

**"ANTHROPOMETRIC MEASUREMENTS OF CONDYLE
AND RAMUS OF MANDIBLE USING COMPUTED
TOMOGRAPHIC SCAN IMAGING IN CENTRAL INDIAN
POPULATION – A DESCRIPTIVE
CROSS-SECTIONAL STUDY."**

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LIST OF ABBREVIATIONS

JCA	Juvenile chronic arthritis
TMJs	Temporomandibular joints
Mx RB	Maximum ramus breadth
Mi RB	Minimum ramus breadth
Mx RH	Maximum ramus height
PH	Projective height of ramus
OPG	Orthopantamogram
CT	Computed tomography
TMD	Temporomandibular disorders
Go	Gonion
Sig	Sigmoid notch
Co	Condylion
Lat Co	Lateral condyle
Med Co	Medial condyle
FH,	Frankfort horizontal plane
M-L	Mesio-lateral
A-P	Anteroposterior
mm	Millimeter
VS	Versus
SD	Standard deviation
WHO	World health organisation
SPSS	Statistical package for the social sciences

Introduction

Temporomandibular joint (TMJ) is a pair of complex and highly mobile joint. TMJ is one of the most active joint in the human body which has more than 2000 movements each day during daily activities such as chewing, biting, swallowing, talking and snoring. The function of TMJ is to provide smooth, efficient movement of the mandible during mastication, swallowing and speech and to provide stability of mandibular position and prevent dislocation from external or unusual forces.

Dupuy-Bonafé I et al., (2014)¹ indicated that the morphologic examination of the TMJ has important applications in the domain of TMJ pathology. Therefore, the reasonable measurement of TMJ morphologic parameters will help us to better understand the structure, function, and variation in morphology according to age and gender estimation of TMJ.

Due to the intricacies of the skull base and TMJ components, multiple studies have been carried out to investigate morphologic parameters of TMJ using different types of imaging techniques. Conventional X-rays were first used to assess the morphology of mandibular condyle and articular eminence². Later on, lateral cephalograms were used to determine the selection criteria for ordering a corrected lateral tomogram of the TMJ³ to investigate the possible association between the joint structure, condylar position, and craniofacial morphology. Later on, computed tomographic scan (CT) images were found to be most reliable for the morphological detection of TMJ⁴.

The assessment of facial dimensions is of prime importance in medical and dental fields in diagnosis and treatment planning. For many years **Farkas et al.,(1992)**⁵ applied direct anthropometry techniques for studying facial morphology. This approach has been applied to study facial growth and to compare different phenotypic norms of population.

Therefore obtaining anthropometric Dimensions for temporomandibular joint is important for performing an accurate preoperative assessment, planning temporomandibular, craniofacial or orthognathic surgeries, and evaluating the postoperative outcome.

The vocable “anthropometry” is derived from the Greek words “anthropos”, which signifies man, and metron, literally meaning to measure. Hence anthropometry is defined as the science of measuring the human body and its parts. Currently, anthropometry provides researchers the single-most uncomplicated, economical, convenient, non-invasive, and universally applicable method for assessing the size and proportions of the human body.⁶

Anthropometric measurements from the head and face together are called Craniofacial Anthropometry. Anthropometry describes the morphology, including size, shape, and proportions of a human face and its parts using certain measurements defined based on specific landmarks.⁷

Anthropometry can be considered an invaluable technique for guiding surgeons in the diagnosis and treatment plan of many conditions affecting the craniomaxillofacial complex. Over the years, the aesthetic standards have been changing due to visual and other media. Currently, orthodontic procedures and maxillofacial surgery are performed on a heterogeneous mix of races and ethnic groups. Hence, a single canon of an ethnic group is inappropriate. Race specific anatomic data can be useful for planning surgical procedures.

Due to racial and ethnical differences, surgeons must be cautious when incorporating these findings into clinical practice. Studies, therefore, should ideally be customized to each population in order to have accurate figures which, in turn, produce better clinical results.⁶

Richardson (1980) defined the term "ethnic group" as a "nation or population with a common bond such as geographical boundary, culture or language or being racially or historically related".⁸

Various researchers have studied cephalofacial relationships in many population samples to diagnose various methods of analysis but without much concern for differences in the face between groups of different ethnic origin. However, some investigators noticed the variation in the craniofacial morphology between different ethnic groups.⁸ Like studies on many different ethnic groups were done including Downs' study of Caucasians (1948), Suh's study of Koreans (1967),

Mitani 's study of Japanese (1980), Chan's study of Chinese (1975) Nanda's study of North Indians { 1969), Garcia's study of Mexican Americans (1975), and Drummond's study of Negroes (1968).⁸

All these investigators noted that normal measurements of one group should not be considered normal for other racial groups. Different racial groups have to be treated according to their individual characteristics.⁸

But due to limited amount of anthropometric studies in the Indian population, surgeons have to rely on North American or Caucasian investigations. It is apparent from the review of literature that most of the studies are done on Caucasian populations and the norms developed by the use of numerous dimensional analyses may be inadequate for application to different racial or ethnic groups. This indicates a gap of knowledge regarding the facial dimensions and norms in context to the Indian population.

Now despite the varying anatomical landmarks, numerous studies have been performed using different ramus metric measurements for sex^{9,10} and age estimation. Mandibular ramus can be differentiated between males and females, based on the stages of mandibular development, growth rates, and duration. Owing to the different masticatory forces exerted by males and females, the size and shape of the mandible vary where males have bigger and more robust mandible than females.¹¹

Among facial bone fractures, after nasal bone fracture, the mandible fracture has the highest incidence. In mandible fracture, condyle fracture occurs most frequently.¹² The reason for a high incidence of mandibular condyle fracture is attributable to the binding of the mandibular ramus with high stiffness and mandibular condyle head with low stiffness.¹³

The mandibular condyle is vital since it provides the expression of mandibular growth.¹⁴ In spite of the high incidence of condylar neck and subcondylar fractures, the treatment for these remains one of the most controversial topics of mandible surgery. Since the disorders caused by mandibular fracture are difficult to recover aesthetically and functionally, an appropriate treatment is required to reconstruct the shape of uninjured status.

To do this, it is again important to have a thorough knowledge of the normal morphology of condyle and Ramus of the mandible. Therefore the purpose of this study was to obtain objective measurements of condyle and ramus of the mandible in an adult central Indian population to establish a norm peculiar to our region in relation to gender & age, which would be useful in providing racially specific values for diagnosis, treatment planning of surgeries, Rigid internal fixation, customizing TMJ appliance and TMJ prosthesis with reference to these measurements.

Aim And Objectives

Aim of the study :

This study aims to assess the dimensions of condyle and ramus of the mandible using computed tomographic scan imaging in the central Indian population.

Objectives of the study:

To measure the dimensions of condyle and ramus of Mandible on computed tomographic scan images.

Review of Literature

Park IC, Bowman D, Klapper L (1989)⁸ in their cephalometric study of 18-year-old Korean subjects with acceptable profile and occlusion was carried out utilizing the Downs, Steiner, Ricketts, and vertical analyses. Means and standard deviations of the Korean subjects were established. To compare Koreans to Caucasians, statistical analyses were performed.

Farkas LG and Posnick in (1992)⁵ performed all the measurements with an anthropometric compass in North American Caucasians. The growth changes in the face due to age and the relationship between its parts were calculated by using two horizontal, three vertical, and two projective surface measurements from 1,594 North American Caucasians that have age between 1 and 18. From which he observed that by 1 year, the width of the mandible was highly developed (80.2%) while its height reached only 66.6% of the eventual adult size. It was clear that the height and width of mandible showed significant development between 1 and 5 years. Whereas, the face

height, upper face height, face width, and two face depth measurements showed continuous growth even after 5 years of age. In females, the upper face height, the mandible height, and the width of the face matured at the age of 12 years. In the case of males, the face height, mandible height, face width, and the depth of the mandible matured at the age of 15 years.

Kjellberg H, Ekestubbe A, Kiliaridis S, Thilander B in (1993)¹⁵ concluded that the method of using a panoramic radiograph for calculating condylar ratios is reliable. The height of the condyle in relation to height of ramus was measured bilaterally in three groups of children, with normal and postnormal occlusion and juvenile chronic arthritis (JCA), to detect if any asymmetries and define differences in the relative condylar height. The JCA group had a shorter relative height of condyle, and the asymmetries were more pronounced than in the other two groups.

The results of this study showed good validity for the reference points used for future studies.

Kawashima T, Abe S, Okada M, Kawada E, Saitoh C IY in (1997)² To clarify changes in the trabecular structure due to loss of the teeth, the author compared soft X-ray images and morphological measurement values of the articular eminence and mandibular condyle between edentulous and dentulous specimens. The center of the skull base having the TMJ was removed along the median sagittal and Frankfort horizontal planes. Hence Conventional X-rays were first used to assess the morphology of mandibular condyle and articular eminence.

Susilo BT, Sulistyani LD, Priaminiarti M, Latief MA in (2004)¹⁶ noted that to the best of our knowledge, there are only a few published reports with anthropometric data about the thickness of the mandibular ramus. The aim of this study was to measure the thickness of the mandibular ramus based on cone-beam computed tomography (CBCT) to be used as a reference while performing BSSO. The study subjects comprised 61 data samples of CBCT based DICOM images which reoriented in three planes, and we measured the thickness of the mandibular ramus. The mean thickness was $8.049 + 1.205$ mm for males and $8.463 + 1.358$ mm for females. For 18 to 30, 31 to 40- and 41 to 50 year-old patients, the mean thickness of the mandibular ramus was $8.087 + 1.29$ mm, $8.176 + 1.49$ mm and $8.742 + 1.04$ mm, respectively. Based on the CBCT images, they found no statistically significant differences between the thicknesses of the mandibular ramus in terms of sex and age.

Ribeiro DPB, Gandelmann IHA, Medeiros PJ in (2006)⁴ noted that though panoramic radiograph is routinely used for evaluation of patients who undergo orthognathic surgery, CT scan is superior on image quality. The purpose of this study was to assess the ramus thickness in skeletal Class III patients and Class II patients.

Sehar Gunduz Arslan, Celal Genc, Bahadur Odabas JDK in (2008)¹⁷ determined the prevalence of three different face types among Turkish young adults based on facial indices, to assess and compare the vertical and horizontal dimensions and to establish anthropometric norms for the Turkish people. Using the landmarks of anthropometric norms, 10 vertical and 8 horizontal direct measurements were made using the millimetric compass.

Ngeow WC, Aljunid ST. in (2009)¹⁸ in their study established the craniofacial anthropometric norms of young adult (18- 25 years) Malaysian Indians. The study group consisted of 100 healthy volunteers with equal female and male subjects with no history of mixed racial percentage. Twenty-two linear measurements were collected twice from 28 landmarks over six craniofacial regions. The Malaysian Indians exhibit some North American White Caucasian features, hence this study showed the variation of Malaysian Indians from that of the North American White Caucasian population.¹⁹

Krisjane Z, Urtane I, Krumina G, Zepa K (2009)²⁰ in their study assessed condylar parameters and condyle position within glenoid fossa of TMJ in volumetric 3D imaging in patients with Class II and Class III malocclusions. Height and width of condyle and glenoid fossa was assessed. Mean values were calculated separately for the left and right sides. Differences between the mean values were tested using the paired t-test. This study showed that there is a tendency for smaller condyle and wider spaces between condyle and walls of glenoid fossa comparing TMJ of Class II with Class III patients.

Hence our study results could be of use to assess the normal values to compare it with abnormal class II class III relations.

Yadav A, Walia C, Borle R, Chaoji K, Rajan R, Datarkar A in (2010)²¹ through their study revealed that the cephalometric norms used for assessment of the deformity and the treatment planning are those for the Caucasian population only, and thus, all the patient regardless of race, are evaluated only by these established standards.

In their study, gave surgically important rectilinear cephalometric norms for the diagnosis and treatment planning of orthognathic surgery in adult Central Indian population are developed for its practical implementation in the treatment of the facial deformities. Their study revealed that some of the cephalometric parameters in the Central Indian population are significantly different than those of the Caucasian population, especially the female gender.

These racial differences are evident in this study and are of clinical importance, and the authors suggest their use while charting out a plan for orthognathic surgery for the Central Indian population.

Christofides EA, Steinmann ME in (2010)²² used One thousand eighty-two participants to obtain normal anthropometric measurements, specifically the ear-to-ear measurement and the glabella-to-external occipital protuberance measurement. Both male and female participants aged 6 months to 25 years were used to obtain these measurements A head chart is created for both the genders using the normal ear to ear measurements and the cephalic index defining both the qualitative and quantitative elements of the growing skull.

Craniofacial surgeons may find this chart useful for managing patients for craniofacial surgeries. This chart comes handy to assess how the skull grows after surgery.

Tecco S, Saccucci M, Nucera R, Polimeni A, Pagnoni M, Cordasco G, et al (2010)²³ conducted a morphometric analysis on 300 temporomandibular joints over 150 Caucasian young adult subjects and found that condylar volume in males was

significantly higher ($p < 0.001$) than females. The condylar measurements for males were $691.26 \pm 54.52 \text{ mm}^3$ and $669.65 \pm 58.80 \text{ mm}^3$ for females. Similar findings were observed for the condylar surface area for males with $406.02 \pm 55.22 \text{ mm}^2$ and females $394.77 \pm 60.73 \text{ mm}^2$. They also compared between right and left measurements where the condylar volume ($693.61 \pm 62.82 \text{ mm}^3$) in the right TMJ was significantly higher than in the left ($666.99 \pm 48.67 \text{ mm}^3$, $p < 0.001$) as was the condylar surface ($411.24 \pm 57.99 \text{ mm}^2$ in the right TMJ and $389.41 \pm 56.63 \text{ mm}^2$ in the left TMJ; $t = 3.29$; $p < 0.01$). The MI is 1.72 ± 0.17 for the whole sample, with no significant difference between males and females or the right and left sides.

Noletto JW, Marchiori E, Da Silveira HM in (2010)²⁴ Studied on comparison of Mandibular Ramus Width in Patients With Prognathism and Retrognathia.

The location of ramus thickness measurement was taken from the scans just above the lingula, in a coronal view. Distances between the outer and inner surface of the ramus at the lingula level were measured in both groups Hallikainen found a reduced mesiolateral width of the mandibular rami in patients with prognathism compared with retrognathism.

Gu Y, McNamara JA, Sigler LM, Baccetti T in (2010)²⁵ in his comparative study noted that smaller midfaces and shorter mandibles were observed in Chinese young adults compared with those of Caucasians. The average value of lower anterior face height (ANS–Me) was longer in the Chinese females than that in Caucasian females.—The differences in hard and soft tissue characteristics were significant between Chinese and Caucasian young adults with normal occlusions and well-

balanced faces. Therefore Gender and racial/ethnic differences must be taken into consideration during orthodontic diagnosis and treatment planning for the individual patient.

Kim JH, Gansukh O, Amarsaikhan B, Lee SJ, Kim TW in (2011)²⁶ The purposes of this study were to establish cephalometric norms of Mongolian adults, which have not previously been reported in orthodontic journals, and to compare them with cephalometric norms of Korean adults. Mongolian adults had shorter anterior facial height, prominent chins, and more upright upper incisors compared to Korean adults. Cephalometric differences can be considered, but a little difference may exist between the orthodontic diagnosis and treatment planning of Korean and Mongolian adults.

Momjian A, Courvoisier D, Kiliaridis S, Scolozzi P in (2011)²⁷ Proved the reliability of a computational method for assessing three condylar measurements on digital panoramic radiographs: condylar height, area, and perimeter. Hence this study also defined the anatomical landmarks for anthropometric measurements of the condyle.

A computer calculation of the area, the perimeter and the height of condyles were determined on digital panoramic radiographs taken from patients.

He also mentioned that the height of the condyle can be rapidly and reliably assessed using a specific computer system directly on digital panoramic radiographs but they were less reliable, mainly owing to problems related to image distortion, magnification, superposition of different anatomical structures and reduced resolution.

Zhao XG, Hans MG, Palomo JM, Lin JX in (2013)²⁸ did a comparative analysis between the Chinese & white population in normal subjects which showed that they have different craniofacial characteristics from which he concluded that these differences should be taken into considerations while doing the treatment planning.

Mittal A, Garg R, Kumar Gupta S in (2014)²⁹ The vertical skeletal measurements for north Indians of both sexes were increased compared to Caucasians. An increase in the posterior middle third height was a contributing factor in an overall increase in length both the males and females. Whereas, in females, an increase in upper third and lower third vertical facial height was responsible too. The maxillo-mandibular relationship of our study group differed much from the Caucasians. A significant difference was found in ramus length, the relationship of maxilla and mandible apical base and retrusive chin in both the genders.

Overall comparison of the skeletal patters showed that the skeletal morphology of North Indians differs in comparison to Caucasians in some parameters.

Markic G, Müller L, Patcas R, Roos M, Peltomäki, Lochbühler N, et al. in (2014)³⁰ in their comparative study between different imaging procedures [cone beam computed tomography (CBCT), computed tomography (CT), magnetic resonance imaging (MRI), orthopantomography (OPG), and lateral cephalometry (LC)] for assessing the mandibular height [ramus height (RH)] and condylar process (CondProc) length where he used the following landmarks which were uniformly

used in all the imaging techniques & hence provided a validity for reference points in future studies

Ramus height: Measured parallel to the tangent at the posterior border of the ramus between the most cranial point of the condyle (Co) and the intersection point with the lower border of the ramus of the mandible [the gonial point (Go)]. The intersection with the lower border of the ramus mandibulae was obtained using a line parallel to the tangent at the posterior border of the ramus that ran through the most cranial point of the condyle (Co).

Height of the Condylar Process: Measured parallel to the tangent at the posterior border of the ramus between the most cranial point of the condyle (Co) and the most caudal point of the incisura mandibulae (In).

Elgüy D, Elgüy M, Figekeçiolu E, Dölekollu S, Ersan N.(2014)³¹ in their study assessed condylar morphology according to age and gender including incidental findings of osseous characteristics associated with osteoarthritis (OA) of the temporomandibular joint (TMJ) using cone-beam computed tomography (CBCT). Gender has a significant effect on eminence height and inclination. This anatomical data may be helpful to understand the Condyle and glenoid fossa and its correlation with age and gender.

Abu-Taleb NS, El Beshlawy DM (2015)³² in their study used 109 panoramic images to measure upper ramus breadth, lower ramus breadth, projective height, condylar ramus height, and coronoid ramus height) and gonial angle measurements were obtained. The results showed that Males had statistically higher mean linear

ramus measurements and lower mean gonial angle values than females. Condylar and coronoid ramus heights were the most significant predictors for gender and age respectively. Thus in the Egyptian population, mandibular ramus showed a high sexual dimorphism while the gonial angle could assist in gender estimation only.

Al-Koshab M, Nambiar P, John J in (2015)³³ studied on the Assessment of Condyle and Glenoid Fossa Morphology Using CBCT in South -East Asians. The volume, metrical size, position of each condyle sample and the thickness of the roof of the glenoid fossa (RGF) were estimated using CBCT. Condylar length - measured from the line extending from the posterior mandibular condyle point (PCo) to the anterior mandibular condyle point (ACo). -These two points are located 4mm inferior to the superior condyle on either side of the condyle.

Condylar width - the linear distance between the medial and lateral mandible poles, was measured in the coronal plane

Condylar height - measured as a perpendicular linear distance from highest point of condyle to a line constructed between the most inferior point of the sigmoid notch (InfSig) perpendicular to the tangent of the posterior surface of the ramus in the sagittal plane

When comparing the thickness of RGF and condylar measurements between the two ethnic groups, no significant difference was found for all the measurements except condylar height. This condylar height was found higher among Chinese.

And they concluded that the similarity in measurements for Malays and Chinese may be due to their common origin. This data can be clinically useful in

establishing the diagnostic criteria for condylar volume, metrical size, and position in the Malaysian East Asians population.

Yong Hyun Kim, Seok Joo Kang, Hook Sun in (2015)³⁴ stated that compared to the many previous studies using CBCT to acquire 3D imaging for cephalometric analysis, MSCT was used in this study.

Although the advantage of CBCT maybe its availability for use by dental health professionals without the need for a radiologist, the images acquired from MSCT are more precise with less distortion. CT Scans are perfectly capable of obtaining high-quality images for a cephalometric analysis; however, it has one disadvantage that it exposes the patient to more radiation than CBCT.

Tejashree B, Thakur M, Palve D, Bhondey A, Dhengar Y, Chaturvedi S. in (2016)¹⁰ did a forensic study on sex determination by using mandibular ramus where landmarks of measurements were standardized as follows

Maximum ramus breadth (Mx RB) - Distance between most anterior and line connecting most posterior part of condyle and angle of the jaw.

Minimum ramus breadth (Mi RB) - Distance between smallest anterior to posterior of the ramus.

Maximum ramus height (Mx RH) - Height of ramus from most superior part on condyle to the tubercle or most protruding portion of the inferior border of the ramus.

Projective height of ramus (PH) - Distance between the highest part of condyle and lower margin of the mandible.

They concluded that Mandibular ramus is a useful aid for sex determination as it is readily available and resistant to any disintegration process.

Maloth KN, Kundoor VK, Vishnumolakala SS, Kesidi S, Lakshmi in (2017)³⁶ in their study showed that different ramus metric measurements on digital panoramic images were considered as indicators for sex determination. The mandibular ramus showed high sexual dimorphism and proved to be beneficial in sex determination. Hence, the use of mandibular ramus is recommended as an aid for sex determination in forensic analysis.

Rehman, Yasmeen T, Qamar N (2017)³⁷ 174 female patients aged 25-85 years and divided them into three groups. They aimed at measuring the ramus height and width through OPG to assess morphological changes in osteoporosis. Their study concluded that Digital OPG is not an accurate tool to assess the changes in osteoporotic patient

Scariot R, Gonsar B, Gill N, Furquim F, Corso PFC de L, Trevillato PC, et al. (2017)³⁸ Compared the anatomical dimensions of mandibular condyles with the same CBCT measurements. Four landmarks were marked on the condyles of dried skulls and were measured with their corresponding areas in CBCT images: Right side Width of Condyle, Left side Width of Condyle, Right side Length of Condyle, and Left side Length of Condyle. With respect to direct measurements on the dry skulls, showed statistically significant differences between sexes ($p < 0.001$). When the real values were compared with the CBCT, it was observed that the bias depends on the magnitude of the measurement. They concluded that CBCT is a reliable imaging

modality, but when compared real measures of condyle length are more reliable than width.

Mahdi AS, Basheer Taha Al-Tekreeti O, Najm AA, Abdul Salam Hadi F, Fadel Ahmed B(2018)³⁹ in their study compared the ramus height between dentulous and edentulous groups using dental panoramic tomography. Panoramic images of 15 dentulous and 15 edentulous subjects, of 20-60 years age group were compared and evaluated to measure the ramus height. They concluded that mandibular basal bony morphology changes as a result of tooth loss, which could be expressed as a shortening of ramus height measurement and ramus height can be a reliable parameter to predict edentulous and dentate status. Also, the standard references used in this study were same as that of our study. Ramus height was measured parallel to the tangent at the posterior border of the ramus between the most cranial point of the condyle and the intersection point with the lower border of the ramus mandibulae (the gonial point (Go)).

Bhuyan R, Mohanty S, Bhuyan S, Pati A, Priyadarshini S, Das P (2018)⁴⁰ this study included 50 dentulous participants to measure Maximum ramus breadth, Minimum ramus breadth, Condylar height, maximum ramus height, Projective height of ramus & Coronoid height through OPG and they concluded that mandible can be a primary object in age and sex determination.

Sairam V, Potturi G, Praveen B, Vikas G (2018)⁴¹ conducted a prospective study with digital panoramic radiographs on 150 subjects and measured (gonial angle, ramus length, condylar length (CL), ramus notch depth, and cortical bone thickness) for fifty edentulous individuals (above 50 years of age), fifty old dentate individuals

(above 50 years of age), and fifty young dentate individuals (below 25 years of age).they concluded that all variables showed increased measurements in males except gonial angles which in females was wider inferring that women get affected by varying statuses more than males.

Obamiyi S, Malik S, Wang Z, Singh S, Fishman L, Rossouw EP, et al. in (2018)⁴² mentioned that most of the epidemiological studies were done in North America and Europe with predominantly White patients. The objective of the study was to radiographically evaluate and compare craniofacial patterns and the condylar findings suggestive of TMD among the racial groups of African, Chinese, Hispanic, Indian and White racial groups. Patients from the Indian group showed the least radiographic features associated with TMD among the racial groups included in this study. This conclusion cannot be construed as a direct attribution of risk or predilection of TMD in any specific race. Instead, it highlights the need for future studies to consider racial differences in the study of potential risk factors of TMD.⁴²

Imanimoghaddam M, Bagherpour A, Nasser S, Madani AS, Rezae MM, Safae A (2018)⁴³ CBCT images of 68 subjects (19 males and 49 females, age range, 20-50 years) were obtained. 40 joints in RDC/TMD (Research Diagnostic Criteria for TMD) II group (disk displacement), 45 joints in RDC/TMD III group (osteoarthritis/osteoarthrosis) and 48 normal joints were included. Variables of length, width, and height of the condyle and slope of articular eminence were measured on CBCT images. Condylar volume was measured using a 3D model of the condyle, reconstructed by 3D rendering software. Results showed that the average condylar volume, width, and height had the highest values in the normal group and the lowest one in RDC/TMD III. The difference of condylar height was statistically significant

between RDC/TMD III and the normal group ($P=0.01$). There was a significant correlation between age and condylar volume in RDC/TMDII ($P=0.049$). In Conclusion TMD, especially in the early stages, will not lead to significant dimensional changes in the condyle, but in more advanced stages it can lead to a decrease in the height of the condyle.

Hegde S, Rao G, Sattur A, Nandimath K, Shetty R, Madi M. in (2019)⁴⁴ stated that Knowledge of morphologic variations in the TMJ is of utmost importance to differentiate normal variant from pathology which would help in arriving at a proper diagnosis. In this study, they evaluated the prevalence of radiologic morphological variations of condylar and temporal components in patients having asymptomatic TMJ. A thorough analysis was made regarding the consequence of age on the variation and comparison between genders and also to evaluate the interobserver reliability in assessing condylar and temporal changes. Which showed the importance of studying normal morphologic variations in TMJ⁴⁴

Hasebe A, Yamaguchi T, Nakawaki T, Hikita Y, Katayama K, Maki K (2019)⁴⁵ included 166 subjects in their study and divided them according to their anteroposterior and vertical skeletal patterns. Condylar length, height, and width were measured using sex as a covariate along with left and right sides. The condylar height and width on both sides showed statistically different anteroposterior skeletal patterns and vertical skeletal patterns ($P < .001$) ($P < .001$), as well as condylar width on both sides, showed similar results for different. After adjusting for sex, the condylar height and width on both sides increased from Class II, Class I, and Class III. And also the condylar width on both sides increased from the hypodivergent group,

normodivergent group, and the hyperdivergent group. Therefore no composite effect of skeletal patterns in both directions was observed.

Mauricio D, Suárez B, Gnecco JP, Castro-núñez J, Gómez-delgado A, Gamboa LF, et al. (2019)⁶ described the measurements of the mandible in an adult Colombian cadaveric sample and to describe their relationship to gender, age, and body mass. The significant differences in all variables between genders, being male mandibles bigger than female ones. Only two exceptions were found: Condylar heights and the central alveolar crest height. The values of the left and right mandibular ramus width presented the major differences between men and women.

Coombs MC, Bonthius DJ, Nie X, Lecholop MK, Steed MB, Yao H (2019)⁴⁶ conducted a human cadaveric study following a multistep protocol to acquire physiologically meaningful measurements for condyle and discs. A total of 11 male cadavers were selected and measurements were obtained from CBCT, MRI, and physical methods. The results obtained were that physical measurement after dissection was larger than either the CBCT-based or MRI-based measurements. They concluded that physical measurements after dissection are still considered the reference standard. However, due to their inaccessibility in vivo, understanding how the imaging technique affects the measurements of TMJ is critical toward the development of high-fidelity solid models to be used in the design and development of regenerative scaffolds, surgical planning, prosthetic devices, and anatomic investigations.

Materials and Method

Study instrument

Multi-slice CT (MSCT) scanner (Light speed 16, Toshiba Activion)

Workstation in Consoler room

Study design :

A descriptive cross-sectional study was conducted in 102 patients who reported to the Department of Oral & Maxillofacial Surgery and Department of Radiology over a period of 18 months.

Time period of study:

1st January 2018 to 30th June 2019.

Study setting:

Study would be carried out in:

- Department of oral & maxillofacial surgery,
- Department of Radiodiagnosis and Imaging.

Study population :

Subjects will be selected from the patients who underwent facial CT scans who were fulfilling the inclusion criteria by random sampling.

Sample size

In this study, we enrolled 102 individuals from the Central Indian Population (n = 102), including 82 men and 20 women.

Sampling technique:

Subjects will be selected from the patients who underwent CT Face by random sampling.

Method of selection -

Inclusion criteria:

- Indian adult males & females aged between 20 and 60 years who underwent facial CT for any reason. (e.g. Head injury patients, facial trauma patients in whom ramus & condyle of the mandible is unaffected, etc.)

Exclusion criteria :

- Patients with congenital or acquired dentofacial deformities (e.g., cleft lip or palate, craniofacial syndrome, agnathia, micrognathia, TMJ degenerative diseases or post-traumatic deformity)
- Patients with obvious facial asymmetry.
- Patients with a history of previous surgery in the TMJ & Ramal region.

Methods of dimensions

Linear and angular dimensions were calculated using established reference points on appropriate CT view (sagittal, axial, coronal images) by two observers and the mean of both the observations was considered for evaluation.

Method of Measurement:-

I. Measurement of Condylar head

To measure antero-posterior dimensions of the condyle.

To measure medio-lateral dimensions of the condyle.

To measure the height of condyle.

II. Measurement of Ramus of mandible

To measure antero-posterior dimensions of ramus of the mandible.

To measure the height of ramus of the mandible.

Methods of data collection

Data collection was done assessing the dimensions of Condyle and Ramus of Mandible using Computed Tomographic Scan Images.

CT analysis

The patients' head was placed in the multi-slice CT (MSCT) scanner (Light speed 16, Toshiba Activion) on a foam platform with the Frankfort horizontal plane parallel to the floor. Then, the patients' head was placed in the center of the MSCT scanner by ensuring that the midline light beam coincided with the mid-sagittal plane. The patients were told to bite their teeth in centric occlusion. The MSCT scans were taken in the extended height mode (120 kVp, 150 Ma, Helical Trauma mode, field of view : 285.00 mm).

Landmarks and measurements

To minimize the identification error in placing the landmarks and obtaining the measurements were calculated using established reference points on appropriate CT view (sagittal, axial, coronal images) by two observers and mean of both the observations were considered for evaluation.

The detailed definitions of the landmarks used are provided in Table (1). The measurements were done used the reference point as mentioned in Table (2). These

measurements were averaged for further statistical analysis. The measurements obtained were noted down in the proforma. Then the data was analyzed.

Table 1: Operational Definitions of landmarks for measurements on mandible

Gonion (G)	The midway point between the lowermost point on the posterior border of the ramus and the most posterior point on the lower border of the mandible
Sigmoid notch (Si)	The deepest point on the sigmoid notch
Condylion (C)	The uppermost point at the center of the condyle
Lateral most point on condyle (Lat-Co)	The most lateral point on the mandibular condyle
Medial most point on condyle (Med-Co)	The most medial point on the mandibular condyle

Table 2- Definition of Measurements of Condyle and Ramus of mandible

Parameters	Definition of Measurements
Mesio-lateral dimensions of Condyle	From the highest point of convexity from mesial side to distal side of condyle in Coronal section of 2D CT Scan image.
Antero-posterior dimensions of Condyle	From the highest point of convexity from anterior surface to the posterior surface of condyle in Sagittal section of 2D CT Scan image.
Height of Condyle	From highest point of convexity of the head of condyle perpendicular to the line passing from the base of Sigmoid Notch in Sagittal section of 2D CT Scan image.
Height of Ramus of mandible	From the highest point of convexity of the head of Condyle to the Posteroinferior most point of Mandible in Sagittal section of 2D CT Scan image.
Antero-posterior dimensions of Ramus of mandible	From anterior border of Ramus till the posterior border of Ramus in Sagittal section of 2D CT Scan image.

Data analysis and interpretation:

The statistical calculations were performed using the software SPSS for Windows (Statistical Presentation System Software, SPSS Inc. 1999, New York) version 19.0.

Linear variables were expressed as mean with their standard deviation. In addition, a unpaired t-test was used for comparing the obtained variables between the two sides of mandible, and an independent t-test was used for comparing the obtained variables between the two sexes.

Descriptive Statistics:

- i. **Sample Mean for a set of observation is given by:**

$$y = \frac{1}{n} \sum_{i=1}^n yi$$

- ii. **Standard Deviation** is summarized as the amount of variation (change) in the observation from their average value (mean).

The formula used for calculating standard deviation:

$$SD = \sqrt{\frac{\sum(\bar{X} - X)^2}{n-1}}$$

Where:

\bar{X} = Mean

X = Values of the variables

Σ = Sum of the value

n = Number of observations

Min = Minimum Value

Max = Maximum Value

iii. Unpaired t Test

Unpaired t test is applied to find out the significant difference between two sample means if data is ungrouped (unpaired)

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S.E.(\bar{X}_1 - \bar{X}_2)}$$

Where, S.E. $(\bar{X}_1 - \bar{X}_2)$ = Standard Error of difference between two sample means for two different groups and can be determined as follows:

i.e. S.E. $(\bar{X}_1 - \bar{X}_2) = \sqrt{SD_1^2 / n_1 + SD_2^2 / n_2}$ Where SD_1 and SD_2 are the Standard Deviations of the two different samples i.e. n_1 and n_2 respectively.

iv. Pearson's Correlation Test:

It is a measure of the linear correlation between two variables X and Y . According to Pearson it has a value between +1 and -1, where 1 is total positive linear correlation, 0 is no linear correlation, and -1 is total negative linear correlation. Pearson's correlation coefficient is the Covariance of the two variables divided by the product of their standard deviations. Pearson's correlation coefficient when applied to a Sample statistics, is commonly represented by the letter r and may be referred to as the sample correlation coefficient or the sample Pearson correlation coefficient.

Range of correlation coefficient ranges from -1 to 0 to +1.

-1 indicate perfect negative correlation (increase in one variable causes decrease in another variable)

+1 indicate perfect positive correlation (increase in one variable cause increase in another variable)

'0' indicates No correlation

Colour Plate I



Figure 1: Multi-slice CT (MSCT) scanner (16 Light speed)

Colour Plate II

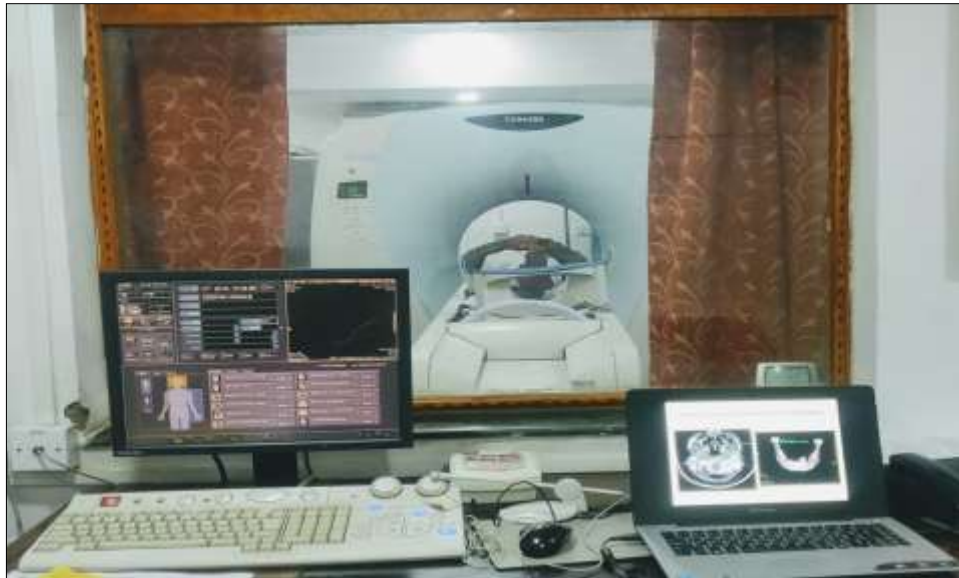


Figure 2: Workstation in Console room



Figure 3: Linear and free hand measurement tools

Colour Plate III

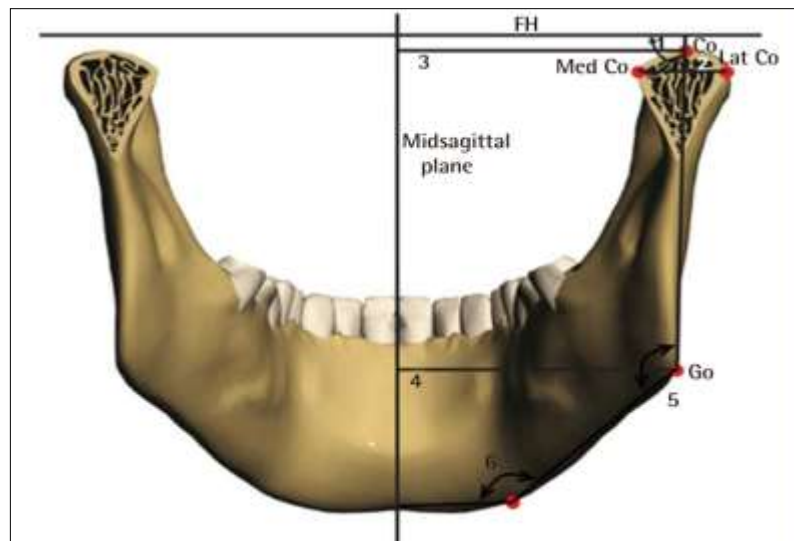


Figure 4: Schematic representation of frontal landmarks and measurements

(FH, Frankfort horizontal plane; Co, condyilion; Med Co, medial condyle; Lat Co, lateral condyle; Go, gonion; 1, ramal mediolateral inclination; 2, condylar width (mesio-lateral); 3, condyle to midsagittal plane; 4, gonion to midsagittal plane; 5, gonial angle; 6, mandibular body angle.)

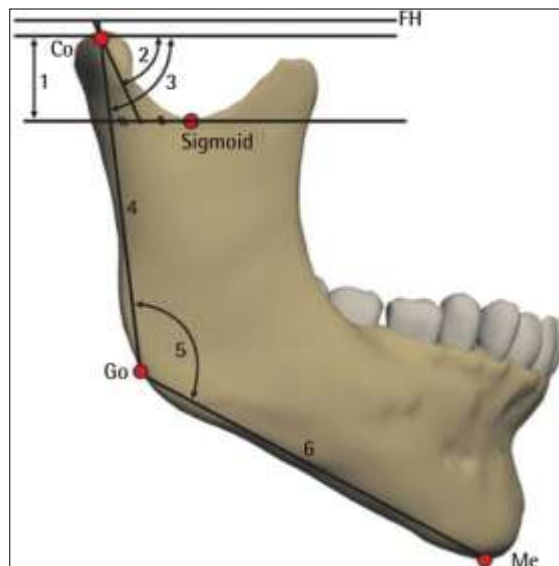


Figure 5: Schematic representation of sagittal landmarks and measurements

(FH, Frankfort horizontal plane; Co, condyilion; Go, gonion; Me, menton; 1, condylar height; 2, condylar anteroposterior inclination; 3, ramal anteroposterior inclination; 4, height of ramus of mandible; 5, gonial angle; 6, mandibular body length.)

Colour Plate IV



Figure 6: Mesio-lateral dimensions of the condyle

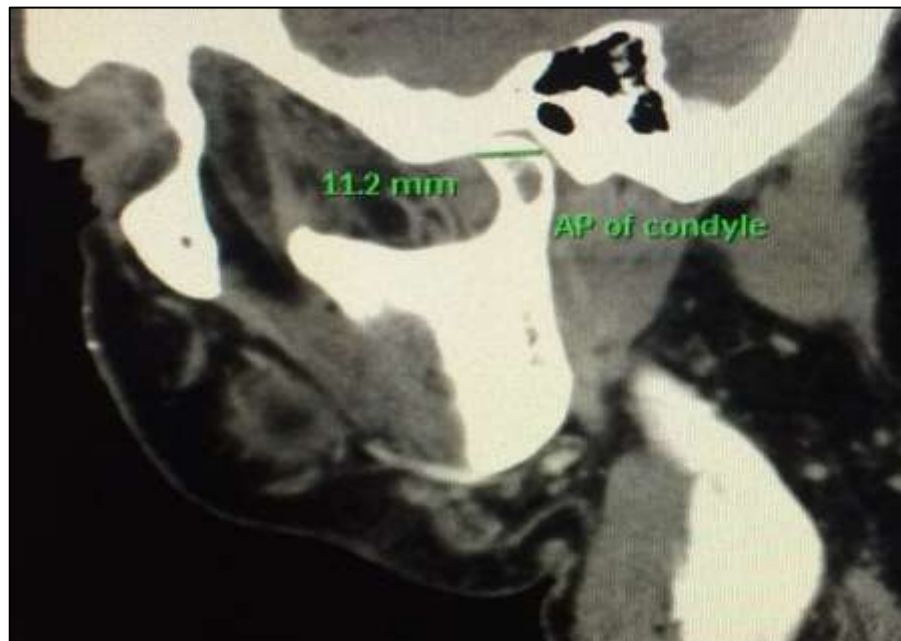


Figure 7: Antero-posterior dimensions of the condyle

Colour Plate V



Figure 8: Height of condyle

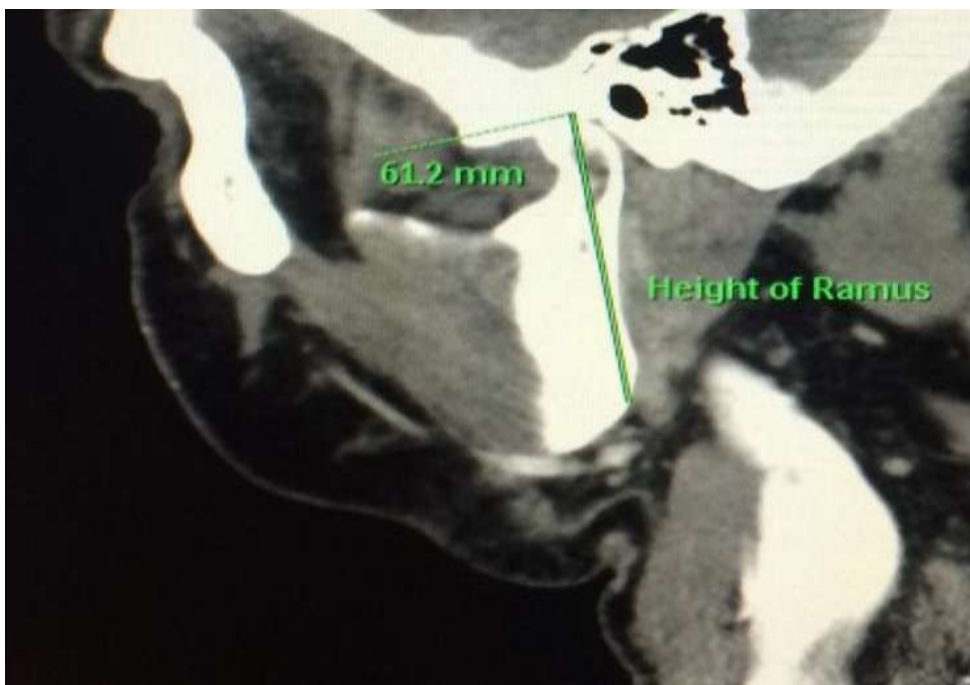


Figure 9: Height of Ramus of the mandible

Colour Plate VI

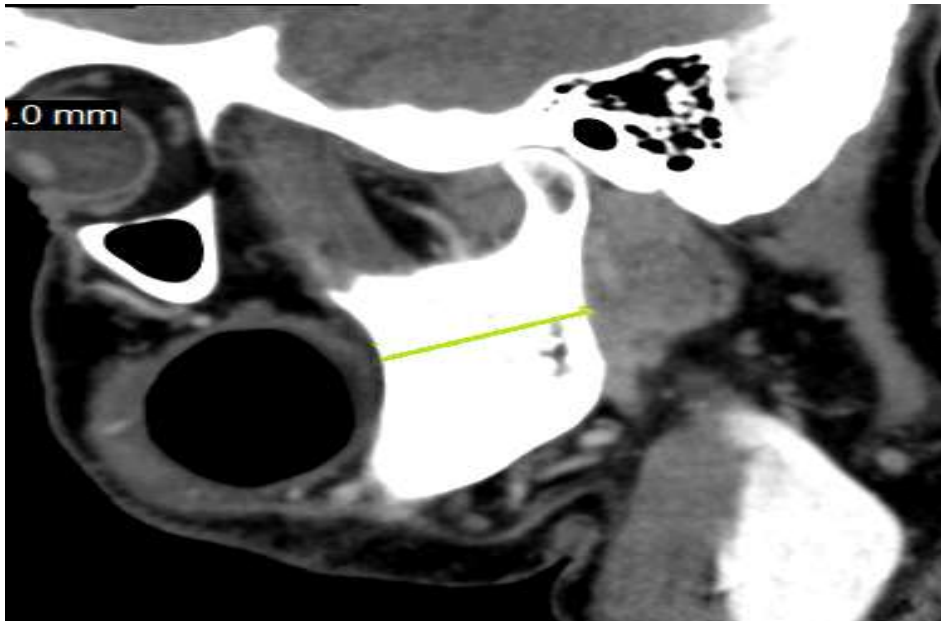


Figure 10: Antero-posterior dimension of Ramus

Results

The present study is conducted by taking measurements from 102 patients who underwent CT scans over a period of 18 months starting from 1st January 2018 to 30th June 2019.

The subjects were selected from the demographics of the Central Indian population as per the inclusion criteria who underwent facial CT. The patients consisted of 80 males and 20 females. The minimum and maximum age of the patients in the sample were 20 years and 70 years respectively.

Linear and angular dimensions were calculated using established reference points on an appropriate CT view (sagittal, axial, coronal) by two observers and the mean of both the observations will be considered for further evaluation.

Table (3) provides the descriptive statistics of mandibular Condylar measurements namely, Mesio-lateral dimensions, anteroposterior dimensions, and height of the condyle.

This Data is represented in Bar Diagram (1) showing the mean Mesio-lateral dimensions, anteroposterior dimensions, and height of the condyle of Mandible

Mesio-lateral dimensions of the condyle were measured from the highest point of convexity from the mesial side to distal side of the condyle in the Coronal section of 2D CT Scan image. The anatomical landmarks are shown in figure (1)

The mean mesio-lateral dimensions were found to be 19.77 mm with a standard deviation of around 1.99. Standard Error for mesio-lateral dimension was 0.13. The minimum mesio-lateral measurement amongst study subjects was 15.10 mm, while that of maximum was 26.30 mm. Therefore the range interval was 11.20 respectively.

Antero-posterior dimensions of the condyle was measured from the highest point of convexity from the anterior to the posterior surface of condyle in Sagittal section of 2D CT Scan image. The anatomical landmarks are shown in figure (2)

The mean antero-posterior dimensions were found to be 9.66 mm with a standard deviation of around 1.33. Standard Error for antero-posterior dimension was 0.09. The minimum antero-posterior measurement amongst study subjects was 7.00 mm, while that of maximum was 19.10 mm. Therefore the range interval was 12.10 respectively.

Height of condyle was measured by the line drawn from the highest point of convexity of the head of condyle perpendicular to the line passing from the base of Sigmoid Notch in Sagittal section of 2D CT Scan image. The anatomical landmarks are shown in figure (3)

The mean of the height of condyle was found to be 19.53 mm with the standard deviation of around 3.21. Standard Error for height of condyle was 0.22. Minimum measurement of height of condyle amongst study subjects was 12.4 mm, while that of maximum was 27.3 mm. Therefore the range interval of the data was 14.90 respectively.

Table (4) provides the descriptive statistics of Mandibular Ramus measurements namely, Height of Ramus of mandible and Antero-posterior dimensions of Ramus of Mandible. This Data is represented in Bar Diagram (2) showing the mean Height of Ramus of mandible and Antero-posterior dimensions of Ramus of Mandible.

Height of Ramus of mandible was measured from the highest point of convexity of the head of Condyle to the Posteroinferior most point of Mandible in Sagittal section of 2D CT Scan image. The anatomical landmarks are shown in figure (4)

The mean height of Ramus was found to be 67.44 mm with the standard deviation of around 4.09. Standard Error for mesio-lateral dimension was 0.28 respectively. Minimum height of Ramus amongst study subjects was 57.0 mm, while that of maximum was 79.30 mm. Therefore the range interval of data was 22.30 respectively.

Antero-posterior dimension of Ramus was measured from anterior border of Ramus till the posterior border of Ramus in Sagittal section of 2D CT Scan image. The anatomical landmarks are shown in figure (5)

The mean antero-posterior dimension of Ramus of Mandible was found to be 35.03 mm with the standard deviation of around 2.56. Standard Error for antero-posterior dimension of Ramus was 0.17 respectively. Minimum antero-posterior measurement of Ramus amongst study subjects was 28.00 mm, while that of maximum was 41.10 mm. Therefore the range interval was 13.10 respectively.

Table 5 gives the comparative measurements of the left and right sides of condyle and ramus of mandible. On all the measured type of the data the t test has been performed and tabulated along with the p-values of the data. The threshold for the level of significance was kept to be 0.05.

Graph (3) shows the graphical representation of comparison between right and left side of Mandible on a bar graph.

Comparative analysis of Right and left side of Condyle -The mean of the mesio-lateral dimensions of the condylar measurements were 19.93mm and 19.61mm with standard deviation of 1.77 and 2.19, respectively on right and left side of Condyle. The unpaired t test revealed the value as 1.175 and the corresponding p value found to be 0.241 (>0.05) revealing there is no significant difference in the mesio-lateral condylar dimensions of left and right side.

The mean of the antero-posterior dimensions of the condylar measurements were 9.68mm and 9.65mm with standard deviation of 1.47 and 1.18, respectively on

right and left side of Condyle. The unpaired t test revealed the value as 0.178 and the corresponding p value found to be 0.859 (>0.05) revealing there is no significant difference in the antero-posterior condylar dimensions of left and right side of Mandible.

The mean of the height of condylar measurements were 19.56mm and 19.50mm with standard deviation of 3.29 and 3.15, respectively on right and left side of Condyle. The unpaired t test revealed the value as 0.122 and the corresponding p value found to be 0.903 (>0.05) revealing there is no significant difference in the height of Condyle of left and right side of Mandible.

Comparative analysis of Right and left side of Ramus of Mandible-

The mean value of the height of ramus of Mandible were 67.20 mm and 67.68 mm with standard deviation of 4.24 and 3.95, respectively on right and left side of ramus of mandible. The unpaired t test revealed the value as 0.835 and the corresponding p value found to be 0.405 (>0.05) revealing there is no significant difference in the height of Ramus on left and right side of Mandible.

The mean value of anteroposterior dimensions of Ramus of Mandible were 35.08 mm and 34.98 mm with standard deviation of 2.65 and 2.48, respectively on right and left side of ramus of mandible. The unpaired t test revealed the value as 0.259 and the corresponding p value found to be 0.796 (>0.05) revealing there is no significant difference in the antero-posterior dimensions of ramus of Mandible of left and right side.

Hence Figure 5 presents the comparison of the left and right side measurements of condylar and ramus parameters. In this comparative analysis ‘*p*’ values for all the dimensions were found to be greater than 0.05. Thus it can be concluded that there is no significant difference found in the left and right side measurements of the Condyle and Ramus of Mandible in the central Indian population.

Furthermore, Table 6 presents the gender-wise comparison of the measurements. For the quantitative meaningful comparison, like in previous Table 5, unpaired t test values and p-values are tabulated, along with the mean, standard deviation of male and female patients. The measurement parameters were similar to Table 5. Contrary to the previous conclusions, there exists a significant difference ($p < 0.05$) in condylar height, ramus height and ramus anteroposterior dimensions among male and female patients. But, for condylar mesio-lateral and anteroposterior, no significant difference observed between both the genders ($p > 0.05$). Figure 6, pictorially presents the comparison of the dimensions between male and female patients.

Furthermore **Table 6** gives Gender wise comparative analysis of measurements of Condyle & Ramus of Mandible. On all the measured types of the data the t test has been performed and tabulated along with the p-values of the data. The threshold for the level of significance was kept to be 0.05.

Graph (4) shows the graphical representation of Gender wise comparative analysis of measurements of Condyle & Ramus of Mandible on bar graph.

Gender wise Comparative analysis of Condyle –

The mean of the mesio-lateral dimensions of the condylar measurements were 19.89 and 19.25 with standard deviation of 1.99 and 1.95, respectively in males and females. The unpaired T test revealed the value as 1.788 and the corresponding p value found to be 0.075 (>0.05) revealing there is no significant difference in the mesio-lateral condylar dimensions of males and female population.

The mean of the antero-posterior dimensions of the condylar measurements were 9.64 mm and 9.75 mm with a standard deviation of 1.39 and 1.03, respectively of males and female population. The unpaired t test revealed the value as 0.425 and the corresponding p value found to be 0.671 (>0.05) revealing there is no significant difference in the anteroposterior condylar dimensions of males female population.

The mean of the height of condylar measurements were 19.78 mm and 18.44 mm with standard deviation of 3.15 and 3.29, respectively of males and female population. The unpaired T test revealed the value as 2.351 and the corresponding p value found to be 0.020 (<0.05) revealing there is significant difference in the height of Condyle of males and female population. Hence we can conclude that the average height of condyle in male is more than that in female population.

Gender wise Comparitive analysis of Ramus of Mandible-

The mean value of the height of ramus of Mandible were 67.9 mm and 65.45 mm with standard deviation of 4.03 and 3.81, respectively in males and female population. The unpaired t test revealed the value as 3.407 and the corresponding p value found to be 0.001 (<0.05) revealing there is significant difference in the height

of Ramus of males and female population. Hence we can conclude that the average height of ramus of mandible is more than that in female population.

The mean value of anteroposterior dimensions of Ramus of Mandible were 35.29 mm and 33.92 mm with standard deviation of 2.59 and 2.11, respectively in males and female population. The unpaired t test revealed the value as 3.021 and the corresponding p value found to be 0.003 (<0.05) revealing there is significant difference in the antero-posterior dimensions in male and female populations. Hence we can conclude that the average antero-posterior dimensions in males is more than that in females.

So collectively we can conclude that the height of Condyle, Height of Ramus and Antero-posterior dimensions of Ramus of mandible in Males is more than that in females

In order to illustrate the changes in the condylar (height, anteroposterior and masio-lateral dimensions) and ramus (height, anteroposterior) structures with respect to the age of patients, Pearson correlation coefficient has been tabulated in Table 7.

The Pearson correlation coefficient is useful in measuring the linear correlation (strength and direction) between two variables. The maximum and minimum value it can assume is 1 and -1 respectively. A positive correlation indicates the positive correlation (directly linear proportional) and negative correlation shows the negative correlation (inverse proportionality). The value of '0' indicates no correlation i.e. both the variables are independent. Unity value of the Pearson

correlation coefficient indicates the strong uphill linear relationship and on the contrary negative unit value indicates a strong downhill linear relationship.

The Pearson correlation coefficient of condylar measurements were 0.114, 0.249 and -0.086 for mesio-lateral, antero-posterior and height of condyle respectively. It can be inferred that there is a weak correlation between the age of the patient to mesio-lateral and antero-posterior dimensions. And, there exist almost negligible correlation between the age of patient and the height of the condyle.

For the ramus measurements, the height and anteroposterior dimensions showed a value of 0.079 and 0.039 respectively. These values indicate very weak on the verge of non-existent correlation between age of the patient to the ramus parameters. In graph (5), the Pearson coefficient is plotted for various measurement types.

Hence this study aims to provide the normal measurements of Condyle and Ramus of mandible in the Central Indian Population, which would be useful in providing racially specific values for diagnosis, treatment planning of surgeries, Rigid internal fixation, customizing TMJ appliance and TMJ prosthesis with reference to these measurements.

Statistical analysis

t-test is a statistical measure used to determine or quantify the significant difference between the data of two groups. These groups can be related in certain way. This test is based on the comparison of the mean values of the two data-sets.

Table 3: Descriptive statistics of mandibular condyle measurements

	Dimensions of Condyle (in mm)		
	Mesio-Lateral (M-L) Dimensions	Anteroposterior (A-P) Dimensions	Height Of Condyle
Mean	19.77	9.66	19.53
Std.Deviation (Sd)	1.99	1.33	3.21
Std.Error (S.E)	0.13	0.09	0.22
Minimum	15.10	7.0	12.40
Maximum	26.30	19.10	27.30
Range	11.20	12.10	14.90

Table 4: Descriptive statistics of mandibular ramus measurements

	Dimensions of Ramus (in mm)	
	Height Of Ramus Dimensions	Antero-posterior Dimensions
Mean	67.44	35.03
Std.Deviation (Sd)	4.09	2.56
Std.Error (S.E)	0.28	0.17
Minimum	57.0	28.0
Maximum	79.30	41.10
Range	22.30	13.10

Table 5 Comparative measurements of right and left side

Measurements (mm)		Right Mean (Sd)	Left Mean (Sd)	Unpaired 't' Test	p-Value, Significance
Condyle	M-L	19.93 (1.77)	19.61 (2.19)	t= 1.175	P =0.241
	A-P	9.68 (1.47)	9.65 (1.18)	t = 0.178	P = 0.859
	Height	19.56 (3.29)	19.50 (3.15)	t = 0.122	P = 0.903
Ramus	Height	67.20 (4.24)	67.68 (3.95)	t = -0.835	P = 0.405
	A-P	35.08 (2.65)	34.98 (2.48)	t = 0.259	P = 0.796

p >0.05 – no significant difference *p<0.05 – significant difference

Table 6: Comparitive measurements between males and females

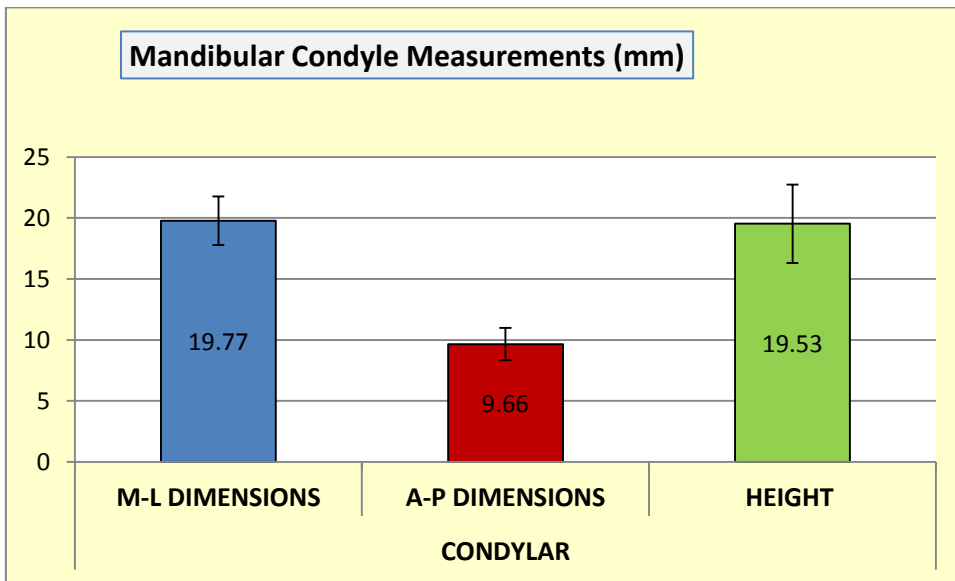
Measurements (mm)		Male Mean (Sd)	Female Mean(Sd)	Unpaired 't' Test	p Value, Significance
Condylar	M-L	19.89 (1.99)	19.25 (1.95)	t = 1.788	p =0.075
	A-P	9.64 (1.39)	9.75 (1.03)	t = -0.425	p = 0.671
	Height	19.78 (3.15)	18.44 (3.29)	t = 2.351	p = 0.020*
Ramus	Height	67.9 (4.03)	65.45 (3.81)	t = 3.407	p = 0.001*
	A-P	35.29 (2.59)	33.92 (2.11)	t = 3.021	p = 0.003*

p >0.05 – no significant difference *p<0.05 – significant difference

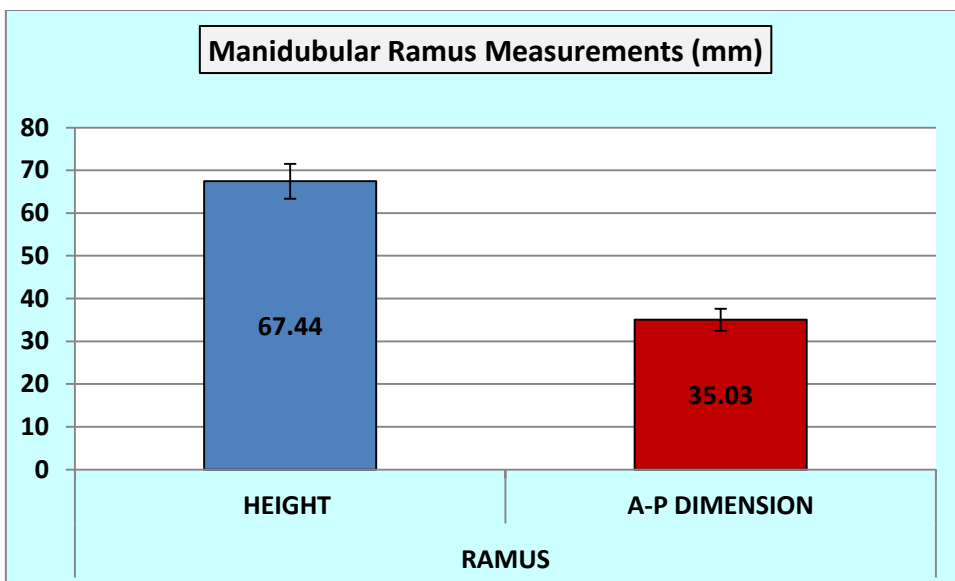
Table 7: Correlation of age with measurements

Variable	Other Variable	Pearson 'r' correlation coefficient	p value, Significance
Age Vs	Condylar M-L	r = 0.114	p =0.254
	Condylar A-P	r = 0.249	p =0.012*
	Condylar Height	r = -0.086	p =0.392
	Ramus Height	r = 0.079	p =0.433
	Ramus A-P	r = 0.039	p =0.701

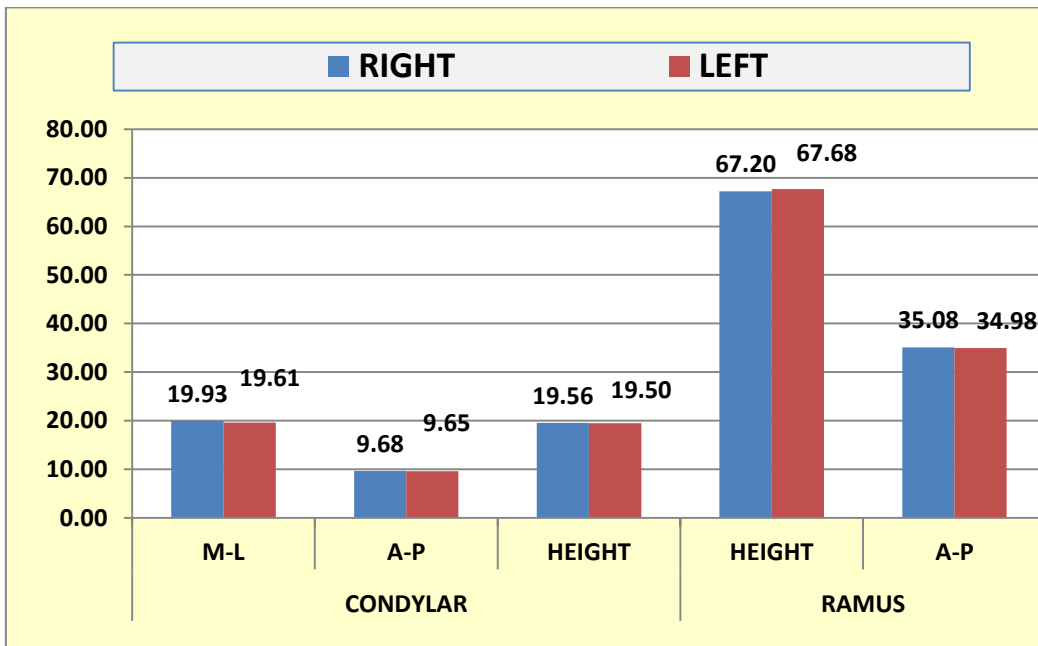
p >0.05 – no significant correlation *p<0.05 – significant correlation



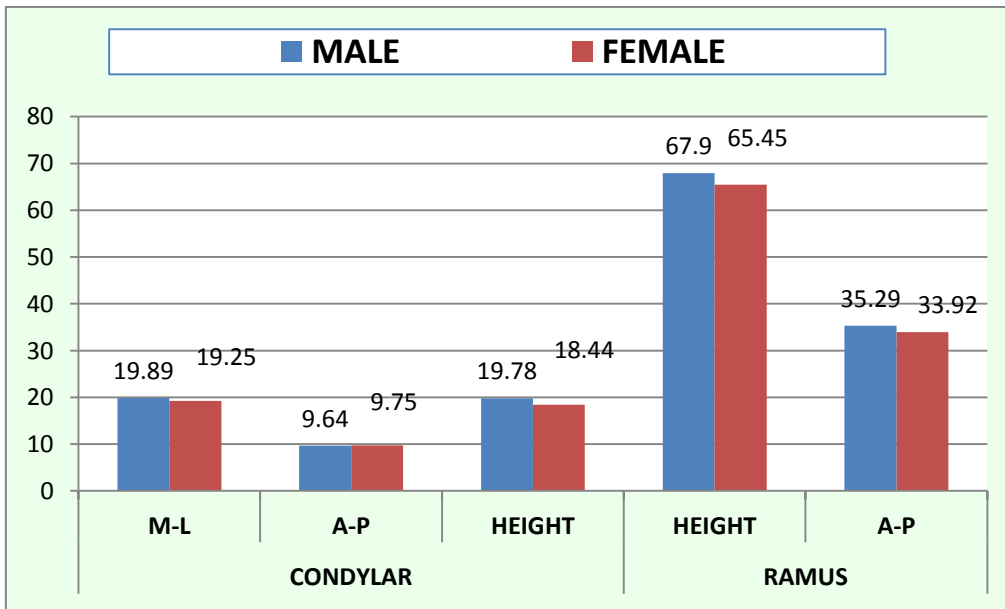
Graph 1: Mean mandibular Condylar measurements.



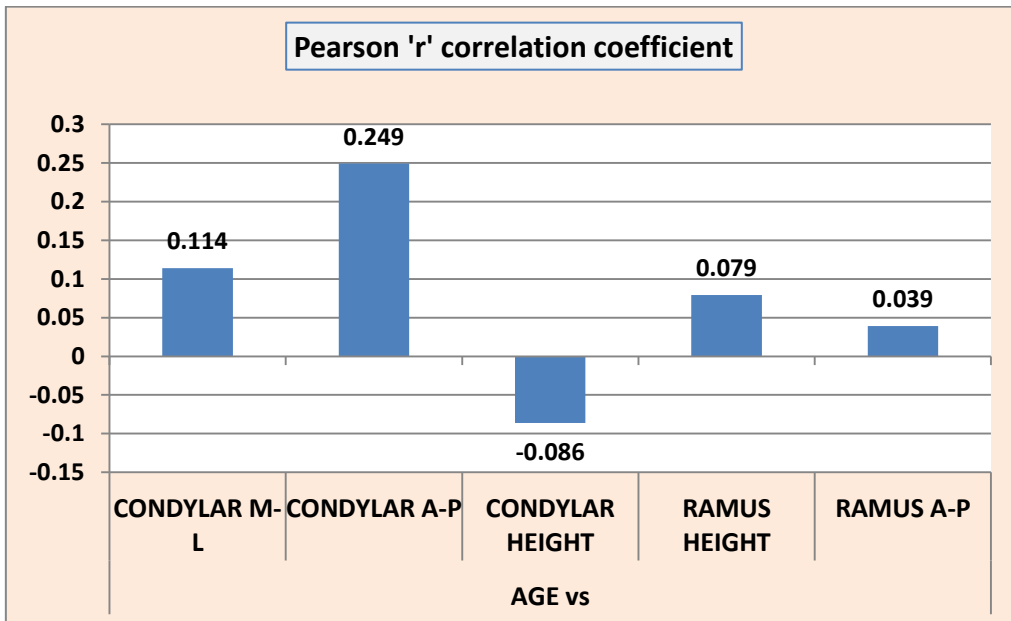
Graph 2: Mean measurements of Ramus of the mandible.



Graph 3: Comparative analysis of right and left side of the mandible



Graph 4 : Comparative analysis of measurements in males and females.



Graph 5: Correlation of age with measurements.

Discussion

The assessment of facial dimensions is of prime importance in medical and dental fields in diagnosis and treatment planning. The implications of anthropometry in surgery were not recognized until recent decades, unless **Farkas LG, Posnick, (1992)**⁵ applied direct anthropometry technique for studying facial morphology. This approach has been applied to study facial growth and to compare different phenotype norms of population. There is a vast majority of the research performed in the United States of America and Europe. Currently, there is a lack of information on mandibular anthropometry in the Indian population and hence this part of the world has to rely on foreign studies.

In spite of the detailed descriptions of the several pathologic changes that involve this joint, a very little attention to the appearance of the normal TMJ has been given.⁴⁴ The reasonable measurement of TMJ morphologic parameters will help us to

better understand the structure, function and variation in morphology in sex & age estimation of TMJ which is important for performing an accurate preoperative assessment, planning temporomandibular, craniofacial or orthognathic surgeries, and evaluating the postoperative outcome.

A Variation of normal morphology of condyle and ramus of mandible occurs with age, gender, facial type, occlusal force, functional load, malocclusion and between right and left sides in various ethnic groups. Several investigators noticed the variation in the craniofacial morphology between different ethnic groups.⁸ Studies on many different ethnic groups were done including Downs' study of Caucasians (1948), Suh's study of Koreans (1967), Mitani 's study of Japanese (1980), Chan's study of Chinese (1975) Nanda's study of North Indians {1969), Garcia's study of Mexican Americans (1975), and Drummond's study of Negroes (1968).⁸

All these investigators stated that normal measurements of one group should not be considered normal for other racial groups. Different racial groups have to be treated according to their own individual characteristics.⁸

But due to the limited amount of anthropometric studies in the Indian population, surgeons have to rely on North American or Caucasian investigations. So the purpose of this study was to obtain objective measurements of the mandible in an adult central Indian population and to describe their relationship to gender & age, which would be useful in providing racially specific values for diagnosis, treatment planning of surgeries, Rigid internal fixation, customizing TMJ appliance and TMJ prosthesis with reference to these measurements.

This study was conducted by taking measurements from 102 patients who underwent CT scans over a period of 18 months. The subjects were selected from the demographics of the Central Indian population as per the inclusion criteria who underwent facial CT. The patients consisted of 80 males and 20 females. The minimum and maximum age of the patients in sample were 20 years and 60 years respectively.

Data collection was done assessing the dimensions of TMJ using Computed Tomographic Scan Images. Linear and angular dimensions were calculated using established reference points on appropriate CT view (sagittal, axial, coronal) by two observers and mean of both the observations will be considered for further evaluation.

For condyle mean mesio-lateral dimensions was found to be 19.77mm with the standard deviation of around 1.99. The similar parameters for the anteroposterior were 9.66 mm and 1.33 respectively. For the height of condyle, the mean was found to be 19.53mm with standard deviation of 3.21.

Details of mandibular ramus consist of height of ramus dimensions and anteroposterior dimensions. The mean of the sample were 67.44 and 35.03 for height of ramus and anteroposterior dimensions respectively.

Comparative analysis of Right and left side of Condyle - The mean of the mesio-lateral dimensions of the condylar measurements was 19.93 and 19.61 respectively on right and left side of Condyle. The mean of the antero-posterior dimensions of the condylar measurements was 9.68 mm and 9.65 mm respectively on right and left side of Condyle and the mean height of condyle was 19.56 mm and

19.50 mm respectively on right and left side of Condyle. Similarly comparative analysis of Right and left side of Ramus of Mandible the mean value of the height of ramus of Mandible were 67.20 mm and 67.68 mm. The mean value of anteroposterior dimensions of Ramus of Mandible were 35.08 mm and 34.98 mm.

In the comparative analysis of left and right side of mandible ' p ' values for all the dimensions were found to be greater than 0.05. Thus it can be concluded that there is no significant difference found in the left and right side measurements of the Condyle and Ramus of Mandible in the central Indian population.

In the gender-wise comparison of the measurements there exists a significant difference ($p < 0.05$) in condylar height, ramus height and ramus anteroposterior dimensions among male and female patients. But, for condylar mesio-lateral and anteroposterior, no significant difference observed between both the genders ($p > 0.05$). So collectively we can conclude that the height of Condyle, Height of Ramus and Antero-posterior dimensions of Ramus of mandible in Males is more than that in females

The Pearson correlation coefficient of condylar measurements were 0.114, 0.249 and -0.086 for mesio-lateral, antero-posterior and height of condyle respectively. It can be inferred that there is weak correlation between age of the patient to mesio-lateral and antero-posterior dimensions. And, there exist almost negligible correlation between the age of patient and height of the condylar.

For the ramus measurements, the height and anteroposterior dimensions showed the value of 0.079 and 0.039 respectively. These values indicate very weak on

the verge of non-existent correlation between age of the patient to the ramus parameters.

Few other similar studies and their results are discussed as follows:

May Al-Koshab, Phrabhakaran Nambiar and Jacob³³ john in their study done in 2015 gave a comparative analysis between Malaysians and Chinese population from which they noted the similarity in the two groups. The similarity in measurements for Malaysians and Chinese may be due to their common origin.

Comparing the mean dimensions of these two groups with that of Central Indian populations that is comparing our results with this study we infer that the mandibular dimensions of Indian population is significantly larger than that of Malaysians and Chinese individuals specifically speaking about Condylar dimensions.

They also gave a comparative analysis of measurements of Mandible in right and left side of mandible, which showed no significant statistical difference, which is similar to the results acquired in our study.

Their comparative analysis between males and females showed that the morphologic dimensions of males are slightly higher than that of females, which is again similar to that of our study.

Mauricio D, et al. (2019)⁶ in his study laid down the measurements of the mandible in an adult 250 Colombian cadaveric sample (192 males and 30 females) and to describe their relationship to gender, age, and body mass.

In this study he came across the following measurements, mean condylar height on right & left side were 17.10, 17.33 mm in males and 16.72, 16.73 in females. In comparison to which in our study, mean condylar height in right and left side was 19.56 and 19.50 mm. Mean condylar height in males was 19.78 while that in females was 18.44mm.

Height of Ramus on right and left side were 60.41, 60.33 for males and 57.36, 57.93 for females. In comparison to which in our study Height of Ramus in right and left side was 67.20 and 67.68mm. Mean height of Ramus in males was 67.9 while that in females was 65.45mm.

Width of Ramus on right and left side was 30.89, 37.50 in males and 30.57, 34.6 mm in females. In comparison to which in our study mean width of ramus on right and left side was 35.08 and 34.98mm while that in males and females the mean was 35.29 and 33.92 respectively.

Hence we can conclude that the overall measurements of condyle and ramus are higher in our study which shows that the size of mandible is slightly larger in Indians than that of Colombian population. There was no significant statistical difference noted in right and left side of mandible which is similar to what we obtained in our study. This study also showed that size of mandible is slightly higher in males than that of females which is again similar to what we came across in our study. But while comparison we need to note that this study was done on cadavers while our study was done on patients who underwent CT scans which is better reliable method of measurement.

Bhuyan R et al., (2018) ⁴⁰ studied the impact of age and gender on ramus height using panoramic radiographs from which he concluded that there is statistically significant difference in the measurements of ramus height in both the genders & also in the right side of condyle which is difference from what we came across that there is no significant statistical difference noted on right and left side of condyle. But the comparative results in gender is same as our study that is males have slightly higher size of mandible than that of females.

Mahdi AS et al., (2018) ³⁹ in his study compared the ramus height between dentulous and edentulous groups using dental panoramic tomography. Panoramic images of 15 dentulous and 15 edentulous subjects, of 20-60 years age group were compared and evaluated to measure the ramus height. This is the same age group that we have considered in our study.

The results showed a significant difference in ramus height between dentulous and edentulous mandibles ($p=0.001$). So he concluded that mandibular basal bony morphology changes as a consequence of tooth loss, which could be expressed as shortening of ramus height measurement and ramus height could be a reliable parameter to predict edentulous and dentate status.

Hence we can see that height of ramus is one of the important parameter which should be assessed in normal individuals to know if there are any physiologic changes occurring in certain age groups. But we should also note that this study is done in panoramic radiographs, while that of our study is done using CT Scan imaging which is more reliable as it is already proved in the literature.

Hasebe A et al., (2018)⁴⁵ in his study compared condylar size among different anteroposterior and vertical skeletal patterns using cone-beam computed tomography (CBCT). The study included 166 subjects (61 men, mean age: 27.2 \pm 7.6 years; 105 women, mean age: 27.4 \pm 9.2 years). The condylar length, height, and width were examined using CBCT images. Results were used to compare three condylar size measurements among the three anteroposterior groups and the three vertical groups using sex as a covariate. Both left and right sides were examined.

Gender as a covariate showed statistical significance in most examinations. Same as in our study where we can see males have higher dimensions than that of females. The condylar height on both sides had statistically different anteroposterior skeletal patterns (P , .001). The condylar width on both sides also had statistically different vertical skeletal patterns (P , .001), which is different from what we came across that left and right side measurements are statistically insignificant.

Mean height of condyle in this study for right and left side was 20.03 and 19.73mm, while in our study it was 19.56 and 19.50. hence the results of our study are nearly same as that of this panoramic study. Mean width of condyle that is mesio-lateral dimension of condyle in their study for right and left side of condyle was 16.54 and 16.3mm while in our study it was 19.93 and 19.61 mm which shows width of condyle in our study is slightly larger, but since their study is done on panoramic radiograph our study has an advantage of accuracy over it.

Kjellberg H et al., (1994)¹⁵ in his study developed and applied a reliable method of measuring the effects of condylar lesions quantitatively on panoramic radiographs. Three different types of machines were tested. Two dry skulls were used

to measure the relative size of the condyle in relation to ramus height. The results showed good reliability for the reference points used. The reference points used in this study are similar to what we have used in our study.

Coombs MC et al., (2019)⁴⁶ conducted a human cadaveric study following a multistep protocol to acquire physiologically meaningful measurements for condyle. A total of 11 male cadavers were selected and measurements were obtained from CBCT , MRI and physical methods.

Condylar height measured on CBCT, MRI and physically were 6.8, 6.0 and 8.6mm respectively while that in our study on CT scan imaging we got the mean of Condylar height as 19.53mm. So we can see a significant difference in dimensions of condyle when we use different modalities but this study was a cadaveric study and had only 11 as sample size. Hence we can assume that the dimensions obtained using CT Scan imaging is more reliable while this study concluded that physical measurements after dissection can still be considered the reference standard and they are larger than that of CBCT and MRI.

Scariot R et al., (2017)³⁸ Compared the anatomical dimensions of mandibular condyles with the same CBCT measurements. Four landmarks were standardized on the condyles of dried skulls and were measured with their corresponding areas in CBCT images: Right side Width of Condyle, Left side Width of Condyle, Right side Length of Condyle, and Left side Length of Condyle.

Mean Condylar length dimensions In this study for right and left in males and females was 20.5, 20.2 mm and 16.4, 16.6 mm respectively. While that in our study it

was 19.56, 19.50 mm and 19.78, 18.44 mm respectively. So we can see that results are quite similar to that of our study.

Similarly for condylar width it was 8.6, 8.9 mm and 8.0, 8.2 mm respectively. Now here we can see the difference that these measurements are different from that of our study which are as follows 19.93, 19.61 mm and 19.89, 19.25mm. Since our study is done on CT Scan imaging. As they have already concluded in their study that that CBCT is reliable imaging modality, but when compared real measures of condyle length are more reliable than of width of condyle. Therefore our measurements for width of condyle on CT scan differ from that obtained from CBCT Imaging.

Gu Y, McNamara JA, Sigler LM, Baccetti T (2011)²⁵The results of their study showed that Chinese females presented with smaller linear facial dimensions than Chinese males and the same was found in the Caucasian group. The main differences between Chinese and Caucasian young adults included smaller linear dimensions of the face in the Chinese sample, along with a significantly more hyperdivergent facial pattern in Chinese females and males when compared with that of Caucasian population. Hence, it appeared that the craniofacial morphology of the Chinese exhibits different craniofacial characteristics than other Asian ethnic groups. Thus, universal cephalometric norms are not appropriate for all Asian populations, that is why our study comes in picture where we have described norms for central Indian population. But we take into consideration that this was a cephalometric study, & mostly compared the soft tissue parameters but we can still note that the craniofacial dimensions for Chinese and Caucasian population are different.

Tecco S, Saccucci M, Nucera R, Pagnoni M, Polimeni A, Cordasco G, et al. (2010)²³ in their study of young adult Caucasian subjects with malocclusion without pain or dysfunction in TMJs shows significant variability in condylar volume and surface between both the genders and the two sides of the mandible. In particular, the Morphologic index of the mandibular condyle (volume/surface) is 1.72 ± 0.17 in this sample, with no significant difference between both genders and right and left sides which is similar to that of our results in our study that there is no significant statistical difference in dimensions of right and left side of mandible.

Mittal A, Garg R, Kumar Gupta S (2014)²⁹ According to them the total cranial base length in north Indian population was similar to the Caucasian population in males but there was statistically significant increase in females. The maxillo-mandibular relationship in north Indians differed from the Caucasians. Statistically significant differences were found in ramus length, maxillomandibular relationship of apical base and retrusive chin in both sexes, whereas north Indian females tend to have increased mandibular plane angle of ramus while males had short mandibular body length. When the north Indian male profile was compared with the Caucasian male's, it was evident that the anterior maxilla is seen to be rotated counterclockwise for north Indians which states the fact that for Caucasians an increased anterior facial height does not make the profile displeasing. North Indian males have a retruded profile as evidenced by decrease in mandibular corpus length, increased length of ramus and decreased chin prominence.

This study shows that North Indians have different maxillomandibular relations than that of Caucasian population, hence explains the importance of our

study in Central Indian population. While there is also a need to compare these results with north Indian population with a greater sample size.

Limitations of our study was that the number of females who underwent CT Scans in 18 months span were significantly less than that of males, hence comparative analysis was difficult for which further studies must be performed where not only the sample size is important but also the number of females included should be equal to that of males. However a larger sample size may be needed to substantiate this study.

Summary and Conclusion

The specialty of oral and maxillofacial surgery has expanded its boundaries tremendously in the last few decades. The complex anatomical structures in the oral and maxillofacial region are involved in various important physiological functions including speech, mastication, swallowing and breathing, not to mention facial esthetics. The assessment of facial dimensions is of prime importance in medical and dental fields in diagnosis and treatment planning.

Through several studies it came to notice that normal measurements of one group should not be considered normal for other racial groups. Different racial groups have to be treated according to their own individual characteristics.

Due to racial and ethnical differences, surgeons must be cautious when incorporating these findings into clinical practice. Studies, therefore, should ideally be

customized to each population in order to have accurate figures which, in turn, produce better clinical results.

The problem facing the maxillofacial surgeon in India has been that most of the studies are basically done in Caucasian, Chinese, Koreans, Japanese, Americans and Negroes population.

Due to limitations of anthropometric studies in Indian population, surgeons have to rely on North American or Caucasian studies. The purpose of this investigation was to obtain objective measurements of the mandible in an adult central Indian population so as to establish a norm peculiar to the region vis-a-vis to gender & age.

In comparison with the studies available in the literature we were able to conclude that morphologic dimensions of mandible, specifically condylar dimensions of mandible are larger in Central Indian population than that of Malaysians, Colombians and Chinese individuals.

This study also stated that the size of mandible especially height of condyle, height of Ramus and anteroposterior dimensions of mandible in males are slightly larger than that of females in Central Indian population. From this study we can also infer that there are no significant difference in the right and left side measurements of Condyle and Ramus of mandible.

Hence we have described the normal measurements of Condyle and Ramus of mandible to establish a norm peculiar to Central Indian Population, which would be

useful in providing racially specific values for diagnosis, treatment planning of surgeries, Rigid internal fixation, customizing TMJ appliance and TMJ prosthesis.

However limitations of our study was that the number of females who underwent CT Scans in 18 months span was significantly less than that of males, hence comparative analysis was difficult for which further studies must be performed where not only the sample size is important but also the number of females included should be equal to that of males. A larger sample size may be needed to substantiate this study.

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ANNEXURE I

PROFORMA

TOPIC : “Anthropometric Measurements of Condyle and Ramus of Mandible using Computed Tomographic Scan Imaging in Central Indian Population – A Descriptive Cross-sectional Study”

Name of patient :

Age :

Sex :

Anthropometric measurements of Condyle –

Parameters	Dimensions on Right side	Dimensions on Left side
Mesiolateral dimensions		
Anteroposterior dimensions		
Height of Condyle		

Anthropometric measurements of Ramus –

Parameters	Dimensions on Right side	Dimensions on Left side
Height of Ramus		
Anteroposterior dimensions		

Master chart

Sr. No	Age	Sex	Side	Condyle			Ramus	
				M-l	A-p	Height	Height	A-p
				A	A	3S	3	3
1.	30	M	Right	17.7	8.4	24.1	69	37.6
			Left	17.7	7.4	23.2	67.3	35
2.	27	M	Right	19.9	11.4	27.1	65.9	31.1
			Left	15.5	10.9	21.2	66.2	34.8
3.	31	M	Right	19.3	9.4	23.9	70	38.4
			Left	20.3	9.5	22.1	72.3	38.8
4.	32	M	Right	16.6	10.5	21.1	67.5	32.1
			Left	19.1	10.8	22.2	68	33.2
5.	23	M	Right	22.2	8.6	16.8	64.9	34
			Left	23.4	8.7	18.8	65.7	33.8
6.	40	M	Right	21.9	9.9	16.3	71.6	33
			Left	21.2	9.4	15.2	72.1	32.5
7.	50	M	Right	19.4	10.1	15	61.6	31.8
			Left	20.4	9.5	14.1	59.3	31.4
8.	31	M	Right	18	9.9	14.2	69.7	28.3
			Left	17.3	9.6	16.9	70.6	32
9.	45	M	Right	19.9	9	19.8	66.3	38.4
			Left	20.5	8.7	19.7	68	36.6
10.	26	M	Right	22.5	10	14.9	66.7	38
			Left	22.3	11.2	20.2	67.9	40
11.	45	M	Right	18.7	9.9	16.8	64.2	35.2
			Left	18.8	9.1	15.2	63.2	34.7
12.	24	M	Right	17.3	8.3	17.7	65.5	33.2
			Left	18.3	8.2	18.4	64.7	32.7
13.	59	M	Right	21.3	9.5	17.6	64.2	37.6
			Left	20.7	9.6	15.5	66.1	36
14.	22	M	Right	22.2	7.4	19.6	70.1	34.3
			Left	20.3	7.5	20.7	68.2	35
15.	26	M	Right	19.6	8.6	15.9	67	32.2
			Left	19.2	7.7	17.4	68.3	34.1
16.	24	M	Right	17.3	8.1	18.5	69.3	34
			Left	17.7	8.4	18.7	67.5	35.1
17.	43	M	Right	21.1	8.4	22.7	70.3	35.2
			Left	18	10.7	22.3	71.1	36.4
18.	40	M	Right	21.1	8.6	16.5	68	38.3
			Left	19.5	9.1	14.8	69.2	37
19.	26	M	Right	17.9	9	18.3	73.4	33.3
			Left	18.6	9	20.6	73.4	32.5
20.	54	M	Right	18.8	19.1	17.1	67.1	34.5
			Left	18.1	9.1	16.5	66.1	35.1
21.	26	F	Right	18.9	9.6	18.5	69.1	36

Sr. No	Age	Sex	Side	Condyle			Ramus	
				M-I	A-p	Height	Height	A-p
			Left	18.7	9.2	16.8	69	34.1
22.	50	F	Right	16.7	10.9	19.3	66.1	37
			Left	16.3	9.2	18.2	67.3	36.7
23.	32	M	Right	21.1	8.9	17.8	64	33
			Left	21	7.8	17.1	65.1	35
24.	60	M	Right	22.5	10.7	16.9	75.4	38.6
			Left	22.3	10.8	17.8	77.1	37.6
25.	22	M	Right	18.3	8.2	16.6	59.2	29.3
			Left	19.4	8.2	16.2	57.6	28
26.	55	M	Right	18.4	11.6	18.8	60.9	32.9
			Left	18.8	12	18.4	60	31.6
27.	35	M	Right	18.4	7.4	15.8	65	31
			Left	19.5	8.6	16.9	68	30.4
28.	40	F	Right	18.6	10	17.2	66	36.5
			Left	19.3	10.5	15	65	35
29.	35	F	Right	18.3	10.2	19.1	63.7	33.4
			Left	19.2	10.5	20.5	60.1	31.5
30.	20	M	Right	20.8	8.4	17.7	63.2	34.5
			Left	21.3	8.9	19.4	65.9	35.8
31.	58	F	Right	19.9	9.6	15.4	67.2	35.2
			Left	18.7	9.1	14.5	68	35.9
32.	28	F	Right	19.4	8.1	16.9	58.1	32.4
			Left	19.6	7.6	20.8	57	31.2
33.	39	M	Right	22.3	10.4	19.6	64.2	32.2
			Left	21	9.5	19.3	66.6	34.3
34.	28	F	Right	17.6	8.7	12.4	66	30.1
			Left	17.8	8.5	12.4	66.5	29.7
35.	39	F	Right	20.7	12.5	15.5	68.2	33.2
			Left	21.6	11.4	16.1	67	34
36.	28	M	Right	19.6	10.7	20.8	73	39.4
			Left	17.3	11.4	19.3	71.8	39.8
37.	51	M	Right	19	8.1	19.5	69	40.7
			Left	19.6	9.5	16.9	68.8	37.3
38.	45	M	Right	19.2	9.8	18.8	66.3	32.8
			Left	18.7	9.6	18.4	67	36.2
39.	58	M	Right	19.1	7.9	19.9	69	35
			Left	18.8	8.2	20.1	68.2	34.2
40.	57	M	Right	20.9	9.9	18.8	67	35.2
			Left	20.1	10.6	22	66.6	36.7
41.	50	M	Right	21.6	12.1	18.2	68	33.8
			Left	22.3	12.1	23.5	66.7	34
42.	29	M	Right	23.1	9.1	21.6	59	33
			Left	23	9.3	18.4	60.1	33.3
43.	26	M	Right	19.1	9.6	15.7	66	36

Sr. No	Age	Sex	Side	Condyle			Ramus	
				M-I	A-p	Height	Height	A-p
			Left	19.7	9.6	15.5	67.2	34.9
44.	35	M	Right	21	9.3	16.7	68.3	35.1
			Left	22.1	9.7	17.2	68.1	37.1
45.	26	M	Right	21.2	10.8	17.8	62.4	34.1
			Left	20.8	10.5	23.4	68.2	36.1
46.	28	M	Right	20.2	9.5	24.3	70	36.5
			Left	20.1	9.5	18.6	70.5	34.1
47.	34	M	Right	20.9	9.1	17.9	69.4	34.2
			Left	21.1	9.5	21.5	64.7	34.9
48.	57	M	Right	22.7	9.3	18.9	67.2	36.3
			Left	22.7	9.7	19.3	67.2	31.1
49.	39	F	Right	18.1	10.7	22.8	58.5	36.5
			Left	15.8	10.6	17.3	63.1	37.7
50.	26	M	Right	22	10.3	20.4	66.3	37.8
			Left	21.7	11.8	23.1	68.6	37.4
51.	50	M	Right	18.8	7.2	18.4	72	37.9
			Left	16.3	8.9	18	73	38.4
52.	60	M	Right	19.3	9.2	23.4	69.9	37.2
			Left	17.7	8.7	22.4	69.2	35.3
53.	30	F	Right	19.9	9.4	22.8	66.3	37.1
			Left	19.3	11.4	23.6	67.1	33.6
54.	52	M	Right	19.2	9.8	21.2	79.3	41.1
			Left	20.8	10.5	21.2	77.1	38
55.	25	M	Right	19.8	10	21	68.1	34.7
			Left	19.2	11	23.2	70.3	32.8
56.	24	M	Right	21.6	10.4	14.6	71.7	38.3
			Left	21.4	11	15.1	70	39
57.	22	M	Right	19.1	11.2	26.8	73.8	38.4
			Left	19.7	10.7	27.3	72.1	38.1
58.	67	M	Right	22.5	9.7	23.8	70.1	35.5
			Left	22.7	8.4	22.4	71.1	33.9
59.	32	M	Right	24.6	9.8	22.6	69.6	37.6
			Left	26.3	10.7	21.8	75.5	33.9
60.	35	M	Right	20.1	8.5	24	73	36
			Left	20.7	9	25.6	72.4	33.1
61.	44	M	Right	19.6	8.5	21.6	70.3	34
			Left	19.9	8.2	24.3	69.1	32.6
62.	22	F	Right	15.8	9.5	20.8	57.9	35.6
			Left	15.1	8.5	16.4	61.5	33.5
63.	53	M	Right	22.1	9.7	22.3	67.8	33.5
			Left	22.8	9.5	19.3	71.3	34.9
64.	22	M	Right	21.2	8.5	23.2	66.4	37
			Left	19.3	7	24.4	69.9	36.7
65.	21	M	Right	21.8	10.6	23.8	76.5	36.5

Sr. No	Age	Sex	Side	Condyle			Ramus	
				M-I	A-p	Height	Height	A-p
			Left	21.1	10.1	25.2	76.8	38.8
66.	50	M	Right	19.9	11.4	27.1	65.9	31.1
			Left	15.5	10.9	21.2	66.2	34.8
67.	23	M	Right	19.3	9.4	23.9	70	38.4
			Left	20.3	9.5	22.1	72.3	38.8
68.	27	M	Right	16.6	10.5	21.1	67.5	32.1
			Left	19.1	10.8	22.2	68	33.2
69.	55	F	Right	22.3	10.4	19.6	64.2	32.2
			Left	21	9.5	19.3	66.6	34.3
70.	28	M	Right	17.6	8.7	12.4	66	30.1
			Left	17.8	8.5	12.4	66.5	29.7
71.	55	M	Right	20.7	12.5	15.5	68.2	33.2
			Left	21.6	11.4	16.1	67	34
72.	27	M	Right	19.6	10.7	20.8	73	39.4
			Left	17.3	11.4	19.3	71.8	39.8
73.	59	M	Right	20.9	9.1	17.9	69.4	34.2
			Left	21.1	9.5	21.5	64.7	34.9
74.	57	F	Right	22.7	9.3	18.9	67.2	36.3
			Left	22.7	9.7	19.3	67.2	31.1
75.	50	M	Right	18.1	10.7	22.8	58.5	36.5
			Left	15.8	10.6	17.3	63.1	37.7
76.	52	M	Right	21	9.3	16.7	68.3	35.1
			Left	22.1	9.7	17.2	68.1	37.1
77.	47	M	Right	21.2	10.8	17.8	62.4	34.1
			Left	20.8	10.5	23.4	68.2	36.1
78.	33	M	Right	20.2	9.5	24.3	70	36.5
			Left	20.1	9.5	18.6	70.5	34.1
79.	56	F	Right	20.9	9.1	17.9	69.4	34.2
			Left	21.1	9.5	21.5	64.7	34.9
80.	40	M	Right	20.1	8.5	24	73	36
			Left	20.7	9	25.6	72.4	33.1
81.	27	F	Right	19.6	8.5	21.6	70.3	34
			Left	19.9	8.2	24.3	69.1	32.6
82.	27	M	Right	15.8	9.5	20.8	57.9	35.6
			Left	15.1	8.5	16.4	61.5	33.5
83.	55	M	Right	18.1	10.7	22.8	58.5	36.5
			Left	15.8	10.6	17.3	63.1	37.7
84.	40	M	Right	22	10.3	20.4	66.3	37.8
			Left	21.7	11.8	23.1	68.6	37.4
85.	28	M	Right	18.8	7.2	18.4	72	37.9
			Left	16.3	8.9	18	73	38.4
86.	40	M	Right	19.3	9.2	23.4	69.9	37.2
			Left	17.7	8.7	22.4	69.2	35.3
87.	27	F	Right	21.9	9.9	16.3	71.6	33

Sr. No	Age	Sex	Side	Condyle			Ramus	
				M-l	A-p	Height	Height	A-p
			Left	21.2	9.4	15.2	72.1	32.5
88.	45	F	Right	19.4	10.1	15	61.6	31.8
			Left	20.4	9.5	14.1	59.3	31.4
89.	55	M	Right	18	9.9	14.2	69.7	28.3
			Left	17.3	9.6	16.9	70.6	32
90.	35	M	Right	19.9	9	19.8	66.3	38.4
			Left	20.5	8.7	19.7	68	36.6
91.	25	M	Right	22.5	10	14.9	66.7	38
			Left	22.3	11.2	20.2	67.9	40
92.	27	M	Right	18.1	10.7	22.8	58.5	36.5
			Left	15.8	10.6	17.3	63.1	37.7
93.	33	M	Right	22	10.3	20.4	66.3	37.8
			Left	21.7	11.8	23.1	68.6	37.4
94.	54	M	Right	18.8	7.2	18.4	72	37.9
			Left	16.3	8.9	18	73	38.4
95.	45	M	Right	19.3	9.2	23.4	69.9	37.2
			Left	17.7	8.7	22.4	69.2	35.3
96.	37	M	Right	19.2	9.8	18.8	66.3	32.8
			Left	18.7	9.6	18.4	67	36.2
97.	30	M	Right	19.1	7.9	19.9	69	35
			Left	18.8	8.2	20.1	68.2	34.2
98.	54	M	Right	20.9	9.9	18.8	67	35.2
			Left	20.1	10.6	22	66.6	36.7
99.	55	M	Right	21.6	12.1	18.2	68	33.8
			Left	22.3	12.1	23.5	66.7	34
100.	22	M	Right	23.1	9.1	21.6	59	33
			LEFT	23	9.3	18.4	60.1	33.3
101.	21	M	RIGHT	17.7	8.4	24.1	69	37.6
			LEFT	17.7	7.4	23.2	67.3	35
102.	51	F	RIGHT	19.9	11.4	27.1	65.9	31.1
			LEFT	15.5	10.9	21.2	66.2	34.8