A STUDY ON OCCLUSAL CONTACT USING COMPUTERIZED OCCLUSAL ANALYSIS SYSTEM

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Ⅰ. INTRODUCTION

Understanding the nature of occlusal tooth contacts of natural dentition is important for correct diagnosis and treatment of diseases developed in stomatognathic system[1]. Several investigators have studied the distribution of the tooth contacts in maximum intercuspation and have reported contact locations with respect to the tooth position[2-7]. The methods used to identify tooth contacts in these studies can be divided into two types[8] : qualitative and quantitative method.

Qualitative methods involve the use of marking papers, shim stocks, occlusal waxes, silicone impressions, or combination of these materials to identify the presence of tooth contacts, and the results are recorded by counting the number of contacts and describing the tooth locations.

Quantitative methods involve the use of photo-occlusion[9], which describes contact intensities, and the T-Scan system (Tekscan, Inc., Boston, U.S.A.)[10,11] which describes the timing and force characteristic of tooth contacts.

Normal occlusion implies bilateral-simultaneous tooth contacts.[12] So for precise determination of occlusal harmony, it is necessary to compare the timing of tooth contacts bilaterally, but with qualitative methods, bilateral simultaneous contact can be obtained only with great difficulty. Therefore, quantitative method with time variables should be used to determine occlusal harmony. However, there were few studies about occlusal contact, using quantitative method with time variables.

A recently developed device, T-Scan system, use both time and force variables to quantify occlusal contacts. [10] which enables refinement of normal occlusion. The purpose of this study was to analyse occlusal contacts quantitatively using various levels of biting pressure.

Ⅱ. MATERIALS AND METHOD

1. Subject

Twenty-one individuals of age ranged from 19 to 26 years(mean, 23.6 years) were examined. They were selected according to the following criteria[1,10] : (1) normal tooth alignment with angle Class I molar and canine relation and no prior to orthodontic treatment, (2) complete dentition except for some occasionally missing third molars, (3) no pathologic periodontal condition or symptoms of craniomandibular disorder, and (4) no prosthesis. The subjects were primarily dental students and graduate students of Seoul National University.

2. Method

Subjects were asked to sit upright in the dental chair without a head rest, and the sensor of T-Scan was placed in the subject's mouth so that the pointer on sensor support was aligned with the midline of the subject's upper incisors(Fig. 1).[13] The T-Scan system, is shown fig 2, digitizes the location and timing of tooth contact and presents a rapid, quantitative method of describing tooth contact data. Then subjects were asked to close on the occlusal sensor of T-Scan using various levels of biting pressure(i.e. biting pressure at level about 20%, 50%, 80% of maximum muscular activity of temporalis anterior) in habitual intercuspal position. Several practice closures were made until a repeatable pattern of contact was seen on the video monitor, and at that time four closures were recorded in time mode. Various levels of biting pressure(i.e. biting pressure at level about 20%, 50%, 80% of maximum muscular activity of temporalis anterior) were measured by EM2(Myotronic Reasearch Inc., Seattle, Washington, U.S.A.) using biofeedback(Fig. 3, 4).

Figure 5, 6, 7 show a typical time sequence display showing the tooth contact position and relative timing at various levels of biting pressure. The data were 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.

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.). Differences in mean values of variables were submitted to paired t-test as all the observations had approximately normal distributions. Differences between distributions of variables were tested with MANOVA.

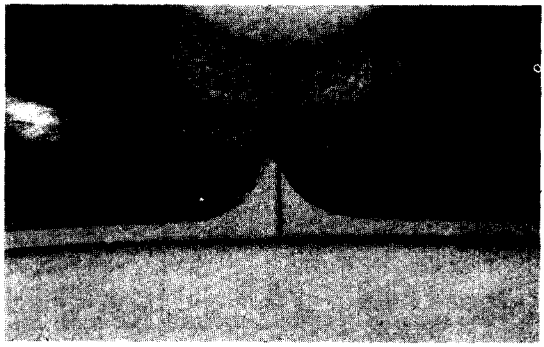


Fig. 1. Proper position of sensor and pointer.

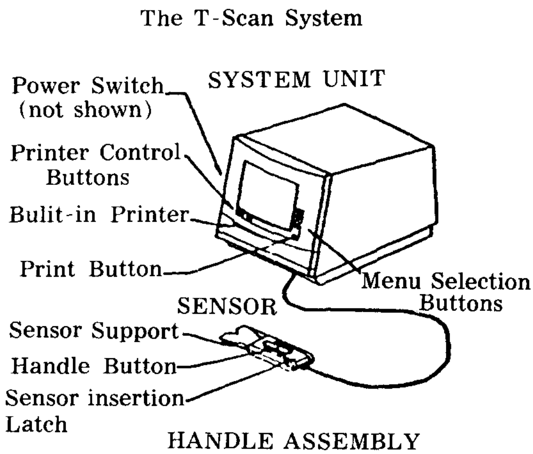


Fig. 2. Schematic diagram of T-Scan system.

Fig. 3. A view of recording procedure by T-Scan and EM2.

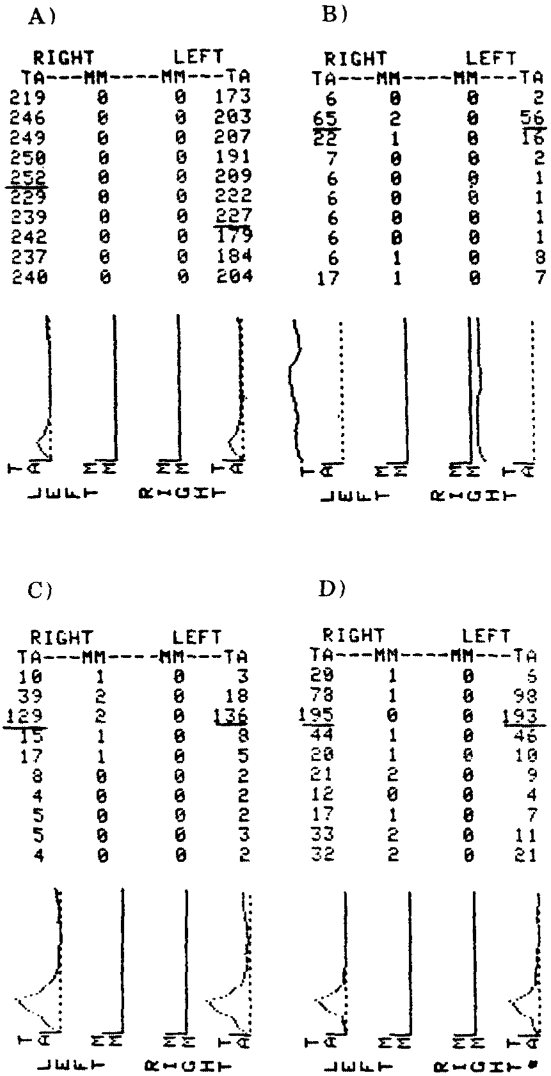
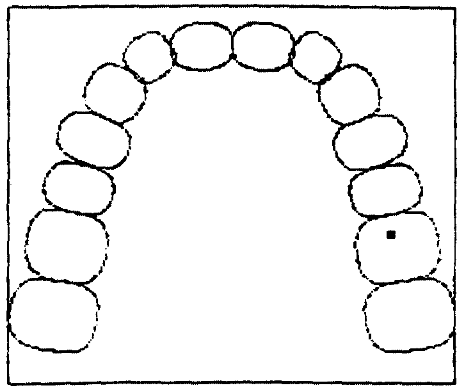


Fig. 4.
A) Muscular activity recorded by EM2 at maximal clenching
B) Muscular activity recorded by EM2 using biting pressure at level about 20% of maximum muscular activity of temporalis anterior.
C) Muscular activity recorded by EM2 using biting pressure at level about 50% of maximum muscular activity of temporalis anterior.
D) Muscular activity recorded by EM2 using biting pressure at level about 80% of maximum muscular activity of temporalis anterior.

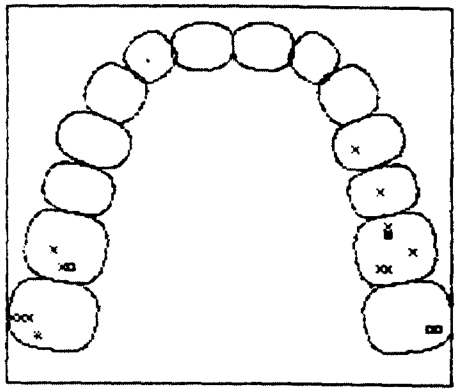
Contact Time (sec)
■ First 0.00
※ Second none
□ Third none



Right Left
Trial: 3-H
Duration of closure: 0.00

Fig. 5.Typical time sequence display recorded by T-Scan using biting pressure at level about 20% of maximum muscular activity of temporalis anterior.

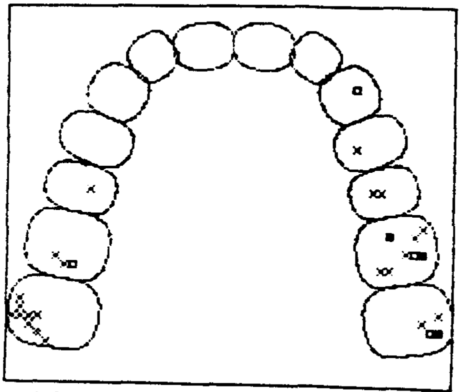
Contact Time (sec)
■ First 0.00
※ Second 0.01
□ Third 0.02
✕ Other



Right Left
Trial: 9-H
Duration of closure: 0.07

Fig. 6.Typical time sequence display recorded by T-Scan using biting pressure at level about 50% of maximum muscular activity of temporalis anterior.

Contact Time (sec)
■ First 0.00
⁘ Second 0.01
□ Third 0.02
✖ Other



Right Left
Trial: 2-H
Duration of closure: 0.21

Fig. 7. Typical time sequence display recorded by T-Scan using biting pressure at level about 80% of maximum muscular activity of temporalis anterior.

Ⅲ. RESULTS

The mean values for the number of tooth contacts were 1.6, 8.8 and 16.7 during biting pressure at level about 20%, 50% and 80% of maximum muscular activity of temporalis anterior, respectively. There was, on a highly significant level (F : $p<0.001$), an increase of the number of tooth contacts as biting pressure is increased(Table 1).

The mean values for the total duration of closure were 0.01sec., 0.08sec. and 0.19sec. during biting pressure at level about 20%, 50% and 80% of maximum muscular activity of temporalis anterior, respectively. There was, on a highly significant levels (F:$p<0.001$), an increase of the total duration of closure as biting pressure is increased(Table 2).

The mean values for the number of contacts per tooth were 0.2, 1.4 and 2.2 for the molars, 0.1, 0.5 and 1.1 for the premolars and 0.1, 0.2 and 0.6 for the anterior teeth during biting pressure at level about 20%, 50% and 80% of maximum muscular activity of temporalis anterior, respectively(Table 3)

There was a highly significant increase of the number of contacts on molars, premolars, anterior teeth as biting pressure is increased.

In 57% of the subjects, they had 60% or more contacts on one side during biting pressure at level about 50% of maximum muscular activity. The corresponding value was 38% during biting pressure at level about 50% of maximum muscular activity of temporalis anterior(Table 4, 5).

The subjects were grouped as symmetrical occlusal distribution group and asymmetrical occlusal distribution group (contacts ≧ 60% on one side). There was not a significant difference in total duration of closure between the asymmetricl occlusal distribution group and symmetrical occlusal distribution group(Table 4, 5).

Table 1. Mean values and standard deviations of the number of tooth contacts recorded by T-Scan in the habitual intercuspal position using various levels of biting pressure.

	IP 20	IP 50	IP 80	F
$\bar{x}$	1.6	8.8	16.7	262.52
s.d.	0.7	3.6	3.0	($p<0.001$)

IP 20: biting pressure at level about 20% of maximum muscular activity of temporalis anterior.
IP 50 : biting pressure at level about 50% of maximum muscular activity of temporalis anterior.
IP 80 : biting pressure at level about 80% of maximum muscular activity of temporalis anterior.

Table 2. Mean values and standard deviations of total duration of closure recorded by T-Scan in the habitual intercuspal position using various levels of biting pressure.

	IP 20	IP 50	IP 80	F
x	0.01	0.08	0.19	229.32
s.d.	0.01	0.02	0.04	($p<0.001$)

IP 20: biting pressure at level about 20% of maximum muscular activity of temporalis anterior.
IP 50 : biting pressure at level about 50% of maximum

muscular activity of temporalis anterior.
IP 80 : biting pressure at level about 80% of maximum muscular activity of temporalis anterior.

Table 3. Mean values and standard deviations of contacts per tooth recorded by T-Scan in the habitual intercuspal position using various levels of biting pressure.

	Molas			Premolars			Anterior teeth		
	IP 20	IP 50	IP 80	IP 20	IP 50	IP 80	IP 20	IP 50	IP 80
$\bar{x}$	0.3	1.4	2.2	0.1	0.5	1.1	0.1	0.2	0.6
s.d.	0.17	0.47	0.37	0.14	0.34	0.42	0.13	0.20	0.31

IP 20 : biting pressure at level about 20% of maximum muscular activity of temporalis anterior.
IP 50 : biting pressure at level about 50% of maximum muscular activity of temporalis anterior.
IP 80 : biting pressure at level about 80% of maximum muscular activity of temporalis anterior.

Table 4. Mean values, standard deviations of total duration of closure in symmetrical occlusal distribution group and asymmetrical occlusal distribution group devided by the number of tooth contacts recorded by T-Scan using biting pressure at level about 50% of maximum muscular activity of temporalis anterior.

	IP 50
Symmetrical group	
n(43%)	9
$\bar{x}$	0.082
s.d.	0.016
Asymmetrical group	
n(57%)	12
$\bar{x}$	0.084
s.d.	0.029
Diff.	0.002 n.s.

IP 50 : biting pressure at level about 50% of maximum muscular activity of temporalis anteror.
n.s. : not statistically signficant.
Diff. : difference between means.

Table 5. Mean values, standard deviations of total duration of closure in symmetrical occlusal distribution group and asymmetrical occlusal distribution group devided by the number of tooth contacts recorded by T-Scan using biting pressure at level about 80% maximum muscular activity of temporalis anterior.

	IP 80
Symmetrical group	
n(62%)	13
$\bar{x}$	0.197
s.d.	0.046
Asymmetrical group	
n(38%)	8
$\bar{x}$	0.195
s.d.	0.023
Diff.	0.002 n.s.

IP 80 : biting pressure at level about 50% of maximum muscular activity of temporalis anterior.
n.s. : not statistically significant.
Diff. : difference between means.

Ⅳ. DISCUSSION

Occlusal contacts in habitual intercuspal position represent important signs of states of disease or health. Complete evaluation of these contacts can show adaptive changes(such as excessive wear), which may be a sign of parafuntional habits or the result of the neuromusular system trying to cope with destructive premature contacts.[14]

An understanding of the forces and timing of these important tooth contacts is essential in diagnosing the health of the patient.

Bilateral simultaneous contact is the accepted standard of an ideal occlusion.[12] It is the most important factor in the construction of an occlusion. Using current methods, such as marking materials, occlusal contacts are still difficult to understood, especially when they are compared bilaterally.[10]

Occlusal force is increased when a high or premature contact is present.[15] In addition, premature contact can create the potential for neuromuscular dysfunction.[14,16,17]

In this study, the number of tooth contacts and total duration of closure recorded by T-Scan in habitual intercuspal position is significantly increased as biting pressure is increased. This finding is in agreement with finding of an earlier investigation.[3,18] It shows that occlusal instability seems to be a common condition, often stated clinically as light pressure by contacts only on one side, or lack of contacts on molars, which in both cases produce pivot effect on the mandible.[3] Thus, occlusal contacts in habitual intercuspal position must be evaluated using various levels of biting pressure.

An interesting result in this study was that the mean values for the number of tooth contacts on molars, premolars, and anterior teeth, respectively, are lower than expected. This should be taken into account in all polishing work as well as in occlusal adjustment. Since the neuromuscular system is extremely sensitive[16,19,20] and reacts to changes as low as 50μm in the occlusal relationship,[20] great care must be taken in order not to decrease the number of existing contacts.[3]

Difference in the number of posterior-canine tooth contacts were found between the sides in many investigations.[4,18,20] McCarroll[18,22] et al. reported that small difference in the number of posterior-canine tooth contacts were shown to affect masseter muscle balance, therefore symmetry in the amount of tooth contacts must be achieved. However, Risse and Ericsson[4] reported that occlusal instability was not related to change in the number or distribution of occlusal contacts only, but is related to the difference between light pressure and hard pressure. In this study, there was no significant difference in total duration of closure between symmetrical occlusal distribution group and asymmetrical occlusal distribution group (Table 4, 5). These results support the conclusion of Risse and Ericsson.

The total duration of closure statistic is a calculation of the total elapsed time from first contact to last and is a always reported by the T-Scan system for any closure, but the total duration of closure statistic[23] and its relationship to muscle incoordination has only recently been described.[11] It is necessary to study patients exhibiting symptoms of muscle dysfunction in the future.

V. CONCLUSION

The author analysed occlusal contacts quantitatively using various levels of biting pressure(i.e. biting pressure at level about 20%, 50%, 80% of maximum muscular activity of temporalis anterior) by computerized occlusal analysis system, in twenty-one adults with complete dentition showing no sign of occlusal complications.

The obtained results were as follows :

1. The mean values for the number of tooth contacts were 1.6, 8.8 and 16.7 during biting pressure at level about 20%, 50% and 80% of maximum muscular activity of temporalis anterior, respectively. There was a highly significant increase of the number of tooth contacts as biting pressure is increased.

2. The mean values for the total duration of closure were 0.01sec., 0.08sec. and 0.19sec. during biting pressure at level about 20%, 50% and 80% of maximum muscular activity of temporalis anterior, respectively. There was a highly significant increase of the total duration of closure as biting pressure is increased.

3. The mean values for the number of contacts per tooth were 0.2, 1.4 and 2.2 for the molars, 0.1, 0.5 and 1.1 for the premolars and 0.1, 0.2 and 0.6 for the anterior teeth during biting pressure at level about 20%, 50% and 80% of maximum muscular activity of temporalis anterior, respectively. There was a highly significant increase of the number of contacts on molars, premolars, anterior teeth as biting pressure is increased.

4. There was not a significant difference in total duration of closure between the asymmetrical occlusal distribution group and the symmetrical occlusal distribution group.

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Computerized Occlusal Analysis System을 이용한 Occlusal Contact에 관한 연구

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연태호 · 김영구

- 국문초록 -

저자는 정상 치열을 가지며 두개하악장애의 증상 및 병력이 없는 성인 21명을 대상으로 Computerized Occlusal Analysis System인 T-Scan system을 이용하여 교합력에 따른 치아접촉수와 총치아접촉시간을 측정한 후 정량적인 분석을 시도하여 다음과 같은 결론을 얻었다.

1. 최대 측두근 전부 근활성도의 약 20%, 50%, 80% 수준의 교합력에서 치아접촉수의 평균은 각각 1.6개, 8.8개, 16.7개로 교합력이 증가할수록 유의하게 증가하였다.

2. 최대 측두근 전부 근활성도의 약 20%, 50%, 80%수준의 교합력에서 치아당 치아접촉수의 평균은 대구치에서는 0.2, 1.4, 2.2개였으며 소구치에서는 0.1, 0.5, 1.1개였고, 전치에서는 0.1, 0.2, 0.6개로 교합력이 증가함에 따라 유의하게 증가하였다.

3. 최대 측두근 전부 근활성도의 약 20%, 50%, 80% 수준의 교합력에서 총치아접촉시간의 평균은 0.01, 0.08, 0.19초로 교합력이 증가할수록 유의하게 증가하였다.

4. 치아접촉분포로 구분된 대칭군과 비대칭군간의 총치아접촉시간에는 유의한 차이가 없었다.

주요어 : 교합접촉, 컴퓨터 교합분석, 최대 근활성도, 치아접촉분포.