A Study on the side effect of the splint therapy for the patient with craniomandibular disorders

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CONTENTS

Ⅰ. INTRODUCTION

Several epidemiologic studies indicated that the prevalence of craniomandibular disorders are high [1-3]. Dentists are routinely requested to treat these disorders.

It is necessary that the craniomandibular disorders be resolved before restorative dental treatment is initiated.

Unfortunately, the etiology and course of treatment of craniomandibular disorders are much more hazy than the desired results.

The treatment of incoordinate muscles, pain and craniomandibular disorders have been approached by different philosophies.[4-9]

Occlusal interferences could cause and lead to neuromuscular incoordination, muscle spasm, pain and other symptoms of craniomandibular disorders. [10-14]

This philosophy would utilize occlusal splint and occlusal adjustment therapy.

The occlusal splint is one of the most generally accepted devices for treatment of signs and symptoms of fuctional disorders in the stomatognathic system.[15-16]

Even though the effect of the therapy is only partially understood and is sometimes equivocal, [17-18] there is evidence that the use of an occlusal splint leads to improvement to dysfunctional signs and symptoms.

The effectiveness of splints has been related to the avoidance of the disturbing input of occlusal interferences on the neuromuscular mechanism of the masticatory system.[9]

Although there is evidence that the use of an stabilization splint leads to improvement to dysfunctional signs and symptoms, several studies have been reported the side effect of splint therapy on patients with craniomandibular disorder.[9,19-21]

The purpose of this study is to investigate the effect and side effect of the splint therapy for the patient with craniomandibular disorders.

Ⅱ. MATERIALS AND METHODS

1. Subjects

42 patients(12 males and 30 females), between 12 and 53 years(mean age : 22.3years) with craniomandibular disorders of one or both joints were studied. Each patient had more than one major symptoms needed for the diagnosis of cranioman-

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dibular disorders : TMJ and / or masticatory muscle pain, TMJ sound(clicking and / or crepitus) and limitation of mandibular movements. Patients were selected according to the following criteria : (1) complete history with clinical and radiographic examination, (2) no more than three missing teeth per arch, (3) no wearing any removable restoration.

2. Method

All patients were treated with the full arch maxillary stabilization splint, considered the best splint for treatment of craniomandibular disorders. The stabilization splint was made with self-cured acrylic resin and had a flat occlusal surface with occlusal contact in centric relation under Dawson's method. The splint provided even, simultaneous contact of all mandibular buccal cusp tips and incisal edges under the mandible was in the centric relation position. Adequate anterior and canine guidance were provided to disarticulate all posterior teeth during eccentric movements. Each patient was asked to wear the splint continuously, except during eating and oral hygiene procedures.
Patients were seen periodically for necessary adjustment of the splint.[22]

The masticatory system of each patient was evaluated before treatment and 1-month, 3-months and 6-months after splint insertion. The evaluation included subjective assessment, clinical examination, electromyographic assessment and computerized occlusal analysis.

The subjective assessment included visual analogue scale(VAS) and Helkimo's anamnestic dysfunction index.

The clinical examination included clinical dysfunction index devised by Helkimo, craniomandibular index by Fricton, amount of comfortable and maximum mouth opening and number of teeth in contact. Number of teeth in contact was calculated with using Accu-film Ⅱ (Parkell, Farmingdale, N.Y., U.S.A.) under dry condition.

Electromyographic assessment and computerized occlusal analysis using with EM2(Myotronic Research Inc., Seattle, Washington, U.S.A.) and T-scan(Teksan Inc., Boston, U.S.A.) were performed at upright position in dental chair. The sensor of T-scan was placed in the patient's mouth so that the pointer of sensor support was aligned with the midline of the subject's upper incisors. Then patients were asked to closed on the occlusal sensor of T-scan during maximal and habitual clenching. Several practice closures were made until a repeatable pattern of contact was seen on the video monitor and at that time 6 closures of habitual clenching and 3 closures of maximal clenching were recorded in time mode. The data was recorded by counting the number of tooth contacts according to tooth location and by getting total duration of closure from printing paper of the time sequence display. Muscle activity of anterior temporal muscle was measured by using EM2 simultaneously.[23-24]

3. Statistical analysis

Data of each variable were inputed into an IBM personal computer and mean values and standard deviations of variables were attained using SPSS PC+(Microsoft Corp.). Statistical analysis were performed with paired t-test and correlations between variables were analyzed.

Ⅲ. RESULTS

A total of 42 patients were examined for this study. The mean age of the patients was 22.3 years with a range from 12 to 53 years of age. Distribution of patients under sex and diagnostic classification was illustrated in Table Ⅰ.

In subjective assessment, the mean values of visual analogue scale and Helkimo's anamnestic dysfunction index were 4.23, 2.76, 2.19, 1.34 and 1.76, 1.54, 1.36, 1.39 each at before and 1-month, 3-months and 6-months after splint insertion. They were decreased significantly(VAS : $p<0.001$, Ai : $p<0.05$) In clinical examination, MM(mandibular movement, $p<0.05$), TM(TMJ capsulepalpation, $p<0.001$), EM(extraoral muscle

palpation, $p<0.05$, Di(Helkimo's clinical dysfunction index, $p<0.01$) decreased significantly and amount of comfortable mouth opening($p<0.001$) increased significantly. TN(TMJ noise, $p<0.074$), IM(intraoraljaw muscle palpation, $p=0.141$), NM (neck muscle palpation, $p=0.068$) showed tendency of decrease and amount of maximum mouth opening($p=0.589$) showed tendency of increase.

The differences, however, were not statistically significant(Table Ⅱ).

Among the 42 patients, occlusal changes were observed in 10 patients and periodontal problems (gingival inflammation or swelling) were observed in 5 patients. Tooth hypersensitivity was observed in 2patients and vomitting tendency was observed in 1 patient. Among the 5 patients who showed periodontal problems, 3 patients had periodontal problems before splint therapy and in 3 patients, occlusal change was combined.

Distribution of 10 patients with occlusal changes according to diagnostic classification and extent of recovery to original occlusion after shortening of splint wearing time was illustrated in Table Ⅲ. 3 patients recovered to original occlusion, 4 patients recovered partially and 3 patients showed no change. Stage V(DJD : degenerative joint disease) showed more frequent tendency of occlusal change and the difference was statistically significant($p<0.05$).

Table Ⅰ. Distribution of patients according to sex and diagnostic classification.

	Male	Female
I.D St. Ⅰ	6	7
St. Ⅱ	1	7
St. Ⅲ	2	7
St. Ⅳ	0	1
St. Ⅴ	3	8
Total	42	

I.D. : Internal Derangement
St. Ⅰ : reciprocal clicking or popping.
St. Ⅱ : periodic locking
St. Ⅲ : locking open / closed lock
St. Ⅳ : soft tissue remodeling
St. Ⅴ : TMJ degenerative joint disease

Table Ⅱ. Mean values and standard deviations of subjective assessment and clinical examination before and 1-month, 3-months and 6-months after splint insertion.

	Before Tx.		1-month		3-month		6-month		2-tail probability
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S. D.	Before Tx. vs. 6-month
MM	4.47	3.11	3.27	3.19	2.64	2.56	2.67	2.66	0.027 *
TN	0.84	0.80	0.66	0.59	0.52	0.45	0.50	0.42	0.074
TM	1.31	1.18	0.56	0.57	0.40	0.38	0.39	0.51	0.000 ***
EM	1.42	1.29	1.00	0.45	0.92	1.14	0.61	0.82	0.014 *
IM	0.27	0.15	0.10	0.37	0.00	0.00	0.00	0.00	0.141
NM	0.24	0.37	0.98	0.30	0.12	0.23	0.06	0.24	0.068
Ai	1.76	0.44	1.54	0.55	1.36	0.64	1.39	0.70	0.049 *
Di	1.96	0.67	1.51	0.68	1.20	0.82	1.33	0.69	0.003 **
VAS	4.23	2.36	2.76	1.91	2.19	1.50	1.34	1.30	0.000 ***
comf. m/o	33.6	12.3	39.5	9.1	40.4	8.1	39.6	8.4	0.029 *
max. m/o	41.8	10.3	43.1	7.3	43.9	6.1	42.9	6.1	0.589

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

MM : mandibular movement
TN : TMJ noise
TM : TMJ capsule palpation
EM : extraoral jaw muscle palpation
IM : intraoral jaw muscle palpation
NM : neck muscle palpation
Ai : Helkimo's clinical anamnestic index
comf. m/o : amount of comfortable mouth opening
Di : Helkimo's clinical dysfunction index
max. m/o : amount of maximum mouth opening
VAS : visual analogue scale

The mean values for the number of tooth contacts during habitual and maximal clenching with using T-scan were 5.53, 4.95, 5.44, 4.96 and 11.73, 8.24, 7.53, 7.26 each at before and 1-month, 3-months and 6-months after insertion. The mean values for the number of teeth in contact calculated with using Accu-film Ⅱ were 18.10, 13.44, 10.00, 10.33 each at the same time. The mean values for the muscle activities of anterior temporal muscle recorded by EM2 during habitual and maximal clenching were 78.90, 98.41, 94.95, 100.76 and 144.00, 146.87, 145.10, 149.11 each at the same time(Table Ⅳ).

Correlations between number of tooth contacts during habitual clenching and maximal clenching, between number of tooth contacts during maximal clenching and number of teeth in contact calculated with using Accu-film Ⅱ were very significant ($p<0.001$). Correlations between number of tooth contacts during habitual clenching and number of teeth in contact calculated with using Accu-film Ⅱ, between total duration of closure during habitual clenching and maximal clenching were significant statistically($p<0.01$) (Table Ⅴ).

Table Ⅲ. Distribution of patients with occlusal change according to diagnostic classification and extent of recovery to original occlusion after shortening of splint wearing time.

I.D St. Ⅰ	N.C	0	2(13)
	R	2	
	P.R	0	
St. Ⅱ	N.C	0	1(8)
	R.	0	
	P.R	1	
St. Ⅲ	N.C	0	1(9)
	R.	1	
	P.R	0	
St. Ⅳ	N.C.	0	0(1)
	R.	0	
	P.R	0	
St. Ⅴ	N.C.	3	6(11)
	R.	0	
	P.R.	3	
Total			10(42)

$df=4$ $X^2=11.00$ $p<0.05$
N.C : No change
R : Recovered to original occlusion
P.R : Partially recovered
( ) : Number of total subjects

Table Ⅳ. Mean values and standard deviations of electromyographic assessment and computerized oclusal analysis of patients with occlusal change.

	Before Tx.		1-month		3-month		6-month	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S. D.
THABC	5.53	2.06	4.95	1.92	5.44	2.65	4.96	2.47
THABD	0.21	0.19	0.21	0.08	0.23	0.12	0.28	0.10
TMXC	11.73	4.16	8.24	2.47	7.53	2.14	7.26	3.75
TMXD	0.49	0.26	0.44	0.17	0.53	0.24	0.72	0.12
EM2M	144.00	35.75	146.87	56.13	145.10	47.03	149.11	66.10
EM2H	78.90	33.06	98.41	39.87	94.95	32.72	100.76	38.52
CON	18.10	4.89	13.44	3.68	10.00	3.30	10.33	4.24

THABC : Number of tooth contacts recorded by T-scan during habitual clenching.
THABD : Total duration of closure of tooth contact recorded by T-scan during habitual clenching.
TMXC : Number of tooth contacts recorded by T-scan during maximal clenching.
TMXD : Total duration of closure of tooth contact recorded by T-scan during maximal clenching.
EM2M : Muscle activity of ant. temporal m. recorded by EM2 during maximal clenching.
EM2H : Muscle activity of ant. temporal m. recorded by EM2 during habitual clenching.
CON : Number of teeth in contact calculated with using Accu-film Ⅱ.

Table V. Correlation between each variables of electromyographic assessment and computerized occlusal analysis of patients with occlusal change.

	THABC	THABD	TMXC	TMXD	EM2M	EM2H	CON
THABC	–						
THABD	.1918	–					
TMXC	.5715	.1512	–				
TMXD	.1248	.4968*	.1180	–			
EM2M	.3790	.2726	.3989	.1813	–		
EM2H	.3388	.2642	.2742	−.0530	.8437**	–	
CON	.4556*	.1398	.5489**	.0759	.2353	.1288	–

THABC : Number of tooth contacts recorded by T-scan during habitual clenching.
THABD : Total duration of closure of tooth contact recorded by T-scan during habitual clenching.
TMXC : Number of tooth contacts recorded by T-scan during maximal clenching.
TMXD : Total duration of closure of tooth contact recorded by T-scan during maximal clenching.
EM2M : Muscle activity of ant. temporal m. recorded by EM2 during maximal clenching.
EM2H : Muscle activity of ant. temporal m. recorded by EM2 during habitual clenching.
CON : Number of teeth in contact calculated with using Accu-film Ⅱ.

Ⅳ. DISCUSSION

Although the effect of occlusal splint is sometimes equivocal, the stabilization splint has been commonly used in the treatment of functional disturbances of the masticatory system.

When properly adjusted, occlusal splint provides a good method of eliminating occlusal interferences, reducing neuromuscular activity and obtaining stable occlusal relationships with uniform tooth contacts throughout the dental arch.

However, some investigators reported that after using the occlusal splint, patients with craniomandibular disorders showed adverse effects.

In a study on the influence of occlusal splints on jaw positon and musculature in patients with craniomandibular disorders, Kovaleski and De Boever showed that after using the splint for 1 month, patients with craniomandibular disorders showed a repositioning of the mandible, which moved anteriorly and laterally.[9]

In a study on occlusal changes following use of soft occlusal splints, Singh and Berry reported that after using the soft occlusal splint, patients with craniomandibular disorders showed occlusal changes, which was expressed as occlusal tooth contact change.[19]

In a study on subjective and objective evaluation of bruxing patients undergoing short-term splint therapy, Mejias and Mehta showed that there was a definite shift in the maxillomandibular relationship in favour of a more distal position of the mandible by about 0.5−1㎜.[20]

In a description on clinical and instrumental functional analysis for diagnosis and treatment planning : Removable splint therapy, Slavicek suggested that splint therapy lasting more than 3-months may intrude teeth, change the occlusal plane and occlusion, alter TMJ function or interfere with muscle programming and proprio ception.[21]

In this study, patients with craniomandibular disorders showed improvement in observable dysfunctional signs and symptoms(Table Ⅱ). This findings agreed with past studies. Also this finding suggested that the elimination of occlusal interfe-

rences by treatment with stabilization splint could reduce the degree of sensory information from periodontal receptors during functioning, causing a decrease in masticatory muscle activity and muscular relaxation.

It was anticipated that use of stabilization splints will encourage jaw muscles to function more normally and thus result in altered occlusal contacts.[25-27]

Among the 42 patients, occlusal changes were observed in 10 patients and periodontal problems (gingival inflammation or swelling) were observed in 5 patients. Tooth hypersensitivity was observed in 2 patients and vomitting tendency was observed in 1 patient. Among the 5 patients who showed periodontal problem, 3 patients had periodontal problems before splint therapy and in 3 patients, occlusal change was combined.

Distribution of 10 patients with occlusal change according to diagnostic classification and extent of recovery to original occlusion after shortening of splint wearing time was illustrated in Table Ⅲ. 3 patients recovered to original occlusion, 4 patients recovered partially and 3 patients showed no change. Stage V(DJD group) showed more frequent tendency of occlusal change and the di fference was statistically significant.

Changes of occlusal relationship may be occurred by the changes of TMJ, tooth position, muscle program and proprioception.

Alterations of bony contour, especially in degenerative joint disease (DJD) may produce permanent occlusal changes. And the persistent remodelling of TMJ structures to desired condylar position (C.R.) during splint therapy can produce irreversible occlusal situations.

The changes of force distribution between upper and lower teeth during splint wearing can be occurred because of the loss of cuspal interlocking effects. In addition, the balance between intraoral and extraoral musculature which stabilize the neutral tooth position may be disturbed in persistent muscle pain disorder such as muscle contracture and may produce undesirable orthodontic ettects. These changes of tooth position may be aptto occur in patients with poor periodontal condition. The occlusal interferences and muscle program which induce occlusal relationship to centric occlusion (C.O.) can be changed and involved in irreversible occlusal changes.

These findings suggested that before use of the stabilization splint on patients included degenerative joint disease, the side effect of splint should be explained to the patients or parents before proceeding with routine diagnosis and treatment with stabilization splint.

Although the effect and side effect of these patients were studied during 1-month, 3-months and 6-months treatment period, there was no control group studied for comparison. And also other factors(psychologic stress, anxiety, life changes, etc.) may have accounted for some of the changes in symptomes. Therefore, it is difficult to evaluate the exact effect of stabilization splint therapy. Future studies are needed to evaluate these variables.

V. CONCLUSION

The author evaluated the masticatory system of 42 patients wearing full arch maxillary stabilization splint to treat for craniomandibular disorders, by means of subjective assessment, clinical examination, electromyographic assessment and computerized occlusal analysis. These evaluations were performed before treatment and 1-month, 3-months and 6-months after splint insertion.

The obtained results were as follows :

1. Visual analogue scale and Helkimo's anamnestic dysfunction index of subjective assessment were decreased significantly. In clinical examination, MM(mandibular movement), TM(TMJ capsule palpation), EM (extraoral muscle palpation), Di (Helkimo's clinical dysfunction index) decreased and amount of comfortable mouth opening increased significantly. There were not a significant differences in TN(TMJ noise), IM

(intraoral jaw muscle palpation), NM (neck muscle palpation) and amount of maximum mouth opening.

2. Among the 42 patients, 10 patients showed occlusal changes and 5 patients showed periodontal problems. Tooth hypersensitivity was observed in 2 patients and vomitting tendency was observed in 1 patient.
3. Among the 5 patients who showed periodontal problems, 3 patients had periodontal problem before splint therapy and in 3 patients, occlusal change was combined.
4. Among the 10 patients who showed occlusal change, 3 patients recovered to original occlusion, 4 patients recovered partially and 3 patients showed no change after shortening of splint wearing time.
5. Stage V(DJD group) showed more frequent tendency of occlusal change and the difference was statistically significant($p<0.05$).
6. Correlation betweens number of tooth contacts during habitual clenching and maximal clenching, between number of tooth contacts during maximal clenching and number of teeth in contacts with using Accu-film Ⅱ, were very significant ($p<0.001$). Correlations between number of tooth contacts during habitual clenching and number of teeth in contact with using Accu-film Ⅱ between total duration of closure during habitual clenching and maximal clehcning were significant statistically($p<0.01$).

REFERENCES

1. Agerberg, G., and Carlsson, G. E. : Functional disorders of the masticatory system. I. Distribution of systems according to age and sex as judged from investigation by questionnaire. Acta Odontol Scand 30 : 497, 1972.
2. Helkimo, M. : Studies on function and dysfunction of the masticatory system. Ⅳ. Age and sex distribution of dysfunction of the masticatory system in Lapps in the north of Finland. Acta Odontol Scand 32 : 255, 1974.
3. Lee, K. K. : A clinical study on the temporomandibular joint dysfunction patients. J. of Dental College, SNU, 5 : 61, 1981.
4. Clark G.T.: Occlusal therapy : occlusal appliances. In the President's Conference on the Examination, Diagnosis, and Management of Temporomandibular Disorders, Chicago, 1983, American Dental Association, p 137.
5. Okeson J.P. : The effects of hard and soft splints on nocturnal bruxism, J. Am Dent Assoc 114 : 788, 1987.
6. Holmgren K, Sheikholeslam A. : Long-term study of the effect of an occlusal splint in patients with parafunctional disorders, J. Dent Res 57(special issue) : 341, Abstr 1968, 1978.
7. Okeson, J. P. : Management of Temporomandibular Disorders and Occlusion, 2nd ed., The C. V. Mosby Co., St. Louis, Missouri pp397.
8. Christensen, L. V. : Effects of an occlusal splint on integrated electromyography of masseter muscle in experimental tooth clenching in man, J. Oral Rehabil., 7 : 281-288, 1980.
9. Kovaleski, W. C., De Boever, J. : Influence of occlusal splints on jaw position and musculature in patients with temporomandibular joint dysfunction, J. Prosthet. Dent. 33 : 321-327, 1975.
10. Jarabak, J. R.:An electromyographic analysis of muscular and temporomandibular joint dusturbances due to imbalances in occlusion. Angle Ortho 26 : 170-190, 1956.
11. Ingervall, B., and Thilander, B.: Activity of temporal and masseter muscles in children with a lateral forced bite. Angle Ortho 45 : 249-258, 1975.
12. McNamara, D. C.:Occlusal adjustment for a physiologically balanced occlusion. J Prosthet Dent 38 : 284-293, 1977.
13. Sheikholeslam, A., Möller, E., and Lous, J.: Postural and maximal activity in elevators of mandible before and after treatment of functional disorders. Scand J Dent Res 90 : 37-46, 1982.
14. Åkerman, S., Nordström, B., and Hansson, T.

L.: The influence of occlusal adjustment on electrical activity in the temporal and masseter muscles. J Phillip Dent Assoc 3 : 136-138, 1986.

15. Kawazoe, Y., Kotani, H., Hamada, T., and Yamada, S.: Effect of occlusal splints on the electromyographic activities of masseter muscles during during maximum clenching in patients with myofacial pain-dysfunction syndrome. J Prosthet Dent 43 : 578-580, 1980.
16. Dahlström, L., and Haraldson, T. : Bite plates and stabilization splints in mandibular dysfunction. Acta Odontol Scand 43 : 109, 1985.
17. Wood, W. W., and Tobias, D. L. : EMG response to alteration of tooth contacts on occlusal splints during maximal clenching. J Prosthet Dent 51 : 394, 1984.
18. Green, C. S. and Laskin, D. M. : Splint therapy for the myofacial pain-dysfunction(MPD) syndrome : a comparative study. JADA 84 : 624, 1972.
19. Singh, B. P., and Berry, D. C. : Occlusal changes following use of soft occlusal splints. J. Prosthet Dent. 54 : 771. 1985.
20. Mejias, J. E., and Mehta, N. R. : Subjective and objective evaluation of bruxing patients undergoing short-term splint therapy. J. Oral Rehabil 9 : 279, 1982.
21. Slavicek, R. : Clinical and instrumental functional analysis for diagnosis and treatment planning : removable splint therapy, JCO 23 : 90, 1989.
22. Kim, K. S. and Kim, Y. K : Comparative study on the clinical effects of splint, laseracupuncture and laser therapy for temporomandibular disorder, Journal of Dental College, 12(1) : 195-216, 1988.
23. Kim, Y. K. : Comparative study on maximal and habitual clenching through T-Scan system. The Journal of Korean Academy of Oral Medicine, 14(1) : 35-42, 1989.
24. Youn, T. H. and Kim, Y. K. : Study on occlusal contact using computerized occlusal analysis system. The Journal of Korea Academy of Oral Medicine, 14(1) : 81-88, 1989.
25. Kim, Y. K., and Hansson, TL, : Klinische interpretation der beziehung zwische okklusionsstörungen und muskelaktivitat, Phillip Journal, 6(1) : 63-66, 1989.
26. McCarroll R. S., Naeije, M., Kim, Y. K., and Hansson, TL. : The immediate effect of splint-induced changes in jaw positioning on the asymmetry of submaximal masticatory nuscle activity. J. Oral Rehabil, 16(2) : 163-170, 1989.
27. McCarroll, R. S., Naeije, M., Kim, Y. K., and Hansson, TL. : Short-term effect of a stabilization splint on the asymmetry of submaximal masticatory muscle activity. J. Oral Rehabil, 16(2) : 171-176, 1989.

교합상을 이용한 치료가 두개하악장애 환자에 미치는 부작용에 관한 연구

서울대학교 치과대학 구강진단·구강내과학교실

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[국문초록]

저자는 두개하악 장애로 교합상치료를 받고있는 42명의 환자를 대상으로 치료전, 치료후 1개월, 3개월, 6개월째에 주관적 평가, 임상적 검사, 근전도 검사, 컴퓨터 교합 분석을 시행하여 다음과 같은 결론을 얻었다.

1. 주관적 평가인 visual analogue scale과 Helkimo's anamnestic dysfunction index는 유의하게 감소하였다. 임상적 검사시 MM(mandibular movement), TM(TMJ capsule palpation), EM (extraoral muscle palpation), Di(Helkimo's clinical dysfunction index)는 유의하게 감소하였고 무통성 개구량은 유의하게 증가하였다.
2. 42명의 환자중 10명에서 교합변화가 관찰되었으며, 5명에서 치주질환, 2명에서 치아 과민감, 1명에서 구토경향이 관찰되었다.
3. 치주질환을 보이는 5명의 환자중 3명은 교합상치료 이전부터 치주질환에 이환된 상태였으며 3명에서는 교합변화가 함께 관찰되었다.
4. 교합변화를 보인 10명의 환자중 교합상의 장착시간을 줄였을때, 3명이 원래의 교합상태로 회복되었고 4명은 부분적으로 회복되었으며 3명에서는 변화를 관찰할 수 없었다.
5. 악관절 내장 제 5기 환자에서 교합변화가 더 빈번히 나타났으며, 통계적으로 유의한 차이를 보였다.
6. Habitual clenching시와 Maximal clenching시 사이의 치아 접촉점의 수, maximal clenching 시의 치아 접촉점의 수와 접촉 치아수 사이에 매우 유의한 상관관계를 보였고, habitual clenching시의 치아 접촉점의 수와 접촉 치아수, habitual clenching시와 maximal clenching시 사이의 치아 접촉시간에서도 유의한 상관관계를 보였다.