ORIGINAL ARTICLE

The Dimorphism Regarding the Trabecular Pattern of Maxillary and Mandibular Bone in the Population of KPK-A Cross-sectional Study

Nida Murad[1] BDS, FCPS, MPhil
Asmat ullah[2] BDS, FCPS
Muhammad Naeem[3] BDS, MPhil
Neelofar Nausheen[4] BDS, MPhil
Asmat Begum[5] BDS

OBJECTIVE: The objective of this study was to take the utility of a three-dimensional CBCT view and determine the sexual dimorphism in the trabecular pattern/type in maxilla-mandibular region.

METHODOLOGY: This descriptive cross-sectional study was conducted from January 2022-2023 on 417 subjects (age limit 18- 80 years) at the Radiology Department of Sardar Begum Dental College and Khyber College of Dentistry. CBCT was used to determine the sexual dimorphism in the trabecular pattern in maxilla-mandibular region. Frequency/percentages were calculated for numerical data using descriptive statistics (version 20.0IBM.SPSS). The chi-square test was used for all the categorical variables. The level of significance was (P value?0.05) for six categories of decade age sub-groups, between both genders.

RESULTS: The overall trabecular pattern of the mandible was principally Type A with dense trabecular pattern. The trabecular pattern of the maxilla was mainly a Type C/ fine pattern (n=240, 57.4%) followed by the Type B/ mixed pattern (n=174, 41.6%).

CONCLUSION: Type I /A pattern of trabecular in mandible and Type II/B pattern of trabecula. In maxillary bone with statistically significant difference between both genders proves the existence of sexual dimorphism in the population of KPK.

KEYWORDS: Mandible, Maxilla, Trabecula, gender

HOW TO CITE: Murad N, Murad A, Naeem M, Nausheen N, Begum A. The dimorphism regarding the trabecular pattern of maxillary and mandibular bone in the population of KPK. A Cross-sectional comparative study. J Pak Dent Assoc 2025;34(1): 00-00.

DOI: https://doi.org/10.25301/JPDA.341.00

Received: *02 October 2024*, ***Accepted:*** *03 April 2025*

INTRODUCTION

Bone is classified as dense (compact) or trabecular (cancellous/bone marrow). The sandwich design gives the bone a high degree of stiffness while reducing weight.[1] Trabecular bone has a tenfold bigger total surface area than composite bone. Trabecular bone predominates in the spine, skull, and maxilla, whereas cortical bone dominates in the long bone and mandible.[1,2,3] Maxillary and mandibular bones are the major bones of the face.[1] Both of these bones, along with the palatine bone, define the boundaries of the oral cavity and house the teeth for occlusion and masticatory function.[1,4]

The Mandible is the face's largest and strongest bone, forming the lower jaw.[1,3] It sits directly beneath the maxillary bone.[19] It is the masticatory unit's moveable bone that absorbs force.[1] It has a distinct morphologic and histological profile, with large cortical plates and a coarse trabecular network that gives it a huge appearance.[4,5] These features are intended to withstand the stresses of mastication.[2]

The main bone of the mid-face is known as the "maxilla".[1] It takes the central position on the face and supports the viscerocranium.[1,2] It plays an important part in facial architecture, both functionally and aesthetically. It is the second biggest bone in the face. It forms the upper jaw.[4,5] It separates the nasal cavity from the oral cavity and houses the largest antrum, the Maxillary sinus/antrum of Highmore.[6]

1. Assistant Professor, Department of Oral Biology, Peshawar Dental College, Pakistan.
2. Associate Professor, Head of Department Oral Pathology, Khyber College of Dentistry, Pakistan.
3. Associate Professor, Department of Community Dentistry, Bacha Khan Dental College, Mardan, Pakistan.
4. Assistant Professor, Department of Oral Pathology, Sardar Begum Dental College, Peshawar, Pakistan.
5. Senior Lecturer, Department of Oral Pathology, KIDS, Kohat, KMU, Pakistan.

Corresponding author: "Dr. Asmatullah Murad" < murad_21_4@hotmail.com >

It is a force distribution unit attached to the base of the neurocranium.[7,8] It differs from the mandible, which has a thin cortical plate and a fine trabecular network.[4] Apart from anatomical variation regarding the trabecular pattern in these two facial bones, sexual dimorphism also significantly impacts trabecular structure.[7] Males have significantly more robust femoral diaphysis of the thigh and leg than females. Males also showed plate-like trabecular patterns than females.[8,9]

Although the maxillary and mandibular regions are rich in trabecular structure, still terms like trabecular volume, trabecular pattern, or trabecular bone density were always described in long bone, calcaneus or metatarsal bone, vertebral body etc. using CBCT, or Micro Ct scans.[9] The trabecular pattern in facial bone is still not properly addressed among both genders.

Cone-beam CT (CBCT) is commonly used in clinical dentistry to assess bone geometry and density because of its benefits over 2D and other 3D imaging methods.[10,11] On the other hand, CBCT is affordable for our region's patients to assess the parameters for bone quality, density and trabecular microstructure.[10]

The objective of this study was to take the utility of a three-dimensional CBCT view and determine the trabecular pattern/type using Brescia and Bajoria[12] classification in two Facial bones (posterior Maxillary and mandibular region) among both genders in different age groups.

The study's rationale was to discuss and understand the importance of sexual dimorphism in trabecular pattern, shape and the type and help the under and post-graduate students to identify the variation radio graphically under normal and pathological conditions while using CBCT.

METHODOLOGY

This cross-sectional comparative study was conducted for one year (Jan 2022-Jan2023) at the radiology Department of Sardar Begum Dental College and Khyber College of Dentistry. Planmeca Romexi CBCT Viewer is a full-featured desktop application for viewing two- and three-dimensional Planmeca Dicom files. For every patient, CBCT images with FOV (Field of View) of 10x13cm for posterior maxillary and mandibular bone were saved as DICOM files. (Digital imaging and communication in medicine standard). The measurements were recorded twice by an independent observer and expert maxillofacial Surgeon to ensure the reliability of the measurements. Data was obtained retrospectively and prospectively. Written informed consent was taken independently from every included subject. The non-probability sampling technique was chosen. The sample size calculated was 415 subjects with a 95% Confidence interval (1-α/2) 1.96, a margin of error of 5% and an anticipated population proportion with Mean/SD of 0.97±0.416mm.[13] The age limit of 18-85 years/both genders, seeking elective and non-elective dental care, good general health, completely healed extraction wound and without the bone defects in the mandible and maxillary arches, no history of growth defects, pathology or surgery, facial asymmetry were inclusion criteria. Pregnant and lactating mothers due to radiation hazards, according to the Consensus Guidelines of the European Academy of the Dental and Maxillofacial Radiology.[1-6] Periodontal defects, pathological conditions like cysts/tumors and posterior metal fillings, precious and metal alloys that can produce streaks and artefacts were excluded from this study. After fulfilling the inclusion criteria, a specially designed performa was used to record all details. Categorical variables like gender, quality of bone in the maxillary and mandibular region (trabecular pattern using the Brescia and Bajoria trabecular bone classification system[12] as Type A, Type B, Type C and the shape of the trabecula as, thick plate type and thin rod type. The SPSS (version 20.0IBM.SPSS) was used to analyse numerical and categorically entered data. The frequency/percentages along with descriptive statistics were calculated for all variables. The Chi-square test was used to determine the significant difference (P value $\leq$0.05) in the trabecular parameters among both genders with different age groups. Data was further elaborated via tables and graphs.

RESULTS

The mean age group recorded was 48.95±17.11 years. The male-to-female ratio was 1.5: 1.

The mandible's trabecular pattern was predominantly Type A, with a thick trabecular pattern (n=223, 54.9%), followed by Type B/mixed (n=186, 44.5%). The maxilla's trabecular pattern was predominantly Type C/fine (n=240, 57.4%), with Type B/mixed (n=174, 41.6%). Table 1

Table 1: Trabecular pattern/shape of the trabeculae in the Mandible and Maxilla

Trabecular pattern	Mandible	Maxilla	Shape of Trabecula	Mandible	Maxilla
Type A/Dense	n=223, 54.9%	n=2, 0.5%	Plate type	n=271,66.4%	n=87,22.3%
Type B/Mixed	n=186, 44.5%	n=174, 41.6%	Rod type	n=146, 34.9%	n=331, 79.2%
Type C/ Fine	n=9, 2.2%	n=240, 54.9%			
Total	417, 100.0	417, 100.0	Total	417, 100.0	417, 100.0

The maxillae of females (132, 31.65%) and males (108, 25.89%) exhibited type C patterns. However, both genders did carry a statistically significant connection with the trabecular pattern in the maxilla. In the mandible, men (142, 34.05%) had the type A pattern of trabecular interconnectivity, followed by the type B/Mixed pattern (n=118, 28.29%) compared to females with the Type C pattern. Table 1

The statistical relationship was found to be substantial for both genders. Figures 1

Figure 1: The Shape and Type of trabecula in both genders

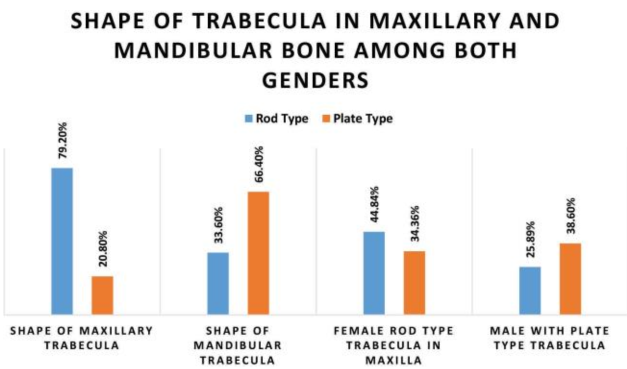

Table 2: Frequency Distribution for the trabecular pattern and Shape of the trabecula in the Mandible and Maxilla between both the Genders

Gender	Trabecular pattern in Mandible			Shape of Trabecula in Mandible		Trabecular pattern in Maxilla			Shape of Trabecula in Maxilla	
	Type A	Type B	Type C	Plate type	Rod type	Type A	Type B	Type C	Plate type	Rod type
Male	142, 34.1 %	68, 16.4 %	0	161, 38.6%	48, 11.6%	2, 0.47%	100, 23.9 %	108, 25.9%	66, 15.8 %	144,34.6%
Female	79, 18.9 %	118, 28.3 %	9, 2.1%	108, 25.8%	98, 23.5%	0	74, 17.7 %	132, 31.7%	19, 4.6%	187, 44.8%
Level of significance	P Value=0.05 (40.365)			P Value=0.01 (27.545)		P Value0.05 (8.247)			P Value=0.05 (31.539)	

Note: Level of Significance P Value < 0.05

The maxillary trabecula was predominantly rod-shaped (n = 331, 79.2%).In contrast, the morphology of the mandibular trabecula was the plate type (n=271, 66.4%), followed by the rod type (n=146, 34.9%). Table 1 The morphology of the rod-type trabecula in the maxillary region of female and male individuals was determined to be 44.84% (n=187 patients) and 34.53% (144 patients), respectively, with a statistically significant difference. Table II

Male individuals (n=161, 38.60%) had more plate-type trabecula in the mandibular area compared to female subjects (n=108, 25.89%) (P=0.05). Figure I

DISCUSSION

The density of the maxilla and mandible justifies the biomechanical and biochemical difference between the two facial bones among both genders.[13,14] According to Beek et al,[15] the architectural makeup of the mandible is with thick/dense cortical bone with coarse/plate type trabecula, which acts as a force absorption unit. On the other hand, the maxilla has a thin cortical bone with fine trabeculae acting as a force distribution unit. The findings of Eriden,[16] Sukhun,[17]Malo[18] and Almasoudi[13] were by the above findings.

Dessel and his colleagues,[19] considered the interpretation of trabecular organization is often more complex, due to heterogeneity in individual trabecular configuration and multiple pathologies can alter the network. Well-structured trabecular bone had more trabecular thickness, with high interconnectivity and plate-like pattern of the trabecula. The present study revealed the posterior mandible with a dense trabecular with the plate type pattern. In contrast, the maxilla had a fine rod-type trabecular pattern.

Jonasson et al,[20] showed that mandibular trabeculation correspondingly alters with age. Men and women subjects, after the age of 50 years displayed sparse trabeculation. Wowren[21] also evidenced that cortical porosity in the mandibles increases with age, but it seems to be independent of gender. The findings in this study correlate well with the above study.

Although Wowren,[21] claimed that trabecular changes were age-dependent and not sex-dependent, Choel et al,[22] denied these findings, as they found a significant difference (P<0.002) in the trabecular pattern between the males and females. Males had more plate type and high connectivity for the trabecula, unlike females with more sparse patterns and low connectivity of the trabecula in the facial bones. Kavitha[23] and their colleagues used the panoramic view to determine the gender difference in the cortical and trabecular components in the mandible. In their study, the male had stronger plate-type trabecular and cortical components when compared to the female. Similar results were generated from the present study while using the 3D-CBCT.

ETHICS APPROVAL

The retrospective and prospective data of maxillo-mandiblur was obtained after ethical approval from two stations, Khyber College of Dentistry and Sardar Begum Dental College Peshawar KPK.

CONSENT TO PARTICIPATE

Written consent on specially designed performa.

DATA AVAILABILITY

The datasets generated during and analyzed during the current study is not publicly available because it contains personal information but are available from the first author on reasonable request.

FUNDING

Not applicable

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS' CONTRIBUTIONS

Asmatullah Murad: Conception/design/interpretation/ final approval of work
Nida Murad: Conception/design/revising Interpretation/ Drafting/ final approval of work
Muhammad Naeem:- Drafting and proof reading
Neelofar Nausheen: Supervision Analysis, revising
Asma Begum: Drafting/ final approval of work

ACKNOWLEDGEMENTS

The authors thank the Department of Radiology, Academic Oral Biology, Oral Pathology of Sardar Begum Dental College and Khyber College of Dentistry Peshawar KPK.

REFERENCES

1. Saers JPP, Cazorla-Bak Y, Shaw CN, Stock JT, Ryan TM. 2016. Trabecular bone structural variation throughout the human lower limb. J Hum Evol.2016:97:97-108. *https://doi.org/10.1016/j.jhevol.2016.05.012*

2. Kulah K, Gulsahi A, Kamburoglu K, Geneci F, Ocak M, Celik HH, Ozen T. Evaluation of maxillary trabecular microstructure as an indicator of implant stability by using 2 cone beam computed tomography systems and micro-computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol. 2019; 127:247-56. *https://doi.org/10.1016/j.oooo.2018.11.014*

3. Van Dessel J, Huang Y, Depypere M, Rubira-Bullen I, Maes F, Jacobs R. A comparative evaluation of cone beam CT and micro-CT on trabecular bone structures in the human mandible. Dentomaxillofac Radiol. 2013; 42:2013-19 *https://doi.org/10.1259/dmfr.20130145*

4. Pauwels R, Faruangsaeng T, Charoenkarn T, Ngonphloy N, Panmekiate S. Effect of exposure parameters and voxel size on bone structure analysis in CBCT. Dentomaxillofac Radiol. 2015;44:20150078. *https://doi.org/10.1259/dmfr.20150078*

5. Ibrahim N, Parsa A, Hassan B, van der Stelt P, Aartman IH, Nambiar P. Influence of object location in different FOVs on trabecular bone microstructure measurements of human mandible: a cone beam CT study. Dentomaxillofac Radiol. 2014; 43:329-44 *https://doi.org/10.1259/dmfr.20130329*

6. Lopez P, Diaz CM, Herrero M.Thickness of buccal bone wall and root angulation in maxilla and mandible an approach to CBCT.BMC Oral Health.2018:194-9

7. Lindh et al. Maxillary bone mineral density and its relation to BMD of lumber spine and hip. Oral Surg Oral Radiol oral Pathol. 2004; 98:102-9 *https://doi.org/10.1016/S1079-2104(03)00460-8*

8. Jonasson G. Mandibular alveolar bone mass structure/thickness in relation to skeletal bone density in dentate women. Swedish Dental J.2015; 177:49-64

9. Fanghanel J et al. The morphological and clinical relevance of mandibular and maxillary bone structure for implantation. Folia Morphol (Warsz). 2006; 65:49-5

10. Kühnel TS, Reichert TE.Trauma of the midface.GMS Curr Top Otorhinolaryngol Head Neck Surg. 2015;14:206-47

11. Saffar JL, Lasfargues JJ, Cherruau M.Alveolar bone and the alveolar process: the socket that is never stable.Periodontol.2000;13:76-90 *https://doi.org/10.1111/j.1600-0757.1997.tb00096.x*

12. Bentsianov B, Blitzer A. Facial anatomy. Clin Dermatol. 2004;22:3-13 *https://doi.org/10.1016/j.clindermatol.2003.11.011*

13. Almasoudi N, tannero N, Marie F.Alveolar bone density and its clinical implication in the placement of dental implants and orthodontic mini-implants.Saudi Med J. 2016;37:684-9 *https://doi.org/10.15537/smj.2016.6.14274*

14. Andersen S et al. "Introduction to force-dependent kinematics: theory and application to mandible modeling.Journal of biomechanical engineering.2017;139:13-24 *https://doi.org/10.1115/1.4037100*

15. Beek M, Aarnts, MP, Koolstra JH, Feilzer AJ, and Van Eijden TM.Dynamic properties of the human temporomandibular joint disc.J Dent Res.2000;80:876-80 *https://doi.org/10.1177/00220345010800030601*

16. Eriden GJ.Biomechanics of mandible. Grit Rev Oral Biol Med. 2000;11:123-136 *https://doi.org/10.1177/10454411000110010101*

17. Sukhun AL, Heleniu M, Linqvist C, Kelleway J.Biomechanics of mandible part I: measurement of mandibular functional deformation using custom made displacement tarnsducers.Basic and patient Oriented Research.2006; 64:11-13 *https://doi.org/10.1016/j.joms.2006.03.009*

18. Maló P, Rangert B, Nobre M. All-on-4 immediate-function concept with Brånemark system implants for completely edentulous maxillae: a 1-year retrospective clinical study. Clin Implant Dent Relat

Res.2005;7:88-94
https://doi.org/10.1111/j.1708-8208.2005.tb00080.x

19. Dessel JV et al. Quantification of bone quality using different cone beam computed tomography devices: Accuracy assesment of edentulous human mandibles.Eur J Oral Implantol. 2016;9:411-24

20. Jonasson et al.Trabecular pattern in the mandible as bone fracture predictor. Clin Oral Investig.2009;108:42-51
https://doi.org/10.1016/j.tripleo.2009.05.018

21. Wowern N, Stoltze K.Sex and age differences in bone morphology of mandibles.Scand J Dent Res.2008;86:478-85.
https://doi.org/10.1111/j.1600-0722.1978.tb00654.x

22. Choel et al. Trabecular alveolar bone in human mandible. A dual-energy X-ray absorptiometery.Oral and Maxillofac Radiol.2003; 95:364-70
https://doi.org/10.1067/moe.2003.119

23. Kavitha SM, Park SY, Subash M, Soe SM. Distributional Variations in the Quantitative Cortical and Trabecular Bone Radiographic Measurements of Mandible, between Male and Female Populations of Korea, and its Utilization. Plos One.2016; 10:1-13
https://doi.org/10.1371/journal.pone.0167992