

# Occlusal Analysis of the Patients with Temporomandibular Disorders Using T-Scan II System

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Correlation between occlusal contact pattern and TMD have been hypothesized and partially investigated but results are controversial and not conclusive. The purposes of this study were to compare right-to-left difference of occlusal contact pattern, through contact points, contact force and occlusal balance, in the patients with unilateral TMD and also to evaluate its change related with TMD treatment.

36 patients with unilateral TMD from Department of Oral Medicine in Dankook University Dental Hospital were selected in this study (M:F=7:29, mean age of 29.2±14.8 years). A computerized T-Scan II system (Tekscan, INC., USA) was employed for occlusal analysis and the simultaneity and occlusal balance through the number of tooth contact and magnitude of contact force were determined before and after TMD treatment.

The number of contact points and contact force was more on the unaffected side than the affected side before treatment ( $p=0.056$  and  $p=0.060$ , respectively) while significant difference between both sides was not found after treatment. The number of contact points and contact force on the affected sides significantly increased after treatment ( $p=0.038$  and  $p=0.052$ ), but the unaffected sides exhibited no significant difference between before and after treatment. In addition, sides difference in relative contact force decreased from about 27% to about 12% after TMD treatment ( $p=0.001$ ).

According to the results of this study, it is likely that unilateral TMD impairs right-to-left occlusal balance and that conservative TMD treatment alleviates the imbalance, subsequently leading to more symmetrical occlusal condition with increased contact points and force.

Key words : T-Scan II, TMD, Contact point, Contact force, Occlusal balance.

## I. INTRODUCTION

Temporomandibular disorders (TMD) cover a

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wide range of abnormal and pathologic conditions caused by physical strain and primary disease of the muscles of mastication and temporomandibular joints, which are accompanied by headache and orofacial pain, and impaired mandibular function<sup>1-3)</sup>.

It is critical, for management of TMD, to appreciate the major causes that may be associated with the condition and a review of scientific literature reveals five major factors associated with TMD including trauma, emotional stress, deep pain input and parafunctional activities and occlusal condition<sup>4)</sup>. Occlusal condition is one contributing factor to TMD that has been strongly debated for many years. In recent years, the acceptance of

theories about the multifactorial etiology of TMD has resulted in less emphasis being placed on occlusion as a TMD-related factor<sup>7)</sup> although the presence of some occlusal abnormalities has been considered a major factor in the etiology<sup>5-6)</sup>.

Aside from occlusal condition as one contributing factor to TMD, change in occlusal contact pattern, which is either temporary or permanent, is one of common complaints from the patients with TMD in clinical setting. Correlation between occlusal contacts and signs and symptoms of TMD have been hypothesized and partially investigated but results are controversial and not conclusive<sup>7-12)</sup>. Naeije et al<sup>13)</sup> indicated that asymmetry of bilateral distribution of occlusal contact in TMD patients whereas Visser et al<sup>14)</sup> showed no significant differences in the electromyographic asymmetries of masticatory muscles. Therefore, assessment of relationships between TMD and occlusal contact patterns could be still of importance.

The purposes of this study were to compare right-to-left difference of occlusal contact pattern, through contact points, contact force and occlusal balance, in the patients with unilateral TMD and also to evaluate effect of TMD treatment. A computerized T-Scan II system was employed for occlusal analysis.

## II. MATERIALS AND METHODS

A computerized occlusal analysis system used for this study was T-ScanTMII (Tekscan, INC., USA). T-Scan II system consists of a piezoelectric foil sensor, sensor support, scanning handle, parallel hardware, and software for recording, analyzing, and viewing the data. The sensor is 60  $\mu\text{m}$ -thick and made of a polyester film. The film is covered by a silver thread grid, the intersecting points of which are bathed by conductive ink. When the patient closes firmly on the sensor, the resultant reduction in electric resistance is translated into an image on the screen<sup>15)</sup>.

A 0.01 second real-time occlusal contact recording and 0.01 second incremental playback of

the tooth contact timing data can illustrate the order of tooth contacts, as well as their force content. The combination of contact order, contact duration that precedes the next occlusal contact, contact location within the arch, and magnitude of contact force determine the degree of contact simultaneity and the occlusal balance that is present or absent in a particular occlusal scheme<sup>16)</sup>.

36 subjects in this study were selected from patients with unilateral TMD examined and diagnosed in the department of Oral Medicine, Dankook University Dental Hospital. Ratio of male to female was 7:29 and their mean age was  $28.9 \pm 14.7$  years. None of them had any serious illness and excluded were those who had extensive prosthesis of more than 3-unit bridgework, missing more than single tooth except third molar, or significant dental and periodontal lesions. All of them gave informed consent prior to the examination.

Occlusal analysis using the T-Scan II system was carried out at the first visit prior to treatment and was repeated after complete or substantial relief of their signs and symptoms. Therapeutic modalities provided to them employed variable conservative treatment including behavioral modification, pharmacological therapy, physical therapy and exercise, and occlusal splint therapy. None of them were involved with any irreversible therapy such as prosthetic, orthodontic and surgical treatment.

During the T-Scan II recordings, the subjects were seated in a dental chair in upright position. Once the foil sensor was correctly inserted between upper and lower arches in the subject's mouth, he or she was asked to close the mouth and occlude the sensor in the habitual intercuspal position with normal pressure. After several practices were made until a repeatable pattern of tooth contacts was produced on the computer monitor to verify the reliability of the data, a representative force movie was recorded and printed. The simultaneity and occlusal balance through the number of tooth contact and magnitude of contact force were

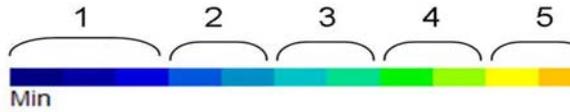


Fig. 1. The legend (color scale) of contact force.

determined. With this system, each test sheet was divided into right and left sides by the midline of the dental arch. The balance of contact force was expressed as the percentage of total contact force on the side, either left or right, which was defined as ‘relative contact force (%)’ here.

Magnitude of contact force was relatively displayed by color scale on the screen (that is, blue is the lowest and red the highest), so that contact force in this study was obtained by multiplying the number of contact points by intensity of each point. The force intensity was determined from 1 (the lowest) to 6 (the highest) according to the legend (Fig. 1).

Collected data was processed using SPSS Window program ver 12.0. Paired t-test was used to compare any difference of occlusal contact pattern between the affected and unaffected sides of the TMD patients, as well as between before and after treatment.

### III. RESULTS

Table 1 represents the number of contact points, contact force and relative contact force in the patients with unilateral TMD. The number of contact points and contact force was more on the unaffected side than the affected side before treatment ( $p=0.056$  and  $p=0.060$ , respectively) while significant difference between both sides was not found after treatment.(Fig. 2 & 3). The number of contact points and contact force on the affected sides significantly increased after treatment ( $p=0.038$  and  $p=0.052$ ), but the unaffected sides exhibited no significant difference between before

Table 1. Number of occlusal contact points, contact force and relative contact force (mean±SD) between before and after treatment.

<i>Number of Contact points</i>			
	Pre-Tx	Post-Tx	Paired t-tests
Affected side	51.94±36.24	65.32±42.12	$p=0.038$
Unaffected side	59.74±36.40	71.55±46.10	$p=0.136$
Paired t-tests	$p=0.056$	$p=0.153$	
<i>Contact force (=number of contact point x intensity of each point)</i>			
	Pre-Tx	Post-Tx	Paired t-tests
Affected side	95.07±87.13	133.26±111.35	$p=0.052$
Unaffected side	112.52±80.93	142.51±121.24	$p=0.172$
Paired t-tests	$p=0.060$	$p=0.295$	
<i>Relative contact force (%)</i>			
	Pre-Tx	Post-Tx	Paired t-tests
Affected side(A)	50.06 ± 18.08	49.17 ± 9.57	
Unaffected side(B)	49.94 ± 18.08	50.83 ± 9.57	
Absolute sides difference ( A-B )	27.38 ± 23.15	12.62 ± 14.32	$p=0.001$

(N=36)

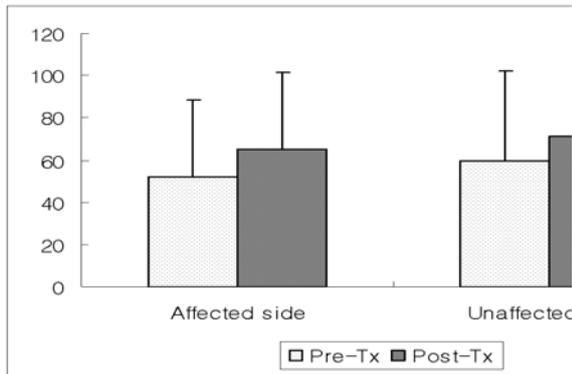


Fig. 2. Number of contact points for the unilateral TMD patients before and after treatment.

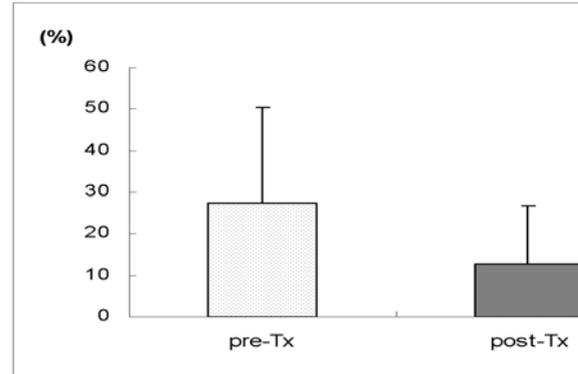


Fig. 4. Absolute sides difference of the relative contact force for the unilateral TMD patients before and after treatment.

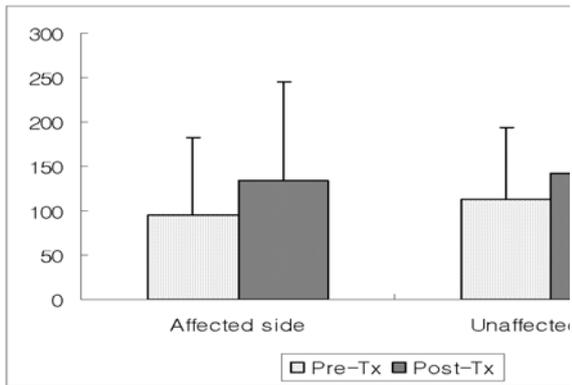


Fig. 3. Contact force for the unilateral TMD patients before and after treatment.

and after treatment.

The mean relative contact force (%) of total contact force before treatment was  $50.06 \pm 18.08\%$  on the affected sides and  $49.94\%$  on the unaffected, symptom-free sides and, after TMD treatment, they were changed into  $49.17 \pm 9.57\%$  and  $50.83 \pm 9.57\%$ , respectively. It is unlikely that their values showed noticeable difference before and after treatment. However, when comparing absolute sides difference of the relative contact force ( $|\text{relative force of the affected side} - \text{relative force of the unaffected side}|$ ), the sides difference significantly decreased from  $27.38\%$  before treatment to  $12.67\%$  after treatment. ( $p=0.001$ , Fig. 4)

#### IV. DISCUSSION

Diagnosis of occlusion for TMD patients is important and variable methods have been used for examination of occlusal contact. T-Scan II system was used for the patients with unilateral TMD in this study. Conventional registration materials such as inked marking strips<sup>17</sup>, waxes<sup>18</sup>, ribbons and silicone<sup>19</sup> and other impression materials such as plaster have been used for occlusal analysis. Although these materials are preferred primarily because of their low cost and easy application, they are affected by the presence of saliva<sup>20</sup> and show low reproducibility and high variability<sup>21</sup>. T-Scan system registers and depicts a measure of the dynamics of occlusion<sup>22,23</sup>. The sensitivity of this system is not changed whether the saliva is present or not<sup>23</sup>. In a few study about comparing the T-Scan system with another registration material in vivo and in vitro, this system showed high accuracy and validity<sup>24,25</sup>. Moreover, T-Scan can be used to objectively and quantitatively analyze the balance of occlusal contact force expressed by percentage value although complicated calculations by hand were required to evaluate number and force of occlusal contact.

The results from this study showed that the number of contact points and contact force was more on the unaffected side than the affected side

before treatment ( $p=0.056$  and  $p=0.060$ , respectively) and that the difference decreased after treatment (Fig. 2 & 3). These findings are closely associated with significant decrease in the sides difference of relative contact force between before and after treatment (Fig. 4), which likely means alleviation of deteriorated right-to-left occlusal balance with TMD treatment.

Ciancaglini et al<sup>26)</sup> studied on occlusal contacts of 25 TMD patients and 25 healthy controls in the intercuspal position through wax registration and showed no difference between the two groups for the overall number and distribution of contacts or for any side and intensity of contact. However, considering intra-subject occlusal contact distribution, they confirmed significant positive association of TMD with bilateral asymmetry of the total number of contact points and of the number of posterior contacts. Mizui et al<sup>27)</sup> also demonstrated a marked difference in occlusal balance between TMD patients and the normal controls by mean of T-Scan system. While the controls had bilateral balance and an anteroposterior center of force in the first molar region, TMD patients showed asymmetrical time moment and occlusal force parameters. In addition, it was observed that the center of effort anteroposteriorly was not always located in the 1st molar region.

Kurita et al<sup>28)</sup> evaluated the effect of splint on occlusal force in patients with masticatory muscle disorders using the computerized system with Dental Prescale<sup>®</sup> and presented that there was no significant changes in the number of occlusal points, mean occlusal pressure, and asymmetry in occlusal balance between before and after the use of the splint. However, the study showed that the integrated occlusal load converged to the normal value with the use of the splint, exhibiting normalizing effect of splint on the occlusal force. The occlusal loads in the higher level decreased and, in contrast, those in the lower level increased with the use of the splint. They suggested that the use of splint has the effect of reducing the hyperactivity and the asymmetry in the activity of

the jaw elevator muscles, and consequently brings a stable and physiologically optimal occlusal force from the muscles. Shoji<sup>29)</sup> evaluated treatment efficacy in the TMD patients through occlusal force with Dental Prescale<sup>®</sup> and exhibited that occlusal force was significantly increased after treatment.

These findings in part agree with ours exhibiting manifest difference between the affected and unaffected sides before TMD treatment and decrease of the difference after TMD treatment, subsequently leading to more symmetrical occlusal condition with increased contact points and force. However, there still exist several studies indicating approximately the same number of contact points on the right and left sides and bilateral almost balanced occlusion<sup>30-32)</sup>.

The study by Ciancaglini et al<sup>26)</sup> also indicated significant concordance (88.9%) between the side of disorder and the side of higher number of contacts in 9 patients with unilateral TMD. This result is in contrast with ours demonstrating the less contact points and force on the affected side compared to the unaffected side. This discrepancy may be in part explained by selection of TMD patients and methodology used for occlusal analysis. As TMD embraces variable conditions related with masticatory muscles and TMJ, it is therefore needed to evaluate occlusal contact pattern in large population with TMD divided more specific subgroups.

Conclusively, based on our results, it is likely that unilateral TMD impairs right-to-left balance of contact force and conservative TMD treatment without any irreversible occlusal therapy alleviates the imbalance, leading to more symmetrical occlusal condition with increased contact points and force.

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국문초록

## T-Scan II 시스템을 이용한 측두하악장애 환자의 교합 분석

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측두하악장애가 교합접촉 양상에 영향을 주는지에 관해 오랫동안 연구가 계속되어 왔으나 아직 명확한 결론을 내리지 못하고 있다. 본 연구의 목적은 편측성 측두하악장애 환자에서 증상측과 무증상측 사이의 교합접촉 양상을 비교하고 치료 전후 변화를 평가하고자 하였다.

단국대학교 치과대학부속병원 구강내과에 내원한 측두하악장애 환자 중 편측 증상만을 가진 환자 36명을 대상으로 T-Scan II system (Tekscan, INC., USA)을 사용하여 치료 전후의 교합접촉 양상을 평가하였다(남:녀=7:29, 평균 29.2±14.8세). 좌우측의 접촉점 수(number of contact point), 접촉력(contact force), 상대적 접촉력(relative contact force, %)을 조사하여 치료 전후의 좌우 균형성을 비교하였다.

연구 결과, 치료 전 환자의 증상측은 무증상측에 비해 접촉점 수와 접촉력이 감소되었으나(접촉점 수: p=0.056, 접촉력: p=0.060), 치료 후에는 증가되어 양측 간에 차이를 보이지 않았다. 증상측의 접촉점 수와 접촉력이 치료 전후에 차이를 보인 반면(접촉점 수: p=0.038, 접촉력: p=0.052), 비이환측은 치료에 따른 유의한 변화를 보이지 않았다. 악궁 내 좌우 균형성을 평가하는 상대적 접촉력의 차이를 비교했을 때, 치료 전 양측간 차이가 약 27%였다가 치료 후에 약 12%로 유의하게 감소되었다(p=0.001).

이와 같은 결과로 볼 때, 편측성 측두하악장애 환자에서는 교합접촉 양상의 좌우불균형을 보이지만, 보존적 치료 후에 그 차이가 현저하게 감소되어 보다 대칭적이고 균형적인 교합을 회복하며 접촉점 수와 접촉력이 증가하는 것으로 생각된다.

주제어: 티스칸, 측두하악장애, 접촉점, 접촉력, 교합균형.