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The effect of temporary hydrostatic splint on occlusion with computerized occlusal analysis system

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Abstract

Aims: The aim of this study was to evaluate the effect of temporary hydrostatic splint on occlusion with computerized occlusal analysis system. **Material and Methods:** Maximal bite force was recorded in intercuspal position by use of computerized occlusal analysis system from 11 female, 9 male, 20 subjects, (average age of 20) with normal intact dentitions. Subjects were instructed to use the hydrostatic splint for 24 h. Occlusal records were repeated three times before and after splint. All recordings were evaluated to determine the repeatability of the computerized occlusal analysis system. **Results and Conclusion:** Hydrostatic splint increased maximum biting force. Relative percentage of left and right bite forces changed in the direction of neurophysiological position of the muscles. Hydrostatic splint can be a viable option for occlusal adjustments.

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Full Text

There exist very different, even conflicting approaches towards occlusion. In 1987, Maness et al. reported the development of the prototype of a new computerized occlusal analysis device (T-Scan system, Sentek Corp, Boston, Mass). [1] The system consisted of a processing unit, a color monitor and a sensor that quantified occlusal contact area. The T-scan system was designed to analyze and display occlusal contact information gathered by the pressure sensitive film. The T-scan system allowed the operator to record parameters such as bite length and the number, distribution, timing and relative force of tooth contacts. [1],[2] There are several studies in the literature conducted with earlier versions of the system but more clinical studies are necessary to evaluate the benefits. [1],[2],[3],[4],[5],[6],[7],[8] The most current available recording sensor for the T-scan III system represents the fourth generation of T-scan system sensors. [9],[10] It is known as the high definition (HD) sensor. A published performance study comparing Generation-3 (G3) sensors against HD sensors revealed that the HD sensor reproduced more consistent force levels than the older G-3 sensor. The G-3 sensor mean force variances were significantly larger than for the same six occlusal contact locations measured with the HD sensor. Additionally, the HD sensor exhibited consistent force reproduction in at least 20 in-laboratory crushing cycles. [9]

A hydrostatic appliance was designed by Lerman over 30 years ago. [11] In its original form, it consisted of bilateral water-filled plastic chambers attached to an acrylic palatal appliance, and the patient's posterior teeth would occlude with these chambers. Later this was modified to become a device that could be retained under the upper lip, while the fluid chambers could be positioned between maxillary and mandibular posterior teeth. The concept was that the mandible would automatically find its ideal position because the appliance was not directing where the jaw should be. With water-filled compartments on both sides, the splint prevents the upper and lower teeth from touching, as the hydrostatic splint softly stops the closing of mandible on the maxilla just prior to the beginning of the occlusion phase. This result is very similar to that of solid splints. However, based on the physical principle of communicating pipes, the patient bites down on two pads filled with water, connected to each other via a thin capillary within which the water can flow back and forth. That is to say, a unilateral left-sided bite of the patient will force the water to move to the right side, whereas a unilateral right-sided bite will force it to the left side. Accordingly, the hydrostatic splint creates compensation for the biting force on both sides. Prof. Lerman describes this flowing back and forward of the water as 'Floating Action'. Another effect of the hydrostatic splint is the one which takes place over the muscular contraction process. The contraction of the muscles is triggered with the action potential that builds anywhere in the stomatomagnetic system and exceeds a certain threshold. The contraction warns if the action potential is not sustained, or falls below the threshold. Another way to start the action potential, apart from a stimulus above the threshold, is through the propagation of the stimuli below the threshold for a certain period of time. Once it starts via the stimulation of the neuron, a responsive neuromuscular conjunction takes place followed by muscular stimulus, and finally, contraction. The hydrostatic splints, in this manner, are quite different than solid splints. The distribution of the biting forces both towards the left and right through the water-filled pads prevents the emergence of a secondary stimulant. This is the most important feature of the hydrostatic splints, which distinguishes them from the solid ones. Hydrostatic splints have been preferred in this study both in order to prevent the emergence of any other secondary stimulus that may be detrimental and in order to remove the neuromuscular model of the biting pattern that might have evolved throughout the habitual occlusion. No independent research has been offered to substantiate this claim. [12]

Occlusal and electromyographic studies have attempted to ascertain the relationship between tooth contact and muscle activity. Baba K et al.[13] conducted a study to investigate the relationships between occlusal contacts, responses of muscles and jaw movements during simulated clenching. Acrylic occlusal stops were fabricated for the lower jaw to simulate various occlusal conditions. Under experimentally altered occlusal conditions, the subjects performed clenching tasks at 50% of their maximal voluntary contraction level. Analysis of EMG responses revealed clenching on the unilateral occlusal support tended to cause a unilateral activity of the ipsilateral anterior temporalis. They mentioned that the alteration of the occlusal relationships has distinct and characteristic influences on mandibular movement patterns during clenching in a predictable manner. Kerstein and Radke [10] reported that reducing prolonged disclusion time to short disclusion time created a therapeutic effect such that within one month's time following treatment there was an observed increase in the maximal clenching capacity of the masseter and temporalis muscle. However, the relationship between occlusal force and muscle physiology should be more studied.

The aim of this study was to evaluate the effect of temporary hydrostatic splint on occlusion with computerized occlusal analysis system.

Materials and Methods

Twenty subjects (11 females, 9 males) of ages ranging between 19 and 21 years (average 20.2) participated in this study. The subjects were all from Marmara University Dentistry Faculty and volunteered freely for the study. All subjects had full dental arches and a healthy periodontal status, were free from pathology and had not undergone any surgical operations on their temporomandibular joints.

T-scan III utilizes an ultra-thin, reusable sensor, shaped to fit the dental arch, which inserts into data acquisition electronics. This system is portable and plugs into the USB port of

Windows-based PC or laptop. The T-scan III sensor is an ultra-thin (0.004", 0.1 mm), flexible printed circuit that detects the volunteer's occlusal forces. These sensors are made up of 1370 active pressure sensing locations for the large sensor (#2001) and 1122 pressure sensing locations for the small sensor (#2501). These locations are referred to as 'sensing elements', or 'sensels'. The 'sensels' are arranged in rows and columns on each sensor. The sensels can be seen as an individual square on the computer screen by selecting the 2D display mode. The output of each sensel is divided into 256 increments, and displayed as a value (raw sum) within the range of 0 to 255, by the software.

The sensor was introduced into the mouth of the subject making sure that the central line was aligned with the midline of the central incisor [Figure 1]. The subject was then asked to close firmly in centric relation. After the occlusal contacts appeared on the screen, the button on the handle was pressed and the arch model was automatically created. Maximal bite force was recorded in intercuspal position by use of computerized occlusal analysis system (T-scan III, (Tekscan Inc., Boston, Mass.). As the patients occluded onto the T-scan sensor, the applied force at various tooth contacts changed over time. Occlusal contacts were recorded and then displayed in two and three dimensions as a continuous force movie of the entire occlusal contact event. The movie was recorded and saved into a patient database for later viewing.{Figure 1}

Occlusal contacts are represented as topographical images that describe the shape of the contact area, relative force and surface area. Differences in occlusal force are shown by color ranging from red as the greatest force to blue as the least force, using the standard order of colors of the spectrum. These contour images of the tooth contacts provide an instant view of the areas of greatest tooth contact and relative force. The images were easily analyzed by the software by summing the force-weighted surface area for comparison. These data are used to calculate the center of force for the occlusion.

Subjects were instructed to use the hydrostatic splint for 24 h [Figure 2] and [Figure 3]. The device was retained under the upper lip, while the fluid chambers were positioned between maxillary and mandibular posterior teeth. Occlusal records were repeated three times before and after splint [Figure 4] and [Figure 5]. All recordings were evaluated to determine the repeatability of the computerized occlusal analysis system.{Figure 2}{Figure 3}{Figure 4}{Figure 5}

Results

The result of percentage of maximum biting force before and after splint was shown in [Table 1]. The evaluation of three measurements before and after hydrostatic splint indicated that T-scan III system showed reproducible results.{Table 1}

Hydrostatic splint increased maximum biting force. Relative percentage of left and right bite forces changed in the direction of neurophysiological position of the muscles. Mean biting forces before and after splint usage was 45.26 and 47.87% on the left side, and 57.24 and 54.63% on the right side, respectively.

The percentage of maximum biting force showed an increase, and the left and right bite force measurements were distributed more equally after hydrostatic splint.

In maximum intercuspation, the number of contacts was higher in the posterior (molars and premolars) than in the anterior zone (incisors and canines).

Discussion

The findings of the present work indicate that, in a position of maximum intercuspation, the number of contacts is always higher in the posterior (molars and premolars) than in the anterior zone (incisors and canines). These findings are consistent with those of Cartagena et al and Garcia et al.[2],[4]

Moini and Neff [3] conducted a study on the reproducibility of detecting occlusal contacts using silk marking paper versus T-scan system and reported the pressure sensitive film method was not as accurate as the silk ribbon; however, there were several flaws of the study. The results presented indicated that if only three teeth are in contact, then the pressure sensitive film device is reasonably accurate. Hsu et al, [6] also reported on the sensitivity and reliability of the T-scan system for occlusal analysis. They concluded that the sensors did not have the same sensitivity throughout their surface and the T-scan always recorded fewer occlusal contacts than were actually present as checked by occlusal foils. Furthermore, Mizui et al.[7] measured the timing and force of occlusal contacts in both 60 normal subjects and 5 patients with an unspecified craniomandibular disorders (CMD) using the T-scan system. They reported that in the normal subjects the timing and force of occlusal contacts were symmetrical and the center of effort was located in the first molar region. For patients with CMD, timing and force of occlusal contacts were asymmetric and the center of effort was not always located in the first molar region, as determined with the T-scan system. This study was conducted with the HD sensor, and it is a completely different sensor than was used within most of the studies and, more modern research has proven the reliability of the very different HD sensor and T-scan III Hardware. [9]

In this study, three measurements were taken for each patient before and after the hydrostatic splints were used. The evaluation of the results indicated that T-scan 3 system showed reproducible results. This is in controversy with the findings of Harvey et al.[5] They conducted a preliminary test of the reproducibility of the earlier version of the computerized occlusal analysis system by comparing two sets of occlusal data generated by an articulator that was set with 0 and 0.2 mm immediate side shifts. They found substantial variability in the results with unpredictable variations scattered among the uses, levels of force and articulator immediate side-sift treatments.

Kernstein and Grundset, [8] describing the utilization of paper markings with a computerized occlusal analysis system (T-scan II for Windows; Tekscan, Inc, Boston, Mass. USA) to establish clinically measurable bilateral simultaneous contacts, illustrated that, multiple similarly sized paper marks, spread around the arch, did not actually demonstrate measurable contact simultaneity. Therefore in this study, the effect of hydrostatic splint was evaluated with a computerized occlusal analysis system instead of articulating paper. Computerized occlusal analysis allows the clinician to efficiently identify significant interceptive contacts by using the order of color previously described. This is helpful because the color-coded occlusal contacts enable interpretation of the marks from the marking materials to effectively adjust the occlusion, while the effects of the adjustments are immediately seen in the center of force display.

In this study, hydrostatic splint increased maximum biting force. Relative percentage of left and right bite forces changed in the direction of neurophysiological position of the muscles. This result is in correlation with Kerstein and Radke, [10] who showed that improvements made to the occlusion of 62 subjects by shortening their posterior disclusion times resulted in statistically significant maximal clench muscle strength improvements in the four muscles of mastication.

Hydrostatic splint can be a viable option for occlusal adjustments. There is a need for additional research on all diagnostic procedures used in dentistry. A cost-benefit analysis assessment of all ancillary documentary procedures and devices is needed, especially for those instruments or methods that have a substantial cost associated with their use.

References

1 Maness WL, Benjamin M, Podoloff R, Bobick A, Golden RF. Computerized occlusal analysis: A new technology. Quintessence Int 1987;18:287-92.
2 Garcia Cartagena A, Gonzalez Sequeros O, Garrido Garcia VC. Analysis of two methods for occlusal contact registration with the T-Scan system. J Oral Rehabil 1997;24:426-32.
3 Reza Moini M, Neff PA. Reproducibility of occlusal contacts utilizing a computerized instrument. Quintessence Int 1991;22:357-60.
4 Garrido Garcia VC, Garcia Cartagena A, Gonzalez Sequeros O. Evaluation of occlusal contacts in maximum intercuspation using the T-Scan system. J Oral Rehabil 1997;24:899-903.
5 Harvey WL, Osborne JW, Hatch RA. A preliminary test of the replicability of a computerized occlusal analysis system. J Prosthet Dent 1992;67:697-700.
6 Hsu M, Palla S, Gallo LM. Sensitivity and reliability of the T-scan system for occlusal analysis. J Craniomandib Disord 1992;6:17-23.
7 Mizui M, Nabeshima F, Tosa J, Tanaka M, Kawazoe T. Quantitative analysis of occlusal balance in intercuspal position using the T-Scan system. Int J Prosthodont 1994;7:62-71.
8 Kerstein RB, Grundset K. Obtaining bilateral simultaneous occlusal contacts with computer analyzed and guided occlusal adjustments. Quintessence Int 2001;32:7-18.
9 Kerstein RB, Lowe M, Harty M, Radke J. A Force reproduction analysis of two recording sensors of a computerized occlusal analysis system. Cranio 2006;24:15-24.
10 Kerstein RB, Radke J. The effect of disclusion time reduction on maximal clench muscle activity level. Cranio 2006;24:156-65.
11 Lerman MD. The hydrostatic appliance: A new approach to treatment of the TMJ pain-dysfunction syndrome. J Am Dent Assoc 1974;89:1343-50.
12 Klasser GD, Greene CS. Oral appliances in the management of temporomandibular disorders. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:212-23.
13 Baba K, Akishige S, Yaka T, Ai M. Influence of alteration of occlusal relationship on activity of jaw closing muscles and mandibular movement during submaximal clenching. J Oral Rehabil 2000;27:793-801.