Review article

doi:10.5633/amm.2025.0116

TEMPOROMANDIBULAR DISC DISPLACEMENT- REVIEW ARTICLE

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Abstract

The articular disc, a resilient structure positioned between the temporomandibular joint (TMJ) surfaces, is essential for proper joint function. Comprising dense fibrous tissue and cartilaginous cells, its key role is to augment contact surface area during loading and ensure even force distribution. Disc dislocation, commonly anteriorly or anteromedially, may be reducible or irreducible. Clinical presentation varies based on dislocation type and TMJ tissue inflammation. Diagnosis relies on clinical assessment and, if needed, magnetic resonance imaging, often prompted by pain. Therapy varies by dislocation type; reducible cases may not always require intervention due to potential retrodiscal tissue adaptation compensating for the disorder. Pain-associated dislocations may be managed conservatively (e.g., analgesics, muscle relaxants) or with reversible occlusal therapy (splints), tailored to condition severity. Acute anterior dislocations without reduction typically necessitate reduction and stabilization splint use. Chronic cases may first require a stabilization splint to allow retrodiscal tissue adaptation, with surgery as a secondary option. Treatment decisions hinge on pain intensity. Carefully tailored interventions can mitigate symptoms and restore joint function, improving patients' quality of life.

Keywords: articular disc, temporomandibular joint, disc displacement, splint

Pregledni rad

doi:10.5633/amm.2025.0116

DISLOKACIJE DISCUSA ARTICULARISA TEMPOROMANDIBULARNOG ZGLOBA- OPŠTI PREGLED

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Sažetak

Discus articularis je žilava, ovalna, fibrokartilaginozna, bikonkavna pločica, interponirana između zglobnih površina TMZ. Sastavljen je od tvrdog, gustog, fibroznog tkiva i hrskavičavih ćelija i njegova uloga je da poveća površinu kontakta između zglobnih površina u momentu opterećenja i omogući njegovu pravilnu distribuciju. Dislokacija diska se može dešavati u više pravaca, a najčešće anteriorno ili anteromedijalno. Anteriorna dislokacija diska može biti sa redukcijom (povratna) ili bez redukcije (nepovratna). Klinička slika prednje dislokacije diska zavisi od tipa dislokacije i stepena inflamiranosti tkiva temporomandibularnog zgloba. Dijagnoza dislokacije diska postavlja se na osnovu kliničkog nalaza i magnetne rezonance, ukoliko je potrebno. Najčešći razlog snimanja temporomandibularnog zgloba pomoću magnetne rezonance jeste prisustvo bola. Terapija dislokacija diska zavisi od vrste dislokacije. U slučaju povratne dislokacije nije uvek neophodna, jer postoji mogućnost adaptacije retrodiskalnog tkiva što rezultuje kompenzacijom nastalog poremećaja. Ukoliko je dislokacija praćena bolom, mere koje se preduzimaju mogu biti konzervativne (analgetici, miorelaksansi) ili u vidu reverzibilne okluzalne terapije (primena splintova). Vrsta indikovanog splinta zavisi od stepena oboljenja. U slučaju akutne anteriorne dislokacije bez redukcije, terapijska mera koja se preduzima je repozicija i korišćenje stabilizacionog splinta, a u slučaju hronične anteriorne dislokacije bez redukcije prvo rešenje je da se uvede stabilizacioni splint i omogući adaptacija retrodiskalnog tkiva, a druga alternativa je hirurška terapija. Odluka o tretmanu zavisi od intenziteta bola koji prati dislokaciju.

Ključne reči: *discus articularis,* temporomandibularni zglob, dislokacija diska, splint

Discus articularis, also known as the meniscus, is a vascularized, oval-shaped, fibrocartilaginous structure that assumes a biconcave form. Positioned between the articular surfaces of the temporomandibular joint (TMJ), it comprises tough, dense fibrous tissue and cartilaginous cells, conferring upon it both flexibility and adaptability. The primary function of this disc is to augment the contact area between the joint surfaces during loading, facilitating the even distribution of forces. (1)

In 1954, Rees defined four zones of the disc (observed in the sagittal direction): (2)

- anterior thickening zone
- intermediate zone
- posterior thickening zone
- bilaminar zone

The anterior and posterior thickenings form a circular ring that stabilizes the disc on the condyle and prevents its dislocation during mandibular movements. The intermediate zone is thinned, allowing for flexibility and shaping. The shape and thickness of the disc result from functional adjustment, meaning that the disc's shape constantly changes during mandibular movements due to the incongruence of the articular surfaces. The bilaminar zone comprises two layers: the upper and lower. The upper layer consists of loose elastic fibrous tissue, well-vascularized, which attaches the disc to the capsule and the posterior wall of the glenoid fossa. The lower layer forms solid, dense, and inelastic fibrous tissue, attaching the disc to the condyle. At the medial and lateral ends, the disc is fused to the capsule and attaches to the poles of the condyle. Fibers of the superior bundle of the lateral pterygoid muscle (LPM, *musculus pterygoideus lateralis*) directly enter the medial end of the disc. Contraction of the superior head of the LPM moves the disc forward (protraction) and inward, limiting backward movement (retraction) of the disc. The lateral pterygoid muscle is active in nearly all movements of the lower jaw, with its role in initiating mouth opening being particularly significant. (3)

The disc divides the articular space into upper and lower (superior and inferior synovial cavities), with the two spaces not normally communicating. The disc alleviates the effects of excessive or abrupt forces, distributes the load over a larger surface area, and compensates for the incongruence of the joint surfaces. (1,2,4)

Histologically, the disc is composed of dense fibers of type I collagen, water, proteoglycans, cells, and elastic fibers. Degeneration of discal collagen and loss of cartilage on articulatory surfaces play a significant role in the development of disc disease, thus the identification of disorders in the disc structure (degeneration) is one of the essential prerequisites for an accurate diagnosis of disc disease. (5)

Load distribution on temporomandibular joint structures

The craniomandibular articular connection serves as a bilateral bulwark to the masticatory muscles throughout all functions of the masticatory organ. Due to its specific characteristics, this connection distributes loads differently from other joints in the body, possessing the capability for a wide range of motion without the risk of harmful loads. Unlike other joints, where the largest surface area comes into contact during periods of maximum load, the condyles of the mandible are not positioned deepest within the articular pits at these times; instead, they rest on the posterior slopes of the articular eminences. Load is transferred in this manner, rather than through the bony roof of the articular fossa, which is covered by a thin layer of fibrous tissue and not genetically predisposed to bear loads. (4)

The small area of contact between the joint surfaces during loading poses a risk to the integrity of the joint structures. However, this risk is mitigated by the presence of the disc and the high-elastic fibrous cartilage covering the articular surfaces. Unlike hyaline cartilage found in other joints, which is resistant to compression forces, fibrous cartilage can deform under load. Due to its high-elasticity properties, the disc tissue compresses during loading, allowing the condyle to 'sink' and align with the disc, thus sliding along the articular eminence. In this manner, the disc compensates for the incongruence of the temporomandibular joint surfaces with its structure. (4)

An internal disorder is characterized as a localized mechanical issue that disrupts joint movements. Internal temporomandibular joint disorders entail abnormalities in the positioning of the disc relative to the mandibular condyle or the articular eminence. (6)

In a healthy joint, the disc is attached to the poles of the condyle by its ligaments, allowing translational movement only between the condyle-disc complex and the articular eminence. The sole physiological movement between the condyle and the disc is rotational, involving the rotation of the disc around its ligamentous connections on the condyle, which limit such movement. The extent of disc rotation per condyle under physiological conditions depends on the disc's shape, the level of interarticular pressure, and the synergistic function of the upper beam of the lateral pterygoid muscle (LPM) and the upper beam of the bilaminar zone of the disc. (4)

During physiological rotation of the disc posteriorly, as the mouth opens, the condyle-disc complex moves forward. Subsequently, the upper layer of the bilaminar zone becomes taut and retracts, thereby rotating the disc in the posterior direction. It is the sole structure capable of posteriorly pulling the disc, exerting force exclusively during the back-and-forth movement of the disc during mouth opening. When the mouth closes, there is no tension in the upper layer of the bilaminar zone. Additionally, the pressure within the joint increases upon mouth opening, maintaining the condyle below the intermediate zone and preventing it from advancing into the region of the anterior thickening of the disc. (4)

During physiological anterior rotation of the disc, the disc is propelled forward by the contraction of the superior bundle of the lateral pterygoid muscle (LPM), which is activated upon mouth closure. As a result, the disc rotates forward, while the entire condyle-disc complex slides backward and upward, facilitating translational motion. (4)

The rotation of the disc by the condyle within moderate parameters, facilitated by the described mechanisms in a healthy joint, ensures that the disc and condyle maintain intimate contact with all movements and positions of the mandible. Uninterrupted movements are facilitated by the smooth and slippery surfaces of the condyle, disc, and articular eminence. (4)

The normal ratio between the condyle and the disc is also upheld thanks to the disc's specific biconcave shape. The thin intermediate zone and the annular thickening contribute to the stability of the disc on the condyle. (4)

Disc dislocation can occur in multiple directions. Larheim systematized the positions of the disc based on closed-mouth MRI recordings, categorizing them into three main categories:

1. Normal superior disc position: The disc is correctly positioned at both sagittal and coronal cross-sections of the MRI.

2. Partial disc dislocation: The disc is partially displaced, with or without medial or lateral dislocation, while remaining in a normal position at several sagittal intersections.

3. Complete disc dislocation: The disc is dislocated at all cross-sections, with or without lateral or medial dislocation.

A modification of this categorization was proposed by Tasaki:

a. Normal-superior disc position ('at 12 o'clock').

b. Pathological position of the disc: includes anterior, internal, external, and posterior dislocations. (7)

The most common type is anterior or anteromedial dislocation. Disc dislocations represent a series of pathological conditions that develop progressively over time. Typically, anterior disc dislocation with reduction occurs initially, followed by anterior disc dislocation without reduction. However, in a certain percentage of patients, anterior dislocation with reduction can persist over decades. Various factors, such as gaps in the dental series (loss of lateral teeth), systemic ligament weakness, or the presence of parafunctional habits, play a significant role in the progression and development of disc disorders. These factors can influence the course of the disorder. (4)

Anterior reciprocal disc displacement. (anterior disc dislocation with reduction)

In Tasaki's classification, the normal position of the disc in the sagittal plane is superior, commonly referred to as the '12 o'clock position', where its posterior portion is directly above the mandibular condyle. (8)

In anterior displacement with reduction, the disc does not occupy its normal position relative to the condyle and articular eminence in closed-mouth conditions. Instead, it is displaced forward, or forward and medially. Upon closing the mouth, the disc returns to a more or less normal position on the condyle. (4)

When the shape of the disc changes and the ligaments protrude, translational movement between the condyle and the disc becomes possible. The extent of this movement depends on changes in the disc's shape, the degree of ligament elongation, and the simultaneous presence of chronic hyperactivity of the upper bundle of the lateral pterygoid muscle (LPM). Discal ligaments lack elasticity, maintaining their stretched position once elongated. Under closed-mouth conditions, the upper beam of the bilaminar zone has no effect on the disc's position. However, in this scenario, the activity of the upper beam of the LPM can influence the disc's anterior positioning. The disc remains in this position as long as the mouth is closed, returning to rest on the condyle's head upon mouth opening. (19) The displacement of the disc itself is restricted by the length of the ligaments and the thickness of the posterior edge of the disc. Prolonged displacement can lead to thinning of the posterior edge of the disc, allowing the condyle to extend beneath the thinned posterior edge of the disc or even into the retrodiscal tissue. (4) As this represents the initial stage of disc disorder development, characterized as the mildest, subjective symptoms are equally mild. (4) (Figure 1)

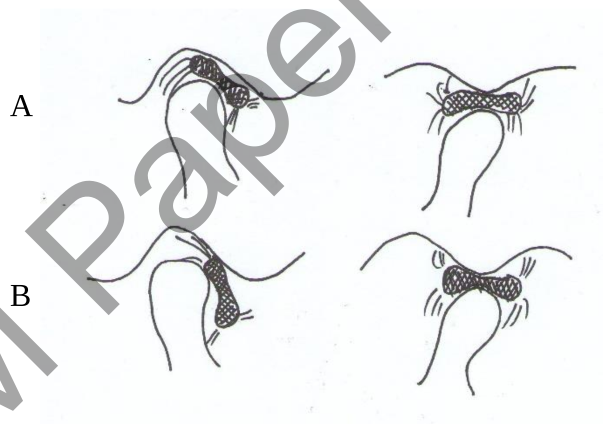

Figure 1. A) Normal position of the disc when the mouth is closed (left) and the normal position when the mouth is opened (right). B) Anterior dislocation of the disc with the mouth closed (left), followed by reduction of the disc, returning it to the normal position upon mouth opening (right).

Clinical Presentation of Anterior Disc Dislocation with Reduction

• A single "click" during the opening and/or closing of the mouth (reciprocal click), resulting from the condyle passing over the posterior (thickened) edge of the disc to position below the thinned intermediate zone. This click can occur at any point in the translational cycle. The term "reciprocal click" refers to the appearance of a softer click upon mouth closure, signifying the return of the disc to its anterior position.

• Deviation of the mandible to the affected side upon mouth opening, occurring early in the opening movement due to temporary blockage of condylar translation by disc dislocation. As the disc returns to its normal position relative to the condyle during mouth opening, the mandible's midline returns to normal until the mouth is fully open. Mandibular deviation is pathognomonic for anterior disc dislocation with reduction.

• Deflection of the mandible, indicating displacement of the jaw's midline throughout the entire mouth opening movement. This is a sign of acute or chronic anterior disc dislocation without reduction (permanent disc dislocation).

• Normal mouth opening range (40-50 mm), with potential for even greater maximum mouth opening than normal. Trismus, if present, is often due to muscle spasm caused by pain rather than mechanical obstruction by the disc.

•Absence of pain, as pain is not always present in cases of anterior disc dislocation with reduction. If present, it usually arises from sprained discal ligaments or condylar pressure on retrodiscal tissue. (4)

Permanent Anterior Disc Dislocation (Disc Dislocation without Reduction)

This condition is characterized by anterior or anteromedial dislocation of the disc in closed-mouth conditions, with the disc failing to return to its normal position upon mouth opening. It develops as a consequence of gradual, progressive degeneration of joint structures, often preceded by symptoms of anterior disc dislocation with reduction. The translation of the condyle by the articularis is limited or impaired in this case because the disc serves as an obstacle, preventing the condyle from passing beneath the dislocated and deformed disc. The disc undergoes a change in shape, transitioning from biconcave to biconvex. The anterior discal connection becomes loosened, resulting in the loss of contact between the condyle, disc, and articular eminence. These deformations and the altered position of the disc restrict translational movement of the condyle in the affected joint. (4) (Figure 2)

A

B

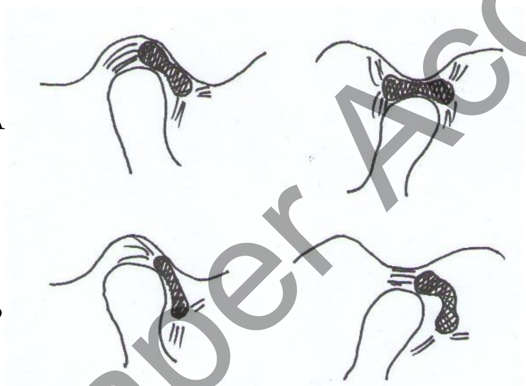

Figure 2. A) Normal position of the disc when the mouth is closed (left) and the normal position when the mouth is opened (right). B) Anterior dislocation of the disc in the closed mouth (left), with the disc returning to an anterior position upon mouth opening (right).

Clinical Presentation of Anterior Disc Dislocation without Reduction

• Limited mouth opening (25-30 mm), sometimes presenting as a complete blockage of mouth opening ("closed lock"). Some patients report sudden blockages without any preceding trauma to the area.

• Clicking sounds: Some patients report joint clicks, occasionally accompanied by blockages during prolonged chewing or bruxism episodes. Occasional blockages suggest irreversible elongation of the bilaminar zone of the disc, resulting in loss of elasticity and function.

• Mandibular deviation towards the affected side during mouth opening (mandibular deflection).

• Restricted mandibular movements:

- Limited protrusion may occur in some patients with mandibular deflection.
- Lateral movement of the mandible to the healthy side is unhindered (the dislocated disc interferes with all translational movements of the condyle). Unrestricted lateral movement to the affected joint serves as an important differential diagnostic sign compared to anterior irreversible disc dislocation resulting from trauma.

• Pain: Arises from concurrent inflammation of the joint capsule, retrodiscal connective tissue, and discal ligaments. Some patients find relief by applying pressure to the affected joint, which alleviates the pain.

• Impaired activity of the temporal and masseter muscles on the affected side: Muscle spasms exacerbate pain and further restrict mouth opening.

• Crepitus during mandibular movement: Absent in acute stages when joint function is significantly impaired, but may develop in chronic cases due to degenerative changes on the joint surfaces. (4)

Magnetic Resonance Imaging (MRI)

Purcell and Bloch described the foundations of nuclear magnetic resonance spectroscopy in 1946, which later led to the development of magnetic resonance imaging (MRI). In 1973, Lauterbur created the first images using proton MR signals on phantoms. The initial application of MRI to the temporomandibular joint (TMJ) was reported by

Helms in 1984. At that time, image quality was limited by low resolution and thicker cross-sections. In 1985, Katzberg, Harms, and Roberts described the advantages of MRI in detecting possible disc diseases. TMJ MRI displays layers in the parasagittal and coronal planes without the need for subsequent reconstruction. Axial imaging lacks diagnostic significance but aids in determining the positions of sagittal and coronal cross-sections. Standard imaging of the condyle-disc complex is performed with the mouth closed (habitual occlusion) and maximally open. The most important parameters assessed in MRI recordings using the T1 sequence include continuity of the articular surfaces, bony architecture of the articular eminence and condyles, as well as the position and shape of the disc. The T2 sequence is utilized to detect the presence of inflammatory exudate in the TMJ. (9,10)

Contraindications for MRI usage are categorized into absolute and relative. Absolute contraindications include patients with implanted aneurysm clips and those with pacemakers. Ferromagnetic objects located in critical areas (such as the eyes), metal heart valves, claustrophobic or uncooperative patients, individuals in their first trimester of pregnancy, and patients unable to lie down during the examination are also considered absolute contraindications. Dental fillings, implants, fixed orthodontic appliances, and metal dentures do not contraindicate MRI imaging, but they may produce artifacts that compromise image quality. (11) The most common indication for TMJ imaging using MRI is to assess the position and structure of the disc in patients experiencing temporomandibular joint pain. Understanding the parameters and standard dimensions of the TMJ is crucial in dentistry, particularly in prosthetics, orthodontics, and maxillofacial surgery. Furthermore, MRI results provide valuable data for anthropology, paleontology, and forensic medicine. (12)

Disc Dislocation Therapy

Therapy for Anterior Disc Dislocation with Reduction

Treatment for this disorder is not necessary in every case. Some dislocations can persist for years without progression, thanks to the adaptation of temporomandibular joint structures. Often, during the course of this disorder, there is elongation of the retrodiscal tissue, which transforms into a modified extension of the posterior edge of the disc, thus functioning to bear the load exerted by the condyle. (13, 14) In cases where patients do not experience pain or significant impairment of joint function, such as limited mouth opening, and the surrounding muscles are not tender upon palpation, therapy is not necessary. However, these patients should be monitored regularly to detect any potential progression of the disorder over time. (4) However, when patients report sensitivity upon palpation of the joint, even if they do not experience pain, it suggests that the joint tissue has not adapted to the new condition. In such cases, patients should be educated about the disease itself, the factors influencing its progression, and potential solutions. This is particularly crucial for individuals engaging in parafunctional activities, as they may require home treatment interventions. (2) Adaptation of the joint tissue is challenging and practically impossible without sufficient support in the form of a stable bite in the lateral segments of the jaw. Therefore, it is crucial to refer patients to appropriate prosthetic treatment. (4)

If the dislocation is accompanied by pain, the treatment options follow a selectable course:

• Conservative methods (analgesics, myorelaxants)

• Reversible occlusal therapy (splint) - the choice of reversible occlusal therapy depends on the degree of dysfunction

• Permanent occlusal therapy

These measures aim to:

• Relieve and eliminate pain - often achieved through repositioning therapy or the use of a repositioning splint. The goal of these interventions is to temporarily stabilize the mandible in the appropriate (propulsive, anterior) position, allowing the disc to return to a normal position on the condyle. This helps alleviate pressure on the retrodiscal tissue, thereby reducing pain and joint clicking.

• Re-establish as normal a relationship between the condyle and disc as possible - by introducing a repositioning splint, the goal is to promote adaptation and regeneration of the retrodiscal tissue, leading to the formation of a pseudodisc (fibrous tissue). This tissue is more resistant to pressure, reducing pain even if the disc remains constantly dislocated forward.

Repositioning therapy is typically successful in terms of alleviating pain and clicking. However, studies indicate that in approximately 50% of clinically successful cases (where pain is absent), a normal disc position is never restored. (14) A drawback of this type of therapy is the subsequent requirement for extensive irreversible reconstruction of the occlusion to maintain a new therapeutic position of the mandible. In some cases, the extent of mandibular protrusion necessary to prevent disc dislocation may be too substantial to sustain with ongoing occlusal therapy. Consequently, repositioning therapy can be considered an effective yet temporary treatment that alleviates pain and joint sounds in a relatively short period. Despite its limitations, repositioning therapy plays a role in conservative approaches to managing patients with recurrent anterior disc dislocation. (4)

Li suggests initially introducing a stabilizing splint over a period of time. If it fails to yield the desired results, it should be converted into a repositioning splint. (15)

The stabilizing splint is a flat, smooth plate made of transparent acrylic, primarily covering the maxillary dental arch (although, for patients unable to tolerate an upper splint, a splint may be constructed for the lower dental arch). It is commonly known as the Michigan splint and aims to provide optimal functional occlusion for the patient. By establishing a stable musculoskeletal relationship in the central position and increasing the vertical occlusal dimension, it allows for maximum engagement of all antagonist muscles. Additionally, it offers canine guidance on the working side. Other types of stabilizing splints include the Tanner splint, Schoettl occlusal plate, Gausch programmable functional plate, among others. However, the Michigan splint is the most commonly used in the treatment of these conditions. (4) In cases of greater severity, where reversible occlusal therapy fails to yield satisfactory outcomes, surgical intervention is warranted. (4)

Anterior disc dislocation therapy without reduction

Acute irreversible disc dislocation

During the acute phase, treatment measures aim to reposition the dislocated disc, either by the therapist or the patient themselves. The therapist achieves repositioning by pulling the mandible downwards, pressing the occlusal surfaces of the lower lateral teeth with their thumbs. This action separates the condyle from the articular eminence, creating a larger space (or gap) for the disc to move and resume its normal position. A prerequisite for successful repositioning is a healthy upper layer of the bilaminar zone, which aids in pulling the disc back into place. (4)

If the repositioning is successful (restoring the normal range of mouth opening and movement to the contralateral side), it is necessary to immediately introduce an anterior repositioning splint that the patient will wear continuously for 10 days (day and night, even during meals), in order to prevent redislocation of the disc. If the disc remains in place after ten days, the patient should continue wearing the repositioning splint day and night, with a smaller splint being made for daily use. If the disc remains in place after two months, the patient may proceed with a stabilizing splint. (4)

If repositioning is unsuccessful, it is recommended to use only a stabilizing splint, with the assumption that the patient will adapt to the new disc position by creating a pseudodisc. Surgical therapy is not recommended due to its invasiveness, and repositioning therapy is also discouraged as it may cause unnecessary tension on the retrodiscal tissue. (15)

However, if there is persistent pain in the joint area, it indicates a lack of adaptation of the retrodiscal tissue. Surgical treatment options should be considered in such cases. (4)

Chronic irreversible disc dislocation

Given that manual disc repositioning does not yield favorable outcomes in these cases, therapeutic options should be carefully evaluated. The initial approach involves the introduction of a stabilizing splint to facilitate adaptation of the retrodiscal tissue. Alternatively, surgical therapy may be considered. The selection of treatment depends on the severity of pain associated with the dislocation. (4)

References

1. Wilkie G, Al-Ani Z. Temporomandibular joint anatomy, function and clinical relevance. British Dental Journal. 2022 Oct 14;233(7):539–46.
2. Rees L.A: The structure and function of the mandibular joint. Srit. Dent. J. 1954; 96(125-133).
3. Wilkie G, Al-Ani Z. Temporomandibular joint anatomy, function and clinical relevance. British Dental Journal. 2022 Oct 14;233(7):539–46.
4. Shu J, Ma H, Jia L, Fang H, Chong DYR, Zheng T, et al. Biomechanical behaviour of temporomandibular joints during opening and closing of the mouth: A 3D finite element analysis. International Journal for Numerical Methods in Biomedical Engineering. 2020 Jun 22;36(8).
5. Guarda Nardini L, Meneghini M, Guido M, Baciorri F, Manfredini D. Histopathology of the temporomandibular joint disc: Findings in 30 samples from joints with degenerative disease. Journal of Oral Rehabilitation. 2021 Jul 9;48(9):1025–34.
6. Adams J.C. HDL. Outline of Orthopedics. 13 e, editor. London: Churchill Livingstone; 2001.
7. Larheim TA, Westesson P, Sano T. Temporomandibular joint disk displacement: comparison in asymptomatic volunteers and patients. Radiology. 2001;218(2):428-32.
8. Tasaki MM, Westesson PL, Isberg AM, Ren YF, Tallents RH. Classification and prevalence of temporomandibular joint disk displacement in patients and symptom-free volunteers. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists,

its constituent societies, and the American Board of Orthodontics. 1996;109(3):249-62.

9. Xiong X, Ye Z, Tang H, Wei Y, Nie L, Wei X, et al. MRI of temporomandibular joint disorders: Recent advances and future directions. Journal of Magnetic Resonance Imaging. 2020 Aug 31;54(4):1039–52.
10. Higuchi K, Chiba M, Sai Y, Yamaguchi Y, Nogami S, Yamauchi K, et al. Relationship between temporomandibular joint pain and magnetic resonance imaging findings in patients with temporomandibular joint disorders. International Journal of Oral and Maxillofacial Surgery. 2020 Feb;49(2):230–6.
11. Ghadimi M, Sapra A. Magnetic Resonance Imaging (MRI), Contraindications. StatPearls Publishing; 2021 Jan.
12. Coombs MC, Bonthius DJ, Nie X, Lecholop MK, Steed MB, Yao H. Effect of measurement technique on TMJ mandibular condyle and articular disc morphometry: CBCT, MRI, and physical measurements. Journal of Oral and Maxillofacial Surgery. 2019 Jan;77(1):42–53. doi:10.1016/j.joms.2018.06.175
13. Sessle BJ, Baad-Hansen L, Exposto F, Svensson P. Orofacial pain. Clinical Pain Management. 2022 Mar 9;343–54.
14. Warburton G, Patel N, Anchlia S. Current treatment strategies for the management of the internal derangements of the Temporomandibular Joint: A global perspective. Journal of Maxillofacial and Oral Surgery. 2021 Feb 24;21(1):1–13.
15. Li J, Zhang Z, Han N. Diverse therapies for disc displacement of Temporomandibular Joint: A systematic review and network meta-analysis. British Journal of Oral and Maxillofacial Surgery. 2022 Oct;60(8):1012–22.