Kaohsiung Journal of Medical Sciences (2011) 27, 323–329

available at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.kjms-online.com

ORIGINAL ARTICLE

Splint therapy for disc displacement with reduction of the temporomandibular joint. Part I: Modified mandibular splint therapy

I-Yueh Huang [a,b,c], Ju-Hui Wu [b], Yu-Hsun Kao [a], Chao-Ming Chen [a], Chun-Ming Chen [a,c], Yi-Hsin Yang [d,e,*]

[a] *Department of Oral and Maxillofacial Surgery, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan*
[b] *Clinic of Temporomandibular Disorder, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan*
[c] *School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan*
[d] *Division of Statistical Analysis, Department of Clinical Research, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan*
[e] *Department of Oral Hygiene, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan*

Received 2 August 2010; accepted 25 October 2010
Available online 10 May 2011

KEYWORDS
Disc displacement with reduction;
Reciprocal clicking;
Splint;
Temporomandibular disorders

Abstract The aims of this preliminary study were to present a modified mandibular splint together with a treatment regimen and to evaluate their effects on the treatment of reciprocal joint sounds of the temporomandibular joint (TMJ). The study participants were recruited from 312 consecutive patients in the temporomandibular disorder clinic of a medical center in Taiwan from January 2003 to December 2003. From among these, 59 cases with typical reciprocal clicking were selected for this study. All participants were treated with a modified mandibular splint and then followed up for 6 months. Successful treatment was defined as leading to the disappearance of the joint sounds of TMJ, as described by patients. Based on clinical evaluation, the overall success rate was 71.2% (42/59) with minimal temporary complications. Patients with clicking at less than 3.5 cm of interincisal opening had a success rate of 92.5%, which was higher than the success rate of patients with clicking at a mouth opening of 3.5 cm or more. This study showed that a modified mandibular splint can be used to treat reciprocal clicking of the TMJ effectively and encouraged us to conduct further study on the efficacy of this splint to treat disc displacement with reduction of TMJ using magnetic resonance imaging examination.

* Corresponding author. Department of Oral Hygiene, College of Dental Medicine, Kaohsiung Medical University, No 100, Shih-Chuan 1st Road, Kaohsiung 807, Taiwan.
E-mail address: yihsya@kmu.edu.tw (Y.-H. Yang).

1607-551X/$36
doi:10.1016/j.kjms.2011.03.006

Introduction

Disc displacement with reduction (DDwR) of the temporomandibular joint (TMJ) is a common noninflammatory temporomandibular disorder (TMD). Previous research has shown that DDwR presents in about 15%—25 % of patients in a TMD clinic [1,2]. Although the treatment for TMJ sounds without other symptoms is still controversial, and DDwR symptoms include more than the joint sounds, it is always preferable to eliminate the sound and achieve the relocation of the disc to its proper position. The reciprocal joint sound is theoretically considered as a sign of treatment result. It has also been suggested that an appliance be used to reposition the displaced disc. DDwR generally can be treated by surgical or nonsurgical methods. Nonsurgical treatments include medication, thermal therapy, habit modification, physical therapy, splint therapy, and manipulation [3]. Splint therapy is considered effective to recapture the displaced disc. Among different types of splints, the anterior repositioning splint (ARS) is generally indicated for DDwR [1,2,4—12]. Previous studies of successful splint therapy have investigated various combinations of splint designs, daily wearing times, therapeutic periods, and even placement in the upper or lower jaw. Some studies showed high success rates in the relocation of the disc by the use of ARS [4,13]. Others reported lower success rates in regaining the normal disc-to-condyle relationship [5,14]. In general, the goals of splint therapy are to correct the relationship between the glenoid fossa, articular disc and condyle, decrease joint pain and sounds, improve jaw function, and eliminate any mechanical interference. Although the position of the disc has been discussed for years, some of the issues are that the disc does not need to be in a normal position for patients to be asymptomatic [15]; the mobility of the disc seems more important for healthy functioning than the position; the structure of the TMJ has the ability to adapt to various conditions within the joint [6]; and that the earlier the disc displacement occurs, the more severe is the disc deformation [7], potentially progressing to disc displacement without reduction, disc perforation and even more severe degenerative joint diseases. This is a preliminary study to evaluate the effects of using a modified mandibular splint and different treatment regimens for DDwR. Because we were unable to use the magnetic resonance imaging (MRI) routinely for diagnosis and evaluation of the results of DDwR, we identified the reciprocal clicking as a measure to evaluate the response of DDwR to modified mandibular splint therapy. This was Part I of the study where we made sure that the splint worked for DDwR. The purposes of the first part of the study were to present the modifications of the splint design and the treatment protocol and also to evaluate the efficacy of the splint in eliminating the joint sounds as an indicator of treatment success as regards the DDwR. A further study is planned to evaluate the efficacy of this splint for the DDwR of TMJ using MRI interpretation.

Materials and methods

Patients

Patients were recruited from the TMD clinic of Kaohsiung Medical University Hospital in Taiwan. There were 312 consecutive patients between 1st January and 31st December 2003. Of these, 224 (71.8%) were women and 88 were men (28.2%) with ages ranging from 5 years to 76 years. Patients with consistent reciprocal joint clicking sounds, unilateral or bilateral, at both early/late opening and late closing, who were responding to our diagnostic procedures (see below), and those with sounds that could be eliminated by a wood tongue depressor qualified as candidates for mandibular splint therapy. This selection process has been the standard treatment for patients with DDwR in our department for years. Patients with persistent pain lasting 2 weeks or in whom MRI examination did not reveal DDwR and patients who refused the therapy for personal reasons were excluded from this study. In total, 59 cases with typical reciprocal clicking were selected for this study. All participants were treated with a modified mandibular splint and were then followed up for 6 months. The outcome was considered successful if the clicking sound was eliminated as described by the patient and examined and confirmed by a dentist who was not a member of this study. This study was approved by the University hospital ethical committee (KMUH-IRB-960287), and all subjects gave informed consent to their participation.

Diagnosis

First, examination of the joint sounds was performed. Each patient was asked to open and close his/her mouth slowly to detect reciprocal clicking sounds by palpation at the preauricular area. Then, the patient was asked to open his/her mouth as wide as possible. Once an opening clicking sound was detected by palpation, the mouth opening was recorded by measuring the distance between the left side of the upper and lower central incisors. A wood tongue depressor (thickness about 1.5 mm for each depressor) was then placed on the upper anterior teeth, and the patient was instructed to close his/her lower jaw into a centric occlusion. When the patient's lower anterior teeth touched the tongue depressor, he/she generally would be made to stop at that position and open his/her mouth again. Patients whose joint sounds could be eliminated by the above procedures were candidates for mandibular splint therapy. Patients whose joint sounds could not be eliminated by the above procedures were excluded from this study. Patients with TMJ pain that could not be alleviated within 2 weeks were also excluded. All patients who participated in this study were pain-free.

Recorded basic information for each patient included age, gender, duration of the joint sound, stage of a mouth opening when the opening clicking occurred, maximum mouth opening before and after treatment, pain of TMJ or muscle, and clicking sounds. The patients were followed up at the 1st week, 4th week, 8th week, and 6th month, and at anytime if the patient had problems with treatment. All details were documented and recorded. The joint sounds, pain of joint or muscles, occlusion, and mouth opening were all recorded at the time of regular follow-ups and any clinical visits. Because of financial constraints, we could not routinely send all patients for MRI examination; only 13 patients had MRI examination in this study.

Splint fabrication and treatment regimen

For all patients, we took the impression of the upper and lower jaws to pour the casts. Then we asked the patients to open their mouth beyond the clicking point and then close the mouth to centric occlusion without protruding the mandible as the ARS demanded (Fig. 1). The elevation of the occlusion at anterior teeth was determined using thickness measurers and heavy body impression material (Fig. 2). The vertical opening of the splint was generally 2—3 mm in the anterior teeth. Subsequently, we checked the occlusion on casts mounted on an articulator in the laboratory. A full-coverage splint with the indentation of the upper teeth (Fig. 3) was made for the mandible with heat-curing resin, and then the splint was fitted in and positioned in the patient's mouth (Fig. 4). We also removed the occlusal interferences on the splint. This design increased the ability of the patient to chew foods, thus improving the motivation of patients to wear the splint all day long, especially while eating. First, patients were instructed to wear the appliance 24 hours a day for 4 weeks, except when brushing their teeth after meals. They were told not to chew without the splint, and advised to reduce parafunction and avoid hard foods. To maintain the position of the reduced disc, patients were instructed to wear the splint only while eating and sleeping for the following 2 weeks. If the splint worked well, patients were asked to continue wearing the splint for another 2 weeks while sleeping only. The standard therapeutic time was 8 weeks. If the 8-week course could not eliminate the sounds, the treatment was considered a failure. All patients were asked to return to the clinic after the 1st week, 4th week, 8th week, and 6th month for regular evaluation. Adjustment of the splint was done immediately if any tooth loosening, sensitivity on biting, or discomfort was noted during splint therapy. When patients noted the disappearance of joint sounds of TMJ, and a dentist from outside of the study group examined and confirmed this, the treatment was considered successful. The success rates with various factors included gender, age, the time from onset to seeking treatment, and the timing at which the opening

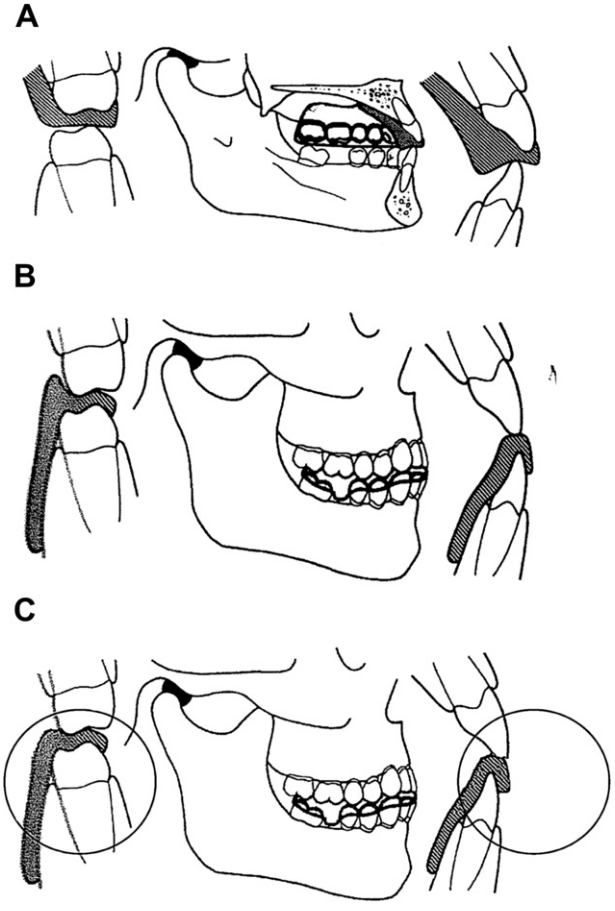

Figure 1. Cross-sectional illustration of the (A) upper ARS; (B) lower ARS; (C) and the modified mandibular splint [1]. ARS = anterior repositioning splint.

Figure 2. The patient was instructed to open the mouth wide to make an opening clicking and then bite down to the thickness measurers, which were added gradually if the closing clicking persisted, until the opening and closing joint sounds disappeared. The measured thickness was the bite elevation for the mandibular modified splint. If the distance was more than 3 mm, the patients were excluded from the study.

Figure 3. The modified mandibular splint is a full-coverage acrylic appliance and is fabricated from heat-cured resin with occlusal indentation for the patient to chew normal diet as best as possible.

Figure 4. The mandibular modified splint is positioned in the patient's mouth. The mandible is not guided into the anterior position, resulting in better acceptance from and more comfort for the patient and less complications because of occlusal changes.

click occurred. Fisher's exact test and χ^2 test for trend were used to compare success rates among age groups, gender, symptoms, and duration of disease. Multivariable adjusted comparison was conducted through a multiple logistic regression.

Results

There were 70 participants (22.4% of all patients with TMD) with reciprocal clicking sounds; 11 did not meet our criteria and were excluded. In all, 59 patients with ages from 10 years to 70 years, with an average of 26.6 years, were selected for this study. Of these 59 patients (Table 1), most were women (74.6%) and 42.4% (25/59) were 20 years old or younger. Of the 59 patients, 67.8% had clicking sounds occurring on mouth opening below 3 cm and 61.0% had clicking sounds lasting less than 6 months. Overall treatment success rate was 42 of 59 (71.2%). However, statistical significance was shown (Table 2) only in factors of age ($p = 0.0182$) and duration from onset to treatment ($p = 0.0468$). With regard to the timing of the opening clicks, patients with clicking at less than 3.5 cm of interincisal opening had a success rate of 92.5%, which was statistically significantly ($p < 0.0001$) higher than the success rate (26.3%) of patients with clicking at a mouth opening of 3.5 cm or more. In terms of the chance of failure, the logistic regression (Table 3) provided odds ratios for individual factors when adjusted for all other analysis variables. The results showed that when considering all together the gender, age, size of mouth opening when clicking occurred, duration from onset to the time of treatment, and complications, the mouth opening on clicking was significantly associated with failure (odds ratio = 87.37, $p = 0.0002$).

No case progressed to DDwoR during the 6-month follow-up period. There were three patients who complained of pain and soreness of the masseter muscles after 1-week follow-up. At the beginning, there were two patients with anterior open bite. After 4 weeks of full course therapy, they gradually returned to normal occlusion during the part-time splint-wearing period, and both of them were under 18 years of age.

We did not take MRI for all patients routinely, but there were 13 patients with typical reciprocal clicking who had MRI examination, and 11 of them (84.6%) were diagnosed with DDwR. Another two cases were diagnosed with disc displacement without reduction and were excluded from the study.

Table 1 Demographics of patients in the study

Variables	Patients (*n*)	Percentage
Sex		
Male	15	25.4
Female	44	74.6
Age group (yr)		
≤20	25	42.4
21–35	23	39.0
≥36	11	18.6
Mouth opening (on clicking) (cm)		
<3.5	40	67.8
≥3.5	19	32.2
S/S (mo)		
<6	36	61.0
≥6	23	39.0
Complications		
Yes	5	8.5
No	54	91.5
Outcome		
Successful	42	71.2
Unsuccessful	17	28.8

S/S = the duration from onset to seeking treatment.

Discussion

DDwR of TMJ is common in TMD clinics. Patients usually present with a complaint of joint sounds, and only few patients present with persistent TMJ pain or locking of the jaw. MRI is a standard diagnostic tool for DDwR but could not be used routinely in this study. Reciprocal joint sounds can be eliminated by a tongue depressor test. This is a useful method for clinical diagnosis. The goals of treatment are to reposition the disc, eliminate the joint sounds and pain, and achieve rehabilitation of jaw functions. Although joint sounds and disc displacement without pain or impaired jaw functions are considered less important clinically, the elimination of sounds contributes to a patient's well being. A normal disc position might prevent more severe diseases from occurring early, making a noninvasive method with a short therapeutic time and less complications preferable to radical surgery or ignoring the problem.

We believe that different TMDs need different splint designs and various treatment regimens. Although upper stabilization splint is good for muscle disorders and bruxism, ARS might be suitable for DDwR, but each has its

Table 2 Success (disappearance of joint sounds) rates for different factors with mouth opening on clicking

Factors	Total				Mouth opening on clicking <3.5 cm				Mouth opening on clicking ≥3.5 cm			
	Patients (*n*)	Successful patients (*n*)	Total success rate	*p* of χ^2 test	Patients (*n*)	Successful patients (*n*)	Success rate	*p* of χ^2 test	Patients (*n*)	Successful patients (*n*)	Success rate	*p* of χ^2 test
Total	59	42	71.2		40	37	92.5		19	5	26.3	<0.0001
Sex												1.0000[a]
Female	44	30	68.2	0.5164[a]	29	26	89.7	0.5480[a]	15	4	26.7	
Male	15	12	80.0		11	11	100.0		4	1	25.0	
Age group (yr)												
≤20	25	20	80.0	0.0182	16	16	100.0	0.0196[b]	9	4	44.4	0.0725[b]
21–35	23	18	78.3		18	17	94.4		5	1	20.0	
≥36	11	4	36.4		6	4	66.7		5	0	0.0	
S/S (mo)												
<6	36	29	80.6	0.0468	26	25	96.2	0.2763[a]	10	4	40.0	0.3034[a]
≥6	23	13	56.5		14	12	85.7		9	1	11.1	
Complications												
Yes	5	3	60.0	0.6199[a]	3	3	100.0	1.0000[a]	2	0	0.0	1.0000[a]
No	54	39	72.2		37	34	91.9		17	5	29.4	

[a] Fisher's exact tests.
[b] χ^2 test for trend.
S/S = the duration from onset to seeking treatment.

Table 3 Adjusted odds ratios for factors related to no disappearance of joint sounds after treatment

Factors	Adjusted odds ratio	95% confidence interval	*p*
Gender			
Male	1.00	—	0.8917
Female	1.15	(0.16—8.24)	
Age (yr)			
≤20	1.00	—	0.1149
>20	6.86	(0.63—75.12)	
Mouth opening on clicking (cm)			
<3.5	1.00	—	0.0002
≥3.5	87.37	(8.45—903.76)	
Duration from onset to seeking treatment (mo)			
<6	1.00	—	0.1856
≥6	3.68	(0.53—25.27)	
Complications			
No	1.00	—	0.7028
Yes	2.20	(0.04—125.26)	

own shortcomings, which need to be overcome. These are open bite, difficulty having normal diet when wearing the appliance, and osteoarthrotic changes in the condylar form. Some patients need complex dental treatment for stabilization of occlusion [1]. Splint therapy for TMDs may be classified into three major groups on the basis of splint functions: stabilization splints (centric splints) [16], the distraction (pivot) [17] splints, and ARS [7,18,19]. The stabilization splint provides a balanced bilateral occlusal contact on a flat splint surface; during lateral movement, only cuspids are in contact with the splint [20]. This method is used to stabilize occlusion, muscles, and joints. The splint is usually worn at night without any chewing. The distraction splint, where the occlusal contact is located predominantly in the posterior part of the splint, aims to reduce the stress on the joint structure [18,20] and to reduce pain, while protecting the associated structures. Because only the posterior area of the splint makes contact, patients can neither chew with the splint on nor can they wear it for 24 hours. The ARS is used to treat DDwR and DDwoR [22,23]. The treatment goals of splint for DDwR of TMJ are to (1) reposition the condyle downward and recapture the disc anteriorly; (2) correct the relationship between the glenoid fossa, articular disc, and condyle; (3) improve jaw function; (4) reduce joint pain and sounds; (5) eliminate mechanical interference; and (6) prevent progression of the disorder [1,19,21]. The results of splint therapy have been evaluated by clinical assessment, arthrotomography [17], CT [14], and MRI [3,8,9,15]. These studies confirmed the possibility of disc recapture.

Previous studies have shown that the prognosis of DDwR is often uncertain because of different designs, wearing times, position of jaws, duration of treatment, and sequence of treatment aftercare [7,16]. Some repositioning splints were used on the maxilla [7,10,17] and some on the mandible [9,21,22]. Some studies did not make the patient wear the splint for 24 hours or allowed the patient to chew without the splint [5,11]. The treatment duration also varied from 1 week to several months, and some have suggested changing the occlusion to maintain the redisplaced disc [12,23]. Also, posterior open bite was common in successful cases. The modified splint used in this study was designed to try to reduce the above problems associated with conventional splints. The splint modifications involved design and treatment regimen, such as wearing in the mandible, having dental indentation, not changing the jaw position, wearing for 24 hours, and allowing the patient to withdraw the splint gradually. Reciprocal clicking sound is an important symptom of DDwR and also is the most common complaint of patients with DDWR. One of the main goals of our treatment is to eliminate the clicking sound. For these reasons, we modified the splint design and treatment regimen with the following considerations: (1) In terms of wearing time, we considered that any biting and swallowing movement may push the condyle backward and upward and cause an unstable reduced disc to relapse. Therefore, we asked the patients to wear the splint 24 hours a day (except when brushing teeth). However, it should be noted that the stabilization and distraction splint cannot be worn 24 hours a day, it is not suitable for DDwR; (2) The splint is to be worn on the mandible. The splints are highly exposed even in the rest position. Owing to esthetic considerations and patients' reluctance, we could not convince our patients to wear the maxillary splint for 24 hours. The phonatory changes are more severe when the splint is installed to the maxilla than when installed to the mandible, and the conventional ARS with a prominent anterior ramp is hard for the patient to accept; (3) The occlusal surface of the splint with indentation of the upper teeth can increase the chewing function when wearing the splint. If we want the patient to wear the splint for 24 hours, we should design it with occlusal indentation to help with chewing; (4) We elevated the bite vertically just enough to eliminate the joint sounds, but we did not reposition the jaw anteriorly. The conventional ARS was designed to protrude the mandible anteriorly to varying amounts, but some patients could not bite back to centrical occlusion when the splint was removed after the treatment course; (5) Treatment time should be long enough to recapture and to stabilize the disc, and the splint should be removed gradually. Although the length of treatment time is still controversial, we suggest 4—8 weeks, followed by slow weaning off; (6) To avoid surgery and posttreatment occlusal therapy (prosthetic or orthodontic treatment), we tried to avoid changing the occlusion of the patient. By this method, our overall success rate was 71.2% (42/59) with mild and temporary complications, which is consistent with the results of other studies [18—21]. If reciprocal clicking can be eliminated only by elevating the bite more than 5 mm vertically or by protruding the jaw, we usually make the conventional ARS for patients. In this study, these cases were excluded.

Some patients complained of interference with speaking and eating, but all could tolerate splint therapy very well after a few days. There were three patients who complained of pain and soreness of the masseter muscles after 1-week follow-up; this condition is not similar to the temporalis muscle pain following the use of the ARS [23]. Also, we found that these patients mistakenly bite the splint all the time and try to correct the jaw position by themselves. After explanation, patients kept the jaw at the rest position and frequently massaged the masseter muscles. Their

symptoms subsided without medication after a few days. Hersek et al. [10] also reported that the ARS does not cause any significant modification in the electromyographic activity. Hence, we deduce that neuromuscular and skeletal adaptation to ARS therapy and muscular pain are not common complications. In the early period of this study, there were two patients with anterior open bite. However, they gradually returned to normal occlusion during the part-time splint-wearing period. These two were younger than 18 years. It is important to note that in patients younger than 18 years, the occlusion should be observed carefully although it is only a temporary complication.

In this study, we were unable to perform MRI in most patients to confirm the diagnosis and results of treatment because of cost considerations. This opens the possibility that we either overdiagnosed or underdiagnosed the internal derangement before treatment. But the MRI examination on patients showed a high correlation between clinical examination and MRI image finding. It is 84.6% in our small patient group. Eberhard et al. [8], in their reports, found that the correlation between clinical and MRI diagnosis was 75 % and Kurita et al. [9] reported that findings on MRI and clinical examination showed agreement in 91.5% of the joints. This study tried to evaluate the effects of the splint for DDwR; the related factors were analyzed with a focus on duration of symptoms; onset of the clicking sounds on opening; and personal data, such as age and gender. The results showed that patients with clicking sounds, which occurred at more than 35 mm of interincisal distances, had a lower success rate. The comparison of the shape and position of the disc assessed by MRI will be presented in the second part of the study.

Modified splint therapy achieved elimination of the joint sounds of patients without aggressive treatment. From the results of this study, we obtained a 71.2% success rate in eliminating joint sounds and 91.5 % of patients had no complications. This is a preliminary study of splint therapy for DDwR of the TMJ. The next part of the study will evaluate the splint efficacy based on MRI examination and discuss factors affecting the success of recapture.

References

[1] Clark GT. Treatment of jaw clicking with temporomandibular repositioning: analysis of 25 cases. J Craniomandibular Pract 1984;2:264—70.

[2] Moloney F, Howard JA. Internal derangements of the temporomandibular joint. III. Anterior repositioning splint therapy. Aust Dent J 1986;31:30—9.

[3] Ohnuki T, Fukuda M, Nakata A, Nagai H, Takahashi T, Sasano T, et al. Evaluation of the position, mobility, and morphology of the disc by MRI before and after four different treatments for temporomandibular joint disorders. Dentomaxillofac Radiol 2006;35:103—9.

[4] Lundh H, Westesson PL, Kopp S, Tillstrom B. Anterior repositioning splint in the treatment of temporomandibular joints with reciprocal clicking: comparison with a flat occlusal splint and an untreated control group. Oral Surg Oral Med Oral Pathol 1985;60:131—6.

[5] Fayed MM, El-Mangoury NH, El-Bokle DN, Belal AI. Occlusal splint therapy and magnetic resonance imaging. World J Orthod 2004;5:133—40.

[6] Okeson JP. Long-term treatment of disk-interference disorders of the temporomandibular joint with anterior repositioning occlusal splints. J Prosthet Dent 1988;60:611—5.

[7] Tecco S, Festa F, Salini V, Epifania E, D'Attilio M. 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. Cranio 2004;22:209—19.

[8] Eberhard D, Bantleon HP, Steger W. The efficacy of anterior repositioning splint therapy studied by magnetic resonance imaging. Eur J Orthod 2002;24:343—52.

[9] Kurita H, Kurashina K, Baba H, Ohtsuka A, Kotani A, Kopp S. Evaluation of disk capture with a splint repositioning appliance: clinical and critical assessment with MR imaging. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:377—80.

[10] Hersek N, Uzun G, Cindas A, Canay S, Kutsal YG. Effect of anterior repositioning splints on the electromyographic activities of masseter and anterior temporalis muscles. Cranio 1998;16:11—6.

[11] Kurita H, Ohtsuka A, Kurashina K, Kopp S. A study of factors for successful splint capture of anteriorly displaced temporomandibular joint disc with disc repositioning appliance. J Oral Rehabil 2001;28:651—7.

[12] Kurita H, Kurashina K, Ohtsuka A, Kotani A. Change of position of the temporomandibular joint disk with insertion of a disk-repositioning appliance. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1984;85:142—5.

[13] Santacatterina A, Paoli M, Peretta R, Bambace A, Beltrame A. A comparison between horizontal splint and repositioning splint in the treatment of disc dislocation with reduction. Literature meta-analysis. J Oral Rehabil 1998;25:81—8.

[14] Manco LG, Messing SG. Splint therapy evaluation with direct sagittal computed tomography. Oral Surg Oral Med Oral Pathol 1986;61:5—11.

[15] Dolwick MF. Disc preservation surgery for the treatment of internal derangement of the temporomandibular joint. J Oral Maxillofac Surg 2001;59:1047—50.

[16] Davies SJ, Gray RJ. The pattern of splint usage in the management of two common temporomandibular disorders. Part III: long term follow-up in an assessment of splint therapy in the management of disc displacement with reduction and pain dysfunction syndrome. Br Dent J 1997;183:279—83.

[17] Lundh H, Westesson PL. Long-term follow-up after occlusal treatment to correct abnormal deformation (temporomandibular joint disk position). Oral Surg Oral Med Oral Pathol 1989;67:2—10.

[18] Moncayo S. Biomechanics of pivoting appliances. J Orofac Pain 1994;8:190—6.

[19] Stiesch-Scholz M, Kempert J, Wolter S, Tschernitschek H, Rossbach A. Comparative prospective study on splint therapy of anterior disc displacement without reduction. J Oral Rehabil 2005;32:474—9.

[20] Schmitter M, Zahran M, Duc JM, Henschel V, Rammelsberg P. Conservative therapy in patients with anterior disc displacement without reduction using 2 common splints: a randomized clinical trial. J Oral Maxillofac Surg 2005;63:1295—303.

[21] Davies SJ, Gray RJ. The pattern of splint usage in the management of two common temporomandibular disorders. Part I: the anterior repositioning splint in the treatment of disc displacement with reduction. Br Dent J 1997;183: 199—203.

[22] Manzione JV, Tallents R, Katzberg RW, Oster C, Miller TL. Arthrographically guided splint therapy for recapturing the temporomandibular joint meniscus. Oral Surg Oral Med Oral Pathol 1984;57:235—40.

[23] Lundh H, Westesson PL, Jisander S, Eriksson L. Disk-repositioning onlays in the treatment of temporomandibular joint disk displacement: comparison with a flat occlusal splint and with no treatment. Oral Surg Oral Med Oral Pathol 1988;66:155—62.