The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 20(3): S.I (3), 326-334, 2025 www.thebioscan.com

Key Gingival Dimensions and Shapes of Maxillary Lateral Incisors in a Middle East Population – A Preliminary Report

Shreya Shetty[1]*; Khamarunissah Sheikh[2]; Hashim Hamzah A Alaidaroos[3]; Khlood Hamed Alghamdi[4]; Omnia Ashraf Mohammed Zaghloul[5]

[1*]BDS, MDS(Periodontics), FICOI, Associate professor

[2]B.Sc, M.Sc(Statistics), Biostatistician

[3]Resident – Periodontics

[4]BDS, Intern, Ibn sina national college of medical sciences, Jeddah, KSA.

[5]BDS, Intern, Ibn sina national college of medical sciences, Jeddah, KSA.

DOI: 10.63001/tbs.2025.v20.i03.S.I(3).pp326-334

KEYWORDS
Maxillary lateral incisor, crown length, crown width, contact surface length, gingival angle, mesiodistal width, esthetics

Received on:

04-06-2025

Accepted on:

02-07-2025

Published on:

11-08-2025

ABSTRACT

Background: Numerous studies have demonstrated that the shape, size, angulation, and position of the maxillary lateral incisor significantly influence smile esthetics. The relationship of the lateral incisor to adjacent teeth—particularly the central incisor and canine—often described by the "Golden Proportion," also affects the perception of smile harmony. The purpose of this study was to evaluate whether a correlation exists between maxillary lateral incisor crown shapes and various periodontal parameters, including gingival and interdental characteristics.

Materials and Methods: Clinical measurements were collected from 60 systemically healthy male and female individuals aged 21–35 years. Parameters recorded for each participant included crown width (CW), crown length (CL), height of the interproximal papilla (Ph), gingival angle (GA), mesiodistal width (MDW), and contact surface length (CS) of the maxillary lateral incisors. Based on the CW/CL ratio, participants were categorized into three crown shape groups: tapered, square, or ovoid. These groups were compared for statistically significant differences in clinical parameters using appropriate statistical methods (ANOVA and post-hoc tests).

Results: Statistically significant differences ($P < 0.05$) were observed among the three tooth shape groups with respect to gingival angle, mesiodistal width-to-crown length (MDW/CL) ratio, and contact surface length (CS). Ovoid and square-shaped incisors showed particularly strong associations with CS and CS/CL ratios, while MDW/CL differed significantly across all groups.

Conclusion: Tooth shape is significantly associated with variations in gingival angle, contact surface length, and the MDW/CL ratio. These findings support the use of tooth morphology as a reliable clinical indicator in esthetic treatment planning for restorative and prosthodontic procedures involving the maxillary lateral incisors.

INTRODUCTION

The morphology of teeth and surrounding periodontal structures is intrinsically interconnected. Gingival architecture is commonly classified into two primary biotypes: **thick-flat** and **thin-scalloped**. The thin-scalloped biotype is typically associated with a narrow cervical tooth contour, smaller contact areas, and interproximal contact points located closer to the incisal edge. Individuals with this biotype also tend to exhibit longer interproximal papillae. In contrast, those with a thick-flat gingival biotype often present with broader cervical contours, wider contact areas positioned nearer to the gingival margin, and shorter interproximal papillae [1,2].

Tooth and gingival morphology are influenced by various factors, including **race, geographic region, gender**, and **dietary habits** [3]. Understanding the average tooth and gingival shapes within specific populations is crucial for accurate prosthodontic planning. Previous studies have shown significant variability in these morphological features both between and within racial and ethnic groups [4-6]. A comprehensive understanding of dental and gingival anatomy forms the foundation of successful prosthetic rehabilitation. Restorative procedures must ensure both biological compatibility and aesthetic harmony with the surrounding soft tissues. Smile aesthetics are determined by a combination of factors, including **tooth shape, size, color, alignment, and symmetry**, along with **gingival contour, regularity**, and **papillary form** [1,2,6]. Among these, the **maxillary anterior teeth** play a particularly important role in defining facial esthetics. They not only contribute to facial harmony and lip support but also perform critical functions such as food incision, speech articulation, and mandibular guidance during eccentric movements [7].

Therefore, a detailed understanding of anterior tooth and gingival morphology is essential to achieving restorative outcomes that are both functionally effective and aesthetically pleasing. The primary goals of restorative dentistry include the recreation of clinical crown morphology, aesthetic rehabilitation, and the preservation or enhancement of periodontal and temporomandibular joint health.[8]

The maxillary lateral incisor plays a significant role in smile aesthetics. Numerous studies have demonstrated that its shape, size, angulation, and position can influence the overall appearance of a smile.[9-12]. Designing a beautiful smile is a complex process that requires a multidisciplinary approach. Recently, there has been growing interest in designing naturally attractive smiles based on architectural blueprints used in cosmetic dentistry to achieve optimal esthetic outcomes.[13-14]

Only a few studies have evaluated the crown morphology of the maxillary lateral incisor, classifying it into types such as trapezoidal-shaped, central incisor-shaped, canine-shaped, and peg-shaped. However, patients' perceptions of smile aesthetics are highly subjective—what may be considered an ideal lateral incisor shape for one individual or group may not be perceived as attractive by others. Previous research has examined the influence of factors such as gender and ethnicity on patients' perception of smile aesthetics.[15-16]Cultural background also plays a significant role in shaping one's understanding of aesthetics, leading to wide variations in aesthetic preferences among individuals.

To define and quantify the morphological characteristics of the permanent maxillary lateral incisors (PMLI), specific measurement parameters were established, and the crowns were categorized into three distinct forms: **tapered (trapezoidal-shaped), square (central incisor-shaped), and ovoid (canine-shaped)**. This classification framework aims to support more precise clinical decision-making in aesthetic prosthodontics, with particular emphasis on the periodontal context and its influence on restorative outcomes.

Among all permanent teeth—excluding third molars—the PMLI exhibits the greatest variation in crown shape. Therefore, the objective of this study was to investigate the correlation between different crown morphologies of the PMLI and associated gingival and periodontal parameters.

MATERIALS AND METHODS

Following ethical approval from the Institutional Review Board (IRRB -02-22122024), a total of 60 Middle Eastern dental patients (both male and female), aged between 21 and 35 years, were recruited from the outpatient department of the ISNC Dental Clinic in Jeddah, Saudi Arabia. All participants were fully informed about the study's objectives and procedures, and written informed consent was obtained prior to the initiation of any clinical interventions.

Inclusion criteria required participants to be in good general health, have completed skeletal growth, and possess fully erupted permanent maxillary central incisors. The exclusion criteria included: presence of destructive periodontal disease; pregnancy or lactation; use of medications known to affect gingival thickness (e.g., cyclosporine A, calcium channel blockers, or phenytoin); extensive restorations or prosthetic replacements involving the maxillary central incisors; interproximal or cervical carious lesions; history of dental trauma altering the natural crown morphology; previous orthodontic treatment; evident craniofacial asymmetry; history of periodontal surgical procedures in the anterior maxillary region; incisal wear (abrasion, attrition, or erosion) extending to dentin; or incomplete passive eruption. Additionally, patients with aberrant maxillary lateral incisor morphology, such as peg-shaped laterals, were excluded.

For each participant, demographic data including age and gender were recorded. Standardized intraoral photographs were taken using a cheek retractor and mouth prop to ensure consistent visualization. A millimeter-calibrated ruler was positioned directly beneath the incisal edges of the maxillary central incisors to facilitate accurate measurements and morphological evaluation.

Measurements

An image analysis software (ImageJ, National Institutes of Health, USA) was utilized to perform quantitative assessments of tooth morphology. The software's built-in calibration tool was employed to convert pixel values into millimeters, thereby ensuring measurement accuracy (Images 1–3).

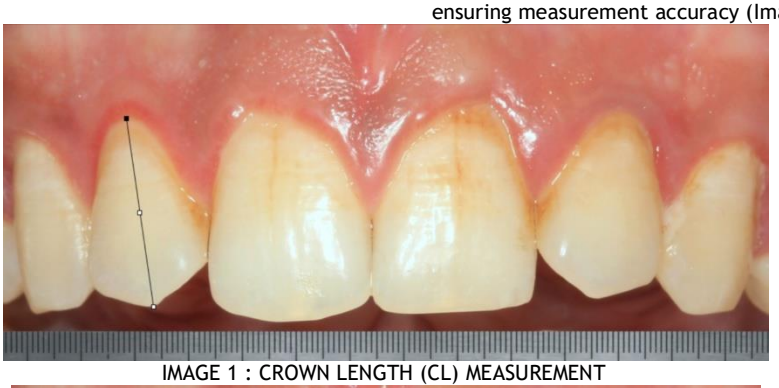

IMAGE 1 : CROWN LENGTH (CL) MEASUREMENT

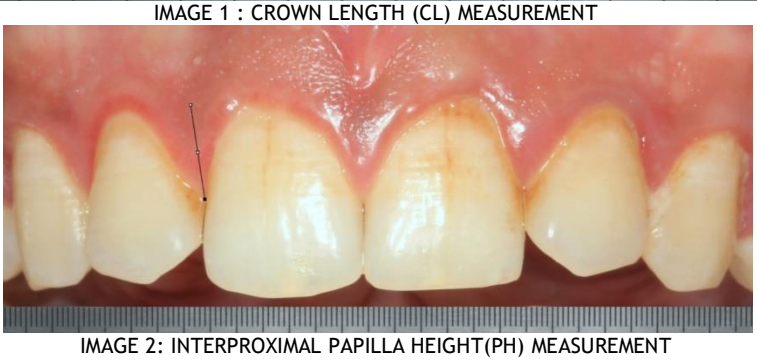

IMAGE 2: INTERPROXIMAL PAPILLA HEIGHT(PH) MEASUREMENT

IMAGE 3: GINGIVAL ANGLE (GA) MEASUREMENT

The following parameters were evaluated:

- Crown Width (CW): The mesiodistal width of the crown was measured at the junction between the middle and cervical thirds of the crown length. This point was determined by dividing the clinical crown into three equal horizontal sections: incisal, middle, and cervical thirds.
- Crown Length (CL): Defined as the longest apicocoronal dimension of the crown, measured parallel to the long axis of the tooth—from the incisal edge to the gingival zenith.
- Crown Width-to-Length Ratio (CW/CL): Calculated by dividing the crown width (CW) by the crown length (CL). This ratio indicates the relative proportion and apical taper of the clinical crown.
- Mesiodistal Width (MDW): The greatest horizontal distance between the mesial and distal interproximal contact points, measured on the labial surface of the tooth.
- Interdental Papilla Height (PH): The vertical distance, measured parallel to the long axis of the tooth, from the highest point of the interdental papilla to a reference line connecting the gingival zeniths of the adjacent teeth on the distal side.
- Gingival Angle (GA): The angle formed at the facial marginal gingiva, determined by the intersection of two lines: one following the tooth's long axis from the most apical point of the gingival margin, and the other connecting the most apical points of the mesial and distal interproximal contact areas.
- Contact Surface Length (CS):Measured along the mesial surfaces of the maxillary central incisors, from the most apical extent of the contact area to its most incisal extent.

RESULTS:

TABLE 1: CLUSTER ANALYSIS OF FREQUENCY TO DETERMINE LATERAL INCISOR SHAPES

CL/CW	FREQUENCY	SHAPE
0.3-0.64	18	TAPER
0.65 - 0.82	61	OVOID
0.83 - 1.08	41	SQUARE
	120	

Data Analysis and Tooth Shape Classification

After calculating the crown width-to-length (CW/CL) ratios, the dataset was subjected to **k-means clustering**, an unsupervised machine learning algorithm commonly used for pattern recognition and cluster analysis. Prior to clustering, a **validity test** was conducted to determine the optimal number of clusters (k), which was identified as three.

Based on the CW/CL ratios of 120 maxillary central incisors from a sample of young Middle Eastern Asian adults, the following three distinct morphological groups were identified:

- **Tapered Shape:** CW/CL ratio between **0.30 and 0.64** (n = 18)
- **Ovoid Shape:** CW/CL ratio between **0.65 and 0.82** (n = 61)
- **Square Shape:** CW/CL ratio between **0.83 and 1.08** (n = 41)

This classification highlights the morphological diversity of maxillary central incisors within the studied population and offers a standardized framework for crown shape evaluation. Such a framework is valuable for enhancing precision in aesthetic dental treatment planning and restorative procedures.

TABLE 2: DESCRIPTIVE FEATURES OF THE GIVEN VARIABLES:

		CROWN WIDTH(CW)	CROWN LENGTH(CL)	CW/CL ratio	MESIO-DISTAL WIDTH (MDW)	INTERDENTAL PAPILLA HEIGHT(PH)	GINGIVAL ANGLE(GA)	CONTACT SURFACE (CS)	MDW/CL	(CS)/(CL)
N	Valid	120	120	120	120	120	120	120	120	120
	Missing	0	0	0	0	0	0	0	0	0
Mean		2.7633	3.6142	0.774	2.7467	1.1742	79.1542	1.1758	0.7686	0.3326
Std. Error of Mean		0.05824	0.07642	0.01301	0.06212	0.03506	0.81669	0.0445	0.0135	0.01224
Median		2.8	3.4	0.7578	2.8	1.2	80	1.15	0.7528	0.311
Mode		3	3.2	.74[a]	2.80[a]	1.5	80	1	.75[a]	0.5
Std. Deviation		0.638	0.83719	0.14253	0.68045	0.38403	8.94637	0.48749	0.14786	0.13412
Variance		0.407	0.701	0.02	0.463	0.147	80.037	0.238	0.022	0.018
Skewness		0.025	1.437	-0.359	0.063	-0.385	-0.293	0.437	-0.066	0.017
Std. Error of Skewness		0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221
Kurtosis		-0.109	5.03	0.311	-0.623	0.482	2.737	0.154	0.319	-1.05
Std. Error of Kurtosis		0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438
Range		2.8	5.9	0.78	2.8	1.9	64.5	2.2	0.82	0.51
Minimum		1.2	2.1	0.3	1.2	0.2	46.5	0.2	0.3	0.08
Maximum		4	8	1.08	4	2.1	111	2.4	1.12	0.59
a. Multiple modes exist. The smallest value is shown										

Descriptive Statistics

A total of 120 maxillary lateral incisors were analyzed. The mean values and standard deviations (SD) for the evaluated morphological parameters are presented below:

- Crown Width (CW): 2.76 ± 0.64 mm
- Crown Length (CL): 3.61 ± 0.84 mm
- Crown Width-to-Length Ratio (CW/CL): 0.77 ± 0.14
- Mesiodistal Width (MDW): 2.75 ± 0.68 mm
- Interdental Papilla Height (PH): 1.17 ± 0.38 mm
- Gingival Angle (GA): 79.15° ± 8.95°
- Contact Surface Length (CS): 1.18 ± 0.49 mm
- Mesiodistal Width-to-Crown Length Ratio (MDW/CL): 0.77 ± 0.15
- Contact Surface-to-Crown Length Ratio (CS/CL): 0.33 ± 0.13

These findings establish baseline morphological data for maxillary lateral incisors within a young Middle Eastern adult population. The results serve as valuable reference points for both aesthetic and periodontal considerations in prosthodontic treatment planning, particularly in cases involving restorative procedures in the anterior maxillary region.

TABLE 3: DESCRIPTIVE FEATURES OF THE GIVEN VARIABLES BASED ON LATERAL INCISOR SHAPES

		N	Mean	Std. Deviation	Std. Error
INTERDENTAL PAPILLA HEIGHT(PH)	Taper(trapezoidal)	18	1.1667	0.47774	0.1126
	Ovoid(canine shaped)	61	1.1951	0.34226	0.04382
	Square(like central incisor)	41	1.1463	0.40565	0.06335
	Total	120	1.1742	0.38403	0.03506
GINGIVAL ANGLE(GA)	Taper(trapezoidal)	18	74.2333	11.66896	2.7504
	Ovoid(canine shaped)	61	79.1869	8.23925	1.05493
	Square(like central incisor)	41	81.2659	7.93378	1.23905
	Total	120	79.1542	8.94637	0.81669
CONTACT SURFACE(CS)	Taper(trapezoidal)	18	1.2111	0.38177	0.08999
	Ovoid(canine shaped)	61	1.2918	0.47864	0.06128
	Square(like central incisor)	41	0.9878	0.49406	0.07716
	Total	120	1.1758	0.48749	0.0445
MDW/CL	Taper(trapezoidal)	18	0.5463	0.08785	0.02071
	Ovoid(canine shaped)	61	0.7638	0.08381	0.01073
	Square(like central incisor)	41	0.8735	0.13299	0.02077
	Total	120	0.7686	0.14786	0.0135
(CS)/(CL)	Taper(trapezoidal)	18	0.3463	0.15849	0.03736
	Ovoid(canine shaped)	61	0.3595	0.13056	0.01672
	Square(like central incisor)	41	0.2865	0.11791	0.01841
	Total	120	0.3326	0.13412	0.01224

Table 3 illustrates the mean values and standard deviations of gingival variables across different maxillary incisor shapes.

TABLE 4: ANOVA TEST RESULTS

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
INTERDENTAL PAPILLA HEIGHT(PH)	Between Groups	0.059	2	0.03	0.199	0.82
	Within Groups	17.49	117	0.149		
	Total	17.55	119			
GINGIVAL ANGLE(GA)	Between Groups	618.756	2	309.378	4.065	0.02*
	Within Groups	8905.702	117	76.117		
	Total	9524.458	119			
CONTACT SURFACE(CS)	Between Groups	2.292	2	1.146	5.16	0.007*
	Within Groups	25.988	117	0.222		
	Total	28.28	119			
MDW/CL	Between Groups	1.341	2	0.671	62.275	0*
	Within Groups	1.26	117	0.011		
	Total	2.602	119			
(CS)/(CL)	Between Groups	0.135	2	0.067	3.931	0.022*
	Within Groups	2.006	117	0.017		
	Total	2.141	119			

Comparative Analysis

One-Way ANOVA Analysis

A one-way Analysis of Variance (ANOVA) was conducted to compare the three classified lateral incisor shapes (tapered, ovoid, and square) in relation to various anatomical parameters. The analysis revealed statistically significant differences among the groups for the following variables:

- Gingival Angle (GA): $P < 0.05$
- Contact Surface Length (CS): $P < 0.05$
- Mesiodistal Width-to-Crown Length Ratio (MDW/CL): $P < 0.05$
- Contact Surface-to-Crown Length Ratio (CS/CL): $P < 0.05$

These findings suggest that tooth morphology is significantly associated with variations in both gingival architecture and dental crown proportions, reinforcing the importance of individualized morphological assessment in aesthetic and periodontal treatment planning.

TABLE 5: GAMES -HOWELL POST HOC ANALYSIS

Dependent Variable		(I) Shape	(J) Shape	Mean Difference (I-J)	Std. Error	Sig.
INTERDENTAL PAPILLA HEIGHT(PH)	Games-Howell	Trapezoidal	Canine shaped	-0.02842	0.12083	0.97
			Central incisor shaped	0.02033	0.1292	0.986
		Canine shaped	Trapezoidal	0.02842	0.12083	0.97
			Central incisor shaped	0.04874	0.07703	0.803
		Central incisor shaped	Trapezoidal	-0.02033	0.1292	0.986
			Canine shaped	-0.04874	0.07703	0.803
GINGIVAL ANGLE(GA)	Games-Howell	Trapezoidal	Canine shaped	-4.95355	2.94577	0.234
			Central incisor shaped	-7.03252	3.01661	0.07
		Canine shaped	Trapezoidal	4.95355	2.94577	0.234
			Central incisor shaped	-2.07897	1.6273	0.412
		Central incisor shaped	Trapezoidal	7.03252	3.01661	0.07
			Canine shaped	2.07897	1.6273	0.412
CONTACT SURFACE(CS)	Games-Howell	Trapezoidal	Canine shaped	-0.08069	0.10887	0.741
			Central incisor shaped	0.22331	0.11854	0.156
		Canine shaped	Trapezoidal	0.08069	0.10887	0.741
			Central incisor shaped	.30400*	0.09854	0.008
		Central incisor shaped	Trapezoidal	-0.22331	0.11854	0.156
			Canine shaped	-.30400*	0.09854	0.008
MDW/CL	Games-	Trapezoidal	Canine shaped	-.21749*	0.02332	0

	Howell		Central incisor shaped	-.32712*	0.02933	0
		Canine shaped	Trapezoidal	.21749*	0.02332	0
			Central incisor shaped	-.10964*	0.02338	0
		Central incisor shaped	Trapezoidal	.32712*	0.02933	0
			Canine shaped	.10964*	0.02338	0
(CS)/(CL)	Games-Howell	Trapezoidal	Canine shaped	-0.0132	0.04093	0.944
			Central incisor shaped	0.05983	0.04165	0.338
		Canine shaped	Trapezoidal	0.0132	0.04093	0.944
			Central incisor shaped	.07303*	0.02487	0.012
		Central incisor shaped	Trapezoidal	-0.05983	0.04165	0.338
			Canine shaped	-.07303*	0.02487	0.012

*. The mean difference is significant at the 0.05 level.

Post Hoc Analysis

It is important to note that a significant result in a one-way ANOVA does not always translate to significant findings in post hoc comparisons. This discrepancy may arise due to several factors, including:

- Insufficient statistical power, particularly when sample sizes within groups are small.
- High intra-group variability, which can obscure between-group differences.
- Adjustments for multiple comparisons in post hoc tests (e.g., controlling the Type I error rate), which increase the threshold for statistical significance.

To further investigate the group differences identified in the ANOVA, a Games–Howell post hoc test was performed, as this test does not assume equal variances and is appropriate for groups with unequal sample sizes. The findings were as follows:

- Papilla Height (PH): No statistically significant differences were observed among the three tooth shape groups ($P > 0.05$).
- Gingival Angle (GA): No statistically significant differences were found between the shapes ($P > 0.05$).
- Contact Surface Length (CS): A statistically significant difference was identified between canine-shaped and central incisor-shaped lateral incisors ($P < 0.05$).
- Mesiodistal Width-to-Crown Length Ratio (MDW/CL): Significant differences were observed between:
  - Tapered (trapezoidal) and canine-shaped incisors ($P < 0.05$)
  - Tapered (trapezoidal) and central incisor-shaped incisors ($P < 0.05$)
  - Canine-shaped and central incisor-shaped incisors ($P < 0.05$)
- Contact Surface-to-Crown Length Ratio (CS/CL): A statistically significant difference was observed between canine-shaped and central incisor-shaped lateral incisors ($P < 0.05$).

These results underscore the influence of crown morphology on certain dental proportions, particularly those related to contact surface dimensions and crown proportions, and support the clinical relevance of shape-based classification in aesthetic and prosthetic dentistry.

TABLE 6:

Correlations							
		CW/ CL ratio	INTERDENTAL PAPILLA HEIGHT(PH)	GINGIVAL ANGLE(GA)	MDW/CL	(CS)/(CL)	CONTACT SURFACE(CS)
CW/ CL ratio	Pearson Correlation	1	-0.017	.243**	.705**	-0.158	-.214*
	Sig. (2-tailed)		0.852	0.008	0	0.084	0.019
	N	120	120	120	120	120	120
INTERDENTAL PAPILLA HEIGHT(PH)	Pearson Correlation	-0.017	1	-.305**	0.076	.330**	.443**
	Sig. (2-tailed)	0.852		0.001	0.407	0	0
	N	120	120	120	120	120	120
GINGIVAL ANGLE(GA)	Pearson Correlation	.243**	-.305**	1	0.15	-0.052	-0.03
	Sig. (2-tailed)	0.008	0.001		0.102	0.571	0.746
	N	120	120	120	120	120	120
MDW/CL	Pearson Correlation	.705**	0.076	0.15	1	-0.114	-0.154
	Sig. (2-tailed)	0	0.407	0.102		0.217	0.094
	N	120	120	120	120	120	120

(CS)/(CL)	Pearson Correlation	-0.158	.330**	-0.052	-0.114	1	.827**
	Sig. (2-tailed)	0.084	0	0.571	0.217		0
	N	120	120	120	120	120	120
CONTACT SURFACE(CS)	Pearson Correlation	-.214*	.443**	-0.03	-0.154	.827**	1
	Sig. (2-tailed)	0.019	0	0.746	0.094	0	
	N	120	120	120	120	120	120
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							

Correlation Analysis

Correlation analysis was conducted to evaluate the relationships between variables influencing the shape of the maxillary lateral incisors. Several statistically significant associations were identified ($P < 0.05$), as outlined below:

- The **Crown Width-to-Length Ratio (CW/CL)** showed significant positive correlations with the following parameters:
  - **Gingival Angle (GA)**
  - **Mesiodistal Width-to-Crown Length Ratio (MDW/CL)**
  - **Contact Surface Length (CS)**
  - **Contact Surface-to-Crown Length Ratio (CS/CL)**
- **Interdental Papilla Height (PH)** demonstrated significant associations with:
  - **Gingival Angle (GA)**
  - **Contact Surface Length (CS)**
  - **CS/CL Ratio**
- The **MDW/CL ratio** was significantly correlated with the **CS/CL ratio**, which, in turn, showed a strong association with **Contact Surface Length (CS)**.
- A particularly strong correlation was observed between **CS/CL** and **Contact Surface Length (CS)** ($P < 0.05$).

These findings highlight the interdependence of crown morphology and periodontal features, suggesting that variations in tooth shape are closely linked to measurable changes in gingival and dental proportions. Such correlations may be valuable in guiding individualized aesthetic and prosthetic treatment planning.

DISCUSSION

Clinically, there is considerable variation among individuals in the morphological characteristics of the periodontium. Two primary gingival architectural "biotypes" have been proposed: the scalloped-thin and the flat-thick types [17, 18].

The scalloped-thin biotype is typically associated with:

1. A tapered crown form;
2. Subtle cervical convexity;
3. Minute proximal contact areas positioned near the incisal edge.

In contrast, the flat-thick biotype is characterized by:

1. A squared facial tooth form;
2. Pronounced cervical convexity;
3. Larger, more apically located proximal contact areas [17,18].

These gingival biotypes have been shown to influence the periodontal tissue response to plaque-induced inflammation. Specifically, individuals with a flat-thick biotype may exhibit deeper periodontal pockets as a result of inflammation, whereas those with a scalloped-thin biotype are more prone to gingival recession [18].

Notably, the majority of existing studies on gingival biotypes have focused primarily on Caucasian populations, with limited reference to other racial or ethnic groups. Given the known genetic and morphological variations across different populations, it is essential to evaluate crown forms and associated gingival characteristics within diverse ethnic groups. This would enhance diagnostic accuracy and improve individualized periodontal treatment planning.

Understanding the typical morphology of teeth and gingival tissues is essential for achieving optimal aesthetic and functional outcomes in clinical dentistry. Comprehensive knowledge of intraoral structures—including the gingiva, oral mucosa, natural teeth, and overall dentition—is fundamental for successful prosthetic rehabilitation and restorative treatment planning.

The present study aimed to evaluate the shape and dimensions of the clinical crown of the maxillary lateral incisors, along with the associated gingival characteristics, in young Middle Eastern Asian adults. The goal was to establish normative reference values that can guide aesthetic and functional restorative procedures in this population.

Previous research has consistently shown that tooth dimensions can vary significantly across different ethnic groups [19–25]. Several studies [17, 26-28] have classified anterior tooth morphology using the ratio of cervical width to crown length (CW/CL), recognizing it as a reliable parameter for characterizing tooth shape. In contrast, another study found that the width-to-length ratio of the clinical crown exhibited minimal variation concerning gender and height, although males generally had longer and wider anterior teeth compared to females. These findings support the CW/CL ratio as a stable and consistent reference point for evaluating anterior tooth form in clinical settings.

Anomalies in the shape, size, and number of permanent maxillary lateral incisors (PMLI) are not uncommon in routine dental practice. However, the management of such variations often presents a clinical challenge due to their impact on both aesthetics and function. These anomalies are not only of individual clinical significance but also represent an important public health concern [19-25].

Cluster analysis has proven valuable in clinical research as an objective method for categorizing large and complex populations into more manageable subgroups. However, it is primarily considered a descriptive and exploratory technique, and its findings should ideally be validated in independent populations to ensure generalizability.In the present study, cluster analysis was utilized to achieve one of the primary objectives: to confirm the existence of three distinct maxillary lateral incisor crown shapes and to quantify their relative prevalence. Given that tooth size and morphology are known to vary significantly among different ethnic groups [26], the study sample was deliberately limited to individuals of Middle Eastern Asian descent. This restriction was implemented to ensure population homogeneity and enhance the reliability of the findings.The results revealed that the most prevalent crown shape of the permanent maxillary lateral incisor (PMLI) was the canine-shaped form (50.83%), followed by the central incisor-shaped form (34.17%), and finally the trapezoidal-shaped form (15%). These findings differ notably from those of Schlegel and Satravaha [28], who reported a significantly lower prevalence (20%) of canine-shaped laterals in their population sample.

Several previous studies have reported that permanent maxillary lateral incisors (PMLI) are the third most commonly developmentally absent teeth, following third molars and

mandibular second premolars [29-32]. In the United Kingdom, approximately 2% of the population exhibit agenesis of one or both PMLI [33]. The prevalence of PMLI agenesis is reportedly higher in European and Australian populations compared to those in North America [32].

Gender differences have also been observed, with females being approximately 1.34 times more likely to be affected than males. Furthermore, bilateral absence of PMLI is more frequently reported than unilateral absence, underscoring the clinical importance of early diagnosis and appropriate management strategies in affected individuals [32].

Consistent with previous studies [8], our findings reinforce the association between morphological characteristics of periodontal tissues and clinical crown shape in the maxillary anterior region. Earlier research has highlighted the cervical width-to-crown length (CW/CL) ratio as a reliable metric for distinguishing periodontal biotypes [34]. In line with these studies, we employed the CW/CL ratio to classify tooth shapes and subsequently analyzed corresponding gingival morphology.

ANOVA analysis revealed statistically significant differences among the three crown shape categories—tapered, ovoid, and square—with respect to several periodontal parameters, including gingival angle, contact surface area, mesiodistal width-to-crown length (MDW/CL) ratio, and contact surface-to-crown length (CS/CL) ratio. However, post hoc analysis did not show significant differences in gingival angle among the three shapes. Significant differences were observed in MDW/CL ratios across all three crown shapes, and in CS and CS/CL ratios specifically between the ovoid and square-shaped lateral incisors.

Previous studies have demonstrated that a lower CW/CL ratio, indicative of tapered crowns, is significantly associated with increased interdental papilla height. This pattern aligns with the scalloped gingival architecture typically seen with tapered teeth, whereas square-shaped teeth are more commonly linked to flatter gingival forms. Interestingly, our study did not find statistically significant differences in papilla height among the different crown shapes, which may be attributed to several confounding factors.[35]

Overall, crown shape parameters such as CW/CL, MDW/CL, and CS/CL ratios appear to have strong correlations with certain periodontal features, particularly in ovoid and square-shaped lateral incisors. Notably, MDW/CL ratios showed consistent variation across all three shape categories. However, the absence of significant correlations between papilla height or gingival angle and crown shape could be due to the relatively small size of the maxillary lateral incisor compared to central incisors and canines, as well as variability in age, periodontal phenotype, height of contact points, and crown morphology within the sample population.

Overall, interdental papilla height was found to be significantly correlated with gingival angle, tooth shape (as determined by the crown length-to-width ratio, CL/CW), contact surface (CS), and contact surface-to-crown length ratio (CS/CL). These findings are consistent with previous literature, which has emphasized the close relationship between maxillary incisor crown morphology and both papillary height and overall gingival contour.

Although tapered crowns tended to exhibit narrower gingival angles compared to square and ovoid forms, these differences were not statistically significant in the current study. Tooth shape—particularly the positioning of the most apical point of the contact area—is a key determinant in restorative planning within the esthetic zone. However, the literature lacks universally accepted criteria for defining truly tapered or square tooth forms.

Gobatto et al. (2012) [36] addressed this limitation by objectively classifying tooth shape using the CS/CL ratio. Their findings suggest that when the CS is less than 43% of the CL, the tooth is triangular or tapered; when the CS exceeds 57% of the CL, the tooth is square. In our study, significant correlations were observed between CS measurements and CS/CL ratios, particularly between square and ovoid crown forms. Tapered teeth, as expected, had smaller contact surfaces compared to square and ovoid shapes—supporting Gobatto's conclusions. Furthermore, their study demonstrated that an increase in gingival angle (GA) correlates with greater crown width (CW) and a higher CS/CL ratio, indicating that wider crowns naturally present with broader contact surfaces.

These findings have important clinical implications, especially in periodontal surgery, esthetic restorations, and implant placement. Procedures such as crown lengthening or full-coverage restorations placed at or apical to the gingival margin require an understanding of the patient's individual tooth shape and gingival architecture to avoid esthetic compromise. For instance, ovoid-shaped teeth often present with incomplete papillary fill of the interdental space. Improper replacement of an ovoid lateral incisor with a single prosthetic crown may lead to esthetic concerns such as black triangles or asymmetrical crown forms. Anticipating these potential complications during treatment planning—by considering both tooth morphology and soft tissue contour—is essential for achieving optimal outcomes.

Additionally, the gingival contour of the lateral incisor plays a critical role in maintaining harmony within the smile, particularly when considering the golden proportion. Even minor deviations in gingival architecture or crown shape can significantly affect smile aesthetics, emphasizing the importance of individualized, morphology-based treatment planning in the anterior maxilla.

CONCLUSION

This study investigated the clinical crown shapes of maxillary lateral incisors in a Middle Eastern Asian population. Within the limitations of this investigation, the following conclusions can be drawn:

- Maxillary lateral incisors can be classified into three distinct crown shapes—**tapered (trapezoidal)**, **square (resembling central incisors)**, and **ovoid (canine-shaped)**—based on the relationship between crown length and crown width. Among these, the canine-shaped (ovoid) form was the most prevalent.
- Tooth shape demonstrated strong correlations with several gingival and morphometric parameters, including **interdental papilla height**, **gingival angle**, the **mesiodistal width-to-crown length (MDW/CL) ratio**, and the **contact surface-to-crown length (CS/CL) ratio**.

These relationships highlight the importance of considering individual crown morphology and associated gingival characteristics in the esthetic restoration and treatment planning of maxillary lateral incisors.

REFERENCES

- Nelson, S.J.; Ash, M.M., Jr. Wheeler's Dental Anatomy, Physiology and Occlusion, 9th ed.; Elsevier: St. Louis, MO, USA, 2010.
- Bath Balogh, M.; Fehrenbach, M.J. Dental Embryology, Histology, and Anatomy, 2nd ed.; Elsevier: St. Louis, MO, USA, 1997; pp. 256–260.
- Thesleff, I. Current understanding of the process of tooth formation: Transfer from the laboratory to the clinic. Aust. Dent. J. 2014, 59, 48–54. [CrossRef] [PubMed]
- Alani, A.A.; Bishop, K. Dens Invaginatus. Part 1: Classification, prevalence and aetiology. Int. Endod. J. 2008, 41, 1123–1136. [CrossRef] [PubMed]
- Heydari, A.; Rahmani, M. Treatment of dens invagination in a maxillary lateral incisor: A case report. Iran Endod. J. 2015, 10, 207–209. [PubMed]
- Oehlers, F.A. Dens Invaginatus (dilated composite odontoma): I. Variations of the invagination process and associated anterior crown forms. Oral Surg. Oral Med. Oral Pathol. 1957, 10, 1204–1218. [CrossRef]
- Hattab, F.N.; Yassin, O.M.; al-Nimri, K.S. Talon Cusp-clinical significance and management: Case reports. Quintessence Int. 1995, 26, 115–120.
- Fekonja, A. Morphological Diversity of Permanent Maxillary Lateral Incisors and Their Impact on Aesthetics and Function in Orthodontically Treated

Patients. Diagnostics 2022, 12, 2759. https://doi.org/10.3390/ diagnostics12112759
- Al Taki A, Hamdan AM, Mustafa Z, Hassan M, Abu-Alhuda S. Smile esthetics: impact of variations in the vertical and horizontal dimensions of the maxillary lateral incisors. Eur J Dent 2017;11:514-20.
- Bukhary SM, Gill DS, Tredwin CJ, Moles DR. The influence of varying maxillary lateral incisor dimensions on perceived smile aesthetics. Br Dent J 2007;203:687-93
- King KL, Evans CA, Viana G, Begole E, Obrez A. Preferences for vertical position of the maxillary lateral incisors. World J Orthod 2008;9:147-54.
- Alsulaimani FF, Batwa W. Incisors' proportions in smile esthetics. J Orthod Sci 2013;2:109-12
- Rosenstiel SF, Ward DH, Rashid RG. Dentists' preferences of anterior tooth proportion—a web-based study. J Prosthodont 2000;9: 123-36 .
- Soh J, Chew MT, Chan YH. Perceptions of dental esthetics of Asian orthodontists and laypersons. Am J Orthod Dentofacial Ortho 2006;130:170-6
- Al-Habahbeh R, Al-Shammout R, Al-Jabrah O, Al-Omari F. The effect of gender on tooth and gingival display in the anterior region at rest and during smiling. Eur J Esthet Dent 2009;4:382-95.
- Cotrim ER, Vasconcelos J unior AV, Haddad AC, Reis SA. Perception of adults' smile esthetics among orthodontists, clinicians and laypeople. Dent Press J Orthod 2015;20:40-4.
- Weisgold AS. Contours of the full crown restoration. Alpha Omegan 1977; 70: 77-89.
- Seibert J, Lindhe J. Esthetics and Periodontal Therapy, 2nd ed. Copenhagen: Munksgaard 1989.
- Guttal, K.S.; Naikmasur, V.G.; Bhargava, P.; Bathy, R.J. Frequency of developmental dental anomalies in the Indian population. Eur. J. Dent. 2010, 4, 263–269. [CrossRef]
- Bello, A.; Jarvis, R.H. A review of aesthetic alternatives for the restoration of anterior teeth. J. Prosthet. Dent. 1997, 78, 437–440. [CrossRef]
- Townsend, G.C.; Richards, L.; Hughes, T.; Pinkerton, S.; Schwerdt, W. The value of twins in dental research. Aust. Dent. J. 2003, 48, 82–88. [CrossRef]
- Townsend, G.C.; Hughes, T.; Luciano, M.; Backmann, M.; Brook, A. Genetic and environmental influences on human dental variation: A critical evaluation of studies involving twins. Arch. Oral Biol. 2009, 54, 545–551. [CrossRef]
- Brook, A.H.; Jernvall, J.; Smith, R.N.; Hughes, T.E.; Townsend, G.C. The dentition: The outcomes of morphogenesis leading to variations of tooth number, size and shape. Aust. Dent. J. 2014, 59, 131–142. [CrossRef]
- Hughes, T.E.; Townsend, G.C.; Pinkerton, S.K.; Bockmann, M.R.; Seow, W.K.; Brook, A.H.; Richards, L.C.; Mihailidis, S.; Ranjitkar, S.; Lekkas, D. The teeth and faces of twins: Providing insights into dentofacial development and oral health for practicing oral health professionals. Aust. Dent. J. 2014, 59, 101–116. [CrossRef] [PubMed]
- Hussain, A.; Louca, C.; Leung, A.; Sharma, P. The influence of varying maxillary incisor shape on perceived smile aesthetics. J. Dent. 2016, 50, 12–20. [CrossRef] [PubMed]
- Ong,E.; Playle, R.A.; Richmond, S. Peer assessment of dental attractiveness. Am. J. Orthod. Dentofac. Orthop. 2006, 130, 16–169. [CrossRef] [PubMed]
- Fekonja, A.Prevalence of dental developmental anomalies of permanent teeth in children and their influence on esthetics. J. Esthet. Restor. Dent. 2017, 29, 276–283. [CrossRef]
- Schlegel, D.; Satravaha, S. Variations in the shape of permanent maxillary lateral incisors in Sundanese. Anat. Anz. **1984**, 157, 57–61.
- Galluccio, G.; Castellano, M.; La Monaca, C.L. Genetic basis of non-syndromic anomalies of human tooth number. Arch. Oral Biol. **2012**, 57, 918–930. [CrossRef]
- Brook, A.H.;Winter, G.B. Tooth abnormalities. In Clinical Dentistry, 3rd ed.; Rowe, A.H.R., Johns, R.B., Eds.; Blackwell Scientific Publications: Oxford, UK, 1986; Volume 3, pp. 55–103.
- De Coster, P.J.; Marks, L.A.; Martens, L.C.; Huysseune, A. Dental agenesis: Genetic and clinical perpectives. J. Oral Pathol. Med. **2009**, 38, 1–17. [CrossRef] [PubMed]
- Polder, B.J.; Van't Hof, M.A.; Van der Linden, F.P.; Kuijpers-Jagtman, A.M. A meta-analysis of the prevalence of dental agenesis of permanent teeth. Community Dent. Oral Epidemiol. **2004**, 32, 217–226. [CrossRef]
- Nunn, J.H.; Carter, N.E.; Gillgrass, T.J.; Hobson, R.S.; Jepson, N.J.; Meechan, J.G.; Nohl, F.L. The interdisciplinary management ofhypodontia: Background and role of paediatric dentistry. Br. Dent. J. **2003**, 194, 245–251. [CrossRef]
- Müller HP, Eger T. Masticatory mucosa and periodontal phenotype: a review. Int J Periodontics Restor Dent 2002;22: 172- 83
- Khaireddine H, Mohamed T, Arij R, Faten K, Faten BA. Factors impacting the height of the interproximal papilla: A cross-sectional study. Clin Exp Dent Res. 2023 Jun;9(3):449-454. doi: 10.1002/cre2.728. Epub 2023 Mar 22. PMID: 36949730; PMCID: PMC10280606.
- .Gobbato, Luca & Tsukiyama, Teppei & Levi, Jr, Paul & Griffin, Terrence & Weisgold, Arnold. (2012). Analysis of the Shapes of Maxillary Central Incisors in a Caucasian Population. The International journal of periodontics & restorative dentistry. 32. 69-78.