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RESEARCH ARTICLE

Comparison of Short-Term Outcomes of Hyaluronic Acid Injection and Hyaluronic Acid with Platelet-Rich Plasma Injections Following Arthrocentesis

Artrosentez Sonrası Hyaluronik Asit ve Trombosit Zengin Plazma ile Hyaluronik Asit Enjeksiyonlarının Kısa Vadeli Sonuçlarının Karşılaştırılması

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ABSTRACT

Objective: The aim of the present study was to evaluate the clinical efficacy of intra-articular PRP+HA injection following arthrocentesis in patients with disc displacement with reduction (DDwR) and disc displacement without reduction (DDwoR).

Methods: This retrospective study included medical records of patients aged 17–60 who underwent unilateral or bilateral temporomandibular joint arthrocentesis at Bezmialem Vakıf University between 2017 and 2024. The joints were categorized into two groups: Group I received hyaluronic acid (HA); and Group II received platelet-rich plasma and hyaluronic acid (PRP+HA) following arthrocentesis. Pain intensity, maximum mouth opening pain-free (MMO-PF), maximum mouth opening with pain (MMO-P), and lateral and protrusive movements were recorded as outcome variables. Pre-operative outcome variables, and post-operative measurements at 1 and 3 month follow-up visits, were collected. All statistical analyses were conducted with a significance level set at $\alpha = 0.05$ (two-tailed).

Results: 36 joints from 23 patients were included in the study and divided into two groups, with 18 joints per group. Both groups demonstrated improvement in pain, but a statistically significant difference was observed only in Group II ($p<0.05$). No significant differences were observed in MMO-PF, MMO-P, and lateral movements.

Conclusion: This study demonstrates that administration of PRP+HA following arthrocentesis is an effective treatment for managing pain in TMDs. However, when compared with HA or PRP alone, the combination did not show a statistically significant superiority.

Keywords: Temporomandibular joint, arthrocentesis, hyaluronic acid, platelet-rich plasma

ÖZET

Amaç: Bu çalışmanın amacı, redüksiyonlu disk deplasmanı ve redüksiyonsuz disk deplasmanı hastalarında artrosentez sonrasında intraartiküler Plateletten Zengin Plazma ve Hyaluronik Asit (PRP+HA) enjeksiyonunun klinik etkinliğini değerlendirmektir.

Yöntem: 2017–2024 yılları arasında Bezmialem Vakıf Üniversitesi'nde tek taraflı veya çift taraflı temporomandibular eklem artrosentezi uygulanmış, 17–60 yaş aralığındaki hastalar bu retrospektif çalışmaya dahil edilmiştir. Eklemler iki gruba ayrılmıştır: Grup I'de artrosentez sonrasında hyaluronik asit uygulanmış, Grup II'de ise artrosentezden sonra plateletten zengin plazma ve hyaluronik asit uygulanmıştır. Ağrı şiddeti (VAS), ağrısız maksimum ağız açıklığı (MMO-PF), ağrılı maksimum ağız açıklığı (MMO-P) ile lateral ve protruziv mandibular hareketler incelenmiştir. Preoperatif ölçümler ile postoperatif 1. ve 3. ay takip verileri değerlendirilmiştir. Tüm istatistiksel analizler, anlamlılık düzeyi $\alpha = 0,05$ (çift yönlü) olacak şekilde gerçekleştirilmiştir.

Bulgular: Çalışmaya 23 hastaya ait toplam 36 eklem dahil edilmiş ve her biri 18 eklem içerecek şekilde iki gruba ayrılmıştır. Her iki grupta da ağrı düzeylerinde iyileşme gözlenmiş olmakla birlikte, istatistiksel olarak anlamlı fark yalnızca Grup II'de saptanmıştır ($p<0,05$). MMO-PF, MMO-P ve lateral hareketlerde gruplar arasında istatistiksel olarak anlamlı bir fark bulunmamıştır.

Sonuç: Bu çalışma, artrosentez sonrasında PRP+HA uygulanmasının temporomandibular eklem hastalıklarında ağrı kontrolü açısından etkili bir tedavi yöntemi olduğunu göstermektedir. Ancak, HA veya PRP uygulamaları ile karşılaştırıldığında, kombine tedavinin istatistiksel olarak anlamlı bir üstünlük sağlamadığı görülmüştür.

Anahtar Kelimeler: Temporomandibular eklem, artrosentez, hyaluronik asit, plateletten zengin plazma

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INTRODUCTION

Temporomandibular joint disorders (TMD) are conditions that affect the temporomandibular joint (TMJ), the masticatory muscles, and associated structures. These disorders are characterized by symptoms such as pain, joint sounds, limited mouth opening, and difficulties with chewing.[1,2]

Internal derangement of the TMJ is one of the most common types of TMD, which involves an abnormal relationship between the mandibular condyle, articular disc, and articular eminence[3]. The underlying causes are often associated with microtrauma, excessive loading, joint laxity, decreased lubrication and increased friction in the joint, and overactivity of the lateral pterygoid muscle, leading to anterior displacement of the disc.[1,2,3]

Treatment options for internal derangements include conservative methods, minimally invasive procedures, and surgical interventions. Conservative methods involve patient education, occlusal splints, physiotherapy, and medication management. Traditionally, minimally invasive procedures such as arthrocentesis and arthroscopy were advised for cases where conservative treatments failed. Recent evidence suggests that these interventions can be used earlier in the treatment process, as they offer faster and more effective symptom relie.[4,5]

Since its introduction by Nitzan in 1991, arthrocentesis has been widely used in the management of internal derangements and has been demonstrated to be a safe and effective minimally invasive treatment.[6] It is performed through two needles inserted into the upper compartment of the TMJ. It washes away the inflammatory products and breaks down adhesions through hydraulic distension.[2,6] A wide range of medical agents, such as corticosteroids, non-steroidal anti-inflammatory drugs (NSAIDs), local anesthetic agents, hyaluronic acid (HA), platelet-rich plasma (PRP), and platelet-rich fibrin (PRF), have been used for intra-articular injections following arthrocentesis.[2,3]

Hyaluronic acid is a glycosaminoglycan produced by chondrocytes and synoviocytes in joints and plays a significant role in joint lubrication. Intra-articular injection of hyaluronic acid restores the viscoelasticity of synovial fluid and promotes the natural production of HA.[7,8]

Combined PRP and HA preparations are closed-system medical devices designed for the simultaneous preparation of autologous PRP and non-cross-linked HA. The HA component provides a viscoelastic scaffold that enhances joint lubrication and prolongs the intra-articular retention of PRP-derived growth factors, while the PRP fraction delivers cytokines and bioactive molecules that promote tissue regeneration and modulate inflammation. PRP also promotes the proliferation of cells and the synthesis of the cartilage matrix by chondrocytes, as well as by bone marrow-derived mesenchymal stromal cells.[9] This synergistic interaction enhances the biological activity of both components, potentially offering superior therapeutic efficacy compared to the individual administration of HA or PRP alone.[10,11]

Many studies have focused on the individual use of PRP and HA after arthrocentesis, but research on their combined application is still limited. The aim of the present study was to evaluate the clinical efficacy of intra-articular injection of PRP+HA following arthrocentesis in patients with DDwR and DDwoR. It was hypothesized that PRP+HA after arthrocentesis may result in superior outcomes for pain reduction and functional improvement compared to HA alone.

MATERIAL AND METHODS

Study Design

This retrospective cohort study was performed at the Department of Oral and Maxillofacial Surgery, Bezmialem Vakif University Faculty of Dentistry. The study was conducted with approval from the Bezmialem Vakif University Non-Interventional Ethics Committee.

This study included patients aged 17 to 60 years who underwent unilateral or bilateral arthrocentesis for disc displacement with reduction or disc displacement without reduction between 2017 and 2024. Diagnoses for all patients were established according to the DC/TMD, based on clinical examination and magnetic resonance imaging (MRI) findings. Exclusion criteria were as follows: autoimmune diseases, benign or malignant TMJ lesions, blood diseases and coagulation disorders, and history of TMJ surgery.

The joints were divided into two equal groups. In group I, arthrocentesis was performed with 100 ml lactated Ringer's solution followed by an intra-articular injection of 1 ml HA (Orthovisc, Anika Therapeutics, Inc., Bedford, MA, USA). In

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group II, arthrocentesis was performed with 100 ml lactated Ringer's solution and intra-articular injection of a combination of 1 ml PRP and HA (The Cellular Matrix™ PRP-HA Kit, RegenLab, Switzerland). The sample size was calculated with a significance level of 0.05 and 80% power, based on the MMO differences reported by Hosgor et al.[12]. The power analysis showed that 18 joints per group were needed.

Arthrocentesis Procedure

Two puncture arthrocentesis with Nitzan's protocol was performed by a single operator. The skin surface was disinfected with a 10% povidone iodine solution. The entry points were marked 10 mm anterior and 2 mm inferior, and 20 mm anterior and 10 mm inferior on the lateral canthus-tragus line (Holmlund-Hellsing line). A 1 ml dose of mepivacaine was injected subcutaneously at puncture points. Through the first entry point, 3 mL of lactated Ringer's solution and 1 mL of mepivacaine were administered into the upper joint compartment (UJC) using a 21-gauge needle and were pumped to distend the UJC. The second 21-gauge needle was inserted at the second point, followed by the irrigation of 100 ml of lactated Ringer's solution. After the arthrocentesis was completed, the second needle was removed and 1 ml of HA was injected into the UJC in Group I, and 1 mL of PRP+HA was injected into the UJC in Group II.

Blood samples were collected from each patient in Group II following the manufacturer's instructions for the PRP-HA kit. Approximately 6 mL of peripheral venous blood was drawn into the sterile, prefilled tube of the kit and centrifuged at 3500 rpm for 5 minutes. After centrifugation, the separated autologous PRP remained in the same closed system and was combined with 2 mL of 2% non-cross-linked hyaluronic acid (40 mg in total). To achieve a uniform mixture, the tube was gently inverted several times before intra-articular injection.

All patients were prescribed tenoxicam 20 mg once daily. Additionally, patients in Group 2 were prescribed amoxicillin and clavulanic acid 1 g, twice daily as a precautionary measure to minimize any potential risk of secondary bacterial contamination during the autologous PRP preparation and injection process. A soft diet for six weeks and jaw exercises performed at a pain-free level, was recommended.

Study Variables

Study variables included demographic factors (age and gender), type of diagnosis, and follow-up duration. Pain intensity, maximum mouth opening pain-free (MMO-PF), maximum mouth opening with pain (MMO-P), lateral and protrusive movements were recorded as outcome variables.

Pain intensity during chewing or maximum mouth opening was evaluated using a visual analogue scale (VAS), ranging from 0 (no pain) to 10 (worst pain possible). Maximum mouth opening was measured in millimeters as the distance between the incisal edges of the upper and lower central incisors, both at a pain-free level (MMO-PF) and at the maximum level with pain (MMO-P). Lateral mandibular movements were measured in millimeters by instructing the patient to move the mandible laterally to the right and left, while protrusive mandibular movement was assessed by asking the patient to move the mandible anteriorly.

All study and outcome variables were obtained from patients' records and forms. Pre-operative outcome variables, as well as post-operative measurements at 1 and 3 month follow-up visits, were collected. All measurements were performed by the same operator.

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics v22.0 (IBM Corp., Armonk, NY, USA). The significance level was set at $\alpha = 0.05$ (two-tailed), and p-values were reported in the conventional format (e.g., $p<0.001$). For within-group comparisons, pre-operative and post-operative measurements were analyzed using the Wilcoxon signed-rank test. To evaluate between-group differences, change scores were primarily calculated to assess the treatment effect and compared between groups using the Mann–Whitney U test. Additionally, pre-operative and post-operative values were compared between groups using the Mann–Whitney U test.

RESULTS

Regarding patient screening, a total of 36 joints from 23 patients were included in the study and divided equally into two groups, with 18 joints per group. Bilateral arthrocentesis using the same technique was performed in 8 patients in Group I and in 5 patients in Group II. In both groups, 15 (83.3%) were female patients and 3 (16.7%) were male patients, with a mean age of 30.10±14.0 and 28.60±8.10, respectively. In Group I, 7 joints (38.9%) presented with DDwR and 11 (61.1%) with DDwoR, while in Group II, 6 joints (33.3%) presented with DDwR and 12 (66.7%) with DDwoR. The mean follow-up duration was

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2.11 ± 1.02 months for both groups. No statistically significant differences were found between the study groups in terms of age, gender, type of diagnosis, and follow-up durations. There were no significant differences in pre-operative MMO-PF, MMO-P, lateral, or protrusive movements between the two groups. However, Group II demonstrated significantly higher pre-operative VAS compared to Group I. This significance was not carried over to the post-operative VAS. No complications or adverse events were recorded in either group (Table 1; Figure 1).

The median VAS decreased from 5 (0-9) to 2 (0-9) in Group I and from 8 (3-10) to 4 (0-9) in Group II. Although both groups demonstrated improvement in pain, a statistically significant difference was observed only in Group II ($p<0.05$). Regarding MMO-PF, MMO-P, and lateral movements, improvements were seen in both groups; however, none reached statistical significance. A significant increase was observed only in protrusive movement within Group I ($p<0.05$) (Table 2).

In the between-group comparison, though Group II showed a greater reduction in VAS, no statistically significant superiority was observed between the two groups. Similarly, no significant between-group differences were observed in MMO-PF, MMO-P, lateral, or protrusive movements (Table 2).

Table 1. Characteristics and diagnoses of all joints.

	HA	HA+PRP	Total
Age (mean±SD)	30.10±14.0	28.60±8.10	29.40±10.90
Gender			
Female	15 (83.3%)	15 (83.3%)	30 (83.3%)
Male	3 (16.7%)	3 (16.7%)	6 (16.7%)
Involved side			
Right	8 (44.4%)	9 (50.0%)	17 (47.2%)
Left	10 (55.6%)	9 (50.0%)	19 (52.8%)
Type of diagnosis			
DDwR	7 (38.9%)	6 (33.3%)	13 (36.1%)
DDwoR	11 (61.1%)	12 (66.7%)	23 (63.6%)
Follow-up duration (months)	2.11±1.02	2.11±1.02	2.11±1.00

SD, Standart Deviation; DDwR, Disc Displacement with Reduction; DDwoR, Disc Displacement without Reduction.

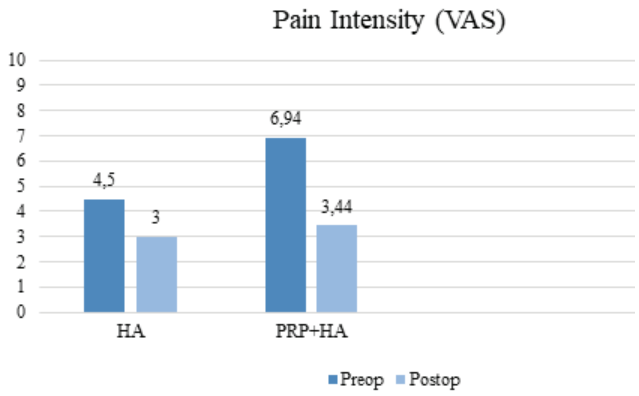


Figure 1. Changes in levels of pain (VAS, visual analog scale) between the study groups across pre-operative and post-operative periods.

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Table 2. Changes in outcome variables at the pre-operative and post-operative periods, and comparisons within and between study groups.

Variables	HA	PRP+HA	Within-Group Comparison (Wilcoxon signed-rank test) P-value		Pre-Post Differences Between Groups (Mann-Whitney U Test) P-value
	Median (range)	Median (range)	HA	HA+PRP	
VAS					0.307
Pre-op	5 (0-9)	8 (3-10)	0.057	p<0.05	
Post-op	2 (0-9)	4 (0-9)			
MMO-PF (mm)					0.341
Pre-op	32 (25-40)	35 (18-45)	0.071	0.231	
Post-op	36 (25-40)	36 (30-47)			
MMO-P (mm)					0.505
Pre-op	37 (30-48)	40 (22-55)	0.371	1	
Post-op	40 (28-47)	40 (33-49)			
Lt. Right (mm)					0.396
Pre-op	7 (4-10)	8 (1-12)	0.116	0.589	
Post-op	8 (4-12)	8 (1-12)			
Lt. Left (mm)					0.381
Pre-op	7 (4-12)	9 (5-12)	0.525	0.124	
Post-op	8 (6-13)	10 (3-13)			
Prot. (mm)					0.221
Pre-op	6 (3.5-13)	7 (3-9)	p<0.05	0.485	
Post-op	6 (2.5-13)	6.5 (3-10)			

HA, hyaluronic acid; PRP, platelet-rich plasma; VAS, visual analog scale; MMO-PF, maximum mouth opening pain-free; MMO-P, maximum mouth opening with pain; Lt. Right, right lateral movement; Lt. Left, left lateral movement; Prot., protrusive movement; SD, standard deviation. Wilcoxon signed-rank test for within-group comparisons and the Mann–Whitney U test for pre–post differences between groups were used. Statistical significance levels: * p<0.05.

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DISCUSSION

Arthrocentesis has been a widely preferred minimally invasive treatment for TMDs since its introduction into the literature.[13,14] Its mechanism of action involves lysis and lavage of UJC, thus removing inflammatory mediators and degraded particles from symptomatic joints. The hydraulic pressure created during lavage also forces apart the disc from the fossa, breaking down adhesions and restoring disc mobility.[15] To enhance its therapeutic effects, numerous studies have combined arthrocentesis with various intra-articular injections.[16,17] Among these, HA and platelet concentrates are currently the most frequently used due to their safety and efficacy. HA is one of the main components of synovial fluid, which supports and protects the joint's lubrication system and contributes to smooth articular motion[1]. Beyond its mechanical role, the anti-inflammatory and analgesic effects of HA have also been reported.[18] Platelet concentrates on the other hand, provide not only symptomatic relief but also regenerative properties through the cells, proteins, and growth factors they contain. As the first generation, PRP has been shown to promote stem cell proliferation and differentiation, while also increasing the synthesis of cartilage matrix components.[19] The long-standing use of HA and PRP in orthopedics, along with the advancements and widespread implementation of their combined applications, has paved the way for their use in the temporomandibular joint.

ElMonem Arboud et al. evaluated the efficacy of intra-articular PRP+HA after arthrocentesis in patients with DDwR or DDwoR and observed significant improvements in pain, mouth opening, and lateral movements. They reported that the PRP+HA was clinically effective in both diagnoses.[20] According to Asadpour et al. PRP+HA injection after arthrocentesis provides greater reductions in pain and functional improvements than HA or PRP alone in patients with TMJ osteoarthritis in 6 months time[21]. Likewise, Harba et al. demonstrated in a prospective observational study that the combined use of PRP and HA resulted in superior improvements in both mouth opening and pain intensity when compared with HA alone.[22]

Recently, a systematic review by Checinski et al. found that PRP+HA produced greater improvements in pain and mouth opening compared to HA or PRP alone; however, these differences did not reach statistical significance. Their findings suggest that this combined approach might be especially beneficial for patients who do not respond to either HA or PRP.[23]

In this study, both the HA and the PRP+HA groups demonstrated a reduction in pain intensity. This reduction was not significantly different between the two groups ($p \rightarrow 0.05$, Table 2). The difference observed in the PRP+HA group was significantly greater, whereas the improvement in the HA group was not. This result may support the previous studies suggesting superiority of PRP in reducing TMJ pain.[21,22,23] Both groups showed improvements in MMO-PF, but these changes were not statistically significant. The HA group improved in MMO-P, while the PRP+HA group did not, although this difference was also not statistically significant. Similarly, no statistically significant differences were found in lateral mandibular movements.

In this study, the homogeneous distribution of demographic variables across both groups, particularly the identical sex distribution and follow-up durations, likely reduced sources of bias. However, although both treatments demonstrated improvements of comparable clinical magnitude, increasing the sample size or reporting effect sizes with confidence intervals would strengthen the interpretability of the outcomes. Considering these limitations, prospective studies with larger cohorts and longer follow-up periods are required.

CONCLUSION

This study demonstrates that administration of PRP+HA following arthrocentesis is an effective treatment for managing pain in TMDs. When compared with HA alone, PRP+HA shows better relief in pain intensity. However, both treatments improve pain and MMO in short term. Studies with larger sample sizes are needed to clarify the comparative efficacy of these treatment modalities.

REFERENCES

1. Nitzan DW. The process of lubrication impairment and its involvement in temporomandibular joint disc displacement: A theoretical concept. J Oral Maxillofac Surg. 2001;59(1):36–45.
2. Yilmaz O, Korkmaz YT, Tuzuner T. Comparison of treatment efficacy between hyaluronic acid and arthrocentesis plus hyaluronic acid in internal derangements of temporomandibular joint. J Craniomaxillofac Surg. 2019;47(11):1720–1727.
3. Karadayi U, Gursoytrak B. Randomised controlled trial of arthrocentesis with or without PRF for internal derangement of the TMJ. J Craniomaxillofac Surg. 2021;49(5):362–367.
4. Tang YH, Zhang M, Duan X, et al. Arthrocentesis versus non-surgical intervention as initial treatment for temporomandibular

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Official publication of AÇBİD (Association of Oral and Maxillofacial Surgery Society)

joint arthralgia: A randomized controlled trial with long-term follow-up. Int J Oral Maxillofac Surg. 2023;52(5):595–603.
5. Andre A, Kang J, Dym H. Pharmacologic treatment for temporomandibular and temporomandibular joint disorders. Oral Maxillofac Surg Clin North Am. 2022;34(1):49–59.
6. Nitzan DW, Dolwick MF, Garza A, Martinez A. Temporomandibular joint arthrocentesis: A simplified treatment for severe, limited mouth opening. J Oral Maxillofac Surg. 1991.
7. Cömert Kılıç S, Güngörmüş M. Is arthrocentesis plus platelet-rich plasma superior to arthrocentesis plus hyaluronic acid for the treatment of temporomandibular joint osteoarthritis? A randomized clinical trial. Int J Oral Maxillofac Surg. 2016;45(12):1538–1544.
8. Guarda-Nardini L, Olivo M, Ferronato G, Salmaso L, Bonnini S, Manfredini D. Treatment effectiveness of arthrocentesis plus hyaluronic acid injections in different age groups of patients with temporomandibular joint osteoarthritis. J Oral Maxillofac Surg. 2012;70(9):2048–2056.
9. Hegab AF, Al Hameed HIA, Hassaneen AM, Hyder AEK. Synergistic effect of platelet-rich plasma with hyaluronic acid injection following arthrocentesis to reduce pain and improve function in TMJ osteoarthritis. J Stomatol Oral Maxillofac Surg. 2023;124(1).
10. Barac B, Damjanov N, Zekovic A. The new treatment approach in knee osteoarthritis: Efficacy of cellular matrix combination of platelet rich plasma with hyaluronic acid versus two different types of hyaluronic acid. Int J Clin Rheumatol. 2018.
11. Renevier JL, Marc JF, Adam P, Sans N, Le Coz J, Prothoy I. Cellular matrix PRP-HA as a treatment option for osteoarthritis: Results of a pilot multicenter French study with long-term follow-up. Int J Clin Rheumatol. 2018;13(4).
12. Hosgor H. Is arthrocentesis plus hyaluronic acid superior to arthrocentesis alone in the treatment of disc displacement without reduction in patients with bruxism? J Craniomaxillofac Surg. 2020;48(11):1023–1027.
13. Nitzan DW. Arthrocentesis: Incentives for using this minimally invasive approach for temporomandibular disorders. Oral Maxillofac Surg Clin North Am. 2006.
14. Tran C, Ghahreman K, Huppa C, Gallagher JE. Management of temporomandibular disorders: A rapid review of systematic reviews and guidelines. Int J Oral Maxillofac Surg. 2022;51(9):1211–1225.
15. Nitzan DW, Naaman HL. Arthrocentesis: What, when, and why? Oral Maxillofac Surg Clin North Am. 2022.
16. Betancor Pérez M, Loro Ferrer JF, Martín Hernán F, Velázquez Cayón RT. Effectiveness of combined arthrocentesis with platelet-rich plasma, platelet-rich fibrin, hyaluronic acid, corticosteroids and NSAIDs in temporomandibular joint osteoarthritis: A systematic review and meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol. 2025;140(5):528–538.
17. Xie Y, Zhao K, Ye G, et al. Effectiveness of intra-articular injections of sodium hyaluronate, corticosteroids, platelet-rich plasma on temporomandibular joint osteoarthritis: A systematic review and network meta-analysis. J Evid Based Dent Pract. 2022;22(3):101720.
18. Altman R, Bedi A, Manjoo A, et al. Anti-inflammatory effects of intra-articular hyaluronic acid: A systematic review. Cartilage. 2019;10(1):43–52.
19. Xie X, Zhang C, Tuan RS. Biology of platelet-rich plasma and its clinical application in cartilage repair. Arthritis Res Ther. 2014;16(1):204.
20. Abd ElMonem Arboud KA, Shoushan MM, El Sharif AM. Evaluation of intra-articular injection of hyaluronic acid with platelet-rich plasma for temporomandibular joint anterior disc displacement with and without reduction. Tanta Dent J. 2022;19(2):89–97.
21. Asadpour N, Shooshtari Z, Kazemian M, et al. Combined platelet-rich plasma and hyaluronic acid can reduce pain in patients undergoing arthrocentesis for temporomandibular joint osteoarthritis. J Oral Maxillofac Surg. 2022;80(9):1474–1485.
22. Harba AN, Harfoush M. Evaluation of the participation of hyaluronic acid with platelet-rich plasma in the treatment of temporomandibular joint disorders. Dent Med Probl. 2021;58(1):81–88.
23. Chęciński M, Lubecka K, Bliźniak F, Chlubek D, Sikora M. Hyaluronic acid/platelet-rich plasma mixture improves temporomandibular joint biomechanics: A systematic review. Int J Mol Sci. 2024;25(17):9401.