ejpmr, 2020,7(5), 453-460

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

RADIOGRAPHIC EVALUATION OF ELBOW JOINTS IN ADULTS IN CENTRAL INDIAN POPULATION

[1]Dr. Sachin Upadhyay and [2]Dr. Tarun Singh*

[1]Associate Professor, Dept. of Orthopaedics, Netaji Subash Chandra Bose Medical College, Jabalpur.
[2]PG Resident, Dept. of Orthopaedics, Netaji Subash Chandra Bose Medical College, Jabalpur.

***Corresponding Author: Dr. Tarun Singh**

PG Resident, Dept. of Orthopaedics, Netaji Subash Chandra Bose Medical College, Jabalpur.

Article Received on 10/03/2020 **Article Revised on 31/03/2020** **Article Accepted on 21/04/2020**

ABSTRACT

Background: The carrying angle is defined as the acute angle made by the median axis of the arm with the fully extended and supinated forearm. It is important in walking, swinging and carrying objects. Various studies have been done on the cause of the formation of carrying angle. Variations in carrying angle have been reported with age groups, gender and race but little attention has been given to correlate the carrying angle with various anthropological parameters. Hence this study was done to co-relate the carrying angle with various anthropological parameters. **Materials and Methods:** The present study was a prospective cross sectional study done between 1st January 2017 to 1st January 2019in the Department of Orthopaedics, NSCB Medical College & Hospital, Jabalpur (M.P.). A total of 354 consenting healthy volunteers were screened for the study who were the relatives and attenders of the patients admitted in the orthopedics ward. A total of 300 healthy volunteers who qualified the inclusion criteria were included in the study all of whom were right hand dominant. **Results:** The mean carrying angle on the dominant side in our study for males is 10.19 degrees with standard deviation of 1.175degrees and for females is 13.44 degrees with standard deviation of 0.610 degrees and on the non dominant side in our study for males is 9.72 degrees with standard deviation of 1.063degrees and for females is 13.38 degrees with standard deviation of 0.634 degrees. The anterior humeral capitellar line on the dominant side intersects the capitellum in its anterior third in 16.7%, intersects the middle third in 55.3% and the posterior third in 28%. The mean articular surface angle is 82.8 degrees with standard deviation of 4.501 degrees. The mean transepicondylar distance on non dominant side to be 6.21cm ranging from 5.1 to 6.9 cm and on the dominant side to be 6.19cm ranging from 5.2 to 7.3 cm with average of both elbows being 6.2cm ranging from 5.1 cm to 7.3cm. **Conclusion:** We concluded that the carrying angle showed variations in sex, side as well as with increasing age. So it needs to be normalized according to all this criterias and a single value for everyone is not an acceptable cut off to diagnose injuries around the elbow. We came to the conclusion that 2 parameters -carrying angle and trans-epicondylar distance if measured routinely and regularly both pre-op and post-op can be used to reduce the early post operative complications like stiff elbow and restricted range of motion.

KEYWORDS: Carrying angle, transepicondylar line.

INTRODUCTION

The carrying angle is defined as the acute angle made by the median axis of the arm with the fully extended and supinated forearm. This research aims at radiographic evaluation of elbow specially in adults to assess the normal pattern &various abnormalities such as variations in carrying angle. It is equally important for management of supracondylar fracture humerus by both conservative and operative techniques. Proper understanding & assessment of tilts of the distal humerus in both coronal & sagittal section plane as well as rotational malalignment during reduction of supracondylar humerus fracture under IITV(Image intensifier television xray) is imperative. Paucity of literature describing normal radiography and abnormality of elbow in adult which makes diagnosis and classification of this injury difficult for both clinical and research purpose.

The normal radiographic anatomy of elbow is very important in assessing abnormality such as osteonecrosis of capitellum(PANNER'S DISEASE), osteochondral defects,medial apophysitis(LITTLE LEAGUE ELBOW)[1] deformity around the elbow and to restore the normal anatomic parameters in post traumatic case with osteosynthesis.

The pool of normal anatomic data in adults will help to plan for corrective osteotomies, to restore normal alignment in case of post traumatic osteosynthesis and to some extent to develope templating for TEA. It will also help to assess the causes of elbow pain in idiopathic cases in view of abnormal elbow parameters.

Despite its importance and the common occurrence of elbow trauma, it is rather surprising that an anthropometric measurement of elbow joint has not caught the fancy of researches, which shows that such detailed study has yet not been undertaken. This study has thus been carried out to ascertain elbow parameters in central indian population.

MATERIAL AND METHODS

The present study was a prospective cross sectional study done between 1st January 2017 to 1st January 2019in the Department of Orthopaedics, NSCB Medical College & Hospital,Jabalpur (M.P.). A total of 354 consenting healthy volunteers were screened for the study who were the relatives and attenders of the patients admitted in the orthopedics ward. A total of 300 healthy volunteers who qualified the inclusion criteria were included in the study all of whom were right hand dominant.

INCLUSION CRITERIA

A written informed consent was taken after explaining the aim of study in detail. Ethical clearance was taken from the institutional ethical committee. Age group included was between18 yrs to 50 yrs. The mean age group of our study is 33±11years.

EXCLUSION CRITERIA: Age group <18yrs and > 50 yrs, those who have upper limb trauma or restriction of shoulder and elbow movement, those who have suffered with any growth abnormality or any congenital abnormality or any of those who have not given written consent.

METHODS

Anteroposterior xray on fully extended supine position

For the anteroposterior view of the elbow, the forearm is positioned supine (palm up) on the radiographic table, with the elbow joint fully extended and the fingers slightly flexed. The central beam is directed perpendicularly toward the elbow joint. this projection demonstrates the medial and the lateral epicondyles, the olecranon fossa, the capitellum, and the radial head. The coronoid process is seen en face, and the olecranon overlaps the trochlea.

Lateral xray on 90 degree flexion on mid prone position with thumb pointing upward

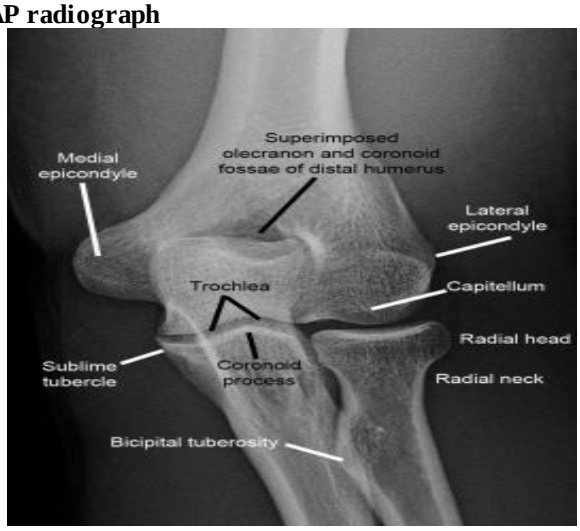
For the lateral projection of the elbow, the forearm rests on its ulnar side on the radiographic cassette, with the joint flexed 90°, the thumb pointing upwards, and the fingers slightly flexed. The central beam is directed vertically toward the radial head. The film in this projection demonstrates the distal shaft of the humerus, the supracondylar ridge, the olecranon process, and the anterior aspect of the radial head. The capitellumisalsoobscured by the overlappingtrochlea.

AP radiograph of elbow were taken according to following methods: Patient is seated alongside the table**.**The fully extended arm and forearm in supinated position are kept in contact with the table by lowering the shoulder joint to the level of the table. They must be in the same plane as that of the detector which is placed below the elbow joint. The shooting distance is kept fixed at 100cm.

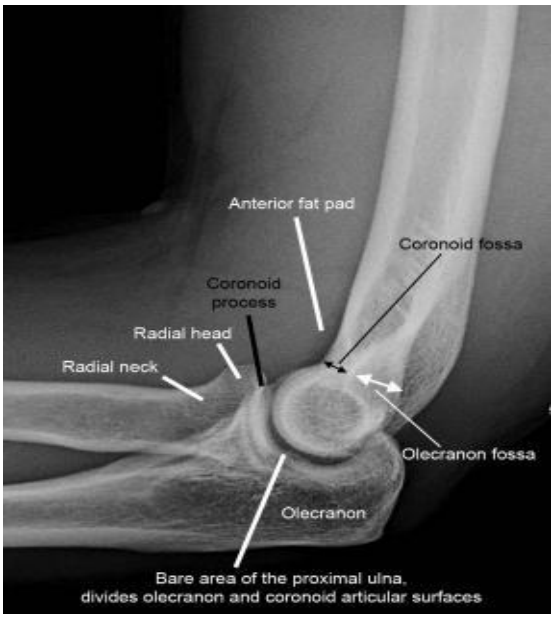
Lateral radiograph of elbow were taken according to following methods

Patient is seated sideways at the end of the table. Arm is flexed at 90 degrees with thumbs pointing upwards. Shooting distance is kept fixed at 100cms**.**

AP radiograph



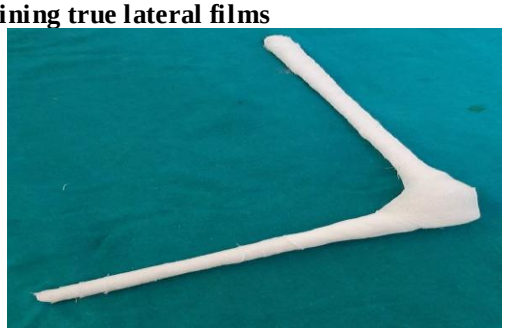
LATERAL RADIOGRAPH



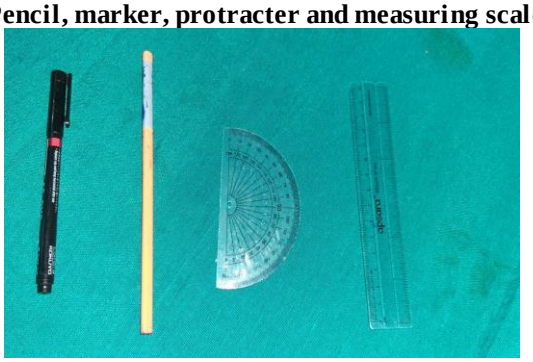
MEASUREMENT TOOLS

1)GONIOMETRE

2)This 90 axis rod was used to align the elbow for obtaining true lateral films

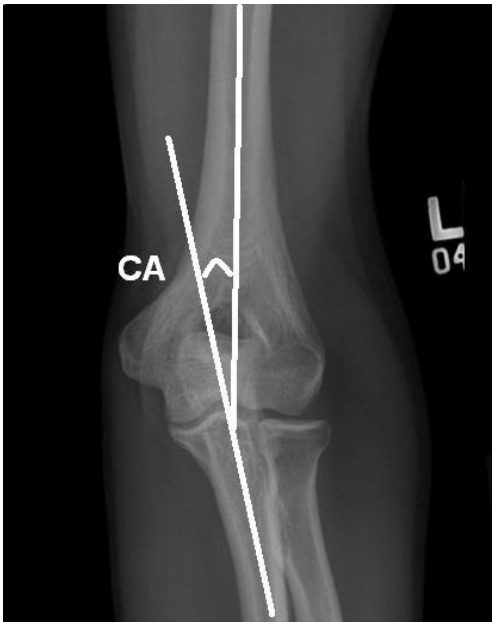


3) Pencil, marker, protracter and measuring scale



MEASURMENT OF ANGLES

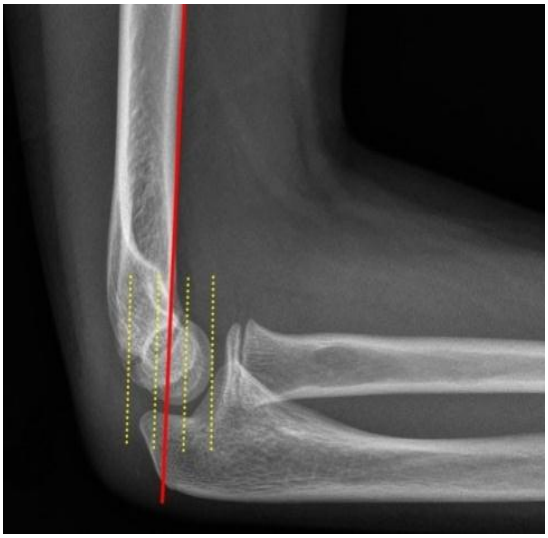
Carrying Angle: The angle between the longitudinal axis of the humerus shaft and a longitudinal line drawn along the shaft of the ulna.



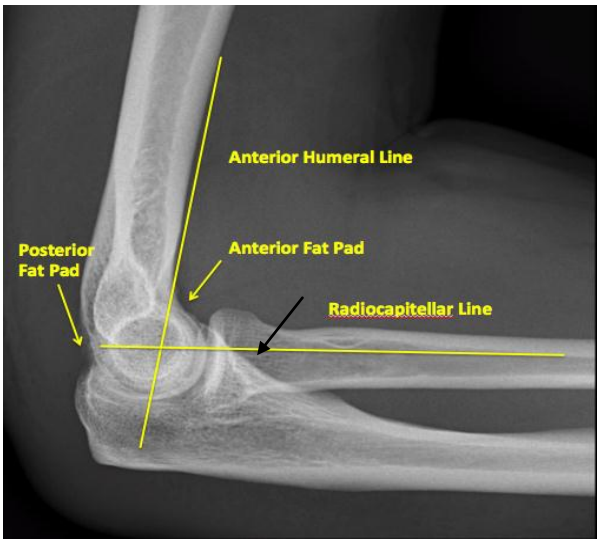
2.Articular Surface Angle- The angle between the longitudinal axis of the humerus shaft and a transverse line drawn along the most distal aspect of the bony trochlea and the capitellum.

MEASUREMENT OF LINES

1.Anterior Humeral- Capitellar Line-- A line was drawn along the anterior surface of the distal humerusand was continued distally to record its relationship with the capitellum as anterior 1/3rd, central 1/3rd or posterior 1/3rd.

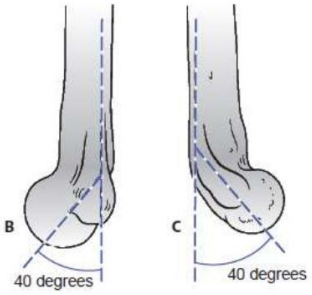


2.**Radiocapitellar Alignment**. To assess the alignment on the lateral radiograph between the radial head/ neck and the capitellum, a line was drawn longitudinally along the central radial neck to assess its intersection point with the capitellum.



3. LATERAL HUMERO CAPITELLAR ANGLE and Anterior Angulation of Articular Surface of Distal Humerus

The angle between a line along the humeral shaft and a line bisecting the capitellum is known as the lateral humero capitellar angle.



The data was tabulated and statistically analysed. Comparison of mean of parameters in between paired observations was done by 'paired t' test. Comparison in between the groups was done by 'unpaired t' test. Correlation between the continuous variables was done. by Pearson's correlation (r) test. The statistically significance level of $p<0.05$ was considered for interpretation.

RESULTS

Age Group	Carrying Angle (in degrees) dominant side					
	Male			Female		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
< 20 Years	20	9.55	.510	0	0	0
20 - 29 Years	65	9.63	.575	41	13.32	.471
30 - 39 Years	71	10.04	.726	32	13.38	.492
40 - 49 Years	36	10.75	.439	25	13.72	.843
>= 50 Years	10	14.20	.789	0	0	0
Total	202	10.19	1.175	98	13.44	.610
	F= 16.37; p<0.001					

The mean carrying angle on the dominant side in our study for males is 10.19 degrees with standard deviation of 1.175degrees and for females is 13.44 degrees with standard deviation of 0.610 degrees.

Age Group	Carrying Angle (in degrees)non dominant					
	Male			Female		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
< 20 Years	20	9.00	0.000	0	0	0
20 - 29 Years	65	9.20	.403	41	13.02	.524
30 - 39 Years	71	9.69	.575	32	13.59	.499
40 - 49 Years	36	10.03	.377	25	13.68	.690
>= 50 Years	10	13.60	.843			
Total	202	9.72	1.063	98	13.38	.634
	F=13.152; p<0.001					

The mean carrying angle on the non dominant side in our study for males is 9.72 degrees with standard deviation of 1.063degrees and for females is 13.38 degrees with standard deviation of 0.634 degrees.

AGE CATEGORY	Frequency	Mean	Stdandard Deviation
< 20 Years	20	79.40	5.236
20 - 29 Years	106	81.70	3.717
30 - 39 Years	103	82.88	5.338
40 - 49 Years	61	85.07	2.400
= 50 Years	10	86.50	1.581
Total	300	82.80	4.501

-In our study the mean articular surface angle is 82.8 degrees with standard deviation of 4.501 degrees.

ANTERIOR HUMERAL LINE

AHL crosses the capitellum in its:	Frequency	Percent	Valid Percent	Cumulative Percent
Anterior one third	50	16.7	16.7	16.7
Middle one third	166	55.3	55.3	72.0
Posterior One Third	84	28.0	28.0	100.0
Total	300	100.0	100.0	

Intersects capitellum In its	Frequency	Percent	Valid Percent	Cumulative Percent
Anterior One Third	52	17.3	17.3	17.3
Middle One Third	165	55.0	55.0	72.3
Posterior One Third	83	27.7	27.7	100.0
Total	300	100.0	100.0	

-In our study we found that the anterior humeral capitellar line on the dominant side intersects the capitellum in its anterior third in 16.7%, intersects the middle third in 55.3% and the posterior third in 28%.

-In our study the anterior humeral capitellar line on the non dominant side intersects the capitellum in its anterior third in 17.3%, intersects the middle third in 55% and the posterior third in 27.7%.

RADIOCAPITELLAR LINE

DOMINANT	Frequency	Percent
Anterior One Third	10	3.3
Middle One Third	267	89.0
Posterior One Third	23	7.7
Total	300	100.0
NON DOMINANT	Frequency	Percent
Anterior One Third	14	4.7
Middle One Third	269	89.7
Posterior One Third	17	5.7
Total	300	100.0

In our study the radio capitellar line on the dominant side intersects capitellum in its middle third in about 89% of population while in 7.7% and in 3.3% it lies in the anterior one third and the posterior one third respectively.

In our study the radio capitellar line on the non dominant side intersects capitellum in its middle third in about 89.7% of population while in 4.7% and in 5.7% it lies in the anterior one third and the posterior one third respectively.

TRANS EPICONDYLAR DISTANCE

Trans Epicondylar Distance	N	Mean(cm) (Minimum –Maximum)
Dominant	300	6.19 (5.2–7.3)
Non dominant	300	6.21 (5.1–6.9)
BOTH	300	6.2 (5.1–7.3)

In our study we found the mean transepicondylar distance on non dominant side to be 6.21cm ranging from 5.1 to 6.9 cm and on the dominant side to be 6.19cm ranging from 5.2 to 7.3 cm with average of both elbows being 6.2cm ranging from 5.1 cm to 7.3cm.

ANTERIOR ANGULATION OF ARTICULAR SURFACE

Side	Mean(degrees)	Standard deviation
Dominant	46.1433	5.69070
Non dominant	46.1433	5.69070

In our study among the total 300 volunteers the mean value of anterior angulation of articular surface of distal humerus in the domiant elbow as well as in the non dominant elbow came out to be 46.14 degrees with a standard deviation of 5.69 degrees.

- Anterior angulation of articular surface of distal humerus is same on both sides.

DISCUSSION

Present study demonstrates that some radiographic measurement techniques like Carrying angle, Articular surface angle, Radio capitellar line, Anterior humero-capitellar line, anterior angulation of distal humerus can be used to assess as well as plan intraoperative decisions.

Cohort comprised of 300 patients (who met the inclusion criteria),both male and females, that were relatives or attenders of the patients who were admitted in the orthopedics ward. Radiographic analysis was done on all these and measurements were taken and normalized values were calculated. In order to assess its usefulness in preoperative assessment of distal humerus surgeries, we also collected radiographic data from 20 post operative patients of supracondylar and intercondylar humerus fractures. Finally statistical analysis was done using T TEST and ANOVA TEST and windows SPSS to find out the significance.

Most of the volunteers in our study belonged to 20- 29 years age group. The mean age group of our study is 32.67±11.294years.In our study the predominant sex was males with 67.3 % dominance.

The carrying angle is accurately measured using a goniometre as per available literature sources.[2]

According to Hubschhr muscular theory- the carrying angle is formed due to 2 strong abductors of forearm (brachioradialis and extensor carpi radialis longus) that create an angle medially. In our study the carrying angle on the dominant side in males is 10.19degrees with SD of 1.175 degrees and in females is 13.44degrees with SD of 0.610 degrees and on the non dominant side in males is 9.72degrees with SD of 1.063 degrees and for females is 13.38degrees with SD of 0.634 degrees. These results are consistent with available previous studies all of which point to the fact that females have larger angle than males and that the angle is more on the dominant side.[3,4] The carrying angle in females is more because of their generalized ligament laxity which is attributed to hormonal variations and hence are purely physiological and therby insignificant. Similarly the difference between dominant and non dominant elbow has been found to be due to muscular variations around the elbow(hubschhr muscular theory[3]) and thereby are also physiological and hence insignificant. So for preoperative planning for elbow surgeries comparison with the other side becomes futile.The mean carrying angle increases with advancing age which is consistent with available studies.[4]

From the 20 postoperative cases that we studied there were 5 patients who developed complications like elbow stiffness with restricted range of motion and in all these cases the carrying angle was found to be more than 20 degrees and thus developed varus deformity. Previous availablestudies[5] for use of carrying angle in pre operative planning in surgeries around the distal end of humerus showed that a postoperative loss of more than 5 degrees of carrying angle should be strictly monitored for at least 1 year to watch out for deformities. So it has

been established from our study that routine pre-op, intraop and post-op measurements of carrying angle can thereby help us plan the surgery and reduce complications following surgical osteosynthesis for management of fracture around the elbow in adults in central India.

In our study the mean articular surface angle is 82.8 degrees with standard deviation of 4.501degrees which is similar to some of previous available studies.[4] It has been described and established that the lateral capitello humeral angle is a measure of saggital plane alignment of distal humerus following supracondylar fracture humerus.[5,6,7,8,9] This angle is used to identify the anterior angulation of distal huemral shaft. In our study the mean value came out to be 46.14±5.69 degrees which is consistent with available studies([10]).The anterior angulation of articular surface of distal humerus in our study is only slightly more in males than in females and hence not significant. We also found that the anterior angulation of articular surface of distal humerus is same on both sidesand that itdoes not show consistent variations with age group. These findings are consistent with previous studies.[10]

Anterior humeral capitellar line[11] is most commonly used to assess sagittal alignment of the distal humerus in supracondylar humerus fractures.[1] In our study we found that the AHCLon the dominant side intersects the capitellum in its anterior third in 16.7%, middle third in 55.3% and the posterior third in 28% and on the non dominant side intersects the capitellum in its anterior third in 17.3%, the middle third in 55% and the posterior third in 27.7% which is consistent with available studies.[11,1,12,13]

RCL is to be accurately measured between the radial neck and the capitellum and in normal cases it has to pass through central third of capitellum.[14] It is accurately and correctly measured on true lateral radiographs.[15] In our study we found that RCL on the dominant side intersects capitellum in its middle third in about 89% of population while in 7.7% and in 3.3% it lies in the anterior one third and the posterior one third respectively and on the non dominant side intersects capitellum in its middle third in about 89.7% of population while in 4.7% and in 5.3% it lies in the anterior one third and the posterior one third respectively.

In our studyamong the total males the radio capitellar line on the dominant side intersected the capitellum in its middle third in about 86.6% and among the females it intersected the capitellum in its middle third in about93.9% and hence do show sex variations.We also found that the RCL can be used clinically to quantify radial head subluxation(20), for preoperative evaluation of injuries around the elbow like supracondylar and monteggia fractures.[9] We also found that RCL shows variation with sex and age.[9] The variations in RCL can be explained by the fact that as age increases bones ossify and the RCL lies more centrally and because females have earlier bone ossification than males so more central will be their RCL compared to males.

In our study we found the mean trans-epicondylar distance on non dominant side to be 6.21cm ranging from 5.1 to 6.9 cm and on the dominant side to be 6.19cm ranging from5.2 cm to 7.3 cm. Similar findings were also obtained in some previous available studies[17] and thus proves thatthe variations in transepicondylar distance between the two sides is nearly insignificant[17]

From the 20 postoperative cases that we studied, 3 of the total 5 patients who had post operative complications like restricted range of motion, elbow stiffness and elbow arthralgia had decreased transcondylar distance than normal which suggested that the screws used in osteosynthesis plates had created overcompression at the interfragmentary site thereby reducing the transcondylar distance. Such cases often needed a secondary procedure to correct the varus or valgus deformity thereby created by overcompression at medial and lateral sides respectively. Sowe can conclude that it is imperative to restore the intercondylar distance as well as distal humeral length even in cases of grossly comminuted supracondylar fractures in adults. In order to achieve this the suggested alternative is the use of autologous bone graft and that screws should not be used to provide interfragmentary compression to prevent collapse at fracture site. Hence it become clear that routine and regular intraoperative measurement of trans-epicondylar distance can thereby help us bring down the post operative complications and thereby improve the outcome of surgical osteosynthesis for supracondylar and intercondylar fractures of humerus among populations of central india.

CONCLUSION

We concluded that the carrying angle showed variations in sex, side as well as with increasing age. So it needs to be normalized according to all this criterias and a single value for everyone is not an acceptable cut off to diagnose injuries around the elbow. The other measurements like the articular surface angle does not show much variation and hence can used in the future for preoperative evaluation of injuries around the elbow.On the lateral radiograph the anterior humeral line and the radiocapitellar line have been found to intersect the middle third of capitellum in majority but not in all cases and hence a more rigorous standardization is needed for its use in evaluationg injuries.

Our third aim was to assess whether the normal radiographic criteria could be used to predict the outcome of surgical osteosynthesis post operatively. We came to the conclusion that 2 parameters -carrying angle and trans-epicondylar distance if measured routinely and regularly both pre-op and intra-op can be used to reduce the early post operative complications like stiff elbow

and restricted range of motion. One such study done by David meekset al in 2017 suggested that the pre existing problem is that there is a historical plate to bone mismatch occuring as all these plates have been designed traditionally focusing on European and US dimensions. So once the radiographic data has been standardized based on ethnicity it will be helpful in better and accurate plate size and shape measurement and thus could improve the results of surgical osteosynthesis drastically. One such study done by Joao Tiago Piao Martins[18] to develop a software for the preoperative planning of closed wedge osteotomy with medial displacement for cubitus valgus and varus deformity. He used radiographs with 3D remodeling of distal humerus to calculate corrective angles necessary for planning of osteotomy and then incorporate it into a software that could simulate the surgical procedure to develop 3D representation of postoperative humerus. This study has initiated a new venture that hopes to fill the void that develops during the preoperative planning for TEA as the same principle can be applied in this surgery also.

Our fourth aim was to assess whether the normal radiographic criteria could be used in future for preoperative evaluation of total elbow replacement. Takuji Iwamoto et alin 2018 did a study with 28 patients who underwent total elbow arthroplasty and all of them were scanned with CT for 3D imaging and Radiograph for 2D modelling of elbow to find the size and position of prosthesis and to plan the implant size properly.

While there is very little research being done on this issue owing to the fact that the TEA is not a routine procedure but we could find a few literature[18] that could help us bridge this lacunae and hopefully set a basement for the upcoming researches.

CONFLICTS OF INTERESTS: None.

REFRENCES

1. Charles A. Goldfarb, J. Megan M. Patterson, Melanie Sutter, Melissa Krauss, Jennifer A. Steffen, Leesa Galatz.Elbow radiographic anatomy: measurement techniques and normative data, 2012
2. Rajesh B, Reshma VR, Jaene RC, Somasekhar IT, Vaithilingam A. An evaluation of the carrying angle of the elbow joint in adolescents, 2013.
3. Daneshmandi Hassan, Shahrokhi Hossein, PegahRahmani, Nazary Sharif Hossein·The study of predictor's anthropometric parameters of upper limb with elbow carrying angle in athletes, 2014.
4. Dr. Sujata Aiyer, Dr.RajibNaskar, Dr.Balgovind S Raja, Dr. Jitesh Manghwani, Dr. Ganesh Khairnar and Dr. Santosh Bindumadhavan. Incidence of residual varus deformity in operated cases of supracondylar humerus fracture in children, 2017.
5. Price CT,Flynn JM. Management of fractures:fractures and disocations around the elbow, 2006.
6. France J Strong M. Deformity and function in supracondylar fractures of humerus in children, 1992.
7. Kocher MS, KasserJR, Waters PM. lateral entry compared to medial entry pin fixation for completely displaced supracondylar humeral fracturesin children, 2007.
8. Mazda K ,Boggione C, Fitoussi F. systematic pinning of displaced extension type supracondylar fractures of humerus in children, 2001.
9. Ponce BA, Hedequist DJ, Zurakowski D-Complications and timing of follow up after closed reduction and percutaneous pinning of supracondylar humerus fractures, 2004.
10. Craig. F.Shank Brett P.Wiater, James Lee Pace, Thomas M. Jinguji, GregoryA. Schmale, RachelC.L. Bittner, Viviana Bompadre, Janna K. Stults and Walter F. Krengel III.
11. Jacob W. Brubacher, Seth D.Dodds.Pediatric supracondylar fractures of the distal humerus, 2008
12. Rey N. Ramirez, MD, Deirdre D. Ryan, MD, Joan Williams, MD, Tishya A.L. Wren, PhD, David Ibrahim, MD, Jennifer M. Weiss, MD, Robert M. Kay, MD, Nina Lightdale-Miric,MD, and David L. Skaggs, MD. A Line Drawn Along the Radial Shaft Misses the Capitellum in 16% of Radiographs of Normal Elbows, 2014.
13. Rogers LF, Malave S, Jr, White H, Tachdjian MO. Plastic bowing, torus and greenstick supracondylar fractures of the humerus: radiographic clues to obscure fractures of the elbow in children. Radiology. 1978;128:145–150.
14. Kunkel S, Cornwall R, Little K, Jain V, Mehlman C, Tamai J. Limitations of the radiocapitellar line for assessment of pediatric elbow radiographs, 2011.
15. Rettig LA, Hastings H, 2nd, Feinberg JR. Primary osteoarthritis of the elbow: lack of radiographic evidence for morphologic predisposition, results of operative debridement at intermediate follow-up, and basis for a new radiographic classification system. J Shoulder Elbow Surg, 2008; 17: 97–105. doi: 10.1016/j.jse.2007.03.014. [PubMed] [Cross Ref].
16. Mandeep S Dhillon, Nirmal Raj Gopinathan, Vishal Kumar. Misconceptions about the three point bony relationship of the elbow, 2014.
17. João Tiago PiãoMartins. Preoperative Planning Software for Corrective Osteotomy in Cubitus Varus and Valgus, 2016.
18. Takuji Iwamoto,Taku Suzuki, Satoshi Oki, Noboru Matsumura, Masaya Nakamura,Morio Matsumoto, Kazuki Sato. Computed tomography–based 3-dimensional preoperative planning for unlinked total elbow arthroplasty, 2018.