THE CORRELATION OF BITE FORCE IN MAXIMAL INTERCUSPAL POSITION BETWEEN PATIENT'S PERCEPTIONS AND T-SCAN III SYSTEM: A PILOT STUDY

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ABSTRACT

The examination of occlusion is traditionally determined by patient's perceptions and clinician subjective interpretation using articulating paper, shimstock foil, or occlusal indicator wax. However, the results of these conventional techniques are quite inconsistency due to the physical properties of the material. To overcome this issue, digital occlusal indicators (e.g. T-Scan III system) have been increasingly suggested. This study aimed to find the correlation of bite force in maximal intercuspal position (MIP) between patient's perceptions and T-Scan III system. Fifteen subjects were participated in this study. They were asked to bilaterally clench their teeth at MIP with Frankfurt horizontal plane paralleled to the horizontal plane. The bite force was evaluated by themselves and T-scan III analysis. Data were analyzed using Cohen's Weighted Kappa test. The results demonstrated that 6 subjects (40% of total subjects) perceived equally bite force on left and right sides, and this perception was coincided with that of T-Scan III analysis when the equal relative bite force (%) of T-Scan III between left and right sides was determined at ± 15.0% (35.0-65.0%) or ± 20.0% (30.0-70.0%). The least agreement (3 subjects, 20% of total subjects) between patient's perception and T-Scan III analysis was observed when the equal relative bite force of T-Scan III was set at ± 5.0% (45.0-55.0%). Cohen's Weighted Kappa showed the poor and slightly agreement correlation between patient's perceptions and T-Scan III analysis when the cut off value of relative bite force of T-Scan III was not more than ± 10.0 and ± 15.0, respectively.

Keywords: T-Scan, Bite force, Patient's perception, Maximal intercuspal position

1. Introduction

Patient's perceptions of biting force results from to the sensory input from proprioceptors (i.e. muscle spindles, golgi tendon organs, pacinian corpuscles, free nerve ending, and periodontal mechanoreceptors) (Crum & Loiselle, 1972; Kobayashi, 2018). The proprioceptors are highly located in the periodontal ligament (Pfaffmann, 1939) and provide information toward static and dynamic jaw positions such as the forces applied to the teeth (Türker et al., 2007).

When occlusion is examined, a combination of patient's perceptions and clinician subjective interpretation is generally used. Traditionally, clinicians interpret the occlusion by evaluating the ink marks of articulating paper, pulling force of shimstock foil between a pair of occluded teeth, and translucent or perforation area of occlusal indicator wax (Qadeer, 2017). Although these occlusal indicators are practical, their results are variable due to limited ability to discriminate dental occlusion.

For clinician, the reliable instrument is necessary for interpretation of patient's occlusion. Recently, digital occlusal indicators (i.e. T-Scan system) have been developed. This technology provides more evidence-based data for diagnosis and treatment planning (Cohen-Lévy & Cohen, 2012; Kim, 2014). The newest version of digital occlusal indicators is T-Scan III which was developed in 2008 (Tekscan®, Boston, MA, USA; Figure 1). T-scan III system demonstrates not only the occlusal contacts but also shows the percentage of relative bite force, sequential occlusal contacts and disclusion time (Cohen-Lévy & Cohen, 2012; Kerstein, 2010; Kim, 2014).

Despite the more precise and quantitative data from T-Scan III system, the routine examination of occlusion is mainly based on clinician subjective interpretation and patient's perceptions. Furthermore, no previous study investigates the accuracy of bite force from patient's perceptions compared to the digital occlusal indicators.

Figure 1 T-Scan III USB (Tekscan®, Boston, MA, USA) and HD sensor

2. Objectives of the study

The objective of this study was to find the correlation of bite force at maximal intercuspal position between patient's perceptions and T-Scan III system.

3. Materials and methods

Fifteen voluntary undergraduate dental students at Naresuan University, Phitsanulok were enrolled in this study. All subjects were presented at least twenty-four permanent teeth with symmetrical dental arch form and

equal number of teeth. The subjects who have bridge, the anterior crossbite, second or third degree tooth mobility, tooth and/or jaw bone lesion, history of temporomandibular disorders (TMDs) and/or parafunctional habits, pending treatment of TMDs, pending active orthodontic treatment and dental treatment during period of the study were excluded.

For each subject, a one-week interval of two appointments was used. During the first appointment, oral examination and alginate impression for study model was made. The study model was used to measure the mesio-distal width of all teeth to set up T-Scan III program. During the second appointment, the patient's perceptions and T-scan III analysis data were collected at the MIP. Briefly, the subjects were trained to pose mandible in the same MIP before data collection. They were asked to triplicatedly bilaterally clench their teeth at MIP with Frankfurt horizontal plane paralleled to the horizontal plane. They were also asked whether or not the teeth were occluded equally on both sides and which side was heavier. To collect the T-scan III data, subjects were asked to bilaterally clench their teeth on the HD sensor of T-scan III for 3-5 seconds. The relative bite force represented as percentage of each side was collected (Figure 2). These processes were repeated three times. Relative bite force was reported as mean values and classified as left, right or both side indicating the heavier relative bite force with different cut off value (±5.0%, 10.0%, 15.0%, 20.0%) from 50% relative bite force.

Cohen's Weighted Kappa was used to determine the correlation of relative bite force. The Kappa score is categorized as follows: poor agreement (Score 0), slight agreement (Score 0.0-0.20), fair agreement (Score 0.21-0.40), moderate agreement (Score 0.41-0.60), substantial agreement (Score 0.61-0.80), and almost perfect agreement (0.81-1.0) (Landis & Koch, 1977).

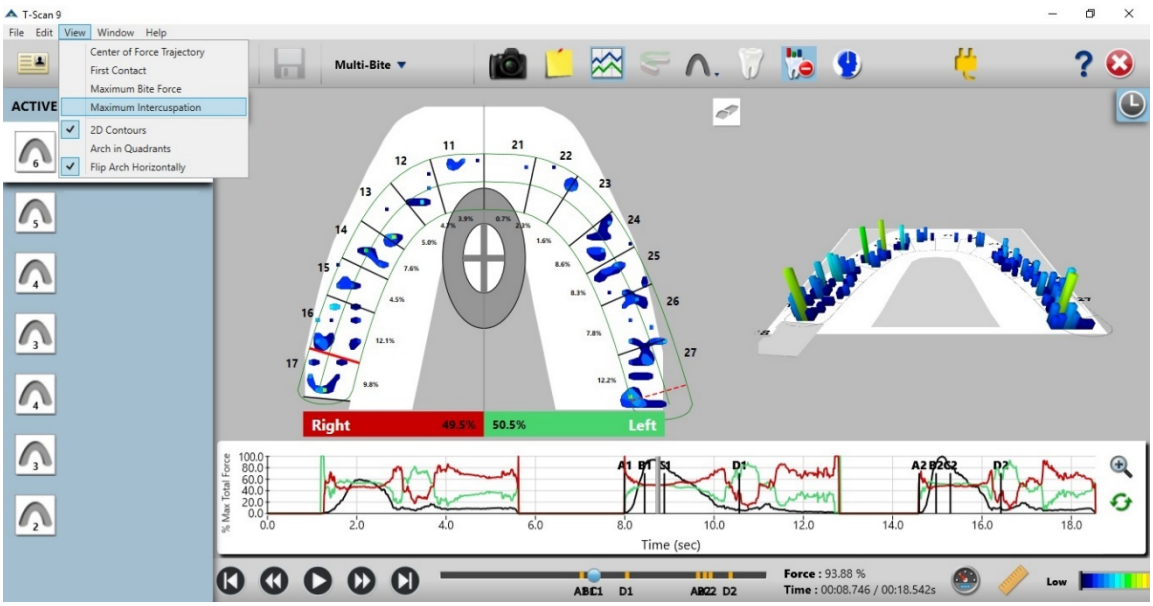

Figure 2 Maximum intercuspation mode in T-scan software and 2D/3D image of relative bite force

4. Results

Among fifteen subjects, nine were female and six were male. The age ranges from 19 to 23 years old. The relative bite force, overall results are shown in Table 1.

The Table 2 demonstrates that 6 subjects (40% of total subjects) perceived equally bite force on left and right sides, and this perception was corresponded with T-Scan III analysis when the equal relative bite force (%) of T-Scan III between left and right sides was determined at ± 15.0% (35.0-65.0%) or ± 20.0% (30.0-70.0%). The least agreement (3 subjects, 20% of total subjects) between patient's perception and T-Scan III analysis was observed when the equal relative bite force of T-Scan III was set at ± 5.0% (45.0-55.0%).

Cohen's Weighted Kappa test indicated the correlation between the patient's perceptions and T-Scan III analysis are shown in Table 3 and Figure 3. According to Landis and Koch (Landis & Koch, 1977), the correlation between patient's perceptions and T-Scan III analysis was poor agreement and slight agreement when the cut off value was not more than ± 10.0 and ± 15.0, respectively.

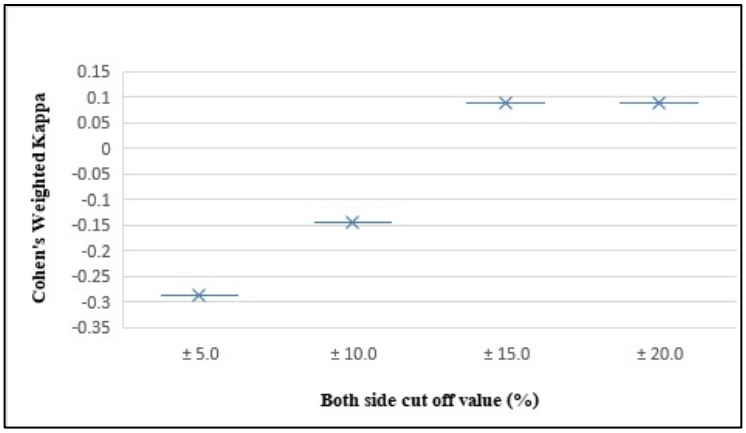

Figure 3 The Cohen's Weighted Kappa of each cut off value

5. Discussion

The poor correlation between patient's perceptions and T-scan III suggested the limited patient's recognition to the bite force. There are a number of studies evaluated the perceptive ability of the masticatory system (Hämmerle et al., 1995; Mäntyvaara, Sjöholm, & Pertovaara, 2000; Pedersen et al., 2018) which results from entired proprioceptive information in masticatory system especially periodontal mechanoreceptors (PMRs) (Crum & Loiselle, 1972; Trulsson, 2007; Türker et al., 2007). In 1963, Siirilä & Laine found that 8-10 microns are the interocclusal thickness that can be distinguished by human (Siirilä & Laine, 1963). However, most studies were performed on the single tooth or localized occlusal contacts. For example, Karlsson & Molin studied the interocclusal and discrimination threshold value of patients who received gold inlays and composite resin bonded ceramic inlays. They found no significant difference of interocclusal and discrimination threshold value between those two groups of patients. Eighty percent of patients had interocclusal and discrimination threshold value of 24

microns (Karlsson & Molin, 1995). In addition, Kampe et al. evaluated interocclusal thickness discrimination (occlusal perception) in young adults found that incisor regions had the best occlusal perception of 9 microns, followed by canine and premolar regions, respectively (Kampe, Haraldson, Hannerz, & Carlsson, 1987). Furthermore, most studies compared occlusal perception before and after changes of occlusal surface. No studies confirmed the accuracy of patient's occlusal perception. To our best knowledge, this is the first study compared patient's perception to a more quantitative T-Scan III analysis in order to identify the accuracy of patient's perception and the correlation of those. Despite of the beneficial information, care should be taken to apply the conclusion to the larger group of population because this is a preliminary study with limited sample size.

Additionally, although several investigators supported the efficacy and reliability of T-Scan III system (Cohen-Lévy & Cohen, 2012; Kerstein et al., 2006; Seth et al., 2016), the thickness of HD sensor may interfere with occluding pair of teeth and create off-centered biting. This is because this 100 microns thick sensor is 10 folds thicker than interocclusal thickness discrimination (9-10 microns) and the unilateral or off-centered biting on HD sensor could produce the heavier force than the uniformed bilateral biting (Koc, Dogan, & Bek, 2010). These could result in false relative bite force. Therefore, this study used the average relative bite forces by asking subjects to clench on the HD sensor 3 times. Moreover, all subjects were dental students who know the biting pattern of their teeth which could reduce the variability of each bite on HD sensor.

Lastly, this study needs further investigation to evaluate the accuracy of patient's perception by increased numbers of subjects or compared with other instruments

6. Conclusion

The correlation of bite force in MIP between patient's perceptions and T-Scan III system is poor. However, the better correlation receives with increasing both side value range of T-Scan III analysis.

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Table Legends

Table 1 The relative bite force values and bite force agreement between patient's perceptions and T-Scan III analysis

Subject code (N=15)	Patient's perceptions	T-Scan III analysis					
		Relative bite force (%)		Both side cut off value (value range, %)			
		Right (mean± S.D.)	Left (mean± S.D.)	± 5.0 45.0-55.0	± 10.0 40.0-60.0	± 15.0 35.0-65.0	± 20.0 30.0-70.0
1	B	44.8±1.63	55.2±1.63	L	B	B	B
2	B	60.3±0.45	39.7±0.45	R	R	B	B
3	B	55.6±1.46	44.4±1.46	R	B	B	B
4	L	49.4±1.83	50.6±1.83	B	B	B	B
5	R	47.0±1.99	53.0±1.99	B	B	B	B
6	L	53.6±0.99	46.4±0.99	B	B	B	B
7	R	63.7±1.66	36.3±1.66	R	R	B	B
8	R	53.6±2.35	46.4±2.35	B	B	B	B
9	L	59.4±1.05	40.6±1.05	R	B	B	B
10	B	61.4±1.46	38.6±1.46	R	R	B	B
11	B	62.0±1.65	38.0±1.65	R	R	B	B
12	R	79.2±3.05	20.8±3.05	R	R	R	R
13	R	39.4±1.92	60.6±1.92	L	L	B	B
14	R	36.0±1.02	64.0±1.02	L	L	B	B
15	R	58.0±0.46	42.0±0.46	R	B	B	B

Abbreviations: R: Right side; L: Left side; B: Both side

Table 2 Bite force agreement between patient's perceptions and T-Scan III analysis at different cut off values.

Both side cut off values (value range, %)	Number of subjects (N=15)	
	Number of subject agreement	Subject agreement (%)
± 5.0 (45-55%)	3	20
± 10.0 (40-60%)	4	26
± 15.0 (35-65%)	6	40
± 20.0 (30-70%)	6	40

Table 3 The Cohen's Weighted Kappa of each cut off values

Both side cut off values (Value range, %)	Cohen's Weighted Kappa
± 5.0 (45-55%)	-0.286
± 10.0 (40-60%)	-0.146
± 15.0 (35-65%)	0.088
± 20.0 (30-70%)	0.088

Figure Legends

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