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Original Article

Comparative Evaluation of Centric Occlusion in the Mixed Dentition of Children in Variable Head Postures Using T-Scan – A Clinical Study

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Abstract

Background and Objective: Dental occlusion is still a controversial field in dentistry. The dental professionals are trying to uncover the relationship between the influence of head posture on mandibular position and, therefore, occlusion. Hence, the present study was conducted to assess and compare the centric occlusion in three different head postures in mixed dentition children.

Materials and Methods: Children with age group between 7 and 12 years were selected for the study, and centric occlusion in three different head postures was evaluated. The three head postures were supine (45° dorsiflexion) head posture, normal upright sitting head posture, and alert feeding (30° ventroflexion). Force outliers were recorded from all the children and were tabulated in SPSS version 20. Kruskal–Wallis test was used to assess the data.

Results: Statistically significant *P*-values were obtained on comparing different head postures in children with mixed dentition.

Conclusion: Statistically significant changes of centric occlusion in varying head postures demonstrate that these parameters have to be evaluated before any oral rehabilitation procedures.

Key words: Head postures, Mixed dentition, Occlusion, T-scan

INTRODUCTION

Normal development of primary dentition is crucial for establishing a healthy chewing movement and proper occlusion in permanent dentition.[1] Occlusion in primary dentition undergoes continuous changes, and it adapts to growth and development. Hence, its functional determinants must be established to explain and assure proper growth and development of the stomatognathic system. If mastication is adequate, it gives stimulus to the normal development of maxilla and mandible.[2] The efficiency of the masticatory system largely depends on alignment and occlusion of dentition.[3]

Dental occlusion refers to the way the incisal edges and occlusal surfaces of upper and lower teeth come together in the act of closure of dental arches.[4] Basic orofacial functions such as mastication, speaking, and deglutition depend on occlusion.[5] More than static occlusal contacts, dynamic contacts affect the mastication and other physiological activities. Occlusal contacts are controlled by temporomandibular joint (TMJ), dentition, and muscles of mastication.[6] Nearby contacts are those areas that range from a contact to a gap of 0.5 mm between the occluding

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surfaces, while non-contacts are those areas wherein, there is a 0.5–3 mm separation of the teeth. True occlusal contact time by description suggests that a time of 0 s elapses between the first and last occlusal contact.[7] Tooth contact should be along its long axis for optimum health of the tooth and supporting periodontal structures.[6] The presence of occlusal interference during mastication will result in occlusal instability, increased activity in muscles of mastication.[7]

In the literature, many authors suggested that head posture has a definite influence on occlusion during initial contacts through a change in upper to lower jaw alignment.[8,9] Normal head posture is defined as a relaxed head position in the horizontal plane.[10] Because of the rising popularity of media devices such as smartphones and computers, frequent users often exhibit incorrect head posture.[10] McClean *et al*. demonstrated that in the supine position, the initial tooth contacts were posterior to those found when the body was upright.[11]

Change in head postures will result in a change of mandible position due to stretching and elongation of the muscles attached to it. Routine functional activities such as eating and drinking alter the head posture. These head postures can be divided into an active feeding position posture, upward erect posture, and extended head posture.[9,12] Head extends forward by approximately 30° during food consumption, known as active feeding posture.[13] This shifts the mandible and its closure path anteriorly. The head is extended around 45° during drinking; this will result in the mandible shift posteriorly. In all the dental therapeutic procedure's, eventual success depends on its harmony with occlusion. Clinicians most commonly use supine position during restorative procedures, occlusion evaluation, and correction. All the essential functional occlusal contacts during appropriate head position are usually ignored.[14]

An occlusal interference of even a few microns can trigger severe dysfunction, 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 include electro-optic and resistive techniques such as the T-scan pressure measurement system.[15,16] T-scan III system (TEKSCAN, USA) analyzes the order of occlusal contacts while simultaneously measures the change in force percentages of the same contacts from the moment the teeth begin making occlusal contact, all the way to maximum intercuspation.[17-19] This enables to assess the force changes during the process of contact evolutions.

Hence, the present study was undertaken to clinically analyze the centric occlusion in children's mixed dentition in different head postures using a computerized occlusal analyzer T-Scan III system (TEKSCAN, USA).

MATERIALS AND METHODS

Institutional ethical committee approval (Ref No-SSMC/Dent/IEC-1/March 2020) was obtained for the study. The study methodology was explained, and written informed consent was obtained from the children selected from the outpatient list of BOCI Dental Clinic, Bengaluru. The inclusion criteria include (1) healthy and cooperative children between 7 and 12 years of age, (2) children with healthy sound dentition, (3) children with no missing teeth in the region of recording, (4) children with no history of orthodontic treatment, (5) children with no parafunctional habits, pathological wear facets, or any other soft-tissue anomaly, and (6) children with no anomalies of form, structure, and no alterations could compromise their dimensions. The exclusion criteria were (1) children with TMJ disturbances or with history of surgery of TMJ, (2) medically compromised children, (3) children with apparent facial asymmetry that could affect the recordings, (4) children with anterior or posterior crossbite or open bite, and (5) children with restorations or occlusal discrepancies.

Head Posture

Occlusion in three head postures was evaluated (1) supine head position (45° flexion). The goniometer was used to standardize all the head postures before recording the bite in that particular position [Figure 1].

Children were made to sit comfortably with lumbar and thoracic spine well supported by the back of the chair. Normal upright sitting position was attained by making the children sit uprightly so that the Frankfort horizontal plane is parallel to the floor. The supine and alert feeding position was standardized with a goniometer. The center of the goniometer was positioned over the external auditory meatus, and the proximal arm was held perpendicular to the floor. The distal arm was aligned to the base of nares. The subject was asked to flex the head to 45° for a supine position and to 30° for an alert feeding position [Figure 2a-c].

Recording Centric Occlusion in Various Head Postures

Initially, a model of the arch has to be recorded by asking the child to sit in an upright posture to avoid the effect of head posture on the occlusal contact pattern. The sensor was positioned close to the maxillary occlusal plane, and the child was asked to bite the sensor. When occlusal contacts appear on the screen, the arch model was created automatically.

Occlusion evaluation was initiated after determining the dental arch dimension and intraoral sensor calibration. Teeth width was measured individually with a digital caliper. Ideal sensitivity for the intraoral sensor was selected by limiting the number of red or pink high force areas/contact observed on the graphical display to a maximum of three during pre-recording test conditions. The children were then asked to occlude the recording sensor with maximum possible bite force for 1 or 2 s. Occlusal data were captured, processed by related software, and the output was displayed as two-dimensional and three-dimensional illustrations. The percentage of applied forces per tooth was represented as bars and columns in graphical displays. This procedure was repeated thrice; the closure with maximum occlusal force was selected for analysis. The percentage of applied occlusal forces displayed was recorded [Figure 3].

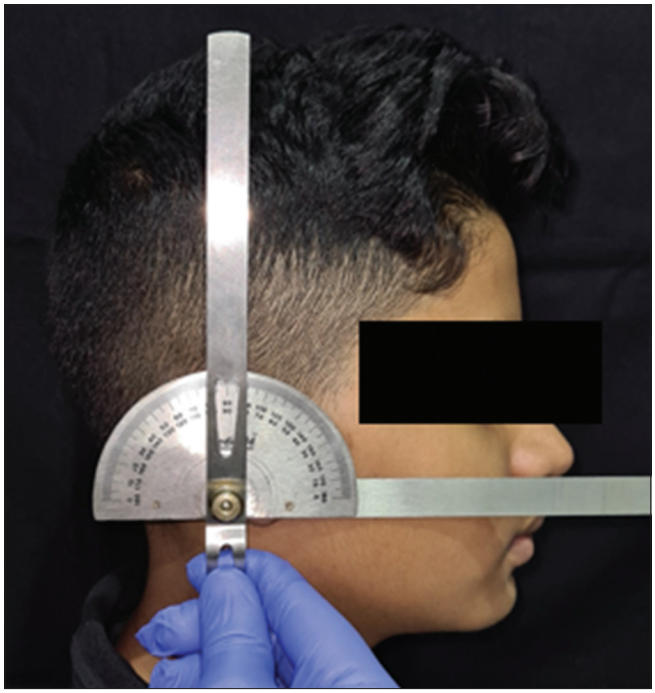

Figure 1: Standardizing the head position using goniometer

Statistical Analysis

The data obtained were collected, tabulated, coded, and fed in SPSS version 20 for statistical analysis. Variables were tested for normality using the Kolmogorov–Smirnov test and depending on the nature of the data, the Kruskal–Wallis test was used for statistical analysis. Results were presented as median and interquartile range. $P < 0.05$ was considered as statistically significant.

RESULTS

The occlusal bite analysis of thirty children was recorded by the T-scan III system. Association between various head posture and occlusal contacts in centric relation was analyzed using force outliers for each patient. The force outlier presented the time (T), force (F), and maximum relative force (S).

Comparison of T, F, and S values among the groups using Kruskal–Wallis in the supine posture, normal upright sitting posture, and alert feeding posture was tabulated [Table 1 and Figure 4].

The median occlusal time (T) and interquartile range were observed to be 2.50 (1.2–3.0) s in the supine posture, 2.20 (1.3–2.7) s in a normal upright posture, and 2.38 (1.5–3.9) s in alert feeding posture. There was no significant difference in relation to occlusion time (T) which was noted in all the three head postures with $P = 0.545$.

The median force in percentage (F%) and interquartile range for normal upright head posture were found to be significantly higher with 32.85 (19.4–40.3) as compared to the alert feeding (18.20 [15.2–19.8]) and supine head posture (23.10 [18.6–36.1]). The difference of force in percentage between three different postures was found to be highly significant with $P < 0.001$.

The median relative force (S) and interquartile range were found to be 5.36 (4.7–7.1) in the supine posture, 5.45 (4.3–

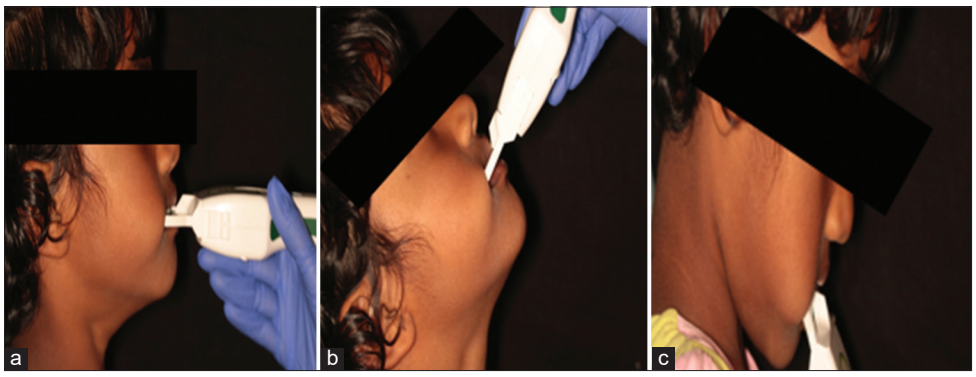

Figure 2: Occlusion recording using T-scan in three head postures – (a) normal upright sitting, (b) supine head position (45° dorsiflexion), and (c) alert feeding position (30° ventroflexion)

Table 1: Comparison of T, F, and S values among the three head postures using Kruskal–Wallis test

Parameters	Positions	N	Median	Interquartile range	Min	Max	Chi-square	*P*-value
T (s)†	Normal upright sitting	25	2.20	(1.3–2.7)	0.56	7.44	1.215	0.545 (NS)*
	Alert feeding	25	2.38	(1.5–3.9)	1.01	12.46		
	Supine head	25	2.50	(1.2–3.0)	0.38	6.75		
	Total	75	2.38	(1.4–2.9)	0.38	12.46		
F (%)‡	Normal upright sitting	25	32.85	(19.4–40.3)	9.80	44.70	15.777	<0.001 (Sig)**
	Alert feeding	25	18.20	(15.2–19.8)	9.80	32.20		
	Supine head	25	23.10	(18.6–36.1)	7.40	48.20		
	Total	75	20.30	(17.4–32.9)	7.40	48.20		
S§	Normal upright sitting	25	5.45	(4.3–6.0)	3.29	8.23	1.036	0.596 (NS)*
	Alert feeding	25	5.67	(4.4–6.9)	4.07	8.01		
	Supine head	25	5.36	(4.7–7.1)	3.20	8.01		
	Total	75	5.36	(4.5–6.5)	3.20	8.23		

†Time in seconds, ‡force percentage, §maximum relative force, *non-significant *P*>0.05, **significant *P*<0.05.

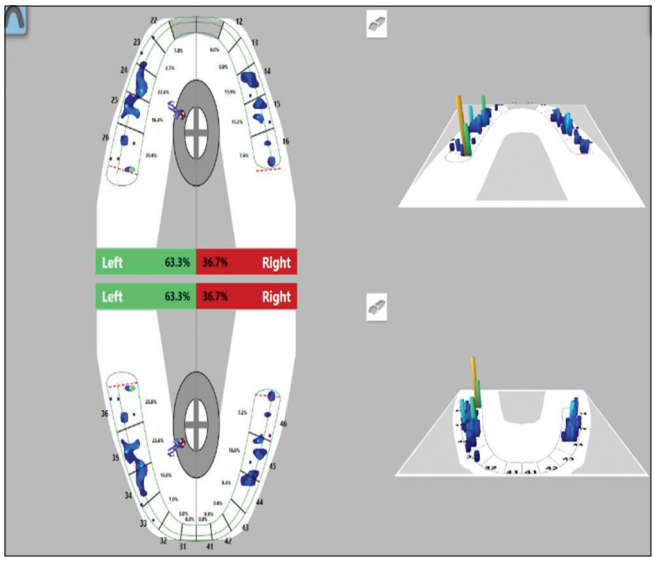

Figure 3: Occlusal force and force distribution in two-dimensional and three-dimensional in subjects

6.0) in a normal upright posture, and 5.67 (4.4–6.9) in alert feeding posture. There was no significant difference in relation to maximum relative force (S) which was found in all the three head postures with $P = 0.596$.

DISCUSSION

The efficiency of the masticatory system is determined mainly by proper occlusal contact. The success of restoration and prosthetic replacements was largely dependent on its compliance with good occlusal parameters. Hence, occlusal evaluation is essential in most of the procedure without which a dental procedure is incomplete.[20]

The basic concept of occlusal interference involves a supra contact of the opposing teeth during maximum intercuspation or an excursive jaw movement.[21] The dynamic occlusal contacts during the mandibular movement are more important than a static relation.[22] Helkimo *et al.* considered occlusal factors to be an important one in the etiology of craniomandibular dysfunction.[22] Mohl[9] stated that changes in head posture would result in the change of mandibular position due to stretching and elongation of the muscles attached to it. Children with increased craniocervical angle are associated with a more vertical facial growth pattern which is also correlated with low bite force.[12]

Accurately identifying and quantifying the occlusal contact during bite as well as determining their relationships and interference are important in the occlusal evaluation.[24] Various methods for occlusal analysis currently in use were articulating paper, articulating silk, waxes, metallic shim stock film, silicone impression, and photocclusion.[19] None of these, however, has proved to be ideal since the operator is always required to take complex and subjective decisions on occlusion based on inadequate and often confusing information.[25]

In 1987, a new computerized system was developed by Maness *et al.*[26] which allowed tooth contact data to be interpreted qualitatively using time as the primary diagnostic variable. With T-scan, it is now possible to record parameters such as bite length, the timing of tooth contacts, and their relative force.

In the present study, centric occlusion in mixed dentition children was compared in three different head postures using a digital occlusal analyzer T-scan III system. The head postures used for evaluating centric occlusion were (1) supine head position (45° dorsiflexion), (2) normal upright sitting, and (3) alert feeding position (30° ventroflexion). The goniometer was used to standardize all the three head postures, before recording the bite in that particular position. The centric occlusion was recorded in terms of force outliers in all the three head posture in the T-scan III system.

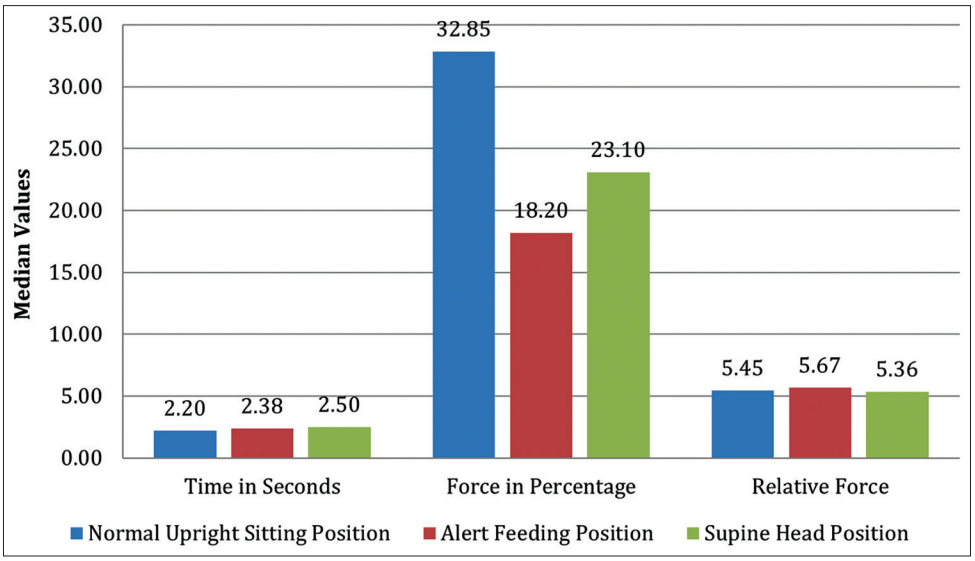

Figure 4: Comparison of T, F, and S values among the three head postures

The rationale behind the selection of these three head postures is based on the change in head posture during various activities. While drinking head extends 45° backward, while eating the head extends 30° forwards, and the supine position was included as this position is most commonly used during restorative procedures, occlusion evaluation, and corrections.[9] Head postures were selected in accordance with the previous study.[27]

The data obtained were analyzed using the Kruskal–Wallis test to assess the difference between centric occlusion in three different head postures. The force outlier was presented as the time (T), force (F), and maximum relative force (S). $P < 0.05$ was considered statistically significant. Based on the results obtained, the present study revealed a statistically significant difference with respect to force (F) in three different head postures. Normal upright head posture was found to be significantly higher with 32.85 (19.4-40.3) as compared to the alert feeding (18.20 (15.2-19.8)) and supine head posture (23.10 (18.6-36.1)). No significant difference was found for relative force and occlusal time in three different head postures.

Preiskel[28] and Goldstein[29] *et al.* demonstrated the relation between head position and mandibular position. The literature suggests[11,30] that the contraction of mandibular elevator muscles shifts the path of mandibular closure slightly anterior to an upright head position during alert feeding position and slightly posterior to upright during supine position. Hence, the teeth may receive different forces and occlusal contacts in different head postures.

Slight variations in occlusal time and relative force were noticed during the study which may be due to certain factors such as the degree of cooperation of the child participant as well as other independent variables such as age, dental occlusion, the number of teeth in occlusal contact, the number of teeth present, as well as the condition of the child's dentition.

On analyzing the force outliers in different head postures in children, some variations in initial contacts were perceived. In the supine head posture, that is, 45° dorsiflexion, the initial tooth contact for most of the children was seen in posterior tooth whereas in alert feeding head posture, that is, 30° ventroflexion, the initial tooth contact occurred in an anterior tooth in a maximum number of children and only some children had posterior tooth contact. In normal upright sitting posture, the initial contact in most of the children was seen in the posterior tooth. This change in the initial tooth contact was justified by Preiskel[28] and Goldstein *et al.*,[29] in their previous studies.

Various head postures are utilized for better visibility and accessibility during routine dental treatments. Supine and upright head postures are routinely used during diagnostic occlusion evaluation to final restoration. Thus, within the limitations of this study, we conclude that centric occlusion recorded as force outliers in terms of time (T), force (F), and maximum relative force (S) changes with different head postures in children. These changes in occlusal contact in varying head posture may be detrimental to the teeth, restorations, and their supporting structures. Hence, it is critical for a pediatric dentist to understand and incorporate these changes to improve the longevity of the restoration and harmonious occlusal relation.

Further studies have to be conducted to understand the relationship between head postures in primary as well as

permanent dentition to evaluate their effect on restorations and oral rehabilitations critically.

CONCLUSION

The dynamic occlusal contacts during functional head postures should be accounted for during the diagnostic and therapeutic procedures. Although this study had demonstrated a change in centric occlusion in supine, upright, and active feeding head postures in children during the management of occlusion in restorative procedures, these changes should be taken into consideration.

AUTHORS' CONTRIBUTIONS

N.C. conceived the idea and guided the study; R.C. and N.S. have provided material support and guidance; D.J., S., and M conducted, collected, analyzed the data, and led the writing of the manuscript.

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