Predictors of arthrocentesis outcome on joint effusion in patients with disk displacement without reduction

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Objectives. The aim of this study was to investigate the preoperative variables in patients with articular disk displacement without reduction that may influence the results of arthrocentesis on joint effusion (JE).

Study Design. The records of 203 patients with clinical signs and symptoms of unilateral painful disk displacement without reduction and JE, confirmed by magnetic resonance imaging (MRI), and treated with arthrocentesis were selected. The following preoperative data were recorded: sex; age; joint side; pain duration; pain intensity, measurement with the visual analogue scale; and maximum interincisal distance (MID). All patients underwent a second MRI examination 3 to 4 months postoperatively to assess JE. The sample was then divided into 2 groups: group 1 (n = 160) comprised patients with no signs of JE; and group 2 (n = 43) comprised patients still showing signs of JE. Univariate and multivariate analyses were used to compare the groups.

Results. Among the studied variables, pain duration ($P = .0175$), pain intensity ($P < .0001$), and MID ($P = .0085$) were shown to affect arthrocentesis outcomes. The longer the pain duration (odds ratio [OR] = 0.930), the more intense was the pain (OR = 0.346), and the smaller the MID (OR = 0.562), the less were the chances of arthrocentesis completely eliminating JE.

Conclusions. Pain duration, pain intensity, and MID can be used as predictors for the effect of arthrocentesis on JE outcomes and considered during treatment planning. (Oral Surg Oral Med Oral Pathol Oral Radiol 2018;125:382–388)

Temporomandibular disorders (TMDs) represent a range of functional and pathologic changes affecting the temporomandibular joint (TMJ), masticatory muscles, and associated structures.[1] Among the existing TMDs, articular disk displacement without reduction (DDWOR) has an estimated prevalence of 35.7%.[2] This condition is characterized by the articular disk remaining anteriorly displaced relative to the mandibular condyle, with the mouth open or closed.[3]

The main reason for patients with TMDs seeking treatment is pain, usually arising from the release and accumulation of inflammatory mediators within the articular structures.[4] In magnetic resonance imaging (MRI) assessments, the presence of inflammatory exudate in the retrodiscal tissues or synovial membrane, characterized by an area of hypersignal on T2-weighted images, is known as joint effusion (JE).[5,6]

DDWOR treatment should initially employ reversible conservative methods, such as drugs, interocclusal devices, and physiotherapy. However, when these do not produce the expected results, surgical alternatives may be considered.[7] Arthrocentesis is a minimally invasive surgical intervention, which consists of washing the upper TMJ compartment, with no direct view, with a biocompatible substance to dilute local algogenic substances and to break adhesions and adherences formed between the surfaces of the articular disk and the mandibular fossa through the hydraulic pressure created by the irrigation itself.[8,9]

The presence of articular DDWOR may result in abnormal mechanical stresses and induction of inflammatory mediators within the TMJ, which may lead to JE.[10] Because a positive association between joint pain and the presence of JE has already been established,[11] it is believed that treatments aiming at eliminating JE may contribute to the reduction of pain. Although arthrocentesis has been proposed as an effective approach for the treatment of signs and symptoms of DDWOR,[7] a very recent study has shown that some factors, such as parafunctional habits, can influence treatment outcomes.[12] These findings suggest that further investigations on the possible effect of different preoperative variables on arthrocentesis outcomes are still required. This information may not only provide support to treatment planning but also clarify the benefits of arthrocentesis to patients with DDWOR and JE.

Therefore, the objective of this study was to investigate the influence of different preoperative variables of

Statement of Clinical Relevance

The effectiveness of arthrocentesis on joint effusion in patients with disk displacement without reduction seems to be dependent on pain duration, pain intensity, and maximum mouth opening. Knowing the effect of these variables can assist the clinician to predict treatment outcome and plan further therapy.

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patients with DDWOR on the results of arthrocentesis used for the treatment of JE and also to evaluate the efficacy of the arthrocentesis in patients with DDWOR. The null hypothesis to be tested is that none of the studied variables will be significant.

METHODS AND MATERIALS

This observational cross-sectional analytical study used MRI scans obtained from patients with articular DDWOR before and after arthrocentesis to investigate the effect of different preoperative variables on the results of the procedure in the treatment of JE. This study was approved by the Ethics Committee for the Research Involving Human Beings of the State University of Maringá, Brazil (CAAE: 59121716.3.0000.0104) and followed the principles of the Declaration of Helsinki and the recommendations set by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[13] Because of the retrospective nature of this study, signed informed consent was not required.

Sample

All the data used were secondary and collected from the records of patients treated at the Orofacial Pain and Deformity Center (CENDDOR), Porto Alegre, Brazil, between January 2006 and August 2016. All clinical examinations and surgical procedures were conducted by a single operator, a specialist in oral and maxillofacial surgery and traumatology, TMD, and orofacial pain, with extensive experience in the area.

The sample comprised records of patients of both sexes aged greater than 18 years who had signs and symptoms of TMD compatible with unilateral painful DDWOR associated with JE that did not respond to conservative treatments (interocclusal device, anti-inflammatory drugs, hot compresses, mild diet, and physical therapy) for at least 3 months and were then treated with arthrocentesis. The contralateral joints were asymptomatic and did not have DDWOR and/or JE and therefore were not treated. Patients with rheumatoid arthritis, agenesis, hyperplasia, hypoplasia and/or malignant neoplasm of the mandibular condyle, bone ankylosis, previous TMJ surgery, and muscular disorders were excluded from the sample.

The presence DDWOR and JE was initially assessed by clinical examination, according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)—Axis I,[1] and later confirmed with magnetic resonance imaging (MRI). In MRI assessments, in the T2-weighted sequences, JE was established by the presence of fine lines or areas of hypersignal in the supra- or infradiscal joint spaces—that is, when more than one thin line or area of hypersignal was evident in at least 2 consecutive sections, it was considered positive for JE.[5,6]

A second MRI examination was performed 3 to 4 months after arthrocentesis to assess the JE status. The sample was then divided into 2 groups: group 1 comprised patients with no signs of JE, and group 2 comprised patients still showing some signs of JE.

Studied variables

The following preoperative data were collected from the records: sex; age (years); joint side; pain duration (months); patient's perception of pain intensity, measured as 0 to 10 on the visual analogue scale (VAS); and maximum interincisal distance (MID), measured in millimeters with a digital caliper (Mitutoyo; Takatsu-ku, Kawasaki, Japan). To evaluate the efficacy of the arthrocentesis in patients with DDWOR, VAS scores and MID were also collected 3 to 4 months after arthrocentesis.

MRI

All MRI examinations were conducted before and after arthrocentesis, with 1.5 Tesla Signa HDxt equipment (GE Healthcare, Milwaukee, WI). T1-weighted sequences were performed with repetition time (TR) of 567 milliseconds and echo time (TE) of 11.4 milliseconds. T2-weighted sequences were performed with TR of 5200 milliseconds and a TE of 168.5 milliseconds, with a bilateral spherical surface coil that was 9 cm in diameter. The matrix used for T1 was 288×192, with the number of excitation (NEX) = 3; for T2, the matrix was 288×160; NEX = 4; and the field of view 11×11 cm. To minimize movement and maintain the maximum mouth opening, as previously identified in the clinical examination, an interocclusal device was placed in the interincisal space. All MRI images were analyzed by the same radiologist on the basis of the findings by Ahmad et al.[3]

Arthrocentesis

Arthrocentesis was performed just once in the affected joint, in accordance with the literature.[7-9] With the patient awake and with the head rotated to the asymptomatic side, a straight line was drawn on the skin with a marker pen along the middle portion of the tragus to the lateral corner of the eyeball. Two points were marked on this line for the insertion of the arthrocentesis needles. The first posterior-most point was marked 10 mm from the tragus and 2 mm below the canthal tragus line; and the second marking was made 20 mm in front of the tragus and 10 mm below the same line. After waiting for about 3 minutes for the ink to dry, antisepsis of the whole face was performed with 2% chlorhexidine solution, with emphasis on the preauricular region and the ear. A cotton ball then was placed next to the external acoustic meatus, and the whole face was covered with a sterile fenestrated surgical drape, with only the joint exposed. The anesthetic blockade of the auriculotemporal nerve and

subsequently anesthesia of the posterior deep temporal and masseter nerves were performed with 2% lidocaine hydrochloride without norepinephrine, at a ratio of 1:100,000 and a total volume of 3.6 mL.

The patient was asked to open the mouth to its maximum, and a sterile mouth opener was placed between the dental arches on the contralateral side of the arthrocentesis to maintain the mandibular condyle down and forward and to facilitate access to the posterior recess of the upper compartment of the TMJ. A 40 × 12 mm needle connected to a 5-mL syringe was inserted into the first mark, and 4-mL of saline solution at 0.9% was administered to distend the joint space. The other needle was inserted in front of the first needle into the distended compartment. This needle was connected to a 60-cm-long No. 20 naso-probe attached to a suction pump (KaVo; Joinville, Santa Catarina, Brazil). This arrangement allowed visualization of the solution and its fluidity and guided the solution flow used in the joint lavage. Next, a 120-cm 15 C infusion extender (Compojet; Conceição do Jacuípe, Bahia, Brazil) was attached to the first needle, coupled to a 60-mL syringe to initiate lavage and joint lysis. A total of 300 mL of saline solution was used to perform the arthrocentesis of the TMJ. Upon completion of the procedure, the needles were removed, and a dressing was placed on the area. The patient was advised to remove the dressing at least 1 hour later. All patients received basic instructions on postoperative care.

Statistical analysis

The data of the quantitative variables were submitted to descriptive analysis with the use of means and standard deviations. For the qualitative variables, the distribution of frequencies, expressed in absolute numbers and percentages, was determined. By adopting the individual as the observational unit, univariate analysis was used to compare the groups and calculate the crude odds ratio (OR). Variables showing Wald P value ≤ .2 were subjected to multivariate analysis by using the multiple logistic regression model to identify the preoperative variables that may affect arthrocentesis outcomes, as well as the size of their impact (adjusted OR). The quality of fit of the multiple model was ascertained by using the Hosmer-Lemeshow test.[14] To evaluate the efficacy of the arthrocentesis, the variables, VAS score and MID, were also evaluated before and 3 to 4 months after arthrocentesis by using the paired t Student test. Data were analyzed in the SAS program, version 9.03 (SAS Institute Inc., Cary, NC).

RESULTS

A total of 203 patients (203 TMJ) met the study criteria. Of these, results of the MRI conducted 3 to 4 months after arthrocentesis demonstrated that JE was completely eliminated in 160 patients (78.81%), who were allocated in group 1 (Figures 1 and 2). The remaining 43 patients (21.19%) still showed some signs of JE and were allocated to group 2 (Figures 3 and 4).

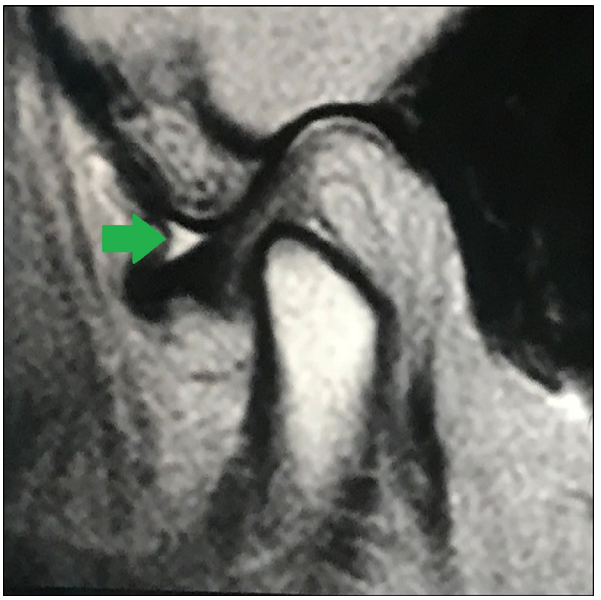

Fig. 1. Group 1 example—patient 1 before arthrocentesis with joint effusion *(green arrow)*.

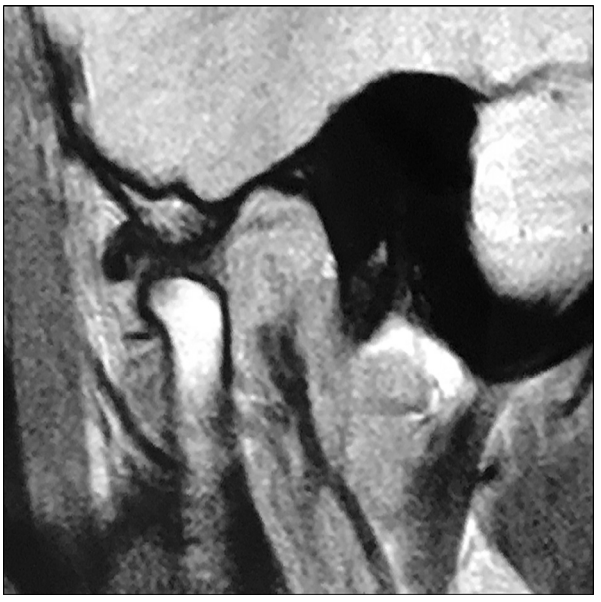

Fig. 2. Group 1 example—patient 1, after arthrocentesis, with complete elimination of joint effusion.

Compared with the results of the first MRI, JE in group 2 patients was considerably reduced after arthrocentesis. The distribution of frequencies, means, and standard deviations of the studied variables are shown in Table I.

The univariate analysis (Table II) demonstrated that joint side was the only variable that did not have an effect

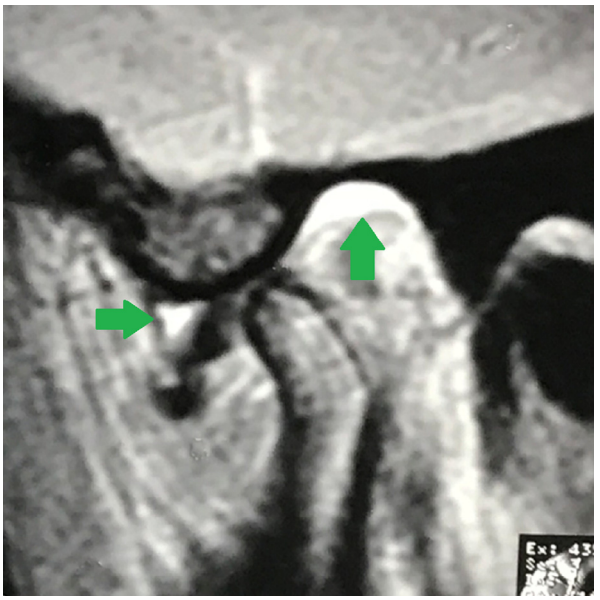

Fig. 3. Group 2 example—patient 2 before arthrocentesis with joint effusion *(green arrow)*.

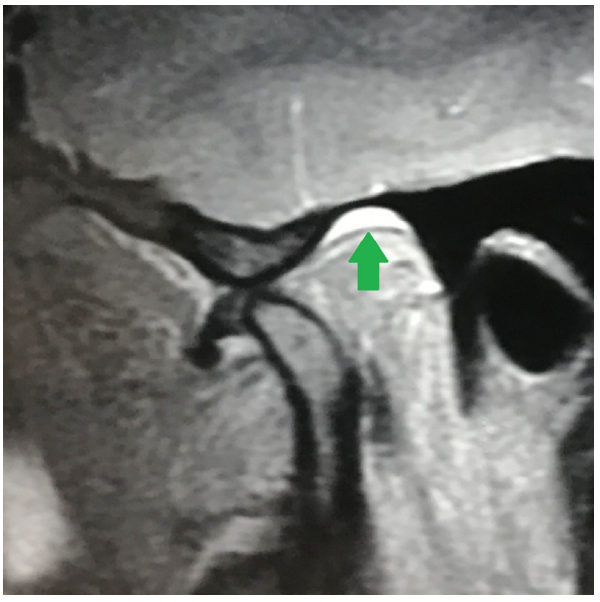

Fig. 4. Group 2 example—patient 2, after arthrocentesis, still presenting some signs of joint effusion *(green arrow)*.

on arthrocentesis outcome ($P = .9242$) and was excluded from further analysis. The variables age, sex, pain duration, pain intensity, and MID all presented a Wald P value < .2 and were considered to compose the statistical model in the multivariate analysis.

The multivariate analysis demonstrated that the variables age and sex were no longer statistically significant for the complete elimination of JE, whereas pain intensity ($P = < .0001$), pain duration ($P = .0175$), and MID ($P = .0085$) demonstrated a statistical effect on arthrocentesis outcomes (Table III). The adjusted OR demonstrated that the longer the pain duration (OR = 0.930), the greater was the reported pain intensity (OR = 0.346), and the more limited the MID (OR = 0.562), the less were the chances of complete elimination of JE by arthrocentesis. The quality of fit of the multivariate model, as verified by the Hosmer-Lemeshow test,[14] presented a P value of .8581, indicating that the variables and the model used were significantly well adjusted.

The paired t Student test showed statistically significant differences ($P < .0001$) in the VAS scores and in MID in both groups before and 3 to 4 months after the arthrocentesis (Table IV). However, there was not a statistically significant difference ($P > .05$) between groups with regard to these variables.

DISCUSSION

The present study attempted to identify the preoperative variables in patients with DDWOR and JE who underwent arthrocentesis to predict the complete elimination of JE. The findings demonstrated that the variables of pain intensity, pain duration, and MID had a significant effect on arthrocentesis outcomes, supporting the rejection of the null hypothesis.

The volume of solution used for TMJ lavage can vary widely, ranging from 50 to 500 mL.[15] In the present study, arthrocentesis was performed in all patients with a total volume of 300 mL of solution, according to the treatment protocol established at CENDDOR. The results demonstrated that the procedure was effective in completely eliminating JE in 78.81% of the TMJs and achieved an important reduction in the amount of JE in the remaining joints (21.19%). These results were not surprising because under sufficient pressure, arthrocentesis can remove adhesions and adherences, eliminate negative pressure within the joint, change synovial fluid viscosity, remove debris from degenerating joint tissues, and eliminate algogenic substances, especially inflammatory mediators, thus reducing the signs of JE.[7,16-18] However, despite the good results, the findings of the present study also suggest that depending on some of the studied variables, the procedure may not be sufficient to completely eliminate JE and that additional therapy may be required.

In the present study, the mean pain intensity score reported by patients was 7.31 ± 1.33, similar to a previous study conducted on patients with DDWOR (7.40 ± 8.39).[19] The multivariate analysis demonstrated that pain intensity had a significant effect on arthrocentesis outcome, with the adjusted OR indicating that for each increased reported score on the VAS, the chance of arthrocentesis completely eliminating JE in the studied patients decreased by ×0.346. JE has been associated with increased

Table I. Frequency distribution, means, and standard deviations of the studied variables

Variable		*Total (n = 203)*	*Group 1 (n = 160)*	*Group 2 (n = 43)*
Sex	Female	184 (90.64%)	148 (92.5%)	36 (83.73%)
	Male	19 (9.36%)	12 (7.5%)	07 (16.27%)
Joint side	Right	91 (44.82%)	72 (45%)	19 (44.18%)
	Left	112 (55.18%)	88 (55%)	24 (55.82%)
Age (years)		34.22 ± 8.60	33.66 ± 8.57	36.32 ± 8.52
Pain duration (months)		11.30 ± 6.34	10.04 ± 5.16	15.97 ± 8.03
VAS score (0-10)		7.31 ± 1.33	7.00 ± 1.14	8.44 ± 1.38
MID (mm)		30.97 ± 1.53	32.64 ± 1.36	30.20 ± 1.53

MID, maximum interincisal distance; VAS, visual analogue scale.

Table II. Univariate analysis—gross OR

Variables	*Wald* P *value*	*Gross OR*	*CI (95%)*
VAS	< .0001*	0.432	0.323-0.578
MID	< .0001*	0.486	0.373-0.633
Pain duration	< .0001*	0.873	0.827-0.922
Age	.0736*	0.964	0.926-1.004
Sex	.0867*	2.398	0.882-6.524
Joint Side	.9242	1.033	0.525-2.035

CI, confidence interval; OR, odds ratio; MID, maximum interincisal distance; VAS, visual analogue scale.
*Statistically significant.

Table III. Multivariate analysis—adjusted OR

Variables	*Wald* P *value*	*Adjusted OR*	*CI (95%)*
VAS	<.0001*	0.346	0.234-0.511
MID	.0085*	0.562	0.366-0.863
Pain duration	.0175*	0.930	0.837-1.033
Age	.6377	0.987	0.937-1.041
Sex	.6499	1.359	0.362-5.106

CI, confidence interval; OR, odds ratio; MID, maximum interincisal distance; VAS, visual analogue scale.
*Statistically significant.

intra-articular pain in the TMJs with DDWOR.[20] JE can activate or sensitize the nociceptive afferent neurons within the joint[21] and increase joint pressure, thus causing mechanical trauma and inducing other inflammatory mediators and pain in the joint.[22] The synovial fluid in TMJs with JE contains higher concentrations of proinflammatory cytokines interleukin-1b (IL-1b), IL-6, and IL-10 compared with TMJs without JE.[23] These higher concentrations of inflammatory mediators in the synovial fluid have been positively correlated with the presence of greater amounts of JE.[24] Therefore, it can be assumed that patients with more joint pain would, as a result, present more inflammatory mediators and more JE, making complete elimination of JE with the use of oral or parenteral anti-inflammatory medication practically impossible.

Patients with DDWOR frequently show more limited mouth opening. In the present study, mean MID was 30.97 ± 1.53 mm, again similar to the findings of previous studies (32.43 ± 6.12 mm).[19] This reduction in MID can be explained by the presence of adhesions and adherences between the mandibular fossa and the articular disk in the intra-articular space, making mouth movement more difficult. Moreover, changes in both the viscosity and the constituents of the synovial fluid affect the lubrication of the TMJ.[25] Although DDWOR cannot be considered a predictor of JE occurrence, abnormal mechanical stress, decreased joint mobility, deformation in the articular disk, and increased release of inflammatory mediators caused by this type of displacement may result in JE in some TMJs.[26] The multivariate analysis indicated that MID was an important factor to be taken into consideration to determine arthrocentesis outcome. The adjusted OR demonstrated that for every reduced millimeter in MID, the chance of arthrocentesis completely eliminating JE in the studied patients decreased by ×0.562.

Although duration is not the only determinant factor, when a painful event lasts for more than 6 months, it may

Table IV. Comparison of VAS scores and MID before and 3 to 4 months after arthrocentesis

Variable		*Before*	*After*	P
VAS score (0-10)	Group 1 (n = 160)	7.00 ± 1.14	0.01 ± 0.13	< .0001*
	Group 2 (n = 43)	8.44 ± 1.38	0.86 ± 0.63	< .0001*
	Total (n = 203)	7.31 ± 1.33	0.19 ± 0.46	< .0001*
MID (mm)	Group 1 (n = 160)	32.64 ± 1.36	44.73 ± 2.61	< .0001*
	Group 2 (n = 43)	30.20 ± 1.53	40.66 ± 2.54	< .0001*
	Total (n = 203)	30.97 ± 1.53	43.44 ± 3.98	< .0001*

MID, maximum interincisal distance, VAS, visual analogue scale.
*Statistically significant.

be considered chronic.[27] In the present sample, mean pain duration was 11.30 ± 6.34 months. The multivariate analysis of the studied groups demonstrated that pain duration had an important effect on arthrocentesis outcome. The adjusted OR demonstrated that for each additional month of pain duration, the chance of arthrocentesis completely eliminating JE in patients with DDWOR decreased by ×0.930. This result emphasizes the fact that the longer the pain duration, the more painful and the more refractory to therapeutic approaches the TMJ becomes.[12,27]

We found that the variables' joint side, sex, and age did not have an effect on arthrocentesis outcome. The present study design used a sample of patients with unilateral DDWOR because it has been shown to be the predominant condition in patients with TMDs.[2] No significant correlation between the joint side and the effect on arthrocentesis outcome was demonstrated by the univariate analysis. This result is not surprising because no intrinsic structural differences in the TMJ between the right or left sides were observed in our patients. The contralateral joints were asymptomatic and did not have DDWOR and/or JE and therefore were not treated and showed no alteration after the second MRI examination.

The literature suggests that MRI signs of JE are more easily identifiable in younger populations[28] and that the rate of arthrocentesis success tends to decrease with advancing age.[12,29] However, no significant differences between groups were found in the present study, suggesting that age did not have an effect on arthrocentesis outcome. This may be explained by the fact that patients of all ages were pooled together in the 2 studied groups. Thus, the present results are in contrast to those of some previous studies, in which age was categorized and samples were segmented into different age groups.[12,29] Further studies comparing samples of older and younger patients with DDWOR and JE undergoing arthrocentesis are required to better ascertain the effect of age on arthrocentesis outcome.

The male/female ratio (1:9.6) in the present study indicates a strong female predominance. This relationship is expected because JE has been shown to be more common in women than in men.[30] The higher occurrence of DDWOR in women can be explained by sex-specific features, such as greater joint laxity, increased intra-articular pressure, and periodical hormonal changes.[2,31] However, because of the design of this study, which grouped males and females together, no significant effect was found for the variable sex on arthrocentesis outcome. Studies comparing men and women with DDWOR and JE undergoing arthrocentesis and with a higher participation of men need to be conducted to elucidate the effect of sex on arthrocentesis outcome.

Apart from the limitations in the study design, as mentioned above, it is also important to emphasize that the findings presented here were derived from a single-center study. Despite the number of participants and the fact that the studied population was composed of ethnically diverse individuals, questions may be raised concerning the generalizability (external validity) of the findings of the present study. Therefore, multicentric studies that include a large number of participants and that focus on each of the studied variables are suggested to confirm the findings of the present study.

Arthrocentesis is an effective option to treat DDWOR.[7] Ours results showed a decrease in the VAS score and an increase of MID in all patients. In the present study, the mean VAS score of the whole sample was significant reduced (from 7.31 ± 1.33 to 0.19 ± 0.46) 3 to 4 months after arthrocentesis, as found in a previous study (from 6.45 ± 1.17 to 1.12 ± 0.42).[17] Reduction of pain is an expected outcome because the irrigation process, conducted with biocompatible substances, allows for removal of debris from the degenerating joint tissues and eliminates algogenic substances.[7,9,18] In the present study, the mean MID of the whole sample was found to be significantly increased (from 30.97 ± 1.53 mm to 43.44 ± 3.98 mm) 3 to 4 months after arthrocentesis, as in a previous study (from 23.7 ± 2.91 mm to 41.05 ± 2.91 mm).[17] The increase in MID can be explained by the fact that arthrocentesis performed under pressure may also remove adherences; eliminate the negative pressure in the joint; distend the joint space, recovering the space of the joint disk and fossa; change the viscosity of the synovial liquid, helping in the translation of the joint disk and condyle; and, consequently, increase mouth opening.[7,16-20]

Taking into account the limitations of the present study, the results, nonetheless, showed that arthrocentesis was effective in decreasing the VAS score and increasing MID in all patients. In addition, the findings suggest that among the studied preoperative variables of patients with DDWOR and JE, pain duration, pain intensity, and MID may be used as predictors for arthrocentesis outcome and could assist in treatment planning. Moreover, because pain intensity may increase and mouth opening may become more limited over time, the results suggest that pain duration is probably the most important preoperative predictive factor for arthrocentesis outcome. This seems to indicate that the sooner the DDWOR and JE diagnosis is reached and the sooner the arthrocentesis procedure is performed, the better the chances of complete elimination of JE are.

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