Occlusal Force Distributions in Various Angle'sMalocclusions: an Evaluation by T-Scan III System

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Abstract

Angle's malocclusions have been documented to affect unbalance force and masticatory performance. Hence, this study aimed to evaluate the occlusal force distributions inthe maximal intercuspal position (MIP) among subjects with various Angle'smalocclusions by using a T-Scan III system.

One hundred subjects were divided into Angle's Class I, Class II division 1, Class II division 2, and Class III malocclusions. Their percentages of occlusal force distributions were recorded by using a T-Scan III system. The data were analyzed by using a one way ANOVA followed by a post hoc test (P< .05).

In the respective malocclusion types, the percentages of force distributions (mean ± standard deviation) were 8.93 ± 6.31, 9.44 ± 6.75, 13.07 ± 8.35, and 10.58 ± 8.46 at the anterior region. They were 24.74 ± 9.42, 24.93 ± 7.25, 22.93 ± 9.92, and 27.78 ± 11.51 at the premolar, and 66.42 ± 12.63, 65.80 ± 11.66, 63.87 ± 16.20, and 61.65 ± 15.33 at the molar regions.

With respect to the region, no significant difference (P> .05) in the percentages of force distributions was found among the malocclusion types. In each malocclusion type, there were significant differences in the force distributions among the regions.

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Introduction

The masticatory system is complex and consisted of temporomandibular joint, masticatory muscles, ligaments, associated tissues, and dental occlusion.[1] The dental occlusion is varied due to several factors such as tooth alignment, dental arch size, tooth position, and tooth eruption sequence.[2,3] Normal occlusion is the orthodontic treatment goal[4,5] encouraging contacts of all teeth with heavier ones among those in the posterior region than those in the anterior.[6-8]

Occlusal force distributions as a result of normal occlusion affect the masticatory system's harmoniously functional patterns.[9-11] By using an articulating paper, an occlusal indicator wax, or a shim stock, the occlusal contacts' locations can be recorded and the occlusal forces are indirectly implied.[12-14]Some digital occlusal indicators including a gnathodynamometer,[15] a Dental Prescale system,[16] and a T-Scan system[17] are reported to overcome such limitations. Unlike other digital indicators, a T-Scan system can record temporal changes related to occlusion, that is, occlusal contact time sequences and disclusion time.[18] The T-Scan III system is the newest version for analyses of both static and dynamic occlusions with a great precision.[19] Although some reports on the utilizations of the T-Scan III system to assess subjects with normal occlusion and malocclusions are available,[8,20,21] none of them have compared the percentages of occlusal forces among malocclusion types.

Classifications by Angle[4] and Andrew[5] are concerned about static patterns of teeth, but not dynamic procedures or their consequences of mastication. Subjects with normal occlusion are reported to have well-distributed occlusal contact areas, while that with malocclusion lower masticatory performances.[22-24] Subjects with

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different Angle's classification of malocclusion were hypothesized to possess different occlusal force distributions. Although some previous studies have indicated the relationships between dental occlusions and force distributions,[20,25,26] the occlusal force distributions among all malocclusions under a T-Scan III system have never been reported. Hence, the objective of this study was to compare and evaluate their occlusal force distributions in the maximal intercuspal position (MIP) by using a T-Scan III system.

Materials and methods

This study was approved by Naresuan University Ethical Committee, Phitsanulok, Thailand (IRB Number 2979). One hundred subjects were participated in this study. All of them had symmetrical dental arch forms with a minimum of 28 permanent teeth (seven teeth in each quadrant). In addition, they showed no restorative material, dental implant, fixed prosthesis, past or undergoing orthodontic treatment, molar relationship's classification on one side different from that on the other, TMD, or parafunctional habit. Based on Angle's classification of malocclusions, they were divided into Class I, Class II division 1, Class II division 2, and Class III (n = 25 for each group). Collections of the data were separated into two visits. In the first visit, impressions of the subjects' maxillary and mandibular dental arches were taken for diagnostic models. Mesiodistal width of maxillary teeth was measured by using an LCD digital vernier caliper (Mitutoyo, Mitutoyo Co, Kanagawa, Japan) and recorded into a T-Scan system (T-Scan III, Software version 9.1.9, TekscanInc, Boston, MA). In the second visit (one week later), the subjects were seated upright in a dental chair with their Frankfort horizontal plane parallel to the floor. Pre-recording by the T-Scan, they were instructed to bite into the MIPseveral times. They were asked to bite into the T-Scan sensor in the MIP and hold for 3-5 seconds before releasing. The percentages of relative occlusal force distributions were recorded by selecting an MIP mode in the program. Summations of the relative force at MIP were recorded at three separated regions, that is, molar (first and second molars, numbers 1-3 and 14-16 in Figure 1), premolar (first and second premolars, numbers 4-5 and 12-13 in Figure 1), and anterior (canine-to-canine, numbers 6-11 in Figure 1) ones. All recording procedures were repeated three times and their mean values werecalculated.

Data were analyzed with a statistical package program SPSS Version 17.0 for Windows (SPSS Inc, Chicago, IL). Descriptive statistics, including means, standard deviations, and ranges of relative occlusal force distributions, were calculated for each region. Comparisons of the relative occlusal force distributions' mean summations were assessed by a one way analysis of variance with post hoc analysis. The level of significance was set at $P < 0.05$.

Results

Sample descriptions and percentages of the relative occlusal force distributions among the malocclusion types are shown in Table 1.There was no significant difference in the subjects' mean ages (P = .716). Significant differences were found among the means of overbite (P = .000). The highest value was observed in Class II division 2, whereas the lowest in Class III. Significant differences were found among the means of overjet (P = .000), except that between Class II division 2 and Class III (P = .614). The highest value was observed in Class II division 1, whereas the lowest in Class III.

The means of occlusal force distributionsat anterior, premolar, and molar regions are shown in Table 1. At the anterior region, the highest value was detected in Class II division 2, while the lowest in Class I. At the premolar region, the highest value was detected in Class II, while the lowest in Class II division 2. At the molar region, the highest value was detected in Class I, while the lowest in Class III.With respect to the region, there were no significant differences in the mean force distributions among malocclusion types (anterior region, P = .220; premolar region, P = .316; and molar region, P = .627). With respect to the malocclusion type, there were significant differences in the force distributions among the regions (P = .000) and post hoc test disclosedsuch significant differences ($P < .05$) among all pairing groups (Table 1).

Discussion

Our results from the utilization of a T-Scan system clearly indicated some similar patterns of the subjects' occlusal force distributions, despite their different Angle's malocclusions, which have never been reported elsewhere.

With its reliable property of digital measurement, T-Scan system was developed for some analyses and evaluations of occlusal contact distributions by measuring the occlusal distributions of forces, not the absolute bite force, applied on the arch. Its high reliability could be obtained when used to perform repeatedmeasurement.[17-19]Its sensitivity and variability of high definition sensor were affected by some repeated closures over 20 times.[27] To overcome some human error in this study, all subjects were instructed to occlude into MIP three times.

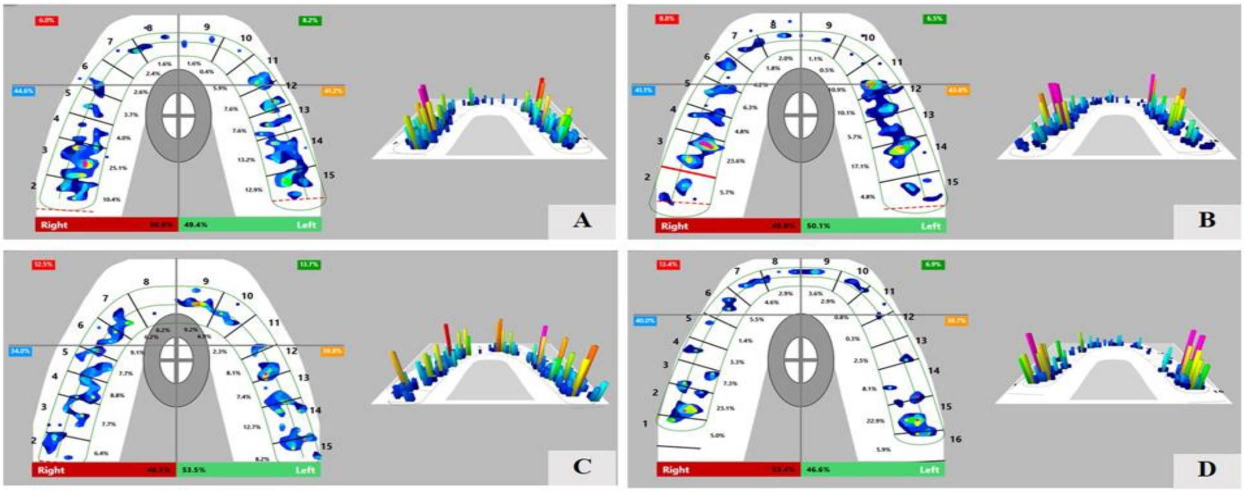

Figure 1. Occlusal force distributions in Angle's Class I (A), Class II division 1 (B), Class II division 2 (C), and Class III (D) malocclusions recorded by using a T-Scan III system and shown by two- (left side of each malocclusion) and three- (right side of each malocclusion) dimensional images. The Universal Numbering System for each maxillary tooth is shown on the facial side.

								Force Distributions (%)												
		Age, y		Overbite, mm		Overjet, mm		Anterior Region				Premolar Region				Molar Region				
Malocclusion Type	Subjects	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	*P*
Class I	25 (F = 14, M = 11)	21.5^{a}	0.78	2.42^{a}	1.05	2.52^{a}	1.04	$8.93^{a,a}$	6.31	0.30	19.40	$24.74^{a,b}$	9.42	12.90	46.70	$66.42^{a,c}$	12.63	39.20	86.87	< .05
Class II division 1	25 (F = 16, M = 9)	22.0^{a}	0.55	3.10^{b}	1.11	4.24^{b}	1.50	$9.44^{a,a}$	6.75	0.00	26.83	$24.93^{a,b}$	7.25	13.70	38.77	$65.80^{a,c}$	11.66	42.37	83.03	< .05
Class II division 2	25 (F = 13, M = 12)	23.5^{a}	1.04	4.70^{c}	1.42	1.62^{c}	0.67	$13.07^{a,a}$	8.35	1.17	26.13	$22.93^{a,b}$	9.92	8.10	47.97	$63.87^{a,c}$	16.20	25.93	87.87	< .05
Class III	25 (F = 16, M = 9)	22.5^{a}	0.44	1.44^{d}	0.95	1.46^{c}	1.11	$10.58^{a,a}$	8.46	0.00	30.87	$27.78^{a,b}$	11.51	13.00	49.53	$61.65^{a,c}$	15.33	37.57	87.00	< .05
P		> .05		< .05		< .05		> .05				> .05				> .05				

* F indicates female, M, male. In each variable, the same uppercase letters indicate non-significant differences (P > .05).
For force distributions, the first uppercase letters indicate comparisons in the same column, while the second ones the same row.

Table 1 Sample descriptions* and their force distributions in each tooth region.

A tendency of force distributions toward the posterior region was shown in all malocclusion types. The highest force was observed at the molar region (61-67%), followed by the premolar (24-28%) and the anterior regions (8-11%). Our results agreed well with those in some previous investigations, which reported that the posterior region possessed a significantly higher occlusal force than the anterior one[20,21] and that patientswith normal occlusion had the trajectory force from first premolar to second molar.[8,26,28,29] In each region, all malocclusions possessed a wide range of forces. These may be contributed to differences in patients' arch shapes and tooth positions on the dental arch.[2] Apart from the highest mean value of overbite, the highest occlusal force at the anterior region was disclosed in Class II division 2, when compared to those in other malocclusion types which were not significantly different. Although no correlation between overbite and Angle'sclassification was seen in a previous report,[20] some relationship between overbite and occlusal force at the anterior region was observable in this study. With respect to bite force and occlusal contact area,subjects with normal occlusion were disclosed with the highest values, followed by those with Class I, Class II division 1, Class II division 2, and Class III malocclusions, respectively.[11,22,25,30,31] By using a digital system, some similar occlusal forces among subjects with different Angle's molar relationships were documented, but without the data of the occlusal force in each region.

Due to some possible effecton the force distributions, subjects with restorative material, dental implant, fixed prosthesis, past or undergoing orthodontic treatment were excluded from this study. Our study has shown a non-significant difference in the force distributions among all malocclusion types. It implied an irrelevance of the malocclusions to the masticatory system in a static occlusion. However, the details on their relationship in a dynamic one need to be clarified. Due to the exclusion of those with open bite, deep bite, or crossbite from our study, some investigations into the occlusal force distributions among the subjects with malocclusions in transversal and vertical dimensions are needed.

Conclusions

In all malocclusions, the posterior region was the area with most force distributions. In each malocclusion type, there were significant differences in the force distributions among molar, premolar, and anterior regions. Relative occlusal force distributions in each regionwere not significantly different among the malocclusions.

Declaration of Interest

The authors declare no conflict of interest.

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