A Study on the Change of Occlusal Contacts and Lateral Cephalometric Variables after Stabilization Splint Therapy in Temporomandibular Disorder Patients

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ABSTRACT

A Study on the Change of Occlusal Contacts and Lateral Cephalometric Variables after Stabilization Splint Therapy in Temporomandibular Disorder Patients

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Objectives: The aim of this study is to assess the relationship between possible occlusal change after stabilization splint therapy and the research diagnostic criteria for temporomandibular disorders (RDC/TMD) Axis I diagnoses and lateral cephalometric variables.

Methods: Clinical and radiographic records of 47 patients treated by occlusal splint therapy after diagnosed as TMD based on RDC/TMD Axis I were reviewed. The number of occluding teeth was recorded and lateral cephalogram was taken at pre-

treatment and 6-month post-treatment. They were divided into two groups. The control group consists of patients whose number of occluding teeth did not decrease after wearing stabilization splint for 6 months (19 females and 4 males). And occlusal-loss group consists of patients whose number of occluding teeth decreased (19 females and 5 males). The difference of RDC/TMD diagnoses and cephalometric variables were compared between two groups.

Results: In the control group, RDC group I, muscle disorders, was 39.1% (9/23), group II, disc displacements, was 17.4% (4/23), group III OA, osteoarthritis/osteoarthrosis, was 73.9% (17/23), and group III pain, arthralgia, was 82.6% (19/23). In the occlusal-loss group, group I was 41.7% (10/24), group II was 41.7% (10/24), group III OA was 70.8% (17/24), and group III pain was 83.3% (20/24). The frequency of RDC groups was not different between two groups, analyzed by binomial logistic regression.

Pre-treatment cephalometric variables were not different between two groups. However, articular angle(S-Ar-Go), AB to mandibular plane and ODI decreased and gonial angle (Ar-Go-Me) increased significantly in the occlusal-loss group, implying clockwise rotation of the mandible, between pre-treatment and 6-month post-treatment, while none of cephalometric variables showed any statistical difference in the control group.

Conclusions:

1. Change in the number of occluding teeth was not related to the RDC/TMD diagnoses.
2. Cephalometric values changed only in the occlusal-loss group as a result of mandibular clockwise rotation.
3. None of cephalometric variables before the stabilization splint therapy was

statistically different between the control and occlusal non-loss group.

Key words: Temporomandibular disorder, Occlusal change, Lateral cephalogram, Stabilization splint

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KOREAN ABSTRACT

Ⅰ. INTRODUCTION

Temporomandibular disorders (TMDs) are defined as a collective term that embraces a number of clinical problems that involve the masticatory muscles, the temporomandibular joint (TMJ), and the associated structures.[1] Epidemiological study shows two distinct age peaks for internal derangement about at 30–35 years and inflammatory-degenerative disorders about at 50–55 years.[2] And women had higher prevalence rates of TMDs than men.[3,4]

Several treatment methods for TMD have been used, including occlusal splints, behavioral treatment, physical therapy, medications and surgical approaches.[5] De Leeuw et al. concluded that nonsurgical treatment is as effective as surgical treatment over the long term.[6] And stabilization splint as conservative treatment is the method of choice for the management of temporomandibular disorders.[7]

The change of occlusion after splint therapy has been reported by several authors. Treatment with anterior repositioning splint usually creates a posterior open bite.[8,9] And significant changes were seen in the disc displacement with reduction group, which was managed with anterior repositioning splint.[10] Fujii et al. investigated a decrease of the number of occluding contact points after full-arch maxillary stabilization splint and the amounts of changes were higher in the bruxer with myofascial pain group than bruxer without it.[11] One study using Gothic arch tracings reported the posterior displacement of mandible in most patients after Michigan splint therapy.[12] However, information still lacks on the cause or physiology of possible occlusal change after stabilization splint therapy. Moreover, lateral cephalometric analysis before and after stabilization therapy has rarely been studied and its relationship with the change of occlusal contacts has never been reported.

The aim of this study is to assess the relationship between possible occlusal change

after stabilization splint therapy and the research diagnostic criteria for temporomandibular disorders (RDC/TMD) Axis I diagnoses and lateral cephalometric variables.

Ⅱ. MATERIALS AND METHODS

1. Subjects

Clinical and radiographic records of the patients who had visited the TMJ and Orofacial Pain Clinic in Seoul National University Dental Hospital for treatment of TMD symptoms in 2010 were reviewed. Among them, the records of the patients who had diagnosed as TMD based on RDC/TMD Axis I and taken stabilization splint therapy by one TMD specialist, Lee, and whose number of occluding teeth and lateral cephalogram at 6-month pre-treatment and post-treatment were available were selected. The records of the patients who were aged under 18 years, had facial deformity, severe malocclusion, rheumatoid disease, or trauma history were excluded.

Finally, records of 47 patients were selected and classified into two groups. The control group consists of patients whose number of occluding teeth did not decrease after wearing stabilization splint for 6 months (19 females and 4 males whose mean age was 40.1 years and 32.7 years, respectively). And occlusal-loss group consists of patients whose number of occluding teeth decreased (19 females and 5 males whose mean age was 40.1 years and 31.8 years, respectively). They had taken conservative treatments including behavior control, physical therapy, medication (e.g. NSAIDs) and night-wearing stabilization splint therapy with periodic check-up. This study was approved by the Institutional Research Board of Seoul National University Dental

Hospital (#CRI12039).

2. RDC/TMD Axis I Groups

Patients were classified into 4 RDC groups based on RDC/TMD Axis I diagnoses,[13,14] which originally allows patients classified into multiple RDC groups.

1. Group I, muscle disorder (N=19) ; pain or ache in the jaw, temples, face, preauricular area, or inside the ear at rest or during function and pain aroused by palpation of the associated muscles; RDC/TMD Ib or Ic
2. Group II, disc displacement (N=14) ; joint sound during jaw movement or images showing displacement of disc; RDC/TMD IIb or IIc
3. Group III OA, osteoarthritis/arthrosis (N=34) ; crepitus in the joint or radiological signs of bony change; RDC/TMD IIIb or IIIc
4. Group III pain, arthralgia (N=39) ; pain in joint sites during jaw movement or by palpation; RDC/TMD IIIa or IIIb

3. Analysis of lateral cephalogram

Lateral cephalograms were taken at pre-treatment and 6-month post-treatment examination. After recording the number of occluding teeth, lateral cephalogram was made in an upright position, with the teeth in intercuspation and the patient's head supported by a cephalostat.

A single examiner, Na, traced all lateral cephalograms. The tracings were done on the digitalized images and analyzed with V-ceph 6.0 software (Osstem, Seoul, Korea). Eighteen landmarks were decided on each radiograph, from which eighteen variables were calculated (Fig 1, 2, 3). The variables used can be classified into 3 categories:

1. Vertical skeletal relationships: saddle angle [Na-S-Ar] (°), articular angle [S-Ar-Go] (°), gonial angle [Ar-Go-Me] (°), facial height ratio [S-Go/N-Me],

lower anterior facial height ratio[N-ANS/ANS-Me], AB to mandibular plane angle, ODI

2. Maxillary and mandibular skeletal relationships: SNA (°), SNB (°), ANB (°), APDI, Wits, facial convexity
3. Dental relationships: IMPA (°), upper occlusal plane to U1 (°), lower occlusal plane to L1 (°), U1 to SN (°)

To test the magnitude of the measurement error involved in this study, Dahlberg's formula was used.[15]

4. Statistical analysis

Binomial logistic regression was performed to evaluate the relationship between the change of the number of occluding teeth and RDC groups. Independent t-test was done to compare the pre-treatment lateral cephalometric values between two groups, while paired sample t-testwas done to compare the pre-treatment and 6-month post-treatment lateral cephalometric values for each group,in order to analyze the dento-skeletal alterations after stabilization splint therapy for 6 months.

Ⅲ. RESULTS

1. The number of occluding teeth and RDC group

Subjects were divided into 4 RDC groups depending on the RDC/TMD diagnoses as follows: group I (muscle disorder), II (disc displacements), III OA (osteoarthritis/arthrosis), III pain (arthralgia). In the control group, RDC group I was

39.1% (9/23), group II was 17.4% (4/23), group III OA was73.9% (17/23), and group III pain was 82.6% (19/23). In the occlusal-loss group, group I was 41.7% (10/24), group II was 41.7% (10/24), group III OA was 70.8% (17/24), and group III pain was 83.3% (20/24). The frequency of RDC groups was not different between two groups, analyzed by binomial logistic regression (Table I).

2. Lateral cephalometric variables

Pre-treatment cephalometric variables were not different between the control and occlusal-loss group (Table IV). In the control group, none of cephalometric variables showed any significant differences between pre-treatment and 6-month post-treatment images ($p>0.05$) (Table II). Meanwhile, articular angle (S-Ar-Go), AB to mandibular plane and ODI decreased while gonial angle (Ar-Go-Me) increased significantly in the occlusal-loss group ($p<0.05$) (Table III). The cephalometric variables describing the position of the maxilla and dentition did not change. It implies that occlusal change was caused by mandibular movement in clockwise rotation.

Ⅳ. DISCUSSION

In this study, we investigated the relationship of the RDC/TMD diagnoses and dento-skeletal patterns with the occlusal changes after stabilization splint therapy. Firstly, the change of the number of occluding teeth was not statistically different among the RDC/TMD diagnoses, even in RDC III OA group. Normally, it is very well known and appreciated that the occlusal change, especially anterior open bite, is clearly related to

osteoarthritis (OA) of the TMJ. On this point, the results of this study can look in contrast to the fact accepted generally. But in this study, because the aim was not to investigate the effect of bony change of the TMJ but the effect of stabilization splint therapy on the occlusal change, presence of clinical or radiological sign of OA was just recorded at pre-treatment examination for RDC diagnosis, while severity or progression of OA were not considered in any further analysis. In other words, if OA had not got worse since the pre-treatment examination so that the number of occluding teeth did not change any more, the case could be classified into the RDC III OA group in the control group.

In the results of cepahlometric analysis, pre-treatment cephalometric variables were not different between two groups. However, articular angle (S-Ar-Go), gonial angle (Ar-Go-Me), AB to mandibular plane and ODI showed significant differences in the occlusal-loss group, implying clockwise rotation of the mandible, between pre-treatment and 6-month post-treatment, while none of cephalometric variables showed any statistical difference in the control group. The cephalometric variables describing the position of the maxilla and dentition did not changed at all.

Previous study using Gothic arch reported a mean posterior displacement of the mandible of 0.3 mm was found after therapy. Displacement ranged from 0.1 to 0.5 mm.[12] It has also been suggested that a change of occlusal condition after short-term use of a splint is thought to be due to displacement or inclination of teeth, a change of masticatory muscle activity or condyle-fossa relationship.[11] In this study, both groups show no significant change in dental relationships (Table II, III). Based on these results of the study, decrease of the number of occluding teeth must be because of mandibular positional change not because of teeth movement.

Several studies have shown that splints improve the balance of masseter muscle activities in myogenous patients.[16,17] Daif reported splint therapy reduces the electromyographic amplitude records of the masticatory muscles.[18] And in a previous

study, splint therapy was regarded as a method of equilibrating masseter and anterior temporalis muscular activity between right and left sides, reaching values close to the asymptomatic control groups.[19] In addition, Helkimo and Ingervall proposed mandibular displacement after splint therapy can be explained by a hyperactivity of the lateral pterygoid muscles.[20] Based on these, it can be assumed that some degree of change in muscle activity after the use of a splint is possible to bring about the clockwise rotation of the mandible resulting in the occlusal change.

In other point of view, several authors has reported that condyles of patients with anterior disc displacement were situated more posterior in the fossa than those in the control group.[21,22] It has been also reported in a previous study using MRI that a reduction of the anterior disc position and a dorsal repositioning of the condyles in the glenoid fossa of joints with disc displacement with reduction took place.[23] Ekberg et al. reported that the stabilization splint changed the condyle-fossa position and suggested that a positive treatment effect could be the unloading of the TMJ.[24] Therefore, if any change of condylar position more posterior or upward in the fossa occurs because of any possible change in the shape or position of the disc, even if bony change does not occur, during the stabilization splint therapy, it can theoretically cause the clockwise rotation of the mandible observed in this study.

Collectively, the clockwise rotation of the mandible can occurin some patients resulting occlusal change after wearing stabilization splint regardless of bony change of the joint, disk displacement, or pain at the moment of the beginning of therapy. Even though it should be supported by further study in a controlled prospective design, based on the results of this study and previous studies, at least, it can be concluded that the clockwise rotation of the mandible resulting in the loss of anterior occlusal contacts can occur after use of the stabilization splint during the night. And it can be carefully assumed that the cause of such clockwise rotation of the mandible must be the comprehensive result of change of the muscle activity controlling the position of the

mandible and the tissue change in the joint such as change of thickness of the tissue, whatever it is, disk or retrodiscal tissue, or flattening of the joint surface without apparent destructive change.

Lastly, dento-skeletal patterns of pre-treatment state in two groups show no significant differences in this study. The reason is regarded due to limitation of lateral cephalogram. A cephalogram is a 2-dimensional image which does not show variations of the transverse dimension. Although there is a controversy, transverse problem such as unilateral posterior crossbite may have association with temporomandibular disorders.[25-27] Further research using 3D image can target the measurement of the variables mentioned in addition to horizontal and vertical relationships. And a study including asymptomatic control group can provide further clues to find predisposing factors, if any, of occlusal change after stabilization splint therapy.

V. CONCLUSIONS

1. Change in the number of occluding teeth was not related to the RDC/TMD diagnoses.
2. Cephalometric values changed only in the occlusal-loss group as a result of mandibular clockwise rotation.
3. None of cephalometric variables before the stabilization splint therapy was statistically different between the control and occlusal non-loss group.

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Table I. Incidence of decrease of the number depending on RDC/TMD

		Control	Occlusal-Loss	Exp(B)	Significance	95% C.I. of Exp(B)
Muscle disorders	Yes	9	10	1.091	0.9	0.296 - 4.016
	No	14	14	Reference		
Disc displacement	Yes	4	10	0.52	0.36	0.127 - 2.133
	No	19	14	Reference		
Osteoarthritis	Yes	17	17	0.886	0.87	0.22 - 3.57
	No	6	7	Reference		
Pain in joint sites	Yes	19	20	1.064	0.94	0.214 - 5.295
	No	4	4	Reference		

Analyzed by binomial logistic analysis.

Table II. Longitudinal comparison of cephalometric variables of the control group

(N=23)	Pre-treatment		6-month		P-value
Variables	Mean	SD	Mean	SD	
Vertical skeletal relationships					
Saddle angle (°)	124.04	4.83	124.52	4.73	0.338
Articular angle (°)	154.56	7.59	154.36	8.18	0.779
Gonial angle (°)	121.16	5.51	121.35	6.06	0.709
Antero_Post. FHR	62.70	6.59	62.38	6.62	0.205
Lower Ant. FHR	53.72	2.42	53.76	2.23	0.786
AB to Mand. Plane (°)	72.15	4.65	72.43	5.04	0.533
ODI	71.50	5.59	71.76	5.99	0.640
Mn.Plane angle to SN (°)	39.76	8.35	40.24	8.20	0.180
Maxillary and mandibular relationships					
SNA (°)	79.49	3.63	79.59	3.78	0.689
SNB (°)	74.74	4.21	74.42	4.45	0.183
ANB (°)	4.74	2.80	5.16	2.68	0.085
APDI	78.37	5.96	77.67	6.04	0.072
Wits	0.37	4.23	0.72	3.70	0.431
Facial convexity (°)	8.61	6.85	9.46	6.26	0.148
Dental relationships					
UOcc.plane to U1 (°)	55.59	5.83	55.29	5.28	0.622
LOcc.plane to L1 (°)	64.63	8.97	64.99	7.75	0.770
U1 to SN (°)	101.8	7.81	101.54	7.58	0.592
IMPA (°)	96.08	5.58	96.30	5.60	0.721

Analyzed by paired t-test.

Table III. Longitudinal comparison of cephalometric variables of the occlusal-loss group

(N=23)	Pre-treatment		6-month		P-value
Variables	Mean	SD	Mean	SD	
Vertical skeletal relationships					
Saddle angle (°)	126.49	5.72	127.16	5.39	0.123
Articular angle (°)	151.37	8.12	149.74	7.71	0.025*
Gonial angle (°)	120.67	6.98	122.33	7.27	0.000***
Antero_Post. FHR	63.17	3.48	62.95	4.11	0.490
Lower Ant. FHR	54.91	2.37	54.98	2.08	0.813
AB to Mand. Plane (°)	71.03	4.77	70.03	4.61	0.002**
ODI	69.73	5.60	68.53	5.76	0.025*
Mn.Plane angle to SN (°)	38.53	4.58	39.23	5.34	0.080
Maxillary and mandibular relationships					
SNA (°)	79.36	4.35	79.32	4.42	0.899
SNB (°)	75.72	3.45	75.77	3.55	0.880
ANB (°)	3.64	2.36	3.55	2.17	0.526
APDI	80.55	4.50	81.15	4.62	0.083
Wits	-0.24	3.00	-0.46	2.66	0.437
Facial convexity (°)	6.01	5.84	5.81	5.69	0.414
Dental relationships					
UOcc.plane to U1 (°)	54.35	4.63	54.20	5.35	0.839
LOcc.plane to L1 (°)	65.88	7.47	64.92	5.52	0.386
U1 to SN (°)	104.46	6.86	105.14	6.92	0.239
IMPA (°)	94.48	7.91	94.56	7.37	0.905

Analyzed by paired t-test.

Table IV. Comparison of pre-treatment cephalometric variables of the control and occlusal-loss group

	Control group		Occlusal-loss group		P-value
Variables	Mean	SD	Mean	SD	
Vertical skeletal relationships					
Saddle angle (°)	124.04	4.83	126.49	5.72	0.120
Articular angle (°)	154.56	7.59	151.37	8.12	0.171
Gonial angle (°)	121.16	5.51	120.67	6.98	0.789
Antero_Post. FHR	62.70	6.59	63.17	3.48	0.761
Lower Ant. FHR	53.72	2.42	54.91	2.37	0.094
AB to Mand. Plane (°)	72.15	4.65	71.03	4.77	0.420
ODI	71.50	5.59	69.73	5.60	0.285
Mn.Plane angle to SN (°)	39.76	8.35	38.53	4.58	0.539
Maxillary and mandibular relationships					
SNA (°)	79.49	3.63	79.36	4.35	0.912
SNB (°)	74.74	4.21	75.72	3.45	0.388
ANB (°)	4.74	2.80	3.64	2.36	0.148
APDI	78.37	5.96	80.55	4.50	0.164
Wits	0.37	4.23	-0.24	3.00	0.573
Facial convexity (°)	8.61	6.85	6.01	5.84	0.167
Dental relationships					
UOcc.plane to U1 (°)	55.59	5.83	54.35	4.63	0.424
LOcc.plane to L1 (°)	64.63	8.97	65.88	7.47	0.606
U1 to SN (°)	101.8	7.81	104.46	6.86	0.220
IMPA (°)	96.08	5.58	94.48	7.91	0.431

Analyzed by independent t-test.

Figure Legends

Figure 1. Landmarks used in this study:
1, nasion; 2, sella; 3, orbitale; 4, porion; 5, anterior nasal spine; 6, posterior nasal spine; 7, articulare; 8, basion; 9, Point A; 10, incisal end of maxilary incisor; 11,apex of maxillary incisor; 12, incisal end of mandibular incisor; 13, apex of mandibular incisor; 14, Point B; 15, pogonion; 16, menton; 17, gonion; 18, occlusal plane point

Figure 2. Angular measurements used in this study:
1, saddle angle (Na-S-Ar); 2, articular angle (S-Ar-Go); 3, gonial angle (Ar-Go-Me); 4, SN to mandibular plane angle; 5, SNA; 6, SNB; 7, ANB; 8, mandibular incisor to mandibular plane angle; 9, maxillary incisor to SN plane; 10, AB to mandibular plane

Figure 3. Linear measurements used in this study:
1, anterior facial height (N-Me); 2, posterior facial height (S-Go); 3, lower anterior facial height (ANS-Me)

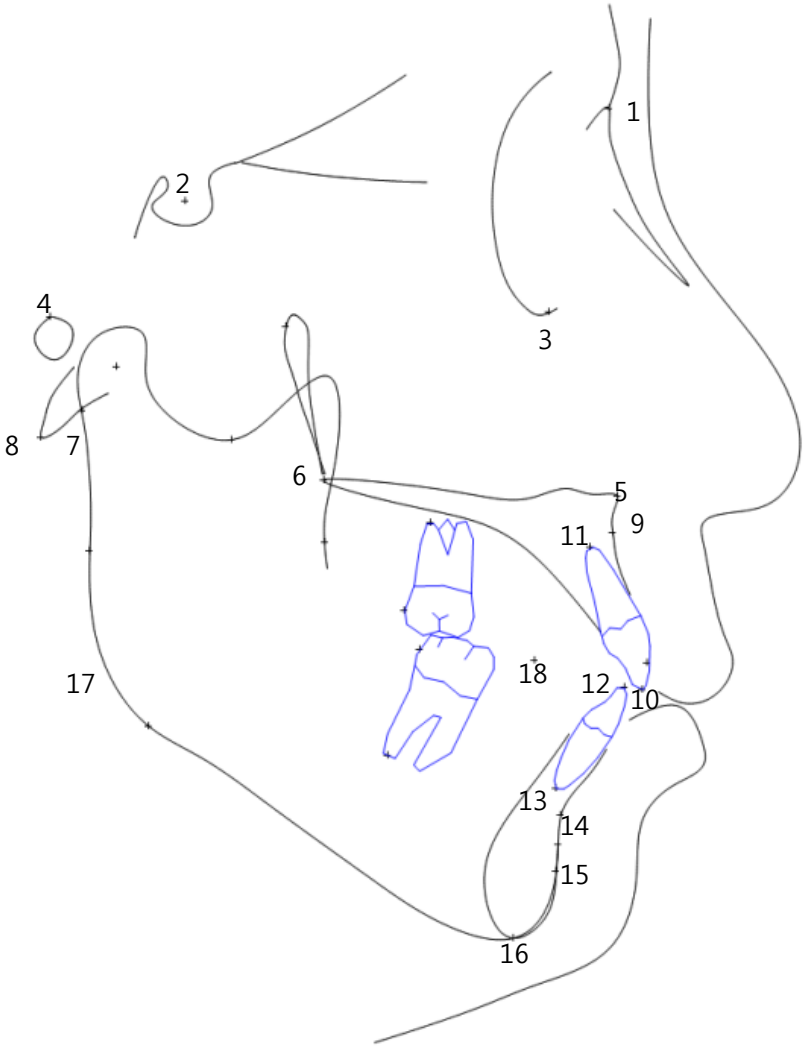

Figure 1.

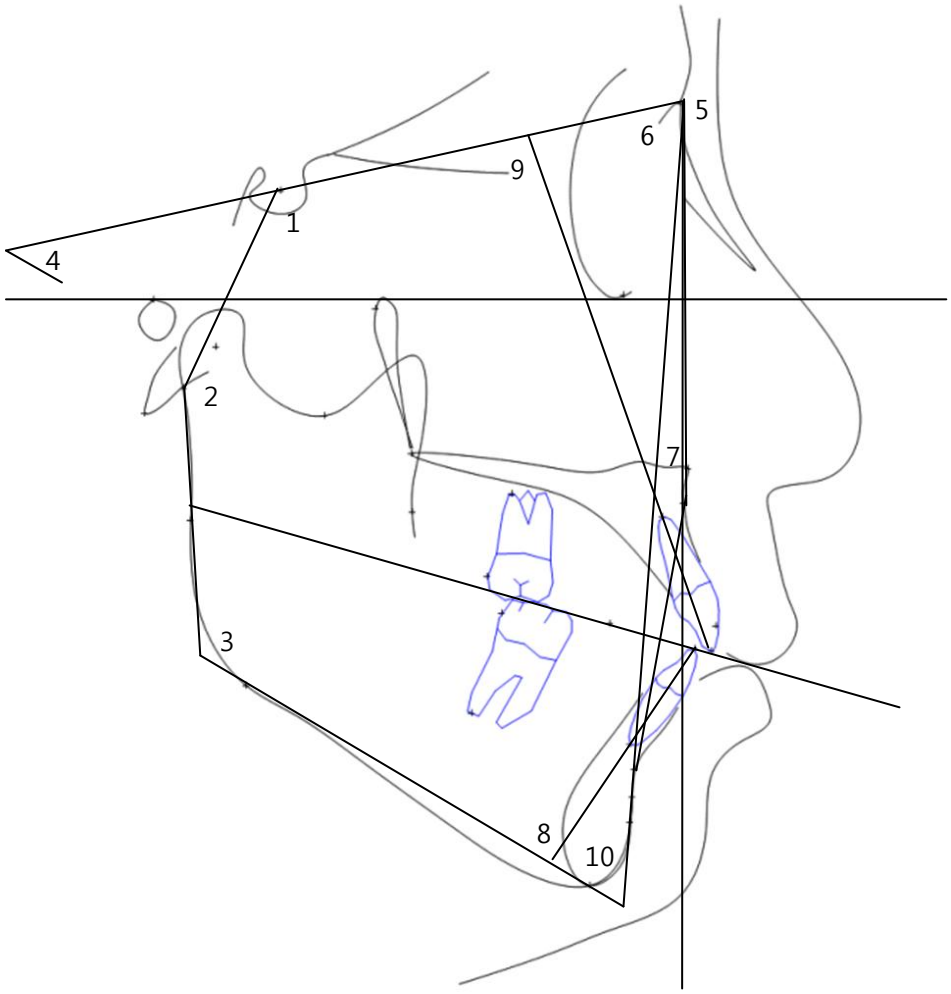

Figure 2.

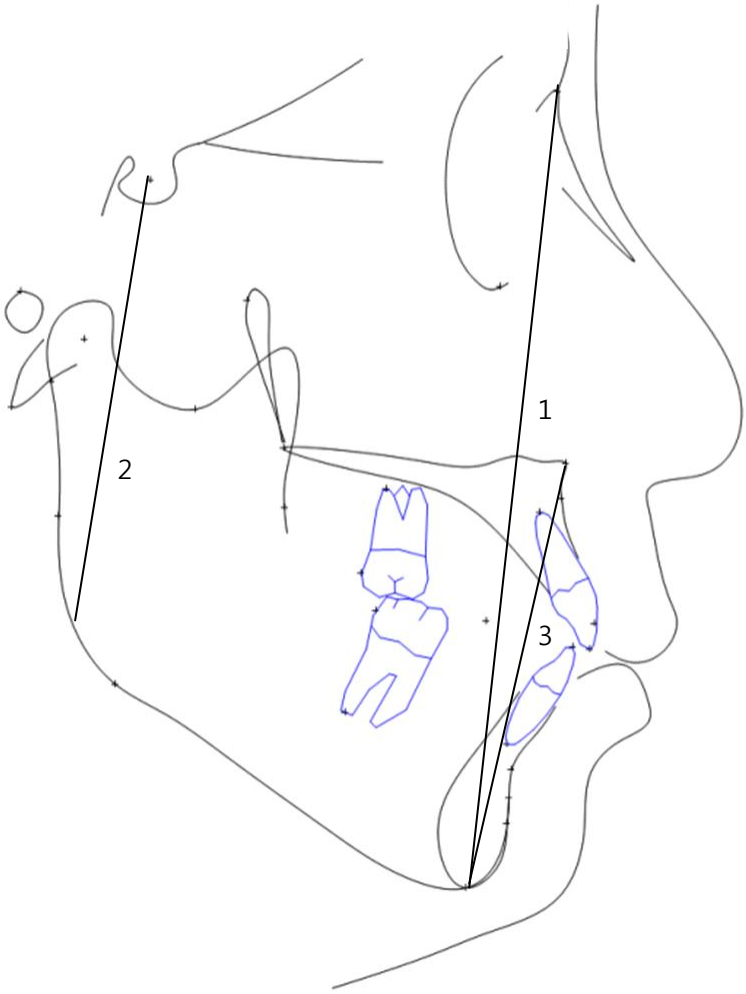

Figure 3.

국문초록

측두하악장애의 교합안정장치치료 후 교합 및 측모두부방사선적 변화에 대한연구

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나 효정

본 연구에서는 교합안정장치 치료를 시행한 측두하악장애 환자의 의무기록과 방사선 검사 자료를 분석하고 교합안정장치치료 후 교합점의 변화와 측모두부방사선 사진 계측치 및 임상정보를 수집하여 그 통계적 연관성을 분석함으로써 교합변화와 관련한 임상적 및 골격적 특성을 파악하고자 하였다.

측두하악장애의 진단과 치료를 위해 서울대학교 치과병원 구강내과 턱관절·안면통증 클리닉에 내원하여 교합안정장치 치료를 받은 환자 중 치료 전과 치료 후 6개월 경과 시 교합변화에 대한 기록과 동 시기의 측모두부방사선 방사선 사진을 촬영한 환자를 대상으로 하였다. 외상 및

기형이 있는 경우, 심한 부정교합이나 류마티스 질환이 있는 경우, 잔여 성장이 계측치 변화에 영향을 줄 수 있는 만 18세 미만 환자들은 대상에서 제외하였다. 대상자는 교합안정장치 치료 후 교합점 개수가 줄어든 감소군(24명)과 그렇지 않은 대조군(23명)으로 분류하여 두 군 간 치료 전 방사선 계측치 차이, 각 군에서 전후 계측치 차이와 RDC/TMD 분류에 따른 빈도 차이에 대해 통계 처리를 시행하였다.

분석 결과 RDC군 분류에 따른 교합 변화의 빈도는 유의한 차이를 보이지 않았으며,교합점 감소군과 대조군 각각에서 치료 전 후 측모두부방사선사진 계측치 변화를 비교한 결과, 대조군은 어떤 계측치에서도 유의한 변화를 보이지 않았으나 감소군에서는 articular angle, , AB to mandibular plane, ODI가 감소하고 gonial angle이 유의하게 증가하였다. ($p<0.05$). 이 계측치들은 하악의 위치와 관련된 계측치로 상악, 상악 전치, 하악 전치는 유의한 변화를 보이지 않아 교합안정장치로 인한 교합 변화는 하악의 위치 변화에 의한 것임을 알 수 있었고 하악은 후하방으로 회전된 것으로 추측할 수 있다.교합점 감소군과 대조군의 치료 전 계측치를 비교한 결과 두 군 간 유의한 차이를 보이지 않았다.

1. 교합안정장치 치료 후 교합점 감소 빈도는 RDC군 분류에 따라 유의한 차이를 보이지 않았다.
2. 교합점 감소군에서 치료 전후 하악의 수직적 위치에 관한 계측치들의 유의한 변화를 보였는데, 이는 하악의 후하방 회전을 반영하고 있다.
3. 교합점 감소군과 대조군의 치료 전 측모두부방사선 사진 계측치를 비교한 결과 두 군 간 유의한 차이를 보이지 않았다.

결론적으로 본 연구의 결과로부터 교합안정장치 장착 후 교합 변화는 장치 장착시의 골변화 유무, 관절절원판변위 유무 및 통증과 무관하게 발생할 수 있으며 이는 치아의 이동에 의하기보다 하악의 후하방 회전에 의한 결과임을 추정할 수 있다.

주요어: 측두하악관절장애, 교합변화, 측모두부방사선사진, 교합안정장치치료

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