



MICHIGAN SPLINT VERSUS SUPERIOR REPOSITIONING SPLINT FOR MANAGEMENT OF TMD'S

Mohamed Katamish * and Tamer Nasr **

ABSTRACT

The aim of this study is to evaluating the effectiveness of use of Michigan splint in the management of Temporomandibular joint disorders (TMD) in comparison to superior repositioning splint (SRS) as a control group in a one-year follow-up..

Material and methods: Sample was initially constituted by 40 patients, randomly divided into two groups: I- Michigan splints, II- Superior repositioning splints. The whole sample was evaluated by means of TMJ and muscle palpation, mandibular range of motion (ROM), analysis of occlusal contacts, joint sounds inspection and Visual Analogue Scale (VAS) for one year.

Results: A significant (after 15 days) improvement in pain report (VAS) and palpation index was found for group II ($p < 0.01$). The occurrence of occlusal alterations as posterior open bite or gross interferences after the splint therapy and increased muscle tenderness were not problems in this study. Similar results in joint noises reduction were observed for the entire sample.

Conclusion: It was concluded that use of repositioning splints is a beneficial tool in the management of intra-articular pain and dysfunction, with no risks of irreversible occlusal changes.

KEYWORDS: Temporomandibular joint; Occlusal splints; Michigan splint

INTRODUCTION

TMJ internal derangements constitute one of the most common findings in TMD patients. Joint sounds, pain and abnormal mandibular movements are frequently reported symptoms by those individuals. Although found in approximately 30% to 35% of an asymptomatic population,

disc displacements are associated with pain and dysfunction in almost 80% of patients 1,2, there will always be a query about the interrelation between disc/condyle position and symptoms severity.

Strongly recommended in the past, the reestablishment of a “normal” condyle/disc relationship as part of a treatment protocol has been discussed,

* Professor of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ain Shams University.

** Lecturer of Oral and Maxillofacial Surgery, Faculty of Dentistry, Misr International University.

based on studies that demonstrated the capacity of the TMJ to adapt into a pain free condition, even with displaced disc 3,4.. This reestablishment and the “permanent” recapturing of the disc used to be achieved by different methods, including mandibular orthopedic repositioning appliance (MORA) followed by full mouth rehabilitation and orthodontic protocols 5,6. Open TMJ surgery with permanent disc suture to condyle also used to be a form of treatment for painful joints refractory to conservative strategies. Another protocol recommended the use of protrusive splints followed by a gradual return to the original intercuspal position in order to bring the disc back to the top of condyle⁷. High levels of relapse and return of symptoms were, however, very frequent 8,9 ,which directed researchers to reconsider the need for a reconstructive phase II therapy¹⁰.

As a part of this scenario, the use of occlusal splints to control joint pain and/or sounds has become very popular worldwide. Flat stabilization appliances and protrusive ones are described as useful tools in the management of these patients, although most conclusions are based on short-time evaluations¹¹.

Based on that, this study aimed at assessing the effectiveness of use of Michigan splint splints in the management of patients with TMJ intra-articular disorders, including pain and sounds, when compared to a group wearing superior repositioning splints for long term as a control group in a one-year period. Indeed, the occurrence of possible secondary effects was also addressed, including muscle symptoms and dental occlusion alterations.

PATIENTS AND METHODS

Sample

The sample was initially constituted of 40 patients, with complaints of TMJ pain presented to treatment at outpatient clinic of Oral and

Maxillofacial Surgery Department Faculty of Dentistry Ain Shams University.

Inclusion criteria were the presence of TMJ discdisplacement with reduction and chief complaint of pain in the joint followed by positive TMJ tenderness to manual palpation, accompanied or not by muscle symptoms. The presence of at least a clicking joint during opening, eliminated on opening in protrusion was also an inclusion criterion. Exclusion criteria were the presence of systemic diseases (i.e. rheumatoid arthritis, osteoarthritis, etc.), history of recent trauma or previous TMJ surgery. All groups were initially matched for gender and age and, after having filled out a consent form to participate in this study, subjects were randomly located into one of the following groups:

Group I- Michigan splints

The Michigan splint is an occlusal bite plane stabilization splint with cusped rise and freedom in centric in a space of 0.5-1.0 mm on the splint plane . During occlusal movements, the concept of canine guidance is realized by planes of the splint in the canines region, whereas the interference, hyperbalance and balance contacts between other teeth and splint plane are avoided.

In Michigan splint, centric relation serves as a therapeutic position which stabilizes the mandible in occlusal relations, wherein the habitual mandibular position is often identical to the centric position in the TMJ. Apart from excluding occlusal interferences, the relaxation of masticatory muscles is achieved by increasing the occlusal.

Group II- Superior repositioning splints

Protrusive splints were used at nighttime for three to four months and then converted into stabilization splints, continuing its use until completion of the one year period. The degree of protrusion was the minimum necessary to eliminate joint clicking or to edge to edge position, when TMJ sound was absent..

The mean age of the whole sample was 31.8 years (32.7 and 31.4) for groups I and II respectively).

Evaluations and follow-up visits

The whole sample was evaluated by means of standardized TMJ and masticatory and cervical muscle palpation 12,13 superficial and deep masseter; anterior, medium and posterior temporalis; insertion of medial pterygoid; upper trapezius and sternocleidomastoid) performed by one previously calibrated researcher, blinded for group distribution. The presence of joint noises and joint pain were detected during TMJ palpation, performed bilaterally in the TMJ lateral and posterior aspects. Muscle palpation was also performed bilaterally and simultaneously, with a digital pressure of 1.5Kg^{12,13}. Analysis of mandibular active range of motion (AROM), joint sounds inspection and occlusal evaluation was also done. Level of pain report was measured by means of a Visual Analogue Scale (VAS), ranging from 0 to 100mm. After initial evaluation, follow-up visits were performed 1 week, 2 weeks, one, three, six months and one year after insertion of appliances, Magnetic resonance images were done when the patients were allocated for the splints groups and at the end of the follow-up (picture 1). For different reasons, 6 patients (3 from group I and 3 from group II) were excluded.

Statistical Analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Maximum Mouth Opening (MMO) and lateral movement data showed normal (parametric) distribution while pain (VAS) scores showed non-normal (non-parametric) distribution. Data were presented as mean and standard deviation (SD) values.

For parametric data, repeated measures ANOVA test was used to compare between the groups as well to study the changes by time within each group. Tukey's post-hoc test was used for pair-wise comparisons when ANOVA test is significant.

For non-parametric data, Mann-Whitney U test was used to compare between the two groups. Friedman's test was used to study the changes after treatment in each group. Dunn's test was used for pair-wise comparisons.

Qualitative data were presented as frequencies and percentages. Chi-square test or Fisher's Exact test when applicable were used to compare between the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

Report of pain and TMJ/ muscle palpation

Analysis within groups and between groups was performed for this variable.

Results have shown a significant decrease in pain levels for both groups studied. For the whole sample, VAS decreased from 53.3mm (sd 29.8mm) to 11.3mm (sd 9.5mm) after one year.

The progress of VAS figures within groups along the seven different examinations is represented in Table 1. A significant and earlier (after 15 days) improvement in pain report could be found for Group II compared to Group I which showed a significant decrease in pain scores after 6 months.

Comparison between both groups showed non-statistically significant difference between the two groups at base line and after 1 week. After 2 weeks, 1 month, 3, 6 and 2 months; Group II showed statistically significantly lower mean pain score than Group I.

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TABLE (1) The mean, standard clicking (SD) values and results of Mann-Whitney U test for comparison between pain scores in the two groups and Friedman’s test for the changes within each group

| Time | Group I | | Group II | | P-value |
|-----------|-------------------|------|--------------------|------|---------|
| | Mean | SD | Mean | SD | |
| Base line | 54.2 ^A | 15.5 | 52.3 ^A | 18.5 | 0.848 |
| 1 week | 50.5 ^A | 18.5 | 45.0 ^A | 20.5 | 0.575 |
| 2 weeks | 48.7 ^A | 16.6 | 26.3 ^B | 18.7 | 0.005* |
| 1 month | 46.2 ^A | 20.2 | 18.2 ^{BC} | 10.1 | <0.001* |
| 3 months | 45.8 ^A | 26.7 | 14.4 ^C | 11.2 | <0.001* |
| 6 months | 23.3 ^B | 15.7 | 8.2 ^D | 9.3 | <0.001* |
| 12 months | 20.2 ^B | 12.4 | 2.4 ^D | 6.1 | <0.001* |
| P-value | <0.001* | | <0.001* | | |

*: Significant at $P \leq 0.05$, Different superscripts in the same column are statistically significantly different

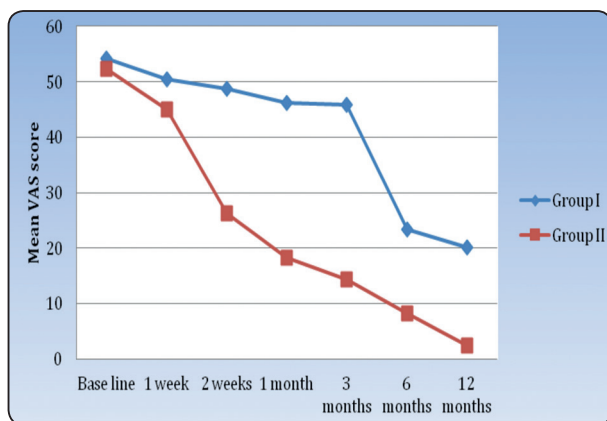


Fig. (1) Line chart representing pain (VAS) scores in the two groups

When the results of TMJ palpation were considered, a significant decrease in tenderness to palpation was observed after one, three and six months for Groups I and II in that order ($p^20.01$).

Muscle palpation detected at least one painful spot in 34.62% of the whole sample at the beginning of the research, with a significant improvement after one year.

Presence of joint noises/ mandibular range of motion

When analyzing the progress of joint noises, similar results could be found for both groups, with a general reduction, judged by means of manual inspection. For both groups I and II, joint noises were no longer present after one year in 40% and 45%, respectively (Table 2).

TABLE (2) The frequencies (n), percentages (%) and results of Chi-square and Fisher’s Exact test for comparison between presence of joint noises in the two groups

| Time | Group I | | Group II | | P-value |
|---------------|---------|-----|----------|-----|--------------|
| | n | % | n | % | |
| Pre-operative | 20/20 | 100 | 20/20 | 100 | Not computed |
| 1 week | 19/20 | 95 | 17/20 | 85 | 0.605 |
| 2 weeks | 18/20 | 90 | 16/20 | 80 | 0.661 |
| 1 month | 17/20 | 85 | 15/20 | 75 | 0.695 |
| 3 months | 14/20 | 70 | 12/20 | 60 | 0.507 |
| 6 months | 12/20 | 60 | 10/20 | 50 | 0.525 |
| 12 months | 8/20 | 40 | 9/20 | 45 | 0.749 |

*: Significant at $P \leq 0.05$

Maximum active opening and excursive movements have also significantly increased for both groups after one year. After one year; Group II showed statistically significantly higher mean MMO than Group I. However, there was no statistically significant difference between excursive movements in the two groups. (Tables 3 and 4).

TABLE (3) The mean, standard clicking (SD) values and results of repeated measures ANOVA test for comparison between MMO (mm) in the two groups and the changes within each group

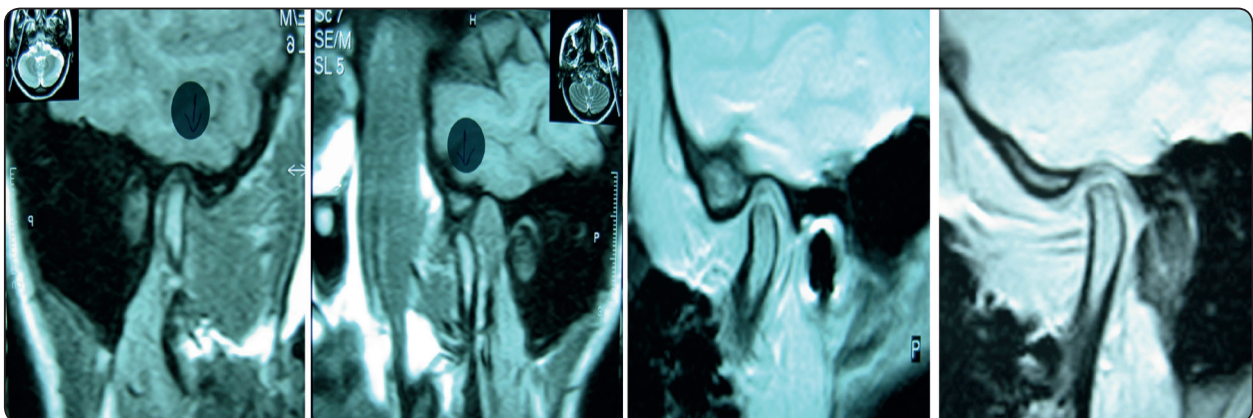
| Time | Group I | | Group II | | P-value |
|---------------|--------------------|-----|--------------------|-----|---------|
| | Mean | SD | Mean | SD | |
| Pre-operative | 35.6 ^B | 7.1 | 37.8 ^C | 4.6 | 0.886 |
| 1 week | 37.0 ^B | 7.8 | 40.2 ^{BC} | 5.0 | 0.715 |
| 2 weeks | 38.8 ^B | 8.2 | 42.5 ^B | 7.1 | 0.625 |
| 1 month | 40.0 ^B | 9.2 | 44.3 ^B | 6.6 | 0.228 |
| 3 months | 42.2 ^{AB} | 8.3 | 47.2 ^{AB} | 6.9 | 0.112 |
| 6 months | 45.5 ^A | 7.7 | 50.2 ^A | 8.9 | 0.065 |
| 12 months | 46.2 ^A | 5.5 | 51.9 ^A | 7.2 | 0.040* |
| P-value | <0.001* | | <0.001* | | |

*: Significant at $P \leq 0.05$, Different superscripts in the same column are statistically significantly different

TABLE (4) The mean, standard clicking (SD) values and results of repeated measures ANOVA test for comparison between lateral movement (mm) in the two groups and the changes within each group

| Time | Group I | | Group II | | P-value |
|---------------|-------------------|-----|-------------------|-----|---------|
| | Mean | SD | Mean | SD | |
| Pre-operative | 3.3 ^C | 0.5 | 3.2 ^C | 0.6 | 0.757 |
| 1 week | 3.5 ^C | 0.5 | 3.5 ^C | 0.7 | 0.958 |
| 2 weeks | 3.9 ^{BC} | 0.6 | 4.0 ^{BC} | 0.6 | 0.947 |
| 1 month | 4.3 ^B | 0.5 | 4.4 ^B | 0.6 | 0.890 |
| 3 months | 4.8 ^{AB} | 0.8 | 5.0 ^{AB} | 0.8 | 0.917 |
| 6 months | 5.2 ^A | 0.6 | 5.7 ^A | 0.7 | 0.775 |
| 12 months | 5.5 ^A | 0.5 | 6.2 ^A | 0.7 | 0.192 |
| P-value | <0.001* | | <0.001* | | |

*: Significant at $P \leq 0.05$, Different superscripts in the same column are statistically significantly different



CT SCAAN : pre-operative and one year post-operative for patient using SRS

DISCUSSION

Several methods have been proposed as part of the management of TMJ pain and dysfunction, including physical therapy, pharmacotherapy, counseling, and occlusal treatment. Based on its non-invasive and conservative features, occlusal splints are an important part of these occlusal therapies^{13,14}. Although extensively studied, the usefulness of this modality in recapturing the disc, decreasing pain and eliminating joint clicking, as well as an ideal design and wearing protocol have not been established so far^{15,16}. The concept of “evidence-based dentistry”⁹, very well accepted in the modern dentistry, has, however, resulted in a new perspective in the field of pain and dysfunction.

In the present paper, the establishment of specific inclusion criteria and long- term evaluations are important when judging results.

For a better understanding, this discussion is divided into different parts.

Joint pain and mandibular motion

Initial VAS figures were not significantly different between groups, which is important as part of the statistical protocol. When considering the analysis within groups, an earlier improvement in pain report was found for the protrusive splint group. These findings agree with several studies in which a repositioning splint provided significant improvements.. In a recent study, Kurita, et al.¹⁷ have described successful disc recapturing in displacements with reduction. Presence of inflammatory process and morphological alterations of the disc were believed to be the reason for failure in cases of displacement without reduction.

Patients wearing protrusive splints reported significant improvements 15 days after the insertion of appliance. For group I, however, a significant improvement has taken place only after 6 months. This condition remained unchanged for the rest of the year.

Considered in the past as an important method to recapture the disc, repositioning splints are also used only to decrease TMJ symptoms. The better and earlier result found for this group may be due to a decreased overload to retrodiscal tissues, allowing healing to occur. The maintenance of a normal disc/condyle relationship and/or a reduced joint pressure at night time could, therefore, provide protection to structures previously damaged secondary to disc displacement. Sindelar, et al.¹⁸ have found increased thickness of posterior band of miniature female pigs after wearing splints for two months. Remodeling of the disc is also suggested as a result of splint wearing¹⁹. The decompressing effect of such tools, however, has been questioned recently²⁰. Daytime functional activities, on the other hand, could stimulate the formation of a retrodiscal fibrosis and the establishment of a pseudodisc^{3,21}. In the present study, after a period of initial use of protrusion, splints were transformed into stabilization splints at once, although a gradual return to an intercuspal position had been proposed in the past⁷.

Although it is widely accepted that most disc displacements will remain stable and asymptomatic, they are present in painful joints in almost 80% of cases^{1,2}. Permanent recapturing of the disc was not the goal of the temporary use of a protrusive splint in this study. The exact disc position after one year could not be established, since an MRI image was not part of this study.

The delayed pain reduction for Group I after six months may be the result of a slower healing process. The improvement for group I characterizes the benign aspect of these conditions and warns about the need for irreversible procedures. This statement supports conclusions of Minakuchi, et al.¹⁵ in which patients with no treatment had similar outcomes when compared to the treated.

The improvement in range of motion for both groups in the present investigation is probably the result of decreased joint pain, associated with the recovery of possible secondary muscle co-contraction.

Joint sounds

One of the most frequent complaints in TMD patients is the presence of “joint noises”. Although found more frequently in TMD patients, part of asymptomatic population has this complaint, with no need for any type of treatment^{12,17}.

Joint sound has been thought to originate from ligament problems, excessive changes on the disc anatomy and joint fibers²³, and changes on disc position related to mandibular movement. Anterior repositioning splints are described as a management strategy for clicking joints²⁴, with reports of success in reciprocal clicking patients, as well as to decrease muscle fatigue⁸.

The possible progression from disc displacements and clicking joints to degenerative changes^{25,26} has led many clinicians to perform disc recapturing therapies as prevention. Some other authors^{27,28}, however, found out that patients with condylar hypermobility and reciprocal clicking (displaced disc) did not present more degenerative changes than hypermobile joints that did not present clicking.

The resolution of clicking is probably due to morphological alterations in the disc itself, especially in its posterior region, eliminating the physical obstruction for translation, and consequently decreasing the sound. This affirmation, however, would require more sophisticated diagnostic tools, set as “gold standard”, such as magnetic resonance image (MRI), not used in the present study.

Muscle pain

The improvement in muscle tenderness to palpation could express a recovery in TMJ condition, which would inhibit protective contraction and associated pain. This finding speaks against the proposition that repositioning splints might induce muscle pain.

Sfondrini, et al.²⁷ attribute this occurrence to a change in the muscle fibers composition, leading to a “myoplasticity” adaptation process.

Occlusal contacts

Posterior open bites, occlusal alterations and intrusions are side effects commonly associated with the use of protrusive splints.²³ Muscle contracture of lateral pterygoid and formation of a mass of posterior reparative connective tissue are thought to be part of these alterations.. Short term use of a full coverage protrusive splint in the present study, however, did not significantly change the number of occlusal contacts and did not cause any skeletal problem.

The maintenance or a slight increase in occlusal contacts found in the present investigation can be the result of healing of a joint pain and associated inflammation, allowing the mandible to return to a stable and physiological position.

CONCLUSIONS

The controlled use of repositioning splints might be very useful in the initial management of TMJ pain and dysfunction. Decreased internal pressure and relieve of retrodiscal tissues could account for this fact. Long-term evaluation, however, showed that most symptoms (pain and joint noises) seem to subside regardless of the group studied, which warns about the need of irreversible treatments after the initial improvement. Irreversible occlusal changes (mainly posterior open bite) and increased muscle pain (caused by the protrusive position) do not seem to be problems with the protocol used in this study.

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