



# Conservative therapy versus arthrocentesis for the treatment of symptomatic disk displacement without reduction: a prospective randomized controlled study

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**Objective.** Disk displacement without reduction (DDwoR) results in pain and limited mouth opening, with negative impact on daily function. Noninvasive interventions are the standard primary treatment for DDwoR. This study compared the clinical outcomes from noninvasive (conservative) and minimally invasive (arthrocentesis) treatments in patients with DDwoR.

**Study Design.** Twenty-four patients with clinically diagnosed symptomatic closed lock were randomized to noninvasive (information, self-exercise, occlusal splints) intervention group and a minimally invasive (information, arthrocentesis with lavage, manipulation, postoperative self-exercise) intervention group. Maximal mouth opening (MMO) and pain (visual analogue scale [VAS]) were measured at baseline and at 3, 6, and 12 months after treatment.

**Results.** Both groups showed a successful outcome after 1 year. In the noninvasive group, the (mean  $\pm$  SD) MMO value was 46.3  $\pm$  7.2 mm, and the VAS score was 11  $\pm$  17.1 in; and in the minimally invasive group, the MMO value was 42.7  $\pm$  6.1 mm, and the VAS score was 10  $\pm$  6.3. There were no significant differences between the 2 groups. Interestingly, a subgroup of patients who recovered spontaneously before treatment start had significantly higher MMO values at baseline ( $P = .028$ ).

**Conclusions.** Outcomes with the 2 interventions (noninvasive and minimally invasive) are similar, and patients with a higher baseline MMO are more likely to experience spontaneous recovery. (Oral Surg Oral Med Oral Pathol Oral Radiol 2019;128:18–24)

Temporomandibular joint (TMJ) disk displacement without reduction (DDwoR), which is a subgroup of temporomandibular disorders (TMDs), is characterized by sudden reduction in mouth opening ability, accompanied by pain, usually referred to as “closed lock.”<sup>1</sup> Restriction of jaw movement, discomfort, and pain have negative impacts on daily function and quality of life.<sup>2</sup> The diagnostic criteria for closed lock, as defined by the international Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) are as follows: a history of locked jaw; limited jaw opening, which entails impaired ability to eat; and a maximum assisted opening of less than 40 mm (including vertical incisal overlap).<sup>3</sup> DDwoR has been proposed to be caused by disk displacement that is usually anterior or anterolateral and which does not reduce with opening of the mouth.<sup>3,4</sup> However, DDwoR has also been diagnosed in asymptomatic patients by using magnetic resonance imaging (MRI).<sup>5</sup> The incidence of symptomatic DDwoR among patients with TMDs is not fully clear, although it has an estimated prevalence of 2% to 8%,<sup>1,6</sup> with reports of higher prevalence among females.<sup>7</sup> Various treatment modalities for

symptomatic closed lock have been suggested, including noninvasive, minimal invasive, and invasive interventions.<sup>1</sup> In the literature, it is recommended that patients with symptomatic closed lock should be treated with the least invasive intervention.<sup>1,7</sup> The hypothesis underlying the present study is that noninvasive treatment (i.e., conservative therapy) for symptomatic closed lock is likely to have a less successful outcome compared with minimally invasive treatment (i.e., arthrocentesis and manipulation). The aim of this study was to compare the outcomes of noninvasive and minimally invasive therapies for treating patients with symptomatic closed lock of the TMJ.

## PARTICIPANTS AND METHODS

### Patients

This study was approved by the Regional Ethics Review Board in Gothenburg, Sweden (No. 306-11). The included patients received verbal and written information regarding the purpose of the study, and written informed consent was obtained. Sample size determination was performed, with a power of 80% and significance level of  $P = .05$  to detect a minimal

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## Statement of Clinical Significance

This present randomized controlled clinical trial demonstrated that symptomatic closed lock can be treated with a noninvasive or minimally invasive intervention with equally successful outcomes. However, males exhibiting higher maximal mouth opening are likely to experience spontaneous recovery.

clinically important difference of 9 mm of maximal mouth opening (MMO; primary outcome), as suggested by Kropmans et al.,<sup>8</sup> with a standard deviation (SD) of 6.8 mm. To compensate for possible dropouts, 2 additional patients were added to each group; 24 patients were included in total. Newly recruited consecutive patients referred for the diagnosis and treatment of TMD to the Department of Orofacial Pain, Sahlgrenska University Hospital, Mölndal, Sweden, were examined by one of the authors (B.J.C.) in accordance with DC/TMD Axis I.<sup>3</sup> If the inclusion criteria were fulfilled, the patients were asked to participate in the study and were randomized to the 2 intervention groups—noninvasive treatment and minimally invasive treatment—by using a sealed-envelope randomization method. The inclusion criteria were as follows:

1. A history of lock jaw—that is, the mouth would not open all the way and interfered with the ability to eat
2. MMO with passive stretch (including vertical incisal overlap) less than 40 mm
3. Mandibular deflection to the ipsilateral side (affected side) during mouth opening and restricted movement of the contralateral side
4. Lack of any systemic disorder that could affect the temporomandibular joint (TMJ).

The intervention groups were as follows:

1. Noninvasive intervention, involving information, self-exercise, and (if needed) occlusal splints, as treated by one of the authors (B.J.C.)
2. Minimally invasive intervention, which comprised information, arthrocentesis with lavage, manipulation, and postoperative self-exercise, as treated by one of the authors (G.W.). Thus, this group did not receive any noninvasive pretreatment.

### Treatment regimens

The baseline for the noninvasive group was set on the day of the examination, and patients in the minimally invasive group were further referred to the Department of Oral and Maxillofacial Surgery. Thus, the baseline for the minimally invasive treatment group was set on the same date as that on which the arthrocentesis was performed. The MMO with passive stretch (including vertical incisal overlap) and visual analogue scale (VAS) for pain were measured, and all the patients were re-examined 3, 6, and 12 months after the baseline date. Intraclass and interclass correlation coefficients (ICCs) for analysis of reliability (within the examiners and between the examiners, respectively) were calculated before starting the study. The MMO values were assessed twice in

19 randomly selected patients (who were neither included in this study nor diagnosed with any TMD), with a 4-week interval. An intra- or interclass correlation coefficients value greater than 0.90 was regarded as indicating excellent reliability.<sup>9</sup>

*Noninvasive treatment.* The noninvasive treatment included provision of information regarding the disorder, including its etiology, prognosis, and treatment options, as well as cognitive behavioral training. Self-exercise, that is, stretching of the jaw muscles, was started immediately and involved stretching mouth opening with the assistance of the thumb and the index finger for a period of 10 seconds. This exercise was repeated twice each day for 2 to 3 minutes in total. When pain relief was required, nonsteroidal anti-inflammatory drugs were prescribed at standard dosages. In cases where symptomatic bruxism was also diagnosed, the patients received an occlusal splint.

*Minimally invasive treatment.* Upon referral to the Department of Oral and Maxillofacial Surgery, this group of patients received information regarding the disorder, its etiology, prognosis, and treatment options, as well as cognitive behavioral training. Arthrocentesis with lavage and manipulation were performed on the affected joint in accordance with the protocol of Nitzan et al.<sup>10</sup>—that is, the double puncture technique—with the following modifications: the patients received premedication with the following: midazolam APL 1 mg/mL administered at 0.2 mL/kg (Apotek Produktion & Laboratorier AB, Kungens Kurva, Sweden); 1 g paracetamol (GlaxoSmithKline, Brøndby, Denmark); 600 mg ibuprofen (Takeda Pharma AB, Solna, Sweden); and 2 g amoxicillin (Sandoz Novartis Company, Holzkirchen, Germany). The treatment was administered under sterile conditions. The tragus–lateral canthus line was marked out. An entry position was marked 10 mm anteriorly and 2 mm inferiorly, and an exit position was marked 20 mm anteriorly and 10 mm inferiorly to the tragus–lateral canthus line. The auriculotemporal nerve, the disk cavity, and the skin were locally anesthetized with approximately 2 mL of a 20 mg/mL solution of xylocaine–adrenaline (Dentsply, Weybridge, UK). Lavage was performed by using two 20-gauge needles inserted at the previously described positions for entry (posterior) and exit (anterior)—that is, with the needle apices in the superior compartment of the articular fossa. In total, 40 to 60 mL of sodium chloride solution was used to lavage the superior joint space. This procedure was followed by assisted manipulations, to reduce disk displacement and increase MMO. This manipulation was carried out until a clicking sound was heard and the translation

movement was obtained. Paracetamol and ibuprofen were recommended for alleviation of pain for 2 to 3 days postoperatively. After 3 days of cautious jaw movements, the patients were introduced to a self-exercise regimen that involved stretching the mouth opening with the assistance of the thumb and the index finger, twice each day, as described previously.

### Statistical analysis

The data were analyzed with the Statistical Package for the Social Sciences software, version 23 (SPSS Inc., Chicago, IL). The ICCs for the analysis of reliability were applied with a 2-way random model and absolute agreement. For assumptions regarding the normality and homogeneity of the data (MMO and VAS), the Shapiro-Wilk test and Levene's test of homogeneity of variance were used. The Mann-Whitney U test was used to assess significant differences ( $P < .05$ ) between the different groups with regard to MMO and VAS, as well as patient age and duration of the TMD.

## RESULTS

Overall, 24 patients (5 men [21%] and 19 women [79%]; mean  $\pm$  SD age  $29.6 \pm 13.3$  years; and mean  $\pm$  SD duration of symptoms  $3.8 \pm 4.5$  months) fulfilled the inclusion criteria and were included in the study (Table I). No dropouts were registered. However, 21 more patients had refused to participate in the study because they wanted to be consulted on the choice of treatment modality, rather than being randomly assigned to a treatment group and hence were not included in the study. The majority of these patients (66.7%) chose the noninvasive treatment, and 33.3% chose the minimally invasive treatment.

The ICC analyses revealed excellent intraclass and interclass reliabilities. The intraclass analysis showed ICC values of 0.99 (95% confidence interval [CI] 0.97–0.99) and 0.98 (95% CI 0.95–0.99) for time point 1 and time point 2, respectively, and the interclass analysis revealed ICC values of 0.97 (95% CI 0.92–0.99) and 0.98 (95% CI 0.94–0.99) for 2 of the authors (G.W. and B.J.C., respectively). ICC values less than 0.5 were considered indicative of poor reliability, those between 0.5 and 0.75 of moderate

reliability, those between 0.75 and 0.9 of good reliability, and those greater than 0.90 of excellent reliability.<sup>9</sup>

In the noninvasive group, 41.7% received an occlusal splint during the study, and 16.7% had received a splint previously. Furthermore, 33.3% of the patients in the noninvasive group were prescribed nonsteroidal anti-inflammatory drugs for daily use over a period of 2 to 4 weeks.

In the minimally invasive group, all of the arthrocentesis, lavage, and manipulation were carried out uneventfully; that is, a clicking sound was heard, and the translation movement was obtained. However, 1 patient had to undergo 2 “stick attempts” in the posterior placement, and in 2 patients, the lavage resulted in some fluid extravasation into the surrounding tissue, which was observed as swelling around the punctured area.

The initial MMO values and reported VAS scores for each group are shown in Figures 1 and 2, respectively. No statistically significant differences between the 2 groups were found at baseline for any of the variables.

Interestingly, some of the patients (29.2% of the overall cohort) recovered spontaneously—that is, the disk displacement diminished between the time of inclusion and the onset of treatment. These patients were excluded from the follow-up measurements. However, when extrapolating the baseline data for this group from that of the total group, it was found that the group with spontaneous recovery had significantly higher MMO of  $33.3 \pm 4.8$  mm (mean  $\pm$  SD) ( $P = .028$ ) at baseline compared with those who did not show spontaneous reduction of disk displacement during the study interval (MMO of  $27.9 \pm 4.3$  mm) (Figure 3). Furthermore, 57% men experienced spontaneous recovery, and 85% of them were from the minimally invasive treatment group.

It was further noted that the mean interval from inclusion until intervention was  $3.3 \pm 2$  months in the minimally invasive group because of further referral to a second department.

No statistically significant differences in MMO or VAS were found between the noninvasive and minimally invasive treatment groups at 3, 6, and 12 months after treatment start (Figures 4 and 5). Nevertheless, the overall success rate was high for both groups, with

**Table I.** Demographic characteristics of the patients included in the study

	Males (%)	Females (%)	Age in years (mean $\pm$ SD)	Duration in months (mean $\pm$ SD)
<b>Noninvasive</b>	2 (16.7%)	10 (83.3%)	$32.5 \pm 17.5$	$3.9 \pm 5.4$
<b>Minimally invasive</b>	3 (25%)	9 (75%)	$26.7 \pm 7.9$	$5.3 \pm 4.7$
<b>Total</b>	5 (20.8%)	19 (79.2%)	$29.6 \pm 13.3$	$3.5 \pm 4.6$

Note: No statistically significant differences were found between the groups regarding age or duration. N = 12 in each group. SD, standard deviation.

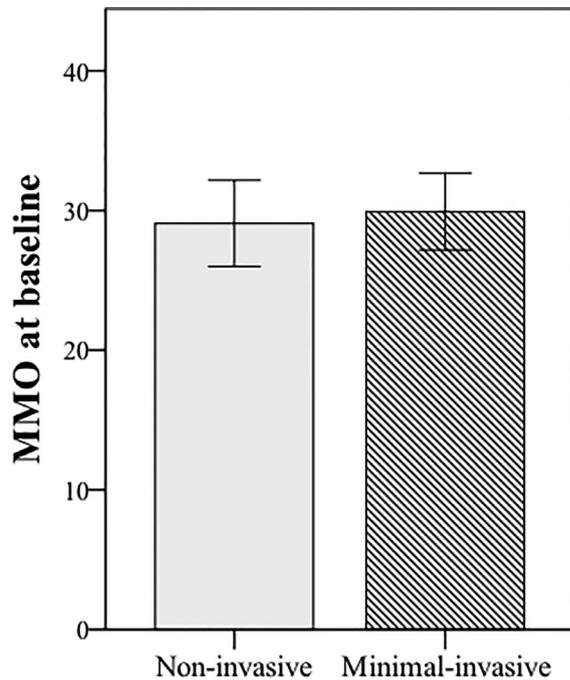


Fig. 1. Maximal mouth opening values at baseline for the patients in the noninvasive and minimally invasive treatment groups. There are no statistically significant differences between the groups. Values shown are means  $\pm$  SD; N = 12 in each group. SD, standard deviation.

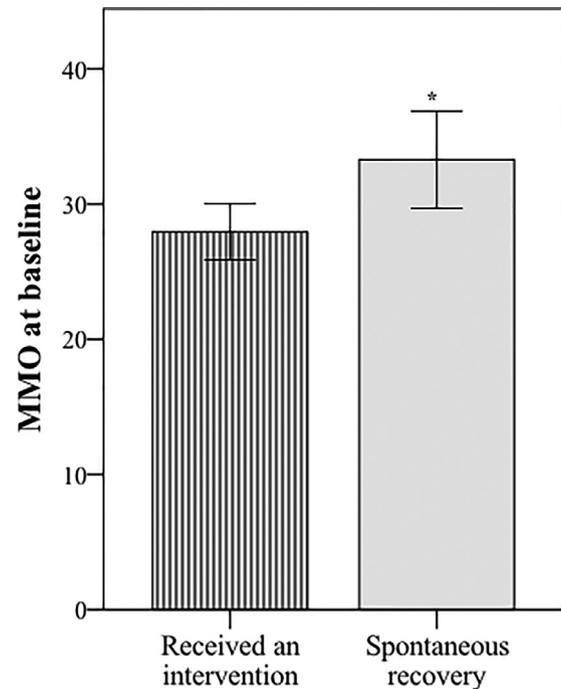


Fig. 3. Maximal mouth opening values at baseline for the patients who received an intervention (N = 17) and those who were not in need of any intervention because of spontaneous recovery (N = 7). The patients with spontaneous recovery have a statistically significant different MMO compared with the remainder of the patients included in the study ( $P = .028$ ). Values shown are means  $\pm$  SD. SD, standard deviation.

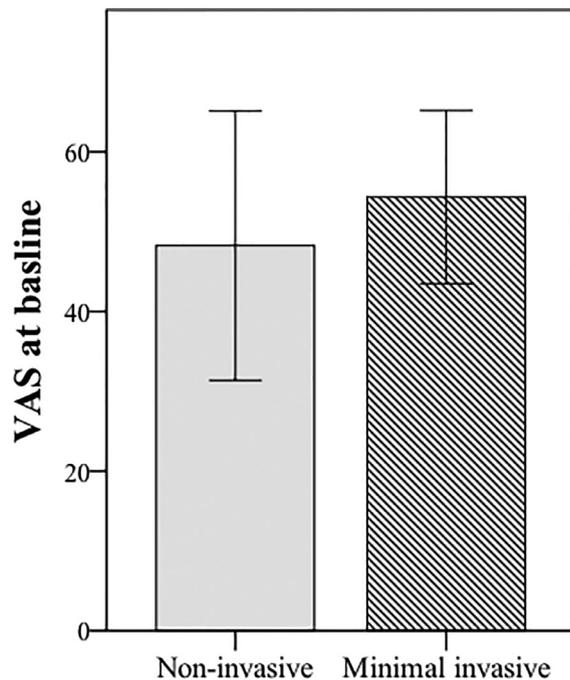


Fig. 2. Visual analogue scale scores at baseline for the patients in the noninvasive and minimally invasive treatment groups. There are no statistically significant differences between the groups. Values shown are means  $\pm$  SD; N = 12 in each group. SD, standard deviation.

continuous improvement up to 12 months after treatment. MMO after 1 year was  $46.3 \pm 7.2$  mm (mean  $\pm$  SD) for the noninvasive group and  $42.7 \pm 6.1$  mm for the minimally invasive group, corresponding to an increase in MMO of 63% for the noninvasive group and 57% for the minimally invasive treatment group. The VAS outcomes 1 year after treatment were  $11 \pm 17.1$  for the noninvasive group and  $10 \pm 6.3$  for the minimally invasive group, representing decreases in VAS scores of 77.8% for the noninvasive group and 82.7% for the minimally invasive treatment group.

When the number of poor responders (e.g.,  $MMO \leq 35$  mm) in each group was also taken to consideration, it revealed that 1 patient in each group did not reach MMO of 35 mm or greater; however, all of the study patients expressed satisfaction with their treatments after 1 year, except for 1 patient in the noninvasive group who requested additional treatment (MMO after 1 year, 34 mm; and VAS after 1 year, 60). This patient had an MRI-verified lateral DDwoR. After noninvasive treatment, this patient continued with arthrocentesis without success; however, ultimately, the patient was treated successfully with discectomy, resulting in an MMO of 43 mm and a VAS score of 0.

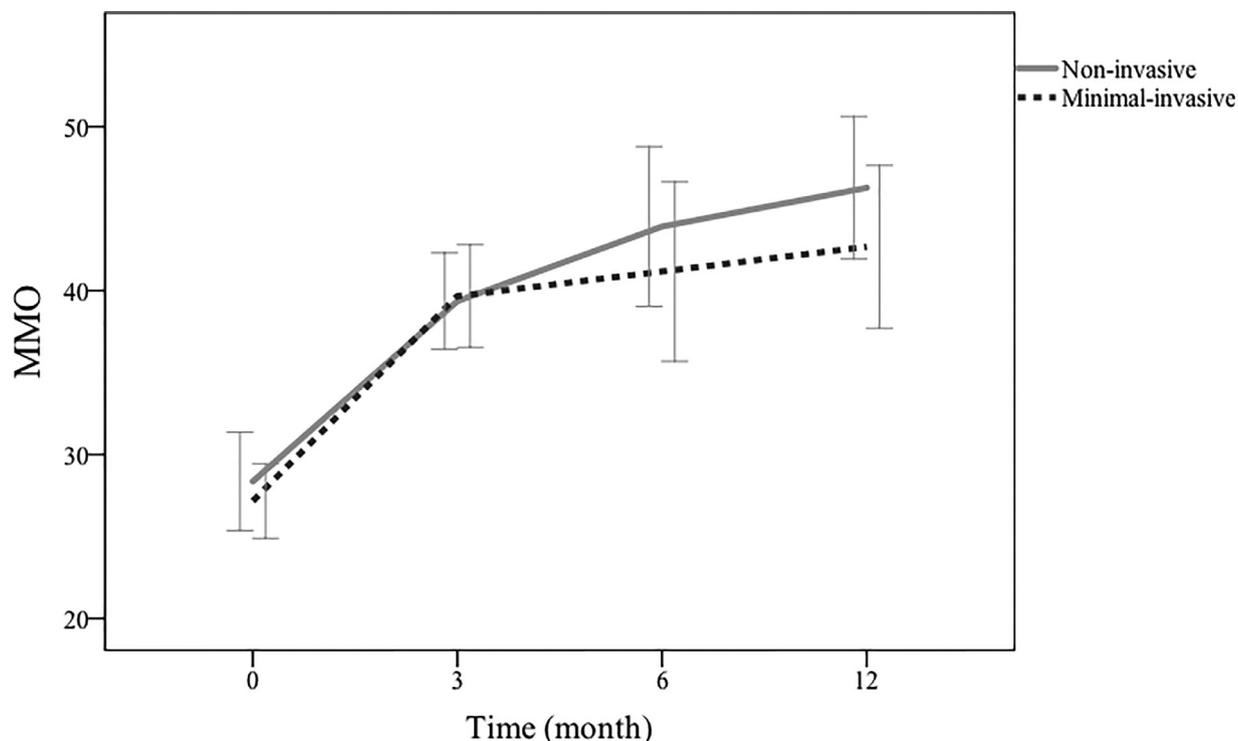


Fig. 4. Maximal mouth opening values at baseline, and at 3, 6, and 12 months after treatment. For the noninvasive group:  $28.4 \pm 5.0$  mm at baseline;  $39.4 \pm 4.9$  mm at 3 months;  $43.9 \pm 8.1$  mm at 6 months; and  $46.3 \pm 7.2$  mm at 12 months. For the minimally invasive group:  $27.2 \pm 2.8$  mm at baseline;  $39.7 \pm 3.8$  mm at 3 months;  $41.2 \pm 6.7$  mm at 6 months; and  $42.7 \pm 6.1$  mm at 12 months. Comparing the 2 intervention groups over time, no statistically significant differences were observed between the groups. However, both interventions resulted in a continuous increase in MMO over time. Values shown are means  $\pm$  SD; N = 11 and N = 6 for the noninvasive and minimally invasive treatment groups, respectively. SD, standard deviation.

## DISCUSSION

Our hypothesis that noninvasive treatment of symptomatic closed lock, in comparison with minimally invasive treatment, would result in a lower success rate, could not be confirmed in this study. Instead, we concluded that both treatment modalities are equally effective. In a previous review of the management of DDwoR, no statistically significant differences could be found between the different interventions used (non-invasive, minimally invasive, invasive).<sup>1</sup> However, despite the lack of statistically significant differences between the interventions in the present study, most of the treatment modalities resulted in statistically significant improvements from baseline for the patients. Sahlstrom et al. compared a lavage group with a control group that only received local anesthetics as treatment for DdwoR.<sup>11</sup> The lavage group did not show a statistically significantly better outcome compared with the control group for all the measured outcomes, 3 months after treatment. Diracoglu et al.<sup>12</sup> compared arthrocentesis with conservative therapy (i.e., a combination of splint, hot-pack application, and self-exercise) in patients with acute DDwoR (duration <4 weeks). In that randomized controlled trial, arthrocentesis demonstrated a statistically significant difference in terms of

VAS scores after 3 and 6 months, although there were no differences in MMO between the interventions.<sup>12</sup> Schiffman et al.<sup>13</sup> evaluated the long-term outcomes of 4 different treatment modalities for patients with DDwoR: (1) medical management; (2) rehabilitation (medical management, splint, physiotherapy, and cognitive behavioral therapy); (3) arthroscopy (lavage, lysis, and cortisone injection); and (4) arthroplasty (disk repositioning or discectomy).<sup>13</sup> No intervention was superior to any other with regard to all of the measured outcomes in the short term or the long term. The fact that improvements in patients' symptoms occurred regardless of the intervention modality may be a reflection of placebo effects or, most probably, the favorable naturally self-limiting course of DDwoR.

Approximately 30% of the included patients in the present study experienced spontaneous recovery between inclusion in the study and the planned initiation of the intervention. This finding is similar to those in previous studies,<sup>14,15</sup> indicating that symptomatic closed lock is self-limiting, rather than progressive. Kurita et al.<sup>14</sup> evaluated the natural course of the disorder in 40 patients who had a diagnosis of DDwoR and did not receive any interventions. After 2.5 years, 43% of the patients were asymptomatic, 33% had decreased

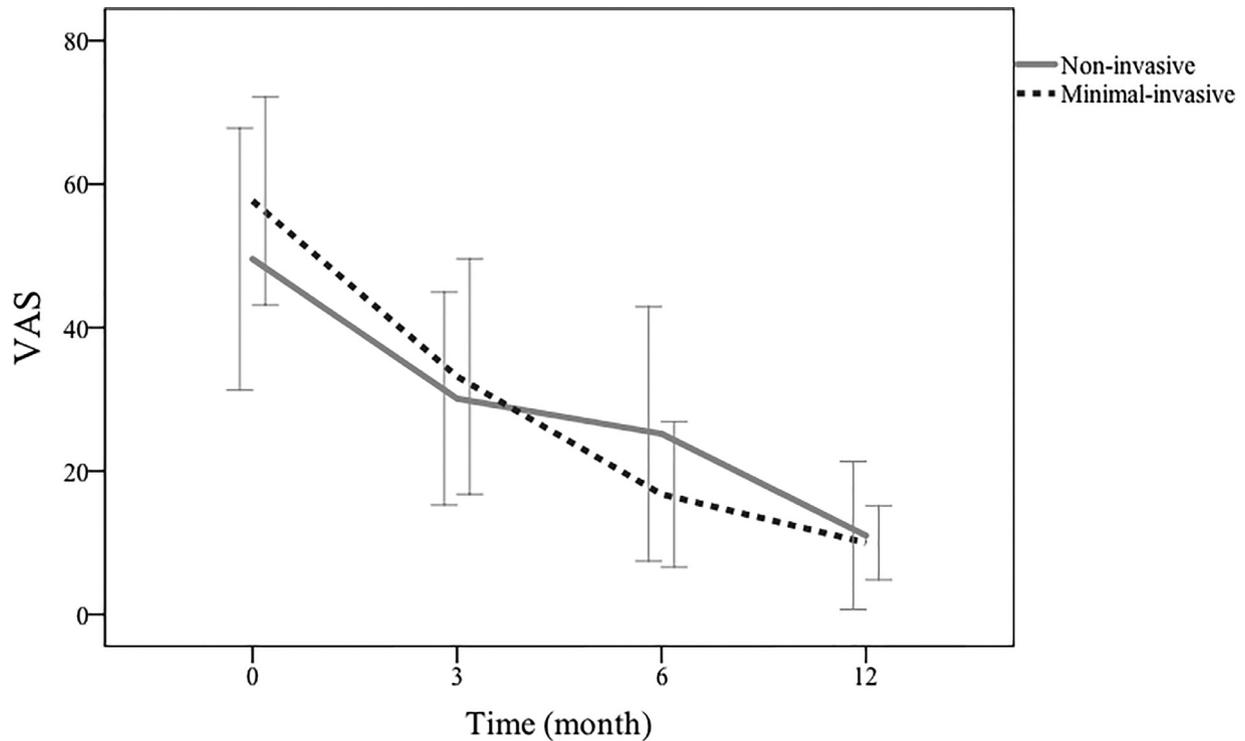


Fig. 5. Visual analogue scale scores at baseline, and at 3, 6, and 12 months after treatment. For the noninvasive group:  $49.5 \pm 30$  at baseline;  $30.1 \pm 25$  at 3 months;  $25.2 \pm 28.1$  at 6 months; and  $11 \pm 6.3$  at 12 months. For the minimally invasive group:  $57.7 \pm 17.8$  at baseline;  $33.2 \pm 20.1$  at 3 months;  $16.8 \pm 12.4$  at 6 months; and  $10 \pm 6.3$  at 12 months. Comparing the 2 intervention groups over time, no statistically significant differences were observed between the groups. However, both interventions result in a continuous decrease in VAS scores over time. Values shown are means  $\pm$  SD; N = 11 and N = 6, for the noninvasive and minimally invasive treatment groups, respectively. SD, standard deviation.

symptoms, and 25% showed no improvement or required treatment.<sup>14</sup> It has also been demonstrated that patients with DDwoR left untreated improve spontaneously in terms of chewing movements and masticatory efficiency.<sup>15</sup> In the present study, patients who experienced spontaneous recovery had significantly higher MMO values at baseline, 57% were male, and they were overrepresented in the minimally invasive treatment group. A possible explanation for the last observation is the fact that these patients had to wait longer (mean 3.3 months) between the time of inclusion in the study and initiation of treatment because of referral to a second department, even though any statistically significant differences between the groups with regard to duration of the interval could not be proven (see Table I). These results indicate that male patients with a higher MMO values (>33 mm) at baseline are likely to experience spontaneous recovery. However, there is evidence of increased susceptibility to degenerative changes in the TMJ in patients with DDwoR. Roh et al. investigated the relationship between disk displacement and degenerative changes in the TMJ in 254 patients by using MRI.<sup>16</sup> Those authors found that the risk of degenerative changes in joints with DDwoR was 4-fold higher than in joints with normal disk

positioning. Kurita et al. also concluded that osteoarthritis and advanced internal derangement, confirmed with MRI at the initial evaluation, were associated with a reduced likelihood of spontaneous improvement.<sup>14</sup> These findings appear to support the need for interventions, although the natural course of DDwoR seems to be self-limiting and the evidence for the effect of locking duration on treatment outcome is conflicting and inconsistent.<sup>6</sup> Furthermore, early management may prevent an acute condition becoming a chronic condition, thereby avoiding the risk of chronic pain and its psychosocial consequences.

The improved MMO noted in the noninvasive treatment group in our study probably resulted from the stretching of the ligaments in the TMJ, in particular, the posterior disk attachment and the retrodiscal tissue. In contrast, the increased MMO in the minimally invasive treatment group probably reflects repositioning of the disk during manipulation, with potentially immediate improvement in MMO. An argument for treating patients with closed lock with a minimally invasive treatment instead of a noninvasive treatment is that a more rapid improvement can be induced. However, this hypothesis could not be tested in the present study because the posttreatment measurements were carried

out first after 3 months. Earlier posttreatment controls (e.g., 1 week after treatment) might have yielded a different short-term result, benefitting the minimally invasive group. Furthermore, a few cases still require invasive treatment, regardless of noninvasive treatment, such as the patient in this study who required discectomy. Availability of diagnostic tools for early identification would have been useful in this group.

A limitation of the present study is the lack of MRI confirmation of DDwoR, although the target sensitivity and specificity were 0.80 and 0.97, respectively. Cutoff points for target validity above sensitivity 0.70 or greater and specificity  $\geq 0.95$  or greater may be considered acceptable.<sup>17</sup> The clinical diagnosis of closed lock does not exclusively refer to DDwoR because anchored disk phenomenon (ADP) results in the same hypomobility symptoms.<sup>6</sup> In the present study, the term “closed lock” has been used to describe the clinical symptoms of the 2 conditions (DDwoR and ADP). However, both DDwoR and ADP have been proven to respond to arthrocentesis.<sup>6</sup>

## CONCLUSIONS

In summary, the present randomized controlled clinical trial demonstrates that symptomatic closed lock can be treated with a noninvasive or minimally invasive intervention with equally successful outcomes. However, male patients with higher MMO values are more likely to experience spontaneous recovery.

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