JOURNAL OF RADIOGRAPHY AND RADIATION SCIENCES

RADIOGRAPHIC DETERMINATION OF NORMAL RANGE VALUES OF ACROMIOCLAVICULAR JOINT SPACE IN NIGERIAN POPULATION

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https://doi.org/10.48153/jrrs/2022/ZJKF4109

Article info
First Submission
17th June 2022

Revised
27th August 2022

Accepted
18th September 2022

ABSTRACT

Background: Acromioclavicular joint space is one of the most common injuries of the shoulder region. Accurate diagnosis of most acromioclavicular (AC) joint pathologies depends on the knowledge of the normal range values of acromioclavicular joint space. The variation in the normal AC joint spaces among the studied population points to the need to have population-specific reference range values of acromioclavicular joint space while the paucity of data on normal acromioclavicular joint space diameter in our locality necessitated this study.

Objective: This study was, therefore, aimed at radiographically determining the normal reference range values of acromioclavicular joint space diameter with age in adult Nigerian and also to find its variation with sex.

Methods: This retrospective study was conducted in three tertiary hospitals in Enugu from January 2019 to July 2019. It involved digital anteroposterior shoulder radiographs of 628 adults (18 – 80 years) obtained using Zanca's view and reported as normal by four consultant radiologists. The acromioclavicular joint space diameter is calculated as an integral of the distances between the superior and inferior borders of the acromioclavicular joint space. Data were analyzed using a linear regression model, Pearson product-moment correlation coefficient, and independent sample t-test.

Results: The mean AC joint space diameter ranged from 3.63 mm at ≤ 20 years to 1.14 mm at 76-80 years of age. Acromioclavicular joint space diameter correlated strongly but negatively with age with correlation coefficients of -0.785, -.839, -.797, and -.780. There was a significant difference between the acromioclavicular joint space diameter of males and females (p = 0.000).

Conclusion: This study has generated a reference range value of normal acromioclavicular joint space diameter with age in our locality while there is a difference in acromioclavicular joint space between male and female adult Nigerians.

Keywords: Radiographic determination, acromioclavicular joint space, adult Nigeria

Introduction

The acromioclavicular (AC) joint is a diarthrodial joint of the shoulder region which is formed by the lateral end of the clavicle and the medial end of the acromion of the scapula and links the upper extremity to the axial skeleton [1]. The AC joint is superficial in position with

its integrity being maintained by acromioclavicular and coracoclavicular ligaments [2]. Due to its diarthrodial nature and superficial position, the AC joint is affected by many pathological processes, including joint separation, osteoarthritis, trauma, post-traumatic arthritis, and distal clavicular osteolysis [3]. These disease processes disrupt the normal anatomy and physiology of the AC joint space diameter leading to pain as the most common symptom. Separation of the acromioclavicular joint remains the most common occurring shoulder injury [4] while asymptomatic joint degeneration is also frequent [3]. Disruption of the AC joint space diameter was found to account for approximately 12% of dislocations involving the shoulder joint and 10% of all shoulder injuries while these injuries occur about five times more frequently in the male population [5]. It is also important to note that degeneration of the acromioclavicular joint space is a natural phenomenon associated with age as disc degeneration can occur as early as the second decade of life [6, 7].

These disease processes can be diagnosed through history taking, physical examination, and imaging. History taking and physical examinations are mainly subjective [8] and any suspicion of acromioclavicular joint injury will require imaging for objective assessment. conventional X-ray examination, computed tomography (CT), and magnetic Resonance Imaging (MRI) are imaging modalities used in the assessment of AC joints. Computed Tomography gives an excellent visualization of the articular surfaces, osseous changes, and subtle or complex fracture and joint mal-alignment coupled with speedy scan time. However, the high cost of CT examination coupled with the high radiation dose to patients made it not justifiable to be used for examinations involving no obvious pathology [9]. Magnetic resonance imaging with its multi-planar capabilities and superior soft tissue resolution gives a high-quality image of AC joint but its relatively high cost and limited availability in the locality make conventional X-ray imaging the preferred first-line imaging modality for the diagnosis of AC joint injuries and pathologies. Conventional X-ray examination of the AC joint is carried out using standard views such as the anteroposterior view (AP), and lateral and axial views of the shoulder although the Zanca view is the best view for imaging the AC joint space [10].

The configuration of AC joint space diameter has been found to vary significantly in studied populations while the craniocaudal (CC) interspace diameter also exhibits considerable variability [10]. Several studies [11, 12, 13] done on radiographic assessment of AC joint space diameter were carried out on the Caucasian population. There is a paucity of data on our local population's radiographic assessment of the AC joint space. Given these revelations from the reviewed pieces of literature, there is a need for this study to provide the necessary data for the locality. This study is therefore aimed at radiographically generating a range of reference values of acromioclavicular joint space diameter according to age and sex and comparing right and left acromioclavicular joint space in both male and female adult Nigerians with normal shoulders. The range of reference values generated will serve as an indigenous value of normal acromioclavicular joint space while its usage in our locality will eliminate errors from possible racial differences when values from Caucasians are used.

Methods:

This retrospective study was conducted in three tertiary hospitals in the Enugu metropolis from January 2019 to July 2019 and involved 628 shoulder radiographs obtained using the Zanca view as described by Li et al, [14]. Included in this study were anteroposterior shoulder radiographs reported as normal and having no evidence of rotation. This study excludes AP radiographs taken in Zanca view but has no radiologist report or missing data in the result. The reporting of the radiographs was done by four Consultant Radiologists in Enugu State, Nigeria. These institutions were selected because they include the Zanca view as part of departmental routine views for shoulder x-ray and also use the same model of the *i*CRco digitizer. Before the actual measurement of the AC joint space diameter, a pilot study was conducted on ten AP shoulder radiographs obtained using the Zanca view by two

Radiographers with more than 10 years of experience in radiography to determine the intra- and inter-observer reliability in the measurement after which one radiographer obtained the rest of the measurements. The upper width (cranial diameter) and the lower width (caudal diameter) were measured three times using an inbuilt electronic caliper in the *i*CRco digitizer PC workstation and their averages were taken. The acromioclavicular joint space diameter was then calculated as an integral value of both the cranial and caudal diameters of the AC joint space **(Figure I**). The patients' demographic data such as age and sex were also recorded. Ethical clearance with Ref. No: CON/MHPHD/1866/94 was obtained from the State Ministry of Health while consent was obtained from the management of the hospitals before the study commenced. The data were deposited in the repository with DOI: 10.17632/d96j4psvdt.1**.**

Data Analysis:

The reliability of acromioclavicular joint space diameter measurement within and between two radiographers was assessed using intraclass and interclass coefficient ICC and a two-way random effect model, assuming a single measurement and absolute agreement. The changes in AC joint space diameter with age was determined using the linear regression model while an independent sample t-test was used to test for significant difference between right and left AC joint space diameter in males and females. The relationship between acromioclavicular joint space diameter and age was determined using the Pearson product-moment correlation coefficient.

Results:

The study comprised 628 shoulder radiographs with 308 (49.0%) females and 320 (51.0%) males. Out of the 308 female radiographs, 145 (47%) were right shoulders while 163 (53%) were left shoulders. Also, of 320 male radiographs, 204(64%) were right shoulder radiographs while 116(36%) were left shoulder radiographs. The mean age of the studied subjects is 43.73 ± 15.56 years with the age range of 29-33 years having the highest frequency while the age range of 64 – 68 years has the least frequency.

Measurement of AC joint space diameter showed excellent agreement within and between radiographers with intra-class correlation coefficient ICC (3,1) of 0.925 while the inter-class correlation coefficient ICC (3,1) is 0.847 **(Table 1)**.

The changes in mean AC joint spaces diameter with age were determined using a linear regression model which generated the regression equation as follows:

$$\text{Mean AC joint space (MACJ)} = 0.675 - 0.05 \times Age$$

From our study, the mean AC joint space decreases with an increase in age. The male ACJ space diameter decreases from 3.62 mm at ≤ 20 years to 1.14 mm at 76-80 years while the female ACJ space diameter decreases from 3.63 mm at ≤ 20 years to 1.14 mm at 76-80 years of age **(Table 2).** The right ACJ decreases from 3.68 mm at ≤ 20 years to 1.14 mm at 76-80 years of age while the left ACJ decreases from 3.55 mm at ≤ 20 years to 1.14mm at 76-80 years of age **(Table 3)**. The Pearson correlation coefficient determined the relationship between acromioclavicular joint space with age. Our study indicated that the mean right male and female AC joint space diameters show a strong negative correlation with age with a correlation coefficient of -.839 and -.785 respectively. In the same manner, mean left male and female AC joint space diameters show a strong negative correlation with age with Pearson correlation coefficients of -.780 and -.797 respectively **(Table 4)**.

The mean right AC joint space diameter for males was compared to females' mean right AC joint space diameter using the independent sample t-test at a significant level of 0.05. The result shows a statistically significant difference between them with a p-value of 0.000. Also, the mean left AC joint space diameter of males was compared to that of the female at 0.05 level of significance, the result shows a statistically significant difference between the two sexes with a p-value of 0.027.

Table 1: Intraclass correlation Coefficient of Acromioclavicular joint space measurement

Intraclass Correlation		95% confidence interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Inter rater							
Single measures		0.729	0.981	25.636	9	9	0.000
Average measures	0.961	0.843	0.990	25.636	9	9	0.000
Intra rater							
Single Measures	0.847	0.499	0.960	12.039	9	9	0.001
Average measures	0.917	0.666	0.979	12.039	9	9	0.001

Table 2: Mean Male and Female Acromioclavicular Joint Space Diameters with Age

	MALES			FEMALES		
Age (years)	**Freq**	**Mean ± SD**	**Range (mm)**	**Freq**	**Mean ± SD**	**Range (mm)**
≤ 20	11	3.62±0.28	3.15-4.15	17	3.63±0.33	3.13-4.16
21-25	31	3.24±0.37	2.57-3.82	33	3.26±0.38	2.57-3.80
26-30	32	3.21±0,39	2.46-4.00	32	3.24±0.39	2.48-3.98
31-35	40	3.09±0.38	2.60-3.68	40	3.09±0.38	2.61-0.38
36-40	29	2.87±0.32	2.49-0.32	26	2.90±0.34	2.48-3.65
41-45	34	2.66±0,45	1.90-3.30	23	2.67±0.48	1.92-3.27
46-50	34	2.49±0.42	1.60-3.22	30	2.48±0.44	1.63-3.23
51-55	28	2.38±0.30	1.81-2.92	28	2.39±0.36	1.67-2.91
56-60	27	2.35±0.36	1.87-3.01	29	2.29±0.43	1.63-3.04
61-65	11	2.09±0.29	1.50-2.65	19	2.04±0.23	1.52-2.62
66-70	20	1.93±0.36	1.46-2.58	20	1.96±0.25	1.55-2.25
71-75	9	1.71±0.18	1.55-2.08	7	1.66±0.18	1.54-2.04
76-80	4	1.14±0.02	1.12-1.12	4	1.14±0.00	1.14-1.16
TOTAL	**320**			**308**		

Table 3: Mean Right and Left Acromioclavicular Joint Space Diameters with Age

Age (years)	Freq	Right ACJ Mean ± SD (mm)	Range (mm)	Freq	Left ACJ Mean ± SD (mm)	Range (mm)
≤ 20	17	3.68±0.31	3.15-4.16	11	3.55-0.31	3.13-4.16
21-25	33	3.28±0.39	2.57-3.82	31	3.23-0.39	2.57-3.82
26-30	32	3.25±0.44	2.46-4	32	3.2-0.44	2.48-4
31-35	51	3.13±0.38	2.6-3.68	29	3.04-0.38	2.61-3.68
36-40	37	2.88±0.33	2.49-3.61	18	2.89-0.33	2.48-3.61
41-45	40	2.62±0.44	1.9-3.3	17	2.78-0.44	1.93-3.3
46-50	35	2.48±0.35	1.6-3.22	29	2.5-0.35	1.6-3.22
51-55	18	2.33±0.36	1.67-2.86	38	2.4-0.36	1.81-2.86
56-60	38	2.32±0.43	1.63-3.04	18	2.37-0.43	1.88-2.88
61-65	18	2.00±0.27	1.5-2.62	22	2.12-0.27	1.52-2.68
66-70	15	1.87±0.28	1.46-2.34	25	2.05-0.28	1.03-2.58
71-75	10	1.78±0.18	1.54-2.04	6	1.96-0.18	1.86-2.08
76-80	5	1.14±0.01	1.13-1.16	3	1.14-0.01	1.12-1.18
	349			**279**		

Table 4: Table 4: Pearson Product Moment Correlation Coefficient of the Mean ACJ and Age

	Pearson Correlation	Sig. (2-tailed)	N
Rt ACJ Female	-0.785**	0.000	204
Rt ACJ Male	-0.839**	0.000	145
Lt ACJ Female	-0.797**	0.000	116
Lt ACJ Male	-0.780	0.000	163

** Correlation is significant at the 0.01 level (2-tailed).

Discussion:

One of the common sources of pain in the body is the shoulder joint. Chronic shoulder pain is a common condition in Nigeria [15], and the incidence of shoulder pain in adults was between 15% and 30% [16]. Also, research has proven that yearly, about 50% of the population will present to a hospital with at least an episode of shoulder pain syndrome [17]. Most causes of shoulder pain are associated with a decrease or widening of the AC joint space diameter [18, 19] which implies that accurate diagnosis of these diseases depends on knowing how the AC joint space diameter deviates from the normal values. Petersson and Redlund [19] also stated that widening of the AC joint space greater than 7mm in males and 6 mm in the female when compared to the normal value is pathological irrespective of the age of the patient. Accurate diagnosis of these pathologies of the acromioclavicular joint space depends largely on the knowledge of the population-specific normal reference range values as Lee et al [20] noted potential differences in average skeletal size between Asian and Western populations. They further opined that the absolute measurement of acromioclavicular joint space of the Asian population will differ from the values in the Western population.

In our study, measurement of AC joint space diameter has been found to show high ICC (3,1) and excellent agreement within and between measurements which goes to show that ACJ space diameter measurement is highly reliable and reproducible (ICC = 0.925 and 0.847, p-value = 0.000 and 0.001 for within and between measurement respectively). This is in line with the findings of Zumstein et al [21] who noted excellent intra- and interobserver reliability in acromioclavicular joint dislocation measurement. Also, Gastaud et al [22] found good to excellent intra- and inter- on the anteroposterior measurement of acromioclavicular joint separation.

Mean AC joint space diameter was found to decrease with age in both females and males. This decrease in AC joint space diameter with age can be attributed to the gradual degeneration of the joint cartilage which occurs as part of the aging process [6]. This finding is in line with similar work done by Zanca [23] who found that the limit of AC joint space diameter in a healthy adult shoulder varies between 1mm and 3 mm. Guillotin et al [24] noted that the incidence of radiological changes in the ACJ increases with age and that degenerative change accounts for 68% in patients below 30 years and 93% in patients above 30 years. Also, similar works [7, 19, 20, 25] on the AC joint space diameter have found a decrease in the joint space with age in both males and females.

The right and left ACJ space diameters in males were compared to that of the females and the results show a statistically significant difference with male ACJ being higher than the female ($p = 0.024$). Also, there is a statistically significant difference between the left ACJ in both males and females with the males being higher than the females ($p = 0.000$). This is in line with the study by Petersson and Redlund [19] which was conducted in Sweden and noted a significant difference in the AC joint space diameter between males and females with males being wider than females. Our finding could be explained by the fact that men are usually involved in hard manual work which results in an increased rate of tears and wears in their acromioclavicular joint spaces when compared to that of the female.

Both right and left ACJ in both sexes' correlate strongly although negatively with age. Male and female right ACJ has a correlation coefficient of -.785 and -.839 respectively while the male and female left ACJ has a correlation coefficient of -.797 and -.780 respectively. This finding is in line with several studies [7,19, 20] which show a negative correlation between acromioclavicular joint space with age. These could be attributed to degenerative changes occurring as age increases.

Conclusion

Acromioclavicular joint space diameter in normal Nigerians decreases with an increase in age while no statistical difference in acromioclavicular joint space exists between males and females.

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