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Ultra sound assisted calculation of rotational malalignment in supracondylar humerus fracture in pediatrics: Comparison with clinical assessment and its reliability

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Abstract
Supra condylar Humerus fracture are the commonest elbow injury in children, constitute 70 – 80 percent. There are three dimensional displacements which include coronal, sagital and rotational planes. Coronal and sagital malalignment can easily calculated by cortical alignments, anterior humeral line, Baumann's angle, metaphyseo diaphyseal angle. For measuring rotational malalignment we need to rely either clinically or on CT scan (cost and radiation).
Ultrasound assisted method is non invasive, cost effective and reproducible. Present study is the assessment of rotational Malunion of Humerus in Supracondylar fracture based on ultrasound calculations in 10 patients and comparison with their contra lateral normal Humerus.

Keywords: Supracondylar fracture, rotational, ultrasound

Introduction
After the formation of cranial limb buds, skeletal elements like head of humerus with greater and lesser tubercles and intertubercular sulcus with biceps tendon are seen at about 10 weeks of gestation [1]. Humeral torsion is defined as the rotational difference in the relative position of the humeral head and the axis of the elbow at the distal humerus [2].
At the time of birth, the humeral head is in marked retroversion and undergoes a process of derotation during the course of development. Rotational stresses result in an adaptive response that derotates the humeral head and reduces the amount of retroversion during this time. This process occurs most rapidly up to the age of 8 years and then slows down, approaching mean adult values by the age of 16 years and ceases with closure of the physis at skeletal maturity [3].
The retroversion of the head of humerus differs slightly on dominant and non dominant side [4]. This present as the internal and external rotation difference of shoulder at 90 degree of abduction, with some change in total arc of motion [5]. The different factors effecting humeral-retroversion angle are throwing activity, age and gender [6]. Obstetric Brachial Plexus Palsy also effects normal correction of torsion in neonates [7]. Fractures malalignment also effect the orientation of distal humerus transcondylar axis with the retroversion and presents as increase in retroversion.
Glenohumeral internal rotation deficit (GIRD) is an adaptive process described for sports involve throwing of ball, in which the throwing shoulder experiences a loss of internal rotation (IR). GIRD has most commonly been defined by a loss of >20° of IR compared to the contralateral shoulder [8].
GIRD has been associated with numerous pathologic conditions, including posterior superior labral tears, partial articular-sided rotator-cuff tears, and superior labral anterior-to-posterior tears [9].

Fractures of humerus especially surgical neck and shaft, in pediatric age group are managed conservatively or by minimal surgical interventions. Supra condylar fracture, constituting about 70% to 75% of elbow injuries, managed most of the time by closed or open pinning targeting optimum, anatomical reduction [10]. The amount of correction of Malunion by remodeling process is very less in these fracture, and it needs complete alignment of fracture fragments in all planes [11]. There is tri planar malalignment in supra condylar fractures, which includes coronal, sagital and rotational plane. Coronal and sagital plane can be measured easily on plane radiograph by assisting cortical alignment, anterior humeral line, Baumann's angle and Metaphyseo Diaphyseal angle [12].

Rotational malalignment of lesser degrees is difficult to make out on X ray during or after surgery. This can be measured post operatively by loss in the internal or external rotation at the shoulder joint with shoulder in abduction of 90 degree. Most of the time there is no change in total arc of movement at the shoulder, but shift of arc may produce pathological lesion in labrum, capsule and joint itself [13].

There are many different methods documented in literature to measure the retroversion of humeral head especially in obstetric brachial plexus palsy by using MRI or CT scan [14, 15]. Very few studies described retroversion calculation by using ultrasound method, that too in adults [16]. To the best of our knowledge no such methods described for pediatric age group. Present study is measurement of humeral retroversion using ultrasound method.

In case of malunited Supracondylar fracture the amount of rotational changes at shoulder is purely contributed by rotational malalignment of fracture with no associated soft tissue component. In other conditions with contracted muscle like OBPP and Cerebral Palsy (CP) the rotational restriction is partially by bone and muscle components each. The amount of retroversion variation should theoretically correlate with clinical examination in rotational Malunion of fracture, but it partly coincides with the findings in OBPP and CP.

Methodology

After IRB (institutional review board) clearance, Study was done over 10 patients with history of Gartland type III supra condylar fracture, managed by any means that is by conservative method or open/closed reduction.

Inclusion criteria

- Patients willing to participate in the study.
- Age groups 2 years to 12 years, male and female are included.
- Patients who passed radiological stage of remodeling.

Exclusion criteria

Patients having the history of previous upper limb fractures.

Method

Patient placed supine on the couch with the elbow flexed 90 degrees. Fore arm supinated and facing 90 degrees to the ground. Orientation of bicondylar axis in this position is considered as a base line, for reference.

The baseline of the proximal humerus was determined to be perpendicular to the line that connected the greater tuberosity and the lesser tuberosity most prominently. The transducer tilted till these land marks appeared horizontal on screen.

The amount of the tilt measured, by attaching smart phone inclinometer to the transducer probe. The measurements obtained were compared with the clinical examination.

Table 1: Showing the details of fracture, clinical rotational mal-alignment and correlation with ultrasound

PT. Name	Age	Gender	Mode of injury	Diagnosis/ fracture side and grade	Other deformity	Shoulder Movement	External rotation	Ultrasound retroversion	Treatment Done.
						Internal rotation			
1.	5 yrs	F	Fall at home	Supracondylar, Gartland type III L- side	Malunited cubitus varus	Rt. 90 Lt 110	Rt 110 Lt 90	R/21 L/42	none
2.	3 yrs	F	Fall at home	Supracondylar, Gartland type III L-side	-------	Rt 95 Lt 95	Rt 100 Lt 100	R/18 L/18	CRIF with K wire
3	2 yrs	M	Fall from bike	Supracondylar, Gartland type III, L- side	---------	Rt 90 Lt 100	Rt 100 Lt 90	R/10 L/22	CRIF with K wire
4.	11yrs	M	Fall from window	Supracondylar, Gartland type III, R- side.	----------	Rt 100 Lt 100	Rt 100 Lt 100	R/14 L/14	CRIF with K wire
5.	8yrs	M	Fall at home	Supracondylar, Gartland type III, L- side	Malunited cubitus varus	Rt 95 Lt 115	Rt 115 Lt 95	R/18 L/38	Corrective osteotomy
6.	9 yrs	M	Fall from rooftop	Supracondylar, Gartland type III, R- side	----------	Rt 100 Lt 100	Rt 110 Lt 110	R/22 L/22	CRIF with K wire
7.	6 yrs	M	Fall at home	Supracondylar, Gartland type III, R-side	----------	Rt 90 Lt 90	Rt 110 Lt 110	R/18 L/18	CRIF with K wire
8.	4 yrs	F	fall from bike	Supracondylar, Gartland type III, L- side.		Rt 100 Lt 130	Rt 100 Lt 90	R/20 L/40	CRIF with k wire
9.	5 yrs	M	Fall from wall	Supracondylar, Gartland type III, R- side.	-------	Rt 100 Lt 100	Rt 100 Lt 100	R/14 L/14	CRIF with K wire
10.	8 yrs	M	Fall at home	Supracondylar, Gartland type III, R- side.		Rt 100 Lt 100	Rt 110 Lt 110	R 18 L18	ORIF with K wire

Results

This study was done in a sample of 10 pediatric patients age group in between 2 years to 11 years old in Gartland type III of Supracondylar fracture.3 females and 7 males in the study. Two presented with mal union with 25 degree of varus and 20 degree shift in arc of rotation (increased internal rotation and decrease external rotation).

All patients treated surgically have almost equal range of movement only one had persistent 10 degree rotational malalignment. There was no significant difference between the dominant and non dominant sides. Mean age was 6.1 years (2 years to 11 years). The involvement side wise was 50 percent each right and left elbow.

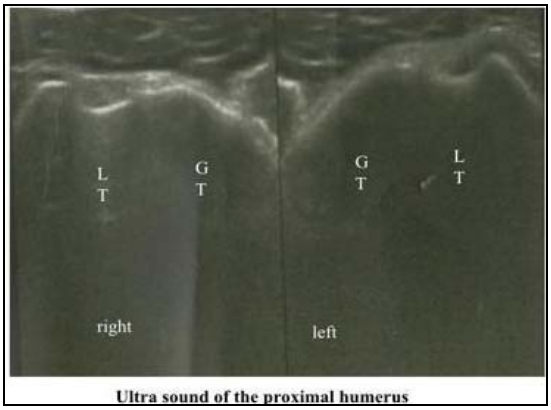
The ante version measured by ultrasound was between 10

degrees to 22 degrees in the normal limbs and was increased in effected side by 10 degrees in one and 20 degrees in two subjects; this was in correlation with the clinical increase in the internal rotation moments.

One patient treated with open reduction and 2 underwent corrective osteotomy using Vellore technique remaining (7 patients) managed with closed reduction and internal fixation using K wires.

Elbow placed 90 degrees to the ground (reference)

The inclinometer inclined to the reference line to view the standard image of proximal humerus



Ultra sound of the proximal humerus

Discussion

All the fractures along the humerus need to be evaluated for the total rotational arc alteration or deficit. Patients at risk of developing GIRD (Glenohumeral internal rotation deficit) need to be followed in future for any possible labral, capsular or joint pathologies associated with it. Among the available modalities ultra sound is cost effective, portable and noninvasive method, which can be used in OPD for this purpose.

The use of this technique can be extended to evaluate the same in other condition effecting humeral torsion like obstetric brachial plexus palsy, spastic cerebral palsy etc.

Conclusion

In this current study, ultrasound methodology shows a significant relationship between internal rotation, external rotation and humeral retroversion at 90 degree abduction and flexion at elbow on affected limb and non affected limb respectively. Patient having cubitus varus with rotational deformity had almost same value clinically and by ultra sound assessment.

Hence this method is reliable, reproducible and cost effective.

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