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Original Article

Comparing Variation with Conventional Powell's Angular Measures to Establish Soft Tissue Norms in Adult Pakistanis

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ABSTRACT

Objective: To assess soft tissue norms in adult Pakistani population using the standard Powell's measurements and to compare the angular measurements between male and female subjects.

Study Design: cross-sectional study.

Place and Duration of Study: Orthodontics department, Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan from Nov 2021 to 30 Apr 2022.

Methodology: Two hundred subjects fulfilling the inclusion criteria were selected and their lateral cephalometric radiographs were recorded to determine the respective norms for Pakistani population. For each subject, four facial soft tissue Powell's angular measurements were recorded namely Nasofacial, Nasofrontal, Nasomental and Mentocervical angles. Student's t-test was used to compare measured values between genders. *p*-value ≤0.05 was taken as significant.

Results: A statistically significant difference was observed in the values of Nasofrontal angle ($p<0.01$) and Mentocervical angle ($p<0.001$) between males and females, where female subjects showed a significantly higher value for both of these angles, suggesting gender dimorphism. Nasofacial angle values showed significant difference between age groups ($p<0.01$).

Conclusion: Notable disparities in the average values of Powell's analysis facial angles between male and female representatives of Pakistani community were observed.

Keywords: Anthropometry, Cephalometry, Diagnosis, Facial Profile, Orthodontics, Soft tissue.

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INTRODUCTION

The notion of facial beauty is universally acknowledged but varies according to ethnicity. The most important contributor to one's facial aesthetics is soft tissue morphology. However, it is difficult to define in tangible terms. Powell's analysis is a cephalometric analysis used to reliably assess patient's soft tissue profile.[1]

Facial morphology is influenced by various orthodontic methods, including growth modification, surgical orthodontics and tooth extraction. Plastic surgery is another method to alter an unfavourable facial profile to an appealing one.[2] Therefore, it's important to have a standardised method, like Powell's analysis, for evaluating facial attractiveness before initiating orthodontic treatment. Powell's Analysis defines relationship between nose, lips and chin. It consists of four angular measurements taken on the patient's soft tissue profile.[3] When done on lateral cephalometric tracings, it has the benefit of giving a full and reliable set of results that can be used for treatment planning.

Research previously undertaken using comparable measures of soft tissue norms in other communities shows existence of variation in angular face measurements and gender dimorphism.[4] It is important that measures of Powell's analysis coincide well with the norms of each population.[5] Moreover, most of the existing data is based on studies done on Caucasian populations while research undertaken on such norms addressing Pakistani population are few and far between.[6-8] Normative data gathered for soft tissue variables in one community may not be reliably relevant to another ethnic group. This highlights the need for studies evaluating soft tissue norms in the Pakistani population to establish population-specific reference values.

The aim of this study was to evaluate soft tissue norms of Pakistani population using Powell's analysis and assess whether gender dimorphism exists in these norms. To the best of our knowledge, such data has not been reported previously and relevant research is very limited. Findings of this study will help in improving routine orthodontic treatment planning.

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METHODOLOGY

A cross-sectional study was undertaken over a 6-months period from Nov 2021 to Apr 2022 after approval by Ethics Review Board (Ref letter number: 918/Trg/Jan/2026) in the department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan. Sample size was calculated using WHO calculator with confidence level (1-α) at 95%, Population mean and standard deviation of nasofacial angle as 35±5 degrees,[9] absolute precision (d) at 0.10, total sample size was calculated to be 200. The following criteria were used to select study subjects:

Inclusion Criteria: Patients of either gender belonging to any ethnic group of Pakistani origin (parents and grandparents both of Pakistani nationality), aged between 15 to 30 years, having skeletally class I jaw relationship with well-proportioned and symmetric faces were included.

Exclusion Criteria: Subjects having skeletal class II or class III jaw relations, history of maxillofacial or plastic surgery, history of orthodontic treatment (mild dental malococclusion i.e Index Of Orthodontic Treatment Need 1 and 2 were accepted) and/or facial trauma, and obvious asymmetry of face were excluded from the study.

The study recruited 200 participants meeting the inclusion criteria from the Out Patient department (OPD) of Orthodontics Department using non probability consecutive sampling technique (Figure-1).

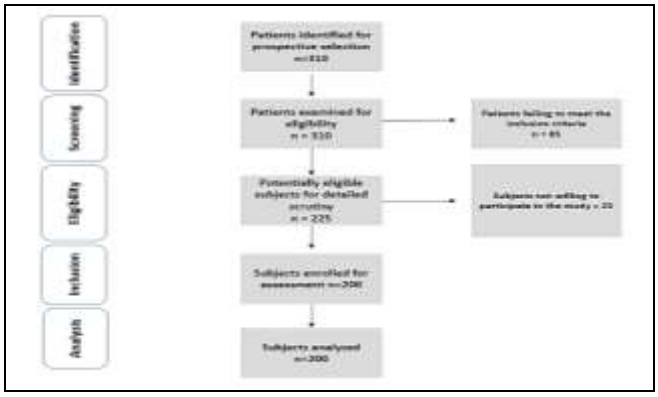


Figure -1: Patient flow-diagram showing selection of study subjects (n=200)

Informed consent was taken from all the participants. A single radiographer recorded all lateral cephalometric radiographs via Lateral cephalogram machine (Sirona Dental system D-64625, 73kV, 15mA) following standard protocols i.e., teeth in inter-cuspal position and head in natural position. Bony and soft tissue outline of each patient was traced by the Principal Investigator on standard acetate paper (0.003 inches thick, 8x10 inches) using a 0.05mm lead pencil and a radiograph light source in a dark room. To minimize intra-operator errors, each measurement was repeated thrice and a mean value of variables was recorded in proforma. Moreover, 25% of the observations were recalculated after two weeks and intra-class coefficient (ICC) test was used to assess intra-rater reliability. A strong correlation value of 0.85 was achieved, showing high reliability.

Following 4 facial angles (Figure-2) were measured for each individual: Nasofrontal angle – the angle formed when a line passing through the centre of the glabella and the nasion meets a line passing through the centre of the nasal dorsum; Nasofacial angle - measured from the point where a line drawn across the nasal dorsum meets a line drawn tangent to the forehead at the glabella and tangent to the chin at the pogonion; Nasomental angle - measured at the junction of line from the nasal dorsum and a line from the nasal tip to the pogonion; Mentocervical angle - the angle created by the glabella to pogonion and menton to cervical point lines. Moreover, in the present study, the following well-established cephalometric points were used as reference points: Glabella (G) – smooth area of skin located between and slightly above the eyebrows; Soft tissue nasion (Na) – the anatomical midpoint of the nasal root's soft tissue shape; Pronasale (Pn) – the most noticeable part of the nose; Soft tissue pogonion (Pog) – the most forward-projecting region of the chin's anterior surface; Soft tissue menton (Me) – the most inferior part of the chin contour in the mid sagittal plane.[10] All the soft tissue points were marked, the four angles described were drawn and measured on all the cephalometric tracings.

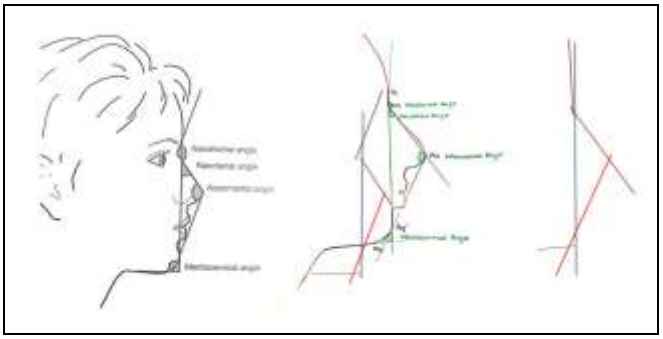


Figure 2: Landmarks and angular measurements used in Powell's analysis

Data collected was analyzed using Statistical Package for the Social Sciences (SPSS) version 23. Normality of data was assessed using Shapiro-wilk test. Mean±SD were calculated for the four facial angles as well as age while gender was expressed as percentage and frequency. Independent sample's t test was used to compare mean values of all facial angles between gender groups and age groups after stratification. *p*-value ≤0.05 was taken as significant.

RESULTS

Of the 200 study subjects, 46% (n=92) were males while 54% (n=108) were females. Mean age of the subjects was 20.5±4.2 years (range: 15-30 years). Table-I highlights the mean values of the four facial angles of Powell's analysis, with nasofrontal and nasomental angles showing considerable variation from class values of Powell's aesthetic triangle.

Table-I: Mean values of four facial angles measured as part of Powell's Analysis (n=200)

Facial Angles	Mean±SD (Degrees)	Range of Powell's Triangle Values from data (degrees)
Nasofacial angle	30.5±2.4	30-40
Nasofrontal angle	138.7±4.1	122-155
Nasomental angle	139.5±4.1	126-154
Mentocervical angle	81.3±5.0	80-95

A statistically significant difference (p<0.05) was observed in the values of Nasofrontal angle and Mentocervical angle between males and females, where female subjects showed a significantly higher value for both of these angles, suggesting gender dimorphism. The remaining two angles did not show any variation based on gender (Table-II).

Table-II: Comparison of Facial Angles of Powell's Analysis with Respect to Gender (n=200)

Facial Angles	Gender	n	Mean±SD	*p*
Nasofacial angle	Male	92	30.8±2.2	0.20
	Female	108	30.3±2.6	
Nasofrontal angle	Male	92	137.9±4.4	0.01
	Female	108	139.0±3.8	
Nasomental angle	Male	92	139.2±3.0	0.40
	Female	108	139.8±4.8	
Mentocervical angle	Male	92	78.7±4.3	<0.001
	Female	108	83.5±4.5	

For the purpose of analysis, subjects were divided into two groups based on their age – Group I: 15-20 years and, Group II: 21-30 years. A statistically significant difference was observed between the two age groups for values of nasofacial angle, with increased values observed in the younger age group i.e., 16-20 years. Table-III highlights the results of age-based comparison of all facial angles.

Table-III: Comparison of Facial Angles for Powell's Analysis on the Basis of age (n=200)

Facial Angles	n	Age Group (years)	Mean±SD (Degrees)	*p*
Nasofacial angle	120	16-20	30.9±2.3	<0.01
	80	21-30	30.0±2.6	
Nasofrontal angle	120	16-20	138.7±4.1	0.60
	80	21-30	138.5±4.1	
Nasomental angle	120	16-20	139.5±3.4	0.70
	80	21-30	139.4±4.5	
Mentocervical angle	120	16-20	81.4±4.6	0.20
	80	21-30	80.6±4.1	

DISCUSSION

The results of the present study highlights variation in soft-tissue norms of adult Pakistani population in comparison to the widely-used norms derived from Caucasian population. Soft tissue paradigm shift in orthodontics has shifted the focus away from skeletal and dental measurements and gives prime importance to soft tissue assessment in orthodontic treatment planning. Various researchers have previously attempted to link the importance of soft-tissue aesthetics to orthodontic diagnosis and treatment planning.[11] The majority of research shows that soft tissues, which vary greatly in thickness, play a significant role in determining a patient's final facial profile.[12]

In the present study, mean value of nasofacial angle was found to be 30.5±2.4 degrees. Comparable findings have been reported by Naeem *et al.*[9] who found nasofacial angle to be 36.46±3.05 degrees in orthognathic profile patients in Pakistani population. Our findings are also endorsed by Goel *et al*. who reported mean nasofacial angle of 36.35 degrees in the Indian population.[13] While the mean nasofrontal angle in the present study was found to be 138.7±4.1 degrees, contrasting results have been reported by Joker *et al*.[14] who found higher values of 148.27±7.75 and 148.37±7.75 in the Fars and Turk ethnic groups among the Persian population. As evident, these differences can be attributed to differences in ethnic origin of the subjects.

The present study found a statistically significant difference in values of nasofrontal angle between males and females (p=0.017), with higher values observed in female subjects (139±3.8 degrees) than in male subjects (137.9±4.4). Similar results have been reported in the North-eastern Indian population, where females had relatively higher values of nasofrontal angle (134.63±6.9 degrees) than males (129.43±8.74 degrees).[13] The difference between the 02 gender groups was statistically significant. Comparable values have also been reported by

Tavakoli *et al*. reported a nasofrontal angle to be 137.64±4.20 degrees in Iranian males.[15]

In the present study results, no statistically significant difference was observed in values of nasofacial angle between gender groups. However, Gupta et al.16 reported higher values of nasofacial angle for females than males (39.12±4.85 vs 38.72±4.99), although, the difference was not statistically significant. Also contrary to our findings, Mahmood *et al*.[17] found a statistically significant difference between gender groups for nasofacial and nasomental angles in the Pakistani population. The study, however, did not report on nasofrontal and mentocervical angles which showed a significant gender dimorphism in our study. Sexual dimorphism suggests that soft tissue patterns vary between males and females, even those belonging to the same ethnicity and hence, require special consideration during treatment planning.[18]

In the present study, soft tissue measurements were performed on cephalometric radiographic tracings. Powell's analysis was chosen due to its simplicity and detailed analysis of lip-nose-chin relationship in terms of angular measurements. Modern orthodontics often includes photographic soft tissue examination. Soft tissue photogrammetry is a radiation-free and reliable method to evaluate imbalances in facial symmetry.[7] 3D Photogrammetry, however, is not a routine orthodontic record as it is not readily available and technique-sensitive.[19] Lateral cephalogram, on the other hand, is required in almost all patients undergoing comprehensive orthodontic treatment. Soft tissue profile angular measurements, as given by Powell, can be done with good inter- and intra-operator reliability.[20]

LIMITATIONS OF STUDY

The study was carried out using cephalometric tracings manually. Although this is the conventional and reliable way of assessing soft tissue profile, it is a 2-dimensional analysis. Current technology of 3D photogrammetry and digital analysis using artificial intelligence and machine learning might provide more in-depth assessment. It was a single-centre study. Although the institute involved receives patients from all across the country, a multi-centre study would provide better representation of all ethnicities residing in Pakistan. Moreover, studies reporting on Powell's analysis in our population are scarce. Hence, results could not be compared to local data in detail. More studies with larger and diverse samples are recommended to establish the angular measurement norms of our population that would make treatment planning more precise, objective and customised to our patients.

CONCLUSION

Results of the present study suggest substantial disparities in the average angular measurements of Powell's analysis in adult Pakistani population. Nasofrontal and mentocervical angles varied significantly between males and females whereas nasofacial angle showed significant difference between age groups. Instead of utilising the established norms for other parts of the globe, Orthodontists and Surgeons should individualize the treatment planning process by referring to local norms that are categorised according to gender as the point of reference.

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Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

RQ & AJ: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

HP & TZ: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AM & KI: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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