Treatment of Joint Pain and Joint Noises Associated with a Recent TMJ Internal Derangement: A Comparison of an Anterior Repositioning Splint, a Full-Arch Maxillary Stabilization Splint, and an Untreated Control Group

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ABSTRACT: Pain and joint noises associated with temporomandibular joint (TMJ) internal derangement are often treated by using an intra-oral splint. This study evaluated whether an anterior repositioning splint (AR splint) could be more effective in the treatment of these symptoms than a full-arch maxillary stabilization splint (FAMS splint), because of its capability to re-establish immediately the normal condyle/disk relationship. The authors treated 40 patients (average age 16.8; range 8.0-24.0) with confirmed internal derangement, joint pain, and joint noises in at least one TMJ for at least two months, with AR splint (20 subjects) or FAMS splint (20 subjects); 10 untreated patients comprised the control group. Joint noise, joint pain, and the intensity of pain were assessed using a visual analogic scale (VAS), and the pain was characterized (i.e., constant or chewing/biting pain) and evaluated monthly for eight months. Significantly fewer AR splint patients experienced pain after four months of treatment. A significantly lower intensity of pain was experienced by the AR splint patients after two months of treatment. Significantly fewer AR splint patients experienced chewing/biting pain after eight months of treatment. The frequency of joint noises decreased over time, with no significant differences between the groups. In conclusion, the AR splint seems to be more effective in decreasing pain, but it seems to make no difference in the treatment of joint noises.

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It is well documented that factors affecting degeneration in human temporomandibular joints (TMJ) can be divided into intra-articular variables (mostly articular disk position and specific joint components) and general factors (gender, age, and tooth loss).[1] Wide consensus seems to exist regarding the role of increasing age[2] and abnormal disk position (internal derangement),[3-5] both of which have been reported to significantly affect TMJ degeneration. Several studies have indicated that the elapsed time since a disk displacement has occurred is an important factor in determining the pathologic state of the TMJ at treatment, since the earlier the disk displacement has occurred, the more severe is the disk deformation.[6] Disk displacement without reduction is considered a more advanced condition than disk displacement with reduction, and it may in some cases be a precursor of osteoarthrosis.[7-8] Articular disk displacement without any

treatment can accelerate osseus degenerative joint changes and become a chronic dysfunction.[5] Patients with this pathology seem to experience more pain, more signs of mandibular dysfunction, more hard tissue changes, and more frequent perforation and deformation of the disk when compared to patients with disk displacement with reduction who do not progress to disk displacement without reduction.[7,9] In 58 randomly selected autopsy specimens of the TMJ, Westesson, et al.[6] showed that in joints with a partial anterior disk position (disk displacement with reduction), disk deformation occurred in 31% and was consistently located in the part of the disk that was anteriorly displaced. Joints with completely anteriorly positioned disks (disk displacement without reduction) showed disk deformation in 77% and irregularities of the articular surfaces in 65%.

Based on these findings, internal derangement is considered an ascending degenerative condition of the TMJ that is conducive, when the biochemical integrity of the extracellular matrix is compromised, to progressive disintegration of the articular surfaces, fibrillation, and splitting.[10,11] The disintegration starts at the surface of a joint component and subsequently increases in severity by progressively involving deeper layers of the articular cartilage and then spreading tangentially along the articular surface. Kurita, et al.[12] examined histological disks obtained at autopsy from ten symptom-free subjects and compared the findings with observations involving 17 surgically removed disks. The normal disks were biconcave, whereas the surgically removed disks were deformed and thicker than the normal disks. Chondrocytes, a surface layer of proliferative connective tissue, a higher maximal density of fibroblasts and vessels, and splitting were seen in the surgically removed disks but not in the normal specimens.

The factor of *time since the pathology occurred* seems to be of great importance in determining the prognosis and the state of the disease. However, although many studies have been done in order to show the more effective therapy for disk displacement,[13-15] these studies have never included as selection criteria, the elapsed time since the symptoms started. Presumably, the time of pathology could also affect the severity of symptoms and the capability and the speed of healing. The aim of this study was to compare different occlusal splints for the treatment of TMD symtoms which had been occurring for at least six months. The criteria of *time since symptoms occurred* was critical in the selection of subjects. Since the most important symptoms associated with TMJ damage are abnormal joint sounds and pain, the authors wanted to study the frequency and the intensity of these symptoms in subjects treated with an anterior repositioning splint (AR splint) or a full-arch maxillary stabilization splint (FAMS splint) and to compare the results with those of an untreated group of subjects. In a literature review of long-term treatment findings for anterior disk displacement with reduction, the AR splint proved superior to the flat occlusal splint, when compared with a control group, in reducing or eliminating joint noise (clicking), joint pain, and associated muscular symptoms.[15]

Material and Methods

The sample was selected from a group of patients who were referred for evaluation of complaints of TMJ pain and dysfunction in a private study in Pescara, Italy. Complaints included the following symptoms: joint tenderness and pain on palpation, joint pain during masticatory movements, and abnormal noises (i.e., popping and clicking). Subjects were included in the study sample according to the following criteria: 1. joint pain and joint noise in at least one TMJ for at least six months; 2. memory of the precise event that caused the onset of symptoms; and 3. internal disk derangement confirmed on magnetic resonance images (MRI). Using this criteria, 50 subjects were selected, 28 males and 22 females (average age 28.8 age, range from 14-63). Internal disk derangement was assessed on MRI: two sequences using dual coil capability; the sequences were performed using proton density image technique. The MRI were read by an oral radiologist who was blinded to the study, and who was told that all subjects were suspected of having internal derangement which he was to confirm. All the subjects were considered to have been asymptomatic until the initial event occurred; 22 patients had been evaluated for orthodontic treatment and were not diagnosed with TMJ dysfunction; 17 wore orthodontic appliances; 28 subjects had never been evaluated by an orthodontist and had only been seen by a general dentist; none of the patients were diagnosed with TMD. All patients were evaluated using MRI and were referred for treatment for internal disk displacement.

Therapy

Occlusal splints are often used in the management of craniomandibular disorders. In this study, the therapy included the use of an occlusal splint. The intent of this study was to evaluate the influence of the type of occlusal splint used in these cases. Since there is no literature relating to a standard therapeutic method for the management of recent internal derangement, the author used a FAMS splint or an AR splint. Ten subjects out of the 50 decided against therapy for differing reasons, but they did agree to undergo a control visit by the clinician monthly

and were used as the control group. The patients' and control subjects' joint noises, joint pain, and pain intensity were assessed using a Visual Analogic Scale (VAS). All subjects were monitored and evaluated monthly for eight months. The data were collected and included in the statistical analysis.

Full-Arch Maxillary Stabilization (FAMS) Splint

Splints provide a useful tool for the elimination of occlusal interferences to reduce neuromuscular activity and to obtain stable occlusal relationships with uniform tooth contact throughout the dental arch (**Figure 1**).[16] For each subject, a full-arch maxillary stabilization occlusal splint was made of transparent thermopolymerizing acrylic resin (with flat occlusal surfaces and uniform, simultaneous, and multiple occlusal contacts at centric relation-centric occlusion). The increases in the vertical dimension of occlusion produced by the splints ranged from 4-5.5 mm measured in the central incisor region. The subjects were asked to wear the splint 24 hours a day for a period of a few months. When the appliance was fitted for the first time, it was balanced for parafunctional excursions. The appliance was first balanced in centric occlusion, then after centric stops were definitively incorporated into the occlusal plane of the acrylic appliance, lateral excursions were recorded. The patient was guided into right lateral and then left lateral excursions.

The patient was then asked to move into a protrusive relationship with optimal contact and finally, the mandible was retruded to the terminal hinge position to remove centric relation prematurities. The appliance was adjusted on a continuing basis over the course of the therapy.

Anterior Repositioning (AR) Splint

An anterior repositioning splint (**Figure 2**) is commonly used in the management of anterior disk displacement with reduction to re-establish the normal condyle-disk relationship. The major goal in protrusive splint treatment is the elimination of joint sounds by recapturing the disk. A smooth, coordinated, painless range of motion often can be obtained if the disk is recaptured. In this way, mandibular deviation, joint noises, and pain can be eliminated.[17,18] For each patient, a full coverage AR splint was constructed for the maxillary arch using clear self-curing acrylic resin as described by Okeson.[19] The base of the occlusal splint was prepared on a model, the anterior stop was constructed, and the splint was fitted to the maxillary teeth. A ramp of acrylic was placed in the anterior palatal area so that during normal closure, the mandibular anterior teeth contacted in the protrusive guiding ramp. The anterior ramp of the splint did not disclude the posterior teeth but allowed full contact. Occlusal

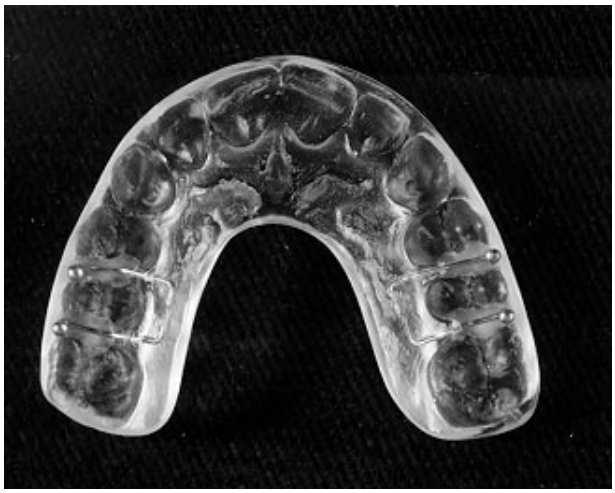

Figure 1
Full-arch maxillary stabilization spint.

contacts were constructed positioning the mandible forward to a position that was effective in decreasing pain and to where the joint noise disappeared. The later in opening the click occurred, the greater was the trend for mandibular protrusion to obtain acceptable condyle-disk position. With the splint inserted in the mouth, the patient was able to see the facial change and feel the difference on palpation through the external auditory meati, as well as a diminution in tenderness in some of the masticatory and neck muscles. The click at closing also disappeared after the splint was inserted, which convinced the patients of its efficacy. The subjects were instructed to wear the splint 24 hours per day. The subjects were treated with the AR splints for eight weeks.[20] After this period, the splint was modified to allow the mandible to return gradually to its original more posterior position.

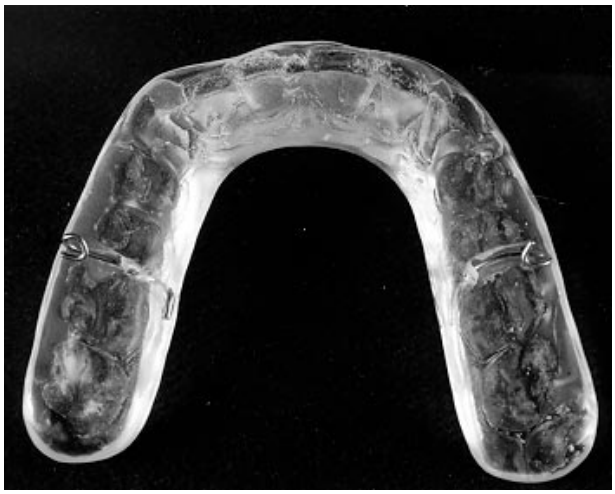

Figure 2
Anterior repositioning splint.

Variables

All the subjects in the three groups (FAMS splint group, AR splint group, and the control group) were monitored each month from the start of treatment for a period of eight months. The presence of joint noise (clicking) was investigated by the same clinician using a stethoscope. Each subject was listed as having or not having any joint noise at each month's evaluation. Based on the clinical evaluation by the clinician and on the referred history of each subject, the subjects were included each month in one of three categories: a *constant* joint noise group, a *sometime* joint noise group, or a *never* joint noise group. Subjects in the first category were still experiencing joint noises during the eighth month; subjects in the second category often showed joint noises during the eighth month, but not always; and finally, subjects in the third category had no joint noises by the eighth month. Relative to pain, the subjects were asked at each month's evaluation whether they had pain or not in the joint area during clinical examination. Subjects with a constant pain and those with pain during function, mostly chewing (*chewing/biting* group), were included together as subjects with pain. Then each patient characterized his/her pain using one of two descriptors based on the McGill Pain Questionnaire, i.e., *constant pain* or *pain when chewing/biting*.[21] The extent of the pain was assessed daily by each subject using a 100 mm Visual Analogic Scale (VAS) with a rating from *no pain* to *worst pain possible*. Each subject was asked to daily note the intensity of pain (VAS score) in a personal day-book. The mean of the daily values indicated by patients, during the current month, were used as VAS scores of the current month being considered.

Statisficial Analyses

This study focused on the follow-up of the distribution and the intensity of pain and joint noises and on the influence of the type of splint (FAMS splint, AR splint, and control groups) on these variables. Therefore, in the analyses, the variables were used separately and/or aggregated to show the influence derived from the use of an orthopedic device and a particular type of the device. Simple descriptive statistics were used and between group differences in frequencies were analyzed with Pearson's chi-square and, where the number of patients was too small, with the Fisher exact test. Due to the skewed data, nonparametric statistics (Kruskal-Wallis and Dunnett) were computed to test significant differences between groups according to the VAS score assessment. In order to investigate the repeated pain assessments, a Friedman's two-way analysis of variance between measurements was calculated, and the differences were estimated with a Wilcoxon's signed rank test. All statistical analyses were performed with the SPSS software program (Microsoft Corp. Ver. 9.0), and the level of significance was set at $p<0.05$.

Results

All participating subjects completed the study. Subjects presented joint pain and joint noise in at least one TMJ for two months at mean (range from one month to six months). The most frequent answers relating to the onset of the pain were: a macro-trauma (motor vehicle accidents, a blow to the head or face due to a fall or a fight); a long dental visit; a gape; an industrial accident; or no particular event. No statistical analysis was performed on the answers. Occlusal features included different types of malocclusion: 42% showed class II molar on one side or bilaterally; 26% showed class III molar on one side or bilaterally; 16% showed the absence of one or more teeth in the posterior zone; and 8% showed agenesia of one or more pemanent teeth.

Follow-up and Pain Treatment

At the beginning of treatment all the subjects reported pain. **Figure 3** shows the number of subjects reporting pain from T0 (the initial visit) to month eight. A large majority of subjects reported pain during the first month (95% in the FAMS splint group; 90% in the AR splint group; 100% in control group). At month two, the number of subjects treated with an AR splint and reporting pain dropped to nine (45%), while 95% of subjects treated with the FAMS splint, and 100% of control subjects continued to report pain. At month eight from the start of treatment, 16 subjects (80%) in the FAMS splint group still were experiencing pain, and nine subjects (90%) in the control group reported pain. Significantly more subjects treated with FAMS splint or in the control group experienced pain during months 4, 5, 6, 7, and 8.

Pain Intensity

The intensity of pain showed a similar pattern (**Figure 4A**-**B**). There was a significant drop in mean scores after two months from the start of treatment in subjects treated with the AR splint compared with the FAMS splint and the control subjects ($p<0.001$) (**Figure 4A**). The differences in scores between the AR splint subjects and the other groups at months 3, 4, 5, 6, 7, and 8 were statistically significant ($p<0.001$ and $p<0.01$) (**Figure 4A**). Also at month eight, the subjects treated with FAMS splints showed significantly lower pain intensity when compared with control subjects ($p<0.05$) (**Figure 4A**). The Friedman two-way analysis of variance showed a highly

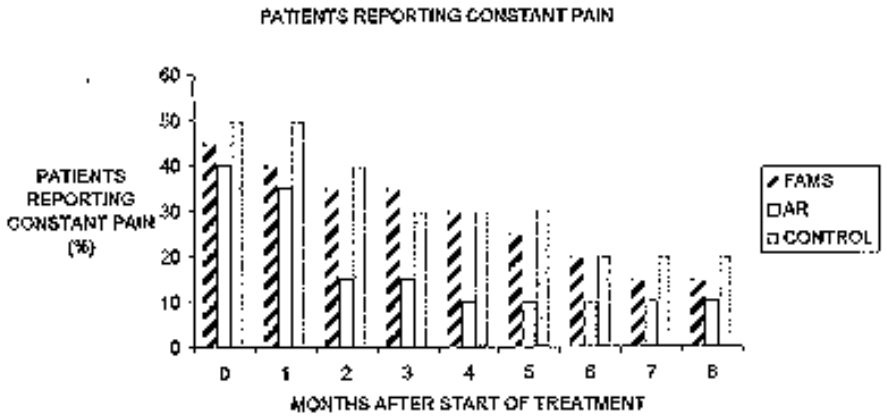

Figure 3
Graph showing joint pain reported by patients (as a percentage of the whole sample) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment.

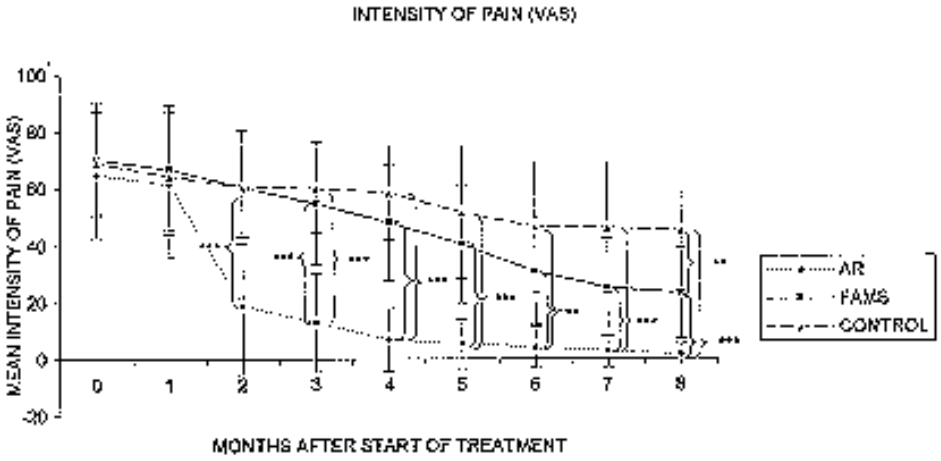

Figure 4A
Graph showing pain intensity reported by patients (as VAS score: mean value and SD) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment. Significant differences between groups are indicated in brackets {} and * ($p<0.05$), **($p<0.01$), *** ($p<0.001$).

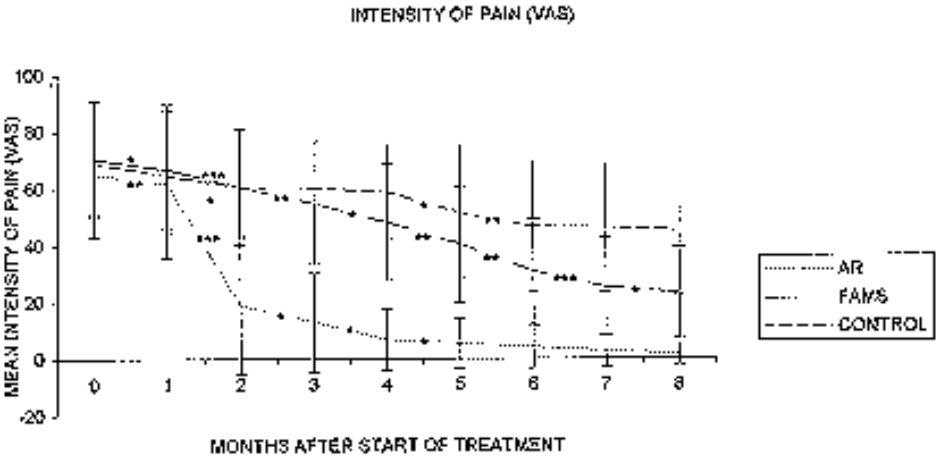

Figure 4B
Graph showing pain intensity reported by patients (as VAS score: mean value and SD) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment. Significant intra-group differences observed over time are indicated in brackets {} and * ($p<0.05$), **($p<0.01$), *** ($p<0.001$).

significant effect over time, and separate Wilcoxon tests between the assessments of months 1, 2, 3, 4, 5, 6, 7, and 8 revealed significant effects for the total group throughout the assessment period. Analyzing the groups separately, the results were not significant based on the VAS scores between months 5 and 6, between months 6 and 7, between months 7 and 8 for the AR group (**Figure 4B**); and were not significant between months 2 and 3, months 3 and 4, months 6 and 7 or months 7 and 8 for the control subjects (**Figure 4B**). Thus, the analyses indicated that the changes in pain assessments were clearly perceivable among the study groups but not in the control group.

Characterizing Pain.

All the subjects described the character of pain as a constant pain or as pain during chewing/biting. Less than 40% of subjects experienced a constant pain during the first three months, with the exception of month one when 50% of the control subjects reported constant pain (**Figure 5**). This frequency decreased during months 3, 4, and 5 when less than 30% reported constant pain, except at month three when 35% of subjects treated with the FAMS splint reported constant pain (**Figure 5**). The frequency decreased again during months 6, 7, and 8, when less than 20% of subjects experienced constant pain (**Figure 5**). A majority of subjects in the control group and the FAMS splint group reported chewing/biting pain after only one month of treatment (**Figure 6**). The frequency of chewing/biting pain decreased after the second month of treatment to less than 30% at the third month and less than 20% at months 4, 5, and 6 (**Figure 6**). During months 7 and 8, it was less than 10%. After eight months from the start of treatment, significantly fewer patients treated with AR splints experienced chewing/biting pain compared with patients treated with FAMS splints ($p<0.05$).

Joint Noises

The frequency of joint noises decreased over time. More than 50% of the subjects in the three groups experienced a constant joint noise at month three (**Figure 7**). At month five, a constant joint noise was observed only in about 30% of subjects treated using the AR splint, while more than 50% of patients in the control group and the FAMS splint group continued to suffer a constant joint noise. There was another evident decrease in the frequency of constant joint noise in the AR splint group during months 6, 7, and 8. In fact, at month eight, only 10% of the subjects in the AR splint group showed a constant joint noise, while 50% of the control subjects continued to have that symptom (**Figure 7**). The frequency of subjects reporting joint noise *sometimes* showed an increasing value over time, but remained less than 50% in each group at month eight, except for month seven, when 50% of subjects in the AR splint group experienced joint noise (**Figure 8**). The frequency increased over time in the three groups, predominantly in the AR splint group (about 15% at month one and 40% at month eight), while the frequency in the FAMS splint group and the control group remained between 10% and 30% (**Figure 8**). The frequency of subjects included in the category *never joint noise* increased over time in the three groups, mostly in the AR splint group (from 5% at month one to 50% at month eight) and the FAMS splint group (from 5% to 40%) (**Figure 9**). Instead, more than 70% of control subjects showed joint noises (90% at month one; 70% at month eight) (**Figure 9**). No significant differences were observed in the distribution of frequencies of joint noises among the three groups.

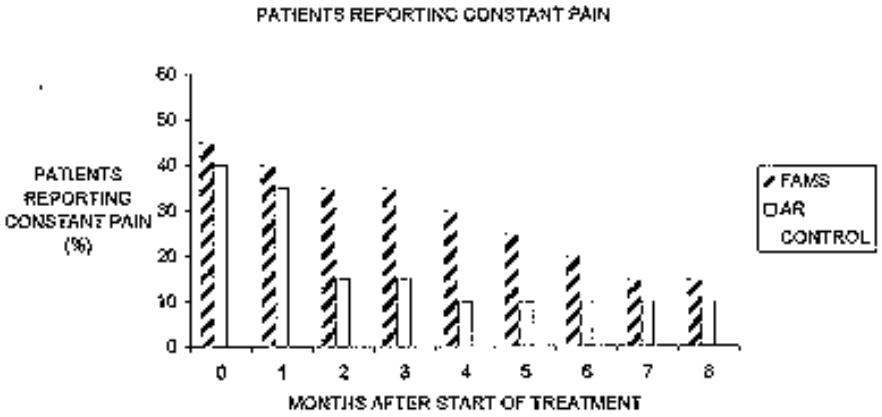

Figure 5
Graph showing constant pain reported by patients (as a percentage of the whole sample) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment. There were no significant differences.

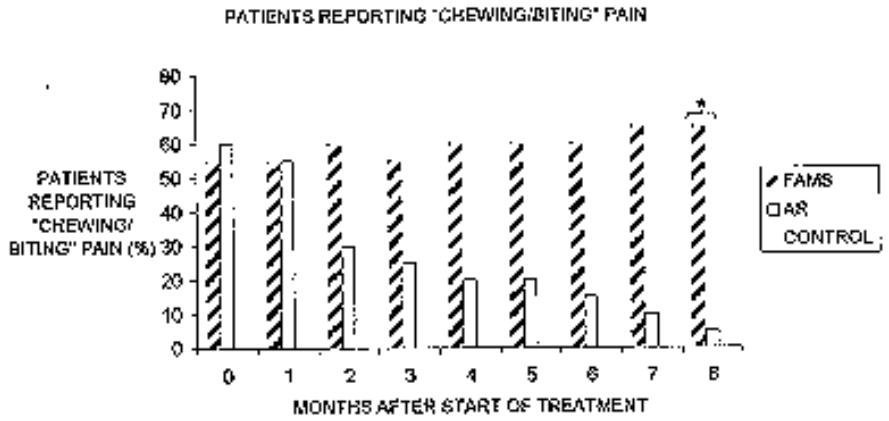

Figure 6
Graph showing *chewing/biting* pain reported by patients (as a percentage of the whole sample) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment. Significant differences between groups are indicated with brackets {}.

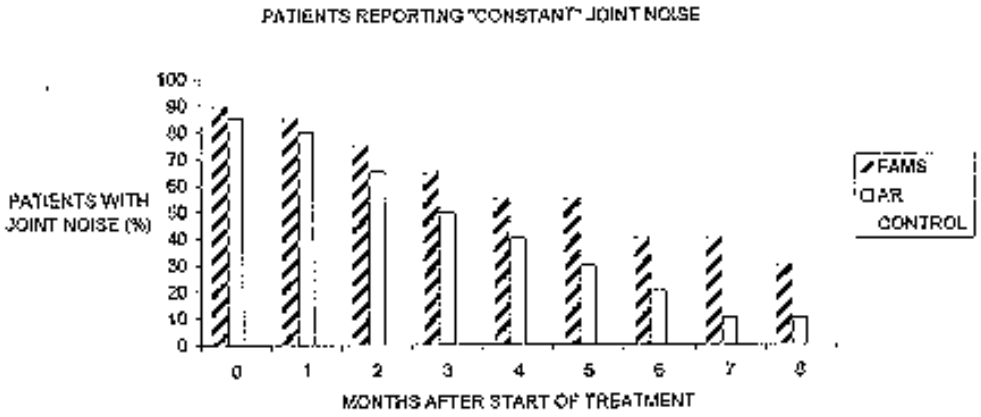

Figure 7
Graph showing *constant* joint noise reported by patients (as a percentage of the whole sample) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment. No significant differences were noted.

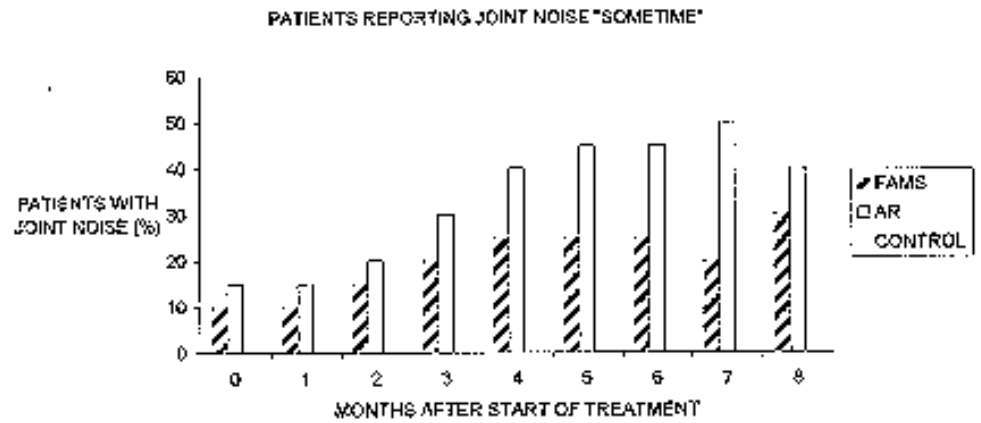

Figure 8
Graph showing *sometime* joint noise reported by patients (as a percentage of the whole sample) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline re-cording (0) to month eight (8) of treatment. No significant differences were noted.

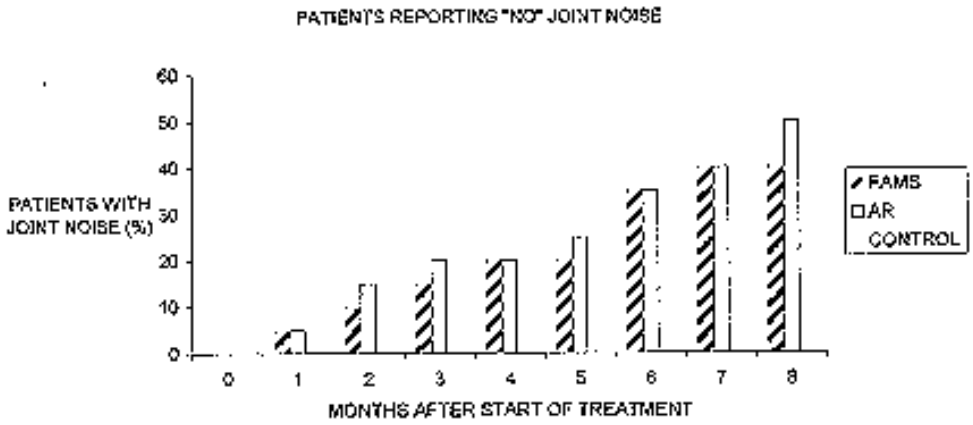

Figure 9
Graph showing patients who reported no joint noises (as a percentage of the whole sample) treated with an AR splint (AR, n=20); FAMS splint (FAMS, n=20); or untreated control group (CONTROL, n=10) from baseline recording (0) to month eight (8) of treatment. No significant differences were noted.

Discussion

The Sample

The criteria of *time since the onset of symptoms* was critical in the selection of the sample. In fact, joint pain and joint sounds were strongly associated with abnormal joint morphology. The presence of pain was previously associated with MRI evidence of joint effusion,[22] and reciprocal clicking was consistently associated with disk displacement with reduction.[23,24] However, Pereira, et al.,[25] who, in TMJ autopsy studies, correlated symptoms before death to anatomical examination of the joints after death, concluded that the association between pain and/or dysfunction and joint morphology was complex and that gross morphologic alterations could be present in the absence of those symptoms. However, since the primary reasons for consulting a clinician are pain and joint noises, in this study we simply assessed the existence of pain and joint noises and monitored over time the presence of these symptoms without assessing morphological alteration of TMJs seen on MRI.

Joint Pain

The primary finding of this study was that subjects treated with AR splints experienced significantly less joint pain from month four to month eight ($p<0.05$ at month 4, 5, and 6 and $p<0.01$ at months 7 and 8) compared with the control subjects and with the subjects treated with the FAMS splint. After two months of therapy, abscence of pain was reported in 55% of patients treated with AR splints. This result does not agree with that of Hersek, et al.,[26] who reported the same condition an elimination of joint pain in about 88.2% of patients. However Hersek[26] did not mention the method used to assess TMJ pain in their study. Although the results in that study were different in conclusion, they also supported the use of AR splints, because of the reduction in pain and symptoms. Based on this point of view, our conclusions can be considerd in accord with those of the Hersek study.[26]

Our findings are also in agreement with those of Lundh, et al.,[15] who compared patients with reciprocal clicking treated with an anterior repositioning splint, a flat occlusal splint, and an untreated control group. The anterior repositioning splint decreased joint pain at rest, during chewing, and during protrusion, and it completely eliminated reciprocal clicking.[15] The flat occlusal splint decreased joint tenderness but did not affect clicking. In the control group, the clicking remained.[15]

Our findings also agree with those of Lundh, et al.,[27] who compared 63 patients with an arthrographic diagnosis of disk displacement with reduction treated with: 1. onlays to maintain disk repositioning, constructed using arthrography to obtain a recaptured disk position relative to the condyle; 2. or a flat occlusal splint; and 3. an untreated control group. Clinical examinations were performed before and after six months of treatment. The disk repositioning onlays improved joint function and reduced joint pain when compared with the flat occlusal splint and with no treatment.[27] The signs and symptoms in the flat occlusal splint group were no different from those in the control group.[27]

Pain Intensity

In the current study, the reduction of joint pain included not only the decreasing of the frequency of reported pain, as shown in **Figure 3**, but also a reduction of the intensity of pain, assessed by VAS score, as shown in **Figure 4A** and **Figure 4B**. A significant decrease in pain in the AR splint subjects was already evident at month two after the

start of treatment ($p<0.001$), compared with both the FAMS splint group and the control subjects (**Figure 4A**). The differences continued to be significant until month eight (**Figure 4A**). These results seem to suggest that a reduction of joint pain symptoms was evident first as a decreasing of pain intensity (at month two) (**Figure 4A**) and then as a disappearance of pain (at month four) (**Figure 3**).

On the contrary, the FAMS splint subjects showed a significant reduction of pain intensity compared with control subjects only after eight months from the start of treatment ($p<0.05$) (**Figure 4A**). While no significant differences were evident in the percentage of subjects reporting pain between the FAMS splint and control subjects (**Figure 3**), the results suggest that the FAMS splint decreased the patients' pain but did not eliminate it.

Longitudinal analysis revealed a significant decrease in pain intensity over time for all groups, and for the three groups separately, from the start of treatment to month eight (**Figure 4B**). The results seem to suggest that it cannot be overlooked that subjects treated with the FAMS splint and the untreated control subjects could experience a highly significant reduction of joint pain over time after the initial contributing event. This point needs further studies of the influence on the healing process of general factors (i.e., age), various pathologic pre-existing conditions, or on the type of causal event. Previously, Kurita, et al.,[28] in a prospective cohort study, indicated that approximately 40% of patients with symptomatic disk displacement without reduction were free of symptoms within 2.5 years, 33% improved, whereas only 25% continued to be symptomatic. Although the current study has a different follow-up and a different disease (disk displacement with reduction), our study seems to confirm that a reduction of symptoms may be observed even in the untreated control patients with disk displacement with reduction.

Pain Characterization

The most important finding in the current study was that there were no significant differences among the groups in the distribution of constant pain (**Figure 5**). In fact, the frequency of constant pain was less than 50% in the three groups at T0 and at month one. It improved to less than 20% at month eight in every group (**Figure 5**). These results confirm that untreated patients could experience an improvement of their symptoms. Although there were no significant differences among the groups, it must be noted that patients wearing an AR splint always experienced a lower frequency of constant pain than the untreated control subjects or subjects treated with the FAMS splint (**Figure 5**). The authors think that this finding can be explained as simply the result of the lower frequency of TMJ pain generally observed in the AR splint group (**Figure 3**). The distribution of *chewing/biting pain* showed a different tendency compared to that of constant pain (**Figure 5** and **Figure 6**), since it increased over time in the FAMS splint group and in the control group. On the contrary, in the AR splint group it decreased and went from 55% at month one to 5% at month eight (**Figure 6**). In the FAMS splint group and the control group, it was always higher than 50% from month one to month eight (**Figure 6**). After eight months from the start of treatment, significantly fewer patients treated with the AR splint showed chewing/biting pain than patients treated with the FAMS splint (**Figure 6**). One interesting point was that the frequency of constant pain tended to decrease over time (**Figure 5**), while chewing/biting pain tended to increase, except in the AR splint group (**Figure 6**). This result was due in part to the fact that most of the subjects experiencing constant pain developed into subjects with chewing/biting pain before becoming patients with no pain.

Joint Noise

The most important finding was that the frequency of a *constant* joint noise decreased over time in the three groups considered (**Figure 7**). The frequency of the subjects experiencing a joint noise *sometimes* or *never* tended to increase over time in every group (**Figure 8** and **Figure 9**). This probably means that the presence of joint noise was disappearing over time and became a *sometimes* joint noise before completely disappearing. After two months of therapy, 15% of subjects in the AR splint group were in the group called *never joint noise*, and this result does not agree with those of Hersek, et al.,[26] who reported an elimination of joint noise in 64.7% of subjects treated with the same splint used in the current study.

One other important finding with regard to the distribution of joint noise was that, since subjects treated with the FAMS splint and the control subjects showed a similar distribution, subjects in the AR splint group always showed a lower frequency of subjects reporting *constant* joint noise (**Figure 7**) and a higher frequency in the distribution of subjects reporting *sometimes* joint noise or *never* reporting joint noise (**Figure 8** and **Figure 9**). At month eight, 50% of the subjects treated with the AR splint reported no joint noise and 40% showed joint noise *sometimes* (**Figure 8** and **Figure 9**). At the same time, 50% of control subjects showed *constant* joint noise (**Figure 7**). These results seem to suggest that the AR splint is more effective for treating recently occurring joint sounds compared with the FAMS splint and the

control subjects. A possible reason for this effect is that the AR splint may alter adverse loading in the joint and correct a pathological disk position while reducing muscle splinting which affects the joint. However, previous studies based on autopsy specimen observation indicated that joint sound is always a sign of joint abnormality, but that the absence of joint sound does not exclude intraarticular pathosis.[24,29] Unfortunately, no conclusions can be drawn as to the prognosis of the control subjects and the effect on their healing process, because they probably had a history of clicking which was replaced by an internal derangement without reduction. The elimination of joint sounds may be a sign of an internal derangement without reduction. In a previous study of 61 patients with a clinical and arthrographic diagnosis of disk displacement with reduction who were followed for six months and received no treatment, progression to closed lock (disk displacement without reduction) occurred in twelve patients (20%) based on clinical and arthrographic examination.[9] Additionally, the retrospective analysis of the findings at the first consultation revealed that the intensity of TMJ pain during chewing and the degree of disrupted joint function were more pronounced, and the frequency of temporary locking was higher in the patients who progressed to closed lock when compared with those who did not progress to closed lock.

In another study with three years of follow-up, 70 patients with reciprocal clicking were followed: reciprocal clicking remained unchanged in fifty patients (71%) and disappeared in twenty patients (29%), and locking developed in six patients (9%). At the initial examination, these six patients had more pain, more frequent joint tenderness, greater frequency of missing molar support and more dental abrasion on the affected side than the patients who developed no locking.[30] These studies seem to suggest that reciprocal clicking does not usually progress to locking; however, the disappearance of joint noise cannot be considered a sign of recovery. This conclusion may be supported by the findings in the current study.

Conclusion

The AR splint seems to be more effective in the treatment of joint pain associated with recently occurring internal derangement, and this becomes evident after only four months of therapy. The difference with the FAMS splint continues to be evident until month eight. Constant pain, more frequent during the initial period, probably progresses to a chewing/biting pain before disappearing. This was true in all three of the groups studied.

Limits of the Study

The study was limited by the amount of time the groups were followed (eight months). Follow-up was concluded when only a part of subjects were asymptomatic. Because of this, the study must be considered a preliminary study. We do not know in how many subjects the pathology became chronic or how many completely recovered. The interruption in the study was due in part to the fact that the control subjects who experienced *constant* or *chewing/biting* pain throughout the eight months decided to begin splint therapy and were subsequently treated with AR splints. Another limitation was that the VAS score was used to assess the quantity of pain, and this method has been shown to be influenced by a subjective perception as to the level of pain intensity.[31] This method is considered by McKay and Christensen[32] to be a pseudoscientific diagnostic technique. Finally, no MRIs were made during the eight months of the study, and the study must be considered only an analysis of the primary symptoms associated with a recently occurring TMD.

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