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A Study of Angle of Human Humeral Torsion

KEYWORDS: humeral torsion, osteometry, measurement,bone

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ABSTRACT

Introduction - *Anatomist, Anthropologist and Orthopaedic surgeons have since long been interested in knowing the angle of humeral torsion.It is found to increase steadily as we pass upwards through the primates from the lower to the higher members of the group.*

Aims &objective - *It is planned to take Angle of torsion in right and left humerus. To find any difference in the values between male and female and compare our data with those of other workers.*

Results - *our study of done of 300 bones the angle of torsion in bone of left side is found to be ranging from -50 to 600 and on the right side it is 120 to 1300.*

Conclusions - *From these studies it is understood that the angle of torsion in humerus has a definite relationship with the status of civilized development of human races.*

INTRODUCTION-

In man, the biologic necessity of humeral torsion has resulted from the development of upper extremities as prehensile appendages, functioning frontally to the trunk axis and thereby assisting in the maintenance of an upright posture. Associated with this evolved posture, torsion occurs between proximal and distal extremities of the humerus, with humeral head facing postero-medially in anatomical position. The arc of humeral torsion is described by the rotation of the humeral head from the posterior position to the normal postero-medial position. Studies reveal that there are two components of humeral torsion as stated:

Primary torsion, which is determined by developmental patterns, characteristic of various species and is present in the embryo.

Secondary torsion, which results from the pull of muscular forces and functions etc. The internal rotators exert their force on the shaft distal to epiphysis and the external rotators within the proximal epiphysis. It is stated that these forces working in opposite directions are responsible for addition of secondary torsion. Various aspects of the humeral torsion have been studied by several workers in different parts of the world.

Definition

Torsion - Torsion is defined as a state of longitudinal twisting or spiraling of shaft of a long bone and can be measured as the angle between joint axis of proximal and distal ends of the bones.

Humeral head retroversion angle:- The humeral head retroversion angle can be defined as the angle between the axis of distal articular surface or inter epicondylar line of humerus. The humeral head retroversion angle values show a significant variance between individuals and different ethnic groups. It is a well-known fact that in the higher Primates, as compared with other Group of animals, the humerus has undergone a twist so that the superior articular surface, which in most Mammals looks backwards, has come to look backwards and medially or almost entirely medially. To this feature the name "torsion of the humerus" has been applied. The amount of this torsion is measured by taking the long axes of the articular surfaces at the upper and lower ends of the bone and noting the angle formed by these two lines when the bone is looked at from above. In most mammals these lines meet at about a right angle, but in the higher Primates the upper axis has rotated. Its posterior end moving medially and its anterior end laterally, so that the angle between it and the lower axis is more than a right angle.

The amount of this torsion occurring in many different group of mammals and man has been measured, and it is found to increase steadily as we pass upwards through the primates from the lower to the higher members of the group. Even within the various group or races of man it is found to vary considerably, being less in primitive races and greater in the more civilised ones. The torsion is greater in females than in male skeletons; it is greater in weak than in strong skeletons, and in the same individual, it is generally greater in the bone from the left side than in that from the right.[1]

Significantly greater retroversion in the dominant throwing arm of a high-performance athletes has been demonstrated. This asymmetry is not seen in age and activity matched controls. Attempts have been made to determine, if retroversion asymmetry could provide information on the activity patterns of Native Americans who used contrasting weapons technologies (spears and atlatls vs. the bow and arrow) Measurement of Humeral Retroversion, humeral torsion and retroversion refer to the angle created by the transcondylar axis of the distal humerus and a line that bisects the humeral head. This measurement has been described in the literature since 19th century[2] but the extent to which it can be altered by asymmetrical use of the arms has only recently been appreciated.

Other French authors use the complimentary torsion angle (180°- retroversion angle). German and American researchers have typically used another torsion angle (90°- retroversion angle) in their studies.[3]

The retroversion angle of the humerus diminishes during

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growth from an average 27° in the newborn to 16° in the adult (Broca, 1881). It is a little lower in women than in men, and on the left side than on the right side.[4]

The variation within and between modern human populations is great. According to Broca . It can vary between 41° and -2° reversed torsion in the French. When population membership is controlled for, the torsion angle seems to be inversely correlated with humeral length.[3]

Until recently, the functional significance of variation in the humeral torsion angle has been unclear. Recent biomechanical studies suggest that humeral retroversion may have a significant bearing on shoulder function and shoulder injuries. Professional baseball pitchers show much greater humeral retroversion in their dominant throwing arms than their non-throwing arms. The members of control groups, in contrast, do not show this marked asymmetry between their dominant and non-dominant arms. The asymmetrical increase in retroversion seen in these athletes appears to be a phenotypic response to extensive external rotation experienced during intensive throwing practice in the preadolescent and adolescent periods of rapid growth. Radiographic studies suggest that the athletes whose humeri do not develop greater retroversion place more strain on their anterior capsules and develop chronic shoulder pain because of anterior instability. Modern clinical studies of the effects that habitual throwing has on the humeral morphology of young athletes suggest the possibility of using temporal variation in humeral retroversion asymmetry to document changes in weapons technology among prehistoric Native Americans.[5]

Early during the prehistoric period, the atlatl (a flat wooden stick with a handhold and a peg or socket to accommodate the butt end of a small spear) was used throughout North American to increase the distance and accuracy with which the spears referred to as "darts" could be thrown during hunting and warfare. Spears and harpoons were also commonly used as weapons. Use of spears and especially the atlatl requires an overhand throwing technique very similar to that seen in baseball pitching. This suggests that the skeletal remains of people who began their training in the use of spears and atlatls during the pre-adolescent period will show marked asymmetry in humeral retroversion similar to that seen in baseball pitchers.[4]

Archaeological evidence (mostly small "arrow head" points) suggests that replacement of the atlatl by the bow and arrow began in the arctic and sub-arctic areas of North America beginning around 3,000 B.C. Artifacts indicating bow and arrow use are present in sites in Alaska and northern Canada dating to around 1,500 B.C. The spread of the bow and arrow to the south occurred much later. Although they may have been used sporadically at earlier times, it did not become common until around the first half of the first millennium A.D. (Midwest A.D. 600-700, Southeast A.D. 700, Western United States A.D. 200-500). Replacement of spears by the bow and arrow would have significant consequences in terms of the mechanical demands placed upon the upper arms. Instead of the retroversion associated with throwing, upper body strength would have been favored by habitual use of the bow and arrow.[6]

In the Channel Island area of southern California, the bow and arrow appears to have abruptly replaced spears and the atlatl as the principal weapon for use in hunting and warfare around 500 A.D. This is seen most strikingly in an increase in the number of homicide victims with arrow points embedded in their bones.[7] Based on this evidence of technological change, It is expect that the retroversion associated with spear throwing would decrease in frequency after the introduction of the bow and arrow. Also, since the use of weapons in hunting and warfare are documented ethnographically to have been primarily male activities,[8] these changes should be seen to a much greater extent in males than in females.

AIMS AND OBJECTIVES

A number of humerus is available in department of Anatomy Netaji Subhash Chandra Bose Medical College, Jabalpur (M.P.)

1.It is planned to take Angle of torsion in right and left humerus.
2.To find any difference in value between right and left.
3.To find any difference in the values between male and female.
4..To compare our data with those of other workers.

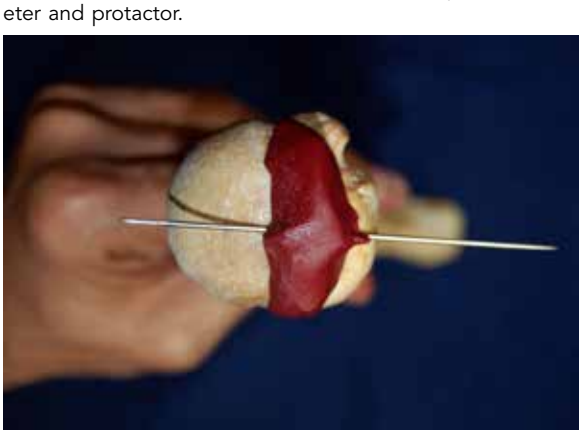
MATERIELS AND METHODS –

The study has been done on three hundred humerus (150 right and 150 left) all these bones are from unknown subjects. On gross examination no definite opinion regarding the sex could be given therefore the bones were kept in two group right & left and measurements were taken.

Instruments-

1 Osteometry board
2. Torsiometer
3. Protactor
4 Sliding caliper
5 Measuring Tape
6 Plasticine and Needle

At the upper end of humerus long steel needle was fixed with the help of plasticine. This needle was put along a line passing from mid point between insertons of supraspinatus and infraspinatus, laterally and mid point at the maximum diameter of articular surface of the head of humerus medially. At the lower end a needle was fixed, angle between these two was measured with the help of torsiometer and protactor.



1.Figure : Showing a pin fixed along the reference line employed at the upper end of humerus

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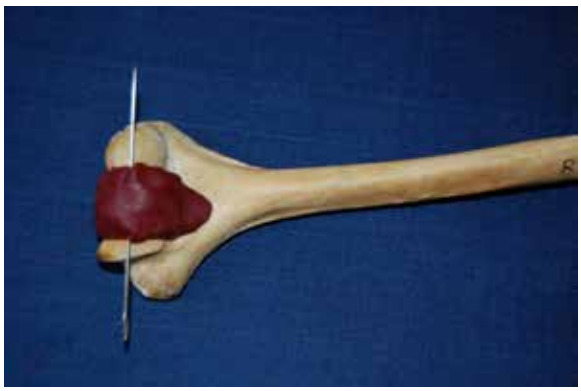
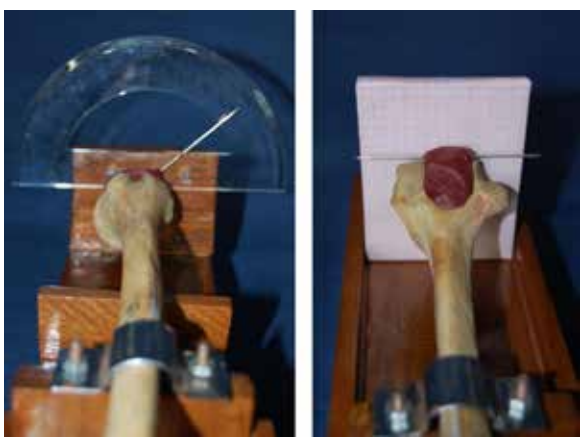


2.Figure : Showing a pin fixed along the reference line employed at the lower end of humerus



3.Figure : Showing the measurement of angle of Humerul Torsion

5.RESULTS-

Angle of humeral torsion was measured in 150 humerus of left side and 150 humerus of Right side.

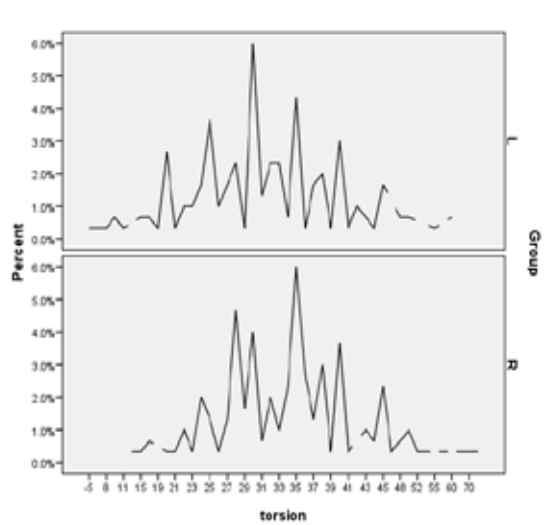
In 11 bones of left side the range of angle of torsion was observed to be between -5 degree to 20 degree. Only four bones of right side are found to have angle of torsion between 10-20 degree.

Large number of bones show the angle of torsion between 20-50 degree 124 humerus of left side are present in this group. Where as 130 bones of right side were present in this group.

In some bones higher degree of angle of torsion was observed it was ranging from 50-55 degree to 125-130 degree. Only five humerus of left side and nine humerus of right side are found to be present in this group.(table No.-1)

Table 1
Distribution of cases according to torsion

Torsion	Left	Right	Total
<0	1	0	1
	0.7%	0%	0.3%
5-10	2	0	2
	1.3%	0%	0.7%
10-15	3	1	4
	2.0%	0.7%	1.3%
15-20	5	3	8
	3.3%	2.0%	2.7%
20-25	20	12	32
	13.3%	8.0%	10.7%
25-30	27	28	55
	18.0%	18.7%	18.3%
30-35	38	30	68
	25.3%	20.0%	22.7%
35-40	26	40	66
	17.3%	26.7%	22.0%
40-45	16	17	33
	10.7%	11.3%	11.0%
45-50	7	10	17
	4.7%	6.7%	5.7%
50-55	2	5	7
	1.3%	3.3%	2.3%
55-60	1	1	2
	0.7%	0.7%	0 .7%
60-65	2	1	3
	1.3%	0.7%	1.0%
70-75	0	1	1
	0%	0.7%	0.3%
125-130	0	1	1
	0%	0.7%	0.3%
Total	150	150	300



(Incidence (in %) of angle of torsion in humerus right and left side)

Angle of humeral Torsion in degree. On left humerus -5 degree torsion was found only in one bone whereas maximum value observed was 60degree only in one bone.

On humerus of right side the minimum value of angle of

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torsion was noted to be 12 degree in one bone whereas maximum degree of torsion measured was 130 degree in only one bone. Mean value for the angle of torsion was calculated to be 31.04 degree for left side and 34.90 for right side (table 2). Statistically mild significant difference between the mean of both right and left was seen (P <0.05).

Table - 2
Torsion in degree

Group	N	Minimum	Maximum	Mean	Std. Error of Mean	Std. Deviation
Left	150	-5	60	31.04	0.796	9.753
Right	150	12	130	34.90	0.946	11.582
Total	300	-5	130	32.97	.627	10.862

DISSCUSSION-

Angle of humeral torsion as seen in the human bones has been a interesting topic for study for anatomist, anthropologist and orthopedic surgeons. In most mammals the superior articular surface of humerus look back word where as in higher primates it has come to look backward and medially or almost entirely medially to this feature the name torsion has been applied. In specimens extending from fossils material to vertebrates and including modern man where occur in gradual in humeral torsion.

The humeral torsion in man has been reported to increase from birth until the bony fusion is completed at the proximal epiphysial cartilage. The humeral torsion has been reported to appear first in level of labynthodonts of the permo-carboniferous period and is formed in all later terrestial tetrapodes . It has been suggested that muscular force help to produce humeral torsion at the level of proximal epiphysis cartilage prior to bony fusion. The angle of humeral torsion has been observed to gradually increase from 27^0 in didelphis, 31^0 in tupaia, 35degree in lemur, 31^0 in gorilla 74^0 in homosepians. [9]

C.P. Martin has also illustrated a gradual increase in this angle, in deferent group of mammals and man, as we ascend the series. He has given the figures which highlight the angle of torsion been 120.2 ^{0} in orang -utan, 128^0 in chimpanzee, 141.1^0 in gorilla, and then ascending to 144.2^0 in negro, 163.9^0 in modern Swedes , 164^0 in modern Swiss and modern individuals. He has suggested that torsion of humerus is due to two stress activities on the bone , one is due to arch formed by acromion and coraco-acromion ligament which forces the head of bone to rotate laterally when the arm is abducted , the other stress is the muscles which are insertion on the anterior aspect of the bone just below the surgical neck.

Phillip L. Walker and Valerie Andrushko Thor Gjerdrum Marian of Medical Center, Santa Maria, California, have on the basis of recent biomechanical studies, quoted that humeral retroversion is greater in dominant (throwing) than in non-throwing arm. The asymmetrical increased in retroversion is suggested to be a phenotypic response. That view is also supported by the clinical studies of affect of habitual throwing on the humeral morphology of young athletes. To confirm these suggestions they have studied the bones of individuals from channel Island area of southern California. Who lived before and after the bow and arrow became the weapon of choice. The result of their studies are tabulated in -

Table 3 : Absolute differenced in the retroversion angles of right and left humerus of Native Americans from the Santa Barbara Channel Area

Period/Sex	N	Mean	S.D.	Minimum	Maximum
Early period					
Male	6	8.7	10.0	0.0	27.0
Female	2	0.0	0.0	0.0	0.0
Sex?	2	2.8	2.8	0.0	4.0
Late period					
Male	6	2.2	3.9	0.0	10.0
Female	5	2.8	2.8	0.0	6.0
Sex?	3	1.2	1.2	1.0	3.0
Late period					
Male	12	5.4	8.0	0.0	27.0
Female	7	2.0	2.6	0.0	6.0
Sex?	8	5.3	5.3	0.0	14.0

Humeral head and retroversion head has been study by Joel Murachovsky et al.

Volkan Ozluma et al suggested that humeral head retroversion angle can be taken as reference to each other. They have measured the angle of retroversion of head of humerus in living subjects by radiographic method with arm held at 20 degree abduction, and suggest their radiographic method to be used for determining the humeral head retroversion angle in the Planning of proximal humeral rotation osteotomy and prosthetic replacement orthoplasty. .[10]

P. P. Symeonides et al measured torsion of the humeral head in 38 patients (40 shoulders) with recurrent anterior dislocation of the shoulder (RADS) and in 40 normal subjects. They found a reduced mean retroversion in the patients with RADS at *4.3* ± 10.56 (17^0 anteversion to 32^0 retroversion) as compared with 16.1 ± 11.07^0 in the control group (0^0 to 49^0) (p = 0.0001). There was anteversion in 11 of the 40 shoulders in the RADS group *(27.5%)* and in none of the control group. .[11]

Comparison of torsion angle as measured by different workers in different races In our study of done of 300 bones the angle of torsion in bone of left side is found to be ranging from -5^0 to 60^0 and on the right side it is 12^0 to 130^0.

Shah R.K. et al have quoted torsion angle measured in different workers in different areas. (table no.4)

Authors		Series	Torsion Angle (Mean)
Broca	(1881)	Whites	74 degree
Mathews et al.	(1893)	Salado-Indians	69 degree
Mathews et al.	(1893)	Indian Tribes	63 degree
Martin	(1928)	Australian	45.5 degree
Martin	(1928)	Paltacalo-Indian	48.5 degree
Martin	(1928)	Feugians	53.9 degree
Martin	(1928)	Peruvians	60.2 degree
Martin	(1928)	Swiss	74 degree
Chillida	(1943)	Urgentine aborigines	61 degree
Ayer & Upshon	(1943)	Indians (South)	62.1 degree
Krahl & Evans	(1945)	Whites	74.4 degree
Krahl & Evans	(1945)	American Blacks	72.6 degree
Kate	(1969)	Indians (Central)	55 degree
Mehta et al.	(1971)	Indians (Rajasthan)	68.5 degree
Kronberg et al	(1988)	Swedish	59 degree
Fuchs et al.	(1991)	Germans	62.8 degree
Robertson et al.	(2000)	Americans	71 degree
Present Study	(02-05)	Indians (Gujarat)	67.57 degree

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Mean torsion angle of our study is 31.04^0 for left humerus and 34.9^0 for the right humerus.

CONCLUSION-

The humerus belonging to the cadavers from Jabalpur and surrounding area was taken for study. Following inference is derived:-.

Mean angle of torsion is 22.97, No significant difference between left and right is observed. (P M 0.05).

it is found to increase steadily as we pass upwards through the primates from the lower to the higher members of the group. Even within the various group or races of man it is found to vary considerably, being less in primitive races and greater in the more civilised ones. From these studies it is understood that the angle of torsion in humerus has a definite relationship with the status of civilized development of human races. The angle of torsion being move in more civilized races.

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