

## Extensive study of internal fixation in fractures of lateral humeral condyle

Nitin S. Patil<sup>1</sup>, S. V. Gowtam<sup>1</sup>, Swapnil Chitnavis<sup>1</sup>

### Abstract

In an extensive study and follow up of 30 years, it is observed that fractures of lateral humeral condyles are relatively common injuries in children in the developing regions of the world. They constitute 16.8% of total fractures of the distal humerus. The present series includes a study of 105 cases of fractures of lateral humeral condyle treated at KIMS, Karad and some other hospitals in the city. Early surgery is advised for established nonunion where the condylar fragment is in good position. Delayed O.R.I.F., while still leaving much to be desired, does result in improvement in stability and function of the elbow. Open reduction and internal fixation of fractures up to 6 weeks after injury, is recommended. Fractures over 6 weeks of duration are best left alone with active physiotherapy as the results become progressively disappointing with delay.

**Keywords:** Lateral Humerus Fracture, Internal Fixation Of Fracture, Pull Off Theory, Milch Classification, Wadsworth Classification, Stages Of Displacement, Operative Approach.

### Introduction

In an extensive study and follow up of 30 years, it is observed that fractures of lateral humeral condyles are relatively common injuries in children in the developing regions of the world. They constitute 16.8% of total fractures of the distal humerus. The patients are usually seen at our clinics either because of onset of tardy ulnar nerve paresis or because a youth's parents are anxious to know whether their son's mobile but somewhat unsightly elbow likely to render him unfit for permanent commission in one of the government services. This injury is common in our country and many come late for treatment and pose an entirely different problem as far as treatment is concerned, as compared to western countries. Wilson has rightly stated that this fracture seems to escape recognition and to receive less satisfactory treatment than almost any other fractures of the elbow".

The injury is serious in view of the disturbance it causes in the important developing area at the lower end of humerus. The incidence of the functional loss of the range of motion of the elbow is much greater with fractures of the lateral condylar physis because the fracture line extends into the articular surface. The complications of lateral condylar physis may not be obvious months after the initial injury. The complications are malunion, nonunion, cubitus valgus deformity, loss of

motion, traumatic arthritis or tardy ulnar neuritis to quote a few. The poor outcome or a lateral condylar physis injury may not be manifested until months or even years later. This declares the term "the fracture of necessity"

In dealing with this fracture, one should realize the chance of pitfalls and having a poor functional result with the poor management. These fractures are difficult to manage because of the displacement and fibrosis around the condylar fragment secondary to the delay. There is a paucity of literature concerning the management of these fractures. An often-repeated finding is the requirement of extensive dissection around the fragment for proper reduction. The diagnosis both on x-ray and clinically may be less obvious as, much of the portion of the condyle is cartilaginous which is not visible on x-ray. Radiograph shows only ossific nucleus of this large piece of incompletely ossified cartilage and accounts for the frequency with which this fracture is overlooked or the displacement misinterpreted. To avoid complications early accurate reduction is desired with stable fixation. Unstable, rotated and displaced (>2 mm) fractures are managed with Open Reduction and Internal Fixation (ORIF) with Kirschner's (K) wires or screws.

The aims and objective of the study is to compare results of open reduction and internal fixation in fresh and old fractures of lateral humeral condyle; to evaluate and compare the results as well as behavior of fractures of lateral humeral condyle fixed internally in children and in adults and to study late results of operative managements.

### Mechanism of Injury

The fracture usually results from indirect violence such as fall on outstretched hand. Two main theories as to the mechanism have been advocated. These can be appropriately called as

<sup>1</sup>Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad.

#### Address for correspondence:

Dr. S. V. Gowtam,

Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad.

E-mail: [svgoutam70@gmail.com](mailto:svgoutam70@gmail.com)

Submitted: 10 February 2021; Reviewed: 5 March 2021; Accepted: 15 March 2021; Published: 10 April 2021

DOI: [10.13107/jto.2021.v16i2.374](https://doi.org/10.13107/jto.2021.v16i2.374)

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License <https://creativecommons.org/licenses/by-nc-sa/4.0/>, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms



Figure 1: Typical, Mobile Fractured Lateral Humeral Condyle

PUSH OFF & PULL OFF theories.

### Pull off/ avulsion theory

It has the most followers. It occurs due to fall on the outstretched hands with the elbow extended and adducted with the forearm supinated. The elbow forced into varus which along with the extensor muscles and lateral collateral ligaments applies an avulsion force to the lateral condyle. Here the fracture line extends to the trochlear notch. The trochlear ridge of the ulna behaves as a fulcrum for avulsion of the lateral condyle. The bone will separate but some epiphyseal and articular cartilage may remain intact as a 'hinge'. If deforming angulation is increased the cartilage hinge may tear which may lead to fracture displacement and dislocation of the elbow. Thus, the elbow is unstable. This is Salter Harris Type II injury.

### Push off theory

Stimson suggested this theory. It occurs when the patient falls forward on the palm with the elbow flexed. This forces the radial head against the capitulum and causes a fracture line through capitulo-trochlear notch. Some authors proposed that it can be a result of direct blow to the olecranon. This is the less common Salter Harris Type IV physal fracture. It is often associated with posterior dislocation of elbow or fractured olecranon.

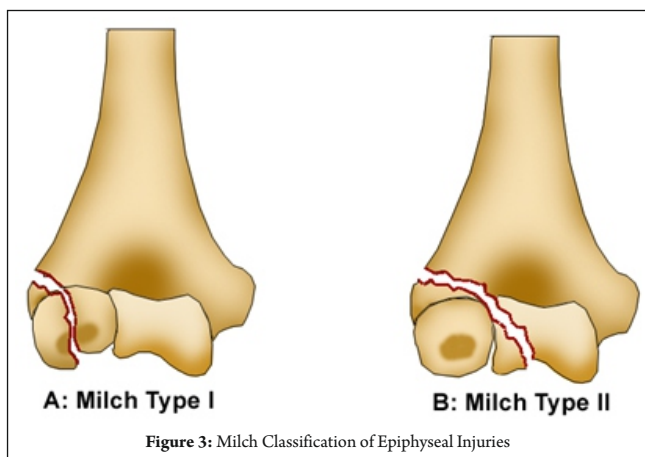


Figure 3: Milch Classification of Epiphyseal Injuries



Figure 2: Fall on Outstretched Hand With Elbow Extended, Adducted and Forearm Supinated


## Materials and Methods

The present series includes a study of 105 cases of fractures of lateral humeral condyle treated at KIMS, Karad and some other hospitals in the city. All mentioned cases were personally operated and reviewed by us. All these cases were treated by open reduction and internal fixation method. It includes both prospective and retrospective study of cases. Out of 105 cases, 18 cases were studied retrospectively while the others prospectively, over a period of about 30 years. They were followed up for 2 months to 30 years after surgery. Cases which did not turn up for follow up are not included in this series.

There were eighteen girls and eighty-seven boys including adults. As such isolated fracture of lateral humeral condyle is rare in adults and majority of the times, they are part of the T-Y fracture of lower end of humerus out of 105 cases, twelve were adults. The youngest was aged 2 years and the oldest was 45 years. The average age was found to be 8 years. Out of these, twelve cases were treated previously in the form of splintage which became displaced in the course of time and were treated by open reduction subsequently. Three cases were operated by 'k' wire fixation but presented to us with frank nonunion.

Twenty-seven of the cases had ununited fractures of lateral humeral condyle out of which fifteen cases presented with frank the nonunion while others were of delayed union in malposition. All the cases reported were operated within 3 days of admission. The average time interval from injury to treatment was 3 days in fresh cases and 9 weeks in

Salter-Harris (SH) Physal Injury Classification	
Type	Characteristics
I	Separation through the physis, usually through areas of hypertrophic and degenerating cartilage cell columns.
II	Fracture through a portion of the physis that extends through the metaphyses.
III	Fracture through a portion of the physis that extends through the epiphysis and into the joint.
IV	Fracture across the metaphysis, physis and epiphysis.
V	Crush injury to the physis.



SH Classification from I - V

Figure 4: Salter - Harris Physal Injuries

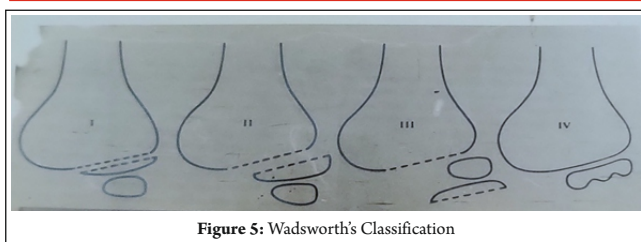


Figure 5: Wadsworth's Classification

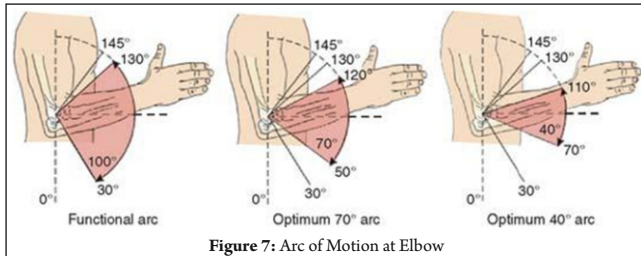


Figure 7: Arc of Motion at Elbow

late/neglected cases. All except three were caused by a fall on the outstretched hand. Each patient was operated by the same team of senior surgeon.

### Method of study

Details – The detailed history was taken preferably from the patient when first seen in the outpatient department or otherwise with special attention to – 1. Fracture Configuration 2. Type of Fracture

Fracture configuration - every patient when first was examined radiologically. Standard anteroposterior and lateral views were taken in each case. In case where doubt existed, oblique views were taken which in some cases revealed the fracture. To see for instability stress x-rays were taken with maximum valgus and varus stress applied to elbow. Lateral views with elbow in as much flexion as possible and in extension were useful to know the mobility of fractured fragment. Associated fractures were also x-rayed. Magnetic resonance imaging was done for patients aged 1 to 3 years to aid in diagnosis

Type - from the x-ray the status of union, either delayed union, mal union or nonunion was noted. The fracture was classified according to 'MILCH' or 'SALTER HARRIS' typing. The degree of displacement was noted.

### Preoperative

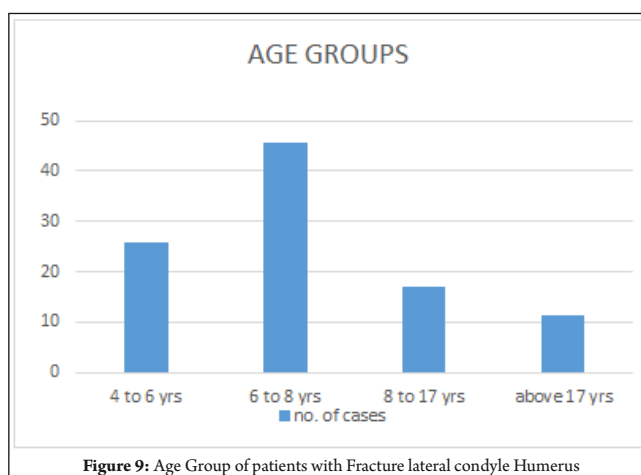


Figure 9: Age Group of patients with Fracture lateral condyle Humerus

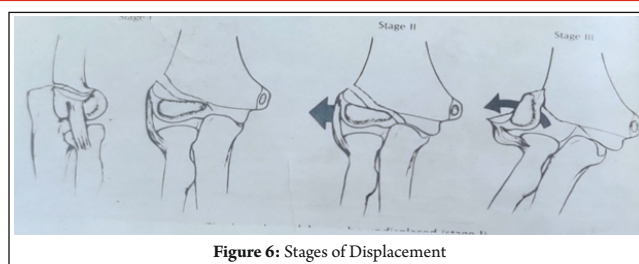


Figure 6: Stages of Displacement

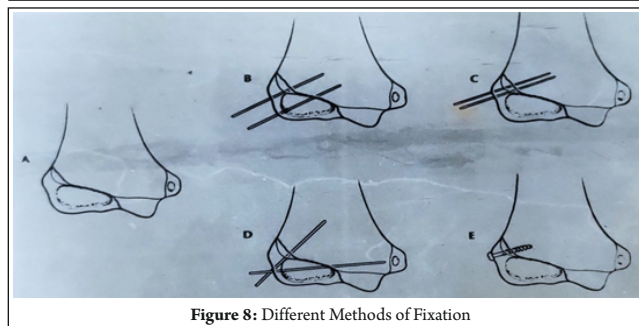


Figure 8: Different Methods of Fixation

Patient was given high elevation preoperatively to reduce the oedema along with injectable antibiotics to eliminate the risk of postoperative infection. The Patient was thoroughly investigated.

In this present study, 'all displaced fractures of lateral humeral condyle were treated by open reduction and internal fixation'

The objectives of operative treatment are:

1. Establishment of condylar alignment so that the axis of rotation of condyles are the same.
2. To restore the developing osseous link between trochlear and capitular surface so as to maintain congruous joint surface and an adequate lip of the trochlea.
3. To achieve accurate anatomical reduction of the fracture along with stability so that early full functional range of motion can be achieved.

All fractures were classified according to Milch classification.

While Stimson was one of the first to describe two fracture lines, it was Milch who attributed a clinical significance to the anatomical location of a fracture line

MILCH TYPE I - Fracture line courses lateral to the trochlea through the capitulotrochlear groove. In this type the elbow stability is maintained as the trochlea remains intact. This is

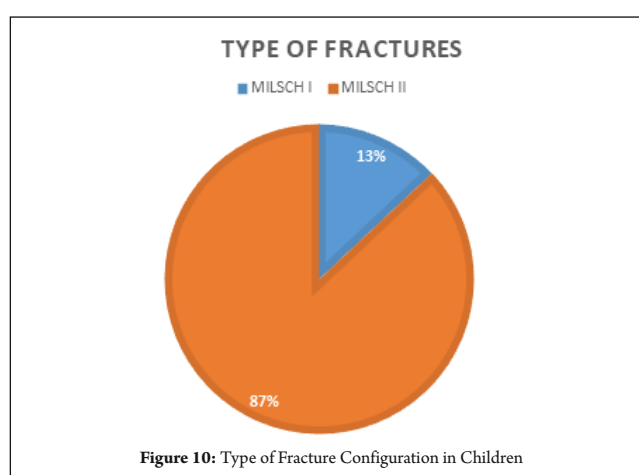
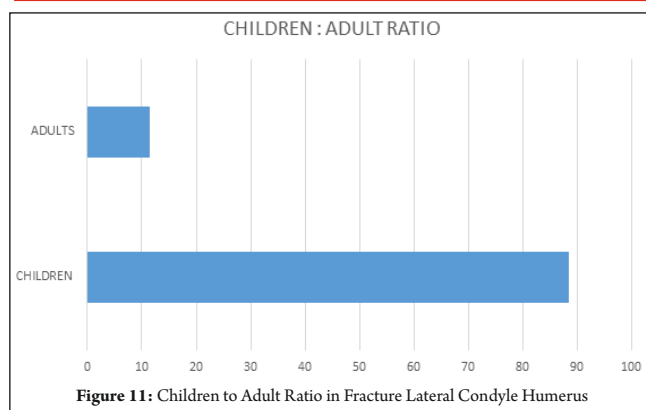


Figure 10: Type of Fracture Configuration in Children





Salter Harris Type IV epiphyseal injury.

MILCH TYPE II - Fracture line extends into the apex of trochlea which produces instability of the elbow because of the ability of the distal fragment and the forearm not only to angulate but translate into lateral position. This is Salter Harris Type II epiphyseal injury.

### Fracture lines

There are two distinct fracture lines involving the lateral condylar physis-

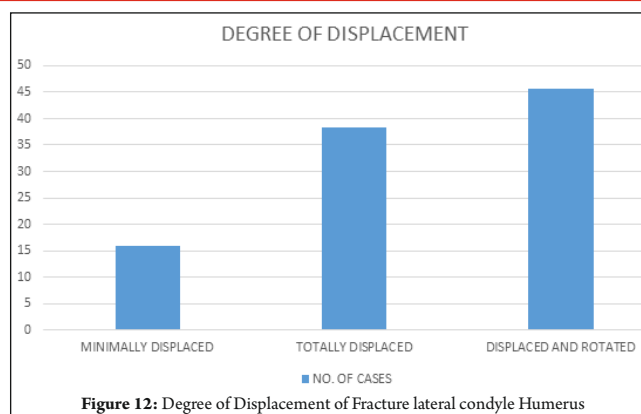
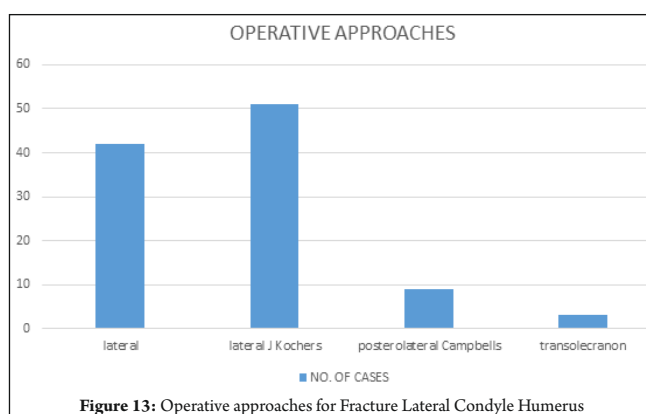
(1) The most common type originates in posterolateral metaphysis, then usually courses along the physal cartilage into the depths of trochlea involving its lateral crista. There is no contact between the ossification center of epiphysis and exposed bone of metaphysis. This is more of Salter Harris Type II epiphyseal injury.

(2) In this, fracture line originates in the metaphysis, then crosses the physis more or less obliquely, finally traverses the physis more or less obliquely and then traverses the ossification center of the lateral condyle to exit in the area of capitulotrochlear groove. There can be contact between bony ossification center of epiphysis and bony metaphysis leading to growth arrest due to an osseous bridge. This is Salter Harris Type IV epiphyseal injury. It is rare.

• MILCH TYPE 1 - FRACTURE PASSES LATERAL TO THE TROCHLEAR GROOVE

• MILCH TYPE 2 - FRACTURE PASSES THROUGH THE TROCHLEAR GROOVE

AS ACCORDING TO EPIPHYSEAL INJURIES; SALTER HARRIS CLASSIFICATION WAS USED



### Wadsworth's classification

Thomas Wadsworth in 1972 described four types of injury to lateral condylar epiphysis. Here the line of fracture and area of separation is in the metaphysis which carries capitular center along with it.

TYPE I - Metaphyseal fragment is a rim of bone and there is no displacement of the epiphysis.

TYPE II - Here there is subluxation of the epiphysis with the metaphyseal fragment accompanied by instability of the elbow joint.

TYPE III - There is dislocation of the epiphysis with its metaphyseal fragment and gross rotatory displacement so that the articular surface may be in contact with the fracture surface at the lower end of humerus. Dislocation of elbow joint may accompany this injury.

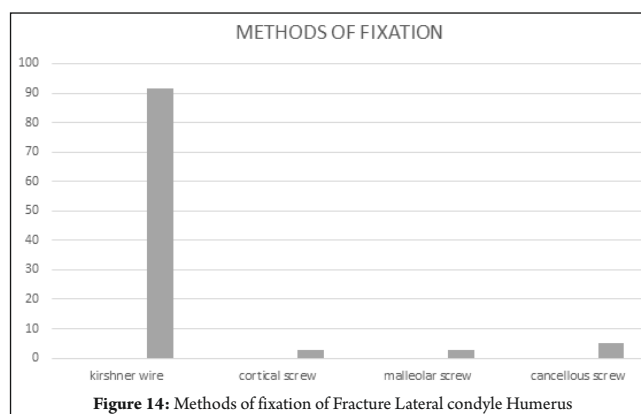
TYPE IV - There are osteochondritic changes in the capitular epiphysis as well as damage to radial head due to repeated impingement of radial head against the capitulum commonly found in baseball players.

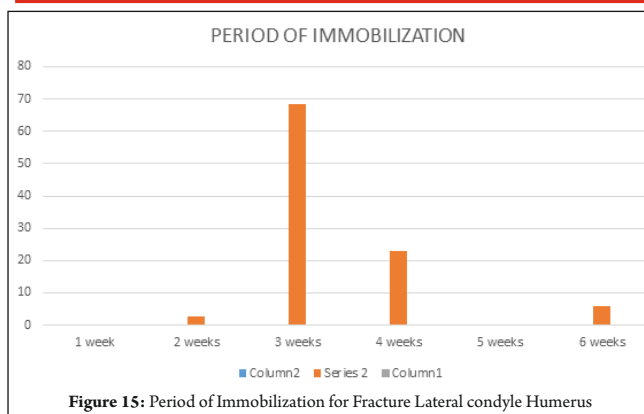
### Stages of displacement

Described by Wilson in 1982 three degrees displacements are observed.

1. An incomplete fracture in which a hinge articular cartilage is formed allowing some lateral angulation at elbow without any displacement. Here the musculotendinous origin of common extensor muscles with the periosteum is torn incompletely.

2. Complete fracture but slightly displaced fragment: the condylar fragment is free to move & it is displaced





proximally. There is no tilting or gross malalignment. Here the periosteum and tendinous origin are completely ruptured.

3. Complete fracture with displaced and rotated fragment: The fragment is displaced and rotated by the pull of extensor muscles not only round the horizontal axis but also round the vertical axis. The fragment lies almost upside down. It is found to be rotated through almost 180 degrees. So, its articular surface opposes the denuded metaphyseal fracture surface. Its lateral margin is found to be posteriorly and medial portion anteriorly. Thus, both static (collateral ligaments) and dynamic forces (muscle pull) account for displacement of distal fragment. Since this fracture line disrupts the lateral crista of trochlea the elbow joint becomes unstable. There may also be lateral translocation of lateral condyle with radius and ulna in addition to just posterolateral subluxation (angulation) of proximal radius and ulna.

### Operative

Patient is taken as early as possible to prevent organization of hematoma with fibrin deposition. The elbow is scrubbed thoroughly. Patient is kept supine with elbow flexed and resting over an arm board. Surgery is preferably done under tourniquet and under general anesthesia.

### Approach

A standard Kocher's lateral approach was preferred. The incision began 5 cm proximal to the elbow over lateral supracondylar ridge of the elbow. It was extended distally,

continued for 5 cm distal to radial head and then curved posteromedial to end at posterior border of ulna.

The interval between triceps posteriorly and brachioradialis and extensor carpi radialis longus anteriorly is found. Quite often a tear in the aponeurosis of the brachioradialis muscle was observed which led directly to the fracture site. Sometimes a tear of both the anterior and posterior elbow capsule was found. The metaphyseal fracture line was found to lie between the origins of brachioradialis and extensor carpi radialis longus and this gap can be explored easily but carefully also. Extreme care must be taken to prevent dissection near the posterior portion of the fragment as this is the entrance of the only blood vessel supplying the lateral condylar physis. Fracture site is then visualized. It is very important to avoid disturbing those structures attached to the distal fragment.

Minimum possible muscle stripping was done. The periosteum and soft tissues may be herniated into the fracture surface which are excised. In fresh fractures the hematoma should be drained and joint thoroughly irrigated. The separated fragment is held gently with toothed tissue forceps or K wire joystick method and reduced anatomically. In rotated fragment reduction can be achieved by adding a varus force over extended elbow and thus opening it laterally. To facilitate maintenance of it, one 'K' wire was passed temporarily through it into metaphysis. To facilitate reduction, it is advisable to identify the smooth articular surface first.

The fragment should be reduced anatomically, both at the fracture line in metaphysis as well as at the joint surface. It is confirmed by direct visualization or digital palpation especially at capitulotrochlear groove and anteriorly.

Now the size of metaphyseal fragment is taken into account and if sufficiently large, a cortical or cancellous or malleolar screw can be used. It is preferable to use two smooth Kirshner wires to prevent rotation of the fragment through metaphyseal piece into the proximal humerus medially. They should engage the opposite cortex. These can be passed in either of the ways as shown in figure no. 8. If the metaphyseal piece is small, the second wire can be passed through the physis itself.

We found the use of two divergent 'K' wires in an angle of 45 to 60 degrees better with one pin passing towards proximal



Figure 16: Case No 1 Preoperative Radiographs



Figure 17: Case No. 1 Post-operative Radiograph



Figure 17: Case No. 1 Post-operative Radiograph



Figure 18: Case No 2 Preoperative Radiograph



Figure 19: 2 Post-operatives Radiographs

humerus taking grip of metaphysis and a second pin transversely across the fracture line between capitulum and trochlea to engage medial cortex, thus maintaining the articular surface and the link between capitulum and trochlea.

Screws should be passed through metaphysis after drilling and screwed firmly against the opposite cortex.

The reduction was verified radiologically and incision was closed in layers with a drain and tourniquet released.

### Post operative

Following points were noted,

1. Type of immobilization:
2. Complications: they were divided into
  - a. Immediate
  - b. Late
3. Stitch removal
4. Mobilization
5. Implant removal

Post operatively a long arm posterior splint with elbow in 90 degrees flexion and forearm in neutral or slightly pronation. In contrast to the position of supination in which extensor muscles are relaxed, the position of pronation was found to be better. Acute flexed position binds the olecranon firmly with trochlea and full pronation of the forearm tends to secure the distal fragment to proximal fragment by radial fixation. Sutures are removed after 10 – 14 days. Post operatively, all patients underwent a common protocol; slab was removed after 3 weeks and cuff collar mobilization continued for another week. Then active exercises of elbow were started.

Implant removal: Implants were removed after 4-6 weeks

### Follow up:

Patients were regularly followed up at least for 6 months in regards to clinical and radiological assessments. They were evaluated functionally and cosmetically by the criteria provided by Hardacre.

Follow up periods were at the end of 3 weeks, 7 weeks and at

6 months

1. Clinically - Local findings like prominence, scar healing, thickening, tenderness, range of motion and carrying angle were noted. Instability of elbow if any judged.

2. Radiologically - Type of union, implant position, growth arrest, premature epiphyseal closure, myositis ossificans, arthritis, avascular necrosis, spur formation, fishtail deformity was carefully observed.

Union was said to have occurred when the fracture was obliterated by trabeculae or the callus.

### Evaluation of results

The criteria for assessment of results were according to that of Hardacre et al. They were based upon the functional and cosmetic points of view. Functional results were further differentiated into clinical and radiological observations

The following points were noted:

1. Status of union
2. Range of movements
3. Status of the epiphysis
4. Change in carrying angle
5. Other signs

Accordingly, the results are classified as as Excellent, Good and Fair.



Figure 20: Clinical Photos – post operative



**Table 1: Hardacre Criteria**

Excellent	a. Complete healing of fracture
	b. Full range of movements
	c. Normal carrying angle and appearance
	d. No symptoms
Good	a. Complete healing of fracture
	b. Loss of extension less than 15 degrees
	c. No arthritis or neurological signs
	d. Efficient range of motion
	e. Mild and subtle deformity
Fair	a. Complete healing of fracture
	b. Alteration in carrying angle and prominent deformity
	c. Presence of arthritic or neurological symptoms
	d. Presence of nonunion or neurological symptoms
	e. Loss of motion to extent of disability

**Table 4: Children to Adult Ratio in Fracture Lateral Condyle Humerus**

GROUP	NO. OF PATIENTS	PERCENTAGE
CHILDREN	93	88.60%
ADULTS	12	11.40%
TOTAL	105	100%

**Table 5 : Degree of Displacement of Fracture Lateral Condyle Humerus**

GROUP	NO. OF PATIENTS	PERCENTAGE
Minimally Displaced (hinge present)	21	20%
Totally Displaced (hinge broken)	36	34.30%
Displaced and Rotated	48	45.70%
TOTAL	105	100%

**Table 9: Range of Motion before and after surgery**

CASE NO.	TIME INTERVAL IN WEEKS	RANGE OF MOVEMENT	
		BEFORE OPERATION (DEGREES)	AFTER OPERATION (DEGREES)
9	4	50 – 90	10 – 140
27	12	30 – 80	0 – 140
42	10	50 – 60	30 – 100
51	20	80 – 105	30 – 100
75	8	35 – 120	10 – 140
78	12	30 – 90	10 – 110
58	4	30 – 110	5 – 135
68	5	40 – 90	15 – 130
105	6	30 – 100	20 – 125

**Table 2: Age Group of patients with Fracture lateral condyle Humerus**

Age group (years)	NO. OF PATIENTS	PERCENTAGE
6-Feb	27	25.80%
8-Jun	48	45.70%
17-Aug	18	17.10%
ABOVE 17	12	11.40%
TOTAL	105	100%

**Table 3 : Type of Fracture Configuration in Children**

FRACTURE TYPE	NO. OF PATIENTS	PERCENTAGE
MILCH TYPE I	12	13%
MILCH TYPE II	81	87%
TOTAL	93	100%

**Table 6: Other INJURIES COMMONLY found to be ASSOCIATED with THIS Fracture**

INJURIES	NO. OF PATIENTS	PERCENTAGE
POSTERIOR DISLOCATION OF ELBOW	3	2.87%
FRACTURE OF OLECRANON	2	1.90%
MYOSITIS OSSIFICANS	5	4.76%
COLLES FRACTURE	3	2.87%
FRACTURE OF INFERIOR PUBIC RAMUS SAME SIDE	1	0.95%

**Table 7: Methods of fixation of Fracture Lateral condyle Humerus**

Status of Union Preoperatively	NO. OF PATIENTS	Percentage
Kirshner wire	96	91.40%
Cortical screw	3	2.87%
Malleolar screw	3	2.87%
Cancellous screw	3	2.87%
TOTAL	105	100%

**Table 8: Period of Immobilization for Fracture Lateral condyle Humerus**

PERIOD OF IMMOBILIZATION	NO. OF CASES	Percentage
ONE WEEK	0	0
TWO WEEKS	3	2.85
THREE WEEKS	72	68.55
FOUR WEEKS	24	22.87
SIX WEEKS	6	5.73
TOTAL	105	100

The present study is based on observation made over 105 cases of fracture of lateral humeral condyle treated by open reduction internal fixation.

Sex Ratio - clearly indicates male predominance in sustaining this type of fracture being more active on playing grounds.

## Observation

**Table 10 : Radiological rESULTS in Neglected CASES**

CASE NO.	RADIOLOGICAL RESULTS	UNION STATUS
9	RADIOLOGICAL RESULTS	UNION
27	PREMATURE EPIPHYSEAL CLOSURE	UNION
42	20 DEGREES VALGUS, FISH TAIL DEFORMITY, ARTHRITIS	UNION
51	DELAYED UNION, S/O AVASCULAR NECROSIS	UNION
75	ARTHRITIS	NON UNION
78	AVASCULAR NECROSIS, SPUR FORMATION, LATERAL DEVIATION	UNION
58	LATERAL DEVIATION	UNION
68		UNION
105		UNION

**Table 13 : complications observed in the study**

Sr no.	COMPLICATIONS	NO. OF CASES
1	PROMINANCE	10
2	TOURNIQUET PALSY	4
3	INFECTION	4
4	PIN MIGRATION	2
5	HYPERTROPHIED SCAR	2
6	CUBITUS VALGUS	17
7	CUBITUS VARUS	2
8	POSTERIOR INTROSSEOUS NERVE PALSY	2
9	TARDY ULNAR NERVE PALSY	-
10	INSTABILITY OF ELBOW	3
11	DELAYED UNION	6
12	MALUNION	3
13	NON-UNION	1
14	AVASCULAR NECROSIS	4
15	ARTHRITIS	5
16	PREMATURE EPIPHYSEAL CLOSURE	7
17	SPUR FORMATION	5
18	FISH TAIL DEFORMITY	6

Side of Injury - Most of the times the child was holding something in his right hand and had a fall on his/her left outstretched hand

The injury was most common during the age group between 6-8 years and least common in adult age group. The average age incidence was calculated as eight years.

Majority of the patients were of Milch Type II fracture configuration i.e., Salter Harris Type II epiphyseal injury.

As such, isolated Fractures of this kind are rare in adults. The child to adult ratio 8:1

Majority of the cases were displaced and rotated with the loss

**Table 11: Length of Follow up carried in our study**

LENGTH OF FOLLOW UP	NO. OF CASES
3 MONTHS	12
6 MONTHS	36
2 YEARS	42
>2 YEARS	15
TOTAL	105

**Table 12: Result according to Hardacre's Criteria**

	FRESH CASES		LATE CASES		CHILDREN		ADULTS	
	NO.	%	NO.	%	NO.	%	NO.	%
EXCELLENT	15	19.1	-	-	12	12.9	3	25
GOOD	42	54	12	44.4	54	58.06	-	-
FAIR	12	15.4	3	11.2	15	16.14	-	--
POOR	9	11.5	12	44.4	12	12.9	9	75
TOTAL	78	100	27	100	93	100	12	100

**Table 14: Carrying Angle of patients with the their presentation**

GROUP	HEALTHY	INJURED	LOSS OF CARRYING ANGLE	P value
	Mean± SD(Degree)	Mean± SD(Degree)	Mean± SD(Degree)	
Early	8.7± 1.1743	7.4±0.8208	1.3±1.03	0.394
Late	9.5±0.8885	7.6±0.9947	1.9±0.9	

of normal osseous link between capitulum and trochlea thus making the elbow more unstable. Pull of extensor muscles have a greater effect over rotation of fractured fragment.

Status of Union in Cases which reported Late - for convenience, cases ununited after time of 5 weeks were labeled as of delayed union and those after 3 months of time as ununited (nonunion).

Whether the dislocation was primary or secondary to instability of elbow, due to displaced fracture fragment, could not be commented. All these injuries occurred due to fall on outstretched hand from height.

Thus, 'K' wire fixation was the method of choice especially in children while screws were used mainly for adults.

Majority of cases did start uniting within three weeks. In a case, the trans olecranon wire was removed after 6 weeks, when active exercises could be started. In another case, immobilization was more as a safety measure, where bone grafts were added to already existing nonunion.

In neglected cases the immobilization was maintained for a longer time i.e., for 4 weeks

1. Range of movement before commencement of treatment and range of movement at follow up after operative intervention; in cases which reported late: in relation to time interval between injury to treatment

It showed clearly that the range of movement was improved after surgery even in 20 weeks old nonunion.

2. Radiological results in Neglected Cases

This showed that the results functionally and radiologically were good in fractures operated within 6 weeks of delay, but were poorer thereafter. Though the range of motion



improved in later group other complications were also visible.

The shortest follow up was three months and the longest was about twelve years (retrospectively).

### 3. Results evaluated according to Hardacre's Criteria in Fresh and Neglected cases as well as in Children and in Adults

From table no. 12, it is observed that fresh cases did well than late cases. Late cases on the other hand gave satisfactory results in children rather than in adults. Poor were the results in which extensive muscle stripping was done and the fragment was not anatomically perfectly reduced.

### 4. Various Complications Observed During Follow up Period and their occurrence

Though the total no. of complications as enumerated above is alarming it must be noted that the cases with poor results had many complications together.

\* In times when Esmarch bandage was used as tourniquet, the cases of tourniquet palsy have been reported. With digital tourniquet, this complication is seldom seen.

## Discussion

Although lateral condyle fracture in children is very common, there are many reasons of its delayed presentation to orthopedic surgeons like lack of awareness of the parents, financial constraint, health care facilities are not available, fractures are being managed by osteopaths. Because of the high incidence of poor functional and/or cosmetic results with closed reduction methods, open reduction and internal fixation has now become the most widely advocated method among many authors. Achieving anatomical reduction is often not possible because of remodeling of the fracture fragment, sclerosis and smoothening of the fracture line and new bone formation. The need for open reduction of these fractures is not a new concept. It is now a common knowledge that all displaced fractures of lateral humeral condyle should be treated by ORIF as early as possible to prevent complications.

Earlier authors while slow to recognize this type of fracture as a separate entity noted that, it often resulted in poor outcome. French Surgeon Desault lamented the ancients have transmitted nothing to us on this point, among the moderns Heister avers to this fracture only to express an unfavourable prognosis respecting it without determining the mode in which it is to be remedied. This clearly indicates the lack of description of this type of fracture. Cooper described the long-term effects of this injury/ in his description of a cadaver specimen in which not the least attempt at ossific union could be detected.

In some earlier cases the results with manipulative closed reduction have been so poor that the closed method has not been recommended. Speed in early 1930's stated that 'our experience with the closed method in acute cases leads us to believe that the percentage of good results is relatively low

and that those cases that come out satisfactorily are more the result of good fortune rather than good management. 'Wilson (1936) in the same era stated 'this method failed so uniformly that he considers it folly to even attempt it.' McDonnell (1948) reported 50 % unsatisfactory results with residual deformity or loss of function in those fractures treated by closed reduction. K i n i ( 1 9 4 9 ) demonstrated that five of his thirteen cases had either delayed union or mal union. Mclearie (1954) was the only author advocating closed reduction as the sole method of treatment.

Most authors agree that prompt Open reduction and internal fixation gives the best results (Speed & Macey 1933, Wilson 1936, McDonnell & Wilson 1948, Rohal 1953, Badger 1954, Blount 1954, Wilson 1955, Jaffery 1958, Fahey 1958, Freeman 1959, Crabbe 1963, Conner & Smith 1970, Salter 1970, Hardacre 1971, Wadsworth 1972). The results reported were good. An occasional radiological finding was mild fish tail deformity of the distal end of humerus due perhaps to damage to growth plate adjacent to fracture line. Wilson and Wadsworth (1955, 1964) stated that it may produce cubitus valgus, loss of motion or degenerative arthritis. The child with a neglected fracture three weeks old or more used to pose a problem of treatment. Wilson (1936) and Bohler (1966) stated that open reduction should be done even for the late cases. But Speed & Macey (1933) thought this should be done for malunion or nonunion only. According to some authors delayed open reduction is unsatisfactory (Speed, Macey 1933, Wilson 1936, Rohl 1953, Blount 1951, Fahey 1958, Hardacre 1971, Smith: 1972, Wadsworth 1972). The results of seven children who had delayed open reduction and internal fixation by Jacob, Toronto & Fowles (1975) are poor. They showed that results of ORIF. more than three weeks after, the fracture was no better than those with no treatment at all.

Gay and Love (1947) showed that a quarter of patient seen at Mayo clinic with tardy ulnar nerve palsy had had a fractured lateral condyle. So major problem in those untreated cases was that of tardy ulnar neuritis.

Blount (1954) believed that a minimum of two pins were necessary to prevent rotation. It was also shown that the passage of a smooth wire especially through the center physis does not result in any growth disturbance.

Bohler (1966) had good results in his patients with delayed treatment. He circumvented doing extensor soft tissue dissection by approaching the fragment transarticularly after performing an osteotomy of olecranon.

Conner & Smith (1970) presented a series of this type of fracture treated by a specially designed screw - Glasgow Screw, 2.5cm coarse threaded screw, designed by Blockey. They showed that, even though that screw crossed the epiphyseal plate, there was no evidence of growth arrest. Complications were, bursa formation over screw head and one case had valgus deformity out of 35 cases. He also stated that this injury was accompanied by posterolateral

dislocation of the elbow.

In 1971 Hardacre along with Stanley proved that those complications were due to inaccurate reductions or insecure fixations. They stated that in delayed union of a fracture in good position, it should be left untreated. Established nonunion in good position requires no intervention or else results in loss of motion. He showed ORIF yields better results in fresh fractures.

Tajima in 1980 believes that osteosynthesis for nonunion of lateral condyle is worthwhile in the adolescents. Flynn in 1975 advocated early grafting and internal fixation of the incipient and established nonunion in good positions at twelve weeks as the growth potential of the fragment still remains. He also showed that delayed union responds effectively to pin stabilization even several months after the injury. According to him bone grafting is unnecessary if drill holes made into metaphyseal fragment.

In 1985 Rutherford concluded that anatomical reduction has to be balanced against avascular necrosis.

Dr. Aggarwal, Dr. Dhaliwal in their study in 1985 observed poorer results of O.R.I.F. with a delay more than 6 weeks in treatment.

Regarding implants for fixation of fracture, k-wires and screws are the most commonly used implants. Although comparison between these two implants in acute cases have been done in literature by Li and Xu in 2012, we have not found any literature regarding the comparison in neglected cases. Li and Xu found no significant difference in functional outcome after reduction and fixation with k-wire or screws in acute cases of lateral condyle fracture. Agarwal et al. observed overgrowth of condylar physis and lower humeral lateral metaphysis in all patients and articular cartilage damage in 18.2% of the patient.

**Incidence** - Fractures of lateral humeral condyle are one of the commonest injuries around elbow. They constitute 16.8% of total fractures of distal humerus while 54.2% of the physeal injuries related to distal humerus.

**Age** - The injury was common in the age group of 6 to 8 years (45.7%).

**Laterality** - This fracture was most common with left side. In our study, 81 patients (77.1%) had their left side injured and only 24 (22.9%) having right-side injured. The child must be holding something in his right hand when he would have had a fall on left outstretched hand. Hardacre showed 64% involvement of left side (1971).

**TREATMENT** - In our series all the 105 cases were treated by open reduction and internal fixation. Most authors agreed that prompt ORIF gave the best results. It is in between 3 and 12 weeks of presentation that falls under gray zone of the treatment modality. If these fractures are treated nonoperatively, the possible complications are malunion, nonunion, instability of the elbow joint, stiffness, cubitus valgus/varus, and tardy ulnar nerve palsy. Whereas, if these fractures are treated operatively, precarious blood supply to the fractured fragment due to excessive stripping of the soft tissues, may later results in avascular necrosis of the fracture

fragment. Despite the inherent risk associated with the surgery, there are reports in the literature of successful outcomes of ORIF of these established nonunion cases. The surgical technique should not be too aggressive to disturb the condylar vascularization. In order to control the intra-articular reduction, it may be necessary to cut some parts of the capsule and the synovia.

A late presentation leads to difficulty in management due to displacement of the fragment as a result of the pull of the common extensors, incongruous reduction of articular surfaces, injury/early closure of the epiphyseal growth plate, and possible damage to vascular supply.

Lagrange and Rigault showed that the blood supply to the lateral condyle enters by its soft-tissue attachments, particularly posteriorly at the origin of the long extensor muscles, and disruption of this will destroy the vessels and render the condyle ischemic.

Out of 105 cases, 27 were neglected cases. All had displaced fractures. They were operated within 3 days of their admission. Out of 27 late cases, 18 showed nonunion in good position. Fractures in children were preferably fixed by two Kirshner wires while in adults, cancellous or malleolar or cortical screws were used.

**Approach** - lateral 'j' approach was advocated by many authors (Ogden, Wadsworth) and we found it satisfactory in almost all cases except in which preferred Campbell's posterolateral approach to take care of associated injuries. Fracture site can easily be located by going through a gap between contused extensor aponeurosis. A tourniquet was necessary to have a clear operative field.

Although, k-wire is more common implant than screw for internal fixation, a plaster cast is required for longer duration, whereas the screws provide more continuous and secure stabilization for fracture than k-wires and patient can initiate elbow physiotherapy early and have better functional outcome. In fracture of more than 3 weeks, retaining the implants for at least 6 weeks is recommended since premature removal of the wire can lead to displacement of the reduction.

**Postoperative** - all candidates should be immobilized in a posterior splint for almost 3 weeks. In our series union was obtained in all but one within 3 – 4 weeks. Immobilization in flexion and pronation maintains good reduction. Implant removal can be done after 4 weeks in children and after 3 months in cases of screw fixation. Thomas et al, in a case series of 104 patients concluded that 3 weeks of immobilization with k wires in situ is sufficient to achieve healing after open reduction and internal fixation in most of the displaced lateral condyle fracture of humerus.

## Results

The criteria for assessment of results were according to that of 'Hardacre et al'. They were based upon the functional and cosmetic points of view. Functional results were further differentiated into clinical and radiological observations.

Functional – Clinically, two patients developed infection which was controlled with proper antibiotics immediately. It led to loosening of pin and migration in three cases; it had to be removed. The incidence of functional loss of range of motion is much greater as the fracture is extended into articular surface.

We did not observe tardy ulnar nerve palsy in any of the cases. Premature closure of the physis and fishtail deformity is a known complication of lateral condyle fractures nonunion after operative treatment. It can be inferred from this observation that premature closure of physis and fishtail deformity can be seen as complication irrespective of implant being used.

Six patients had partial tourniquet palsy due to long operative time needed for additional bone grafting. Three cases had posterior interosseous nerve palsy intraoperatively.

Six patients showed instability of the elbow; due to extensive soft tissue injury around the elbow and presence of nonunion leading to translocation of ulna laterally.

According to Toh et al non-union consistently lead to pain, instability, loss of function, and tardy ulnar nerve palsy, they should be treated as soon as possible after injury, preferably before skeletal maturity.

Dhillon et al and Zions et al reporting uniformly bad results which included cubitus varus and valgus deformities, osteonecrosis, non-union and malunion, and loss of motion. They recommended that patients presenting late be left alone and any sequelae evaluated at a late stage. Preoperative stiffness that is found in these cases is likely to affect the post-operative result.

Aggarwal et al reported in their study of 22 cases with delayed presentation. According to them exact anatomical reduction of the lateral condylar fragment was difficult to achieve, but conspicuous alteration in carrying angle was not present except in 2 cases. Fish-tail appearance was seen in 7 cases and premature closure of lateral condylar epiphysis was noted in 4 cases.

Saraf et al in their series of 20 cases reported avascular necrosis of the lateral condyle in one patient, premature

fusion in two patients, pin tract infection in three patients, and gross restriction of elbow movements in three patients

## Conclusions

1. Fractures of lateral humeral condyles are one of the commonest injuries occurring around elbow. Average age incidence was found to be 7 years. The male to female ratio was 5:1 whereas left side was involved more common than right.
2. It is caused by either a push off or pull off mechanism and frequently associated with other injuries like posterior dislocation of elbow, fracture of olecranon, Colle's fracture, etc.
3. All displaced fractures should be treated by prompt open reduction and internal fixation.
4. Early surgery alone does not ensure a good result unless the reduction is nearly anatomical.
5. Smooth Kirschner wire is a preferred method of fixation in children while screw fixation is useful in adults.
6. Minimum of two pins are necessary to prevent rotation of the fragment.
7. Divergent pins preferably from the posterolateral surface in a manner of 'V' yields good result.
8. A minimum of soft tissue dissection & muscle stripping should be done during operation to prevent avascular necrosis of the fragment and further complications like nonunion, cubitus valgus etc.
9. Passage of wires through the center of epiphysis does not cause much growth disturbance.
10. Early surgery is advised for established nonunion where the condylar fragment is in good position.
11. Delayed O.R.I.F., while still leaving much to be desired, does result in improvement in stability and function of the elbow.
12. Open reduction and internal fixation of fractures up to 6 weeks after injury, is recommended.
13. Fractures over 6 weeks of duration are best left alone with active physiotherapy as the results become progressively disappointing with delay.

**Declaration of patient consent :** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflict of interest:** Nil **Source of support:** None

## References

1. Alan Conner and G. H. Smith, Displaced fractures of Lateral humeral condyle in children 3.8.3.5., 528 (1-6), 1970.
2. Alex. Rutherford, Fractures of lateral condyle in children, 3.8.3.5., 67A - 1965
3. Agarwal N. D. and R. S. Dhaliwal, Management of fractures of lateral humeral condyle with special emphasis on neglected cases. 1.3.0., Vol.19, No.1, Jan. 1965.
4. Badger F. G., Fracture of lateral humeral condyle J.B.3.s., 36-8, 147: 1954.
5. Blount W. P., Fractures of the lateral condyles humerus.
6. Bush L. F. and Meclain E. J., Fractures in Chd. PP, 43-45, 1954. : Operative treatment of fractures elbow in adults. A.A.O.S.: 1.c. lectures. Vol.16 St. Louis: 1959.
7. Flynn J. C., Richards J. F. and Saltzman R. I, Prevention and treatment of nonunion of slightly displaced fractures of the lateral humeral condyle in che. 3.8.3.5., 57-A, (5-8), 1975.



8. Flynn J. C., Nonunion of minimally displaced fractures of lateral condyle of the humerus in children, J.8.3.5., 53A, NO.6. Sept. 1971
9. Hardacre J. A. and Stanley, Fractures of the lateral condyle of humerus in children, J.8.3.5., 53A, (5-8), 1971
10. Ingerhol R. E., Fracture of humeral condyle in children. Clin.orthop.41:33. 1965
11. Jacob R. and Fowles J. V., Observations concerning fractures of the lateral humeral condyle in children, 3.3.3.5., 570 (1-4), 1975.
12. Jeffery C. C., Nonunion of the epiphysis of the lateral condyle of the humerus. J.8.3.5.. Vol. 0-8, No.3, Aug. 1958
13. Knight Robert, Fracture humeral condyle in adults A.A.O.S., 1.0. lectures, Vol.14, 1957.
14. Kini M. G., Fractures of lateral humeral condyle with complications. 3.8.3.5., 24:270, 1942.
15. Ogden, Skeletal injury in child P.263-276.
16. Rockwood and Green, Fractures in children, Vol. III, 432 - 457.
17. Speed J. S. and Macey H. B., J.B.J.S., 15, 903 : 1933.
18. Speed J.S., Surgical treatment of condylar fractures of humerus. A.A.O.S.: I.C. lectures Vol.7, 1950.
19. Siddique H. D. and Raza H.K.T., Results of Surgery for fractures of the lateral humeral condyle in Children, Clin.ortho., India No.4, Aug.89.
20. Smith F. M. and Joyce J. J., Fractures lateral humeral condyle in children, A.J.S., 87: 324, 1954
21. Wadsworth T. G., Premature epiphyseal closure after injury to the capitulum. J.B.J.S., 46B, No.1, Feb. 1964
22. Wadsworth, The elbow P.156-171 (1972)
23. Wilson P. D., Fracture of lateral humeral condyle in childhood; J.B.J.S., 18:301, 1936
24. Wilson J. N., British J.S., 43:88, 1955
25. Wilson J. N. (Edward), Watson Jones fractures and joint injuries, Ed.6th Edinburgh, 1982.

**Conflict of Interest: NIL**  
**Source of Support: NIL**

#### How to Cite this Article

Patil NS, Gowtam SV, Chitnavis S. Extensive study of internal fixation in fractures of lateral humeral condyle. Journal of Trauma and Orthopaedic Surgery April-June 2021;16(2):6-17.