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Articular disc displacement disorders and its prosthodontic management: A literature review

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Abstract
Articular disc displacement is a relatively common clinical condition that requires an accurate clinical diagnosis and comprehensive management for a successful treatment. An electronic search within the PubMed, Medline, Science Direct and Google scholar were performed using the MeSH terms. Different treatment modalities from conservative treatment to surgical intervention with varying success rates have been reported. Occlusal appliance therapy is conservative and often the initial treatment for patients who develop temporomandibular joint symptoms. This literature review is aimed at addressing the etiology and recent views on prosthodontic management of disc displacement disorders.

Keywords: Disc displacement, temporomandibular disorders, occlusal splint, joint clicking

Introduction
The area of craniomandibular articulation is called the Temporomandibular joint (TMJ). The joint is a synovial joint consisting of a mobile condyloid process of the mandible articulating with the squamous portion of the temporal bone. The articular surface of the temporal bone consists of the concave articular fossa and the convex articular eminence. The articular disc is a fibrocartilaginous, saddle-shaped structure separating the condyle and the temporal bone. The articular disc and its attachments divide the joint into superior and inferior spaces. The superior joint space is bounded by the articular fossa and the articular eminence. The inferior joint space is bounded by the condyle at the bottom.[1] The articular disc is believed to have several roles, such as, cushioning and distributing joint loads, promoting joint stability during chewing, facilitating lubrication and nourishment of the joint surfaces, preventing gross degenerative changes in the condyle and fossa, and promoting the normal growth of the mandible.[2]

Temporomandibular disorders (TMD) are recognized as the most common nontooth-related orofacial pain conditions that challenges the dentists and other healthcare providers. According to the American Academy of Orofacial Pain, Temporomandibular disorder (TMD) is a collective term embracing a number of clinical problems that involve the masticatory musculature, TMJ and associated structures or both.[3] TMD are clinically characterized by muscle and/or TMJ tenderness; TMJ sounds; and restriction, deviation, or deflection of the mouth. [4]

Articular disc displacement involving the condyle–disc relationship is the most common intra-articular cause of TMD. According to the classification of Research Diagnostic Criteria for TMD the three main types of internal TMJ derangement are: 1) disc displacement with reduction, 2) disc displacement without reduction with or 3) disc displacement without reduction and without limited mouth opening. [5] In disc displacement with reduction, the articular disc is displaced anteromedially to the condylar head. The disc reduces during condylar translation and therefore the range of motion is not limited. However, due to the momentary sliding of the condyle on and off of the disc results in TMJ clicking and/or popping sound. Disc displacement without reduction is a clinical condition in which the disc is dislocated, anteromedially to the condyle and does not return to normal position with condylar movement. Disc displacement without reduction is usually presented as a closed lock. Westesson *et al*. described three different presentations for posterior disc displacement: 1) A thin disc spans from the superior portion of the condylar head to posterior to the condylar head 2) a centrally-perforated disc is present, with a small portion anterior to the condylar head,

and a larger portion posterior to the condylar head, and 3) the entire disc is posterior to the condylar head [6].

Epidemiological studies confirm a high prevalence of temporomandibular disorders (TMD) [7]. It has been reported that disc displacement accounts for 41.1%. of temporomandibular disorders [8] Therefore, this literature review is aimed at addressing the etiology and highlighting the recent management for disc displacement disorders.

Methodology

A non-systematic search was conducted to identify articles related to the etiology and treatment of disc displacement disorders. An electronic search within the PubMed, Medline, Science Direct and Google scholar were performed using the Medical Subjective Headings (MeSH) terms "temporomandibular disorders", "temporomandibular joint", "disc displacement", "disc displacement with reduction" "disc displacement without reduction". Literature reviews, systematic reviews, meta-analysis, observational studies and clinical trials published before June 2020 were included.

Etiology

The etiology of TMD remains controversial. It is generally agreed that the etiology of symptoms of TMD are multifactorial- several different factors acting alone, or in varying combinations.

The etiological factors sometimes be called as either of these:

- Contributing factors –factors that initiate, perpetuate or result in a disorder
- Initiating factors – factors that cause the onset of disorder
- Predisposing factor – factors that increase the risk of TMD or orofacial pain
- Perpetuating factors – factors that interfere with healing which can complicate management

Depending on the type of disorder and pathology in an individual, these factors influence each other and act together. Various etiological factors for disc displacement mentioned in the literature have been shortlisted (Table 1) and are briefly discussed below:

Trauma

It is found that an increase in the articular friction has been implicated as a cause of disc displacement.[9] An increase in the friction coefficient may be the result of a series of events. Chronic (microtrauma) or acute injuries (macrotrauma) directed against the TMJ can be associated with most cases of disc displacement.[10] Macrotrauma or direct extrinsic trauma to any element of the masticatory system can initiate loss of structural integrity thus reducing the adaptive capacity and altering the function. Mandibular fractures or face and neck injuries may result in disc displacement. [11, 12] Prolonged opening of mouth, third molar extractions have been associated with TMDs. These conditions seem to be predisposing factors for disc displacement [13]

Microtrauma refers to any minor injuries developing from repetitive adverse loading of the masticatory system through postural imbalance or from parafunction. Bruxism is found to be a source of articular overload and thus found as the most frequent cause of microtrauma, although recent studies associate parafunctional habits to muscle disorders rather than to disc displacement [14, 15].

Disc Deformation

Once mechanical stresses exceed adaptive capability the TMJ progresses to dysfunctional remodeling.[16] A disc with altered shape is more likely to be displaced. In order for the disc to shift over the condyle, a deformation of its surfaces is needed, together with damage to the discal ligaments. In many cases of internal derangement, it is found that the posterior band of the disc is thinner than usual and thus allows disc to be displaced, which occurs mostly in an anteromedial direction. Tumor necrosis factor-a (TNF-a) and interleukin- 1 (IL-1) and IL-6 plays an important role in the activation of macrophages and the pathogenesis of internal derangement. [17, 18] These factors can promote bone resorption through the differentiation and activation of osteoclasts that may lead to the acceleration and progression of cartilage degradation.

Occlusion

Previously occlusal abnormalities was considered as the primary factor in the onset of TMD symptoms, whereas it is now suggested that they only represent one of the numerous factors that might be associated with TMD.[19,20] No relationship has been found between the onset of TMD-related symptoms and the loss of posterior occlusal support.[21] From a biomechanical viewpoint, dynamic malocclusions, such as a wide slide between RCP (Retruded Contact Position) and ICP (Intercuspal Position) and medio/laterotrusive interferences, are likely more important risk factors than static malocclusions. [22, 23] Condylar positional changes associated with intracapsular alterations are found to be the reason for a large overjet, minimal anterior overlap and open bite, unilateral posterior crossbite, occlusal slides greater than 2 mm, and loss of posterior support, prevalent in TMD patients. Therefore, these occlusal factors are now considered as the result rather than the cause of the disease.

Inclination of The Articular Eminence

The disc should rotate forward over the condyle to maintain the correct relationship during movements, and therefore it is suggested that a steep articular eminence may be a predisposing factor for disc displacement. Hall *et al.* demonstrated association between the presence of a steep articular eminence and displaced disc. [24] Further studies reported controversial results and thus association of steepness of articular eminence and presence of disc displacement has not been established. In a recent study it is found that the disc position in disc displacement with/without reduction is not influenced by morphology of articular eminence, however, the articular eminence inclination and condylar excursion angle demonstrated influence on disc reduction.[25] Even though the anatomical and structural factors influencing the onset of a disc displacement have not been clarified as yet, it is found that joints characterized by a condyle centered in a well-shaped fossa of normal dimensions are the most resistant to disc displacement.

The Role of the Lateral Pterygoid Muscle

The lateral pterygoid muscle is commonly thought to be responsible for the anterior displacement of the disc with respect to the condyle. A hypo/hyperactivity of this muscle or a poor coordination of its two bellies are thought to be possible causes of functional imbalance of the TMJ as the lateral pterygoid muscle plays an important role in the stabilization of the joint. From a clinical viewpoint, tenderness to palpation of the lateral pterygoid muscle is an almost constant symptom/observation in TMD patients. [26]

Joint Hypermobility

TMJ hypermobility, defined as condylar translation beyond the eminence at maximum mouth opening, has also been positively correlated with disc displacement with reduction. The theory that some types of TMD, and disc displacement in particular, could have a high prevalence in subjects with articular hypermobility was based on some early studies pointing out an association between TMD and the generalized joint hypermobility syndrome. [27]

According to the literature, the role of occlusal abnormalities, the inclination of the eminence, or hyperactivity of the lateral pterygoid muscle appears to be less important than considered in the past. Therefore, it can be summarized that understanding the mechanism of joint lubrication and their impairment has improved understanding of the pathogenesis of disc displacement disorders.

Management

The treatment of internal derangement of temporomandibular joint can be divided into three groups: non-invasive, minimally invasive and invasive management. According to Wilkes classification for internal derangement, early stages of internal derangement can be managed by non-invasive or minimally invasive methods; however advanced stages may require invasive/surgical approach.[28] The principle treatment consists of removal of factors causing internal derangement, reduction of symptoms and promoting healing of the articular structures. Non-invasive methods include patient education, nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, mouth opening exercises and physiotherapy, softer diet, occlusal appliances, thermotherapy, bio-stimulating lasers and inter-maxillary fixation. Minimally-invasive methods include intra-articular injections, arthrocentesis. Invasive/surgical methods include arthroplasty which includes reshaping of the articular surfaces, discectomy and implementation of autologous and alloplastic material and total joint replacement.

Prosthodontic management of TMDs involve altering the patient's occlusal condition and relieving symptoms. Use of irreversible treatments, occlusal adjustment/equilibration is not recommended. [29] Appliance therapy is often the initial treatment intervention for patients who develop temporomandibular joint symptoms, therefore knowledge of the evidence-based literature on occlusal appliances is necessary for clinicians.

Treatment for anterior disc displacement with reduction

Occlusal appliance/ splints are a standard method to treat disc displacement with reduction of the temporomandibular joint. The stabilization splint, distraction splint and the anterior repositioning splint is used to treat disc displacement with and without reduction. [30] Lundh *et al.* concluded that anterior repositioning splint eliminates reciprocal click of the TMJ. [31] The study also showed recurrence of reciprocal click in majority of the patients when the splint was removed after six weeks. Tsuga *et al.* studied the short-term effectiveness of stabilization-type occlusal splint therapy and the result suggested that the stabilization-type occlusal splint should be selected as the first approach among other therapies. [32] Davies and Gray in their study concluded an anterior repositioning splint is an appropriate method of treatment for disc displacement with reduction. [33] Truelove and colleagues evaluated treatment outcomes in 200 patients with anterior disc displacement with reduction, arthralgia, and myalgia and divided them in different treatment groups (self-care, hard splints, soft-splints). [34] Treatment outcomes were evaluated at 3 months and 12 months, which revealed no significant difference in all 3 groups. These investigators concluded that self-care and low-cost therapy are as effective as occlusal splint therapy.

Huang, *et al*. treated patients with painless clicking with a mandibular stabilization occlusal splint (hard acrylic) and found that after six months, TMJ clicking was eliminated in 71.2% of cases. [35] Ohnuki *et al.* reported no significant difference in the degree of reduction of displaced disc between pre and post-treatment MRI. [36] They suggested that the splint therapy does not necessarily improve the disc position with respect to the condyle, but is important for the improvement of signs and symptoms. Splint therapy is however indicated for a short-term use only. Longer treatment duration may result in undesirable occlusal changes and dependency [37, 38].

Treatment for anterior disc displacement without reduction

Mandibular Manipulation

The aim of mandibular manipulation is to recapture a displaced disc. The common technique for mandibular manipulation is pulling the condyle of the affected side downward and forward in order to locate the condyle on the anteriorly displaced disc. Usually the operator's thumb is placed on occlusal surfaces of lower molars on the affected side and the rest of the fingers are covering the external surface of mandible. The other hand is placed in temporal area to stabilize patients head. Foster *et al*. in their study concluded that mandibular manipulation under general anesthesia showed improvement in patients with disc displacement without reduction [39]. It is difficult to predict the therapeutic effect of this method as it depends not on the duration of locking, but rather on the stage of internal derangement. Kurita *et al*. reported that in 9% of cases, closed locked disc could be reduced by manipulation technique and if the procedure is performed under general anesthesia in the presence of muscle relaxants the percentage of successful outcome rises to 42%. [40]. After successful unlocking it is recommended that the patient is provided with an anterior repositioning splint in order to eliminate acoustic symptoms in TMJ disc. The literature on manual manipulation for TMD indicate that it is a viable, cost effective and reversible mode of conservative treatment. [39, 40, 41]

Occlusal Appliance

According to many authors, stabilization splint leads to a significant reduction of symptoms of closed lock. Minakuchi *et al*. compared the short-term effect of combined splint plus exercises (self-care/medication/ education) with education only, found no statistically significant differences in effect between the interventions on all measured outcomes [42] Schmitter *et al*. found that stabilization splint seems to be more effective than distraction splint in closed lock therapy [43] Stiesch-Scholz *et al*. reported that stabilization splint therapy is an efficient method of closed lock treatment [44] In that study the significant improvement of clinical outcomes was present in 92.7% of patients.

The findings of evidence-based studies on occlusal splints for disc displacement are listed (Table 2) [45-55]

Treatment for posterior disc displacement

The treatment of posterior disc displacement has been described as manipulation of the joint under local or general

anesthesia followed by short-term maxillomandibular fixation.[56] The most conservative treatment therapy used for posterior disc displacement was NSAID for the pain, physiotherapy in the form of exercise, muscle massage, and stabilization splint to improve the occlusion [6, 57, 58]

Table 1: Etiological and risk factors for disc displacement.

Trauma	Macrotrauma (external source) Microtrauma (repetitive minor injuries)
Disc Deformation	A deformation of its surface, altered shape together with damage to the discal ligaments
Occlusion	Dynamic malocclusion
Inclinationof Articuar Eminence	Steep articular eminence
Lateral Pterygoid	Hypo/Hyperactivity of lateral pterygoid
Joint Hypermobility	Condylar translation beyond the eminence at maximum mouth opening

Table 2: Summary of recent literature in disc displacement disorders.

AUTHOR	ARTICLE
Ajalbeg *et al*. (2015) [45]	It was found that for anterior disc displacement without reduction, simultaneous use of stabilization splint and physical therapy was more efficient in reducing deviations and improving range of mouth opening than stabilization splint used alone within 6 months.
Tatli *et al*. (2017) [46]	Compared the effectiveness of three treatment methods for unilateral TMJ disc displacement without reduction and found that arthrocentesis reduces pain and functional impairment more rapidly and effectively than splint therapy.
Hegab *et al*. (2018) [47]	In a prospective study examined a method using magnetic resonance imaging (MRI) to assess the appropriate effective occlusal splint vertical thickness in the management of disc derangement and recommended 4-mm for disc displacement with reduction and 6-mm for disc displacement without reduction, for 1 year.
Yang *et al*. (2018) [48]	In their study evaluated centric relation occlusal splint (CROS) treatment and intra-articular injection treatment with liquid phase concentrated growth factors (LPCGFs) in patients with disc displacement without reduction (DDWOR). They found that CROS alone can alleviate TMD clinical symptoms, except for the joint crepitus sound. The results also showed approximately 72.2% of joint crepitus sounds could be improved within 48 days, on average, once 2 mL of LPCGF was injected.
Shen *et al*. (2019) [49]	This study evaluated the success rates and prognosis of patients treated with ARS (Anterior repositioning Appliance) used to reposition the anterior disc displacement with reduction. After 2 years follow-up, 53% of the joints had a normal disc–condyle relationship as assessed using MRI. It was concluded success rate of recapturing DWR is inferior. It was suggested to explore more therapeutic options.
Aggad *et al*. (2019) [50]	In this study, a combination of stabilization appliance and arthrocentesis using platelet-rich plasma along with patient education has been proved effective for the conservative management of patients with disc displacement without reduction TMJ dysfunction.
Heo *et al*. (2019) [51]	Unilateral arthrocentesis on more symptomatic TMJ and subsequent stabilization splint therapy was highly successful for pain and achievement of normal range of mandibular movements in patients with both ADDWoR (Anterior Disc Displacement Without Reduction) and bony changes.
Wannman *et al*. (2020) [52]	This study found that occlusal splints had positive effect on TMJ clicking sounds and was helpful in treatment with locked jaws.
Zhang *et al*. (2020)[53]	This systematic review concluded that the occlusal splints were effective in relieving pain and improving mandibular movements of patients with TMD.
Touche *et al*. (2020) [54]	This recent systematic review showed therapeutic exercise or manual therapy may be beneficial and play a role in the treatment of disc displacement without reduction. It also suggested that exercise significantly improves mouth opening in comparison to splints.
Tunc *et al*. (2020) [55]	This study evaluated the effects of additional low-level laser therapy (940 nm GaAlAs) to the routine occlusal splint therapy on maximal mouth opening (MMO), visual analog scale (VAS) scores, and passive mouth opening (PMO). It suggested that short-term low-level laser therapy additional to conventional treatment (NSAID and occlusal splint) provides satisfactory outcomes with higher MMO score in the laser group.

Conclusion

More conservative treatment modalities have replaced irreversible occlusal equilibration and jaw-repositioning procedures for joint and muscle pain and dysfunction. Signs and symptoms of disc displacement disorders can be successfully managed with occlusal appliances and a combination of patient education, recommendations for home care, physiotherapy, cognitive behavioral therapy and pharmacology. Continuous and/or excessive use of an appliance can contribute to the development of a malocclusion and must be avoided, particularly for appliances that provide partial coverage of the dentition. Clinical research conducted to date has demonstrated the superior outcomes with combination of conservative approach and occlusal splints for managing disc displacement disorders. However, more studies are required, preferably with a randomized clinical trial approach to compare the efficacy of various treatment procedures and the time required to establish their effectiveness.

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