Research Article

Exploring palatal dimensions in a sample of kurdish edentulous population: influence of age, gender and duration of edentulism

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Abstract: Background: Complete denture construction requires accurate measurements of the edentulous palate to ensure optimal fit and function. This study aimed to evaluate palatal dimensions in a sample of Kurdish edentulous population and determine the effects of age, gender and duration of edentulism on these measurements. Materials and Methods: Maxillary stone models were obtained from 51 edentulous participants, comprising 26 women and 25 men aged 40–75 years. Palatal linear measurements, including length, width and height, along with ratios involving palatal, rugae, and incisive papilla area size, were evaluated and correlated with age, sex and the edentulous duration. Digital caliber and ImageJ software were employed for accurate linear measurements and size evaluations. Results: A significant sex-related impact was found on the palatal size in middle palate width and posterior height, with men exhibiting higher values than women (45.29 and 12.47 mm vs. 43.2 and 10.78 mm). Palatal ratios remained consistent across both sexes. Notably, an increase in palatal height was observed with longer durations of edentulism (H1–H3 increased from 6.68, 10.42 and 10.07 mm, respectively, to 8.30, 12.72 and 12.87 mm, respectively). Conclusions: Men demonstrated significantly higher values in middle palatal width, posterior height and palate area size than women. This study underscores the influence of age and edentulous duration on palatal dimensions, providing valuable data to guide clinicians in their dental rehabilitation planning. Palatal height indices were identified as a valuable tool for exploring denture construction.

Keywords: Edentulous palate, palatal dimensions, Kurdish population, edentulous duration, palatal height indices

Introduction

Knowledge about the dimensions of the upper jaw in human populations holds crucial implications for various dental fields like prosthodontics, orthodontics and oral surgery. Accurate assessment of the hard palate serves clinical purposes in forensic anthropology, cleft palate repair and treating conditions like obstructive sleep apnoea syndrome and various maxillofacial pathologies [(1)]. Prior investigations have underlined the capacity of palatal morphology and its measurements to serve as dependable indicators of sex and individual identification, particularly in situations where other comparative data may be limited [(1,2)]. Earlier research has also established that a heightened palatal vault in children may indicate a propensity for mouth breathing and could serve as a guide for healthcare professionals to identify patients prone to otitis media, offering potential avenues for recurrence prevention [(3)].

In prosthodontics, the height of the palate in edentulous patients has been a focal point in several investigations, exploring aspects such as the flexural strength of the denture base, distortion in the polymerisation of the denture base and posterior palatal seal [(4)]. The height of the palate in edentulous patients is influenced by its initial height before tooth extraction and subsequent residual ridge resorption post-extraction. However, standardising the factors affecting ridge resorption poses a remarkable challenge [(5)]. The inevitable height and contour changes in the residual ridge, along with the overall health of the surrounding hard and soft tissues, considerably affect the success of a precisely constructed prosthesis [6]. Rapid ridge resorption primarily occurs in the labial and buccal bone following tooth extraction, especially within the first year in denture wearers. Resorptive processes in the edentulous maxilla led to an overall reduction in arch length and width, particularly affecting the height of the residual ridge, which stands as a significant process in this context [7].

Studies focusing on the edentulous maxilla and its transverse palate-maxillary dimensions are limited. Johnson et al. [8] conducted a study examining palate shape in the American population, categorising it into shallow, medium and deep based on palate depth relative to the crests of residual ridges (6, 12 and 18 mm, respectively). Their findings indicated an average cross-arch width of 45 mm at the posterior border within their population. Avci et al. [5] considered arch width and edentulous maxillary height and introduced the palatal height ratio (PHR). This ratio, defined as the ratio of the edentulous maxillary arch's width to the palate's height at a specific point, offered an applicable dimensionless criterion. It enabled the classification of edentulous maxillae as small, average or large on the basis of PHR values. For instance, the PHR for the small posterior palatal region in women and men was up to 3.55, and for the average palate, it ranged between 4.44 and 4.59. For the large palate, it was approximately 10.8 and 10.2.

In other studies, researchers primarily used the palatal height index (PHI) in dentate cases (palatine height/palatine breadth × 100) [9, 10]. This index, introduced by Rakosi et al. [11], helps standardise and compare studies conducted on dental arches. Palate depth was classified into low (≤ 27.9 mm), medium (28–39.9 mm) and high (≥ 40 mm) categories based on PHI values in dentate cases [9, 10]. McCartney [12] employed a similar index, termed 'palatal slope index' (PSI), in the edentulous maxilla. His investigation focused on the influence of palatal height on the polymerisation distortion of the maxillary denture base, concluding that palatal form significantly affects palatal base distortion. These metrics (PHR, PHI and PSI) offer valuable tools for categorising palatal dimensions and establishing a standardised framework for clinical assessment, aiding in treatment planning and prosthetic design [12].

The surface area of edentulous jaws is crucial for denture retention, stability and surgical planning. Multiple methods have been employed to measure these surfaces, including polar plane-meter assessment, three-dimensional (3D) finite element analysis and 3D virtual models for edentulous jaws, often utilising size-measuring software or photographic techniques [13].

Palatal structures, particularly palatal rugae, possess unique traits crucial in forensic dentistry and sex estimation. The anterior part of the palate is well protected by the teeth and maxillary bone, the buccal pad of fat, the lips and the neurocranium. Moreover, it is considered resistant to external factors such as burning [14]. Palatal rugae morphology can serve as forensic identification for siblings [15]. These irregular ridges on the palatal mucosa behind the incisive papillae serve as guides for orthodontic mini-screw insertion procedures. They have been instrumental in determining tongue position during swallowing and measuring tongue pressure [16].

The rugae area is crucial in denture stability as a secondary stress-bearing zone that resists forward displacement. Given that it remains unaffected by resorption, it is also considered a primary support area for dentures. The rugae region is sometimes covered to enhance retention for extended denture bases. Efforts have been made to use palatal rugae as guides for placing artificial maxillary anterior teeth and articulating palatolingual speech sounds [17]. Rugae patterns, in some cases, are carved on the denture surface during fabrication to replicate patients' sensations [18]. Multiple classification systems based on rugae shape, distribution, direction and position have been proposed in literature [19]. Various methods are used to classify these structures, including inspection, intraoral photographs, stereoscopy, stereophotogrammetry and plaster model analysis [20]. Although recent advances in imaging technologies, such as intra-oral surface scanning with generated large datasets of high-resolution 3D samples and geometric morphometric method, have remarkably enhanced the quantification of shape [15], the gypsum models remain practical with no clinically significant differences from the digital models [21].

Another stable anatomical landmark is the incisive papilla, usually positioned over the incisive foramen, where the nasopalatine nerves and palatine vessels emerge. This papilla's relationship with the central incisors aids in designing the anterior segment of complete dentures. Alveolar resorption patterns can alter the position of the incisive papilla, necessitating consideration of its posterior border as a reference point during denture design [22].

This research is a cross-sectional design aimed to explore various dimensions of the edentulous hard palate amongst the Kurdish population, encompassing length, width, depth and the palatal and rugae areas. The investigation considered factors, such as gender, age and the duration of edentulism, which may affect these hard palate dimensions.

Materials and Methods

A total of 51 diagnostic maxillary stone casts (Elite stone, type IV, Zhermack) were obtained from secondary impressions by using zinc oxide eugenol (S.S White Manufacturing, Gloucester, England) in fully edentulous participants of Kurdish origin, consisting of 26 females and 25 males aged between 40 and 75 years. These individuals were seeking complete denture construction at the prosthodontics department of Sulaimani College of Dentistry. A convenient sampling method was used to facilitate the study's practicality. A sample size of 49 was initially determined through a priori power analysis conducted using G*Power software, assuming a medium effect size ($r = 0.3$), a significance level (α) of 0.05 and a power ($1-\beta$) of 0.80. This calculation ensured the ability to detect statistically significant correlations. Additional cases were recruited to further strengthen the study's justification.

Casts displaying excessive localised bone resorption, recent extraction sites or abnormal tissue growth were excluded from the study. Participants with smoking habits, diabetes, steroid or bisphosphonate use, autoimmune disease history or osteoporosis during their period of edentulousness were not included.

Individuals were provided with a consent form and an information sheet, collecting details such as age, sex, edentulous periods and medical history. This study received approval from the Medical Ethics Committee of the University of Sulaimani (Approval No. 32, dated 24/01/2023). The participants were categorised into three age groups: age 1 (40–59 years), age 2 (60–69 years) and age 3 (70 years and above). They were also divided into four edentulous period groups: Ede.P1 (less than 1 year), Ede.P2 (more than 1 year to 5 years), Ede.P3 (more than 5 years to 10 years) and Ede.P4 (more than 10 years to 25 years).

Palatal linear measurements

The maximum midpoint of the anterior ridge (A) and the hamular notches on the right and left sides (W4 R, W4 L) were marked on the diagnostic cast. A line drawn from point A perpendicular to the line connecting the hamular notches (W4 R and W4 L) represented the palatal midline. These lines intersected at the H4 point (Figure 1).

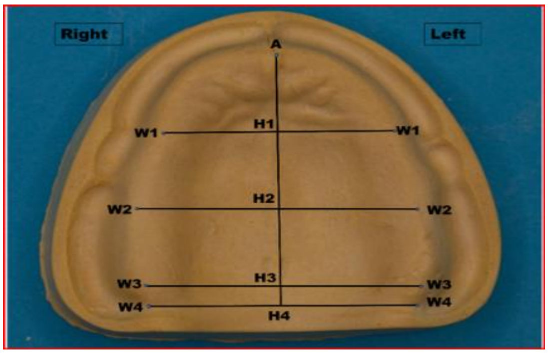

Figure 1: Maxillary edentulous cast with measuring points.
W: width; H: height; A: midpoint of the incisive papilla; H4: midpoint of the interhamular line [W4 R(right) - W4 L(left)]. The line (A-H1-H2-H3) divides the palate into anterior, middle, and posterior regions. Palatal width was measured at four levels (W1 = W1 R - W1 L, W2 = W2 R - W2 L, W3 = W3 R - W3 L, and W4 = W4 R - W4 L), while height was recorded at three points (H1, H2, H3).

A cross line connecting the tuberosities located 5 mm anterior to the interhamular notch was determined (W3 R-W3 L), intersecting the palatal midline at point H3. The distance between points A and H3 was divided into three equal lengths (A-H1-H2-H3), effectively segmenting the palate into anterior, middle and posterior regions (Figure 1). The width of the palate on these four lines (W1 = W1 R-W1 L, W2 = W2 R-W2 L, W3 = W3 R-W3 L and W4 = W4 R-W4 L) was then measured (Figure 1).

The height of the palate at points H1–H3 was measured as the vertical distance from a horizontal line to the palatal surface. Notably, the height at point H4 was not recorded due to its tendency to yield minimal values in palatal height measurements in that region. Subsequently, PHR (PHR 1–3) was computed by dividing the palate width by the corresponding height at these designated points. PHI (PHI 1–3) was determined by dividing the height by the width and multiplying by 100.

The anteroposterior distance (A-4H), the arch width and the palatal height of the cast were measured in millimetres by using a digital calibre. The palatal length measurement was assessed by a single examiner (L.L.R), who performed the measurements at three different time points, using the test–retest reliability index to assess intra-rater reliability. The reliability was evaluated using the intraclass correlation coefficient (ICC) of a statistical method commonly employed for assessing inter-examiner reliability. The analysis yielded an ICC value of **0.986**, and the 95% confidence interval of the test–retest difference for 20 casts indicated excellent reliability across the three timepoints [23].

Measurements of the palate, rugae and incisive papilla size areas

The palate area and rugae on the same diagnostic cast were meticulously traced using a superfine sharp graphite pencil under controlled artificial lighting and magnification [24]. A standardised photograph was then taken using a Canon camera (Canon Brasil, São Paulo, SP, Brazil) positioned 30 cm above the model. The images were subsequently subjected to analysis using ImageJ software [25] to ensure accurate measurements. The software's calibration scale was aligned with the metric ruler present in the photograph for precise measurements. The meticulous analysis of these photos was conducted by a singular calibrated examiner (J.F.A), who quantified the size of the two-dimensional hard palate area, individual rugae sizes (measured in square millimetres) and the total count of palatal rugae [13].

Statistical analysis

Data obtained were subjected to statistical analysis using PASW Statistics for Windows (version 18, SPSS, Inc). Descriptive statistical values, such as mean and standard deviation (SD), were calculated for measurements and ratios concerning sex, age group, edentulous period and palate and rugae sizes. Considering the data followed a normal distribution, one-way ANOVA was conducted to assess differences in means amongst various groups, and chi-square test was applied to identify distinctions between groups. Differences in variables between male and female groups were assessed using two-tailed Student's test (with a significance level set at $\alpha = 0.05$ for all tests).

Results

Effect of sex, age and edentulous period on palatal linear measurements

Table 1 presents a comparative analysis of palatal dimensions, including length, width and height (in mm), along with PHRs and PHIs across genders. Men generally exhibited slightly nonsignificant higher values in most variables. Significant differences emerged specifically in palate width at line 2 (W2, 45.29 mm vs. 43.2 mm, p = 0.047) and posterior palate height at line 3 (H3, 12.47 mm vs. 10.78 mm, p = 0.028), leading to a notably higher PHI at line 3 in men than in women (26.68 vs. 23.52, p = 0.046). However, the PHRs remained similar between genders.

The widest segment of the palate was observed at W3 for both sexes, with women measuring 45.64 mm and men measuring 46.89 mm. Notably, the deepest portion in women was in the middle palate (11.14 mm), and in men, it appeared in the posterior part (12.47 mm). The highest mean values of the largest

PHR were recorded at PHR3 (5.49 in women vs. 5.26 in men), and PHI2 exhibited a higher value in women (25.71) and PHI3 in men (26.68).

Table 1: Comparison of palatal dimensions measurements (mm) between women and men.

	Female		Male		
Variables	**Mean**	**SD**	**Mean**	**SD**	**P value**
P. length	47.47	3.36	49.07	10.17	0.296
W1	35.43	2.73	36.84	4.84	0.204
W2	43.2	3.4	45.29	3.91	0.047
W3	45.64	3.75	46.89	3.69	0.235
W4	44.28	4.02	45.52	2.98	0.219
H1	6.87	1.55	7.64	2.34	0.170
H2	11.14	2.86	11.96	2.98	0.317
H3	10.78	2.29	12.47	3.01	0.028
PHR 1	4.40	0.88	3.98	1.11	0.142
PHR 2	4.22	1.67	4.07	1.30	0.716
PHR 3	5.49	1.67	5.26	1.73	0.627
PHI 1	19.49	4.6	20.86	6.14	0.371
PHI 2	25.71	6.04	26.59	7.17	0.639
PHI 3	23.52	4.33	26.68	6.52	0.046

P.: palate; W: width; H: height; PHR: palatal height ratio; PHI: palatal height index

Regarding age-related changes, a significant increase was observed in the linear measurements across all width dimensions and H3, moving from Age1 to Age3 (W1 from 33.75 mm to 36.93 mm, W2 from 41.75 mm to 45.79 mm, W3 from 44.45 mm to 47.65 mm and H3 from 10.73 mm to 12.68 mm). However, the increase in H1 and H2 was not significant. No significant alterations were noted in PHRs and PHIs with advancing age (Table 2).

Table 2: Effect of age on palatal dimensions linear measurements (mm) and ratios.

Age groups (N)		Mean	SD	Sig.		Mean	SD	Sig.
Age G.1 (17)	W4	43.47	4.12	a	Palate	48.7	2.88	a
Age G.2 (18)		44.99	3.52	ab	length	48.6	3.43	a
Age G.3 (16)		46.29	2.43	b		48.1	3.26	a
Age G.1 (17)	W1	33.75	3.72	a	PHR 1	5.33	1.45	a
Age G.2 (18)		37.64	2.88	b		5.44	2.02	a
Age G.3 (16)		36.93	4.18	b		5.35	1.61	a
Age G.1 (17)	W2	41.75	3.13	a	PHR 2	4.06	0.98	a
Age G.2 (18)		45.17	3.52	b		4.46	2.17	a
Age G.3 (16)		45.79	3.52	b		3.89	0.92	a
Age G.1 (17)	W3	\44.45	4.01	a	PHR 3	4.36	0.99	a
Age G.2 (18)		46.71	3.71	ab		4.35	1.29	a
Age G.3 (16)		47.65	2.81	b		3.85	0.53	a
Age G.1 (17)	H1	6.65	1.34	a	PHI1	20.13	5.57	a
Age G.2 (18)		7.63	2.20	a		20.27	5.67	a
Age G.3 (16)		7.45	2.30	a		20.07	5.27	a
Age G.1 (17)	H2	10.84	2.72	a	PHI2	26.01	6.49	a
Age G.2 (18)		11.45	3.13	a		25.38	6.93	a
Age G.3 (16)		12.39	2.85	a		27.14	6.52	a
Age G.1 (17)	H3	10.73	2.75	a	PHI3	24.16	6.22	a
Age G.2 (18)		11.48	2.95	ab		24.59	6.08	a
Age G.3 (16)		12.68	2.38	b		26.58	4.55	a

P.: palate; W: width; H: height; PHR: palatal height ratio; PHI: palatal height index; Age G.1: 40–59 y; Age G.2: 60–69 y; Age G.3: 70 y and more. Same letter (letters): no significant differences; different letter (letters): significant differences (*P > 0.05*). [(ab): not statistically different with (a) nor (b); (b): statistically different with (a) but not with (ab)].

Examination on the changes linked to the edentulous duration revealed a notable increase in all palate height measurements (from Ede P1 to Ede P4: H1 increased from 6.68 mm to 8.30 mm, H2 from 10.42 mm to 12.72 mm and H3 from 10.07 mm to 12.87 mm), without corresponding changes in palatal widths nor length. Only the posterior ratio (PHR3) demonstrated a significant reduction (from 7.49 to 3.84 P > 0.05), whereas the posterior palatal index (PHI3) significantly increased with prolonged edentulous periods (from 21.84 to 27.38, P > 0.05, Table 3).

Table 3: Effect of edentulousness period length on palatal dimensions linear measurements (mm) and ratios.

		Mean	SD	Sig.		Mean	SD	Sig.
Ede P. 1(19)		44.86	3.53	a	Palate	47.42	3.06	a
Ede P. 2 (9)	W4	45.36	4.35	a	length	49.02	2.60	a
Ede P. 3 (12)		44.76	2.81	a		49.1	3.13	a
Ede P. 4 (11)		44.69	4.15	a		48.1	3.63	a
Ede P. 1(19)	W1	35.84	3.30	a	PHR 1	5.81	1.90	a
Ede P. 2 (9)		35.59	2.03	a		5.66	1.21	a
Ede P. 3 (12)		35.42	5.57	a		5.07	1.99	a
Ede P. 4 (11)		37.79	4.04	a		4.73	1.11	a
Ede P. 1(19)		43.65	3.52	a		4.68	2.06	a
Ede P. 2 (9)	W2	43.99	2.73	a	PHR 2	4.09	1.08	a
Ede P. 3 (12)		44.13	4.29	a		3.80	0.98	a
Ede P. 4 (11)		45.52	4.49	a		3.66	0.71	a
Ede P. 1(19)		46.00	3.51	a		4.79	1.15	a
Ede P. 2 (9)	W3	46.11	4.24	a	PHR 3	4.00	1.03	b
Ede P. 3 (12)		46.00	3.56	a		3.84	0.69	b
Ede P. 4 (11)		47.09	4.29	a		3.72	0.50	b
Ede P. 1(19)		6.68	1.80	a	PHI1	18.71	5.12	a
Ede P. 2 (9)	H1	6.48	1.03	a		18.32	3.47	a
Ede P. 3 (12)		7.77	2.63	ab		22.11	7.08	a
Ede P. 4 (11)		8.30	1.72	b		22.06	4.30	a
Ede P. 1(19)		10.42	2.96	a	PHI2	23.86	6.49	a
Ede P. 2 (9)	H2	11.51	3.39	ab		26.00	6.85	a
Ede P. 3 (12)		12.27	3.03	ab		27.99	7.42	a
Ede P. 4 (11)		12.72	1.74	b		28.19	4.82	a
Ede P. 1(19)		10.07	2.29	a	PHI3	21.84	4.45	a
Ede P. 2 (9)	H3	12.34	3.76	b		26.54	6.95	b
Ede P. 3 (12)		12.34	2.37	b		26.99	6.05	b
Ede P. 4 (11)		12.87	2.05	b		27.38	3.85	b

P.: palate; W: width; H: height. Ede P: edentulous period, Ede P.1: less than 1 y, Ede P 2: 1–5 y, Ede P 3: 5–10 y, Ede P 4: 10–25 y. Same letter (letters): no significant differences; different letter (letters): significant differences (*P > 0.05*). [(ab): not statistically different with (a) nor (b); (b): statistically different with (a) but not with (ab)].

Effect of sex, age and edentulous period on palate, rugae and incisive papilla size areas

In edentulous individuals, men exhibited notably larger palate sizes than women (2690.81 mm^2 vs. 2451.41 mm^2, P = 0.011). Conversely, despite men demonstrating greater rugae and incisive papilla sizes and a higher mean number of rugae on both sides, these differences did not reach statistical significance (230.50 mm^2, 31.91 mm^2 and 4.7 in men vs. 215.27 mm^2, 31.33 mm^2 and 4.46 in women). The proportion of rugae size to palate size remained relatively similar between genders at 8.7% in women and 8.52% in men, with no significant difference observed (Table 4).

Age and the duration of edentulousness did not significantly affect the sizes of the palate, rugae or incisive papilla. However, a minor increase in palate and incisive papilla sizes and a decrease in rugae size were noted from Age 1 to Age 3. Similar reductions in these measurements were observed from Ede P.1 to Ede P.4 (Figure 2).

Table 4: Comparison of palate size area, rugae size area, incisive papillae size (mm²) and rugae numbers between women and men.

	Female		Male		
Variables	**Mean**	**SD**	**Mean**	**SD**	**P value**
Palate size	2451.41	332.83	2690.81	314.56	0.011
Whole rugae size	215.27	102.05	230.50	66.02	0.532
% rugae to palate	8.70	3.52	8.52	2.07	0.083
R. rugae size	110.06	47.30	113.32	36.72	0.785
L. rugae size	105.21	56.41	117.19	37.10	0.377
Incisive papilla size	31.33	8.73	31.91	12.91	0.850
R. rugae number	4.46	1.61	4.72	1.49	0.554
L. rugae number	4.46	1.58	4.68	1.60	0.626
Mean of R and L rugae number	4.46	1.24	4.7	1.68	0.525

R. right side, L. left side.

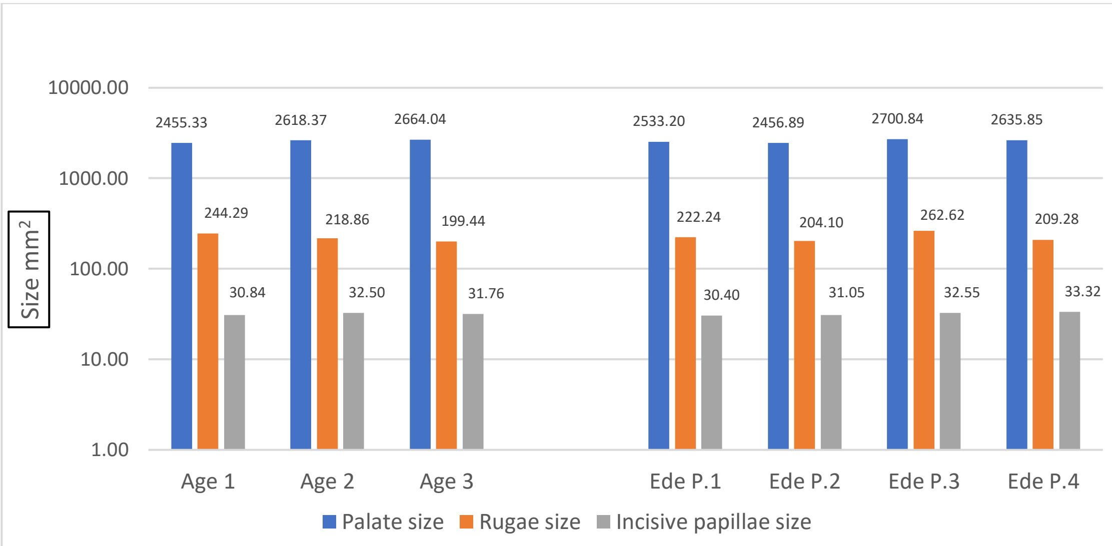

Figure 2: Comparison of palate, rugae and incisive papilla size areas (mm²) amongst different age groups and edentulous periods. Age1: 40–59 y; Age2: 60–59 y; Age3; 70 y and more; Ede P.1: less than 1 y; Ede P.2: 1–5 y; Ede P.3: more than 5 y–10 y; Ede P.4: more than 10 y–25 y.

Discussion

A comprehensive understanding of the hard palate's morphology holds crucial clinical relevance across various medical disciplines. Its role extends to passive articulation during speech, addressing sleep apnea syndrome, guiding interventions in maxillofacial and orthopedic cases related to oral syndrome, facilitating intricate surgical procedures in soft and hard palate concerns (such as cleft palate surgery), strategising orthodontic treatments and devising denture designs for edentulous patients [26]. The success of complete dentures, a significant milestone in prosthodontics, is notably affected by factors like palate depth, which significantly influence treatment outcomes [27].

Palatal linear dimensions and indices

The average measurements of palatal length, width and height indicate a significantly larger maxillary size amongst men than women [5]. Amongst women, the highest height was observed in the middle palate (H2), whereas in men, it was in the posterior palate (H3). Correspondingly, the highest PHI for women was PHI2; for men, it was PHI3. Notably, a previous study examining Iraqi edentulous patients by Kazanje and Noori [28] indicated a prevalent moderate middle palate height amongst the Iraqi population, aligning with the findings observed in Kurdish edentulous individuals, where moderate middle palate height ranging between 10.5 and 15 mm was identified.

The widest palatal dimensions were observed in the posterior regions (W3) for both sexes, leading to the largest PHR (PHR3) compared with the middle and anterior regions (5.49 in women vs. 5.26 in men). According to Avci et al. [5], who categorised palate sizes for women and men on the basis of PHR, the Kurdish posterior palate exhibited a large size (exceeding 4.44 in women and 4.59 in men), whereas the middle and anterior sections showed an average size. The dimensionless ratios (PHIs and PHRs) could be helpful for enhanced standardisation of the same variables in future studies.

Unexpected findings in this investigation unveiled positive relations between age and specific linear dimensions of the palate, particularly width and posterior height. Notably, the duration of edentulousness exhibited a positive association with palatal depth. Although the loss of teeth typically results in alveolar bone resorption, leading to a decrease in height and inward progression of maxillary outer bone [29], the remodeling of the residual alveolar ridge tends to be progressive. This process varies amongst individuals and is often more pronounced in the initial year post-extraction [30]. Multiple factors, including denture use, duration of edentulousness, the number of prosthetic restorations, muscle function, skeletal patterns and bone quality, influence the morphology of the alveolar bone. Moreover, specific factors, such as age, gender, hormones and metabolic diseases, play pivotal roles in shaping alveolar bone morphology [31, 32].

Throughout the period of edentulousness, the positioning of the palatal-gingival margin undergoes an outward shift, positioning itself more facially and superiorly than its location in the dentate oral cavity. This alteration offers additional inner width within the palate [33]. Prior research indicated that denture wearers tend to exhibit thicker soft tissue covering the ridge than non-denture wearers [34]. Consequently, the observed increase in bony ridge height amongst most participants, who had previously worn dentures during an extended edentulous period, may be associated with the thickness of the soft tissue covering the ridge rather than bone deposition. This phenomenon potentially leads to greater palate height amongst those wearing dentures than those who do not (comprising only a minority, 15 participants out of 51). However, a notable detail that this study did not track the palatal measurements of participants as they aged.

Size of palatal and rugae area analysis

In line with prior research, the supportive area of the edentulous maxilla displayed a significant discrepancy between males and females [35]. Specifically, the surface areas of the edentulous maxilla in males and females measured 2690.81 ± 314.5 and 2451.41 ± 332.8 mm², respectively ($p = 0.011$). Notably, the study referenced herein reported higher palate area sizes (4654 ± 407 mm² in men and 4212 ± 368 mm² in women), potentially attributed to divergent measurement methodologies. This sex disparity in arch size may be linked to differences in musculature, particularly the overall strength of facial muscles, affecting the measurement of the maxillary arch's breadth, width and height [1].

Studies examining gender disparities in palatal rugae have produced varied findings, often influenced by skin thickness and collagen composition. However, the current study revealed no significant gender-related distinctions in palatal rugae density and count, aligning with specific previous research endeavors [36]. Other investigations have demonstrated conflicting outcomes, with reports of a higher count of palatal rugae in Indian women [37], and separate studies in Japan indicated a reduced number of rugae in females compared with males [38].

Interestingly, this study did not observe a significant decline in rugae size associated with age, edentulous periods or even in participants wearing complete dentures (all subjects in edentulous periods 2–4 were denture wearers, whereas only four from 19 participants were in edentulous period 1). This disassociation contrasts with prior research that noted a considerable reduction in rugae length attributed to the sustained mechanical pressure exerted by dentures on the palatal rugae [39].

Prior research primarily focused on assessing the length rather than the actual size of the incisive papillae in dentate adults. A study highlighted significant gender-based variations in papilla size and its potential use in predicting the distance between the labial surface of the central incisors and the incisive papilla [40]. By contrast, the present study determined that the actual size of the incisive papilla was not influenced by sexes, age groups nor edentulous periods.

This study offers valuable insights into the characteristics of the edentulous hard palate within the Kurdish population, and its relationships with various influencing factors. The primary objective was to establish baseline data on palatal dimensions, which serve as a foundation for exploring their correlations with denture functional outcomes, such as retention, stability, and comfort. Demographic factors like ethnicity, socioeconomic status, and regional variation, alongside systemic health conditions, smoking habits, oral habits, and prosthetic use—though not included in this study—may significantly influence palatal dimensions. While this research specifically examined the Kurdish population within a defined age range, it provides a basis for future investigations into more diverse demographics. Future studies will incorporate additional variables and focus on larger and more diverse sample sizes, including participants from broader age groups and ethnic backgrounds, to enhance the generalisability and applicability of the findings. Longitudinal studies will also aim to understand how palatal dimensions evolve over time, offering deeper insights into their role in long-term prosthetic planning. These objectives form the core of future research efforts to improve denture design and patient outcomes.

Conclusion

The findings of this study enhanced the understanding of the palatal structure in Kurdish population and its potential impact on various dental fields. Although the sample size limits generalisability, this study provides foundational insights into palatal dimensions amongst the Kurdish population. Men exhibited significantly greater values in middle palatal width, posterior height and overall palate area size than women, though other linear measurements and area sizes showed no significant gender differences. Age and the duration of edentulism were found to affect palatal dimensions. Specifically, palatal widths and posterior height showed a significant positive correlation with age, whereas no such association was observed in the overall palate, rugae or incisive papilla areas. The edentulous period had a notable influence on palatal heights, but other linear and size measurements remained unaffected. PHRs indicated that the anterior and middle palate types were considered average, whereas the posterior palate was classified as large. PHIs showed potential as valuable tools for exploring denture construction processes and can help clinicians develop optimal dental rehabilitation strategies.

Future studies with larger and more diverse cohorts are planned to validate and expand upon these findings to strengthen the conclusions. Future longitudinal studies will be conducted to explore age-related changes and the dynamic effects of edentulism over time.

Conflict of interest

The authors have no conflicts of interest to declare.

Authors' Contributions

N.A and J.A developed the study concept and design, and N.A, J.A, and L.R collaboratively designed the methodology. N.A and L.R carried out the investigation and data collection. N.A performed the data analysis. N.A, J.A and H.F prepared the initial draft. All authors reviewed and approved the final manuscript.

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Informed consent

Informed consent was obtained from all individuals or their guardians included in this study.

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استكشاف أبعاد الحنك في عينة من السكان الأكراد عديمي الأسنان: تأثير العمر والجنس ومدة فقدان الأسنان

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المستخلص:

يتطلب تصميم الأطقم الكاملة قياسات دقيقة للحنك الخالي من الأسنان لضمان الملاءمة المثلى والوظائف المطلوبة. تهدف هذه الدراسة إلى تقييم أبعاد الحنك في عينة من السكان الكرد وتحديد القيم المعيارية للأبعاد الخطية وحجم الحنك، بالإضافة إلى دراسة العلاقة بين هذه القياسات والعمر والجنس ومدة فقدان الأسنان لتقديم رؤى مفيدة في تخطيط العلاج السني. تشمل الدراسة استكشاف أبعاد الحنك الصلب الخالي من الأسنان لدى السكان الكرد، بما في ذلك الطول، والعرض، والعمق، ومساحات الحنك والطيات الحنكية، مع مراعاة الجنس والعمر ومدة فقدان الأسنان كعوامل مؤثرة. تم الحصول على نماذج حجرية للفك العلوي من 51 مشاركًا خاليًا من الأسنان، شملوا 26 امرأة و25 رجلًا تتراوح أعمارهم بين 40 و75 عامًا. تم تقييم القياسات الخطية للحنك، بما في ذلك الطول والعرض والارتفاع، إلى جانب النسب المتعلقة بحجم الحنك والطيات الحنكية ومنطقة الحليمة القاطعة، وربطها بالعمر والجنس ومدة فقدان الأسنان، باستخدام المقياس الرقمي وبرنامج Image Jللحصول على قياسات دقيقة للأبعاد وتقييم الحجم. أظهرت النتائج تأثيرًا كبيرًا مرتبطًا بالجنس على حجم الحنك، خاصة في عرض الحنك الأوسط وارتفاع الحنك الخلفي، حيث أظهر الرجال قيمًا أعلى (45.29 ملم و12.47 ملم مقارنة بـ 43.2 ملم و10.78 ملم للنساء)، بينما بقيت نسب الحنك ثابتة بين الجنسين. كما لوحظت علاقة إيجابية بين طول فترة فقدان الأسنان وزيادة في ارتفاع الحنك، حيث زاد H1 من 6.68 ملم إلى 8.30 ملم، و H2من 10.42 ملم إلى 12.72 ملم، و H3من 10.07 ملم إلى 12.87 ملم. تؤكد هذه الدراسة على تأثير العمر ومدة فقدان الأسنان على أبعاد الحنك، مما يوفر بيانات قيمة لتوجيه الأطباء في تخطيط إعادة التأهيل السني، كما تم تحديد مؤشرات ارتفاع الحنك (PHIs) كأداة فعّالة لاستكشاف طرق تصميم الأطقم السنية.