Journal of Rare Cardiovascular Diseases
ISSN: 2299-3711 (Print) | e-ISSN: 2300-5505 (Online)
www.jrcd.eu
RESEARCH ARTICLE

Clinical and MRI Based Assessment of Articular Disc Repositioning of TMJ During Various Orthodontic Tooth Movements: An Original Research Study

Dr. Aishwarya Sonti[1], Dr. Bogi Prashanthi[2], Dr. Manikanta Koyi[3], Dr. Sahithi Ram Vatram[4], Dr. Kavya Kandula[5], Dr. Chimata Pavan Tejasri[6]

[1]MDS, Senior Lecturer, Department of Oral Medicine and Radiology, Sibar Institute of Dental Sciences, Takkellapadu, Guntur, Andhra Pradesh, India
[2]MDS, Reader, Department of Oral Medicine and Radiology, Nimra Institute of Dental Sciences, Ibrahimpatnam, NTR District, Andhra Pradesh, India
[3]BDS, Masters in Health Informatics, Westfield, Indiana, USA (Corresponding Author)
[4]Post Graduate Student, Department of Oral Medicine and Radiology, St. Joseph Dental College, Eluru, Andhra Pradesh, India
[5]MDS, Senior Lecturer, Department of Pedodontics, Nimra Institute of Dental Sciences, Ibrahimpatnam, NTR District, Andhra Pradesh, India
[6]BDS, Associate Dentist at Rainbow Dental Care, Vuyyuru, Krishna District, Andhra Pradesh, India

*Corresponding Author
Dr. Manikanta Koyi

Article History
Received: 14.10.2025
Revised: 05.11.2025
Accepted: 25.11.2025
Published: 16.12.2025

Abstract: ***Aim:*** This study assesses articular disc repositioning in the TMJ during various orthodontic tooth movements using clinical and MRI methods. ***Materials and Methods:*** This study involved 40 patients aged 35 to 60 with symptoms of temporomandibular joint (TMJ) dysfunction, including jaw pain and restricted movement. Clinical exams and high-resolution MRI revealed that 20 participants showed signs of articular disc repositioning, affecting jaw function. Selection criteria ensured balanced gender representation and excluded individuals with mental health issues, pregnancy, recent trauma, systemic diseases, prior treatments, or MRI contraindications. Informed consent was obtained, and participants were positioned supine during the MRI, which included T1-weighted sequences in both closed and open-mouth positions. Participants were divided into two groups: Group 1 had normal TMJ function, while Group 2 had confirmed articular disc repositioning and assessed the mechanical dynamics of the articular disc during orthodontic movements, with findings expected to enhance treatment strategies for temporomandibular disorders (TMD) and improve patient outcomes. ***Statistical Analysis and Results:*** This study analyzed 40 patients divided into two groups based on temporomandibular joint (TMJ) functionality. The demographic distribution included 21 males and 19 females. Group 1 served as the control with 20 individuals having normal TMJ function and no pain, with clinical evaluations confirming the absence of disc abnormalities. Notably, 11 participants reported a significant improvement in their quality of life. In contrast, Group 2 consisted of 20 individuals with articular disc repositioning issues, with follow-up assessments showing no improvement in quality of life after treatment. A one-way ANOVA analysis highlighted the complexities of TMJ disorders and the need for further research into effective treatments.
Conclusion: This study concluded that a comprehensive approach, combining clinical evaluations and advanced imaging techniques like Magnetic Resonance Imaging (MRI), effectively assesses TMJ conditions. Successful treatment is linked to reduced pain, restored jaw function, and confirmed disc repositioning. These findings emphasise the importance of a multidisciplinary approach in managing TMJ disorders and indicate a need for further research into TMJ dysfunction and disc displacement to enhance clinical practices.

Keywords: Articular Disc, Temporomandibular Joint, Tooth Movements, Magnetic Resonance Imaging (MRI), Orthodontic Tooth Movement

INTRODUCTION

Orthodontic tooth movement (OTM) is a multifaceted process that involves the deliberate shifting of teeth through the application of specific forces, which can effectively occur whether the mouth is open or closed. This intricate movement plays a pivotal role in correcting dental misalignments, enhancing bite efficiency, and ultimately improving oral health and function.[1,2] The various types of tooth movement include: Tipping movement involves the crown of the tooth tilting in one direction, while the root shifts in the opposite direction. Tipping is commonly employed during the initial phases of orthodontic treatment, as it helps create space for the alignment of adjacent teeth or achieve a specific angulation that is essential for correcting malocclusions. Bodily Movement (Translation), unlike tipping, bodily movement entails a uniform shift of the entire tooth, with the crown and root moving the same distance and in the same direction. This type of movement is critical when significant tooth displacement is necessary, such as when closing gaps within the dental arch, which may result from tooth loss or extraction. Intrusion and

Extrusion refer to the process of pushing a tooth deeper into the alveolar bone, which is often utilised to correct overbite situations or ensure that the tooth is in proper alignment with its neighbouring counterparts. Conversely, extrusion involves gently pulling the tooth outward from the gums; this movement may be required to address issues like deep bites or to properly align the occlusal plane. Both movements require careful calibration of orthodontic forces to ensure optimal results. Rotation movement involves the tooth pivoting around its long axis, allowing for the correction of teeth that have become rotated due to misalignment. Rotational movement is particularly beneficial for improving both the overall alignment and spacing of teeth within the arch, promoting better aesthetics and functionality. Torquing is a specialised technique that focuses on adjusting the position of the tooth's root to modify its axial inclination. This movement is particularly important for the anterior teeth, where proper angulations significantly contributes to both aesthetic appeal and functional efficiency.[3-6] Achieving the correct torque levels ensures that the teeth function harmoniously within the bite. While the position of the mouth is a critical factor in diagnosing bite issues known as malocclusion, as well as in evaluating the functionality of the temporomandibular joint (TMJ), it does not alter the cellular mechanisms that underpin tooth movement.[7,8] Instead, the application of orthodontic forces stimulates the periodontal ligaments, which leads to the remodelling of the surrounding alveolar bone, facilitating movement over time. Advanced imaging techniques, including magnetic resonance imaging (MRI), are invaluable in assessing conditions that affect the TMJ. These modalities are specifically designed to evaluate the position of the articular disc within the joint, particularly in instances where conservative treatments such as physical therapy, splint therapy, or orthodontic adjustments fail to relieve symptoms.[9,10] In such cases, surgical intervention may be warranted to reposition the disc, which can improve jaw function and alleviate associated pain, thereby enhancing the patient's overall quality of life.[11] A thorough understanding of the diverse aspects of orthodontic tooth movement not only supports accurate diagnosis and effective treatment planning but also contributes to achieving lasting results in orthodontic care. Implementing these principles ensures that patients benefit from optimal functional and aesthetic outcomes, fostering not only a healthier smile but also enhanced confidence and well-being.[12,13] This study aims to assess articular disc repositioning in the TMJ during various orthodontic tooth movements using clinical and MRI methods.

MATERIAL AND METHODS

This study engaged a cohort of 40 patients, aged between 35 and 60 years, who presented with a diverse array of symptoms indicative of temporomandibular joint (TMJ) dysfunction. The symptoms included pain localized around the TMJ, noticeable swelling, tenderness to palpation, and restricted mobility during mouth opening and closing activities. After conducting comprehensive clinical examinations alongside high-resolution magnetic resonance imaging (MRI) scans, it was identified that 20 of the participants exhibited signs of articular disc repositioning within the TMJ, a condition that can significantly affect jaw function and overall quality of life. Participants were carefully selected based on specific inclusion criteria designed to ensure a balanced representation across genders. Eligible individuals were those experiencing anterior disc pain or other related craniomaxillofacial pain disorders, which can significantly impact quality of life. To maintain the integrity of the study, individuals were systematically excluded if they had any histories of mental health issues, were currently pregnant, had recently experienced physical trauma that could affect their condition, or had any systemic diseases, including autoimmune disorders that might interfere with the study's outcomes. Additionally, individuals who had previously undergone treatments for temporomandibular disorders (TMD) were excluded to ensure that the data reflected first-time experiences with these disorders. Furthermore, individuals with contraindications related to MRI procedures, such as implanted medical devices that could pose risks during imaging, were also systematically excluded from participation. Before entering the study, informed consent was meticulously acquired from all potential participants. This process ensured that each individual had a comprehensive understanding of the study's objectives, procedures, potential risks, and benefits. Participants were encouraged to ask questions, and only those who expressed clear understanding and agreement proceeded to join the study. This careful approach underscores the commitment to ethical standards and participant well-being in research. To enhance patient comfort and clarity during the MRI scans, all metallic objects were carefully removed from the vicinity of the patients. Additionally, earplugs were provided to mitigate the loud noises typically associated with MRI machines, creating a more pleasant experience. Each participant was positioned supine on the imaging table with their heads immobilized using restraints to prevent any movement during the imaging process. The MRI protocol included T1-weighted sequences specifically designed to evaluate the intricate anatomical structure of the mandibular condyle, as well as oblique scans for enhanced imaging of the TMJ. The analysis involved examining the joint in both closed and open-mouth positions, providing a comprehensive perspective on its dynamic function. For the purpose of this analysis, participants were carefully stratified into two distinct groups based on their temporomandibular joint (TMJ) function. Group 1, serving as the control, comprised 20 individuals exhibiting normal TMJ function, characterized by no reported pain or dysfunction and typical range of motion during mandibular movements. In contrast, Group 2 included 20 individuals diagnosed with articular disc repositioning, a condition confirmed

through comprehensive clinical assessments, including symptom questionnaires, and diagnostic imaging via magnetic resonance imaging (MRI), which revealed the displacement of the articular disc within the joint. The primary objective of this study was to meticulously evaluate the behavior and mechanical dynamics of the articular disc during various orthodontic tooth movements, such as molar extrusion, incisor retraction, and lateral expansion. By analyzing these movements, the research sought to understand how the repositioned disc interacts with the surrounding anatomical structures and how this interaction influences TMJ function. The findings from this study are anticipated to provide valuable insights into the implications for the treatment and management of temporomandibular disorders (TMD). By understanding the unique challenges posed by articular disc repositioning during orthodontic procedures, dental and orthodontic practitioners may develop more effective, patient-centered treatment plans. Ultimately, the goal is to inform and enhance future clinical practices in the realms of dental and orthodontic care, potentially improving patient outcomes and quality of life.

Statistical Analysis and Results

In this comprehensive analysis, all statistical computations were carried out using SPSS version 30.0 a sophisticated software suite specifically designed for statistical modelling and intricate data analysis within the realm of social sciences. To rigorously assess the significance of our findings, we utilized the chi-square test, a powerful statistical tool that is particularly effective for examining discrepancies in proportions among distinct groups. This method allowed us to conduct an in-depth and meticulous comparison of categorical variables, ensuring that our results not only reflect the complex relationships within the dataset but also accurately capture the underlying patterns and trends that characterize the data.

RESULTS

This study undertook a comprehensive analysis involving 40 patients, strategically categorized into two distinct groups based on the functionality of their temporomandibular joint (TMJ) and the associated clinical presentations observed. In Table 1, we present a detailed demographic breakdown of the participants, which encompasses an extensive age distribution and gender analysis. The sample was comprised of 21 males and 19 females, reflecting a well-balanced distribution that enhances the generalizability of our findings across diverse populations. Group 1 functioned as the control group, consisting of 20 individuals exhibiting normal TMJ functionality. These participants reported no symptoms of pain, dysfunction, or any impairment during their mandibular movements, all of which fell within established normative ranges. Comprehensive assessments, which included thorough clinical evaluations alongside advanced imaging studies, validated the absence of articular disc abnormalities in this group. This suggests that proper TMJ function may be linked to a higher quality of life and further underscores the potential implications of TMJ health on daily activities. Conversely, Group 2 included 20 individuals diagnosed with issues related to the repositioning of the articular disc, a condition validated through rigorous clinical evaluations and MRI imaging modalities. The imaging results revealed significant displacement of the articular disc, a common pathology associated with various TMJ disorders, which often leads to substantial functional impairments and discomfort in affected individuals. Table 2 provides an in-depth analysis of the findings for Group 1, wherein no surgical intervention was deemed necessary as there was no requirement for repositioning of the articular disc. The clinical assessments, alongside follow-up MRI evaluations, were instrumental in reassessing the TMJ conditions of these participants. To rigorously evaluate the significance of the observed findings, we applied the Pearson Chi-Square test, producing promising results. Notably, 11 patients within this group reported a significant improvement in their overall quality of life, highlighting the positive implications tied to healthy TMJ function. In contrast, for Group 2, as detailed in Table 3, a repositioning procedure for the articular disc was performed, and subsequent clinical and MRI assessments were conducted to gauge the therapeutic efficacy of this intervention. Following the same rigorous methodology employed in Group 1, we again utilized the Pearson Chi-Square test to delve deeper into the relationships between categorical variables within this group. Unfortunately, the outcomes were less encouraging, as none of the participants in this group reported an improvement in their quality of life post-surgery, suggesting that the surgical intervention did not yield the anticipated benefits and raises questions regarding the efficacy of such procedures in treating TMJ disorders. Lastly, Table 4 summarizes the estimated outcomes across all studied groups through the application of one-way ANOVA. This statistical approach facilitates a comprehensive comparative analysis of the effectiveness of the interventions in relation to the patients' perceived quality of life. By offering a detailed perspective on the impacts of TMJ disorders and the resultant treatments, this study aims to enhance our understanding of the complexities involved and inform clinical practices related to the management of TMJ conditions and their profound effects on overall patient well-being. The findings underscore the need for ongoing research into alternative treatment modalities that may prove more beneficial for individuals suffering from TMJ-related issues.

Table 1: Age & gender based statistical description of contributing patients

Age Group (Yrs)	Male	Female	Total	P value
35-40	**4**	**3**	**7**	**0.12**
41-45	**5**	**2**	**7**	**0.02***
46-50	**3**	**5**	**8**	**0.01***
51-55	**4**	**5**	**9**	**0.30**
56-60	**5**	**4**	**9**	**0.60**
Total	**21**	**19**	**40**	***Significant**
***p<0.05 significant**				

Graph 1: Patients demographic distribution and associated details

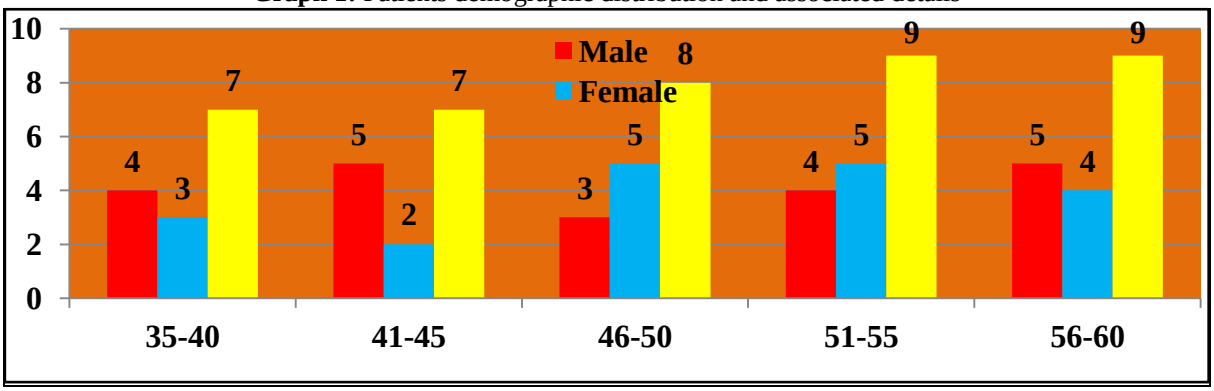

Table 2: In Group 1, which consisted of 20 participants, no repositioning of the articular disc in the temporomandibular joint (TMJ) was performedand clinical and MRI assessment was made. To evaluate the significance of the observed findings, a statistical analysis was conducted utilising the Pearson Chi-Square test. This method provided an in-depth assessment of the relationships between categorical variables within the study group

Evaluation	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Clinical Evaluation								
Joint Sounds	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
Tenderness	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
Pain	0	-	-	-	-	-	-	-
Palpitations	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
MRI Assessment								
Disc Position (Closed Mouth Position)	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
Disc Condylar Relation (Open Mouth Position)	2	1.10	1.07	1.05	1.06	1.09	1.010	1.0
Deformed Disc Morphology	0	-	-	-	-	-	-	-
Condylar Flattening Osteophytes	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
Joint Effusion	2	1.10	1.07	1.05	1.06	1.09	1.010	1.0
Improved Quality of Life	11	1.40	1.32	1.27	1.22	1.20	1.25	0.8
*p<0.05 significant								

Table 3: In Group 2, which consisted of 20 participants, with repositioning of the articular disc in the temporomandibular joint (TMJ) was performed, and clinical and MRI assessment was made. To evaluate the significance of the observed findings, a statistical analysis was conducted utilising the Pearson Chi-Square test. This method provided an in-depth assessment of the relationships between categorical variables within the study group

Evaluation	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Clinical Evaluation								
Joint Sounds	2	1.10	1.07	1.05	1.06	1.09	1.010	1.0
Tenderness	3	1.14	1.09	1.27	1.28	2.18	2.02	0.2*
Pain	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
Palpitations	3	1.14	1.09	1.27	1.28	2.18	2.02	0.2*
MRI Assessment								
Disc Position (Closed Mouth Position) Anterior To 11 O'clock Position	3	1.14	1.09	1.27	1.28	2.18	2.02	0.2*
Disc Condylar Relation (Open Mouth Position) Does Not Return To Original Position	2	1.10	1.07	1.05	1.06	1.09	1.010	1.0
Deformed Disc Morphology	3	1.14	1.09	1.27	1.28	2.18	2.02	0.2*
Condylar Flattening Osteophytes	2	1.10	1.07	1.05	1.06	1.09	1.010	1.0
Joint Effusion	1	1.08	1.03	1.04	1.01	1.04	1.08	0.01*
Improved Quality of Life	0	-	-	-	-	-	-	-
*p<0.05 significant								

Table 4: Estimation amongst all studied groups using one-way ANOVA

Variables	Degree of Freedom	Sum of Squares ∑	Mean Sum of Squares m∑	F	Level of Sig. (p)
Between Groups	3	1.420	1.537	1.3	0.001*****
Within Groups	15	2.204	0.623	_	
Cumulative	104.13	07.644	*p<0.05 significant		

DISCUSSION

Butrón-Téllez Girón C et al reviewed in their study that orthodontic tooth movement (OTM) refers to the complex biomechanical process through which teeth are repositioned within the alveolar bone. This process involves the application of continuous mechanical forces that facilitate the remodelling of both the periodontal ligament and the surrounding bone structures. The underlying mechanisms of OTM are intricately tied to the biological responses of the tissues involved. Specifically, bone resorption occurs on the pressure side of the tooth as a response to applied forces, resulting in the removal of bone, while new bone formation takes place on the tension side, where the tooth is being pulled away from the bone.14,15 El-Angbawi A et al showed in their study that tooth movements can be categorised into several distinct types, each characterised by specific biomechanical principles. Tipping movement involves the application of a single, localised force that causes the crown of the tooth to shift in one direction. Conversely, the root moves in the opposite direction, enabling a tilting motion that alters the tooth's position in the arch. Bodily Movement, the entire tooth, including both the crown and root, is translated uniformly in the same direction. This type of movement is particularly effective when a comprehensive repositioning of the tooth is necessary. Intrusion and Extrusion are axial movements that involve repositioning the tooth along its long axis. Intrusion entails moving the tooth towards the alveolar crest (the edge of the gums), thereby decreasing the tooth's height, while extrusion involves moving the tooth in the opposite direction towards the occlusal plane, effectively increasing its height within the dental arch. Rotation movement refers to the twisting of a tooth around its long axis. Rotational movements are crucial in correcting the alignment of teeth, particularly those that are misaligned rotationally within the dental

arch. Torquing movement addresses the axial inclination of a tooth by displacing the root either buccally (towards the cheek) or lingually (towards the tongue). Torquing is vital for achieving optimal root position and ensuring proper alignment and stability of the tooth. Uprighting technique specifically targets the correction of teeth that have been tipped mesiodistally (either towards the midline or away from it). Uprighting is particularly important for restoring proper occlusion and alignment.16-18 Articular repositioning plays a crucial role in effectively managing the temporomandibular joint (TMJ), especially in instances marked by articular disc displacement and a range of temporomandibular disorders (TMDs). An effective orthodontic treatment plan is designed not only to achieve optimal alignment of the teeth and establish a stable occlusion but also to safeguard the proper functioning and overall health of the TMJ.19,20 Matheson EM et al included in their study that in most cases, routine orthodontic movements exert minimal influence on the positioning of the TMJ disc; however, more complex scenarios may require surgical intervention to adequately address significant displacements or dysfunctions. The primary goal of these surgical procedures is to attain stable positioning of the condyle—the rounded end of the jawbone that articulates with the skull—while simultaneously promoting healthy bone remodeling processes around the joint. This comprehensive approach ensures that both the mechanical functions and the biological health of the TMJ are optimized, ultimately leading to improved patient outcomes.21,22 Niraj LK et al reviewed in their study that magnetic resonance imaging (MRI) is an invaluable non-invasive diagnostic tool that excels in producing high-resolution images of soft tissues, including the delicate articular disc of the temporomandibular joint (TMJ). This advanced imaging technique is indispensable for the thorough evaluation of TMJ disorders, as it adeptly identifies disc displacement by capturing comparative images in both open and closed mouth positions. Furthermore, MRI can uncover additional complications such as inflammation or degenerative changes within the joint, providing critical insights that are essential for tailoring treatment plans and management strategies for patients experiencing a range of TMJ-related conditions. This detailed imaging not only enhances diagnostic accuracy but also facilitates informed decision-making in clinical practice.23,24

CONCLUSION

In accordance with the limitations of the study, the author conducted a thorough examination of the clinical and MRI-based assessment of articular disc repositioning in the temporomandibular joint (TMJ) during various orthodontic tooth movements. The results indicated that the evaluation of tooth movement and TMJ articular disc repositioning is effectively carried out through a comprehensive approach that combines detailed clinical examinations with advanced imaging techniques. It was concluded that among these, Magnetic Resonance Imaging (MRI) stands out as the gold standard for assessing both the disc and the surrounding soft tissues due to its superior ability to visualise non-bony structures. The findings suggest that successful orthodontic treatment is typically associated with a notable reduction in pain, the restoration of normal jaw function, and verifiable repositioning of the disc as demonstrated through imaging studies. These outcomes underscore the importance of a multidisciplinary approach in the management of TMJ disorders, integrating orthodontic treatment with accurate diagnostic methods. Furthermore, the results highlight the critical need for further research to explore the underlying mechanisms of TMJ dysfunction and disc displacement. Such investigations could provide deeper insights into the pathophysiology of these conditions and pave the way for more effective clinical practices and therapeutic interventions in the future.

REFERENCES

1. Danz JC, Degen M. Selective modulation of the bone remodelling regulatory system through orthodontic tooth movement-a review. Front Oral Health. 2025 Mar 6;6:147-151.
2. Li Y, Jacox LA, Little SH, Ko CC. Orthodontic tooth movement: The biology and clinical implications. Kaohsiung J Med Sci. 2018 Apr;34(4):207-214.
3. Alghamdi B, Jeon HH, Ni J, Qiu D, Liu A, Hong JJ, Ali M, Wang A, Troka M, Graves DT. Osteoimmunology in Periodontitis and Orthodontic Tooth Movement. Curr Osteoporos Rep. 2023 Apr;21(2):128-146.
4. Kacprzak A, Strzecki A. Methods of accelerating orthodontic tooth movement: A review of contemporary literature. Dent Med Probl. 2018 Apr-Jun;55(2):197-206.
5. Davidovitch Z. Tooth movement. Crit Rev Oral Biol Med. 1991;2(4):411-420.
6. Roessler DM. Aetiology and management of the anterior dislocated disc. Management of articular disc displacement. Ann R Australas Coll Dent Surg. 1994 Apr;12:183-188.
7. Al-Saleh MA, Alsufyani N, Flores-Mir C, Nebbe B, Major PW. Changes in temporomandibular joint morphology in class II patients treated with fixed mandibular repositioning and evaluated through 3D imaging: a systematic review. Orthod Craniofac Res. 2015 Nov;18(4):185-201.
8. Marlière DAA, Vicentin Calori MJA, Medeiros YL, Santiago RC, Strujak G, Asprino L. Clinical outcomes of the discopexy using suture anchors for repositioning disc displacement in temporomandibular joints: Systematic review and meta-analysis. J Craniomaxillofac Surg. 2023 Jul-Aug;51(7-8):475-484.
9. Sorrenti NG, Manfredini D, Sornig F, Ferrari M, Colonna A, Val M. Correlation between bilateral TMJ MRI findings: A systematic review of the

literature. Dent Med Probl. 2024 May-Jun;61(3):401-406.
10. Hara GF, de Souza-Pinto GN, Brasil DM, Poluha RL, Iwaki LCV, Filho LI, Neto FH. What is the image appearance of juvenile idiopathic arthritis in MRI, CT, and CBCT of TMJ? A systematic review. Clin Oral Investig. 2023 May;27(5):2321-2333.
11. Singer SR, Mupparapu M. Temporomandibular Joint Imaging. Dent Clin North Am. 2023 Apr;67(2):227-241.
12. Inarejos Clemente EJ, Tolend M, Navallas M, Doria AS, Meyers AB. MRI of the temporomandibular joint in children with juvenile idiopathic arthritis: protocol and findings. Pediatr Radiol. 2023 Jul;53(8):1498-1512.
13. C. L. Chang, D. H. Wang, M. C. Yang, W. E. Hsu, and M. L. Hsu, "Functional disorders of the temporomandibular joints: internal derangement of the temporomandibular joint," Med ical Science, vol. 34, no. 4, pp. 223–230, 2018.
14. Butrón-Téllez Girón C, Sánchez-Almanza M, Martínez-Zumarán A, Pozos-Guillén A, Garrocho-Rangel A. Effects of Vitamin Administration on Orthodontic Tooth Movement: A Scoping Review. Nutr Rev. 2025 Oct 1;83(10):2015-2027.
15. Seddiqi H, Klein-Nulend J, Jin J. Osteocyte Mechanotransduction in Orthodontic Tooth Movement. Curr Osteoporos Rep. 2023 Dec;21(6):731-742.
16. El-Angbawi A, McIntyre G, Fleming PS, Bearn D. Non-surgical adjunctive interventions for accelerating tooth movement in patients undergoing orthodontic treatment. Cochrane Database Syst Rev. 2023 Jun 20;6(6):10-18.
17. Huang H, Williams RC, Kyrkanides S. Accelerated orthodontic tooth movement: molecular mechanisms. Am J Orthod Dentofacial Orthop. 2014 Nov;146(5):620-32.
18. Makrygiannakis MA, Kaklamanos EG, Athanasiou AE. Medication and orthodontic tooth movement. J Orthod. 2019 Jun;46(1_suppl):39-44.
19. Barlattani A Jr, Martelli M, Gargari M, Ottria L. Articular disc of temporomandibular joint: an anatomical and histological study. Functional considerations. J Biol Regul Homeost Agents. 2019 Nov-Dec;33(6 Suppl. 2):199-208.
20. Askar H, Aronovich S, Christensen BJ, McCain J, Hakim M. Is Arthroscopic Disk Repositioning Equally Efficacious to Open Disk Repositioning? A Systematic Review. J Oral Maxillofac Surg. 2021 Oct;79(10):2030-2041.e2.
21. Matheson EM, Fermo JD, Blackwelder RS. Temporomandibular Disorders: Rapid Evidence Review. Am Fam Physician. 2023 Jan;107(1):52-58.
22. Sang S, Ameli N, Almeida FT, Friesen R. Association between clinical symptoms and MRI image findings in symptomatic temporomandibular joint (TMJ) disease: A systematic review. J Craniomaxillofac Surg. 2024 Jul;52(7):835-842.
23. Niraj LK, Patthi B, Singla A, Gupta R, Ali I, Dhama K, Kumar JK, Prasad M. MRI in Dentistry- A Future Towards Radiation Free Imaging - Systematic Review. J Clin Diagn Res. 2016 Oct;10(10):ZE14-ZE19.
24. Q. Zhang, J. Li, L. X. Ma, and Z. H. Wang, "Diagnostic value of temporomandibular joint open and closed magnetic resonance imaging in anterior disc displacement of temporomandibular joint," Journal of Imaging Research and Medical Applications, vol. 5, no. 14, pp. 26–28, 2021.