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Facial Metrics as Predictors of Occlusal Vertical Dimension: An Anthropometric Analysis

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ABSTRACT

BACKGROUND & OBJECTIVE: Accurate reconstruction of facial features from skeletal remains, especially the maxillofacial region, is crucial in forensic identification. Specific facial measurements from anatomical landmarks provide important correlations with the vertical dimension of occlusion for forensic experts and dental procedures. There is a gap in such a study in Sargodha, therefore the study was planned to evaluate the correlation & association of facial measurements with the vertical dimension of occlusion (VDO) amongst the students of Rai Medical College, Sargodha.

METHODOLOGY: The Observational Cross-sectional study engaged a cohort of 152 third-year MBBS students at Rai Medical College, Sargodha, comprising 74 males and 78 females. Institutional ethical approval was secured prior to the commencement of the research. Facial dimensions were meticulously evaluated, including the expanse from the corner of the eye to the angle of the mouth, the angle of the mouth to the tragus, and the Glabella to sub-nasion. The vertical dimension of occlusion (VDO) traverse from the base of the nose to the chin was precisely measured using a modified digital Vernier caliper. SPSS version 27 was used to analyze statistical data.

RESULTS: One-sample t-tests confirmed that mean values for all variables were significantly different from zero. Significant correlations were observed between specific facial measurements but not with gender.

CONCLUSION: This study concludes the facial morphology and demographic characteristics, revealing significant differences in facial measurements across demographic groups.

KEYWORDS: Anthropometry, Forensic Science, Prosthodontics, Phenotypic Variation, Facial Measurements, Facial Reconstruction, Identity Verification.

INTRODUCTION

From peoples of ancient times till today, humans enthusiastically tried to find out the dimensions of the human body for various purposes. Anthropometria was first used in the 17th century in the manual of Johann Sigismund Elsholtz[1-3]. This manual claims to be the first written work on the investigation of the human body, which explored the scientific as well as medical perspectives. It introduced a quantitative approach that helps to understand the disparities and modifications in organismal methods, shedding important light on the correlation between human physiology and disease[4]. Anthropometry elaborated the mass dimensions, and various ratios of the human body and demonstrated important and unbiased insights into phenotypic variation and dysmorphology[5]. The specific significance of facial measurements showed transversely the importance of anthropology, forensic sciences, and medicine. Differentiation among the population's facial measurements helps in understanding population variations with unique individual characteristics. Vertical dimension Occlusion (VDO) plays a precious role in forensic surveys, assisting in the identity of a person through dental records and age estimation based on the tooth wear & tear process, and also helping in bite mark analysis and facial reconstruction in

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criminal cases and mass disaster cases[6-8]. Endorsing an individual's identity is of vital importance and constitutes a core element of forensic science practices [9,10].

The gathering of additional forensic facts, such as lip prints, palatal rugae patterns, and bite marks, has crucial importance at crime scenes. These distinctive markers are particularly essential in cases of sexual assault and vehicular incidents, serving as fundamental elements in the verification of individual identities[9,10]. The Glossary of Prosthodontic Terms delineates Vertical dimension Occlusion (VDO) as the span measured between two predetermined points, generally from the nose's apex to the chin's base, attained when the teeth are fully interlocked. VDO abnormalities drastically impact functional efficiency with aesthetic harmonization and musculature governing mastication. Due to their lack of homogeneity, benchmarks offer a challenging obstacle for dental surgeons for VDO quantification.

This pioneering study of Rai Medical College, Sargodha, explores the potential interplay amongst the students of the Sargodha region, Punjab, to find out the vertical dimension occlusion and facial metrics. The objective is to ascertain a consistent pattern of correlation specific to the Punjabi Pakistani populace. Revelation of such patterns could yield pivotal guidelines for standardizing vertical dimensions in edentulous participants, thereby enabling a method that is cost-effective and precise both for VDO assessment.

METHODOLOGY

We have conducted the observational cross-sectional study comprising 152 3rd year Rai Medical College, Sargodha students, which includes 78 females and 74 males. A research proposal was submitted to the IRB for approval. After getting approval from the Institutional Review Board (IRB), it approved the research proposal via letter No. RMCS/ERC/08/24 dated January 5, 2024. Data was collected after getting verbal informed consent from the participants during the month of January to June,2024. Data was collected through the non-probability convenience sampling method. There are various anthropometric measurement techniques/methods of recording vertical dimensions at occlusion.

The VDO was measured from the base of the nose to the base of the chin, with the facial measurements like the corner of the eye to the angle of mouth, angle of mouth to the tragus, and glabella to sub-nasion measured by using a modified digital Vernier caliper. All data was meticulously recorded and analyzed on SPSS version 27 while performing the two-sample independent t-test and correlation analysis for their association and prediction with a 95% confidence interval and P value taken as $P < 0.05$ considered as significant.

The inclusion criteria for participation in our research were 1. Participants having all 28 natural permanent teeth 2. Those who are exhibiting a Class-I molar connection. 3. People with a straight profile and symmetrical face. 4. People who have never before sustained a facial injury. The exclusion criteria of our study were individuals who have undergone orthodontic treatment and individuals who have any neurological conditions affecting the eye, orbit, or any craniofacial deformity.

RESULTS

We performed an independent sample-t test (Table-I), which depicts low t-values and raised levels of p-values being more than 0.05 highlighted no any statistical indication in which the confidence interval does not include 0 among the male & female participants. The mean values of males 7.551±0.8426 cm and females 7.526±0.7855 observed in base of the nasal septum to the lower border of chin with mean difference of 0.025cm with t- value of 0.189.Angel of mouth to the tragus highlighted the mean values of male 10.045±0.8316 and females 9.822±1.1552 with mean difference of 0.223cm and t- value 1.37. Corner of eye to the angle of the mouth demonstrated the mean values of male 6.893 ±.7002 and female 6.937 ±0.5942 with mean difference of -0.048cm and t- value of -0.417. Glabella to subnasion highlighted the mean values in males 5.3430 ± 0.67484 and females'±0.66637 with mean difference of -0.110 cm. All these measurements did not showed any significance with raised p-values ranging from 0.176 to 0.846.

Table-II demonstrated the Pearson correlation coefficients between the gender and four facial measurements, including the base of the nasal septum till the lower border of the chin, the angle of the mouth to the tragus, the corner of the eye to the angle of the mouth, and the glabella to the subnasion. Correlation between gender and nasal septum till lower border of the chin $r = -0.016$, $p = 0.846$ gender and angle of mouth to tragus ($r = -0.110$, $p = 0.176$) gender and corner of eye to angle of mouth (($r = 0.034$, $p = 0.676$) and gender with glabella to sub nasion ($r = 0.083$, $p = 0.312$) demonstrated no significant correlation among each other. When we correlate between measurements of the base of the nasal septum till the lower border of the chin, the angle of the mouth to the tragus ($r = -0.030$, $p = 0.711$), the angle of the mouth to the tragus, and the corner of the eye to the angle of the mouth ($r = -0.002$, $p = 0.977$) did not show any significant correlation. A significant negative correlation of 0.01 was found in the angle of mouth to tragus with glabella to subnasion ($r = -0.243$, $p = 0.003$). Significant positive correlations were found in the base of the nasal septum till the lower border of the chin and the corner of the eye to the angle of the mouth ($r = 0.158$, $p = 0.052$) at the level of 0.01, the base of the nasal septum till the lower border of the chin and the glabella to subnasion ($r = 0.293$, $p < 0.001$) at the level of 0.05. Significant correlation between these measurements helps to understand that facial measurements are related to each other and none of the measurements are significantly correlated with gender.

DISCUSSION

Facial measurements are of principal importance in the jurisdiction of forensic science, serving as an essential tool for human identification and criminal inquiries. They contribute to judicious anatomical variations, which are decisive for facial reconstruction, recognizing facial

Table-I: Comparison of gender variation in facial measurements.

Variables	Gender	n	Mean ± SD	t	P-value	95% Confidence Interval of the Difference	
						Lower	Upper
Base Of The Nasal Septum Till Lower Border Of Chin	Male	74	7.551 ±0.8426	0.189	0.846	-0.2352	0.2866
	Female	78	7.526 ±0.7855			-0.2357	0.2872
Angle Of Mouth To Tragu	Male	74	10.045±0.8316	1.371	0.176	-0.1013	0.5469
	Female	78	9.822±1.1552			-0.0988	0.5444
Corner of Eye to Angle of Mouth	Male	74	6.893 ±0.7002	-0.417	0.676	-0.2517	0.1638
	Female	78	6.937 ±0.5942			-0.2527	0.1648
Glabella To Subnasion	Male	74	5.3430±.06748	-1.013	0.312	-0.32536	0.10463
	Female	78	5.4533±0.6663			-0.32543	0.10471

Table-II: Correlations VDO association with facial measurements.

Variables		Gender	Base of the nasal septum till lower border of chin	Angle of mouth to tragus	Corner of eye to angle of mouth	Glabella to subnasion
Gender	PearsonCorrelation	1	-0.016	-0.110	0.034	0.083
	Sig. (2-tailed)	-	0.846	0.176	0.676	0.312
	n	152	152	152	152	152
Base of the nasal septum till lower border of chin	Pearson Correlation	-0.016	1	-0.030	0.192*	0.158
	Sig. (2-tailed)	0.846	-	0.711	0.018	0.052
	n	152	152	152	152	152
Angle of mouth to tragus	Pearson Correlation	-0.110	-0.030	1	-0.002	-0.243**
	Sig. (2-tailed)	0.176	0.711	-	0.977	0.003
	n	152	152	152	152	152
Corner of eye to angle of mouth	Pearson Correlation	0.034	0.192*	-0.002	1	0.293**
	Sig. (2-tailed)	0.676	0.018	0.977	-	0.000
	n	152	152	152	152	152
Glabella to subnasion	Pearson Correlation	0.083	0.158	-0.243**	0.293**	1
	Sig. (2-tailed)	0.312	0.052	0.003	0.000	-
	n	152	152	152	152	152
*Correlation is significant at the 0.05 level (2-tailed)						
**Correlation is significant at the 0.01 level (2-tailed)						

phenotypes and inherited disorders, and considering facial anthropometric features. Additionally, these measurements are basics for advanced forensic applications, which further include facial recognition, facial superimposition, as well as both 2 and 3-dimensional imaging and reconstructions. The amalgamation of computer-based techniques further augments the accuracy and reliability of these forensic methods [9-19]. Our study is designed to explore the association between facial measurements with VDO from the base of the nasal septum till the lower border of the chin. The results deliver valuable insights into facial morphometry and its inferences for various fields, like orthodontics, maxillofacial surgery, and forensic anthropology. We performed a two-sample independent t-test, which proved that the gender did not demonstrated any variation but the facial measurements of the glabella to subnasion, the angle of mouth to the tragus, the corner of the eye to the angle of the mouth, and the base of the nasal septum to the lower border of the chin were statistically significant and measurable, highlighting the importance of this information in anatomical studies.

Correlation analysis demonstrated the crucial connection among the facial features. A positive correlation was found between the glabella to subnasion and the corner of the eye to the angle of the mouth and the base of the nasal septum till the lower border of the chin. It was also found that there was a positive association between the corner of the eye and the angle of the mouth, along with glabella and subnasion. Furthermore, there was a negative correlation found between the angle of mouth and the tragus. It was suggested by these findings also demonstrated that gender did not have any effect on their measurements. It indicated understanding these relations is crucial for accurate treatment planning in orthodontics and maxillofacial surgery, where accurate measurements of facial features are essential for optimum results. Studies in different regions like Saudi Arabia, Sudan, Egypt, and India showed statistically significant results [20,21].

Experiential relations have important clinical implications. Orthodontists can use facial dimensions as diagnostic tools to evaluate facial morphology and design a plan for orthodontic treatments more effectively. Similarly,

maxillofacial surgeons can apply these measurements to plan surgical interventions, such as orthognathic surgery, with greater accuracy. Moreover, forensic anthropologists can use facial measurements to aid in the identification of human remains, especially in cases where mutilated skeletal remains are incomplete or degraded.

LIMITATIONS

Our study is not without limitations. A small sample size with limited participants' diverse range of demographics along with measurement variability and potential biases in participant selection could have prejudiced the results. Future research should be conducted while aiming to address these limitations by employing larger and more diverse samples further utilizing standardized measurement techniques, and conducting longitudinal studies to track changes in facial measurements over time.

CONCLUSION

Our study concluded that contribution to the growing body of knowledge on facial morphology and its clinical applications. The observed associations between facial measurements and skeletal structures underscore the importance of considering both soft tissue and bony landmarks in clinical practice and research. By further exploring these associations and addressing the limitations of our study, we can enhance our understanding of facial morphology and improve clinical outcomes in orthodontics, maxillofacial surgery, and forensic anthropology.

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Authors' Contribution:

Syed Muhammad Yadin: Substantial contributions to the conception and design of the work.
Tufail Ahmed Soomro: Acquisition and analysis of data for the work.
Farooq Ahmed Abro: Interpretation of data for the work.
Mudaser Hussain Abbasi: Drafting the work.
Kamran Arzoo: Reviewing it critically for important intellectual content.