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Technical Note

Palate depths in relation to available dental stock impression tray design

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Abstract: Palate depth is highly influenced by the genetic factor and differs significantly among the ethnic groups, but most of the impression tray manufacturers disregard it and produce stock trays with uniform depth. Thus, the impression becomes inappropriate and causes a massive loss of impression material. This study aims to measure the palate depths of a young Malay population and categorise them into different classes and determine the suitability of available stock trays by comparing impression material thickness. The palate depths of 123 maxillary dental arches were measured using Mitutoyo digimatic indicator and the Class interval was used for grouping the palate depths. The Duncan Multiple Range Test and Analysis of Variance were used for assessing differences among the groups. The range of depth of the stock trays was 3.32-8.99 mm in the canine region (DCC) and 10.18-20.80 mm in the first molar region (DM1M1) while for the casts these were 6.42-10.76 mm and 17.88-23.10 mm respectively. The palate depths of Malay dental arches can be grouped into three categories (shallow, moderate and deep palate) but the available stock trays were not adequate to accommodate these palates without any adjustments to the trays.

Keywords: palate depth, stock tray, grouping of palate, Malay ethnic group

INTRODUCTION

Good-quality dental impression and perfect working cast preparation are the most important steps in fabricating well-fitting dental restorations and prostheses. The impression tray plays a vital role in proper primary impression setting and consequently in precise cast manufacturing [1]. The impression tray acts as a rigid carrier for the impression material, facilitates their insertion into the

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mouth, and holds the impression material in its appropriate position during impression setting. The impression tray could be a custom tray or stock tray that should have sufficient extension to support an impression of all structures with adequate space for impression material [2]. However, there has not been much improvement in the design of dentate stock impression trays and available stock trays frequently require modifications before use [1, 3]. Clinical experience has also shown that the stock trays are not suitable for providing all variations present in the anterior-posterior widths or palatal depth of dental arches [4]. Image processing techniques have also proved that the available stock trays are only suitable for a particular population [5]. Moreover, most of the stock trays cannot accommodate the depth of the maxillary arch properly without pre-packing of impression material but are still routinely used in clinical practice, although the use of custom trays is recommended for maximising impression and cast accuracy [6, 7].

The dimensional stability of impression material is affected by the distance between the tray and the surface to be impressed (i.e. space for the impression material). There should be an optimum space of 2-4 mm between the cast and tray for an appropriate fit [8]. The thickness of more than 2-4 mm might affect the dimensional stability and restoration quality [9]. Hence the American Dental Association (specification no. 19) has emphasised using proper impression material for recording (± 20μm) information of the palate [10, 11].

The palate might be square-, U-, V- and oval-shaped while the palatal depth might be deep (high), medium (moderate) and shallow [12-14]. The genetic factor highly influences the variation in palatal depth and the Malaysian Malays possess a deeper palate than other ethnic groups (Chinese and Indian ethnic groups) [15, 16]. Conversely, commercially available stock trays are U-shaped with uniform palate depth and the maximum depth of 14 mm seems to be inadequate for a proper impression for Malays [6]. Hence the aim of this study is to measure and categorise the palate depth of Malays in order to recommend a suitable design of stock trays for proper impression for the Malay ethnic group.

MATERIALS AND METHODS

Collection and Preparation of Stone Casts

Dental casts of 123 young Malay adults (63 men and 60 women) who fulfilled the inclusion criteria of being fully dentate with Class I Angle's Classification and regular arches with minimal attrition were prepared according to the protocol of Isa et al. [17]. A maxillary impression was taken using alginate (Zhermack SpA, Italy) and considered acceptable if all the anatomical landmarks (hamular notches, maxillary tuberosity areas and full depth of sulcus) were recorded in the impression. The impression was rinsed quickly under cool running water and inspected to ensure that it was free from air bubbles before spraying with a disinfectant solution, i. e. 2% Perform®-ID (Schulke and Mayr, Germany). It was then wrapped in gauze moistened with the disinfectant and left for 10 minutes [18]. The impression was rinsed again under running water and then immediately poured with type III dental stone (Heraeus Kulzer GmbH and Co., Germany) to obtain a cast. The cast was allowed to dry in air for 24 hours to produce a hard surface.

Each cast was then numbered and labelled; detailed information regarding the age, sex and racial ethnicity of the subject was kept separately in the consent form. The stone casts were based in Plaster of Paris with sufficient height to allow adequate material around the buccal sulci to permit trimming. All the casts were trimmed to produce a surface parallel to the line joining the maximum concavity of the hamular notches on each side. The casts were then placed upside down on a

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reference plate with the mesio-palatal cusps of molar teeth and the incisal edges contacting the plate in the most stable position. The ascribed line was then engraved on the side of the cast using a geometric compass with an indelible pencil attached to it. The compass arm was placed on the reference plate parallel to the surface table and stabilised using cold cured acrylic resin. The base of the cast was then trimmed to obtain an occlusal plane parallel to the horizontal plane with all the required landmarks present on the cast (Figure 1). This study was approved by the Medical Ethics Committee of the Faculty of Dentistry, University of Malaya (DF PD1106/0089 L).

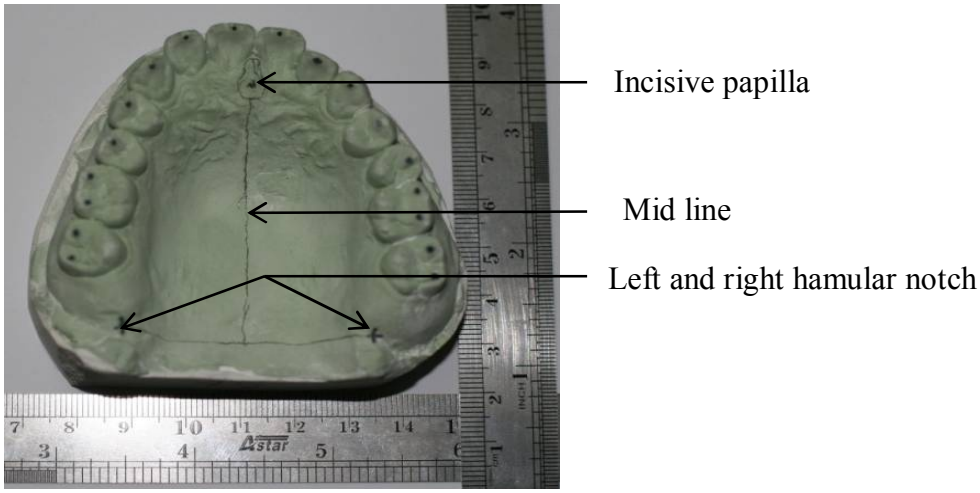

Figure 1. Cast with scale and landmarks

Measurements of Palate Depth

The palate depth measures the height of the vertical distance of a point in the midline of the palate from a plane that passes through the occlusal plane at a line where the depth measurements are made. A protractor was used to indicate a line joining the points where depth measurements were made in the midpoint of canine to canine (DCC), first premolar to first premolar (DP1P1), second premolar to second premolar (DP2P2), first molar to first molar (DM1M1), second molar to second molar (DM2M2), and in the midpoint of left hamular notch to right hamular notch (DHNHN). A Mitutoyo digimatic indicator (Mitutoyo, Japan) was used to measure palate depths (Figure 2). The palate depths in the first molar region were used to classify the palates into shallow (less than 19 mm), moderate (19-22 mm) and deep (more than 22 mm), which is a modification of the edentulous palate depth classification used by Kazanje and INoori [13].

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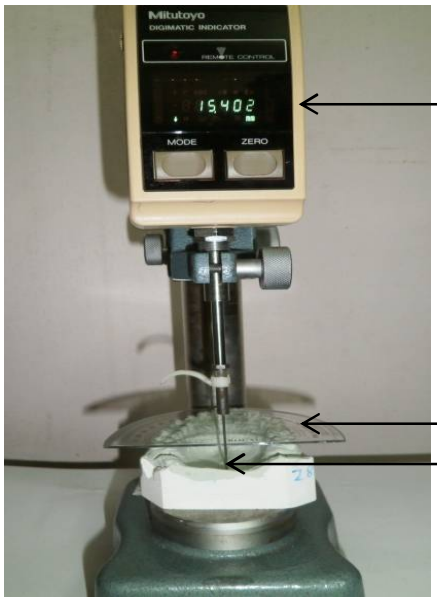

Figure 2. Depth measurements of cast using Mitutoyo digimatic indicator. For measuring palate depth, a protractor is placed upon the cast and the Mitutoyo indicator pin is placed on the protractor surface which is indicated as '0' at different points. Then the indicator pin is allowed to touch the palate depth for measurement at different points.

Measurement of Available Stock Trays

The four available types of perforated maxillary stock impression trays of various sizes (Figure 3) were measured. The depth at canine region and the maximum depth at molar region were measured by Mitutoyo digimatic indicator (Mitutoyo, Japan). The canine region and molar region in the stock tray were identified by placing the tray on different casts randomly.

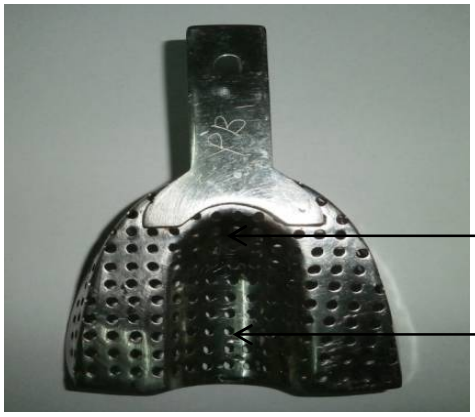

Figure 3. Example of available impression trays used for measurements

Calibration Procedure

All measurements were made at two different times by two examiners and the second measurement was made a month after the first. To evaluate inter-examiner reliability, 10 casts were measured, and the means of the measurements by the two examiners were not significantly different

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at 5% level. A mean value (from 4 measurements) of each variable was used as the final measurement for each variable.

Statistical Analysis

The descriptive statistics, i.e. Duncan Multiple Range Test (DMRT) and Analysis of Variance (ANOVA), were performed and space for impression materials was measured using Minitab 17 software (Minitab 17 Statistical Software, Sydney, Australia).

RESULTS AND DISCUSSION

Measurement of Casts

The descriptive statistics (mean, standard deviation, minimum and maximum values) of six variables for depth measurement are presented in Table 1, which shows that the DCC has the lowest value and the DM1M1 has the deepest value among the six variables. Moreover, DCC and DM1M1 can be located on the available stock impression trays. Therefore, these two variables were chosen for grouping the palate depths, measuring the space for impression material and assessing the appropriateness of the trays.

Table 1. Descriptive statistics of six variables for palate depth measurement

Variable	Mean (mm)	± SD (mm)	Min (mm)	Max (mm)
DCC	8.31	1.27	5.60	12.54
DP1P1	14.68	2.01	11.25	20.16
DP2P2	18.91	1.99	14.27	23.66
DM1M1	20.63	1.87	16.30	24.96
DM2M2	19.84	2.38	14.56	24.41
DHNHN	15.76	2.13	10.58	20.91

Previous researchers have observed that available stock trays do not accommodate all the arches of the Malaysian Malay population adequately at the palatal region of the deep palate [6]. The present research highlights a measuring and grouping technique for palate depths in order to design stock impression trays.

Grouping of Palate Depths

Based on the class interval, the studied palate depths were classified into three categories (shallow, moderate and deep palate). The descriptive statistics and DMRT of the three palate groups are presented in Table 2, which shows that the three palates in both variables (DCC and DM1M1) are statistically different ($p < 0.05$) and belong to different groups. The palate depths were further tested by the variance analysis (Table 3).

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Table 2. Descriptive statistics and DMRT of three palate groups

Variable	Palate depth	Number	Mean (mm)	± SD (mm)	Min (mm)	Max (mm)	Duncan group
DCC	Shallow	19	6.42[c]	0.29	5.60	6.84	C
	Moderate	92	8.37[b]	0.73	7.03	9.87	B
	Deep	12	10.76[a]	0.71	10.08	12.54	A
DM1M1	Shallow	21	17.88[c]	0.89	16.30	18.88	C
	Moderate	72	20.41[b]	0.82	19.06	21.93	B
	Deep	30	23.10[a]	0.80	22.01	24.96	A

Note: SD = standard deviation; Means with different letters are significantly different at 5% level.

Table 3. ANOVA of three palate depths

Variable	Source of variance	df	Sum of square	Mean square	F-value	P-value
DCC	Palate depths	2	140.52	70.26	148.71***	0.00
	Error	120	56.69	0.47		
DM1M1	Palate depths	2	345.22	172.61	251.67***	0.00
	Error	120	82.30	0.68		

Note: df = degrees of freedom; F-value = F-distribution value; P-value = P-probability distribution value; *** = significant at 1% level

Table 3 demonstrates highly significant differences ($p < 0.01$) of the three palate depths using two variables. In earlier studies three types of palate depth were reported by Kazanje and INoori [13] in edentulous population (shallow, moderate and deep palates) and by Maria et al. [14] for children at mixed dentition stage (low, medium and deep palates).

Measurement of Available Stock Trays and Space for Impression Material

The stock trays used for impression of attending patients at the Faculty of Dentistry, University of Malaya were measured for depth at the canine region (DCC) and at the first molar region (DM1M1), as presented in Table 4. The space for impression material was also measured by comparing the tray values with the group mean (palate depth groups) values (Table 4).

Table 4 shows that the range of depth of stock trays in the canine region (DCC) and in the first molar region (DM1M1) was 3.32-8.99 mm and 10.18-20.80 mm respectively, but the depths of the three types of palate were 6.42-10.76 mm and 17.88-23.10 mm respectively. Thus, some trays well fit at the canine region but are not suitable for the molar region and vice versa. Previously, the palate depths of the Malaysian people were measured by Hsu [19], Omar and Isa [6] and Mohammad et al. [16], but they did not measure the adequacy of the available stock trays at the palatal region. They concluded that Malaysian Malays had higher palate depths and a single standard of dentoalveolar structures could not be applied to the entire ethnic group [6, 16, 19].

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Table 4. Measurement of available stock trays and space for impression material

Available tray			Space for impression material (tray value - cast mean value)			Available tray	Space for impression material (tray value - cast mean value)		
Brand (Country)	Tray number	DCC (mm)	Shallow (6.42 mm)	Moderate (8.37 mm)	Deep (10.76 mm)	DM1M1 (mm)	Shallow (17.88 mm)	Moderate (20.41 mm)	Deep (23.10 mm)
Derfla (Germany)	BO0	7.16	0.74	-1.21	-3.60	15.58	-2.30	-4.83	-7.52
	BO1	8.99	2.57	0.62	-1.77	16.29	-1.59	-4.12	-6.81
	BO2	7.87	1.45	-0.50	-2.89	19.48	1.60	-0.93	-3.62
	BO3	8.80	2.38	0.43	-1.96	20.80	2.92	0.39	-2.30
Medesy (Italy)	U4	6.33	-0.09	-2.04	-4.43	10.36	-7.52	-10.05	-12.74
	U3	4.11	-2.31	-4.26	-6.65	10.92	-6.96	-9.49	-12.18
	U2	5.35	-1.07	-3.02	-5.41	13.48	-4.40	-6.93	-9.62
	U1	4.83	-1.59	-3.54	-5.93	10.59	-7.29	-9.82	-12.51
Prima (England)	A0	4.33	-2.09	-4.04	-6.43	10.18	-7.70	-10.23	-12.92
	A1	4.78	-1.64	-3.59	-5.98	11.37	-6.51	-9.04	-11.73
	A2	5.09	-1.33	-3.28	-5.67	12.14	-5.74	-8.27	-10.96
	A3	6.88	0.46	-1.49	-3.88	13.49	-4.39	-6.92	-9.61
NDSS (Pakistan)	15	4.57	-1.85	-3.80	-6.19	12.22	-5.66	-8.19	-10.88
	14	4.40	-2.02	-3.97	-6.36	11.15	-6.73	-9.26	-11.95
	13	5.20	-1.22	-3.17	-5.56	10.59	-7.29	-9.82	-12.51
	12	4.97	-1.45	-3.40	-5.79	12.50	-5.38	-7.91	-10.60
	11	3.32	-3.10	-5.05	-7.44	15.44	-2.44	-4.97	-7.66

In the present investigation some stock trays were observed to be too shallow (requiring a pre-packing of impression material for deep palate) and some too deep (impression material overflowing for shallow palate), which resulted in an uneven distribution and loss of impression material. Besides, the available stock trays did not allow 2-4 mm space for the perfect impression. Thus, the available trays are not adequate for a proper impression for Malay ethnic group without adjustments to the trays before impression. Hence a new tray design is required which can accommodate the variation in the palate depths of the Malay ethnic group.

CONCLUSIONS

This study has established a new reference data for the palate depths of young Malays and estimated the variations that are relevant when making comparisons to commercially available stock trays. Based on the palatal depths, the Malay dental arches may be grouped into three categories,

viz. shallow, moderate and deep. A new tray design which accommodates the observed variations in the palate depth is necessary for accurate impression and cast production of the Malay ethnic group.

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