Original Article

Effect of head posture on tooth contacts in dentate and complete denture wearers using computerized occlusal analysis system

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Abstract

Purpose: The purpose of the study was to assess and compare the occlusal contacts in dentate and edentulous patients wearing complete denture with varying head posture.

Materials and Methods: *Ad hoc* sampling of 30 subjects (15 dentate and 15 edentulous) based on inclusion and exclusion criteria was done. Subjects were divided into two groups: dentate and edentulous. Each group was further divided into two subgroups based on two head postures-upright 90° and ventroflexed 30°. For recording of every posture, a new sensor was used, and the subject was asked to clench on the sensor in maximum intercuspation position at the two head postures.

Results: Data were summarized as mean ± standard error and compared by Student's *t*-test using SPSS software (windows version 17.0 IBM corporation, New York, USA). A statistically significant correlation between head posture and contact area was found in dentate and denture wearers, i.e., tooth contact area varies with head posture.

Conclusion: It was concluded that the occlusal contacts vary at different head posture in dentate as well as in denture wearers. With ventroflexion, the number of tooth contact decreased as compared to upright-erect position in both groups. Clinical implication - since the number of tooth contacts varies with varying head postures, it is recommended that the balancing of the contacts should be done at varying head postures.

Keywords: Computerized occlusal analyzer, goniometer, head posture, tooth contacts

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INTRODUCTION

The efficiency of the masticatory system largely depends on alignment and occlusion of dentition. Occlusal contacts are controlled by temporomandibular joint (TMJ), dentition and muscles of mastication. It is believed that improper occlusal contacts, incorrect head posture are few of the main etiological factors for the initiation of TMJ disorder.

Head posture varies according to the physiological and functional activity of the human. These head postures can be divided into an active feeding position posture,

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upward erect posture and extended head posture.[1,2] The head extends forward by approximately 30° during food consumption; this head posture is known as active feeding posture.[2] This posture shifts the mandible and its closure path anteriorly. The head is extended around 45° during drinking; this will result in the mandible shift posteriorly.[3] Any change in head postures results in a change of mandible position due to stretching and elongation of the muscles attached to it. Consistent forward head posture is also known to cause the neck, head and shoulder tension, and pain along with occlusal changes.[4]

An occlusal interference of only few microns can trigger severe dysfunction, leading to TMJ pain and myalgia, and various materials and methods have been used to detect occlusal interferences. Occlusal indicators can broadly be divided into two categories based on their measurement capacity. Qualitative indicators such as articulating paper and articulating silk are limited as a measurement to only location and number of tooth contacts. These are commonly used because of their low cost and ease of application. Quantitative indicators, on the other hand, include electro-optic and resistive technique such as T-scan pressure measurement system. They come with added capability of measuring the time force characteristics of tooth contacts but are more expensive. The computerized occlusal analysis system is a dental device used to analyze relative occlusal force that is recorded intraorally by a pressure-mapping sensor. This digital device converts the occlusal event into a graphical display.[5,6] The use of computerized occlusal analyzer in the field of occlusal rehabilitation is still a new concept which is in developing stage, and limited literature is available on the influence of the functional head posture on the dynamic occlusal contact using computerized occlusal analyzer. There is no published literature on comparing the occlusal contacts of dentate and complete denture wearer with varying head postures.

Therefore, the pilot study attempted to discover a relationship between change in head posture and the amount of occlusal contact in dentate and edentulous subjects using computerized occlusal analyzer.

MATERIALS AND METHODS

The Institutional Ethical Committee approval was obtained for the study before the commencement of the study. The study was conducted in the Department of Prosthodontics, Babu Banarsi Das College of Dental Sciences, Lucknow from July 2014 to August 2015. *Ad hoc* sampling for 30 subjects irrespective of gender was done from the edentulous patients between 50 and 65 years with normal healthy ridges in Class I ridge relation requiring complete dentures and healthy dentulous subjects between 18 and 25 years irrespective of gender with no reported pain or history of pain in TMJ and neck region, no sign and symptoms of myofascial pain dysfunction, Class I jaw relationship with intact dentition. General exclusion criteria included: Any abnormal range of mandibular movements, any postural abnormality of cervical spine system such as scoliosis and kyphosis history of chronic pain or pathology or previous surgery related to masticatory system or cervical spine or TMD symptoms at least 1 year before study and for dentate subjects: Abnormal jaw relationships and for complete denture wearer: Long-term denture wearers, severely resorbed ridges, and abnormal ridge form.

The subjects were divided into two groups, namely, Group I (dentate) consisting of 15 patients and Group II (edentulous) also consisting of 15 patients. In each group, each subject was subjected to two different head postures (upright and ventroflexed).

To exclude inter-examiner variations, all recordings were performed by the same examiner at the same time of day to avoid possible diurnal variations. To decrease between-tester variability, we standardized subject position and placement of the measurement devices. All the subjects sat in a standard dental chair with the backrest and their arms rested freely at their sides, eyes looking straight. The starting position for cervical flexion was assumed after the tester manually adjusted the subject's neck so that the center of external acoustic meatus-to-base of nares reference line was parallel to the floor. The goniometer (ISICO, Transparent, 360°, India) axis was centered over the external acoustic meatus, the fixed arm was held vertical, while the movable arm was aligned with the meatus-to-base of nares reference line as the subject actively flexed the neck. Goniometer has been used in various studies to standardize head posture changes.[7-10]

The 40 μ thick articulating paper (Bausch articulating paper Inc., Nashua, NH, USA) balanced denture was placed in patient's mouth. The subject was trained to close in centric relation in predecided head positions. For the recording of every posture, a new sensor (Fuji Prescale Sensors, Fuji Photo Film Co., Tokyo, Japan) was used [Figure 1]. The sensor with the help of sensor holder (Nupai Bite Scan, India) was inserted into the subject's mouth in such a way as to make its support aligned centrally with the midline of the upper incisors [Figure 2]. The subject was then asked

to clench on the sensor in a maximum intercuspal position for 5 s at maximal clenching level in the two head positions using goniometer [Figure 3a and b].

Figure 1: Sensor with sensor holder

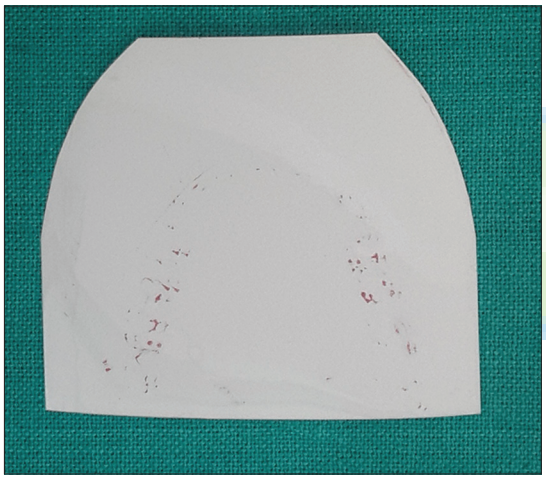

Figure 2: Sensor with bite marks

Figure 3: (a) Goniometer on patient in 90° flexion (b) goniometer on patient in ventroflexion

RESULTS

Statistical analysis

Data were summarized as mean ± standard error (SE). Groups were compared by Student's *t*-test [Table 1]. A two-tailed $P < 0.05$ was considered statistically significant. The pressed area of Group I (dentate) and Group II (edentulous) at 90° ranged from 62.0–240.0 mm^2 to 18.0–148.0 mm^2 respectively with mean (± SE) 131.47 ± 14.04 mm^2 and 63.80 ± 8.47 mm^2 respectively. The mean pressed area at 90° of Group I was significantly higher (51.5%) in Group I as compared to Group II (131.47 ± 14.04 vs. 63.80 ± 8.47, $t = 4.13$, $P < 0.001$).

The pressed area of Group I and Group II at 30° ranged from 34.0–198.0 mm^2 to 13.0–76.0 mm^2 respectively with mean (± SE) 114.93 ± 13.36 mm^2 and 38.27 ± 4.55 mm^2, respectively. The mean pressed area of Group I was significantly higher, i.e., 66.7% in Group I as compared to Group II (114.93 ± 13.36 vs. 38.27 ± 4.55, $t = 5.43$, $P < 0.001$).

Student's *t*-test showed almost similar pressed area between two angles in Group I (131.47 ± 14.04 vs. 114.93 ± 13.36, $t = 0.85$, $P = 0.401$) though it is lower by 12.6% in 30° as compared to 90°. However, in Group II, it is lower by 40.0% significantly in 30° as compared to 90° (63.80 ± 8.47 vs. 38.27 ± 4.55, $t = 2.66$, $P = 0.01$).

The data analysis showed a statistically significant correlation between the two head postures and dentate/edentulous subjects.

DISCUSSION

In the present study, pressed occlusal contact area (mm^2) was taken into consideration as given by the Dental Prescale System. The Dental Prescale System (Dental Prescale, Fuji Film Co., Tokyo, Japan) is a computerized occlusal analysis system used for the measurement and analysis of bite force (N), occlusal contact area (mm^2), and bite pressure (MPa). This records the location and force of contacts with the force sensitive film. It consists of a horseshoe-shaped prescale pressure sensitive foil, a pressure distribution

Table 1: Pressed area (Mean±SE) of two groups at two different angles

Group	90° (*n*=15)	30° (*n*=15)	*t*	*P*
Group I	62.0 to 240.0 (131.47±14.04)	34.0 to 198.0 (114.93±13.36)	0.85	0.401
Group II	18.0 to 148.0 (63.80±8.47)	13.0 to 76.0 (38.27±4.55)	2.66	0.013

mapping software (FPD, Fuji Film Co., Tokyo, Japan), and a suitable scanner.[11,12]

The sensor foil contains a layer of microcapsules of different sizes which contain a colorless dye and a developer layer. When subjected to pressure above five MPa the largest and thinnest capsules start to break and release the dye; with increasing pressure, the smaller and thicker capsules break and release their dye which reacts with the developer and gives a red color. The scanner reads the area and the color intensity of the red dots to calculate bite force and occlusal contact area using the pressure distribution mapping software.[13] The Dental Prescale System has already been used for analyzing occlusion in dentures, dental implant, and orthognathic surgery.[11,13-15]

Head postures evaluated in this study were the normal upright sitting and 30° ventroflexion. Rationale of including upright sitting position was due to the fact that most of the dentists use normal upright sitting position during restorative procedures. 30° ventroflexion was included in the study for it is considered as active feeding head position based on the earlier research findings.[1] The head extends forward by approximately 30° during food consumption; this head posture is known as active feeding posture. It is critical for the dentist to evaluate and understand the possible effect of a change in head posture on occlusal contacts[1] as generally only upright-erect position is used during restorative procedures, occlusion evaluation, and correction.

Goniometer was chosen for standardization of head postures because of several advantages such as it is very handy, convenient, cost-effective, and gives reliable and reproducible result.

On comparing the pressed area at 30° and 90° in edentulous and dentate subjects, it was found that dentate subjects exhibited more pressed area at any posture as compared to edentulous and it was found to be statistically significant. It is hypothesized that this greater decrease in pressed contact area in complete denture wearer could be due to a combination of the two factors namely muscle laxity associated with old age and may be articulating paper balanced complete denture used in the study. The complete denture in the study was balanced using articulating paper and it was found that the balancing was deficient as demonstrated by the marks on the sensors of Dental Prescale system. Articulating paper labeling is an inadequate indicator of perceived occlusal contact time simultaneously as it renders no occlusal contact force or time sequencing[16] and size of articulation paper mark is an unreliable indicator of applied occlusal force, to guide treatment occlusal adjustments.[17] This study reported statistically significant correlation between the two parameters.

A decrease in values of pressed area (initial tooth contact) was seen on forward bending of head,[18] i.e., 30° in the study. As the head is tilted forward, it creates a loss of contact in dorsal region,[19] thus overall tooth contact in ventroflexion decreases. Cervical posture change can affect the mandibular path of closure,[20] mandibular rest position,[21] and masticatory muscle activity[22,23] along with gravitational forces.[23] Although none of the studies have mentioned the percentage decrease in tooth contacts as the head posture changes.[20-22]

On comparing the occlusal contacts with the two groups and two head postures, statistically significant difference was not observed. This could be due to smaller sample size, articulating paper balanced complete denture, inadvertent faulty reading by the sensor: The sensors may be damaged when forces are concentrated over a small area, such as a sharp tooth cusp in dentate subjects. This is due to increased intensity of otherwise relatively low bite forces which become focused onto a small area and produce high pressure. This may also lead to the inaccurate recording of the occlusal contact and/or artifacts in the produced images.

This study is the only study which compares the occlusal contacts in dentate and complete denture wearer at two clinically applicable head postures with statistically significant result although the study has few limitations like smaller sample size, as it was a self-sponsored study so had to limit the number of subjects, *ad hoc* sampling technique, the sensors were not reusable which added to the cost, the Dental Prescale system gives no information about timing of occlusal contact or sequence of occlusal forces build up, and also no information about occlusion disocclusion time while T-scan quantify both force and time variance from initial tooth contact to maximum intercuspal position. Both the computerized occlusal analyzers are still in developing state. More research work is required to make them more clinically useful.

The result of the study can be clinically applied while balancing occlusion as generally upright head posture is routinely used during diagnostic occlusion evaluation to final restorations. As the study indicates that the number of tooth contacts varies with varying head posture therefore, the balancing of the contacts should be done at varying head postures in dentate as well as edentulous complete denture wearers.

CONCLUSION

On the basis of observations, statistical analysis and discussion, the following conclusions were drawn from the study:

- The occlusal contacts vary at different head posture. With ventroflexion, the number of tooth contact decreases as compared to upright-erect position
- Edentulous denture wearers have lesser tooth contacts as compared to dentate subjects
- The head posture of the patients should be considered while balancing or analyzing occlusion
- The size of articulation paper mark is not an accurate indicator in the selection of tooth contacts for occlusal adjustment treatment. Computerized occlusal analyzer is a more precise tool for full analysis of occlusion.

The research project was approved by Institutional Ethics Committee, and the subjects gave informed consent about the study.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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