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ORIGINAL ARTICLE

Prospective study to evaluate the influence of joint washing and the use of hyaluronic acid on 111 arthrocentesis

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Abstract

Background Temporomandibular dysfunction is a generic term that covers a large number of clinical problems affecting not only temporomandibular joint but also the masticatory musculature and related structures. Arthrocentesis is used in patients with joint pathology in which conservative treatment has failed.

Methods A prospective, observational, analytical cohort study has been carried out to evaluate the results of 111 arthrocentesis. We have performed an inferential statistics study between the variables: improvement of pain and improvement in the oral opening with the variables and access joint, washing joint, hyaluronic acid infiltration, and type of joint pathology.

Results Joint washing and intra-articular hyaluronic acid injection significantly improved the pain at 1-week, 1-month, and 3-month postarthrocentesis, although this improvement was limited in time, at 6 months, joint washing and hyaluronic acid infiltration are no longer significant. Only the joint access ($p = 0.014$) and the type of joint pathology ($p = 0.028$) are significant.

Conclusions The effectiveness of joint access in the arthrocentesis at 6 months is high, although less than at 1-month and 3-month postarthrocentesis. The type of joint pathology is another important factor. Patients with degenerative pathology worsen the most after 6-month postarthrocentesis. Arthrocentesis could avoid the evolution of acute pathology.

Keywords Temporomandibular joint dysfunction · Arthrocentesis · Access temporomandibular joint · Lavage temporomandibular joint · Hyaluronic infiltration

Introduction

Temporomandibular joint (TMJ) is a complex joint covered by a capsule, and divided by the intracapsular disc into an upper and lower compartment [1]. The main cause of the displacement of the articular disc is the overloading of the joint, which causes a degradation of all the articular components and increases the articular friction. In consequence, all insertions between the condyle-disc are damaged and stretched resulting in the disc that does not move together with the condyle [2].

Temporomandibular disorder (TMD) is a generic term that covers a large number of clinical problems affecting not only TMJ but also the masticatory musculature and related structures. It is an alteration of the articular function, in which the normal relations between the articular disc and meniscus are modified with respect to the condyle and the articular eminence. This usually causes a forward displacement of the meniscus, interfering with articular displacement [3]. Among these disorders of the temporomandibular joint are disc pathologies (displacement of the articular disc) and intra-articular joint pathologies (capsulitis, synovitis, retrodiscitis, osteoarthritis, osteoarthrosis, free bodies) [3, 4].

The treatment of TMD is combined and multidisciplinary, including dentists, physiotherapists, psychologists, neurologists, otolaryngologists, and maxillofacial surgeons [3]. The

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difficulty of the treatment is the difference between the signs and symptoms of the different pathologies that occur in this territory. These are basically two, muscular and articular, and are very interrelated.

There are two types of treatment, conservative and surgical. Surgical treatment can be invasive (arthroplasty, discectomy, and joint reconstruction) or minimally invasive (arthrocentesis and arthroscopy). Regardless of the type of pathology and clinical stage, arthrocentesis is the most commonly used technique in patients with pain or limitation of the oral opening due to joint causes when conservative treatment has failed. This improves the quality of life of patients, with almost no side effects and is usually performed under local anesthesia and sedation.

In most studies, joint washing has shown a significant success rate in joint problems, especially when DDWoR (discal displacement without reduction) exists [5]. However, there are studies in which, after 3 years of follow-up, no significant differences have been found between washing the joint and just infiltrating the local anesthesia periarticularly. Joint washing would be effective only in certain pathologies and some joint pathologies resolve without the need to perform a temporomandibular arthrocentesis, because the improvement over time may be due to the course of the disease itself and not to the joint washing [6].

Regarding the infiltration of hyaluronic acid into the joint cavity, it has been shown in numerous studies to be effective in the replacement of synovial fluid, the elimination of free radicals, and the inhibition of tissue granulation [7]. However, studies that find significant differences in favor of hyaluronic acid injection are short-term studies only.

The aim of our study is to evaluate the results of arthrocentesis and if the access, lavage, and hyaluronic acid intra-articular injection influence this results over time.

Material and method

A prospective, observational, and analytical cohort study has been conducted to evaluate the results of 111 arthrocentesis performed in patients with joint pathology from January 2014 to July 2017, evaluating the overall results of temporomandibular arthrocentesis and evaluating whether washing and injection of hyaluronic acid influence these results at 1 week, 1 month, 3 months, and 6 months after arthrocentesis.

The inclusion criteria have been temporomandibular joint pain and/or limitation in oral opening less than 30 mm due to temporomandibular joint pathology in patients with acute, subacute, or chronic pathology without response to conservative measures, during a 3- to 6-month period. Although in case of acute limitation of oral opening (joint blockage), when conservative measures do not work, treatment is surgery as soon as possible, in the first month.

Patients with only muscle pathology; patients with previous jaw fractures, disabling psychological factors, previous intra-articular surgical measures; and patients lost during follow-up have been established as exclusion criteria.

Preoperatively, we have collected as dependent variables: oral opening measured in millimeters and the pain measured on VAS scale (10 is the maximum of pain and 1 the minimum), and as an independent variable, the type of joint pathology, discal displacement or degenerative and inflammatory joint pathologies.

Intraoperatively, we have collected as independent variables joint washing: yes/no, intra-articular access is achieved; yes/no and hyaluronic acid infiltration: yes/no. In all patients with joint access, joint washing and hyaluronic acid infiltration is tried, but it is not always that the lavage of the joint is possible because the joint cavity is small and sometimes is difficult to access and make a lavage of it.

Postoperatively, each patient was followed at 1-week, 1-month, 3-month, and 6-month postarthrocentesis, always measuring the oral opening in millimeters and pain in a VAS scale.

First of all, a descriptive study has been carried out on all patients with joint pathology: acute, subacute, or chronic treated with a temporomandibular arthrocentesis, measuring the prevalence of TMJ pathologies intervened and the results in pain and oral opening, as well as joint access, joint washing and hyaluronic acid infiltration that is achieved. Subsequently, we have performed an inferential statistics study between these factors and the results in improvement of pain of more than 2 points on the VAS scale and improvement in the oral opening of more than 5 mm. We have accepted as null hypothesis: the type of joint pathology, the access, the lavage, and the hyaluronic infiltration do not influence the results of the arthrocentesis at 1-week, 1-month, 3-month, and 6-month postarthroecentesis.

For the statistical analysis of the collected data, a bivariate study has been conducted using the statistical software SPSS 20.0. For all variables following a normal distribution, a X^2 test was used, whereas for those not following a normal distribution, the exact statistic of Fisher was followed. Using the significant variables of the study on improvement of pain and oral opening postarthrocentesis, a multivariate analysis using binary logistic regression was performed. The significance level was $p \leq 0.05$.

This article was approved by University Hospital Miguel Servet review board of Zaragoza and there is no conflict of interest.

Results

Descriptive statistics results

The improvement in pain on the VAS scale has been after 1 week, 73% of all arthrocenteses performed, or in other words, 81 of the 111 patients (79 of them with joint access and 73 with joint access and lavage, and where there are only 2 patients who improve without joint access). At 1 month, 79.3% of the 111 arthrocenteses (88 patients, 85 with joint access and 73 with joint access and lavage) reported improvement. At 3 months, 79.3% of patients still report less pain than before the surgery. However, at 6 months, improvement decreases to 71.2% of patients, i.e., 79 out of the 111 arthrocenteses are still better than before of arthrocentesis (76 with joint access and 68 with joint access and lavage). In conclusion, we see that the results worsen with time (Fig. 1).

In terms of oral opening improving, the following results were obtained: 68.5% of the patients at 1 week (76 of the 111 patients, 74 of them with joint access and 68 with join access and lavage). At 1 month, 71.2% of all arthrocentesis (79 patients, 77 with joint access and 70 with joint access and lavage) had an opening of ≥5 mm than before surgery. At 3 months, 73% of patients (81 patients, 78 with joint access and 71 with joint access and lavage) opened more. And at 6 months, the improvement in oral opening decreased, 68.5% of patients (76 patients, 73 with joint access and 65 with joint access and lavage) were better off than before arthrocentesis.

The access and distension of the joint during the arthrocentesis procedure, regardless of whether or not effective washing of the joint with more of 20 cc (centimeters cubic) of Ringer Lactato was achieved, was 88.3% of the patients, or what is the same, 98 of the 111 arthrocentesis performed.

The percentage of patients who underwent joint cavity lavage, with entry and exit of more than 20 cc of Ringer Lactato, was 79.3%, or in other words, 88 patients out of the 111 arthrocentesis performed.

If joint access to the articular cavity is achieved, we can infiltrate hyaluronic acid, especially in cases of degenerative pathology. The percentage of patients in whom hyaluronic infiltration was performed was 78.4%, 87 patients out of 111 arthrocentesis performed.

Inferential statistics results

Bivariate analysis

Joint access (98 of the 111 arthrocentesis) significantly improved the results in a bivariate analysis at 1-week, 1-month, 3-month, and 6-month postarthrocentesis ($p < 0.001$) in both oral opening and pain. However, at 6-months postarthrocentesis, this improvement decreased (Table 1).

Joint washing also significantly influenced the improvement of the oral opening and pain throughout follow-up. However, with time, at 6 months, this improvement is the same whether or not joint washing with more than 20 cc is achieved, becoming non-significant for the oral opening ($p = 0.05$). With a $N = 88$ (in 10 patients joint access is achieved but no washing is performed) and at 6 months, these results are the same as patients with lavage of the joint (Table 2).

The use of intra-articular hyaluronic acid also significantly improved oral opening and degree of pain, but also decreased after 6 months, and was no longer significant ($p = 0.05$). The number of patients with hyaluronic infiltration is 87, independent if lavage of the joint is achieved or not (Table 3).

If we consider the type of joint pathology, divided into dislocations and degenerative disorders, at 6 months, patients with joint degeneration were significantly worse than those with meniscal dislocations occurring in the early stages. Patients with dislocations improved or remained stable with the time. However, patients with degenerative disorders tend to worsen after a 6-month postarthrocentesis, with an OR of 2.62 for pain and 2.6 for the oral opening.

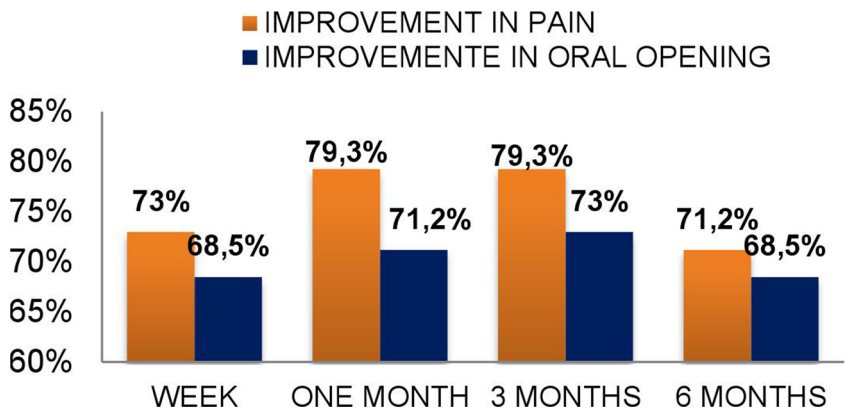

Fig. 1 Distribution graph of the variable improvement in pain and oral opening at 1 week, 1 month, 3-months, and 6-month postarthrocentesis

Table 1 Joint access and improvement in postarthrocentesis pain and oral opening correlation

Improvement with joint access	Pain		Oral opening	
	OR (IC 95%)	Signification	OR (IC 95%)	Signification
Week	22.86 (4.67–111.88)	< 0.001	16.95 (3.50–81.95)	< 0.001
Month	21.79 (5.28–89.81)	< 0.001	20.16 (4.14–98.10)	< 0.001
3 months	13.50 (3.65–49.86)	< 0.001	11.70 (2.89–47.25)	< 0.001
6 months	11.51 (2.91–55.52)	< 0.001	7.78 (1.91–31.65)	< 0.001

Multivariate analysis

In the multivariate analysis, joint washing and intra-articular hyaluronic acid injection significantly improved pain at 1 week, 1 month, and 3 months, although this improvement was limited in time, at 6 months, both joint washing and hyaluronic acid infiltration are no longer significant. Only joint access would be associated with clinical improvement in both pain and the oral opening at a 6-month postarthrocentesis (Table 4).

If we consider the type of joint pathology in the multivariate analysis, at 6 months, patients with degenerative joint disorders are significantly worse than those with meniscal dislocation, $p = 0.028$ with an OR of 3.02 (1.12–8.09).

Discussion

The limitations of this study are several: first of all, pain is a subjective parameter and depends on many psychological and individual factors. And in almost all patients, the access and the lavage of the joint are achieved. Only in 10 patients, joint access is achieved but lavage is not performed, and only in 11 patients, joint access is achieved and hyaluronic is not infiltrated.

It is not yet clear whether access to the joint, joint washing and hyaluronic acid infiltration prevent progression of TMD. It should be noted that 40% of cases with discal displacement without reduction (DDWoR) are asymptomatic after two and a half years without treatment; 33% improve symptoms with conservative treatment and 25% remain blocked with joint problems that progress to more advanced stages.

In the results of Xu et al. [8], intra-articular access and the pressure and washing speed of the temporomandibular joint are critical, with better results in cases where higher pressure and washing speeds are achieved. Joint access and distension break-up pathological adhesions. In our study, joint access significantly improves oral opening and pain at all times whether or not effective lavage with more of 20 cc of Ringer Lactato is performed. This is consistent with the results obtained by Skármeta et al. [9], in their study "A single-puncture arthrocentesis technique, using a peripheral intravenous catheter," a single puncture would be enough to distend the joint and achieve good results comparable to the use of two needles with intra-articular washing. Also according to Yura et al. [10], and in the study of Zhu et al. [11], the results would depend more on the pressure achieved than on the amount of lavage.

With respect to joint lavage in the multivariate analysis, there was a significant improvement in pain at 1-week, 1-month, and 3-month postarthrocentesis, independent of the other variables. This is because joint lavage allows adhesions to be broken and inflammatory mediators to be eliminated from the joint cavity [12]. Although at 6 months, the lavage with more than 20 cc of Ringer Lactato is no longer significant and only joint access continues being significant.

In relation to the intra-articular injection of hyaluronic acid, the same occurs as for joint lavage in our results. In the bivariate analysis, it improved the results at all times of follow-up postarthrocentesis; however, in the multivariate analysis, it is significant only at 1 week, 1 month, and 3 months for pain, losing its effectiveness over time and in the improvement of the oral opening that is not associated at any time. Moreover, the efficacy of hyaluronic acid with respect to infiltration of other therapeutic alternatives has not yet been concluded in the literature [13].

Table 2 Joint washing and improvement in postarthrocentesis pain and oral opening correlation

Improvement with joint washing	Pain		Oral opening	
	OR (IC 95%)	Signification	OR (IC 95%)	Signification
Week	9.12 (3.28–25.36)	< 0.001	6.37 (2.36–17.19)	< 0.001
Month	13.65 (4.61–40.39)	< 0.001	6.03 (2.26–16.19)	< 0.001
3 months	7.63 (2.71–21.46)	< 0.001	5.01 (1.85–13.51)	< 0.001
6 months	3.70 (1.42–9.66)	< 0.001	2.56 (0.96–6.84)	< 0.05

Table 3 Hyaluronic acid injection and improvement in postarthrocentesis pain and oral opening correlation

Improvement	Pain		Oral opening	
	OR (IC 95%)	Signification	OR (IC 95%)	Signification
Week	8 (2.95–21.66)	< 0.001	5.58 (2.12–14.66)	< 0.001
Month	9.1	< 0.001	5.36 (2.04–14.06)	< 0.001
3 months	6.9 (2.49–19.15)	< 0.001	4.49 (1.69–11.90)	< 0.001
6 months	3.35(1.30–8.60)	< 0.001	2.31 (0.88–6.08)	< 0.05

Alpaslan et al. [14] find no significant difference between arthrocentesis alone or supplemented with hyaluronic acid at 24 months of follow-up. Guarda-Nardini et al. [15] compare the use of a single session of hyaluronic acid with the use of five sessions, seeing that at 6 months, the patients with five sessions improve more, due to over time, hyaluronic acid loses its effect. The same has been seen in our results, those of Manfredini et al. [16] and those of Triantaffilidou et al. [17]

On the another hand, according to Gurung et al. [18], in a randomized study in 20 patients with osteoarthritis, 10 treated with arthrocentesis plus hyaluronic acid and other 10 with arthrocentesis alone, the improvement at 3 months is significantly greater if hyaluronic acid is infiltrated not only for pain but also for oral opening. In the study of Morey et al. [19], in patients with stage III and IV Wilkes, the improvement in pain is significantly greater in the group using hyaluronic acid at 2 weeks and also at 3-month postarthrocentesis. And for Gorrela et al. [20], the improvement is also significant at 6-month postarthrocentesis; however, for oral opening, they do not find differences, as our results.

Zhong et al. [21] said that, in patients with DDWoR, the use of hyaluronic acid is also effective compared to conservative treatment. According to Yeung et al. [22], in their study of 27 patients with DDWoR, injection of two cycles of hyaluronic acid significantly improves pain and oral opening at 6 months. In addition, Tuncel et al. [23] also suggest that repeated infiltration of hyaluronic acid together with the performance of arthrocentesis would help to reduce disc displacement in early stages.

We must take into account that patients who worsen in our study after 6 months of treatment, regardless of whether effective access and washing of the joints is performed, are patients with more advanced pathology, with degenerative disorders and Wilkes stage III and IV. Patients with DDWR (discal displacement with reduction) and DDWoR (discal displacement without reduction), with stage Wilkes II, however, tend to remain stable or even improve over months after treatment, especially if effective access and joint washing are achieved, could possibly avoiding progression to more advanced stages.

Honda et al. [24], in their study "Causes of persistent joint pain after arthrocentesis of temporomandibular joint" carried out in 36 patients, explain that persistent pain after arthrocentesis is associated with erosive and degenerative intra-articular changes. There are patients with meniscal dislocations and acute pathology, who progress favorably with conservative treatment. However, if there is no improvement after several months of conservative treatment degenerative pathology is already established at the time of diagnosis, conservative measures are generally not effective.

In the study of Vos et al. [25] and Hosgor et al. [26], comparing the results of performing arthrocentesis with the use of conservative measures in acute joint disorders, it is shown that pain and oral opening improve more rapidly in the group of patients treated with arthrocentesis; however, at a 26-week postarthrocentesis, both groups show significant improvement without differences between them. Schiffman et al. [27] also do not find differences between arthrocentesis or conservative treatment in patients with DDWoR at 3- and 6-month postarthrocentesis, explaining that treatment with conservative measures should be in the forefront to avoid unnecessary and more aggressive procedures in these patients with acute pathology. Baker et al. [7], in their study, say that at 3 years of follow-up in 37 patients with DDWoR, the results are similar among those who have only performed intra-articular infiltration of local anesthetic versus those who have performed joint lavage. And Sahlström et al. [28], in their study in 45 patients

Table 4 Multivariate analysis of the improvement of pain and oral opening according to joint access, joint washing and hyaluronic injection, at 6-month postarthrocentesis

6 months	Joint access		Joint washing		Hyaluronic injection	
	Yes	No	Access + washing	Access no washing	Access + hyaluronic	Access no Hyaluronic
Pain	76.5%	23.1%	77.3%	70%	77%	72.7%
Oral opening	74.5%	27.3%	73.9%	80%	73.6%	81.8%

with DDWoR "Lavage treatment of painful jaw movements at dislocation without reduction. A randomized controlled trial in a short-term perspective," do not even find significant differences in both pain and the oral opening at 1 month and 3 months between patients treated with local anesthesia plus intra-articular lavage versus those who received intra-articular local anesthesia alone without lavage. However, in almost all studies such as Tatli et al. [29] and Gouveia et al. [30], it is agreed that the patients with acute pain with DDWoR and DDWR do not improve with conservative measures, and arthrocentesis would be in the first line of treatment for improving pain significantly faster and it could also prevent progression to chronic pathologies.

However, Diraçoğlu et al. [31], in its study in 120 patients with DDWoR and Tatli et al. [29], in another randomized study in 120 patients with diagnosis of DDWoR divided into conservative treatment or arthrocentesis, find differences in pain between the two groups of treatment at 1-month and 6-months postarthrocentesis. And in the meta-analysis conducted by Bouchard et al. [32], of five studies comparing joint lavage in 135 patients with only conservative measures in 173 patients, joint lavage is found to be superior to conservative measures in pain at 3- and 6-month postarthrocentesis, with no superiority in oral opening improvement at any point of time. Although this meta-analysis has its limitations, due to the heterogeneity of the treatments received in each study, the different types of joint pathology treated in each of them and the small number of patients in all the studies reviewed. Significant differences have been found between the performance of arthrocentesis and conservative measures in many studies, despite the fact that at short term, acute joint pathology tends to evolve in many cases in a positive way with conservative measures, as is said by Baker et al. [7]. And as we have seen in our study, since in early stages I and II, there is no joint degeneration and in many cases, a spontaneous reduction of the meniscus occurs due to the fact that joint inflammation subsides with conservative measures.

Conclusions

The effectiveness of arthrocentesis at 6 months of follow-up is high for both pain and oral opening, although less than at a 1-month and 3-month postarthrocentesis. Joint access and distension are significantly related to a greater oral opening at all times of follow-up, and it is also the only intraoperative variable that is related to the improvement of both pain and oral opening at 6-month postarthrocentesis.

The type of joint pathology is another important factor to control because patients with degenerative pathology is worse after a 6-month postarthrocentesis. Arthrocentesis may be one possible measure to prevent the progression of 25% of patients with DDWoR who do not improve with conservative measures to more advanced stages. Few studies follow patients for more than 6 months to assess their progress over several years to find out if patients with DDWoR who improve with only conservative measures continue stable or worsen over time.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article was approved by University Hospital Miguel Servet review board of Zaragoza.

Informed consent An informed consent was obtained from all individual participants included in the study.

References

1. Kaplan AS, Assael LA (1991) Temporomandibular disorders. Diagnosis and treatment, 1st edn. Saunders, Estados Unidos
2. Nitzan DW (2001) The process of lubrication impairment and its involvement in temporomandibular joint disc displacement: a theoretical concept. J Oral Maxillofac Surg 59(1):35–46
3. Navarro Vila C (2004) Patología quirúrgica de la articulación temporomandibular: transtornos funcionales. In: Navarro Vila C, García Marín F, Ochandiano Caicoya S (eds) Tratado de Cirugía Oral y Maxilofacial. Arán, Madrid, pp 266–277
4. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet J et al (2014) 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 1(28):6–27
5. Goizueta Adame C, Muñoz-Guerra M (2012) The posterior double pass suture in repositioning of the tempromandibular disc during arthroscopic surgery: a report of 16 cases. J Craniomaxillofac Surg 40(1):86–91
6. Chandrashekhar V, Kenchappa U, Chinnannavar S, Singh S (2015) Arthrocentesis a minimally invasive method for TMJ disc disorders - a prospective study. J Clin Diagn Res 9(10):59–62
7. Baker Z, Eriksson L, Englesson Sahlström L, Ekberg E (2015) Questionable effect of lavage for treatment of painful jaw movements at disc displacement without reduction: a 3-year randomised controlled follow-up. J Oral Rehabil 42(10):742–750
8. Xu Y, Lin H, Zhu P, Zhou W, Han Y, Zheng Y et al (2013) A comparative study between use of arthroscopic lavage and arthrocentesis of temporomandibular joint based on computational fluid dynamics analysis. PLoS One 8(11):e78953
9. Skármeta N, Pesce M, Espinoza-Mellado P (2016) A single-puncture arthrocentesis technique, using a peripheral intravenous catheter. Int J Oral Maxillofac Surg 45(9):1123–1125
10. Yura S, Totsuka Y, Yoshikawa T, Inoue N (2003) Can arthrocentesis release intracapsular adhesions? Arthroscopic findings before and after irrigation under sufficient hydraulic pressure. J Oral Maxillofac Surg 61(11):1253-6

11. Zhu P, Lin H, Zhou Q, Lv J, Zhang Z, Xu Y (2017) Dynamic evaluation of lavage efficacy in upper compartment of the temporomandibular joint. J Oral Maxillofac Surg 75(2):276–283
12. Nitzan D, Dolwick M (1991) An alternative explanation for the genesis of closed-lock symptoms in the internal derangement process. J Oral Maxillofac Surg 49(8):810–815
13. Manfredini D, Piccotti F, Guarda-Nardini L (2010) Hyaluronic acid in the treatment of TMJ disorders: a systematic review of the literature. Cranio. 28(3):166–176
14. Alpaslan G, Alpaslan C (2001) Efficacy of temporomandibular joint arthrocentesis with and without injection of sodium hyaluronate in treatment of internal derangements. J OralMaxillofac Surg 59(6):613–618
15. Guarda-Nardini L, Rossi A, Arboretti R, Bonnini S, Stellini E (2015) Single- or multiple-session viscosupplementation protocols for temporomandibular joint degenerative disorders: a randomized clinical trial. J OralRehabil 42(7):521–528
16. Manfredini D, Bonnini S, Robretti R, Guarda-Nardini L (2009) Temporomandibular joint osteoarthritis: an open label trial of 76 patients treated with arthorcentesis plus hyaluronic acid injections. Int J Oral Maxillofac Surg 38(8):827–834
17. Triantaffilidou K, Venetis G, Bika O (2013) Efficacy of hyaluronic acid injections in patients with osteoarthritis of the temporomandibular join. A comparative study. J Craniofac Surg 24(6):2006–2009
18. Gurung T, Singh R, Mohammad S, Pal U, Mahdi A, Kumar M (2017) Efficacy of arthorcentesis versus arthorcentesis with sodium hyaluronic acid in temporomandibular joint osteoarthritis: a comparision. Natl J Maxillofac Surg 8(1):41–49
19. Morey-Mas MA, Caubet-Biayna J, Varela-Sende L, Iriarte-Ortabe JI (2010) Sodium hyaluronate improves outcomes after arthroscopic lysis and lavage in patients with Wilkes stage III and IV disease. J Oral Maxillofac Surg 68(5):1069-74
20. Gorrela H, Prameela J, Srinivas G, Reddy B, Sudhir M, Arakeri G (2017) Efficacy of temporomandibular joint arthrocentesis with sodium hyaluronate in the management of temporomandibular joint disorders: a prospective randomized control trial. J Maxillofac Oral Surg 4(16):479–484
21. Zhong W, Zhou G (2004) Intraarticular injection-dilatation and later lavage plus viscosupplementation of TMJ for the treatment of anterior disc displacement without reduction. Shanghai Kou Qiang Yi Xue 13(1):23–26
22. Yeung R, Chow R, Samman N, Chiu K (2006) Short-term therapeutic outcome of intra-articular high molecular weight hyaluronic acid injection for nonreducing disc displacement of the temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 102(4):453–461
23. Tuncel U (2012 Diciembre) Repeated sodium hyaluronate injections following multiple arthrocenteses in the treatment of early stage reducing disc displacement of the temporomandibular join: a preliminary report. J Craniomaxillofac Surg 40(8):685–689
24. Honda K, Yasukawa Y, Fujiwara M, Abe T, Urade M (2011) Causes of persistent joint pain after arthrocentesis of temporomandibular joint. J Oral Maxillofac Surg 69(9):2111–2115
25. Vos L, Huddleston Slater J, Stegenga B (2014) Arthrocentesis as initial treatment for temporomandibular joint arthropathy: a randomized controlled trial. J Craniomaxillofac Surg 5(42):e134–e139
26. Hosgor H, Bas B, Celenk C (2017) A comparison of the outcomes of four minimally invasive treatment methods for anterior disc displacement of the temporomandibular joint. Int J Oral Maxillofac Surg 11(43):1403–1401
27. Schieffman E, Look J, Hodges J, Swift J, Decker K, Hathaway D et al (2007) Randomized effectiveness study of four therapeutic strategies for TMJ closed lock. J Dent Res 86(1):58–63
28. Sahlström L, Ekberg E, List T, Petersson A, Eriksson L (2013) Lavage treatment of painful jaw movements at disc displacement without reduction. A randomized controlled trial in a short-term perspective. Int J Oral Maxillofac Surg 42(3):356–363
29. Tatli U, Benlidayi M, Ekren O, Salimov F (2017) Comparison of the effectiveness of three different treatment methods for temporomandibular joint disc displacement without reduction. Int J Oral Maxillofac Surg 46(5):603–609
30. Gouveia M, Barbalho J, Pereira Júnior E, Nascimento M, Vasconcelos B (2015) Effectiveness and satisfaction evaluation of patients submitted to TMJ arthrocenthesis: a case series. Braz Oral Res 29(50):1–5
31. Diraçoğlu D, Saral I, Keklik B, Kurt H, Emekli U, Ozçakar L et al (2009) Arthrocentesis versus nonsurgical methods in the treatment of temporomandibular disc displacement without reduction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1(108):3–8
32. Bouchard C, Goulet J, El-Ouazzani M, Turgeon A (2017) Temporomandibular lavage versus nonsurgical treatments for temporomandibular disorders: a systematic review and meta-analysis. J Oral Maxillofac Surg 7(75):1352–1362