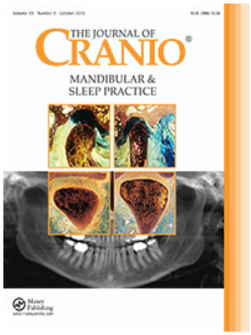

CRANIO®

The Journal of Craniomandibular & Sleep Practice

ISSN: 0886-9634 (Print) 2151-0903 (Online) Journal homepage: http://www.tandfonline.com/loi/ycra20

Arthrocentesis with different irrigation volumes in patients with disc displacement without reduction: One-year follow-up

Eduardo Grossmann PhD, Rodrigo Lorenzi Poluha DDS, MSc, Lilian Cristina Vessoni Iwaki PhD & Liogi Iwaki Filho PhD

To cite this article: Eduardo Grossmann PhD, Rodrigo Lorenzi Poluha DDS, MSc, Lilian Cristina Vessoni Iwaki PhD & Liogi Iwaki Filho PhD (2018): Arthrocentesis with different irrigation volumes in patients with disc displacement without reduction: One-year follow-up, CRANIO®

To link to this article: https://doi.org/10.1080/08869634.2018.1491930

Published online: 26 Jul 2018.

CRANIO®: THE JOURNAL OF CRANIOMANDIBULAR & SLEEP PRACTICE
https://doi.org/10.1080/08869634.2018.1491930

Taylor & Francis
Taylor & Francis Group

TMJ

Arthrocentesis with different irrigation volumes in patients with disc displacement without reduction: One-year follow-up

Eduardo Grossmann PhD [a], Rodrigo Lorenzi Poluha DDS, MSc [b], Lilian Cristina Vessoni Iwaki PhD [b] and Liogi Iwaki Filho PhD [b]

[a]Department of Dentistry, Federal University of Rio Grande do Sul, Porto Alegre, Brazil; [b]Department of Dentistry, State University of Maringá, Maringá, Brazil

ABSTRACT

Objective: This study evaluated the clinical efficacy of arthrocentesis when varying the irrigation volume in patients with disc displacement without reduction (DDWOR).

Methods: Thirty DDWOR patients were equally divided into two groups: G1 (50 mL) and G2 (200 mL). Information was compared for pain, the maximum interincisal distance (MID), protrusion, and right and left laterality.

Results: Arthrocentesis was able to reduce the pain and increase the MID, protrusion, and both laterality values significantly one year after the procedure ($p < 0.001$) in both groups. However, comparisons between the groups revealed no significant difference ($p > 0.05$). Furthermore, changes in volume did not affect the arthrocentesis results ($p = 0.626$, odds ratio = 1.625; 95% confidence interval = 0.230–11.461).

Conclusion: Arthrocentesis techniques using 50- and 200-mL irrigation volumes were both effective, with no significant differences between techniques observed after one year of follow-up.

KEYWORDS
Facial pain; temporomandibular joint; arthrocentesis

Introduction

Temporomandibular disorders (TMD) are a heterogeneous group of musculoskeletal disorders that affect the mastication muscles, the temporomandibular joint (TMJ), and associated structures [1]. The prevalence in the adult population ranges from 5% to 15%, with a preference for females between 20 and 40 years of age [2,3].

Among TMJ disorders, disc displacement without reduction (DDWOR) has a prevalence of 35.7% [3]. In this condition, the articular disc is displaced anteriorly relative to the condyle when the mouth is both open and closed [1,4,5]. DDWOR treatment should initially involve reversible conservative methods (drugs, interocclusal devices (ID), and physiotherapy). It is only when these approaches do not produce favorable results that surgical alternatives should be used [5].

Arthrocentesis is a minimally invasive TMJ surgery [6] that involves washing the upper TMJ compartment with a biocompatible substance without direct viewing [7], which may be followed by additional infiltration with another substance, such as sodium hyaluronate [8]. The success of arthrocentesis treatment is strongly dependent on the lysis of adhesions formed between the articular disc surfaces and the glenoid fossa by the hydraulic pressure caused by irrigation, along with the partial removal of inflammatory mediators to relieve pain and improve function [7,9].

Although the technique was introduced 27 years ago [7], there is still controversy in the literature regarding the ideal volume to be used for irrigation because studies usually use a restricted sample and have a short postoperative follow-up time [10–12]. The results of a long-term study of arthrocentesis in which the irrigation volume is varied may contribute to improvement of the technique and could benefit both clinicians and patients. Therefore, the objectives of this study were to evaluate the effectiveness of two arthrocentesis-based therapies, varying the irrigation volume in patients with DDWOR. The null hypothesis being tested is that these variables will not differ.

Materials and methods

This study was approved by the Human Research Ethics Committee of the State University of Maringa (Number: 1.751.299/2017). A retrospective, cross-analytical observational study was performed, according to Strengthening the Reporting of Observational Studies in Epidemiology (Strobe) recommendations [13]. All data used in this study were secondary and were

CONTACT Eduardo Grossmann grossmanneduardo@gmail.com; edugdor@gmail.com Faculty of Dentistry, Federal University of Rio Grande do Sul, Ramiro Barcelos St., 2492, Porto Alegre 90035-004, Brazil

derived from the clinical records of patients treated at the Pain and Orofacial Deformity Center (Centro de Dor e Deformidade Orofacial – CENDDOR), located in Porto Alegre, Rio Grande do Sul (RS), Brazil. All clinical examinations were conducted by a single evaluator, who was a dental surgeon specializing in TMDs and orofacial pain. Clinical evaluation followed the parameters and criteria of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Axis I [1], in its Portuguese version and official adaptation.

The following inclusion criteria were applied: individuals over age 18, of both sexes, with clinical signs and symptoms of intra-articular unilateral TMJ dysfunction compatible with DDWOR associated with painful joint complaint (either acute or chronic), who had not responded to prior conservative treatment for at least three months (interocclusal device, anti-inflammatories, hot compresses, bland diet, and physiotherapy). The articular disc positioning diagnoses were confirmed by a combination of clinical examination, based on RDC/TMD, and nuclear magnetic resonance imaging (NMRI) examinations and reports. Asymptomatic patients were excluded, along with individuals with facial pain of non-articular origin, those with neurological diseases, primary headaches, fibromyalgia, rheumatoid arthritis, agenesis, hyperplasia, hypoplasia, and/or malignant neoplasm of the condyle; bony ankylosis; previous TMJ surgery; and/or those having undergone facial surgery. Patients with continuous use of drugs such as analgesics, benzodiazepines, antipsychotics, or antidepressants were also eliminated from the sample.

An 80% test power and a 5% significance level were adopted for the sample calculation. The planned sample size was 30 patients, equally divided into two groups submitted to arthrocentesis: Group 1 (G1 n = 15), in which 50 mL of 0.9% saline was used (Linhamax®, Eurofarma, São Paulo, SP, Brazil); and Group 2 (G2 n = 15), in which the same substance was used, but with a volume of 200 mL. After arthrocentesis, 10 mg sodium hyaluronate with a 1-mL volume (Osteonil Mini®, TRB Pharma, São Paulo, SP, Brazil) was used in the upper compartment on the entire sample. Patients were blinded regarding the procedure. All patients were treated sequentially, consecutively, and daily during the first week of August 2016 (six patients per day, totaling five days). Patients received the same basic recommendations for post-procedure care. Post-arthrocentesis, all patients were followed for a period of one year (August 2017). During this period, among the previous approaches, only the ID was maintained to help to control the dental wear from nocturnal parafunctional habits of the patients. The ID was a conventional acrylic full-covered stabilization splint with canine guidance on the maxillary arch (Michigan splint). This design allowed disocclusion of all posterior teeth by the contact between canines during lateral movements and between anterior teeth during protrusive movement. The patients were instructed to wear their ID only at night, while sleeping. The dental contacts in the ID were checked at all return visits, as well as patient occlusion. No occlusal changes occurred during the follow-up period.

The following data were recorded: sex; age in years; side of the complaint (right/left/both); duration of pain, in months; subjective pain regarding joint area, measured using a 0–10 visual analog scale (VAS); maximum interincisal distance (MID); protrusion; and right or left laterality. All metric measurements were taken in millimeters (mm) with the aid of a digital caliper (Mitutoyo®, Takatsuku, Kawasaki, Kanagawa, Japan). These data were obtained on four occasions: prior to arthrocentesis (T1), seven days after arthrocentesis (T2), six months after arthrocentesis (T3), and one year after arthrocentesis (T4).

Arthrocentesis

Arthrocentesis was performed once on each given joint following the technical references in the literature [7,14–18]. With the patient awake and the dental chair in the supine position, the head was isolated with a cap and micropore, leaving exposed only the TMJ area to be treated. The patient was asked to turn his or her head to the asymptomatic side, and a straight line was drawn along the skin from the middle portion of the ear tragus to the lateral canthus of the eyeball. Two points were marked on this line for needle insertion. The first point, more posterior, was located at a distance of 10 mm from the tragus and 2 mm below the tragus-canthal line; the second marking was made 20 mm in front of the tragus and 10 mm below this same line. The next step was antisepsis with 2% chlorhexidine solution across the entire surface, with emphasis on the pre-auricular region and ear to be treated. A fenestrated sterile field was placed. Auriculotemporal nerve blocking was then performed, using 2% lidocaine hydrochloride without epinephrine 1:200,000 with one tube (1.8 mL), followed by posterior and masseteric deep temporal nerve anesthesia with one to two tubes. This step aimed to avoid discomfort and/or pain caused by pressure that might occur at the beginning of the joint washing procedure, thereby obtaining analgesia of the region and avoiding the need for sedation. A sterile mouth opener was inserted by the auxiliary on the dental arches of the side contralateral to the arthrocentesis to maintain stable displacement of the condyle downward and forward, facilitating access to the posterior recess of the upper TMJ compartment. A 40/12 needle was then inserted at the

most posterior point and connected to a 5-mL syringe, and 4 mL of 0.9% saline solution was administered to distend the joint space. Another needle with the same dimensions was introduced into the distended compartment in front of the first needle and then connected to a 60-cm-long plastic #20 tube attached to a vacuum pump (KaVo®, Joinville, Santa Catarina, Brazil). A 120-cm 15C infusion extender (Compojet®, Conceição do Jacuípe, Bahia, Brazil) coupled to a 60-mL syringe was then connected to the posterior needle so that joint washing and lysis could begin. The extenders had three purposes: to facilitate injection of the solution by the syringe, to prevent movement of the needles from the injection locations and their displacement and direction toward the skin, and to perform the procedure quickly. The quantity of saline used to remove the algogenic substances present in the joint space and mobilize the articular disc varied from 50 to 200 mL. In this case, if a limitation to the maximum interincisal distance was clinically observed, one of the needles was blocked, increasing the pressure on the syringe plunger to release possible adherence and/or adhesiveness present in the joint compartment. After arthrocentesis, the patient was asked to cooperate with the procedure, performing opening and laterality movements, to try to reestablish a pattern of interincisal distance greater than or equal to 35 mm and a protrusion at least 4 mm greater than that measured preoperatively. After this step, one of the needles was blocked for the slow injection of 1 mL of 10 mg sodium hyaluronate in the other needle. Thereafter, the needles were removed, and a gauze and sterile micropore dressing was applied to the area. The patient was provided 750 mg of paracetamol to be taken orally every 6 hours for a maximum of three days if necessary, and an ice pack to be applied to the treated joint intermittently for a period of 48 hours. In addition, the patient was advised to take in liquids and soft food for 96 hours, avoid exposure to the sun, and to not undergo any medical/dental procedure while recovering.

Statistical analysis

All data were tabulated and subjected to descriptive analysis. The effects of the arthrocentesis on the variables of interest within each group were evaluated using Student's *t*-test. The same test was used to compare the groups at the four evaluation times. In addition, univariate analysis by logistic regression model was used to check whether the difference in volume was responsible for the effects of the arthrocentesis in the patients. All tests were performed with a significance level of 0.5%. Data were analyzed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

The 30 patients were evaluated at four stages. There was no loss or withdrawal of any subjects, nor were there any complications during or after the process. The descriptive data of the sample are shown in Table 1.

Analyzing each group internally, according to Student's *t*-test, the arthrocentesis procedures were able to reduce the VAS pain scores and increase the MID, protrusion, and both laterality values in a statistically significant manner between stages T1 and T4 ($p < 0.001$). However, in the comparison between groups, there was no statistically significant difference ($p > 0.05$) in any of the variables studied at any of the evaluation times (Table 2). In the univariate analysis, changing the volume (50–200 mL) showed no significant association with the results provided by arthrocentesis ($p = 0.626$, odds ratio = 1.625; 95% confidence interval = 0.230–11.461).

Table 1. Distribution of frequencies (%), means and standard deviations (±SD) of the sample descriptive variables.

Variables	G1 (n = 15)	G2 (n = 15)
Sex		
Female	12 (80%)	12 (80%)
Male	3 (20%)	3 (20%)
Side of complaint		
Right	7 (47%)	11 (73%)
Left	8 (53%)	4 (27%)
Age (Years)	30.86 ± 7.58	29.33 ± 5.44
Duration of pain (Months)	9.13 ± 2.01	8.46 ± 2.64

G1: Group 1, patients submitted to arthrocentesis with 50 mL of saline. G2: Group 2, patients submitted to arthrocentesis with 200 mL of saline. SD: Standard deviation

Table 2. Student's *t*-test – Comparison of study variables between G1 and G2.

Variable	Evaluation stage	G1 Mean (± SD)	G2 Mean (± SD)	*p*
VAS	T1	6.93 (± 1.94)	7.60 (± 0.98)	0.246
	T2	1.53 (± 0.89)	1.66 (± 1.10)	0.853
	T3	0.46 (± 0.83)	0.86 (± 1.35)	0.338
	T4	0.26 (± 0.79)	0.21 (± 0.41)	0.776
MID	T1	31.52 (± 1.62)	30.46 (± 1.96)	0.124
	T2	41.08 (± 3.63)	39.75 (± 4.02)	0.349
	T3	42.27 (± 3.87)	41.00 (± 4.17)	0.393
	T4	43.13 (± 4.27)	41.58 (± 4.03)	0.335
Protrusion	T1	6.16 (± 0.84)	5.69 (± 0.96)	0.127
	T2	8.45 (± 1.57)	8.02 (± 1.36)	0.373
	T3	8.46 (± 1.12)	8.13 (± 1.33)	0.466
	T4	8.79 (± 0.98)	8.38 (± 1.55)	0.400
Right Laterality	T1	7.14 (± 3.79)	9.15 (± 3.03)	0.098
	T2	8.72 (± 2.25)	9.65 (± 2.42)	0.271
	T3	8.76 (± 2.22)	9.69 (± 1.83)	0.169
	T4	8.94 (± 2.09)	9.72 (± 2.35)	0.344
Left Laterality	T1	7.94 (± 3.62)	5.74 (± 3.34)	0.096
	T2	9.48 (± 2.13)	8.14 (± 2.28)	0.133
	T3	9.51 (± 1.99)	8.23 (± 2.31)	0.115
	T4	9.56 (± 1.85)	8.29 (± 2.21)	0.098

G1: Group 1, patients submitted to arthrocentesis with 50 mL of saline. G2: Group 2, patients submitted to arthrocentesis with 200 mL of saline. T1: before arthrocentesis; T2: 7 days after arthrocentesis; T3: 6 months after arthrocentesis; T4: 1 year after arthrocentesis. SD: standard deviation; VAS: visual analog scale; MID: maximum interincisal distance.

Discussion

The ideal volume to be used for irrigation in arthrocentesis therapies is still debated in the literature, with studies reporting 50–100 mL [15], 109 mL [11], 120 mL [5], 200 mL [17], and 300 mL [18]. To the best of the authors' knowledge, this is the first study to compare different arthrocentesis irrigation volumes in an exclusive DDWOR population with a one-year postoperative follow-up time. The present results revealed no statistically significant difference ($p > 0.05$) in the clinical treatment response between G1 (50 mL) and G2 (200 mL). Furthermore, changes in volume showed no significant association ($p = 0.626$) with the results provided by arthrocentesis, confirming the null hypothesis.

In a study with 10 DDWOR patients and 7 patients with TMJ osteoarthritis submitted to arthrocentesis with volumes of 50–400 mL, Kaneyama et al. [10] showed that the concentrations of bradykinin and interleukin-6 were effectively reduced with the use of 300–400 mL of irrigation. However, clinical pain and joint mobility were not evaluated. The present results corroborate those of the Barros Melo et al. [12] study, who, when varying the arthrocentesis volume (100 or 250 mL) in 13 patients, found no differences in pain and mouth opening values after 90 days of follow-up.

Arthrocentesis is an effective therapy for treating DDWOR [5]. According to Student's t-test, arthrocentesis reduced the VAS pain scores and increased the MID, protrusion, and both laterality values in both groups in a statistically significant manner between stages T1 and T4 ($p < 0.001$). The reductions in the VAS pain scores in G1 (6.93 ± 1.94 to 0.26 ± 0.79) and G2 (7.60 ± 0.98 to 0.21 ± 0.41) were similar to those reported in other studies in the literature (7.31 ± 1.33 to 0.19 ± 0.46) [18]. The reduction in pain is expected, as arthrocentesis facilitates dilution and elimination of algogenic substances [5,7]. The increases in the MID values in G1 (31.52 ± 1.62 to 43.13 ± 4.27) and G2 (30.46 ± 1.96 to 41.58 ± 4.03) were similar to previous results in the literature (30.97 ± 1.53 to 43.44 ± 3.98) [18]. The increases in protrusion values in G1 (6.16 ± 0.84 to 8.79 ± 0.98) and G2 (5.69 ± 0.96 to 8.38 ± 1.55) were similar to those reported in previous studies (4.15 ± 0.99 to 7.05 ± 1.98) [8]. The increases in the right laterality values in G1 (7.14 ± 3.79 to 8.94 ± 2.09) and G2 (9.15 ± 3.03 to 9.72 ± 2.35) and in the left laterality values in G1 (7.94 ± 3.62 to 9.56 ± 1.85) and G2 (5.74 ± 3.34 to 8.29 ± 2.21) were similar to those reported in another study in the literature (right laterality of 7.15 ± 1.25 to 9.49 ± 0.61 and left laterality of 7.59 ± 1.26 to 9.31 ± 0.70) [17]. The increase in jaw movement is expected, as arthrocentesis under sufficient pressure can remove adherences, eliminate negative pressure within the joint, extend the joint space, and recover the articular disc space in relation to the glenoid fossa, thus helping to increase translation of the articular disc and condyle [7,19–22].

The positive results obtained by the techniques used in this research may also be due to the use of sodium hyaluronate immediately after arthrocentesis; when these procedures (arthrocentesis and sodium hyaluronate) are combined, the results regarding pain and mouth opening tend to be better [23,24]. Sodium hyaluronate promotes increased joint lubrication by increasing synovial fluid viscosity, which acts as a shock absorber, thereby preserving homeostasis, allowing repair processes to be activated, and normalizing actions that affect the synthesis of endogenous synovial cells. It also promotes greater joint mobility, reduces attrition and noise, and improves synovial fluid nutrient and metabolite perfusion to the vascular tissue [25]. The results obtained may be due in part to the natural course of DDWOR; after one year, there was a reduction or elimination of pain and an increase in jaw mobility, which corroborates the findings of Sato et al. [26]. In addition, an idiosyncrasy in the arthrocentesis technique performed, i.e., the use of a suction pump, may have contributed to the results obtained, as it enabled the solution and its fluidity to be observed and its flow to be directed to joint washing, optimizing irrigation irrespective of the volume used.

Arthrocentesis was first described in 1991 [6,7] and since then, technical variations have been described. Any change that improves the procedure is beneficial to patients and clinicians [27]. The literature shows that techniques using a single needle [28,29] are just as effective as the conventional two-needle technique [7]. In a study using cadavers, Sindel et al. [30] observed no difference in irrigation efficiency in arthrocentesis with one or two needles. Moreover, there was no difference between the two volumes (50 or 200 mL) in the present study. These results suggest that simplification of the arthrocentesis technique by using a single needle and a smaller irrigation volume can be effective in improving DDWOR, with possibly lower costs, morbidity, and time required to perform procedures. However, the results should be analyzed with caution, because the findings presented here derive from a single-center study with a restricted population; also, the patients were instructed to wear their interocclusal device during the one year of follow-up, and this may have contributed to the good results of the research. Analysis of the synovial fluid would also be important to understand tissue response to different arthrocentesis techniques, which could be used to predict the outcome of the procedure. Future studies may help elucidate this matter.

Conclusion

Regarding the proposed objective, the results obtained and considering the limitations of this study, it can be concluded that in patients with DDWOR, arthrocentesis techniques with irrigation volumes of 50 and 200 mL in conjunction with interocclusal device protocol maintained for the full year of the study were effective in reducing the VAS pain scores and increasing the MID, protrusion, and laterality values after one year of follow-up, with no statistically significant differences between techniques ($p > 0.05$). Furthermore, changes in volume did not significantly affect the arthrocentesis results ($p = 0.626$).

Disclosure Statement

No potential conflict of interest was reported by the authors.

ORCID

Eduardo Grossmann PhD http://orcid.org/0000-0001-7619-3249
Rodrigo Lorenzi Poluha DDS, MSc http://orcid.org/0000-0001-7180-6448
Lilian Cristina Vessoni Iwaki PhD http://orcid.org/0000-0002-1822-3056
Liogi Iwaki Filho PhD http://orcid.org/0000-0001-9117-6826

References

1. Dworkin SF, Leresche L. Research diagnostic criteria for temporomandibular disorders: review criteria, examinations and specifications, critique. J Craniomandib Disord. 1992;6(4):301–350.
2. Schmitter M, Rammelsberg P, Hassel A. The prevalence of signs and symptoms of temporomandibular disorders in very old subjects. J Oral Rehabil. 2005;32:467–473.
3. Lazarin RD, Previdelli IT, Silva RD, et al. Correlation of gender and age with magnetic resonance imaging findings in patients with arthrogenic temporomandibular disorders: a cross-sectional study. Int J Oral Maxillofac Surg. 2016;45(10):1222–1228.
4. Ahmad M, Hollender L, Anderson Q, et al. Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009;107(6):844–860.
5. Tatli U, Benlidayi ME, Ekren O, et al. Comparison of the effectiveness of three different treatment methods for temporomandibular joint disc displacement without reduction. Int J Oral Maxillofac Surg. 2017;46(5):603–609.
6. Nitzan DW. Arthrocentesis-incentives for using this minimally invasive approach for temporomandibular disorders. Oral Maxillofac Surg Clin North Am. 2006;18(3):311–328.
7. Nitzan DW, Dolwick MF, Martinez GA. Temporomandibular joint arthrocentesis: a simplified treatment for severe, limited mouth opening. J Oral Maxillofac Surg. 1991;49(11):1163–1167.
8. Sharma A, Rana AS, Jain G, et al. Evaluation of efficacy of arthrocentesis (with normal saline) with or without sodium hyaluronate in treatment of internal derangement of TMJ - A prospective randomized study in 20 patients. J Oral Biol Craniofac Res. 2013;3(3):112–119.
9. Goudot P, Jaquinet AR, Hugonnet S, et al. Improvement of pain and function after arthroscopy and arthrocentesis of the temporomandibular joint: a comparative study. J Craniomaxillofac Surg. 2000;28(1):39–43.
10. Kaneyama K, Segami N, Nishimura M, et al. The ideal lavage volume for removing bradykinin, interleukin-6, and protein from the temporomandibular joint by arthrocentesis. J Oral Maxillofac Surg. 2004;62(6):657–661.
11. Zhu P, Lin H, Zhou Q, et al. Dynamic evaluation of lavage efficacy in upper compartment of the temporomandibular joint. J Oral Maxillofac Surg. 2017;75(2):276–283.
12. De Barros Melo MN. Dos Santos Melo JN, Sarmento VA, et al. Influence of arthrocentesis irrigation volume at temporomandibular disorder treatment. Indian J Dent Res. 2017;28:655–660.
13. Von Elm E, Altman DG, Egger M, et al. STROBE initiative. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344–349.
14. Holmlund A, Hellsing G. Arthroscopy of the temporomandibular joint: an autopsy study. Int J Oral Surg. 1985;14(2):169–175.
15. Neeli AS, Umarani M, Kotrashetti SM, et al. Arthrocentesis for the treatment of internal derangement of the temporomandibular joint. J Maxillofac Oral Surg. 2010;9(4):350–354.
16. De Riu G, Stimolo M, Meloni SM, et al. Arthrocentesis and temporomandibular joint disorders: clinical and radiological results of a prospective study. Int J Den. 2013;4:1–8.
17. Chandrashekhar VK, Kenchappa U, Chinnannavar SN, et al. Arthrocentesis a minimally invasive method for TMJ disc disorders - A prospective study. J Clin Diagn Res. 2015;9(10):59–62.
18. Grossmann E, Poluha RL, Iwaki LCV, et al. Predictors of arthrocentesis outcome on joint effusion in patients with disk displacement without reduction. Oral Surg. Oral Med Oral Pathol Oral Radiol Endod. 2018;S2212-4403(18):30016.
19. Yura S, Totsuka Y, Yoshikawa T, et al. Can arthrocentesis release intracapsular adhesions? Arthroscopic findings before and after irrigation under sufficient hydraulic pressure. J Oral Maxillofac Surg. 2003;61(11):1253–1256.
20. Yura S, Totsuka Y. Relationship between effectiveness of arthrocentesis under sufficient pressure and conditions of the temporomandibular joint. J Oral Maxillofac Surg. 2005;63(2):225–228.
21. Ohnuki T, Fukuda M, Nakata A, et al. Evaluation of the position, mobility, and morphology of the disc by MRI before and after four different treatments for temporomandibular joint disorders. Dentomaxillofac Radiol. 2006;35(2):103–109.

22. Sembronio S, Albiero AM, Toro C, et al. Is there a role for arthrocentesis in recapturing the displaced disc in patients with closed lock of the temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;105(3):274–280.
23. Alpaslan GH, Alpaslan C. Efficacy of temporomandibular joint arthocentesis with and without injection of sodium hyaluronate in treatment of internal derangements. J Oral Maxillofac Surg. 2001;59:613–618.
24. Gorrela H, Prameela J, Srinivas G, et al. Efficacy of temporomandibular joint arthrocentesis with sodium hyaluronate in the management of temporomandibular joint disorders: a prospective randomized control trial. J Maxillofac Oral Surg. 2017;16(4):479–484.
25. Shi Z, Guo C, Awad M. Hyaluronate for temporomandibular joint disorders. Cochrane Database Syst Rev. 2003;1:CD002970.
26. Sato S, Takahashi K, Kawamura H, et al. The natural course of nonreducing disc displacement of the temporomandibular joint: changes in condylar mobility and radiographic alterations at one-year follow up. Int J Oral Maxillofac Surg. 1998;27(3):173–177.
27. Şentürk MF, Yazıcı T, Gülşen U. Techniques and modifications for TMJ arthrocentesis: A literature review. CRANIO®. 2017;15:1–9.
28. Guarda-Nardini L, Ferronato G, Manfredini D. Two-needle vs. single-needle technique for TMJ arthrocentesis plus hyaluronic acid injections: a comparative trial over a six-month follow up. Int J Oral Maxillofac Surg. 2012;41(4):506–513.
29. Grossmann E, Guilherme Vargas Pasqual P, Poluha RL, et al. Single-needle arthrocentesis with upper compartment distension versus conventional two-needle arthrocentesis: randomized clinical trial. Pain Res Manag. 2017;1–8.
30. Sindel A, Uzuner F, Sindel M, et al. Comparison of the efficiency of irrigation of single and double-needle techniques of temporomandibular joint arthrocentesis: A cadaver study. CRANIO®. 2017;35(6):405–409.