articular pathologies such as osteoarthritis, synovitis, ID, disc perforation, and adhesions. Operative arthroscopy permits surgical management of the pathology that is seen, such as the removal of adhesions, direct injection of drugs into inflamed synovial tissues, disc mobilization, and debridement and shaving of osteoarthritic fibrillation tissue. However, complications may arise such as haemorrhage, joint cartilage damage, joint disc perforation, face inervation damage, midear perforation, intracranial perforations and the risk of infection.
**TREATMENT:**

Treatment of ID has always presented a therapeutic challenge to the oral and maxillofacial surgeon. One should not expect a single treatment modality for this malady which is always successful in decreasing the patient's affliction. On the contrary, there is a wide spectrum of different interventions which may help in treating ID. In point of fact, treatment of ID is usually like a treatment ladder starting with the simplest and the least expensive and then ascending with the more aggressive until resolution of the patient's signs and symptoms occur. Of course, this is not an absolute concept and there may be some exceptions for this treatment philosophy.\(^{139}\)

As in any disease, an understanding of the natural course of ID is necessary to guide rational treatment. Since many individuals lacking ideal mandibular function do not seek treatment, a clinician needs to determine a patient's deviation from ideal and ability to adapt before recommending any intervention. Definitive treatment for a disc displacement is to reestablish a normal condyle-disc relationship. Although this may sound relatively easy, it has not proved to be so. Most patients with articular disc displacements either improve spontaneously or can be managed efficiently with appropriate non-surgical therapy. Some patients, however, may become refractory to conservative treatment and require surgical intervention to relieve the troublesome TMJ symptoms.\(^{140}\)

Generally, treatment efforts are directed toward reduction of pain, improvement of dysfunction and slowing the progression of ID. Although few current treatment options appear to affect progression of ID favorably,\(^{141}\) this goal gains importance with accumulating evidence suggesting that progression to late-stage disease has a deleterious effect on pain resolution\(^{142}\) and plays a
role in the development of facial deformity. This could be achieved by reduction of disc interference, because of its adverse effect on pain, dysfunction, and its possible role in development of the deformed condyle of late-stage ID.

As a consequence, treatment of ID is usually started with non surgical methods and when these methods are exhausted surgical techniques are attempted. Non surgical techniques include wide range of different approaches such as behavioral medicine, pharmacological therapy, physical medicine, and occlusal adjustment while surgical techniques includes closed and open joint surgery.

**Non-Surgical Treatment**

Non-surgical treatment should be considered for all symptomatic patients with ID. For mild or moderate pain and dysfunction, this treatment alone often suffices. Considerable percentages of patients with ID respond well to nonsurgical treatment. Patients with severe pain and dysfunction may also be treated non-surgically, but if adequate reduction of symptoms does not occur within 2-3 weeks, surgical consultation is indicated. In instances of closed lock, regardless of the degree of pain, early surgical consultation is indicated. There are mainly four types of treatment that should be considered for patients with painful ID. These are patient education (Behavioral medicine), physical therapy, occlusal therapy and pharmacological therapy.

**Behavioral medicine** is the initial step in approaching patients with ID. What a patient does with his occlusion in reacting to a stress seems more important than any malocclusion that he may have. This psychophysio logic conception which was expanded by Laskin in 1963 led to the emerge of biopsycological approach in the management of ID and thus many clinicians
started to appreciate the significance of controlling the patient's stresses to achieve good results.\(^{148}\) Patient education, biofeedback, stress management, relaxation training and counseling are all parts of the behavioral agenda needed to control the patient's stresses. Patients' education is done by explaining to them confidently and thoroughly the pathology, prognosis of their disease in attempt to motivate them to get involved in their treatment i.e. patients who are aware of their problem will appreciate the provided treatment and will actively participate in their own treatment. Lack of motivation, feeling of dissatisfaction and pessimism will compromise any provided treatment. In addition, patients should be taught to discard any habits which may excessively load the TMJ. Thumb and pencil suckling, opening the mouth maximally during yawing, eating sticky food are all hurtful habits that should be abandoned by the patients. Encouraging the patients to cut their food into small pieces and may even shift to semi fluid blenderized diet is also needed to rest the TMJ.

Patient education is intended to help patients understand and avoid stress-related lifestyle habits.\(^{(149)}\) Patient education is very important in order to modify the patient’s behavior and therefore a brief description of the mechanism of internal derangement should be given. A well informed patient could play a major role in the treatment since the disorder is of biomechanical nature and therefore the patient should be instructed to eat softer food in order to decrease loading of the joint. The patient should also be informed about the disorders natural course and treatment so that reasonable expectations can be met.\(^{(44,146)}\)

**Physical Therapy** in conjunction with other methods of treatment is used to relieve musculoskeletal pain and improve range of motion.\(^{(150)}\) Physical therapy comprises a vast number of different interventions such as home exercises, heat application, ultrasound therapy, transcutaneous
electronic nerve stimulation (TENS), mandibular manipulation, intramuscular injection of botulinum toxin, and intra-oral appliances.

Home exercises may be helpful in maintaining normal function and they include gentle stretching exercises done through active opening or passively by devices as Therabite.\(^{(151)}\) It has been stated that these home passive rehabilitation programs can result in restoration of normal mandibular mobility in patients with closed lock over a period of several months.\(^{(151)}\)

Heat therapy whether by moist heat application or by ultrasound waves will theoretically increase the blood flow to the injured areas increasing the uptake of the painful metabolic byproducts which will decrease the pain and improve the function of the TMJ. Transcutaneous nerve stimulation is used for chronic pain management and it depends on the idea that stimulation of the superficial nerve endings electronically will result in overriding the pain input from the injured TMJ.\(^{(151)}\)

Another interesting modality in controlling the diffuse pain which is usually associated with ID is the intramuscular injection of botulinum toxin. Botulinum toxin is produced by the anaerobic organism Clostridium botulinum and is considered to be a pre-synaptic neurotoxin. It causes a dose dependant weakness in the skeletal muscles by blocking the release of acetyl-choline from the motor nerve endings as well as lowering the muscle tone. As a result, loading of the joint will be significantly reduced allowing the joint to rest and providing it with the opportunity to heal. In addition, botulinum toxin may have an anti-inflammatory effect in large doses.\(^{(152)}\)

Home exercises are an excellent method for treating a patient’s symptoms, getting the patient and family members actively involved in the patient’s therapy.\(^{(153)}\)
Occlusal therapy has gained a wide acceptance as one of the initial modality used for management of ID. A wide variety of occlusal splints has been used. However, stabilization and anterior repositioning splints are the most commonly used for treatment of ID. Several authors reported the use of anterior repositioning appliance to treat TMJ ID. Based upon clinical experience and the literature; anterior repositioning appliances appear to be more effective than the flat-plane occlusal splint in eliminating joint clicking, joint and headache pain, and muscle pain from a dislocated joint. (154-158) Summer and Westesson (159) reported that 92% of 75 patients found pain relief by using an anterior repositioning appliance. Such an orthopedic device must either cover all the teeth of one arch or incorporate the anterior determinants of occlusion (such as anterior guidance and canine disclusion) to avoid intrusion or over eruption of teeth. (160) Patients must wear this appliance at all times. (161)

Superior repositioning appliance (gnathologic appliance, centric relation splint, stabilization splint, flat-plane splint, anti-bruxism appliance, and occlusal appliance) is used to treat bruxism, muscle hyperactivity, and muscle pain. (162-164) The appliance’s major purpose is to provide neuromuscular relaxation via the trigeminal afferent neurons, first through the mesencephalic nucleus and then through the motor nucleus. Through this complex reflex, the motor innervations to the elevator muscles is adjusted, producing a neuromuscular relaxed position of the mandible that is independent from the occluding surfaces of the opposing teeth. (165) The superior repositioning appliance covers all of the teeth in either the maxilla or mandible. Mechanically, there is no difference which arch is used as long as all of the teeth in the arch are covered; the vertical thickness is kept to a minimum (1.0–2.0 mm). (166,167) It is recommended to be worn only at night. After a period of
successful splint therapy (normally between two to three months), patients can be weaned off the splint.\textsuperscript{(168)}

Conti et al.\textsuperscript{(166)} evaluated the effectiveness of partial use of anterior repositioning appliances in the management of TMJ pain and dysfunction when compared to stabilization splints and a control group in a one-year follow-up. They concluded that controlled partial use of repositioning splints is a beneficial tool in the management of intra-articular pain and dysfunction.

Prolonged use of repositioning appliances for ID can cause undesirable and irreversible changes in dental occlusion, skeletal structure, and muscle dynamics.\textsuperscript{(146)} After symptom relief permanent occlusal modification should be performed in order to gain a lasting effect, a treatment that may include occlusal equilibration, prosthetic restoration and orthodontics. Occlusal adjustment, either permanent or temporary, can still be an appropriate treatment for dental pathology, but its role in the primary treatment of TMJ disorders is uncertain.\textsuperscript{(127)}

**Pharmacological therapy**: its main goal in the management of ID is not to cure the disorder but is aimed at helping patients manage their pain and/or dysfunction for extended periods of time often used with other therapies (i.e., physical therapy, appliance therapy).\textsuperscript{(147)} Several drug classes have been used in management of ID involving analgesic, corticosteroid, Non Steroidal Anti Inflammatory Drugs (NSAIDs), muscle relaxant, antidepressants, and sedative hypnotics. A recent study\textsuperscript{(169)} concluded that in patients who have TMJ closed lock, medical management with a 6-day regimen of oral methylprednisolone (Medrol DOSEPAK) followed by 3 to 6 weeks of NSAIDs therapy worked equally as well over a 5-year period as arthroscopy or open joint therapy in reducing jaw pain and dysfunction as
measured by the Craniomandibular Index.\(^{(169)}\) It was reported that patients who have severe disc interference disorders and inflammatory conditions, such as capsulitis, synovitis, and TMJ osteoarthritis/rheumatoid arthritis, may benefit the most from this class of drugs.\(^{(170)}\)

NSAIDs represent first-line drugs for many clinicians treating TMJ pain. Patients who have early painful disc displacement, capsulitis, synovitis, and arthritis associated with the TMJ may benefit the most from these drugs. Low dose tricyclics are effective in controlling pain from night time bruxism, when doses are adjusted to provide improved sleep.\(^{(127)}\) After psychiatric consultation, if it is determined that clinical depression is an aggravating factor, antidepressant medication can be helpful as part of the treatment.\(^{(171)}\)

**Intra-articular injections:**

Growing evidence suggests that patients with a closed lock, especially one that is long-standing showed significant reduction of pain and dysfunction after *intra-articular injection of sodium hyaluronate.*\(^{(147,172)}\) Yavuz et al.\(^{(173)}\) in their prospective study, 40 TMJs of 33 patients who had TMD were treated with intra-articular sodium hyaluronate injections at weekly intervals for 3 weeks. They concluded that intra-articular hyaluronic acid injection for the treatment of reducing and non-reducing disc displacement of TMJ is an effective and safe management.

Also, Yeung and his coworkers\(^{(174)}\) reported that two cycles of intra-articular injection using high molecular weight sodium hyaluronate on alternative weeks looks very positive for patients affected by non-reduced disc displacement and is encouraged to be used as a primary treatment of TMD.
The *intra-articular corticosteroids injection* holds promise for control of TMJ inflammation and prevention of associated morbidities. Corticosteroid joint injection has been popularized as prompt and lasting therapy for juvenile idiopathic arthritis.\(^{(175)}\)

Steroids possess anti-inflammatory properties. On the cellular level, steroids are highly lipophilic and are believed to bind to the cell’s nucleus. Intra-articular steroids seem to reduce the number of lymphocytes, macrophages, and mast cells \(^{(176,177)}\); this, in turn, reduces phagocytosis, lysosomal enzyme release, and the release of inflammatory mediators.\(^{(178)}\) Inflammation is reduced, particularly through reductions in the release of interleukin-1, leukotrienes, and prostaglandins \(^{(179,180)}\). With the reduction of these inflammatory mediators, pain symptoms often are improved.

Because they are injected locally, intra-articular steroids avoid most of the systemic effects of oral steroids, including high blood pressure, osteoporosis (thinning of the bones), Cushing’s syndrome (weight gain, moon face, thin skin, muscle weakness and brittle bones), cataracts, slowed growth, reduced resistance to infection, sudden mood swings and increased appetite, muscle weakness, skin thinning resulting in easy bruising, peptic ulceration, and aggravation of diabetes. \(^{(24,181)}\) Unfortunately, intra-articular corticosteroid injection have deleterious effects on joint tissues such as destruction of the articular cartilage, infections and progression of existent joint disease. \(^{(172,182)}\)

*Opioid receptors* have been discovered in the peripheral nervous system. Mu, delta, and kappa receptors were found on peripheral nerves.\(^{(183,184)}\) The effectiveness of opiates in inflamed tissues has been explained by a disruption in the perineurium, allowing for easier access of
opioids to neuronal receptors.\textsuperscript{(184,185)} It was proposed that the effects of \textit{intra-articular morphine} might simply be due to systemic absorption; however, the plasma concentration achieved from an intra-articular injection was found to be too low for a systemic effect to be observed.\textsuperscript{(184)} Within the joint itself, the relative concentration is high.

Kalso et al\textsuperscript{(186)} reviewed 36 randomized controlled trials. Four studies that compared opiates with placebo found greater efficacy for intra-articular morphine, another four studies that compared intra-articular morphine with intravenous or intramuscular morphine showed greater efficacy for intra-articular morphine.\textsuperscript{(187)} Upon reviewing the literature, different dosages were used with varying effects. Specifically, the minimum dose tested (0.5 mg) did not show efficacy, but a dose of 1 mg did. No greater effect was found when a dose of 1 mg was compared with 2 mg\textsuperscript{(186,187)}.

Non surgical methods play an imperative role in treating ID. Sidebottom\textsuperscript{(188)} declared that more than 80\% of the ID patients will benefit from the conservative techniques and only minority may require more aggressive intervention. Better results were mentioned by Gaudot et al\textsuperscript{(189)} where he stated that from 708 patients consulted his team with clinical features of temporomandibular dysfunction only 62 underwent surgical procedures with success rate of nearly 91\%.

The best results reported in the literature were by Dolwick et al\textsuperscript{(190)} and Fridrich et al\textsuperscript{(191)} where they concluded that only 5\% of the patients will need surgical treatment. Lee et al\textsuperscript{(192)} reported a relatively lower results where he avowed that the success rate of non surgical methods is approximately 60\%.
Then we can wrap up by acknowledging that non surgical methods are effective in treating ID with success rate ranging from 60% to 95%\textsuperscript{(145)} and that they play the major role in alleviating the patients' suffering. The only blemish in non surgical means is that the length of time for patients to reach a normal pain free range of motion may be suboptimum.\textsuperscript{(145)} When these non surgical techniques prove to be unsuccessful surgical procedures are deemed necessary. TMJ surgery ranges from minor minimally invasive surgeries to aggressive ones. The minimally invasive surgical techniques include two main entities which are Arthrocentesis and Arthroscopy. These minimally invasive surgical techniques have filled the large void between the non surgical methods and the aggressive open TMJ surgeries.

**Surgical Treatment**

Surgery for treatment of ID has the twin advantages of effectiveness and a rapid response. Surgical consultation should be offered within 2-3 weeks to patients with documented ID and in whom severe pain and dysfunction persists after a trial of non-surgical therapy.\textsuperscript{(147)} Various surgical procedures have been used for management of ID and could be categorized into closed and open treatments.

**Closed surgical treatment**

Closed surgical treatment of ID does not involve surgical exposure of the TMJ. The currently employed techniques include Arthroscopy and Arthrocentesis.
Arthroscopy.  

With the advent of arthroscopy, arthroscopic surgery gained wide acceptance and popularity among oral and maxillofacial surgery.

TMJ arthroscopy is a surgical modality which has rapidly gained worldwide acceptance in the last century. It is an equipment dependant minimally invasive surgical procedure that requires a great skill on the part of the surgeon and it involves placement of an arthroscopic telescope into the joint space.  

A brief historical review is needed to understand its historical background.

In 1867 Desormeaux described a mean of examining the genitourinary passages using an open tube endoscope and he was the first to realize the importance of a lens system to concentrate the beam of light. In 1868 Bevan performed the first endoscopic surgical procedure where he extracted foreign bodies from the esophageous. In 1879, Nitze collaborated with Benche, an optician, and Leiter, an instrument maker to design the first well premeditated endoscope. The endoscope had an external diameter of 7 mm and a prism as an optical system and a burning platinum wire was used as the light source. In 1882 Nitze developed the first successful photographic endoscope and he later published the first endoscopic atlas in 1884. The first introduction of the endoscopic technology to the joints was in 1920 by Tagaki who used an endoscope to examine a tubercular knee. In 1931, Takagi developed a 3.5 mm arthroscope suitable for the examination of smaller joints using saline dilation. In 1955 Watanabe, a student of Takagi performed the first knee arthroscopic surgery to remove a giant cell.
tumor. Modern arthroscopy was born in 1959 when Takagi, Watanabe, and Ikeuchi (200) developed single puncture and multiple puncture (triangulation) techniques and they performed arthroscopic synovial biopsies, cautery of intra-articular structures, extraction of loose bodies, resection of tumors, and partial meniscectomies. (200)

This improvement in knee arthroscopic procedures and the ability to perform a wide range of different surgeries attracted the attention of oral and maxillofacial surgeons to the capabilities and benefits of arthroscopy. So in 1975 the first report of diagnostic TMJ arthroscopy was made by Ohinishi (17), 57 years after the earliest attempt at knee arthroscopy. In 1982 Murakami (19) published descriptions of the arthroscopic anatomy and pathology. In 1985 Holmund and Hellsing (20) described soft tissue landmarks for arthroscopic TMJ penetration. The first TMJ arthroscopic lysis and lavage (ALL) procedure was described by Sanders in 1986. In 1988 Heffez and Blaustein (200) described the arthroscopic criteria for normal TMJ disc position and internally deranged joints.

Until that time operative arthroscopy was still limited by the size of the instruments and the lack of miniature instruments needed to be engaged in different procedures in the TMJ. This was changed in 1991 by the introduction of the fiber-optic laser technology to the field of TMJ arthroscopy by Indresano and Koslin (201,202) which had a magnificent impact on increasing the potentials of operative arthroscopy. Lastly, McCain (203) developed suturing techniques that allowed operative arthroscopy to compete open arthroplasty in repositioning the TMJ disc. (204,205)

As described before, arthroscopy is a highly technique sensitive, equipment demanding procedure. In addition, it needs considerable dexterity from the surgeon which can be achieved by proper training. In fact, a skillful
operator may need a lengthy, learning curve to start mastering arthroscopy.\(^{(204)}\) In consequence; many points should be addressed while dealing with the TMJ arthroscopy. Arthroscopic equipments, classification and the different types of performed arthroscopic surgeries are the two principle topics that will be conversed.

At the outset, an arthroscope or an endoscope can be defined as a cylinder that conducts light to a cavity and transmits an image back to the eye.\(^{(205)}\) Arthroscopic equipments and instrumentation can be divided into three sections.

The first section discusses the arthroscopic proper, the second section discusses the solid instruments for penetrating the TMJ space, and the last section discusses the equipments required for adequate illumination.\(^{(203)}\)

The arthroscopic proper is the main core of any arthroscope and is usually made of some essential components regardless the type of the endoscope. These indispensable components include an ocular lens mounted on an eyepiece, an illuminating mechanism, a transmitting mechanism consisting of a series of lenses or a fibers and a working end made of a prism and an objective.\(^{(203)}\)

The arthroscope can be classified according to the optical principles upon which it is based into: traditional lens system, rod lens system, and self-scope lens system.\(^{(205)}\) The traditional lens system and the rod lens system are examples of rigid endoscopy in which the transmitting mechanism consists of a series of lenses. The self-scope lens endoscope is more flexible than the previous ones since it uses glass fibers rather than the rigid lenses as its transmitting mechanisms. The traditional lens system is seldom used nowadays since it usually produces images of low contrast. The self-scope lens system is as well rarely used due to inherent limitations in the
degree of brightness, color, resolution, and contrast of the images produced by this endoscope. This makes the rod lens system the most frequently used endoscope in the field of TMJ surgery.\(^\text{(203)}\)

Available telescopes also vary in their direction of view or their viewing angles where the objective lens can be mounted at 0, 10, 25, 30, 70, and 120 degrees. The most versatile endoscopes are those with either 0 or 30 degree viewing angle. Finally, telescopes used for engaging the TMJ usually run from 1.8mm to 2.6mm in diameter.\(^\text{(199,203)}\)

The basic instruments required for penetration and joint exploration can be categorized into capsule penetration instruments, and hand-held surgical instruments.\(^\text{(205)}\) For capsule penetration three principal components are needed: external sheath or cannula, sharp trocar or obturator, and blunt trocar. Sharp trocars are used to penetrate through the skin and the underlying tissue layers until the joint capsule is reached then blunt trocars will be needed for any maneuver in the joint space. External sheaths actually act as the housing through which trocars and the telescope can reach the inside of the TMJ.\(^\text{(203)}\)

Hand held instruments include wide range of different instruments needed to perform diverse arthroscopic operative procedures. Probes are effective tool in both diagnostic and operative arthroscopy.\(^\text{(203)}\) By virtue of the dull hook in its distal end, the probe may be used to practice triangulation, retract the retrodiscal tissue, and check the consistency of remodeled retrodiscal tissue and disc. Scissors and punch forceps with long working arms may be introduced through the external sheath of the second port to be used for retrieval of foreign, removal of small pieces of tissues, and incision of adhesions.\(^\text{(205)}\) Knives are also frequently used in the TMJ arthroscopic surgery to incise tissues as diseased synovuim or remodeled
retrodiscal tissue. The last section in arthroscopic instruments deals with illumination. The light sources are needed to illuminate inside the joint cavity for optimum diagnosis and video photography.

Two light sources are available: xenon, and halogen. Xenon has the advantage of providing brighter images with better color quality than halogen light sources. However, xenon light sources are more expensive than the halogen ones.

Secondly, *arthroscopic technique* can be classified according to the space inspected or the number of the portals used. Classified by the number of the portals used, arthroscopy can be a single port when only one opening is made into the joint or as double port arthroscopy when a second instrument port is used. Being classified according to spaces, arthroscopy is actually two types: superior joint arthroscopy or inferior joint arthroscopy.

Inferior joint arthroscopy can be achieved directly through a puncture via the lateral capsule or indirectly via a perforation in the remodeled retrodiscal tissues. Inferior joint arthroscopy is rarely done because of the confinement of the inferior joint space where the volume of the inferior joint space is nearly half that of the upper joint space. Moreover, because of the tight attachment of the medial and lateral capsular ligaments, ready access to the inferior joint space recesses is significantly limited.

The final issue that should be tackled is the diverse procedures that can be accomplished by arthroscopy. They can be divided into two major procedures: diagnostic arthroscopy and operative arthroscopy.

Diagnostic arthroscopy is useful in detecting many forms of joint pathology affecting the synovuim, the cartilage surfaces, and the retrodiscal
tissue. The joint should be examined systematically starting from the posterior aspect and continuing to the anterior recess. Diagnostic examination is done under dilation provided by lactated Ringer's solution to maintain hemostasis and increase the joint space to allow for adequate examination.

Operative arthroscopy includes variable sophisticated procedures ranging from simple irrigation of the joint to disc plication. Nevertheless, most surgeons limit the use of arthroscopy to simple lysis and lavage (ALL). ALL can be accomplished by simple sweeping movement using the blunt trocar to break the present adhesions which is followed by thorough joint irrigation to remove any blood clots and debris.

Likewise, irrigating the joint has also the benefit of distending the joint and breaking the suction cup effect. Capsular release procedures are also beneficial in improving range of motion in joint with restrictions caused by ID. In general, these restrictions can be enhanced by either anterior or lateral capsular release. Anterior capsular release aims to widen the anterior wall of the joint which can be accomplished by probes or laser which will have a weighty effect on joint translation. Lateral capsular release, on the other hand, increases lateral excursions and it is achieved by stretching the lateral wall of the capsule by probes or sharply dissecting it by Holmium: YAG laser. Last but not least, disc repositioning can be also done by arthroscopy. This can be done by combining anterior release and contracting the posterior attachment by laser, injecting sclerosing agents as sodium morrhuate, or the suturing maneuver described by McCain et al in 1992.

Although TMJ arthroscopy is considered a relatively safe technique, it is not exempt from complications. Most of these complications may take
place during the procedure or immediately after it. In addition, these complications may vary from minor insignificant ones to serious complications. These complications may be otologic, neurologic, vascular, ocular or infections in the joint area.\(^\text{215}\)

Vertigo, hearing loss, lacerations of external auditory canal, lesions of tympanic membrane and blood clots in the external auditory canal are the otologic complications that may take place during arthroscopic surgery. This may be attributed to the close proximity of the joint to the external auditory canal, tympanic membrane, and middle ear.\(^\text{215}\)

Injury of nerves in vicinity of the joint area may occur as well during operative arthroscopy. This includes paresis of facial nerve, injury to the auriculotemporal nerve and inferior alveolar nerve\(^\text{215}\).

Moreover, cardiac depression has been reported in the literature and is caused by stimulation of the trigeminal nerve. This may be caused by stimulation of the vagus nerve via its central nucleus which receives the afferent fibers of the trigeminal nerve. Although extremely rare, this complication may compromise the vital signs of the patient requiring rapid intervention of the anesthesiologist to re-establish the patient's vital signs.\(^\text{216,217}\)

Bleeding is the most common complication during TMJ arthroscopy. Usually, it does not cause significant effects other than compromising the visibility during the procedure. Although alteration of visual accuracy was also reported as a complication which may accompany arthroscopy, there is still no clear explanation for its pathogenesis.\(^\text{215}\)
Infections as otitis media, joint infection, and infratemporal space infection were reported in conjunction with arthroscopy and they are usually successfully managed by antibiotics.\(^{(218)}\)

Complications of arthroscopy are in general of unusual occurrence, low in severity and permanence. In fact the largest retrospective study in literature by McCain et al reported 4% complication when arthroscopy was performed in 4831 joints in more than 3000 patients.\(^{(208)}\) Furthermore, Garcia et al reported more recently a 1.34% complication in 670 different arthroscopic procedures.\(^{(215)}\) Thus; arthroscopy can be considered a safe and non invasive technique.

**Arthrocentesis:**\(^{(24-26)}\)

Nitzan et al.\(^{(24)}\) were the first to describe arthrocentesis of TMJ as a treatment concept for severe closed lock symptoms. Orthopedic arthrocentesis, by definition, refers to needle puncture of a joint space, aspiration of fluid from that space and injection of a therapeutic substance.\(^{(219,220)}\)

Arthrocentesis was based on two treatment modalities; namely pumping manipulation procedure\(^{(220)}\) and the arthroscopic lysis and Lavage.\(^{(221-223)}\) It entails placing two needles into the superior joint space for lysis and Lavage via hydraulic pressure, which will release the displaced disc and thereby re-establish normal maximal mouth opening. Upon reviewing the literatures, a wide variety of needles as well as amount and type of irrigating solutions have been used for Arthrocentesis procedure. The gauge of utilized needles varies from 18-21.\(^{(223)}\)

The joint is irrigated with 50–100 ml of Ringer’s solution or sterile normal saline.\(^{(172,223)}\)
The amount of irrigating solution is arbitrary, with no minimum or maximum amount having been proven to be within the therapeutic range,(224) although the ideal volume for Lavage of the UJC has been reported to be between 300 and 400 ml. (224-225)

There have been many variations in the technique since its emerge in 1991 which all aimed to increase its efficiency and expand its scope. Yura et al (226) in 2003 claimed that the standard low pressure Arthrocentesis is not always effective in chronic closed lock cases as it does not remove adhesions in the joint space. As a consequence, he modified the standard technique and used an infusion accelerator of blood bag for irrigation which establishes a pressure of 40Kpa compared to 6.7Kpa of the standard low pressure technique and. (226) Yura also proved by arthroscopic examination before and after irrigation under sufficient pressure that this high pressure irrigation can actually release band like adhesions and thus high pressure Arthrocentesis has wider application in TMDs than low pressure (227)

Alkan et al (228) achieved the highest pressure reported in literature (300Kpa) by irrigating the joint via the irrigation pump of the dental implant motor.

Additionally, Laskin (229) reported also that changing the standard portals for the joint space may make Arthrocentesis easier. He found that, although placement of the posterior needle is usually accomplished easily, insertion of the anterior one is often more difficult. Even though their placing in this way may be necessary for complete visualization and for triangulation of instruments during Arthroscopy, it is not necessary for Arthrocentesis. Therefore, he suggested placing the posterior needle as in the standard technique in the posterior recess and inserts the anterior needle as well in the
posterior recess by placing it 3-4 mm in front the posterior needle. This accomplishes the same purpose and is a much easier technique.

Nardini et al. (230) proposed a single needle Arthrocentesis technique where one needle is placed in the posterior recess as in the standard technique while the patient is maximally opening his mouth and then the fluid gets off the joint is when the patient close his mouth elevating the intra-articular pressure. This technique offers many advantages over the two needle Arthrocentesis which provides more stable access to the joint space, this technique also decreases the trauma to joint space and thus decrease postoperative pain and discomfort. Finally, it decrease the execution time needed to perform the procedure.

Arthrocentesis has proved to be a minimally invasive treatment modality, relatively safe, reversible and it can be done on outpatients under local anesthesia which significantly revert the mouth opening to a normal range. It is an effective method for the re-establishment of normal disc-condyle-fossa relationship. (24)

An interesting question is how does arthrocentesis work. Why should this simple Lavage of the upper joint space (UJC) in patients with TMJ closed lock (CL) be therapeutic (231)? It was proposed that Lavage and lysis of the UJC would eliminate the vacuum effect and alter the viscosity of the synovial fluid (SF) thereby aiding translation of the disk and condyle. (24,231) Arthrocentesis is also said to address the three common symptoms of TMJ-CL: limitation in MMO, pain and dysfunction (232). These symptoms are interrelated where increased pain causes decreased MMO, which in turn causes dysfunction. Correction of one problem can lead to correction of the other two (232). Thus, Arthrocentesis in combination with shearing forces generated by joint manipulation is thought to release adhesions, thereby
Review of Literature

enabling normal MIO.\textsuperscript{(233)} The washing out of inflammatory mediators \textsuperscript{(234-236)} as well as the direct action of instilled medications on intra-capsular receptors have their effect in pain reduction. Improved perfusion of nutrients into the joint following Arthrocentesis allows some components of repair and adaptation. \textsuperscript{(231,235)}

Various drugs such as Corticosteroids, Local anesthetic agents, Morphine, Sodium hyaluronate have been injected in the TMJ in conjunction with arthrocentesis to enhance its outcome. It was reported that intra-articular corticosteroid injection after arthrocentesis provides long-term palliative effects on subjective symptoms and clinical signs of TMJ pain. Unfortunately, intra-articular corticosteroid injection has an unpredictable prognosis and also can cause local side effects on joint tissues.\textsuperscript{(172)} Sodium hyaluronate (SH) has been proposed as an alternative therapeutic agent with similar therapeutic effects. This highly viscous, high-molecular substance plays an important role in joint lubrication and protection of the cartilage.\textsuperscript{(172)} Intra-articular morphine was used after arthrocentesis. This has been described in orthopedics, particularly after arthroscopic knee surgery, with good clinical effects, \textsuperscript{(237,238)} suggesting that opiate receptors may be present within joints. It was found that the instillation of low dose morphine alone (either 0.1 mg or 1 mg) in patients with unilateral TMJ pain significantly increased the pain threshold and improved mouth opening ability.\textsuperscript{(239)}

\textbf{Open surgical treatment}

Criteria to select candidates for these aggressive surgical treatments may not be clear and non specific. The \textit{first} criterion is that the pain and dysfunction is localized only to the joint area. The more diffuse the pain and dysfunction, the less likely it is that the surgical interventions will be successful. The \textit{second} criterion is extremely important as it entails that
surgical intervention are only accepted when non surgical techniques and minimally invasive procedures are exhausted for a considerable time. The third criterion is an imaging evidence of the disorder. \(^{(240)}\)

Open surgical procedures are divided into two main groups: *Disc preservation procedures, and Discectomy*. \(^{(241-248)}\)

*Disc preservation* procedures are those techniques in which the disc is not sacrificed. Although literature support the efficacy of these maneuvers many surgeons still have the perception that disc repositioning procedures are not that successful. This may be attributed to the poor unrealistic expectations of the surgeons and their patients. In addition, the postulation that appropriate disc reposition is not always needed to achieve reduction in patient's symptoms has also decreased the interest in these procedures. Finally, the variation in the surgical techniques used may have confused the surgeons since the aspects of these procedures have not been accurately communicated. These techniques include full thickness plication, partial thickness plication, disc reshaping, condylar shaving, modified condylotomy, eminence reduction, and various combinations of these techniques. \(^{(241)}\)

*Disc repositioning* involves removal of tissue from the bilaminar zone in an amount that corresponded to the degree of the disc displacement. The disc should then be repositioned over the condyle and sutured to the distal and the collateral ligaments. \(^{(241)}\)

The *Modified Condylectomy* \(^{(242-245)}\) is a modification of the intraoral vertical ramus osteotomy used in orthognathic surgery and the aim of this procedure is to reposition the condyle anteriorly and inferiorly beneath the
displaced disc. This will result in a slight increase in joint space, which will allow the disc to move to a more favorable position.

Alloplastic implants are not generally indicated for initial surgical treatment of joints with ID. Prosthetic joint replacement may be indicated in selected patients with severe joint degeneration, destruction, or ankylosis.\textsuperscript{(246-249)} The remaining of a significant number of patients who have continued pain or dysfunction following open surgery could be due to failure of open joint surgery to correct some unknown biochemical disturbances.

Complications are not uncommon after these aggressive open surgical procedures. Facial nerve injury is the most significant complication. Although total facial nerve paralysis is possible, it is rare. Inability to raise the eyebrows is the most commonly observed finding. It occurs in about 5% of the cases and usually resolves in 3 months. Other complications include limited mouth opening because of heterotropic bone formation, occlusal changes, bleeding and infection.\textsuperscript{(250)}

So TMJ surgical interventions are reserved for a minority of cases, and are usually used with caution as well.
AIM OF THE STUDY
**Aim of the study**

The purpose of this study was to evaluate the clinical outcome and the changes in disc position, mobility, and morphology in patients with temporomandibular joint closed lock in response to arthroscopic lysis and lavage versus arthrocentesis using magnetic resonance imaging (MRI).
PATIENTS & METHODS
Patients and Methods

Patients

The current prospective study was conducted on healthy adult patients with closed lock (DDnR), based on clinical and MRI findings. They were selected from those who attained to the outpatient clinic, Oral and Maxillofacial Surgery Department, Faculty of Oral and Dental Medicine, Cairo University with ID. They had fulfilled the following inclusion criteria:

Inclusion criteria:

- Age ≥ 18 years
- Obtaining written informed consents signed by the patients.
- Willingness and ability to commit to follow-up

Exclusion criteria:

- Patients who received previous TMJ surgery
- The selected patients were excluded from the study if they respond to conservative therapy in the form of:
  1. Non-steroidal anti-inflammatory drug (Antiflam*1 50 mg one tablet twice daily).
  2. Muscle relaxant (Myolgen *2 one tablet twice daily).

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1 *Antiflam 50: Diclofenac potassium 50 mg, Manufactured by T3A Industrial for T3A pharma, Assiut, Egypt.
2 *Myolgen: Each capsule contains chlorzoxazone 250 mg+Paracetamol 300 mg Manufactured by GlaxoSmithKline S.A.E. EL Salam City, Cairo, Egypt.
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4. Superior repositioning occlusal splint (vacuum-formed upper hard splint of 4 mm. Thickness) was worn day and night.
5. Thermotherapy in the form of hot application for half an hour three times daily.

The drugs were stopped after two weeks and the patients continued on the splint alone for additional 8 weeks.

Grouping of the patients

Twelve out of 23 patients (52.17%) did not respond to the used conservative therapy. Their ages ranged from 22-34 years, with an average of 29.4 years. They were all females. Tables 4 and 5 show the demographic data of the selected patients. They were assigned into 1 of 2 equal groups:

Group I:
Arthroscopic lysis and lavage was performed with intra-articular injection of 1ml of Depomedrole*3 (40mg/1ml) at the end of the procedure.

Group II:
Arthrocentesis was performed with intra-articular injection of 1ml of Depomedrole (40mg/1ml) at the end of the procedure.

Preoperative evaluation:

The participants were reassessed. Preoperative evaluation included history, detailed medical and Magnetic resonance imaging (MRI) investigation. Data for each patient were collected in her own questionnaire and examination chart (Fig. 1)

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Clinical examination

I. TMJ examination:
A. TMJ function:

- Maximal inter-incisal opening (MIO) as measured in mm from maxillary dental midline to mandibular dental midline.
- The presence of mandibular deviation or deflection during mouth opening.
- The maximum protrusive movement by measuring the horizontal distance between the maxillary and mandibular dental midline in mm.
- The maximum lateral excursion by measuring the horizontal distance between the maxillary and mandibular dental midline in mm.

Table 4: Data of patients responded to conservative therapy

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age(yrs)</th>
<th>Sex</th>
<th>Site of complaint</th>
<th>Duration in months</th>
<th>Chief complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>Male</td>
<td>Right</td>
<td>9</td>
<td>TMJ pain, limited MMO</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>Male</td>
<td>Left</td>
<td>12</td>
<td></td>
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<tr>
<td>3</td>
<td>23</td>
<td>Male</td>
<td>Right</td>
<td>7</td>
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<tr>
<td>4</td>
<td>23</td>
<td>Male</td>
<td>Left</td>
<td>3</td>
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<td>5</td>
<td>30</td>
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<td>Left</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>Female</td>
<td>Left</td>
<td>18</td>
<td>TMJ pain, muscle tenderness</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>Female</td>
<td>Left</td>
<td>5</td>
<td>TMJ pain, limited MMO</td>
</tr>
<tr>
<td>8</td>
<td>29</td>
<td>Female</td>
<td>Right</td>
<td>7</td>
<td>TMJ pain, muscle tenderness</td>
</tr>
<tr>
<td>9</td>
<td>31</td>
<td>Female</td>
<td>Right</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>27</td>
<td>Female</td>
<td>Right</td>
<td>2</td>
<td>TMJ pain, limited MMO</td>
</tr>
<tr>
<td>11</td>
<td>30</td>
<td>Female</td>
<td>Right</td>
<td>8</td>
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</tbody>
</table>
Patients and Methods

Table 5: Demographic data of the participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Case no</th>
<th>Age (years)</th>
<th>Site of complaint</th>
<th>Chief complaints</th>
<th>Duration in months</th>
</tr>
</thead>
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<td>I</td>
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<td>TMJ pain, limited MMO</td>
<td>12</td>
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<tr>
<td></td>
<td>2</td>
<td>25</td>
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<td>24</td>
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<tr>
<td></td>
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<td>32</td>
<td>Left</td>
<td>TMJ pain, limited MMO, muscle tenderness</td>
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<td>TMJ pain, limited MMO</td>
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<tr>
<td></td>
<td>6</td>
<td>28</td>
<td>Right</td>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

B. TMJ palpation:

TMJ was examined by palpation via preauricular and meatal approaches to determine:

- The presence of TMJ tenderness or pain.
- The translatory movement of the condyle during different mandibular movements.
- Joint sounds: the presence or absence of joint sounds.

II. Muscle examination:

The masticatory and sternocleidomastoid muscles were examined by palpation to determine the presence of tenderness.
**Patients and Methods**

**Fig.1: Questionnaire chart.**

1. **History:**
   The case history of each patient was taken by direct conversation with him or her.

   **A- Personal history**
   - Name………………………………….. - Age……
   - Sex………………………………….. - Occupation………………..  
   - Marital status……………………….. - Address
   - Phone number………………………………………………..<br>**B- Past dental history**
   - Have you had any teeth problems lead to their extraction, yes or no? ........
     - If yes: Was there any relation between extraction and onset of complication? ..........  
     - Have you had any oral appliance, yes or no? ..............  
     - Have you had any dental treatment, yes or no? ...................
     - If yes: What is the kind? Orthodontic treatment, prosthetic appliance, restorative treatment………………..<br>**C- Medical history**
   - Have you had any related discomfort, yes or no? ............
     - If yes: What is the type? Headache, hypertension, neck ache, other joint pain, ulcer, colitis, ear pain, or change in hearing? ..........  
     - Have you had any previous treatment for pain or muscle, yes or no?
     - If yes: What is the type? ………………..<br>   - Have you had any of the following: rheumatoid arthritis, osteoarthritis, sinus infection, ear infection, blood vessels diseases?
   - Do you take any medication regularly? …………………..<br>**D- Chief complaint and present illness**
   - What is the main problem that brings you here? …………………..<br>   - Do symptoms affect one or both sides? …………………………..
   - How long have you been bothered by this problem? …………………..<br>**History of chief complaint:**
   **1- pain**
   - Site of pain.
   - Nature: sharp, lancinating, dull, referred, aching, deep, superficial, pulsating………………..<br>   - Strength: Pain was evaluated by two methods:
     - Patient self-assessment using visual analogue scale ranging from 0-10.
     - Pain was estimated by the patient as severe, moderate, or mild.
   - Tolerability: tolerable or not………………..<br>   - Onset; immediate, gradual………………..<br>   - Duration: For how long? ………………………..<br>   - Course: Progressive, regressive, fluctuant………………..<br>   - Location: localized or diffuse Unilateral or bilateral? …………………..<br>   - Does pain spread, radiate, or migrate? ………………………..<br>   - What events that initiate, precipitate or relief the pain? …………………..<br>   - Time of pain (morning, afternoon, evening)……………………..<br>**2- Dysfunction**
   - Do you have any disturbance in jaw movements, yes or no? …………………..<br>   - Do you grind or clench your teeth at night or during day, yes or no? ...........
     - If yes, what is the kind? …………………..<br>   - Do you have any other oral habits, yes or no? …………………..<br>   - Do you notice any change in your ability to chew? …………………..<br>**3- Psychological background**
   - Do you consider yourself under stress or depression? …………………..<br>   - Are you under any psychological treatment? …………………<br>
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III. Dental occlusion examination:

- Inspection of dental occlusion to determine the presence of malocclusion and its relation to TMJ troubles.
- The presence of badly constructed movable or fixed restorations and dental fillings.

MRI investigation:

MRIs were obtained for all patients preoperatively to confirm clinical diagnosis (Fig.2).

Image Acquisition:

- MRI was ordered in closed and open mouth positions.
- Closed mouth position: the patients were instructed to put the posterior teeth in the position where they fit the best and the clinician should verify it visually. MR images at closed mouth were oblique sagittal proton density and T2 weighted images at closed mouth using a dedicated TMJ surface coil.
- Open mouth position: each patient was instructed to open as much as she can. Open MRI were acquired in proton density algorithm only using a dedicated TMJ surface coil.
- A minimum of 6 sagittal slices were taken for each joint with a slice thickness of 3mm.
- Proton density had repetition time (TR): 2,000.0 and an echo time (TE): 17, 0.
- T2 had TR: 2,000.0 and TE: 102, 0.

Non Osseous components assessment criteria using MRI:

- Disc position; closed mouth position: normally, in the sagittal plane, relative to the superior aspect of the condyle, the border between the low
signal of the disc and the high signal of the retrodiscal tissue is located between the 11 and 12 clock positions. If the disc is located anterior to the 11 clock positions, it is considered displaced.

- **Disc position; open mouth position**: normally, the intermediate zone is located between the condyle and the articular eminence. If the intermediate zone is located anterior to the condylar head, the disc is considered non-reduced displaced.

- **Effusion; T2 closed mouth position**: it was considered positive if a bright signal was seen in either joint space that conforms to the contours of the disc, fossa/articular eminence, and/or condyle.

**Disc diagnosis for TMJ using MRI:**

- **Normal**: Disc location is normal in closed and open mouth positions.
- **Disc displacement with reduction (DDwR)**: Disc is displaced anteriorly in closed mouth position and normal in open mouth position.
- **Disc displacement without reduction (DDnR)**: Disc is displaced anteriorly in both closed and open mouth positions. (Fig.3)
- **Not visible**: Neither signal intensity nor outlines make it possible to define a structure as the disc in the closed-mouth and open-mouth

**Standardization of MR and inter-examiner reliability:**

The MRI examinations were conducted at the same centre (Kasr el aini radiology department-Cairo University) to ensure standardization of the technique. The MR imaging was acquired on MR machine, Intera 1.0 Tesla superconductive unit with bilateral TMJ surface coil. All MRI images were reviewed with 2 different clinicians.
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**Fig. 2**: Sagittal proton density MR image for the left joint in the closed mouth position (A) showing anterior disc displacement and in open mouth position (B) showing non reducible disc.

**Arthrocentesis technique:**

- The patient head was draped in the usual surgical manner. The ear and the operated preauricular area were disinfected using Betadin*⁴ surgical scrub solution.

- Two points were marked on the skin over the articular fossa and eminence along a line drawn from the middle of the tragus to the outer canthus of the eye (Fig. 3A).

- The posterior inlet point was located 1 cm from the middle of the tragus along the canthotragal line and 0.2 cm below the line.

- The anterior outlet point was located 2 cm from the middle of the tragus and 1 cm below the canthotragal line.

- Auriculotemporal nerve block anesthesia was then performed using Mepecaine L*⁵ (Fig. 3B).

- Few drops of local anaesthesia were injected subcutaneously at the anterior and posterior points (Fig. 3C).

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*Betadin: povidine-iodine USP Nile Pharmaceuticals Co., Cairo, Egypt.

*Mepecaine L: Mepevacaine Hcl 2% with Levonordefrin 1:20000, Alexandria Co.for pharmaceuticals, Alexandria, Egypt.
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- About 1cm spacer was placed between teeth to increase the intra-articular space and to stabilize and fix the condylar position at the operated side during injection.

- At the posterior inlet point, a 16 gauge cannula was inserted into the superior joint space and 2 ml of saline was injected through it into the superior joint space. The joint entry was confirmed by the presence of back pressure during injection, and the flow back of some drops of the solution from the inlet needle (Fig.3D). Then 2 ml of Saline was injected into the superior joint space to distend it (Fig.3E).

- At the outlet anterior point another 16 gauge cannula was inserted into the distended compartment to permit an outflow for the irrigating solution which was collected in a kidney dish. Manual lavage with 200 ml saline was then performed to establish free flow of the solution and to release adhesions (Fig.3F). During lavage the outlet cannula was momentarily blocked with finger pressure 2 or 3 times, and the patient was instructed to move the mandible through opening, protrusive, and lateral movements to facilitate lysis of the joint adhesions.

- At the end of the procedure, the outflow cannula was removed and the inlet cannula was used to inject into the joint space 1 ml of (40mg/1ml) Depomedrole.

- The inlet cannula was then removed and the patient was instructed to gently manipulate the jaw in vertical, protrusive, and lateral excursion to remove any excess of intra-articular fluid.

Post operative care and instructions

Each patient was instructed for ice bags application over the operated preauricular region. The ice bags were applied for 10 minutes followed by 10 minutes rest for 4-6 hours postoperatively in order to decrease post operative edema.
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♦ All patients were given postoperative medications as following:
  o Non steroidal anti-inflammatory drug (Antiflam 50 mg, one tablet twice daily for 1 week)
  o Antibiotic (E-mox* 500 mg, every 6 hours for 3 days) as a prophylactic measure in order to overcome any possibility of joint space infection.
♦ Each patient was instructed to apply hot fomentation at TMJ area 24 hours after injection (for 20 minutes/hour, 6 times daily) to reduce inflammation and edema.
♦ Course of physiotherapy in the form of muscle exercise was commenced immediately postoperatively for rehabilitating the muscle length and strengthens the muscles that surround the joint. The following 3 exercises were performed

* Passive stretch exercise: The patient opened to the full limit of movement and then gently stretched beyond the restriction assisted by placing the fingers between the teeth. The stretching was gentle and momentary so as not to traumatize the muscle tissues. (101,252)

* Resistant opening to encourage harmonious bilateral muscular contraction. The thumb was placed under the chin and the patient opened against gentle resistance. This exercise was repeated 10 times for 3 periods during the day. The resistant force provided by the finger was gentle and did not induce painful symptoms. (101,252)

* Minimize Zigzag opening A mirror and a straight edge were used. Patient practiced making lower midline open and close along a straight line. This exercise was repeated 10-20 times for 3-4 times during the day. (101)

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6 * E-mox 500 mg: Amoxycilin (as trihydrate) 500 mg Manufactured by Egyptian Int Pharmaceutical Industries Co. E.I.P.I.CO, Egypt.
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♦ The patients were instructed to wear the previously performed occlusal splint day and night and to remove it only for cleaning and at eating time for one month then it was removed gradually according to the improvement of signs and symptoms and the patient condition.

♦ Each patient was instructed to receive soft diet only for two weeks in order to decrease the effort upon TMJ.
Fig. 3: Arthrocentesis technique. A: Making 2 points for inlet and outlet needles. B: Auriculotemporal nerve block anesthesia. C: Subcutaneous injection of local anesthetic at the outlet needle site. D: Flow back of some drops of the solution from the inlet needle. E: Distension of the upper compartment. F: Insertion of the outlet needle and manual washing of the upper compartment with establishment of free flow of the washing solution.
Arthroscopic lysis and lavage procedure:

Armamentarium:

- Delivery system:
  a) Cannula (sheath): 2.2 mm protective metallic sheath.
  b) Sharp trocar
  c) Blunt trocar

- Arthroscope proper: arthroscope rod lens type, 2.0 mm 30° angle (KARL STRORZ, Germany)

- Illumination system: Halogen light source with a fiberoptic cable (KARL STRORZ, Germany)

- Documentation system:
  a) single chip digital video camera composed of head and a camera console (LEMEKE, vision, Germany)
  b) Digital video CD recorder and player (Caira Corporation, China) and DVDs
  c) Monitor

Arthroscopic technique:

Arthroscopic procedures were carried out under general anesthesia via nasotracheal intubation. All the procedures were done by the same specialist and assistant. The surgical field was scrubbed with betadine solution and the patient was draped in the usual manner with sterile towels.

Skeletal landmarks including the glenoid fossa and articular eminence were marked with a marking pen \(^{(20)}\). The Hollmlund- Hellsing (canthotragal) line was drawn from the lateral canthus of the eye till the tip of the tragus of the ear. From the tip of the tragus, a point was marked 10 mm anterior to the tragus along the canthotragal line and 2 mm inferior to
the line. This point represented the puncture site into the posterior recess of the upper joint space. A second point was marked 20 mm anterior to the tragus along the canthotragal line and 10 mm inferior to it. This point represented the site of the entry of the outflow needle in the anterior recess of the upper joint space.

For distension of the superior compartment and in order to avoid iatrogenic damage to the cartilaginous surfaces during introduction of the trocar and to provide a degree of hemostasis during the procedures, the assistant surgeon distracted the mandible anteriorly and inferiorly, and 1.8 mL of 2% mepivacaine with 1:200,000 epinephrine was injected into the superior joint space. A syringe with a 21-gauge needle, filled with 2-3 mL lactated Ringer’s solution, was then introduced through the puncture point into the superior joint space for further insufflation and distention (Fig. 4A).

As described by Mccain (138), the first puncture was placed at the maximum concavity of the glenoid fossa using the inferolateral approach. A sharp trocar protected by an outer cannula was advanced through the puncture point (10-2mm point) till contacting the bone of lateral crest of the fossa. Puncture of the capsule was accomplished by rotating the trocar till a pop was felt (Fig. 4B). By use of the locked connections, lactated Ringer’s solution was introduced into the joint space to confirm the position of the cannula. (Fig.4C) Once the capsule had been entered, the sharp trocar was removed to avoid scuffing of the articular surfaces and a blunt trocar was introduced in the cannula. (Fig.4D) The head of the single ship digit camera (LEMEKE, vision, Germany) was attached to the ocular end of the arthroscope (KARL STORZ, Germany). The fiber optic cable of the halogen light source (KARL STORZ, Germany) was also attached to the caudal end of the arthroscope (Fig.4E).
2.0mm arthroscope was inserted into the cannula and the cannula was locked. The arthroscopic image was received on the connected monitor and was used to verify for proper placement in superior compartment. After receiving arthroscopic image of the superior joint space, capsular distension and intermittent lavage with Ringer’s lactate were maintained through the irrigation system. The upper joint compartment was examined from the posterior pouch via the intermediate zone to the anterior pouch and was swept clear under constant irrigation. This manipulation allows translation of the disc along the eminence, allowing the condyle to complete its natural path.

An outflow cannula was inserted 10 mm anterior and 8 mm inferior to the first puncture site to allow outflow of the irrigating solution (Fig.4F). Joint lavage was the achieved using continuous irrigation of 500ml Ringer’s lactate solution. The quality of image was checked and diagnostic sweep from posterior synovial pouch to anterior synovial pouch was made. The arthroscopic images were recorded and saved on DVDs as MPEG4 format using digital video CD recorder and player.

Once the diagnostic examination and lysis and lavage procedures were finished, termination of the procedure was done first by unlock the arthroscope from the cannula, followed by cannula and outflow needle withdrawal. Cloth adhesive strips were applied to the skin punctures. For each TMJ, the extent, and distribution of various arthroscopic variables were recorded in a written form immediately after the arthroscopic examination.
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Fig. 4: Arthroscopic technique. A: Distension of the upper compartment of the TMJ. B: A sharp trocar in an arthroscopic sheath inserted into upper posterior recess C: 2.0 mm arthroscope fiber optic light transmission was inserted into the cannula. D & E: Capsular distension and intermittent lavage with Ringer's lactate were maintained through the irrigation system. F: Insertion of an outflow cannula into the upper TMJ space.
Post operative care and instructions

Routine analgesic (Antiflam 50mg Tid) and a routine antibiotic (E-mox 500mg Tid) were prescribed for the first post operative week. On second post operative day, passive mandibular exercises were started. The patients were asked to continue mandibular exercise for at least 1 month. Patients were instructed to follow a soft diet till the end of the second post operative week.

Description of the normal arthroscopic anatomy:

After the arthroscope was introduced in the superior joint space, sequential examination started in each procedure based on the protocol suggested by MCcain (253). Seven areas of the superior joint space can be examined. These areas are:

1. Medial synovial drape
2. Pterygoid shadow
3. Retrodiscal synovium:
   a. Zone 1: oblique protuberance
   b. Zone 2: retrodiscal synovial tissue attached to posterior glenoid process
   c. Zone 3: lateral recess of retrodiscal synovial tissue
4. Posterior slope of articular eminence and glenoid fossa
5. Articular disc
6. Intermediate zone
7. Anterior recess
- The first area to be arthroscopically examined is the medial synovial drape which has a gray-white translucent lining and a tense appearance with distinct superior-to-inferior striae, which serve as the first classic anatomic landmark. (Fig. 5A)

- The second area to be examined is the pterygoid shadow which is located anterior to the medial synovial drape and frequently well marked. In normal situations, the pterygoid shadow has a purple appearance, because of the pterygoid muscle under the synovial lining.(Fig.5B)

- The third area to be examined is the retrodiscal synovium. A key point within the superior joint space is the synovial membrane with a soft appearance, located in the posterior side of the posterior synovial recess. From the lateral side, several folds on the surface of the synovial membrane appears, and they disappear as long as the disc is displaced anteriorly. The synovial membrane covers the posterior insertion of the disc and is reflected superiorly to the temporal fossa. While the mouth is open, the posterior insertion covered by the synovial lining appears as a crest or crease. This finding is named oblique protuberance. The location of the oblique protuberance is in the middle third of the retrodiscal synovium. The vascular network is observed throughout the normal synovial membrane.(Fig.5C)

- The fourth area of the joint is the posterior slope of the articular eminence. The fibrocartilage is white and highly reflective with anteroposterior striae. In the back slope of the eminence, the fibrocartilage is thick. Toward the glenoid fossa, the fibrocartilage becomes darker and thinner, and becomes thin without striae over the glenoid fossa.(Fig.5D)

- The articular disc, which is the fifth area to be examined, is milky white, highly reflective, and without striae. In normal conditions, its
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surface is smooth and without fibrillations. The red-white line is the union between the posterior band of the disc and the synovium. (Fig. 5E)

- The intermediate zone is the sixth area to be examined. Without disorders, this area has a white-on-white appearance of the disc opposite to the eminence. This means as well that the disc completely roofs the condylar head (100% roofing). (Fig. 5D)

- In the anterior recess, the anterior slope of the articular eminence is evident. The fibrocartilage and the anterior band of the disk maintain the same color but without striae. In this zone, the anterior band of the disc, anterior synovial pouch and the pterygoid shadow can be seen. The junction between the anterior band and the anterior synovuim is termed the disc synovial crease. The most lateral part of the anterior synovial crease represents the site of the entry of the outflow needle in the arthroscopic lysis and lavage or the working cannula in triangulation procedures.
Fig.5: **Normal arthroscopic findings.** Medial synovial drape (MSD) and disc (D) Eminence (Em), Pterygoid shadow (PS) Retrodiscal synovuim (RDS) **A:** Normal medial Synovial drape. **B:** Condyle opposite eminence. **C:** Healthy disc. the pterygoid shadow and the posterior band of the disc **D:** Intermediate zone (normal white to white appearance). **E:** Ascending slope of the eminence (black arrow), the pterygoid shadow and the anterior band of the disc.
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Fig. 6: Abnormal arthroscopic findings A & B: On opening, the retrodiscal synovium is seen opposite to the eminence (disc displacement without reduction). C: retrodiscal synovium with Mild synovitis, arrow denotes the end of the retrodiscal synovium and beginning of the posterior band. D: Slight disc fragmentation (arrow). Significant redundancy of the retrodiscal synovium.

Outcome measures

I. Clinical outcome measures

The following outcome measures were clinically assessed and documented immediately postoperatively, after one week, and three months postoperatively.

- **Patients’ subjective pain experience.** Each patient rated her pain at rest and during function on numerical rating scale (NRS) of 0-10 with zero being no pain and ten corresponds to the worst pain that the patient ever had.
- **Maximum mouth opening (MMO).** Assessment of MMO was performed by measuring the distance in mm between the incisal edges of the upper and lower central incisors using a ruler.
- **Mandibular dysfunction.** Assessment of TMJ dysfunction was performed using Helkimo’s index.

II. MRI parameters

The disc position, mobility, and morphology were assessed and documented at the baseline and three months postoperatively.

- **Disc displacement** was classified as normal (no displacement), mild (disc displacement with reduction), and severe (disc displacement without reduction).
- **Disc morphology** was clarified in the closed-mouth projection in the sagittal plane and classified as normal (biconcave- shape), mild (biplanar or convex-shape), or severe (folded-shape or amorphous).
- **The disc mobility** was determined in the closed- and opened mouth projection in the sagittal plane. It was classified as mobile (normal) if
the disc changed its position relative to the glenoid fossa and the articular eminence. Disc fixation was considered to be present in case of lack of the position change.\(^{(251)}\)

**III. Success criteria**

The treatment was considered successful if mouth opening capacity was at least 35 mm at the end of the study and TMJ pain according to a 10-graded NRS as assessed by patients as 4 or less.

**Statistical analysis**

Data were presented as mean and standard deviation (SD) values. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Maximum inter-incisal opening (MIO) data showed normal (parametric) distribution while Helkimo index scores, Numerical rating scores and % changes in different variables showed non-parametric distribution.

The percentage changes of these parameters were calculated as:

\[
\frac{Parameter \ (post - operative) - Parameter \ (Pre - operative)}{Parameter \ (Pre - operative)} \times 100
\]

For parametric data, Student’s t-test was used to compare between the two groups. Paired t-test was used to study the changes by time in each group.

For non-parametric data, Mann-Whitney U test was used to compare between the two groups. Wilcoxon signed-rank test was used to study the changes by time in each group.
The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

® IBM Corporation, NY, USA.

® SPSS, Inc., an IBM Company.
RESULTS
Results

Postoperative course:

Generally, all patients in both groups tolerated the treatment procedures with no major complications. In the arthroscopy group, 2 patients complained of blocked ears, and two other patients reported vertigo. The vertigo lasted approximately 24 to 72 hours, and the blocked ears lasted 2 to 6 days.

3 patients from the Arthrocentesis group experienced transient facial palsy due to the anaesthetic technique that resolved within 1-2 hours postoperatively, 2 patients showed pre-auricular swelling due to fluid extravasation of the articular capsule that resolved by the second postoperative day.

Clinical results

Subjective findings:

Tables 6, 7, 8 and 9 summarize the assessments of TMJ pain using Numeric Rating Scale (NRS). Pre-operatively as well as after 1 week; there was no statistically significant difference between the two groups. After 3 months, Group I showed statistically significantly lower mean NRS score than that of Group II (Fig.7).

Both groups showed statistically significant decrease in mean NRS scores throughout the study periods (Fig.8). Comparison between the percentages decrease in NRS scores in the two groups showed no statistically significant difference (Fig.9).
### Results

Table 6: The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between Numerical rating scores in the two groups

<table>
<thead>
<tr>
<th>Period</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-operative</td>
<td>7</td>
<td>1.7</td>
<td>8.3</td>
</tr>
<tr>
<td>1 week</td>
<td>3.3</td>
<td>1.4</td>
<td>3.7</td>
</tr>
<tr>
<td>3 months</td>
<td>1.3</td>
<td>0.8</td>
<td>4</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

Table 7: The mean difference, standard deviation (SD) values and results of Wilcoxon signed-rank test for the changes by time in mean Numerical rating scores of Group I

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean difference</th>
<th>SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative – 1 week</td>
<td>-3.7</td>
<td>1.8</td>
<td>0.026*</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td>-5.7</td>
<td>1.4</td>
<td>0.027*</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

Table 8: The mean difference, standard deviation (SD) values and results of Wilcoxon signed-rank test for the changes by time in mean Numerical rating scores of Group II

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean difference</th>
<th>SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative – 1 week</td>
<td>-4.7</td>
<td>1.9</td>
<td>0.027*</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td>-4.3</td>
<td>2.9</td>
<td>0.027*</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$
**Results**

Fig. 7: Bar chart representing comparison between Numerical rating scores in the two groups

Fig. 8: Line chart representing changes by time in mean Numerical rating scores in the two groups

Fig. 9: Bar chart representing comparison between % decreases in Numerical rating scores in the two groups
**Results**

**Table 9:** The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between % decreases in Numerical rating in the two groups

<table>
<thead>
<tr>
<th>Period</th>
<th>Group</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-operative – 1 week</td>
<td></td>
<td>51.4</td>
<td>55.8</td>
<td>15.4</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td></td>
<td>81.3</td>
<td>51.4</td>
<td>7.8</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

**Objective findings**

- **Maximum interincisal opening (MIO)**

Tables 10, 11, 12 and 13 show the assessments of MIO at the study intervals. Pre-operatively as well as after 1 week; there was no statistically significant difference between MIO in the two groups. After 3 months, Group I showed statistically significantly higher mean MIO than Group (Fig.10).

**Table 10:** The mean, standard deviation (SD) values and results Student’s t-test for comparison between MIO in the two groups

<table>
<thead>
<tr>
<th>Period</th>
<th>Group</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-operative</td>
<td></td>
<td>21.3</td>
<td>20.5</td>
<td>2.5</td>
</tr>
<tr>
<td>1 week</td>
<td></td>
<td>34.8</td>
<td>33.3</td>
<td>1.2</td>
</tr>
<tr>
<td>3 months</td>
<td></td>
<td>38.7</td>
<td>34.5</td>
<td>1.2</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$
Results

Throughout the study periods, there was a statistically significant increase in mean MIO in both groups (Fig. 11) and insignificant difference between the two groups regarding the percentages increases in MIO (Fig. 12).

Fig. 10: Bar chart representing comparison between MIO in the two groups

<p>| Table 11: The mean difference, standard deviation (SD) values and results of paired t-test for the changes by time in mean MIO of Group I |</p>
<table>
<thead>
<tr>
<th>Period</th>
<th>Mean difference</th>
<th>SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative – 1 week</td>
<td>13.5</td>
<td>2.1</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td>17.3</td>
<td>1.9</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

<p>| Table 12: The mean difference, standard deviation (SD) values and results of paired t-test for the changes by time in mean MIO of Group II |</p>
<table>
<thead>
<tr>
<th>Period</th>
<th>Mean difference</th>
<th>SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative – 1 week</td>
<td>12.8</td>
<td>5.9</td>
<td>0.003*</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td>14</td>
<td>5.7</td>
<td>0.002*</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$
Results

Fig. 11: Line chart representing changes by time in mean MIO in the two groups

Table 13: The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between % increases in MIO in the two groups

<table>
<thead>
<tr>
<th>Period</th>
<th>Group</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-operative – 1 week</td>
<td></td>
<td>64.8</td>
<td>16.5</td>
<td>67.4</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td></td>
<td>82.9</td>
<td>17.6</td>
<td>72.6</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

Fig. 12: Bar chart representing comparison between % increases in MIO in the two groups
**Results**

- **Mandibular dysfunction**

Tables 14, 15, 16 and 17 show the assessments of TMJ dysfunction using Helkimo’s indices at the study intervals. Pre-operatively as well as after 3 months; there was no statistically significant difference between Helkimo index scores in the two groups. After 1 week, Group I showed statistically significantly lower mean Helkimo index score than Group II (Fig.13).

<table>
<thead>
<tr>
<th>Table 14: The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between Helkimo index scores in the two groups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Period</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Pre-operative</strong></td>
</tr>
<tr>
<td><strong>1 week</strong></td>
</tr>
<tr>
<td><strong>3 months</strong></td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

<table>
<thead>
<tr>
<th>Table 15: The mean difference, standard deviation (SD) values and results of Wilcoxon signed-rank test for the changes by time in mean Helkimo index scores of Group I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Period</strong></td>
</tr>
<tr>
<td><strong>Pre-operative – 1 week</strong></td>
</tr>
<tr>
<td><strong>Pre-operative – 3 months</strong></td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$
Results

Throughout the study periods, there was a statistically significant decrease in mean Helkimo index score in both groups (Fig.14). On Comparing between the two groups, Group I showed statistically significantly higher mean percentages decrease in Helkimo index scores than that in Group II. However, no statistically significant difference existed at the end of the study (Fig.15).

![Bar chart representing comparison between Helkimo index scores in the two groups](image)

**Table 16: The mean difference, standard deviation (SD) values and results of Wilcoxon signed-rank test for the changes by time in mean Helkimo index scores of Group II**

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean difference</th>
<th>SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative – 1 week</td>
<td>-12.3</td>
<td>4.8</td>
<td>0.027*</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td>-19</td>
<td>3.7</td>
<td>0.027*</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$
Success rate

According to our success criteria, the arthroscopic group showed 100% success while 4 out of 6 cases (66.7%) were successful in the arthrocentesis group. The remaining two cases showed postoperative improvement but beyond our success criteria.

Table 17: The mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between % decreases in Helkimo index in the two groups

<table>
<thead>
<tr>
<th>Period</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-operative – 1 week</td>
<td>78.9</td>
<td>7.4</td>
<td>53</td>
</tr>
<tr>
<td>Pre-operative – 3 months</td>
<td>88.2</td>
<td>4.1</td>
<td>82.6</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

Fig.14: Line chart representing changes by time in mean Helkimo index scores in the two groups
Results

Fig. 15: Bar chart representing comparison between % decreases in Helkimo index scores in the two groups

Qualitative analysis of MRI

Comparison of characteristics between the arthroscopic and the arthrocentesis joints is summarized in Table 18, 19 and 20. Both groups showed improvement in the evaluated parameter by time. Postoperatively, there was no statistically significant difference between the two groups with regard to disc position, disc mobility and disc configuration. However, arthroscopy group showed statistically significant higher prevalence of condylar translation than arthrocentesis group (Figs. 16,17)
Results

Fig. 16: Sagittal proton density MR images for left joint in the closed mouth position 3 months after arthroscopic lysis and lavage. Showing anterior disc displacement and in open mouth position Recapture of the disc.

| Table 18: Comparison of characteristics between the arthroscopic and the arthrocentesis joints |
|-----------------------------------------------|-----------------|-----------------|
| Parameters                                    | Group I         | Group II        |
| Disc displacement                             | DDwR : 5        | DDwR: 4         |
|                                               | DDnR: 1         | DDnR: 2         |
| Morphologic change of disc                    | Normal: 4       | Normal: 2       |
|                                               | Mild: 1         | Mild: 0         |
|                                               | Severe: 1       | Severe: 4       |
| Disc mobility                                 | Mobile: 6       | Mobile: 5       |
|                                               | Fixed: 0        | Fixed: 1        |
| Condylar translation                          | Present: 6      | Present: 3      |
|                                               | Absent: 0       | Absent: 3       |
| Disc position                                 | Changed: 5      | Changed: 3      |
|                                               | No change: 1    | No change: 3    |
Table 19: The frequencies (n), percentages (%) and results of Chi-square test for comparison between the two groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc position</td>
<td>5  83.3</td>
<td>4  66.7</td>
<td>0.505</td>
</tr>
<tr>
<td>Disc mobility</td>
<td>6  100</td>
<td>5  83.3</td>
<td>0.296</td>
</tr>
<tr>
<td>Disc configuration</td>
<td>5  83.3</td>
<td>2  33.3</td>
<td>0.079</td>
</tr>
<tr>
<td>Condylar translation</td>
<td>6  100</td>
<td>2  33.3</td>
<td>0.014*</td>
</tr>
</tbody>
</table>

Table 20: MRI assessment of the therapeutic outcome in the two groups

<table>
<thead>
<tr>
<th>MRI Parameter</th>
<th>Improve</th>
<th>No Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc displacement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroscopic joints</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Arthrocentesis joints</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Morphologic change of the TMJ disc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroscopic joints</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Arthrocentesis joints</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Disc mobility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroscopic joints</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Arthrocentesis joints</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Condylar translation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroscopic joints</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Arthrocentesis joints</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Disc position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroscopic joints</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Arthrocentesis joints</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Fig. 17: Bar chart representing comparison between MRI findings in the two groups.
DISCUSSION
Discussion

Arthroscopic lavage and Arthrocentesis are the current minimally invasive techniques used to treat TMJ closed lock that fail to improve following a reasonable course of non-surgical therapy. Despite of the great similarity in methodology and philosophy, comparison between these methods is important because of the difference in the required training and skills as well as the cost. Most studies on this subject were retrospective and uncontrolled centered on the clinical results attending each technique, with no regard to their influence on disc position, mobility, and morphology.

Arthrocentesis and Arthroscopy work well when the pain is only localized to the TMJ. To control the present study, it was imperative to exclude patients with combined muscular and articular disorders or at least we did not perform our intervention unless the muscular pain was properly controlled. In the present study, the entire evaluated parameters were not significantly different between groups preoperatively which are important as part of the statistical protocol. Also, the establishment of specific inclusion criteria is important when judging results.

Within the context of TMJ diseases, one logical parameter of success was considered to be “changing the impaired mandibular function in sufficient measure” as the result of restored movement and reducing pain in the TMJ. In the present study, clinical assessment of both groups showed statistically significant decrease in mean NRS scores, statistically significant increase in mean MIO and statistically significant decrease in mean Helkimo index score throughout the study periods. This could be attributed to the ability of these techniques to eliminate restrictions on the disc and lateral capsule, to wash out microscopic debris resulting from the breakdown of the
articulated surfaces, to irrigate the joint of enzymes and prostaglandins and to stimulate the normal lubricating properties of the synovial membrane (253)

Pain decrease after arthrocentesis was shown to be related to the reduction of pain and inflammatory mediators (147,254,255). The alleviation of clinical signs and symptoms of closed lock by arthrocentesis and arthroscopic lysis and lavage in the current study supports their reported effectiveness to relieve TMJ painful hypomobility (16,147,254,255,256,257,258,259)

The success rate of the arthrocentesis group in our study was 66.7%. This finding is disappointing compared to that of reported by Nitzan (253) who noted the results obtained at three centers (in Japan, Israel and the United States) to determine the efficacy of arthrocentesis in the management of closed lock and found that the results in 68 patients presenting with symptoms of severe closed lock included a maximal-mouth-opening increase from an average of 25.29 mm to 43.6 mm and that the overall, arthrocentesis was successful in 94.1% of patients. The lower success rate in the present study could be attributed to the disadvantage of small sample size that exaggerates the positive as well as the negative findings. Nevertheless, our result is within the range reported by Monje-Gil et al (260) who reported that in most of the publications reviewed, improvement in maximum jaw opening and the reduction of pain levels and articular dysfunction on the VAS were the criteria used to define a successful result. They found that the results of the studies reviewed show that 612 joints with acute closed lock (disc displacement without reduction or anchored disc phenomenon) in 586 patients were successfully treated with arthrocentesis with the rate of success ranged from 64 -100 %. They stated these criteria were defined with considerable variability, and the precision limits of the measurement procedure applied were not described in any study and that these are usually
Discussion

based on conviction rather than on a research design proper and statistical analyses.

The success rate of the arthroscopic group in our study was 100% with the mean of NRS scores was 1.3 ± 0.8 and that of MMO was 38.7± 1.2 mm at the end of the study. This finding compares favorably to that of Murakami et al.\textsuperscript{221}, Fridrich et al\textsuperscript{261}, Ohnuki et al\textsuperscript{262}, and Smolka & Iizuka\textsuperscript{263} who reported success rates of 91%, 82%, 74%, and 78%, respectively. The higher success rate in the present study could be attributed to the disadvantage of small sample size that exaggerates the positive as well as the negative findings. In a retrospective study, Hansson\textsuperscript{264} investigated what characterizes a successful and an unsuccessful outcome of TMJ arthroscopic surgery. Of 67 patients treated with arthroscopic lysis and lavage, he found 46 successful and 21 unsuccessful cases with a success rate of 68.7% that was considered somewhat disappointing. He stated that one explanation for this result may be the strict success criteria he used which was almost the same criteria used in the current study. He found that the mean maximum preoperative mouth opening among patients with successful outcome was 33.53 (range 20 - 50) mm. The corresponding value among the unsuccessful cases was 28.90 (range 20 – 51) mm. The difference in terms of mean maximum preoperative mouth opening in relation to successful or unsuccessful outcome was statistically significant. These values are much higher than that of the arthroscopic group in the present study which was 21.3 ± 2.5 mm.

In our study, both groups showed improvement in the evaluated parameter by time with a range of 33.3 – 83.3 % for arthrocentesis group and of 83.3 - 100 % for arthroscopic group. Postoperatively, there was no statistically significant difference between the two groups with regard to disc position, disc mobility and disc configuration. However, arthroscopy group
showed statistically significant higher prevalence of condylar translation than arthrocentesis group. This could be attributed to the relatively higher hydraulic pressure during arthroscopic lavage compared to the manual pressure applied during arthrocentesis and emphasizes the concept of Nitzan\(^{(253)}\) who believed that a major part of the success of surgical arthroscopy in the treatment of severe closed lock is attributable to the lavage rather than to the surgical instrumentation. These findings in part support Sanders\(^{(265)}\) concept that in cases of chronic closed lock, intra-capsular lysis using probes between the disc and fossa is necessary to release superior compartment adhesions. Since all the arthroscopic joints showed disc mobility while 5 out of 6 showed the same finding in arthrocentesis joints.

Recapturing the disc with arthrocentesis was observed in 4 out of 6 joints. Disc mobility and morphology after arthrocentesis showed considerable improvement in 5 and 2 joints respectively. In contrast, Emshoff et al. \(^{(266)}\) studied patients with MRI but found no change in the prevalence rates of the types of ID after the treatment, demonstrating that arthrocentesis is a valuable procedure for alleviating or eliminating pain and dysfunction and re-establishing MMO rather than re-altering disc position or shape. Our findings also compare favorably to those of Ohnuki et al \(^{(267)}\). In his study, 1 out of 9 joints (11.1%) affected by DDnR and treated with arthrocentesis showed anterior disc dislocation with reduction on postoperative MRI.

Also Sembronio et al \(^{(268)}\) performed arthrocentesis and mandibular manipulation as an initial treatment in 33 patients with closed lock and found that the disc was recaptured in only 3 cases.
Our observation is in general agreement with that of Lee and Yoon (269) who evaluated the clinical outcome and MRI changes of patients with TMJ internal derangement before and after performance of arthrocentesis and stabilization splint therapy and found that arthrocentesis and stabilization splint therapy provide significant improvement in the clinical outcome, disc position, disc mobility and joint effusion.

Disc mobility, position and morphology after arthrocentesis showed considerable improvement in 6, 5 and 5 joints respectively. These results are in general agreement with those of Moses et al (270) who found improvement in disc position and morphology following arthroscopic lysis and lavage. Contradictory, other studies reported an increase in fibrous adhesions after arthroscopic lysis and lavage (271) even disc reposition may not always be successful (262,272). Gabler et al (273) used MRI to assess disc–condyle relationships before and after arthroscopic surgery for symptomatic TMJ disorders associated with disc displacement. Disc positions relative to condyles were found to be generally unchanged. Nevertheless, 11 of 12 patients (92%) were judged to have had successful outcomes based on criteria that included presence of pain, interincisal opening, protrusive and excursive mandibular movements and masticatory function. They suggested that repositioning or reduction of displaced discs is not a prerequisite for clinical success in symptomatic patients. Our results support the observation of Ohnuki et al (262) who studied MRI of TMJ discs before and after arthroscopic surgery for TMJ disorders, and found that disc mobility increased, nevertheless deformity of the discs progressed after arthroscopic surgery and disprove their observation that disc position remained anterior displaced without reduction after arthroscopic surgery.

Concerning disc mobility, the disc mobility progressed in all the joints treated with arthroscopy and in 5 out of 6 joints treated by arthrocentesis.
This indicates that the joints with a fixed disc respond well to both techniques and supports the hypothesis that the rationale of lysis and lavage of the TMJ is to release the disc, and to enable mobilization of the joint by flushing the upper joint space. This result was compares favorably to that of kurita et al (143) who found improvement in disc mobility in 6 out of 11 joint treated with arthroscopy.

By the end of the present study, arthroscopic group showed significant reduction of pain and increase in mouth opening and insignificant decrease of Helkimo index score when compared with those of the arthrocentesis group. According to our success criteria, the arthroscopic group showed 100% success while 4 out of 6 cases (66.7%) were successful in the arthrocentesis group. In contrast Nitzan (274) showed that the mean MIO following arthrocentesis surpassed arthroscopic surgery due to the formation of intra-articular scarring inflicted upon the TMJ by arthroscopic surgery. This finding is in general agreement with those of other studies (126,253,254). Fridrich et al (275) studied 19 patients randomized into one of two groups: arthroscopic lysis and lavage, or arthrocentesis and patients were followed 26 months postoperatively. There were no statistically significant differences in outcome between the two groups for any of the parameters evaluated. The overall success rates were 82% for arthroscopy and 75% for arthrocentesis. Therapeutic success rates were not significantly different for arthroscopy and arthrocentesis; both modalities were useful for decreasing TMJ pain while increasing functional range of mandibular motion. Murakami (221) reported that the clinical efficacy of arthrocentesis might be somewhat inferior to that of arthroscopic surgery. However, the comparison between group differences of the post-operative data of VAS, pain, jaw dysfunction and jaw opening revealed no statistical differences.
Summary and Conclusion

The purpose of this study was to evaluate the clinical outcome and the changes in disc position, mobility, and morphology in patients with temporomandibular joint closed lock in response to arthroscopic lysis and lavage versus arthrocentesis using (MRI).

Subjects were chosen to participate in this study suffered from closed lock, based on clinical and MRI findings. Twelve out of 23 patients (52.17%) did not respond to the used conservative therapy. Their ages ranged from 22-34 years, with an average of 29.4 years. They were all females. They were assigned into 1 of 2 equal groups:

**Group I:**

- Arthroscopic lysis and lavage was performed with intra-articular injection of 1ml of Depomedrole (40mg/1ml) at the end of the procedure.

**Group II:**

- Arthrocentesis was performed with intra-articular injection of 1ml of Depomedrole (40mg/1ml) at the end of the procedure.

The evaluated parameters include assessment of articular pain (0 – 10 NRS), MMO and mandibular dysfunction as expressed by Helkimo index scores. The clinical outcome measure parameters were assessed preoperatively, then 1 week and 3 months postoperatively. The treatment outcome was judged according to our success criteria. The MRI parameters including changes in disk position, mobility, and morphology and clinical outcomes were statistically analyzed.
By the end of the present study, arthroscopic group showed significant reduction of pain and increase in mouth opening and insignificant decrease of Helkimo index score when compared with those of the arthrocentesis group. According to our success criteria, the arthroscopic group showed 100% success while 4 out of 6 cases (66.7%) were successful in the arthrocentesis group.

MRI assessment revealed considerable improvement in the evaluated parameter by time in both groups. Postoperatively, there was no statistically significant difference between the two groups with regard to disc position, disc mobility and disc configuration. However, arthroscopy group showed statistically significant higher prevalence of condylar translation than arthrocentesis group.

Conclusions

The efficacy of TMJ arthrocentesis and arthroscopy for treatment of closed lock is emphasized once again to reduce symptoms of pain and limited mouth opening. However, the clinical efficacy of arthrocentesis is somewhat inferior to that of arthroscopic surgery. Nevertheless, its simplicity makes it the treatment of choice when conservative therapy failed.
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المملخص العربي

لقد كان دائما علاج اضطرابات الفصل الفكي الصدغي أمرًا مثيرًا نظراً لنقص فهم فسيولوجيا أمراض الفصل الفكي الصدغي.

هذه الدراسة قبمت تأثير الغسيل المفصلي والمنظار كلاهما اكلينيكيا واشعاعيا لمرضى الاضطرابات المفصلية الفكية.

أجرت هذه الدراسة على اثني عشر مفصل فكي صدغي مصاب بالخلل الداخلي.

تم اختيار المرضى من قسم جراحة الفم والوجه والفكين – كلية طب الفم والأسنان – جامعة القاهرة.

تم خضوع المرضى للعلاج التحفظي باستخدام مضادات الالتهابات و مبسطات العضلات لمدة ثلاثة أشهر.

فلم يستجيبوا لهذا العلاج.

تم تقسيم المرضى إلى مجموعتين:

• المنظار للمجموعة الأولى.
• البزيل للمجموعة الثانية.

تم مراجعة المرضى اكلينيكيا و اشعاعيا باستخدام الرنين المغناطيسي بعد أسبوع و بعد ثلاثة أشهر.

في هذه الدراسة وجد تحسن في الأعراض الاكلينيكية للمرضى في المجموعتين لكن اشعاعيا باستخدام الرنين المغناطيسي وجد تحسن و تغير أكثر في البناء الداخلي للفصل في المجموعة الأولى.

عملية المنظاروغسيل الفصل طرق علاج قياسية ناجحة جدا و عالية الكفاءة بالإضافة أنها فعالة لعلاج حالات الخلل الداخلي للفصل الفكي الصدغي عند عدم جدوى طرق العلاج التحفظي وغير الجراحي.
التقييم السريري والتصوير الإشعاعي للتحلل والفسيل بالمنظار مقابل البزل

علاج القفل المغلق للمفصل الفكي الصدغي

رسالة مقدمة من

الطبيب/ أسامة محمد عبد التواب طعيمه

كجزء من مقومات الحصول على

درجة الدكتوراه في جراحة الفم والوجه و الفكين

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