MAXILLARY ARCH DIMENSIONS AND THE ADEQUACY OF STOCK IMPRESSION TRAY DESIGN

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Abstract

An investigation of arch dimensions in relation to stock tray sizes and design will facilitate impression making, and in certain cases, make custom trays unnecessary. The aim of this study was to examine whether the currently available stock impression trays can accommodate the maxillary arches of a selected Malaysian population, namely the Malay, Chinese and Indian ethnic groups. Ten dental and bony landmarks in the maxillary casts of randomly selected subjects from the three ethnic groups with permanent, intact dentition and normal occlusion were measured directly using digimatic calipers, a protractor and a profile gauge. Trays of various sizes and designs from 4 different manufacturers were investigated in this study, and their dimensions and shape compared to the dimensions and shape of the subjects in the study. The results show that the maxillary arches of the subjects in the study are almost V-shaped (i.e. tapering or smaller towards the anterior region), whereas the maxillary stock trays are U-shaped, with anterior widths almost equal to the posterior widths. The results also indicate that the impression trays would not accommodate the longer, wider and deeper palate depths of the maxillary arches of 41.3% of the population studied. It can be concluded that currently available stock impression trays do not adequately fit the dimensions and shape of the Malaysian dental arches.

Key words: maxillary arch dimension, impression tray design

INTRODUCTION

Different racial and ethnic groups have been shown to have varying dental arch sizes and shapes.\textsuperscript{1,3} Information concerning arch dimensions and stock tray impression design is of great relevance as the most restorative procedures are made indirectly on casts fabricated from these impressions. The main purpose of the impression tray is to act as a rigid carrier for the impression materials, facilitating their insertion into the mouth and holding the impression material in place while it sets. The tray must have sufficient spacing between the tray and the tissues to be recorded so that an optimum thickness of the impression material may be used in the tray.\textsuperscript{4} Although many factors may contribute to the distortion in dental impressions and the subsequent inaccuracies in the stone casts, not much attention is given to the possibility of distortion being produced by using an inadequate impression tray.\textsuperscript{5}

Clinical experience has shown that the currently available stock impression trays often need to be modified at the chair-side before they can be used satisfactorily for making primary impressions. The most recurrent problem noted was the eccentric seating of the arch on seating.\textsuperscript{6} Too many spaces may exist in some regions, resulting in an uneven thickness of the impression material. Some trays are either too short or too long to record the oral hard and soft tissues that need to be recorded. Under extension of the tray gingivally or at the most distal tooth leaves an unsupported impression material, leading to a feather-edged impression. Modifications to the extension of the tray therefore have to be made by further extending the periphery using wax or green stick tracing compound. Inadequate widths of the trays are normally overcome by bending the trays with pliers to increase or decrease its width. However, bending the trays induce stresses that would reduce the lifespan of the trays. Deep palate depths are also not accommodated by the shallow depths of the stock trays, making pre-packing the impression material in the palatal region necessary to allow the impression material to be brought into contact with the palatal tissues.
Although it appears that the problems encountered with the use of the available stock impression trays could be overcome with relative ease in the clinics, there is a need to establish the parameters required for good impression tray design, especially for the use with populations of different ethnic groups. It was shown that stock impression trays were inadequate to accommodate the larger African arches, and therefore it would be prudent to investigate if these trays were satisfactorily accommodate the Malay, Chinese and Indian ethnic groups of the Malaysian population.

**MATERIALS AND METHODS**

The subjects in the study were randomly selected and comprised of 126 adults aged between 19 and 40 years with permanent, intact dentition and normal occlusion. Table 1 shows characteristics of the subjects.

Ten dental and bony landmarks in the maxilla were used as reference points to evaluate the arches i.e. the arch length (AL), the distance between incisor to canine-canine line (I-C), the distance between incisor to molar-molar line (I-M2), the inter-canine distance (C-C), inter-molar distance (M2-M2), width at maximum buccal bone of the second molars (max M2-M2), palatal inclination (PI), palatal depth (PD), molar tooth width (MW) and the length of the central incisor (IL) (Figures 1, 2 and 3). Measurements were made directly on the casts using digimatic calipers, a profile gauge and protractor. Measurements were only made for maxillary arches as the mandible would normally correspond to the maxilla.

In order to compare the measurements obtained from the maxillary casts to commercially available stock trays, four brands of perforated maxillary stock impression trays of various sizes and designs available in the Faculty of Dentistry, University of Malaya, Kuala Lumpur were examined. The trays were manufactured by Ash (England), Ansa (Italy), NDSS (Pakistan) and Derfla (Germany). The measurements made were: i) length of the trays, ii) width of the trays, iii) maximum depth of the palatal part of the tray, and iv) width of the ‘box’ part of the tray. These measurements were made directly on the trays using a metal ruler and calipers.

**Table 1.** Characteristics of the subjects in the study.

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Malay</th>
<th>Chinese</th>
<th>Indian</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
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<td>23</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td>n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age (y)</td>
<td>23.6</td>
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<td>24.1</td>
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</tbody>
</table>

**Figure 1.** Landmarks used to measure the arches.

**Figure 2.** The use of the profile gauge to measure arch length (AL), palatal inclination (PI) and palatal depth (PD). The profile gauge is adapted to the palatal surface of the stone cast between the incisal edges of the central incisor and a perpendicular line joining both hamular notches to obtain the cast profile in this region. This profile is then transferred to a millimeter graph paper.
max M2-M2 in both the Malay and Chinese groups was also significantly wider. However, the Indian group had significantly steeper palatal slope than the Malay and Chinese groups, as shown by the PI values.

As the stock trays were produced in various sizes, only the maximum values are shown in Figure 5. Both Ansa and NDSS trays show almost the same length and width, the Ash tray is also of the same width but slightly shorter and the Derfla tray is the shortest and smallest among all the trays measured. There is also little variation in the palatal depth of all the tray types. The box part of the trays shows small variations with the same maximum values for all the tray types.

Figure 3. The cast profile mentioned in Fig. 2 is transferred onto a millimeter graph paper to measure AL, PD and PI. AB-represents the midline of the maxillary arch (mid-palatal raphe), CD-represents a horizontal line drawn to join hamular notches on each side, EF-represents the length of the dental arch (AL) i.e. the line drawn on the highest point of the incisive papilla and parallel to the occlusal plane, GH-represents the maximum palate depth (PD), and \( \theta^\circ \)-represents the inclination of the palate (PI).

Data were analyzed using SPSS package (Version 11.0 for Windows). The mean, standard deviation and minimum and maximum values were calculated for all the variables measured. The analysis of variance between groups (ANOVA) and independent group t-test statistics were chosen to determine whether significant differences were seen in the maxillary arch dimensions of the different ethnic groups. The level of significance used was \( \alpha = 0.05 \).

RESULTS

Figure 4 shows that no significant differences were found in the arch dimensions between the Malay and the Chinese groups. However, when compared to the Indian group, 4 significant differences were observed: C-C and M2-M2 are significantly greater in the Chinese group, and

Figure 4. The variables measured in all the subjects studied, irrespective of gender. Values are mean ± SD. *denotes the significance level (P < 0.05) of the differences between the Malay and Chinese groups compared to the Indian group.

Figure 5. The largest dimensions of all the stock trays studied.
DISCUSSION

Standard or stock impression trays have been used for over a century in dentistry but no comprehensive study of their design in relation to the size and form of the human dental arches could be found in the literature, although manufacturers had made claims that the trays were designed based on “research in laboratories throughout the world and is able to cover any anatomical situation”.

This can be seen in the results of the present study where the commercially available stock trays are U-shaped, with the anterior width almost equal with the posterior width. However, the dimensions in Fig. 4 show that the arch form is tapering towards the anterior region (V-shaped). The flange at the posterior region of the currently available stock tray drops down in a straight line from the molar tooth to the buccal bone area, whereas the shape of maxillary arch at the molar region is diverging or bigger towards the buccal bone area.

Figure 5 shows that the longest tray was about 61 mm, and this will only allow an impression to be made in an arch length of about 57 mm, 4 mm being the allowance given as a space for impression materials (3 mm anteriorly and 1 mm posteriorly). In this study 52 subjects had arch lengths of more than 57 mm. This means that about 41.3% of all the total population studied could not be accommodated by the available stock impression trays measured.

The width of the widest tray is about 77 mm and the smallest is 65 mm. This can only accommodate an arch width of about 71 mm, 3 mm on each side being given as allowance for the thickness of impression materials. In this study 7 subjects had arch widths of more than 72 mm. This means that about 5.6% of the total population studied could not be accommodated adequately by the available stock impression trays measured. However, an increasing in the length of the dental arch may or may not correlate with an increasing in the width of the human dental arch.

The maximum depth of the palatal part among all trays was 14 mm, whereas PD of the subjects ranged from 9-20 mm. For the impression material to be brought close to the palatal tissues at least 17 mm of palate depth of the tray is required (with allowances given for impression materials and presence of teeth, refer to Fig.3). This appears that no existing tray would accommodate the depth of the maxillary arches studied, without pre-packing impression materials at the palatal region before inserting the tray.

It may seem a paradox to use stock trays which were “unacceptable”, modified to make them “acceptable”, make the impressions with these trays which then became no different from one another, and obtain casts to make the measurements of the arch dimensions. This is however unavoidable, as the aim of the study was to relate the maxillary arch dimensions to commercially available stock impression tray design, and not to see how the design of the trays affect the adequacy of the resultant casts.

Within the limitations of this study, the following conclusions were drawn: The shape of the available stock impression trays appears to be U-shape but the Malaysian dental arches samples seemed to be V-shape. The maxillary arch dimensions of Malays are similar to Chinese. The Indian group has narrower arches, with significantly lower values in three out of ten variables measured i.e. the inter-canine distance (C-C), inter-molar distance (M2-M2), and maximum width at buccal tissues of second molars (max M2-M2). However, they show significantly steeper palatal inclination (PI). Maxillary impression trays with bigger, wider and deeper palatal depths are required to accommodate 41.3% of the population studied. The currently available stock impression trays do not adequately accommodate the arches of the Malaysian population, and therefore specifications for new design of stock trays are highly recommended.

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References