ABSTRACT

Aim: The aim of the present research is to assess the distribution of the alveolar ridge height (ARH) and compare the values obtained intraorally and from plaster, master-casts poured from two-step final impressions.

Materials and methods: For the purpose of this study, 96 patients aged 49-88 were examined between 2016-2019. The research was conducted during the practical classes in prosthetic dental medicine and oral and maxillo-facial surgery at the Faculty of Dental Medicine, Medical University - Sofia. The study methods included an individual interview, observation, palpation, and clinical and laboratory measurements of the ARH in predefined locations. The results were collected in pre-made patientcards. The investigated variables were age, gender, and height of the alveolar ridges in the frontal and distal areas for the upper and lower jaws.

Results: The intra oral measurements showed a mean 8.64±2.6mm height of the entire upper jaw with the highest average value obtained in the frontal area – 9.48±2.67 mm. Both distal areas were with comparable heights, demonstrating similar results to the frontal segment, which suggests equability in the atrophic maxilla for our sample. For the entire lower jaw, the intraoral measurements showed a mean score of 4.32±2.09 mm. A similar tendency was observed for the frontal – 5.08±2.20 mm and both distal areas, but with a more pronounced difference between them. There was a significant difference between the intra- and extra-oral measurements averaging at 0.77±68 mm across all values.

Keywords: compete edentulism, ARH, final impressions

INTRODUCTION

Life expectancy is continuously increasing in both high and low income countries and could result in the global population over 60 years of age surpassing two billion by 2050 [1]. The prevalence of tooth loss is positively correlated to age, hence the number of partially and totally edentulous people is expected to grow despite the advancements in oral-related patient education and care [2].

The most common treatment approach in totally edentulous patients is the fabrication of conventional complete dentures (CDs). This process involves multiple steps, some of which are crucial for its outcome [3, 4].

One such step is obtaining an adequate final impression. The latter is undoubtedly among the most difficult and unpredictable procedures, with a variety of methods. The success in this stage is detrimental to the future retention and stability of the prostheses, which in turn greatly influences chewing efficiency, patient comfort, and overall treatment satisfaction [5, 6, 7, 8]. Impression techniques and materials have evolved alongside the increased understanding of oral tissue biology and advancements in dental materials. Impression methods in CDs treatment can be grouped into mucostatic, mucocompressive, selective pressure, functional, and neutral zone impression techniques [9, 10, 11]. In a recent systematic review regarding impression materials and techniques, Jayaraman S. et al. [12] assessed the available literature as of low scientific quality, hence no conclusions could be drawn for an optimal method or material. Although scientific evidence for better treatment outcomes might be inconclusive, a general preference for border molding procedures and elastomeric impression materials is observed in recent publications. The final impression procedure in completely edentulous arches can be challenging when residual ridges are with moderate to severe atrophy or unfavorable morphological features [9, 10]. These findings tend to be prevalent in the lower jaw, with significant differences reported between intraoral tissues and the replica of the prosthetic field [13].

The aim of the present research is to assess the distribution of the ARH and compare the values obtained intraorally and from plaster, master-casts poured from two-step final impressions.
MATERIALS AND METHODS

Ninety-six edentulous patients (54 female and 42 male) aged 49-88 were included in the study between 2016 and 2019. The patients were chosen at random. All participants were informed about the purpose of the research in oral and written form, and informed consent was obtained. The research was conducted during the practical classes in prosthetic dental medicine and oral and maxillo-facial surgery at the Faculty of Dental Medicine, Medical University - Sofia. The study methods included an individual interview, observation, palpation, and clinical and laboratory measurements. The variables considered in this article – Part 2, are presented in Fig. 1. After the interview, intraoral measurements using a caliper (BSW Aluminium Vernier Caliper, Bharat Scientific World) with 0.02 mm accuracy were performed. Three points of interest were evaluated in both jaws – the left central incisor area and both first molar areas. In this study, the distance between the highest point of the ridge in the zone of interest and the adjacent (inner) border of the neutral zone was considered as the ARH.

The final impression was taken with an adjusted, light-cured, resin-based composite custom tray (Palatray XL, Heraeus, Austria). The borders of the tray were formed in such a way as to ensure a 2 mm distance to the neutral zone, frenula, and gingiva-labial and buccal folds. The latter allows sufficient space for the border molding material and unrestricted functional movements of the oral tissues.

The final impression was taken in two steps – an initial border molding procedure with silicone Type1 (Xantopren H green, Kulzer, Mitsui group), followed by a corrective phase with silicone Type 2 or Type 3 (Oxasil mucosa or light 140 ml, Kulzer, Mitsui Group) for fine registration of the tissue morphology. To ensure repeatability of the intra- and extra-oral measurements does not appear to be modifying the subject the points of interest – highest perceived points of the alveolar ridge. Due to the nature of the copying ink, these were transferred to the final impression and subsequently to the plaster models – Fig. 2, which were poured from dental stone (Moldastone, Kulzer, Mitsui group). Extraoral measurements were completed using the same protocol and instruments on the gypsum models.

RESULTS

Age and gender distribution:

The age and gender distributions of the study sample are visualized and described in part 1 of this series. The female patients are slightly more than the males but without a significant difference in proportion ($\chi^2=1.50$, $p=0.221$). The age follows a normal distribution with a mean of 68.06±7.66 years. The youngest patient was 49, whereas the oldest was 88 years old.

ARH – intraoral measurements:

The intraoral measurements of the ARH at the three areas of interest are presented in Fig. 3. The average measurements obtained in the study sample for both jaws was 6.48±3.2 mm. The lowest measured height was on the lower jaw - 1 mm, and the highest on the upper jaw – 19 mm.
Upper Jaw
The average measured ridge height for the entire upper jaw was 8.64±2.66 mm, with a minimum of 4 mm and a maximum of 19 mm. The frontal area showed the highest overall mean score – 9.48±2.67 mm, followed by the left-distal – 8.23±2.44 mm and right-distal area with 8.20±2.49 mm.

The comparison between the 3 areas of interest – frontal and the two distal at the 1st molar zone, revealed a significant difference \( \chi^2_{Kruskal-Wallis} (2) = 15.90. \ p<0.001 \). Dunn’s pairwise comparison showed a significant difference between the frontal and two distal areas of the alveolar ridge with a Holms adjusted p-value of 0.002. The average scores for the two distal areas are similar, without a significant difference – p = 0.967.

Lower Jaw
The average measured ridge height for the entire lower jaw was 4.32±2.09 mm, with a minimum of 1 mm and a maximum of 10 mm. The frontal area showed the highest overall average score – 5.08±2.20 mm, followed by the left-distal – 4.04±1.99 mm and right-distal area with 3.82±1.85 mm.

The comparison between the 3 areas of interest – frontal and the two distal at the 1st molar zone, revealed a significant difference \( \chi^2_{Kruskal-Wallis} (2) = 19.77. \ p<0.001 \). Dunn’s pair wise comparison showed a significant difference between the frontal and two distal areas of the alveolar ridge with a Holms adjusted p-value of 0.001. The average scores for the two distal areas are similar, without a significant difference – p = 0.471.

ARH – extraoral measurements
The extraoral measurements of the ARH at the areas of interest are presented in Fig. 4. The average ARH in the study sample for both jaws was 5.7±3.02 mm. The lowest measured height was on the lower jaw – 1 mm and the highest on the upper jaw – 18 mm.
**Upper Jaw**

The average measured ridge height for the entire upper jaw was 7.73±2.6mm, with a minimum of 3 mm and a maximum of 18 mm. The extraoral measurements by area showed a similar tendency to the intraoral – frontal area, had the highest overall mean score – 8.49±2.48 mm, followed by the left-distal – 7.42±2.37 mm and right-distal area with 7.27±2.53 mm.

The comparison between the 3 areas of interest – frontal and the two distal at the 1st molar zone, revealed a significant difference $\chi^2_{\text{Kruskal-Wallis}}(2) = 15.90$. $p<0.001$.

Dunn’s pair wise comparison showed a significant difference between the frontal and two distal areas of the alveolar ridge with a Holms adjusted $p$-value between 0.003 and 0.001. The average scores for the two distal areas are similar, without a significant difference – $p = 0.635$.

**Lower Jaw**

The average measured ridge height for the entire lower jaw was 3.68±1.92mm, with a minimum of 1 mm and a maximum of 9mm. The frontal area showed the highest overall average score – 3.5±1.88 mm, followed by the left-distal – 3.50±1.99 mm and right-distal area with 3.25±1.73mm.

The comparison between the 3 areas of interest – frontal and the two distal at the 1st molar zone, revealed a significant difference $\chi^2_{\text{Kruskal-Wallis}}(2) = 13.78$. $p = 0.001$.

Dunn’s pair wise comparison showed a significant difference between the frontal and two distal areas of the alveolar ridge with a Holms adjusted $p$-value of 0.001 for the pair front-right and $p$-value of 0.017 for the pair front-left. The average scores for the two distal areas are similar, without a significant difference – $p = 0.34$.

To assess the difference between the intraoral and extraoral measurements does not appear to be modifying the subject a pair wise Wilcoxon rank-sum test. – Fig. 5.

The results show a highly significant difference between the scores for all measured areas in both jaws.

**Fig. 5.** Comparison between intra- and extraoral measurements of the alveolar ridge height.
The stage of atrophy was evaluated through clinical observation and recorded as “first”, “second”, and “third” degrees for the upper jaw. The lower jaw had only a few cases with severe “fourth” stage of atrophy. Table 1 shows the quantitative distributions – clinically measured ARHs in the qualitative categories – stage of atrophy for all areas of interest in both jaws. The lower jaw had lower median ARH values for all areas of interest in all atrophy stages but with overlapping CI values between equivalent degrees of atrophy.

**DISCUSSION AND CONCLUSION**

The age of the participants in our sample is similar to the age of CD wearers in Bulgaria reported previously [14].

Several studies characterize the height of the edentulous alveolar bone and its relation to different classification systems. Common research method is the use of either CBCT or a panoramic radiograph [15]. Results from radiological investigations are of great importance for implant planning but have limited usefulness for treatment with conventional CDs since their inherent lack of information regarding soft tissue morphology, thickness, and features. Quantitative assessment of ARH in the current study followed a clinical protocol with additional qualitative assessment (see part 1 for reference). This approach has its limitations – errors in accuracy and precision of the instrument, measurement technique, data recording and the human factor in the research process. However clinical and/or model measurements are more useful for CD’s treatment due to the direct representation of the serviceable area – the actual prosthetic field.

The intraoral measurements in the upper jaw showed the highest ARH values in the frontal area (8,64 mm) compared to the first left and right molar areas (about 8,20 mm). This may be explained by the lower masticatory forces in the frontal area and the slow resorption of the frontal area because of the alveolar bone structure. The mastication forces in the frontal area are 3 times lower compared with the molar area [16, 17, 18, 19]. The height in the left and right first molar sites is similar, which is typical for the occlusal scheme most commonly used for CDs – bilateral balanced occlusion. Similar distribution across the three areas of interest in the lower jaw was observed – the highest ARH values were measured in the frontal area - 3,5 mm, compared to the distal left and right areas – 3,25 mm. A significant difference was observed between the ARH values for the upper and lower jaws – mean 7,7 upper jaw and mean 3,7 lower jaw. This might be explained by the higher and faster bone resorption in the mandible [20].

The extraoral measurements of the explored areas revealed similar relations but with significant differences between the intra- and extra-oral values. The height measured intraorally tends to be bigger than the extra-orally measured one. These results may be explained with the impression technique – the subjective, manually controlled pressure, the adjustment of the custom tray, the type of the impression material, and the functional movements of the patient in the final impression stage.

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Received: 26/03/2021; Published online: 10/06/2022

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