Original article:

Study of evaluation of reliability and validity of radiographic measurement of the humerus -elbow- wrist angle versus clinical measurement in healthy individuals

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Abstract

Purpose: Evaluation of the reliability and validity of radiographic measurement of the humerus -elbow- wrist angle versus clinical measurement in healthy individuals.

Methods: 100 healthy children of age group upto 12 years were selected. Anteroposterior radiographs were done to generate digital radiographic images that were stored in a picture arching and communication system (PACS) in digital core. Humerus-Elbow - Wrist Angle, Carrying Angle, Baumann Angle were measured.Assessment of intraobesever variability radiological measurements of different angles was done by same resident after two week interval and assessment of interobesever variability radiological measurements were done by three different resident. The mean esteem and standard deviation of each radiographic parameter was computed with utilization of information from the first and second procurement sessions. Intraclass relationship coefficients (ICCs) were ascertained by standard factual techniques. The ICCs for intraobserver and interobserver dependability were figured with utilization of information from both the first and second obtaining sessions.

Results: There is near perfect correlation between the measurement of the carrying angle, HEW angle by the three individual observers. When the readings of the carrying angle were correlated with the HEW angle for all observer readings inter-alia and within intra-observer, the HEW angle readings were more consistent and of lesser values than the carrying angle values, showing the difference in the measurements produced by the methods of recording.

INTRODUCTION:

The elbow is a joint that articulates the distal humerus with the proximal radius and ulna allowing flexion/extension movements[1].The range of movement is a primary measure for assessing the elbow's integrity and to verify disease progression or treatment effectiveness.[2] Very little information exists describing the normal radiographic anatomy of the elbow in the adolescent population thus making diagnosis and classification of injury difficult for both clinical and research purpose previous literature focuses primarily on fracture outcomes ossification centre patterns and gender differences.There is no information however describing normal morphology of the developing distal humerus and proximal olecranon and radius, In order to establish treatment algorithms and evaluate outcomes common and reliable methods of measurement and assessment of angle around the elbow are neccessary.[3]

METHODOLOGY:

Anteroposterior radius graphs will be done in radiology department in a standard manner without the use of sedation either the patient sitting in a chair with the arm in "0" degree extension and with the forearm in supination.

Inclusion Criteria

- All individuals under 12 years of age are included .(because capitellar physis is closed in some patients who are under 13 years)
- All the individuals who gave consent for examination.

Exclusion criteria

- Patients with previous trauma history to elbow.
- Flexion contracture of elbow.
- Congenital disorders.
- Individuals above 12 years of age.
- The study was approved by Ethical Committee of National Institute Of Medical Sciences, from January 2017 to July 2018. 100 healthy children of age group upto 12 years were selected. As indicated by the convention at our healing center, radiographs of the healthy elbow were created at the tie when the initial injury or trauma was caused; these radiographs were looked into for the present examination.

  Patients who were below the age of ≤12 years were taken as sample size and no one above the age of 12 was taken into consideration in light of the fact that the capitellar physis is fused in a few patients who are ≥13 years old . A senior occupant (M.H.), who did not take part in this examination, surveyed all the medical records thoroughly and radiographs of the 75 patients and chose radiographs as indicated by the criteria. All radiographs were evaluated freely by orthopedic specialists with various terms of involvement in the medical field at the hospital.

- Examination

  The essential goal was to decide the typical qualities and scopes of the humerus-elbow – wrist angle ,carrying angle. The optional goal was to decide the intraobserver and interobserver dependability of the estimations of the humerus-elbow - wristangle ,carrying angle , and Baumann angle . The third target was to decide the relationship between the humerus-elbow –wrist angle and the carrying angle to decide simultaneous legitimacy.

  The examiners chose the carrying angle since this angle is a dependable instrument to evaluate precise deformation of the elbow and in light of the fact that the idea of the carrying angle,which demonstrates a relationship between the humeral and ulnar tomahawks, is like the humerus-elbow - wrist angle [64].

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RESULTS

Out of total 100 patients , 24% were <5 years of age, 63% were 6-10 years , 13% were 10-12 years of age.

First Measurement	N	Minimum	Maximum	Mean	Std. Deviation
Hew angle -observer 1	100	10.20	18.10	13.54	1.47
Hew angle -observer 2	100	11.10	15.90	13.68	1.23
Hew angle -observer 3	100	10.80	16.80	13.76	1.31
Carrying angle -observer 1	100	10.10	16.90	14.22	1.49
Carrying angle -observer 2	100	10.90	16.80	14.02	1.34
Carrying angle -observer 3	100	11.80	16.90	14.17	1.34

Hew angle of observer 1, 2 and 3 were 13.54, (10.20-18.10)13.68,(11.10-15.90) and 13.76 (10.80-15.80),respectively, on first measurement . Carrying angle of observer 1, 2 and 3 were 14.22 (10.10-16.90) , 14.02(10.90-16.80)and 14.17(11.80-16.90), respectively.

Second measurement	N	Minimum	Maximum	Mean	Std. Deviation
Hew angle -observer 1	100	10.10	18.00	13.57	1.45
Hew angle -observer 2	100	1.90	15.90	13.58	1.70
Hew angle -observer 3	100	10.90	16.80	13.82	1.31
Carrying angle -observer 1	100	10.00	17.00	14.21	1.52
Carrying angle -observer 2	100	10.90	17.00	14.05	1.34
Carrying angle -observer 3	100	11.90	16.90	14.18	1.34

Hew angle of observer 1, 2 and 3 were 13.57, (10.10-18.00)13.58,(1.90-15.90) and 13.826(10.90-16.80),respectively, on second measurement . Carrying angle of observer 1, 2 and 3 were 14.21 (10.00-17.00) , 14.05(10.90-17.00)and 14.18(11.90-16.90)

Laterality	No. of patients	Percentage
LEFT	48	48.0
RIGHT	52	52.0
Total	100	100.0

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Out of 100 measurements , left and right elbow was used in 48 and 52 childrens , respectively

Correlation between First Measurement with Second Measurement

Hew Angle	Correlation	p-value
Observer 1	0.998	0.000
Observer 2	0.998	0.000
Observer 3	0.966	0.000

Comparison between first measurement and second measurement of Hew angle showed almost perfect linear positive correlation. The values for correlation for observer 1 was 0.998

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Carrying angle	Correlation	p-value
Observer 1	0.990	0.000
Observer 2	0.998	0.000
Observer 3	0.998	0.000

Comparison between first measurement and second measurement of Carrying angle showed almost perfect linear positive correlation. The values for correlation for observer 1 was 0.990

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Hew angle	Mean	SD	Min	Max	Sw	Pr	Rep	ICC	(95% CI)	
Observer 1	13.55	1.46	13.54	13.57	0.048	0.094	0.133	0.999	0.998	0.999
Observer 2	13.69	1.50	13.68	13.70	0.016	0.032	0.045	0.999	0.998	0.999
Observer 3	13.79	1.71	13.76	13.82	0.179	0.352	0.497	0.983	0.974	0.988

Mean Hew angle measurement of Observer 1 , Observer 2 and Observer 3 were 13.55 (SD 1.46, Range-13.54-13.57), 13.69(SD 1.50, Range-13.68-13.70) and 13.79(SD 1.71, Range- 13.76-13.82) respectively .Within subject standard deviation (Sw) precision, repeatability and the intraclass correlation coefficient (ICC) of

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Observer 1 , were 0.048, 0.094, 0.133 and 0.999; Observer 2 were 0.016, 0.032,0.045and 0.999; and Observer 3 were 0.179, 0.352,0.497 and 0.983. These results show very high Intra observer correlation , precision and repeatability.

Carrying angle	Mean	SD	Min	Max	Sw	Pr	Rep	ICC	(95% CI)	
Observer 1	**14.21**	**2.26**	**14.21**	**14.22**	**0.004**	**0.008**	**0.011**	**0.995**	**0.993**	**0.997**
Observer 2	**14.03**	**1.80**	**14.02**	**14.05**	**0.026**	**0.052**	**0.073**	**0.999**	**0.999**	**0.999**
Observer 3	**14.17**	**1.79**	**14.17**	**14.18**	**0.013**	**0.025**	**0.035**	**0.999**	**0.999**	**0.999**

Mean Carrying angle measurement of Observer 1 , Observer 2 and Observer 3 were 14.21 (SD 2.26, Range-14.21-14.22), 14.03(SD 1.80, Range-14.02-14.05) and 14.17 (SD 1.79, Range- 14.17-14.18) respectively .Within subject standard deviation (Sw) precision, repeatability and the intraclass correlation coefficient (ICC) of Observer 1 , were 0.004, 0.008, 0.011 and 0.995; Observer 2 were 0.026, 0.052,0.073and 0.999; and Observer 3 were 0.013, 0.025,0.035 and 0.999. These results show very high Intra observer correlation , precision and repeatability.

HEW ANGLE	Observer 1	Observer 2
First measurement	**13.54**	**13.68**
second measurement	**13.57**	**13.70**

Comparison of measurement of Hew angle between Observer1 and Observer 2 on first measurement was 13.54 and 13.68 respectively. The results for second measurement of Hew angle for observer 1 and observer 2 were 13.57 and 13.70 respectively.

HEW ANGLE	Observer 1	Observer 3
First Measurement	**13.54**	**13.76**
Second Measurement	**13.57**	**13.82**

Comparison of measurement of Hew angle between Observer1 and Observer 3 on first measurement was 13.54 and 13.76 respectively. The results for second measurement of Hew angle for observer 1 and observer 3 were 13.57 and 13.82 respectively.

HEW ANGLE	Observer 2	Observer 3
First Measurement	**13.68**	**13.76**
Second Measurement	**13.70**	**13.82**

Comparison of measurement of Hew angle between Observer 2 and Observer 3 on first measurement was 13.68 and 13.76 respectively. The results for second measurement of Hew angle for observer 1 and observer 3 were 13.70 and 13.82 respectively.

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CARRYING ANGLE	Observer 1	Observer 2
First Measurement	14.22	14.02
Second Measurement	14.21	14.05

Comparison of measurement of Carrying angle between Observer1 and Observer 2 on first measurement was 14.22 and 14.02 respectively. The results for second measurement of Carrying angle for observer 1 and observer 2 were 14.21 and 14.05 respectively.

Carrying Angle	Observer 1	Observer 3
First Measurement	14.22	14.17
Second Measurement	14.21	14.18

Comparison of measurement of Carrying angle between Observer1 and Observer 3 on first measurement was 14.22 and 14.02 respectively. The results for second measurement of Carrying angle for observer 1 and observer 3 were 14.21 and 14.05 respectively.

CARRYING ANGLE	Observer 2	Observer 3
First Measurement	14.02	14.17
Second Measurement	14.05	14.18

Comparison of measurement of Carrying angle between Observer2 and Observer 3 on first measurement was 14.02 and 14.17 respectively. The results for second measurement of Carrying angle for observer 2 and observer 3 were 14.05 and 14.18 respectively

n=200	Observer 1	Observer 2
HEW ANGLE	13.55	13.69
CARRYING ANGLE	14.21	14.03

Cumulative Hew angle after first and second measurement of Observer 1 and Observer 2 were 13.55 and 13.69 respectively. Cumulative Carrying angle after first and second measurement of Observer 1 and Observer 2 were 14.21 and 14.03 respectively.

n=200	Observer 1	Observer 3
HEW ANGLE	13.55	13.79
CARRYING ANGLE	14.21	14.17

Cumulative Hew angle after first and second measurement of Observer 1 and Observer 3 were 13.55 and 13.79 respectively. Cumulative Carrying angle after first and second measurement of Observer 1 and Observer 3 were 14.21 and 14.17 respectively

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n=200	Observer 2	Observer 3
HEW ANGLE	13.69	13.79
CARRYING ANGLE	14.03	14.17

Cumulative Hew angle after first and second measurement of Observer 2 and Observer 3 were 13.69 and 13.79 respectively. Cumulative Carrying angle after first and second measurement of Observer 1 and Observer 2 were 14.03 and 14.17 respectively

DISCUSSION

In the present investigation, radiographic measurements were performed to decide the normal value and the range of the humerus-elbow - wrist angle in children which were under 13 years of age and were healthy too. The intra-observer and interobserver reliabilities of humerus-elbow - wrist angle estimations were good and were equivalent to or more prominent value than those for the carrying angle and the Baumann angle.[4] The simultaneous legitimacy of estimation of the humerus-elbow – wrist angle was affirmed by the solid relationship between the humerus-elbow - wrist angle and carrying angle measurements.[5]

However, the methods used for the purpose of carrying angle and Bauman angle have certain limitations. For the most part, measurement of radiographic report of the carrying angle is characterized by the axis of the shafts of the humerus along with the ulna. Since the ulnar shaft is muddled by the S state of the ulna, meaning of the hub of the ulnar shaft is distinctive for every examiner. Diverse examiners or pediatric experts have utilized the proximal part of the ulna [6-8], the diaphysis of the ulna, or the midline between the focal or central points at 2 areas along the ulna of the ulna, though others have given no reasonable definition. Henceforth, the announced estimation of the carrying angle fluctuates as indicated by the definition. The Baumann angle is characterized by the axis of the humeral shaft and a line along the capitellar physis. Some examiner have also questioned the reliability of the Baumann angle in light of the fact that great amount of difficulty is faced in recognizing capitellar development and distal humeral osseous landmarks . Various authors in the past have demonstrated that the metaphyseal outskirt is excessively unpredictable in children, which can cause alteration of the Baumann angle.[9-11] The humerus-elbow - wrist angle demonstrates the angulation of the longitudinal pivot of the humerus and lower arm.

The pivot or axis of the forearm is characterized by a line going through the midpoints of 2 transverse lines interfacing the cortices, which help to decide the focal axis of the fore arm. Despite the fact that the first writing and different reports with respect to the humerus-elbow - wrist angle just depicted the level of 2 transverse lines over the lower arm as "1 proximal and 1 distal,"4-14 it has been determined the level of these lines at the radial tuberosity and the highest point of the outspread bowing. This definition may lead to higher reliability of the measurement.[12]

In 1984, Oppenheim et al. first wrote about the estimation of the humerus-elbow - wrist angle with utilization of full view radiographs of the humerus and forearm. In that report, the distal transverse line of the lower arm was drawn around the distal area of the radius. In 2005, Kim et al. altered the measurements by utilizing just radiographs of the elbow.

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The uneven circulation by gender or laterality in the present examination could have influenced the normal value and range computed for each radiographic parameter. An impartial populace based vast examination with an enlistment of all the volunteers being healthy is attractive to acquire genuine standardizing information on coronal arrangement of the upper appendage in the developing kids. Second, as portrayed over, the first writing and different past reports in regards to the humerus-elbow – wrist angle did not unmistakably characterize the level of the proximal and distal transverse lines of the forearm . For exact estimations, we utilized our own technique for estimating the measurements of the humerus-elbow - wrist angle . Our estimation technique for the carrying angle was chosen since it is generally used to decide the hub of the ulnar shaft1 yet there are a wide range of meanings of the carrying angle . The utility of our data in regards to the humerus-elbow – wrist angle and carrying angle might be essentially restricted. The humerus-elbow - wrist angle and carrying angle can't be effectively estimated in patients with elbow contractures, which speaks to a hindrance of this estimation strategy. [13] Regardless of such constraints, we found that the estimation of the humerus-elbow - wrist angle was related with great both reliability as well as validity.

Conclusion:

Measurement of the humerus-elbow-wrist angle demonstrated good reliability and validity. We infer that the humerus-elbow - wrist angle is a dependable radiographic measurement of coronal arrangement of the humerus and forearm.

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