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Statistical Investigation of the Standard Height of Occlusal Rim Blocks among Patients Attending Makerere University Dental Hospital, Kampala, Uganda

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Abstract

Edentulous patients desire to reinstate oral function and aesthetics in the most comfortable state and to regain their self-esteem. Due to racial anatomic differences, there is a need to ascertain the standard height of Occlusal Rim Blocks (ORBs) for edentulous patients in Uganda. This study was aimed at statistical investigation of the standard height of ORBs among patients attending Makerere University Dental Hospital, Kampala, Uganda. This was a cross-sectional quantitative study that comprised 240 pairs of wax ORBs requested by clinicians for patients in need of complete dentures. Consecutive sampling was used to select the ORBs. The height of the anterior and posterior portions of the maxillary and mandibular ORBs were recorded using a pair of pliers and a flexible ruler, and data were entered into Excel and exported into STATA software version 15 for analysis. The mean height for the anterior portion of maxillary ORBs was 19.4 mm and for the posterior, 17.4 mm after adjustment while the mean height for the mandibular counterparts was 16.4 mm and 16.0 mm, respectively. There was a statistically significant difference between the mean height of ORB before and after adjustments and between the newly established and internationally accepted standard height of ORB. There was no significant sex difference in the mean height of ORBs. Overall, the mean height of ORBs for the Ugandan population was significantly shorter than the internationally accepted standard height.

Keywords: *Bite registration, Complete denture, Dental hospital, Edentulous patients, Height, Occlusal rim blocks.*

Introduction

Edentulism is a phenomenon that affects millions of people across the globe [1]. Oral diseases including dental caries and periodontal disease, as well as dental trauma, are the major causes of tooth loss, which impair masticatory function with the risk of developing nutritional problems and other health disorders [2, 3]. In Uganda, according to the World Health Organization (WHO) [4] the prevalence of severe periodontal disease in people aged 15 years and above is 19.2 %, untreated caries of permanent teeth in 5 years and above is 24.9 %, and edentulism in 20 years and above is 1.8 %.

Provision of Removable Complete Dentures (RCDs) is one way of restoring oral function. The fabrication of an RCD entails several steps which include diagnosis, treatment planning,

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impression taking and border molding, casting dental models and occlusal rim blocks, bite registration, selection and setting up of artificial teeth, denture processing, and insertion [5]. The main goal of fabricating RCD is to attain harmonious occlusion that is compatible with the stomatognathic system intended to bring back the patient's mastication, phonetics, esthetics, and improved social esteem [6].

Furthermore, an RCD has three surfaces (fitting, polished, and occlusal surfaces), which are designed at different construction stages [7]. Occlusal Rim Block (ORB), which is employed in the third stage of denture construction consists of a rigid and stable denture base and a rim made of a base plate wax.

It is used to establish the occlusal plane level, the arch form, and the jaw relationship both horizontally and vertically, i.e. bite registration [7].

In an effort to determine the height of teeth, McGrane [8] used casts poured from muco-static impressions and found that the distance from the mandibular incisal edge of unworn teeth to the labial mucosal fold next to the lower labial fraenum was 18 mm and for the maxillary counterpart 22 mm, giving a total of 40 mm when mounted together. While Yanikoglu [9] in Turkey, found that the mean distance from the depth of the maxillary mucobuccal/vestibule to the tip of the buccal tubercle of the maxillary and mandibular posterior teeth was 17.2 mm and 16.4 mm, respectively. Reports from Stananought and Newton [10] suggested 20 mm for the anterior upper jaw and 18 mm for the anterior lower jaw.

Already, Ellinger [11], through a radiographic study, found 20 mm for the anterior upper jaw and 16.3 mm for the anterior lower jaw. However, another work from Ellinger et al., [12] suggested that the height of ORBs should be 24 mm and 20 mm for the anterior upper and anterior lower jaw, respectively. Moreover, Johnson and Winstanley [13] and Johnson, Winstanley, and Wildgoose [14], found that the mean height of the anterior maxillary ORB was 18 mm and for the anterior mandibular counterpart was 14.3 mm. In a more recent study in Jordan, Marashdeh [7] reported 20.3 mm for the anterior upper jaw and 15.0 mm for the anterior lower jaw. Still, when he used students to fabricate the ORBs, he reported 19.8 mm for the anterior upper jaw and 16.4 mm for the anterior lower jaw.

Furthermore, in a study among the edentulous Indian population to determine the ORB height for the fabrication of removable complete dental prosthesis, More et al, [15] found that the height of maxillary anterior and posterior aspects when measured from the depth of sulcus (reference point) perpendicular to the ORB plane were 19-20 mm and 14 – 15 mm, respectively, while that of mandibular anterior and posterior aspects were 14 mm and 12-13 mm, respectively [15]. However, [16] emphasized that when fabricating the ORBs, the height of the maxillary anterior and posterior portions should be 22 mm and 18 mm, respectively, while that of the mandibular anterior and posterior portions should be 18 mm throughout from the depth of the sulcus.

The Uganda National Oral Health Policy [17] recommends the fabrication of complete dentures for the treatment of edentulous patients using the internationally accepted standard height of ORB of 22 mm for the maxilla and 18 mm for the mandible [18]. Despite recognizing the height of ORBs based on the internationally accepted standard in the fabrication of complete dentures in Uganda, there is a continued experience of challenges in adjusting them to fit the patients. The challenges include prolonged denture fabrication process, injury to the oral soft tissues, delayed chair side time, and so forth. In addition, there is no published study that has estimated the height of ORBs among the Ugandan population.

The purpose of this study was to statistically investigate the standard height of ORB among Ugandan edentulous patients attending Makerere University Dental Hospital, Kampala, Uganda.

Materials and Methods

Study Design

This was a cross-sectional quantitative study where data were collected through laboratory procedures.

Study Site

The study was conducted at Makerere University Dental Hospital in Kampala, the capital city of Uganda. The hospital is a teaching and health service delivery facility of Makerere University. It is the largest and adequately equipped dental facility employing the highest number of oral health workers in Uganda. It has a well-established prosthetic dental laboratory and offers specialized dental services including rehabilitation of edentulous patients with RCD to the patients including staff and students at the University, and other communities outside the University at a minimal fee. The hospital attends to approximately 660 outpatients per month of which about 20 are treated using RCD (Registry of Dental Records, 2022). The site was chosen because of the large number of edentulous patients (on average 20) who receive RCDs per month (Registry of Dental Lab Records, 2022), which could raise the required sample size.

Selection of Study Materials

Study materials comprised of pairs of wax ORBs routinely requested by clinicians for dental stone models of patients in need of RCDs. A consecutive sampling procedure was used to select a total of 240 pairs of ORBs (upper and lower arches). This was determined based on the hospital records where approximately 20 patients sought rehabilitation with RCDs per month, totaling 240 ORB pairs for the study period.

Inclusion Criteria

All ORBs with Free-Way Space (FWS) of 2 to 4 mm during the bite registration process.

Exclusion Criteria

ORBs of patients with flat alveolar ridges.

Data Collection Procedure

ORBs were fabricated in collaboration by a clinician and dental technologist in the dental clinic and dental laboratory, respectively. After obtaining administrative clearance from the Makerere University Dental Hospital, edentulous patients who came for complete denture treatment had clinical oral examination by the dental clinician. The clinician took the primary impressions of the patient's upper and lower arches and sent them to the dental technologist to cast them into dental stone to produce study models. The models were assessed to rule out flat alveolar ridges and used to fabricate a special/custom tray for the patient. The trays were used by the clinician to take secondary impressions of the patient's arches and sent to the dental technologist to fabricate the ORBs. The ORBs were sent to the clinician for bite registration of the patient with a free-way space of 2 to 4 mm. The measurements of the height of ORBs in mm were taken before and after bite registration by a trained and calibrated dental technologist as previously described [19, 20] using a pair of dividers (Kofa, China) and a ruler (Kofa, China). The values were recorded in a data abstraction form. Measurements for anterior height were taken from the deepest point of the facial sulcus adjacent to the labial fraenum (reference point) perpendicularly to the occlusal plane of the maxillary and mandibular ORB, respectively. While for the posterior height, measurements were done from the deepest point of the sulcus in the posterior region (reference point) perpendicularly, to the occlusal plane of the maxillary and mandibular ORB, respectively. These measurements from different ORBs were used to compute the mean height values (Table 2).

Quality Control

The clinical procedures were done by trained clinicians while the ORB measurements were done by a trained dental technologist. In order to minimize examiner variability, 1 trained and

calibrated dental technologist recorded the height of ORBs before and after bite registration.

Data Management and Analysis

The collected data were entered into an Excel spreadsheet from where they were exported into STATA software version 15 for data analysis to obtain the mean height of the occlusal rim blocks. Student's t-test was used to determine any significant differences in height of the occlusal rim blocks before and after bite registration, and compared to the internationally accepted standard. P-value< 0.05 was considered as a statistically significant difference in the measurements of the height of ORBs in millimeters.

Ethical Consideration

Ethical approval of the protocol was obtained from the Makerere University School of Health Sciences Research Ethics Committee (Reference Number: MAKSHSREC-2023-486) as well Uganda National Council for Science and Technology (Reference Number: HS3092ES). Permission to carry out the study was obtained from the administration of Makerere University Dental Hospital.

Written informed consent was obtained from all the participants who took part in the study. The purpose of the study was explained to the participants and their participation was voluntary. Their agreement to participate in the study did not waive their rights in any way and this was in accordance with the Helsinki Declaration [21]. All the data collected were kept securely in a cabinet under lock and key and only accessible to the investigator.

Results

Table 1. Demographic Characteristics of Respondents (N= 240)

Variable	Frequency	Percentage
Age (years)		
Mean	54 ± 9.3	
Range	28-78	
Sex		
Male	88	36.7%
Female	152	63.3%

The mean age of the patients who needed complete dentures was 54 (SD=9.3), range: 28-78 years. The majority were females (n=152, 63.3 %; Table 1).

Table 2. Mean Height of the Maxillary and Mandibular Occlusal Rim Blocks before and after Adjustments (n=240)

Maxillary arch	Anterior (Mean height in mm)	Posterior (mean height in mm)	P-value	CI
Before adjustment	21.6 ±1.2	19.3±1.2		21.43 – 21.74
After adjustment	19.4±1.5	17.4±1.5	<0.05	19.21 – 19.60
Mean difference	2.2	1.9		1.98 – 2.37
Mandibular arch				
Before adjustment	17.9±1.0	17.7±0.9		17.78 – 18.04
After adjustment	16.4±1.2	16.0±1.3	<0.05	16.23 – 16.55
Mean difference	1.5	1.7		1.37 – 1.66

The mean anterior height for maxillary occlusal rim blocks before and after adjustment was 21.6 mm and 19.4 mm, respectively, while the posterior mean height before and after adjustment was 19.3 mm and 17.4 mm, respectively (Table 2). The mean anterior height for mandibular rim blocks before and after adjustment was 17.9 mm and 16.4 mm, respectively. On the other hand, the mean posterior height for mandibular rim blocks before and after adjustment was 17.7 mm and 16.0 mm, respectively (Table 2).

In comparing the estimated height of ORBs before and after bite registration with the internationally accepted standard height, there was a significant difference for maxillary and mandibular jaws (p-value < 0.05), (Table 2).

Table 3. The Mean Height of Maxillary and Mandibular Occlusal Rim Blocks before and after Adjustment for Male and Female Participants (n=240)

Variable	**Maxillary occlusal rim block**			
	Anterior height (mm)		**Posterior height (mm)**	
Sex	Before	After	Before	After
Male (n=88)	21.5	19.3	19.4	17.3
Female (n=152)	21.6	19.4	19.3	17.4
Mandibular occlusal rim block				
-	**Anterior height (mm)**		**Posterior height (mm)**	
Sex	Before	After	Before	After
Male (n=88)	19.8	16.5	17.6	16.0
Female (n=152)	19.7	16.4	17.7	16.1

The general difference in the height of ORBs between the male and female participants within the maxillary and mandibular jaws in the anterior and posterior portions before and after adjustment was 0.1 mm. There was no significant difference between the mean height of maxillary and mandibular ORB before and after adjustment among the male and female participants (p>0.05, Table 3).

Table 4. The Mean Height of the Maxillary and Mandibular Occlusal rim Blocks after Adjustment in the Present Study and from Different Studies

Author(s)	**Sample size**	**Country**	**Maxillary (in mm)**		**Mandibular (in mm)**	
			Anterior	**Posterior**	**Anterior**	**Posterior**
Internationally accepted height Driscoll & Glen [16]	-	USA	22	18	18	18
More [15]	200	India	19-20	14 – 15	14	12-13
McGraine [8]	-	USA	22	-	18	-
Yanikoglu [9]	45	Turkey	-	17.22	-	16.42
Ellinger [11]	50	USA	20	-	16.3	-
Stananought [10]		UK	20	-	18	-
Johnson & Winstanley [13,14]	414	UK	18	-	14.3	-

Marashdeh [7]	(300)	Jordan	-		-	-
(Students)	150		19.8		16.4	
(Technicians)	150		20.3		15.0	
Wood & Johnson [19]	-	UK	22	-	18	18
Wood [20]	-	UK	22	-	18	18
Bishop & Johnson [27]	-	UK	20	-	16	-
Nallaswamy [28]	-	UK	22	-	18	18
Zarb [29]	-	USA	22	-	18	18
Rangarajan [31]	-	India	22	-	18	18
Present study	240	Uganda	19.4	17.4	16.4	16.0

USA, United States of America; UK, United Kingdom

Discussion

To our knowledge, there is no published information regarding the determined height of ORBs for Ugandan edentulous patients. The present study established the baseline data of the estimated standard height of ORBs using a method previously described [8]. The present findings will inform policymakers in reviewing existing guidelines [17] in fabricating ORBs that are suitable for Ugandan edentulous patients. The implication of the present findings is that there will be saving of resources in terms of materials and chair side time in adjusting ORBs during the bite registration visits.

In the present study, the mean age of the patients was 54 years which is like the reported age by [22] in Istanbul, Turkey. However, Miranda et al. [24] reported a higher mean age of 69 years. Globally [2] including Uganda [23] dental caries is one of the causes of edentulism and being a cumulative disease could partly explain the age of the participants.

In the present study, most of the respondents were females which supports findings in other studies [12, 22-24]. Apart from females being more affected by caries [23], hence edentulism, Kršek and Dulčić [25] indicated that complete dentures offer good restoration of appearance, correction of speech defects/phonetics, restoration of masticatory efficiency and occlusion, which are all cherished by females compared to males. In contrast, Bekiroglu et al. [22] and Oweis et al. [26] reported a higher prevalence of males with RCDs compared to females, the reason for the observed difference is not readily obvious.

Mean Height of Maxillary and Mandibular Occlusal Rim Blocks

The present study showed a significant mean height difference before and after adjustment in the maxillary anterior and posterior portions by at least 1.9 mm and then 1.5 mm for mandibular ORBs (Table 2) to achieve a 2-4 mm freeway space. This is in support of the findings from earlier studies [13,14]. This implies that the technologists were following the international guidelines [18] adopted in Uganda [17] for the fabrication of complete dentures. These findings are comparable to reports from McGrane [8] whose measurements from the same reference points were 22 mm and 18 mm for anterior maxillary and mandibular ORBs, respectively. Furthermore, [13] reported slightly lower values for the maxillary ORBs before bite registration of 21.4 mm and 17.6 mm for mandibular. Earlier, [16] had emphasized that when fabricating the ORBs, the height of the maxillary anterior and posterior ORB should be 22 mm and 18 mm respectively while that of mandibular anterior and posterior ORB should be 18 mm throughout from the depth of the vestibule/sulcus [16].

It could be argued that most of the technologists are following the international guidelines [8, 14, 27] for the fabrication of ORBs, and therefore, measurements before bite registration are adhered to. However, it has been reported that some experienced technologists fabricate ORBs with reduced heights compared to the international guidelines [7]. This could be aimed at easing the bite registration process and more accurately fitting removable complete dentures.

During bite registration, in the present study, clinicians reduced the anterior and posterior portions of the maxillary ORBs by 2.2 and 1.9 mm respectively, as well as 1.5 and 1.7 mm for the respective counterparts of the mandibular ORBs (Table 2). Other studies [27,13,7] reported higher values of height reduction of 4 and 3-4 mm from the internationally accepted standard heights of maxillary and mandibular ORBs compared to the present study. It is noteworthy that reducing the height of ORBs during bite registration to achieve a standard freeway space of 2-4 mm could lead to a waste of time and materials.

More et al [15] found that the anterior height of maxillary ORB was like the findings of the present study but recorded lower values of posterior height of the maxillary and both anterior and posterior height of the mandibular ORB (Table 4).

The sex difference in the ORBs' mean height between the respective anterior and posterior portions of the maxillary and mandibular jaws before and after adjustment was 0.1 mm.

Implications for Clinical Practice

The findings of the present study among the Ugandan population will set the center stage for improved rehabilitation of edentulous patients. This will save time and resources during the registration stage and help to improve the accuracy of the removable complete dentures. Furthermore, the findings will be used to review the training curriculum of dental surgery and dental technology students.

Implications for Future Research

Prospective scholars should consider conducting studies involving participants from several dental hospitals for better generalizability of the study results. In addition, follow-up studies to evaluate patient and health provider satisfaction with the use of removable complete dentures based on different heights of ORBs are recommended.

Limitations of the Study

The bite registration of ORBs has an inherent input of the patient, which is outside the control of the clinician. This was a cross-sectional study in nature and thus not able to identify the causality of the outcome of interest. The study conclusions should be drawn with caution because the study was conducted in only one dental hospital so the results may not be generalized to the entire Ugandan population.

Recommendations

The present study recommends Ministry of Health to review the Uganda National Oral Health Policy guidelines in line with the newly established height of occlusal rim blocks. The training curriculum of dental surgery and dental technology students' needs to be reviewed in consideration of the established height of ORBs.

Conclusion

Overall, the mean height of Occlusal Rim Blocks (ORBs) for the Ugandan population was significantly lower compared to the internationally accepted standard. The mean height for the anterior portion of maxillary ORBs was 19.4 mm and for the posterior, 17.4 mm after adjustment while the mean height for the mandibular counterparts was 16.4 mm and 16.0 mm, respectively.

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The study was self-funded.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Author's Contributions

DN, IO, EM, and CMR participated in the conception, study design, data analysis, and manuscript preparation. DN and GB participated in data collection. All authors read and approved the final manuscript.

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