AJDS LAZHAR Al-Azhar Journal of Dental Science
Vol. 28- No. 3- 467:476- July 2025
Print ISSN 1110-6751 | online ISSN 2682 - 3314
https://ajdsm.journals.ekb.eg
Oral Biology, Medicine & Surgical Sciences Issue *(Oral Biology, Oral Pathology, Oral Periodontology, Medicine, Oral & Maxillofacial Surgery)*

EFFICACY OF COMPUTER ASSISTED DOUBLE-NEEDLE ARTHROCENTESIS WITH INTRA ARTICULAR INJECTION OF SODIUM HYALURONATE VERSUS PLATELET RICH PLASMA FOR TREATMENT OF TMJ INTERNAL DERANGEMENT (A CLINICAL STUDY)

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ABSTRACT

Objective of the present study evaluated the efficacy of computer-assisted arthrocentesis with intra articular injection of sodium hyaluronate versus platelet rich plasma for treatment of internal derangement of TMJ. **Subjects and methods:** Randomized controlled trial conducted on fourteen patients diagnosed with bilateral TMJ-ID divided into two equal groups were randomly selected from the patients (7 in each group). Group I (SH) treated with TMJ arthrocentesis using customized 3D printed computer assisted guide followed by intra articular injection of sodium hyaluronate. Group II (PRP) received a similar surgical protocol but injection with platelet-rich plasma. All patients were clinically and radiographically evaluated for the pain intensity through visual analog scale (VAS), maximum inter incisal opening (MIO). **Results: Regarding the change in pain score** the pain level sensation increased immediately after arthrocentesis for about two or three days then the pain level decreases dramatically for fourteen days to reach mild level lower than preoperative scores after six months postoperatively, there was a statistically insignificant difference between both groups in all observation intervals. But, within each group there was significant improvement. **Regarding the change in maximum inter incisal opening** decreased significantly immediately postoperative and begun to improve gradually and gained a noticeable increase after six months postoperatively, there was a statistically insignificant difference between both groups in all observation intervals. But within each group there was significant improvement. **Conclusion:** Either intra-articular injections of hyaluronic acid (SH) or autologous platelet-rich plasma (PRP) have shown promising results in managing temporomandibular disorders (TMD) with internal derangement. The study did not reveal any significant preference for one material over the other in terms of clinical efficacy.

KEYWORDS: Temporomandibular joint; Internal derangement; Computer- assisted surgery; sodium hyaluronate; platelet-rich plasma

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DOI: *10.21608/ajdsm.2024.313485.1566*

INTRODUCTION

Temporomandibular joint (TMJ) internal derangement, a frequent manifestation of TMDs, involves abnormal disc, eminence, and condyle alignment, often causing pain, clicking, limited mouth opening, and jaw deviation[1,2]. While conservative management is effective for many, hyaluronic acid (HA) has emerged as a promising treatment for TMJ internal derangement, offering a potential alternative for symptom relief[3-5].

Arthrocentesis, a minimally invasive procedure involving the lavage of the upper compartment of the TMJ to release adhesions and remove inflammatory mediators, has gained recognition as a conservative and cost-effective approach for TMJ disorders, offering fewer complications than joint arthroscopy[6-8]. This procedure bridges surgical and nonsurgical TMJ treatments by irrigating the upper joint compartment, releasing adhesions, removing inflammatory substances, and ultimately improving pain and function[9].

Hyaluronic acid (HA), a natural lubricant in synovial fluid, is investigated for its therapeutic potential in TMJ diseases. While its mechanism remains unclear, HA is thought to improve synovial fluid viscosity and elasticity, inhibiting adhesions and benefiting degenerative joints [10, 11]. Recent advancements in regenerative medicine have introduced platelet concentrates (PCs), including PRP, PRF, and PRGF, as promising treatments for TMJ arthrocentesis. These autologous biological products, derived from a patient's own blood, have shown potential to reduce pain and improve function in TMDs, potentially stimulating bone and cartilage regeneration through PRP's ability to promote matrix production and chondrogenic differentiation[12, 13].

While arthrocentesis is a minimally invasive procedure, the complex anatomical structures surrounding the TMJ necessitate a cautious approach due to the proximity of facial nerves and blood vessels. The potential for complications such as facial nerve injury, Penetration of the middle cranial fossa, or irreversible changes to the TMJ itself underscores the importance of precise needle insertion[14].

The advent of computer-assisted surgical simulation has revolutionized surgical planning, enabling the translation of virtual plans into the operating room via specialized surgical splints and devices[15]. In 2019, Krause et al. [16] developed a patient-specific template based on cone-beam computed tomography (CBCT) to achieve accurate access to the superior joint space. Preliminary findings, based on the treatment of six joints, suggest promising results in terms of simplicity, accuracy, and time efficiency.

This current study aims to evaluate the effectiveness of computer-assisted double-needle arthrocentesis with intra-articular injection of sodium hyaluronate versus platelet-rich plasma in the management of TMJ internal derangement.

SUBJECTS AND METHODS

This randomized controlled clinical trial included 14 patients among those attending the Outpatient Clinic of Oral and Maxillofacial Surgery, Faculty of Dental Medicine (Boys), Al-Azhar University, Cairo, Egypt and Sayed Galal University Hospital. Inclusion criteria: Patients (18-55) age with TMJ internal derangement indicated for arthrocentesis including both genders, Patients who didn't respond to conservative treatment including behavior modification, physiotherapy, occlusal splints and/or adjustments, and pharmacological agents as the first line of treatment were included. Exclusion criteria included patients with previous surgical operation related to TMJ, previous history of fractured condyle, previous minimally invasive treatment of TMJ, patients with immune compromised status and hematological disorders, pregnancy, known hypersensitivity to hyaluronic acid (HA) or photopolymer resin and refusal for written consent and follow-up.

Study grouping:

Patients who have fulfilled the eligibility criteria were randomly divided into two equal groups (seven patients each): **Group I** (n=7): Patients were managed with TMJ arthrocentesis using customized 3D printed computer assisted guide followed by intra articular injection of sodium hyaluronate*(Curavisc 20 mg Sodium Hyaluronate. Curasan compony / Lindigstraße Germany). **Group II** (n=7): Patients were managed with TMJ arthrocentesis using customized 3D printed computer assisted guide followed by intra articular injection of autogenous platelet-rich plasma.

Preoperative assessment:

Upon inclusion in the study, comprehensive data was collected from each participant. Personal information, including name, age, gender, occupation, address, and phone number, was recorded. A thorough medical history was obtained to rule out any systemic conditions potentially influencing the study. Furthermore, a detailed dental history was collected to assess patients' attitudes towards dental treatment and to identify any odontogenic pain, missing molars, bruxism, nail biting, deep bite, or occlusal abnormalities that could potentially impact the study's outcomes. Every patient was examined clinically and radiographically for the following:

(A) Clinical examination:

Preoperative examination of all eligible patients included the following:

1. **Preoperative clinical examination**: was performed according to Diagnostic Criteria for Temporomandibular Disorders DC/TMD [17]. Assessment of All details were recorded in a questionnaire by the examiner including the personal data, past history, previous treatments and chief complaint.
2. **Preoperative pain level**: was determined by patient's self-assessment using Visual Analogue Scale (VAS) [18] from 0 to 10 where "0" indicates no pain, "1" excellent ability to talk and the least pain felt while "10" refers to unbearable pain cannot be scored by the patient.
3. **Maximum inter incisal opening (MIO)**: was measured using digital caliper and the patients were instructed to open maximum opening unassisted and the measurements by putting the tip of the caliper between the incisal edges of the maxillary and mandibular central incisors and the measurement was taken in Millimeters.

(B) Radiographic evaluation:

1. **Magnetic resonance imaging (MRI):** was taken and assessed for every patient preoperatively. The MRI was requested in open and closed positions of TMJ, including oblique sagittal cuts with 1mm thickness and 1 mm interval in T1, T2 and Proton weighted sequences. For assessment of the relation of the disk condyle glenoid fossa articular eminence in both open and closed position.
2. **Multi-slice computed tomography (MSCT):** In coronal ,axial, sagittal and 3D reconstruction bony and soft tissue with 1.5 slice thickness and 1 interval window was taken to each patient, for diagnosis any bony lesion ,designing guide on the soft tissue mask and positioning needle in relation to the osseous structure of the joint ,the scan was obtained with patient in maximum mouth opening with a bite-block utilized to maintain this maximum opening to design and print the surgical guide.

Fabrication of patient customized computer assisted 3D printed guide for arthrocentesis:

It employs a multi-step process to create personalized treatment plans for patients with temporomandibular joint (TMJ) disorders.

The procedure commences with the fabrication of a customized bite block using cold-cure acrylic resin. This bite block, crafted on a patient jaw model, ensures precise positioning and maximum

pre-operative jaw opening. Subsequent multi-slice computed tomography (MSCT) scans, acquired with the patient wearing the bite block, capture detailed anatomical data in Digital Imaging and Communication in Medicine (DICOM) format. This DICOM data is processed using specialized software (MIMICS, Materialise) to generate a comprehensive virtual model of the patient's skull and facial structures, encompassing the bony components of the temporomandibular joint (TMJ) and surrounding soft tissues.

This virtual model, constructed in stereolithography (STL) format, serves as the foundation for precise surgical planning, facilitating the creation of patient-specific guides for procedures like arthrocentesis. Following virtual model generation, a physical surgical guide is printed using a 3D printer. The printed model undergoes a series of post-processing steps, including cleaning, post-curing to enhance its strength and stability, and finalization by removing support structures. Prior to surgery, the guide undergoes chemical sterilization in a glutaraldehyde 8% solution, ensuring its sterility and safety for surgical use.

Surgical intervention:

All patients underwent general anesthesia, routine hospital admission, laboratory investigations, and multispecialty referrals prior to surgery. Following standard disinfection and draping protocols, leaving the auricle, joint, and lateral canthus exposed, a bite block was inserted to achieve the planned jaw position. A 3D printed; patient-customized surgical guide was adapted precisely to the planned position. Arthrocentesis was then performed using a 20 G needle, injecting 2 ml of Ringer solution to distend the TMJ capsule through the posterior sleeve and 100 ml for arthrocentesis through the anterior sleeve, as depicted in **Figure (1)**

After completing arthrocentesis, the outlet needle was withdrawn from the guide sleeve, and the intra-articular space of the joint was injected with a different material according to each group:

* **Group I**: The intra-articular space of the joint was injected with 1 ml of medium molecular weight (MMW) sodium hyaluronate (1200–1400 kDa).
* **Group II:** The intra-articular space of the joint was injected with patient autogenous PRP.

For both groups, after injection, the inlet needle was withdrawn from the guide sleeve, and the guide was removed. The jaw was manipulated, and the surgical site was cleaned and covered with surgical dressing.

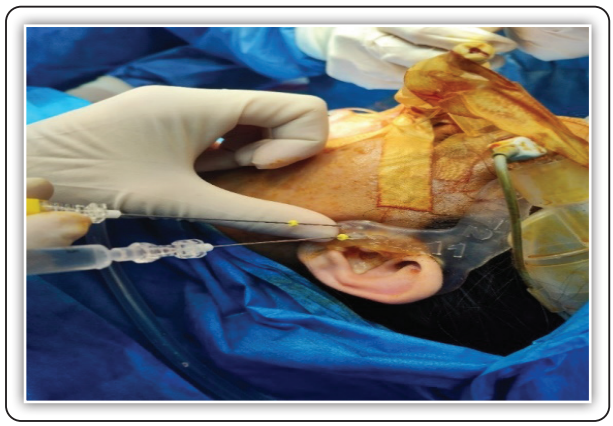

FIG (1) Intraoperative arthrocentesis with the 3D guide, inlet and outlet needle in place

Preparation of autogenous PRP [19]:

Autogenous PRP was prepared by collecting 10 ml of peripheral blood from the patient's arm, which was immediately transferred into glass tubes containing sodium citrate as an anticoagulant to prevent premature thrombosis. The collected blood was mixed with the citrate using rotational motions, and an equal number of tubes were placed in a centrifuge rotor. The centrifugation parameters were 3200 rpm for 12 minutes. After separation, the platelet-rich plasma was carefully aspirated into a separate syringe. This prepared concentrate was then ready for injection into the TMJ.

Postoperative evaluation:

Postoperative follow up and assessment will be done for each patient both clinically and radiographically for the following:

(A) Clinical evaluation:

Pain was assessed using visual analogue scale (VAS) for the first 14 days after the treatment, and Maximum inter incisal opening (MIO) was measured by digital caliper at 2 days, 1 week, 1 month, 3 months and 6 months postoperatively.

(B) Radiographic evaluation:

MRI of the patient was performed after 6 months in which they were followed up and compared based on their sign and symptoms, ending the postoperative observation periods with a postoperative MRI.

RESULTS

Fourteen female patients who were diagnosed with bilateral ID of TMJ were enrolled in the present study. They were randomly divided into two equal groups (7 patients each). All patients who were enrolled in the study have completed the follow up post-surgical period. In either group, the mean and standard deviation of the ages of participants within group I and group II were 31.43 ±7.28 and 35.29±7.11 respectively. There was no statistically significant difference between the mean age values of the two groups p=0.336.

Clinical evaluation

1. Postoperative pain

Postoperative pain was assessed using the Visual Analog Scale (VAS) over the first 14 days following surgery, as depicted in Figure 2. Both groups began with moderate levels of preoperative pain. Following arthrocentesis, pain levels increased slightly over the first two to three days before significantly decreasing throughout the 14-day period, ultimately falling below preoperative levels.

In **Group I (SH),** the preoperative pain score was 6.00±0.82, which decreased progressively to 1.14±1.35 by the 14th postoperative day. While the reduction in pain was statistically significant overall (P = 0.000), most observation intervals did not show significant changes, except between the preoperative period and the 1st postoperative day and between the 6th and 7th days, where p-values were 0.047 and 0.025, respectively.

In **Group II (PRP)** exhibited a similar trend, with a preoperative pain score of 5.94 ± 0.62, which decreased to 1.14 ± 1.35 by the 14th postoperative day. Although the overall reduction in pain was statistically significant (P = 0.000), most intervals did not show significant changes, with the exception of the intervals from the preoperative period to the 1st postoperative day (P = 0.014), from the 1st to the 2nd day (P = 0.046), from the 7th to the 8th day (P = 0.034), and from the 9th to the 10th day (P = 0.020).

Despite the significant improvement in VAS scores within each group over time, the differences in pain reduction between the two groups at each observation interval were not statistically significant. This suggests that both treatment approaches were similarly effective in reducing postoperative pain.

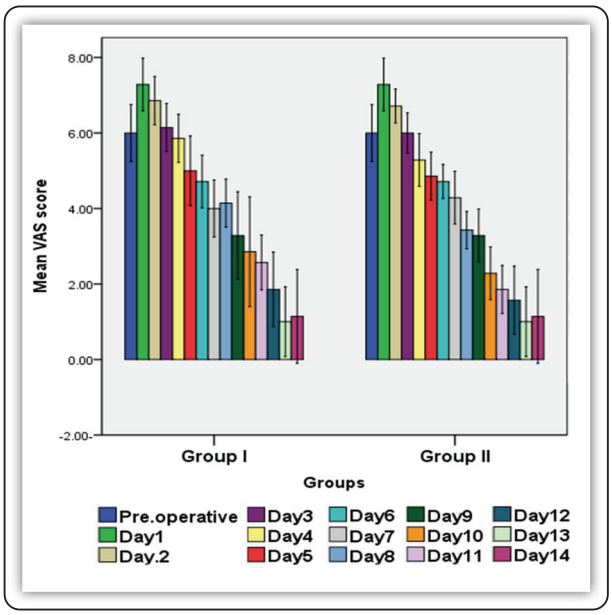

FIG (2) Bar chart illustrating mean value of pain (VAS) at different observation intervals

2. Maximum Inter-incisal Opening (MIO)

Maximum Inter-incisal Opening (MIO) was measured for all patients in both groups over a 6-month postoperative period, as illustrated in **Table 1**. After six months, there was a statistically insignificant difference between the two groups, though significant improvement was observed within each group.

For **Group I (SH)**, the preoperative MIO was 31.91±1.89mm. This value decreased to 29.68±1.45mm on the 2nd postoperative day but increased progressively to 38.55±2.28 mm by the 6th postoperative month. Statistically significant improvement was observed between various intervals, including preoperative to Day 2 (p=0.006), Day 2 to 1 Week (p=0.003), and subsequent intervals up to the 6th month.

In **Group II (PRP),** the preoperative MIO was 33.17±2.63 mm. It decreased to 30.55 ± 1.87 mm on the 2nd postoperative day and then increased to 38.13±2.03 mm by the 6th postoperative month. Similar to Group I, significant improvement was noted between various intervals, including preoperative to Day 2 (p = 0.001) and subsequent periods.

Overall, while the improvement in MIO was significant within each group, the differences between the two groups at each observation interval were not statistically significant.

TABLE (1) Descriptive statistics of maximum inter-incisal opening in in each studied group in all evaluation intervals

(MIO) (mm)	Group 1	Group 2	Difference	*P value*
	Mean±SD	Mean±SD		
Pre op	31.91±1.89	33.17±2.63	1.26	.322 ns
Day 2	29.68±1.45	30.55±1.87	.87	.350 ns
Preoperative - Day2	.006*	.001*		
1 Week	32.42±1.81	33.52±1.40	1.09	.229 ns
Day2 - 1 Week	.003*	.000*		
1 Month	35.22±2.47	34.41±1.46	.81	.471 ns
1 Week - 1 Month	.000*	.031*		
3 Months	37.01±2.76	36.50±1.68	.51	.682 ns
3 Months - 1 Month	.002*	.002*		
6 Months	38.55±2.28	38.13±2.03	.43	.718 ns
6 months - 3 Months	.000*	.007*		
Probability	0.000	0.000		

Significance level p≤0.05, ns=non-significant

DISCUSSION

Temporomandibular disorders (TMDs) are a prevalent condition affecting 5-12% of adults, causing pain and dysfunction in the jaw. Treatment aims to alleviate pain, restore function, and improve quality of life, encompassing a wide range of approaches from lifestyle changes to surgery in severe cases. [20]. (TMDs) encompass a spectrum of conditions affecting the temporomandibular joint (TMJ), each with unique features. Common subtypes include myofascial pain, internal derangement (ID), and arthralgia. Less frequent presentations include degenerative changes, TMJ capsule inflammation, posterior disc displacement, and ankylosis, a rare condition causing joint fusion and severe jaw limitations [21]

In the present study, we evaluated the clinical outcome of double-needle TMJ arthrocentesis using custom made computer assisted injection guide, comparing two different intra articular injection materials; HÀ vs PRP. Fourteen patients were allocated in present study after of fulfilling eligibility criteria and randomly divided into two equal groups (seven patients each); Group I (SH) Patients were managed with TMJ arthrocentesis using customized 3D printed computer assisted guide followed by intra articular injection of sodium hyaluronate. Group II (PRP) Patients were managed with the same surgical protocol except that the intra articular injection material was autogenous platelet-rich plasma.

All the patients which had history of previous arthrocentesis or surgery were excluded, while all the patients who suffered TMJ-ID were included in the study, as TMJ-ID is considered one of the most common disorders faced by maxillofacial surgeons in their daily practice. This is in accordance with Paesani et al. [22], who determined the prevalence of TMJ-ID in patients with signs and symptoms of craniomandibular disorders, and concluded that almost 80% of their samples exhibited various forms of TMJ-ID. This suggests that internal derangement is a common finding in patients presenting with symptoms related to the jaw joint.

In the present study, although the patients randomly divided into two group, both groups were consisted of fourteen female's patients. That was not intended in eligibility criteria, but in general, females are more prone to suffer from TMDs more than males. This is accordance with Jo et al. [23], who confirmed higher prevalence of TMD in female patients. They concluded that there was a high prevalence of parafunctional habits, emotional stress and higher level of the severity of chronic pain and a tendency of myogenous pain than men.

In the present study, all patients in both groups were evaluated clinically for the pain intensity, maximum interincisal distance and radiographically after MRI 6 months postoperatively. Regarding pain, it was evaluated in both groups for all patients for fourteen postoperative days through visual analog scale (VAS). Accurate pain assessment is crucial for establishing a correct diagnosis. The Visual Analog Scale (VAS) is a widely used and validated tool for measuring pain intensity, demonstrating high test-retest reliability, indicating consistent and dependable results over repeated measurements[24,25].

This study found that all patients experienced moderate pain preoperatively, which increased immediately following arthrocentesis but significantly decreased within two weeks. While no significant difference was observed between the two treatment groups, significant pain improvement was noted within each group. The combination of computer-guided arthrocentesis, occlusal splint therapy, and intra-articular injection of either synovial fluid or platelet-rich plasma may contribute to a marked reduction in pain perception. This is in accordance with Dhiman et al. [26], compared and evaluated the efficacy of arthrocentesis with injections of corticosteroids (CS) or (HA) in management of TMJ-ID. They concluded that

Injection of HA post-TMJ arthrocentesis is found to be comparatively more effective method of treating TMD IDs with resultant decrease in pain & improved functionality of the jaw.

In the present study, all cases of both groups have received TMJ double-needle arthrocentesis guided with computer assistant splint. Arthrocentesis is a surgical term of noninvasive procedure aimed for lavaging the synovial fluid of the affected joint through double-needle lumen. After arthrocentesis, the joints were injected with one of two materials: SH for group I and PRP for group II. Grossmann et al. [27], investigated the long-term efficacy of two arthrocentesis techniques for treating temporomandibular joint disc displacement without reduction (DDWOR). After three years of follow-up, both double-puncture and single-puncture arthrocentesis methods were found to be effective in reducing pain and increasing maximal inter-incisal opening (MIO) in patients with DDWOR.

Platelet-rich plasma (PRP) injections demonstrate therapeutic potential in temporomandibular joint disorders. PRP's anti-inflammatory and analgesic properties may reduce pain and improve joint function, while its regenerative properties restore hyaluronic acid levels, stimulate chondrocyte activity, and promote balanced angiogenesis. [28]. This is consistent with the study by Sousa et al**.** [29], where patients who received PRP showed an improvement in maximum pain-free mouth opening. On the other hand, therapeutic effect of sodium hyaluronate molecule had been exploited in orthopedics diseases reducing subchondral bone damage, chondrocyte apoptosis, cartilage inflammation, and overall cartilage deterioration. SH intra-articular infiltration in worn joints results in pain reduction and function improvement [30,31]. Sait et al. [32], evaluated the efficacy of arthrocentesis with and without sodium hyaluronate injection for internal derangement of temporomandibular joint. And they concluded that TMJ arthrocentesis with sodium hyaluronate injection had better clinical outcome compared to TMJ arthrocentesis alone for TMJ disorders.

In the current study, based on the evaluation of mean changes for the two groups, joint sounds and MIO movements statically significantly improved in each group, and insignificant between groups. And significantly improved in protrusive and left lateral jaw movement. These results are in accordance with Neeli et al. [33], in this study, we found significant increase in MIO and lateral movement with significant decrease in joint pain and clicking between baseline and 6 months follow up within the arthrocentesis group.

Computer-assisted surgery (CAS) revolutionizes oral and maxillofacial surgery, enhancing precision and patient outcomes. This technology integrates imaging, modeling, and navigation, enabling accurate and minimally invasive procedures, particularly in complex reconstructive surgeries and TMJ disorders, ultimately improving functional and aesthetic restoration while accelerating recovery. [34]. Custódio et al. [35], reported that the guide seems to be a reliable tool for accurate percutaneous injection of drugs into the inferior compartment of the TMJ and the lateral pterygoid muscle.

In both groups, none of the patients reported postoperative complication, hematoma formation or facial nerve affection from the procedure. This result agreement with Saad et al.[36]**,** concluded that a computer guided patient specific arthrocentesis guide based on a preoperative CT-scan is a reliable and reproducible method for accurate and more robust conduction of the arthrocentesis procedure with minimal modifications and low complication rate. This treatment requires additional patient costs for laboratory work, specifically the fabrication of a surgical guide by a qualified professional. The procedure's precision hinges on the accurate positioning and stability of this guide, which is particularly challenging when teeth cannot be used for support.

CONCLUSION

Either intra-articular injections of hyaluronic acid (SH) or autologous platelet-rich plasma (PRP) have shown promising results in managing temporomandibular disorders (TMD) with internal derangement. The study did not reveal any significant preference for one material over the other in terms of clinical efficacy.

REFERENCE

1. Al-Moraissi EA. Arthroscopy versus arthrocentesis in the management of internal derangement of the temporomandibular joint: a systematic review and. Int J OralMaxillofac Surg. 2014; 44:104-12.
2. Gauer RL, Semidey MJ. Diagnosis and treatment of temporomandibular disorders. Am a Fam Physician. 2015; 91:378-86.
3. Ungor C, Atasoy ÃKT, Taskesen ÃF. Long-term outcome of arthrocentesis plus hyaluronic acid injection in patients with Wilkes stage II and III temporomandibular joint internal derangement. J Craniofac Surg. 2015; 26:2104- 8.
4. Giraddi GB, Siddaraju A, Kumar B, Singh C. Internal derangement of temporomandibular joint: an evaluation of effect of corticosteroid injection compared with injection of sodium hyaluronate after arthrocentesis. J Maxillofac Oral Surg. 2012; 11:258-63.
5. Naeije M, TeVeldhuis AH, TeVeldhuis EC, Visscher CM, Lobbezoo F.Discdisplacement within the human temporomandibular joint: a systematic review of a'noisy annoyance'. J Oral Rehabil.2013; 40: 139-58.
6. Jamot SR, Khan ZA, Khan TU, Waraich RA, Farooq M. Arthocentesis for temporomandibular joint pain dysfunction syndrome. Ayub Med Coll Abbottabad.2017; 29:54-57.
7. Nitzan DW, Dolwick MF, Martinez GA. Temporomandibular joint arthrocentesis; a simplified treatment for severe, limited mouth opening. J Oral Maxillofac Surg. 1991; 49:1163-7.
8. Laskin DM: Arthroscopy versus arthrocentesis for treating internal derangements of the temporomandibular joint.Oral MaxillofacSurgClinNorthAm. 2018; 30:325-328.
9. Dhiman NK, Jaiswara C, Hirani MS, Chauhan N, Mahajan AD, Krishnan A. Efficacy of arthrocentesis with intra-articular injection of hyaluronic acid and corticosteroid in the treatment of internal derangement of temporomandibular joint. Natl J Maxillofac Surg. 2023;14:93-100.
10. Fernández-Ferro M, Fernández-Sanromán J, Blanco-Carrión A, Costas- López A, López-Betancourt A, Arenaz-Bua J, et al. Comparison of intra- articular injection of plasma rich in growth factors versus hyaluronic acid following arthroscopy in the treatment of temporomandibular dysfunction: A randomised prospective study. J Craniomaxillofac Surg. 2017; 45:449-454.
11. Saad K. Intra articular injection of hyaluronic acid alone in comparison with hyaluronic acid and PRP in the treatment of internal derangement of temporomandibular joint. EDJ.2017; 63: 3113-24.
12. Hegab AF, Ali HE, Elmasry M, Khallaf MG. Platelet-rich plasma injection as an effective treatment for temporomandibular joint osteoarthritis. J Oral Maxillofac-Surg.2015; 73:1706-13.
13. CömertKiliç S, Güngörmüş M. Is arthrocentesis plus platelet-rich plasma superior to arthrocentesis plus hyaluronic acid for the treatment of temporomandibularjoint osteoarthritis?: a randomized clinical trial.Int J Oral MaxillofacSurg . 2016; 45:1538-1544.
14. Elkholy A, El-Moniem N, Hassan S, Enite A. Effect of plasma rich in growth factors intra articular injection in management of patients with internal derangement of TMJ using CT guided puncture versus conventional technique. ADJ-for Girls.2019; 4: 427-35.
15. Mahmoud K, Galal N, Ali S, Gibaly A, Elbehairy MS, Mounir M. Computer-guided arthrocentesis using patient-specific guides: a novel protocol for treatment of internal derangement of the temporomandibular joint. J Oral Maxillofac Surg. 2020; 78: 372-7.
16. Krause M, Dorfler HM, Kruber D, Humpfner-Hierl H, Hierl T. Template-based temporomandibular joint puncturing and access in minimally invasive TMJ surgery- a technical note and first clinical results. Head Face Med. 2019; 15:10.
17. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, et al. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache. 2014;28:6-27.
18. Williamson A, Hoggart B. Pain: A review of three commonly used pain rating scales. J ClinNurs. 2005; 14:798-804.
19. Marlovits S, Mousavi M, Gäbler C, Erdös J, Vécsei V. A new simplified technique for producing platelet-rich plasma: a short technical note. Eur Spine J. 2004;13: 102-6.

20. Mehndiratta A, Kumar J, Manchanda A, Singh I, Mohanty S, Seth N, et al. Painful clicking jaw: a pictorial review of internal derangement of the temporomandibular joint. Pol J Radiol 2019;84:e598-615
21. Warzocha J, Gadomska-Krasny J, Mrowiec J. Etiologic Factors of Temporomandibular Disorders: A Systematic Review of Literature Containing Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) and Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) from 2018 to 2022. Healthcare 2024; 12(5): 575.
22. Paesani D, Westesson P, Hatala M, Tallents R, Kurita K. Prevalence of temporomandibular joint internal derangement in patients with craniomandibular disorders. Am. J. Orthod. Dentofac. Ortkop.1992;101:41-47.
23. Jo J.-H., Chung J.-W. Gender Differences in Clinical Characteristics of Korean Temporomandibular Disorder Patients. Appl. Sci. 2021; 11:3583.
24. Gupta N, Gupta S, Agarwal A, Agarwal S, Mahto R. A comparison of visual analog scale and Wong Baker facial pain scale for pain measurement in post lower caesarean section case. International Journal of Reproduction, Contraception, Obstetrics and Gynecology.2016;5:3033.
25. Begum R, Hossain M. Validity and reliability of visual analogue scale (vas) for pain measurement. JMCRR. 2019:2;394-402.
26. Dhiman NK, Jaiswara C, Hirani MS, Chauhan N, Mahajan AD, Krishnan A. Efficacy of arthrocentesis with intra-articular injection of hyaluronic acid and corticosteroid in the treatment of internal derangement of temporomandibular joint. Natl J Maxillofac Surg. 2023; 14:93-100.
27. Grossmann E, Poluha RL. Double-Puncture Versus Single-Puncture Arthrocentesis: A Randomized Controlled Trial with 3 Years of Follow-Up. J Oral Facial Pain Headache. 2022; 36:141-146.
28. Thu AC. The use of platelet-rich plasma in management of musculoskeletal pain: a narrative review. J Yeungnam Med Sci. 2022, 39:206-15.
29. Sousa BM, López-Valverde N, López-Valverde A, Caramelo F, Fraile JF, Payo JH, Rodrigues MJ. Different Treatments in Patients with Temporomandibular Joint Disorders: A Comparative Randomized Study. Medicina (Kaunas).2020;56:113.
30. Rydell, N.; Balazs, E.A. Effect of intra-articular injection of hyaluronic acid on the clinical symptoms of osteoarthritis and on granulation tissue formation. Clin. Orthop. Relat. Res. 1971, 80, 25-32.
31. Zhang, Z.; Christopher, G.F. The nonlinear viscoelasticity of hyaluronic acid and its role in joint lubrication. Soft Matter. 2015, 11, 2596-2603.
32. Sait AI, Sequiera JP, Chandra J. Efficacy of Arthrocentesis with and Without Sodium Hyaluronate Injection for Temporomandibular Joint Disorders: A Comparative Study. J Maxillofac Oral Surg. 2023;22:1066-1071.
33. Neeli AS, Umarani M, Kotrashetti SM, Baliga S. Arthrocentesis for the treatment of internal derangement of the temporomandibular joint. J Maxillofac Oral Surg.2010; 9:350-4.
34. Sukegawa, S., Kanno, T. Computer-Assisted Navigation Surgery in Oral and Maxillofacial Surgery. Oral and Maxillofacial Surgery for the Clinician. Springer, Singapore.2021.841-62.
35. Custódio ALN, Cameron A, Bakr M, Little C, Chrcanovic BR, Reher P. Positioning accuracy assessment of minimally invasive percutaneous injection techniques for the treatment of temporomandibular disorders. Dentomaxillofac Radiol. 2021; 50:20200313.
36. Saad A, Nevein S. Mohamed N, El Halawani G. 3D printed computer guided vs convential arthrocentesis in the management of temporomandibular joint internal derang ement.A.D.J.2022:48;94-101.