Management of Cubitus Varus by Ilizarov

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Post-traumatic cubitus varus: long-term follow-up of corrective osteotomy using the Ilizarov method of compression distraction osteogenesis

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The term cubitus varus describes the inward inclination of the supinated forearm on the extended elbow. The deformity manifests clinically as a decreased carrying angle, decreased range of motion (ROM) along with a cosmetically unsightly appearance. The aim of the present study was to evaluate the technique of compression-distraction osteogenesis using the Ilizarov apparatus in the management of patients with post-traumatic cubitus varus deformity. The objectives were to study the impact of this method on the ROM, the Humerus Elbow Wrist (HEW) angle as well as the Lateral Prominence Index. A total of 32 patients who presented with a cubitus varus deformity of ≥10° at the elbow were retrospectively analyzed using data retrieved from a computerized hospital database. All patients had undergone a mini-incision subperiosteal osteotomy followed by application of an Ilizarov frame. Clinico-radiological follow-up was carried out at regular intervals until union was achieved and yearly thereafter. The mean time to union was 11 weeks. The mean follow-up period ranged from 2 to 12 years (mean 4.0 years). Results were graded as excellent in 25 cases (78.1%), good in 2 (6.3%) and poor in 5 case (15.6%) using the grading system of Oppenheim. The mean HEW angle at final follow-up improved from 20° of varus to 6° of valgus. The mean flexion/extension improved from 121°/−3° preoperatively to 125°/−4° at final follow-up. The Mayo Elbow Performance scores at final follow-up were excellent in 23 cases, good in 7 and fair in 2. Complications encountered included superficial pintract infections in three cases, lateral condylar prominence in one case, loss of terminal flexion in three cases and valgus over-correction in one case. *J Pediatr Orthop B* XXX: 000–000

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Keywords: cubitus varus, corrective osteotomy, compression-distraction, deformity correction, external fixation, Ilizarov

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Introduction

Cubitus varus, also known as 'bow elbow' or 'gunstock deformity' is a term describing the inward inclination of the supinated forearm on the extended elbow [1]. It is one of the most common complications of supracondylar fractures of the humerus in children [2]. The reported incidence varies from 9 to 58% depending upon the treatment [3]. The deformity consists of varus, hyperextension and internal rotation of the distal fragment [4]. The indications for corrective surgery include an unacceptable cosmetic appearance or a functional impairment in elbow motion or a combination of the two.

The deformity is usually a consequence of inadequate reduction or loss of reduction, typically a medial displacement and internal rotation of the distal fragment [5,6]. Surgical correction usually involves an osteotomy in the supracondylar region, correction of the varus tilt and rotation, to restore the normal valgus alignment of the elbow. Historically, several procedures have been described for cubitus varus such as the medial opening wedge osteotomy (King and Secor, 1951) [1], the lateral closing wedge osteotomy (French, 1959) [7], the oblique osteotomy (Amspacher and Messenbaugh, 1964) [8], the step-cut osteotomy (De Rosa and Grazanio, 1988) [9], the dome osteotomy (Kanaujia, 1988) [10], the pentalateral osteotomy (Laupattarakasem, 1989) [11] and the three dimensional osteotomy (Uchida, 1991) [12]. However, the method preferred by most surgeons, by virtue of its technical simplicity and reproducibility, is the lateral closing wedge osteotomy [13]. Despite being an effective means of correction of the varus deformity, several authors have reported a poor cosmetic appearance due to lateral condylar prominence [14,15]. Furthermore, the tendency of the distal fragment to angulate into varus following internal fixation by screws or staples often resulted in a recurrence of the deformity [16]. This led to the emergence of external fixation, ranging from simple

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Step by Step®

Management of Cubitus Varus by Ilizarov Technique

RA Agrawal
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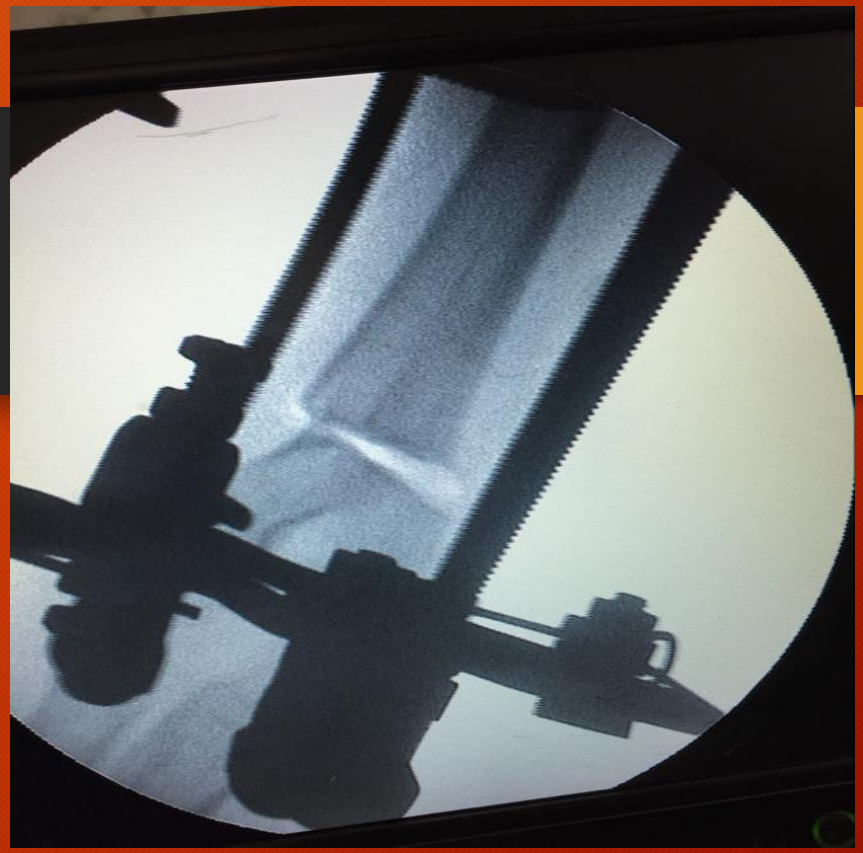
Introduction

Cubitus Varus

- Inward inclination of supinated forearm on extended elbow
- Most common complication of supracondylar fractures in children (9 to 58%)
- Varus, hyperextension and internal rotation of distal fragment

Introduction



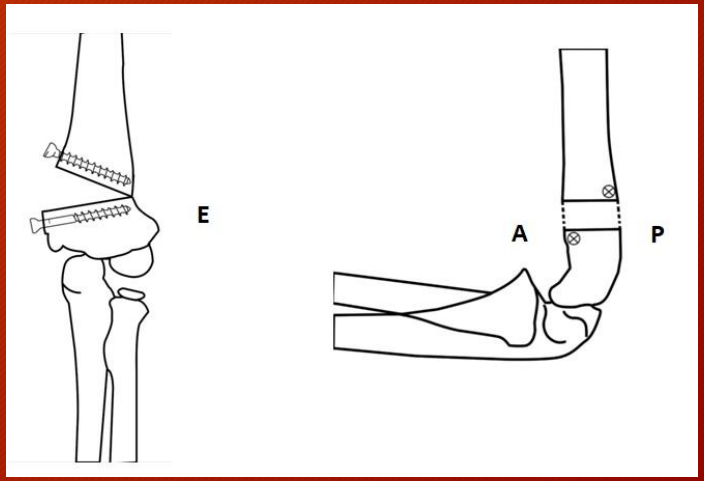
Osteotomy

- Indication –
  - Unacceptable cosmetic appearance
  - Functional impairment
- Principle of surgery –
  - Inadequate reduction – medial displacement and internal rotation of distal fragment
  - Surgery- correction of varus tilt and rotation

The problem

Many osteotomies described in literature:

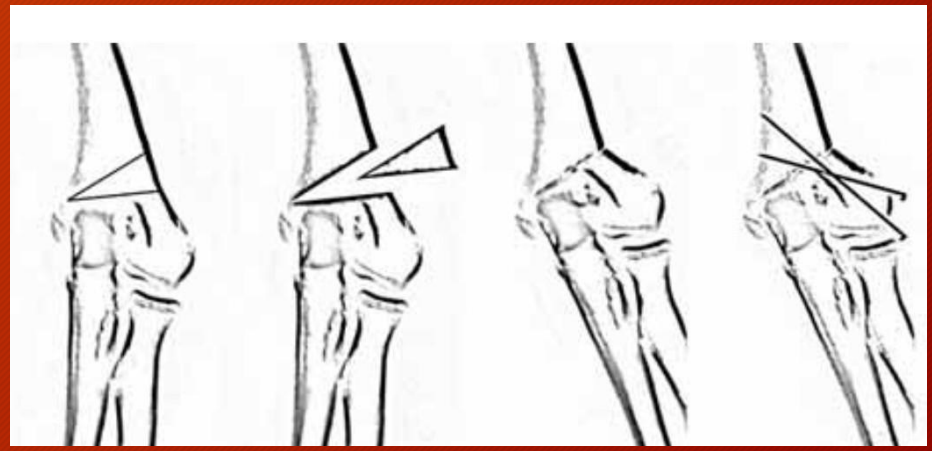
- Medial opening wedge (King and Secor 1951)
- Lateral closing wedge (French)
- Oblique (Amspacher and Messenbaugh1964)
- Step cut (De Rosa and Graazanio)
- Dome (Kanaujia 1988)
- Pentalateral (Laupaatarakesem 1989)
- 3 dimensional (Uchida 1991)



The problem

Lateral closing wedge osteotomy and internal fixation

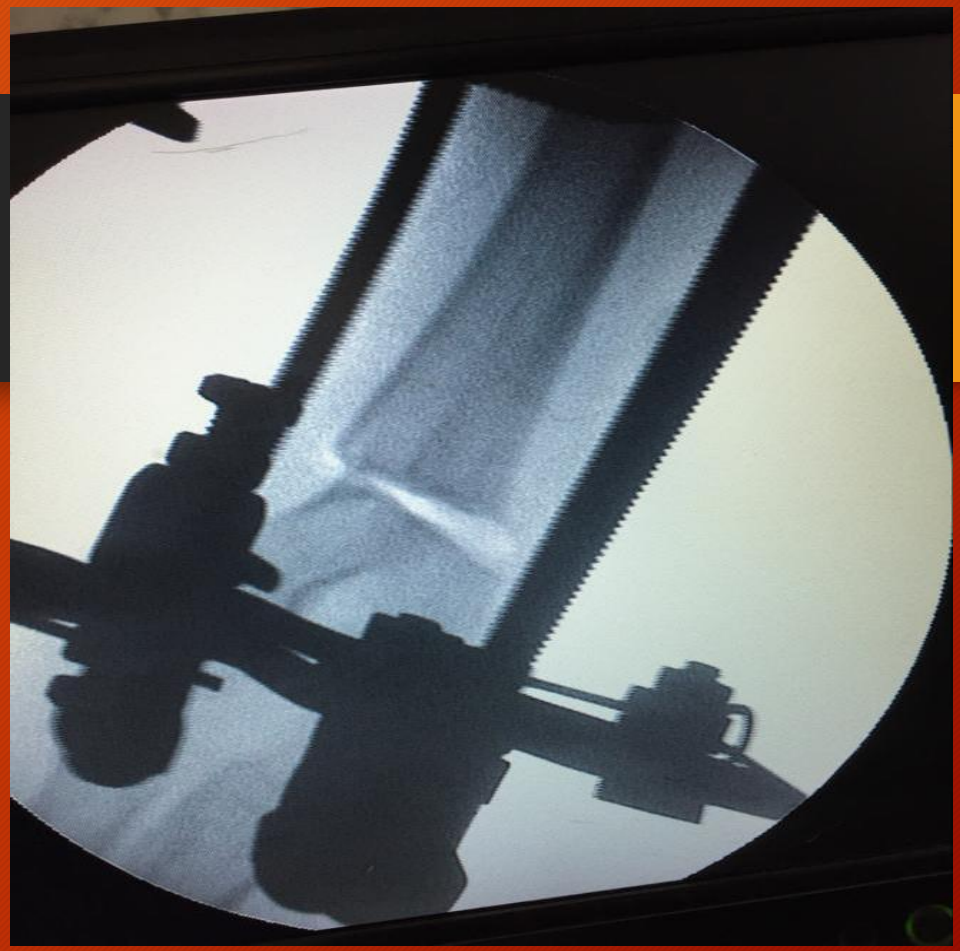
- Poor cosmetic appearance due to lateral condylar prominence
- Recurrence - tendency of distal fragment to angulate in varus after internal fixation
- Surgical Exposure



The solution

Ilizarov

- Overcomes limitations of internal fixation
- Postop adjustments – complete accurate correction
- Minimally invasive
- Early mobilization



II – Patients and Methods

- Introduction
- Patients and Methods
- Surgical details
- Results
- Discussion
- Conclusion
- Acknowledgements

Patients and Methods: Methodology

- Type of study: Retrospective
- Center: Tertiary center (Agrawal Orthopedic Hospital Gorakhpur)
- Data collection:
- Computerized patient data from Sep 2005- Dec 2018 analysed
- Sample size (n=32);

  26 M, 6 F

- Inclusion criteria:

1. post-traumatic cubitus varus deformity of ≥10°
2. <18 yrs
3. Surgical correction done using Ilizarov

- Exclusion criteria:

1. Patients who had undergone any other corrective surgery
2. Incomplete database

Patients and Methods: Demographical data

- Mean age: 9.2 Y (range 5-18)
- Side of deformity: Left in 22/32 cases (68.75 %)
- Dominant hand injured in 17/32 (53.1%)
- Mean duration since initial injury: 2.9 Y
- Etiology:

1. Supracondylar fracture type 3: 27/32
2. Supracondylar fracture type 2: 03/32
3. Unknown: 02/32

- Treatment undergone at the time of initial injury:

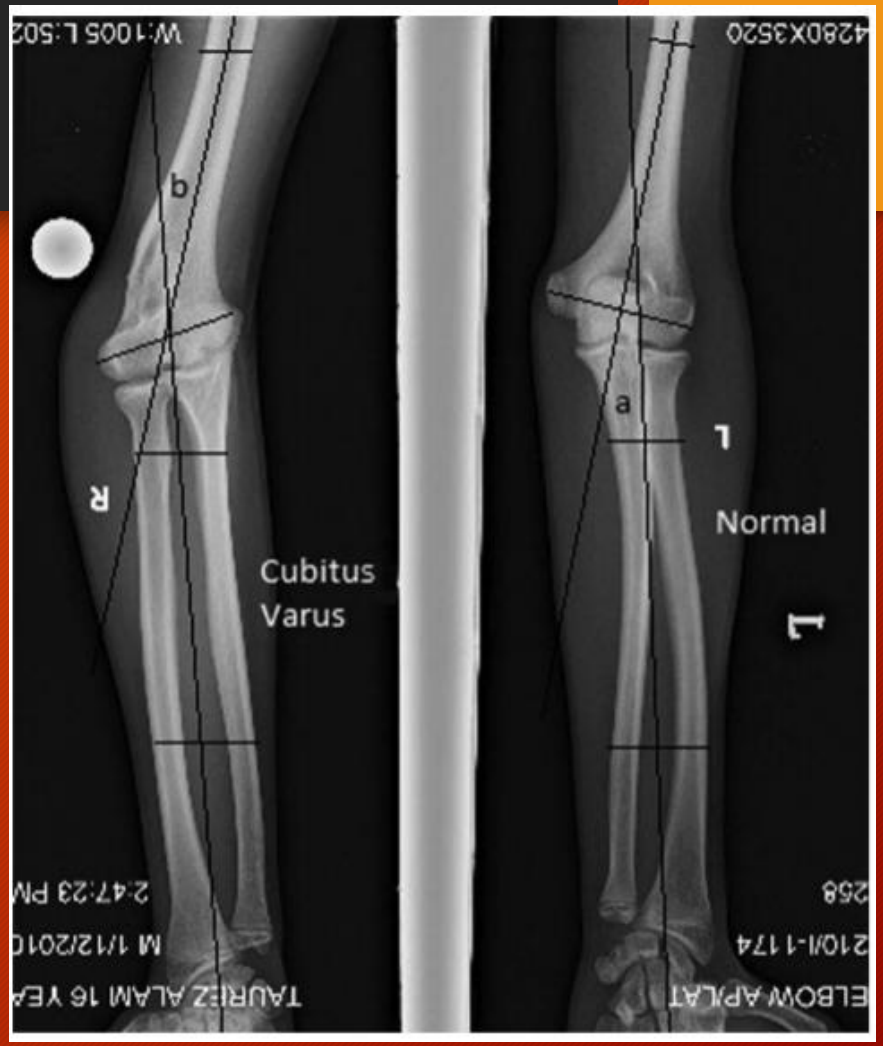
1. CR + POP cast in 07/32
2. CRPP in 18/32
3. ORIF + Pinning in 06/32
4. Unknown in 01/32

- Mean time to union: 11 weeks (range 8-18)
- Mean follow-up: 4 Yrs (range 2-12)

Patients and Methods

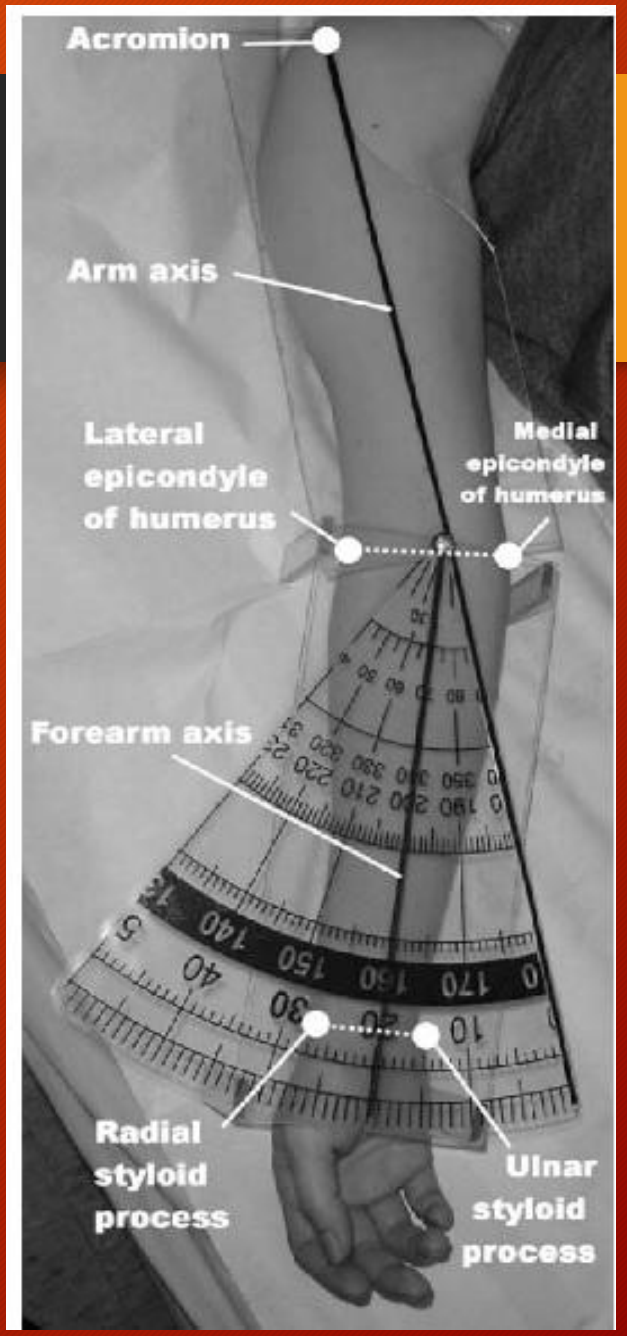
Preop assessment –

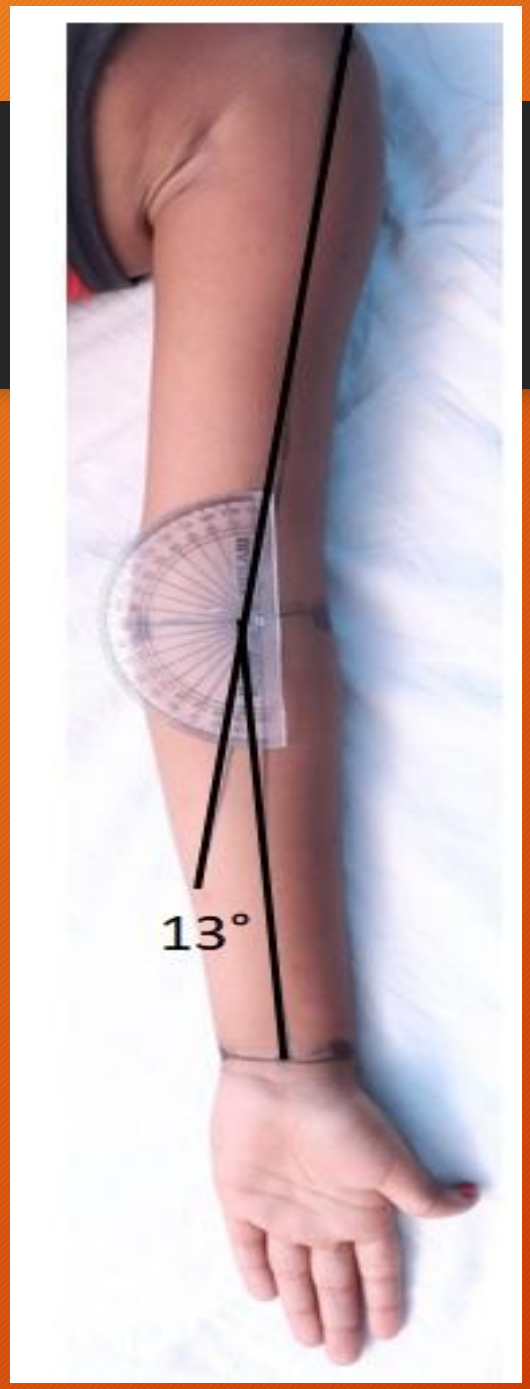
- Clinical –
  - Carrying angle
  - ROM
  - Internal rotation deformity
  - Neurovascular assessment
- Radiological assessment:
  - CORA
  - HEW angle
  - LPI

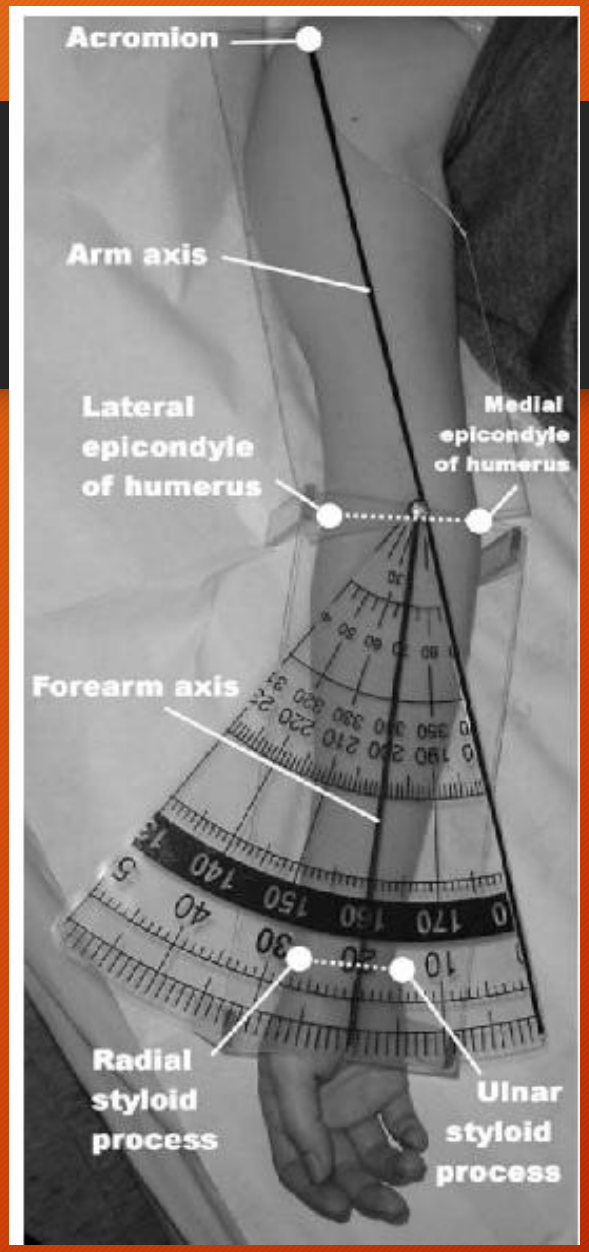


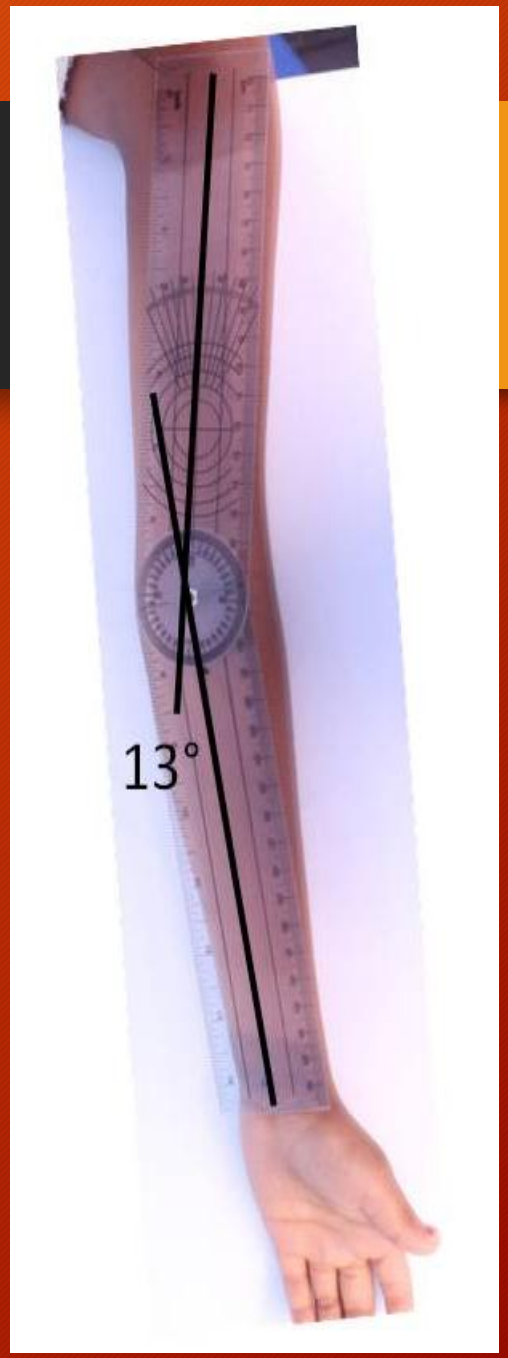
Carrying angle

- Angle between lines joining the midpoint of wrist and antecubital space and humeral head
- Elbow in full extension and wrist in supination
- Normal – 5 to 15 degree (Male- 6.5 degree, Female 12 degree)









Measurement of Elbow Angle by Goniometer

Internal Rotation deformity

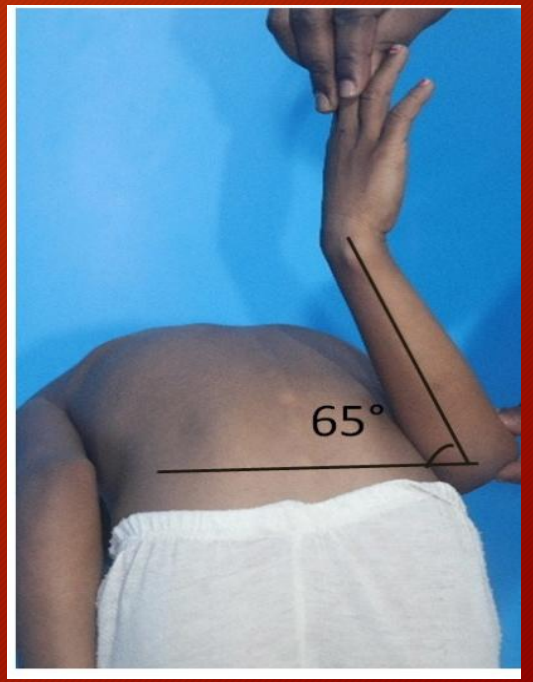
Yamamoto et al

- Patient bends forward slightly
- Place forearm on back
- Elbow flexed 90 degree
- Shoulder hyperextended
- With elbow as a fulcrum, forearm is lifted off the back to have maximum internal rotation of humerus
- Normal – foream cannot be brought up from the back
- Cubitus varus – forearm is lifted off forming an angle which is amount of internal rotation deformity

Cubitus Varus Deformity Following Supracondylar Fracture of the Humerus

A Method for Measuring Rotational Deformity

Isao Yamamoto, M.D.,* Seiichi Ishii, M.D.,** Masamichi Usui, M.D.,† Toshihiko Ogino, M.D.,‡ and Kiyoshi Kaneda, M.D.§



HEW Angle (Humerus Elbow Wrist angle)

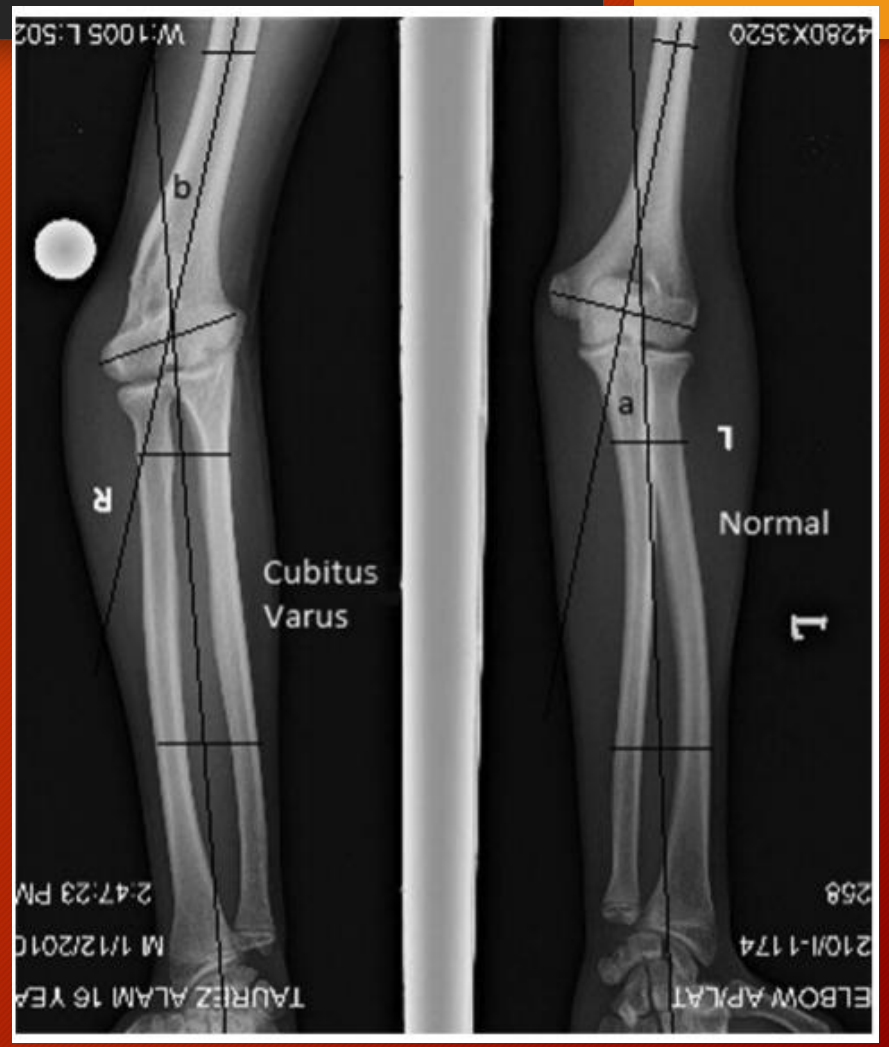
Management of Cubitus Varus and Valgus

By Hui Taek Kim, MD, Jung Sub Lee, MD, and Chong Il Yoo, MD

Investigation performed at the Department of Orthopaedic Surgery, Pusan National University Hospital, Pusan, Korea

HEW – angle between anatomical axis of humerus and forearm

- AP radiograph of both upper extremities with elbow extended and forearm supinated
- Anatomical axis of humerus – mid diaphyseal line
- Anatomical axis of forearm –
  - 2 transverse lines drawn - at level of bicipital tuberosity of radius and at maximum interosseous space between radius and ulna
  - Line connecting midpoint of these 2 transverse lines
- Point of intersection is CORA
- Amount of correction – sum of varus deformity and HEW angle of normal side



LPI

Lateral prominence index

- Difference between medial and lateral width of bone from central mid humeral axis
- Measured from AP radiograph
- Measured from point of intersection of humerus middiaphyseal axis and inter epicondylar axis
- Normal – it is negative as usually there is slight medial prominence
- Cubitus Varus – it is positive

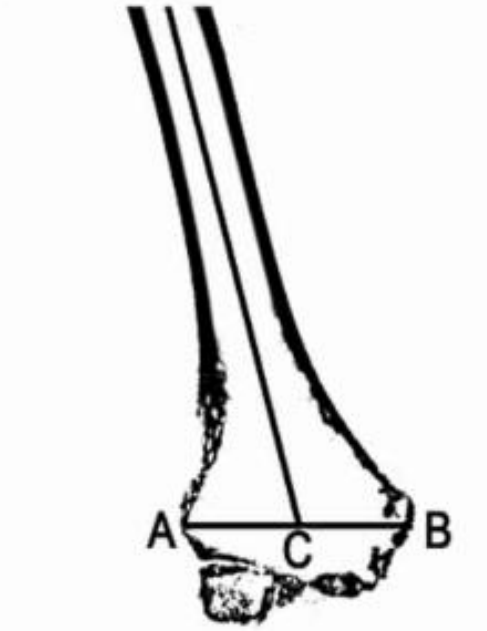
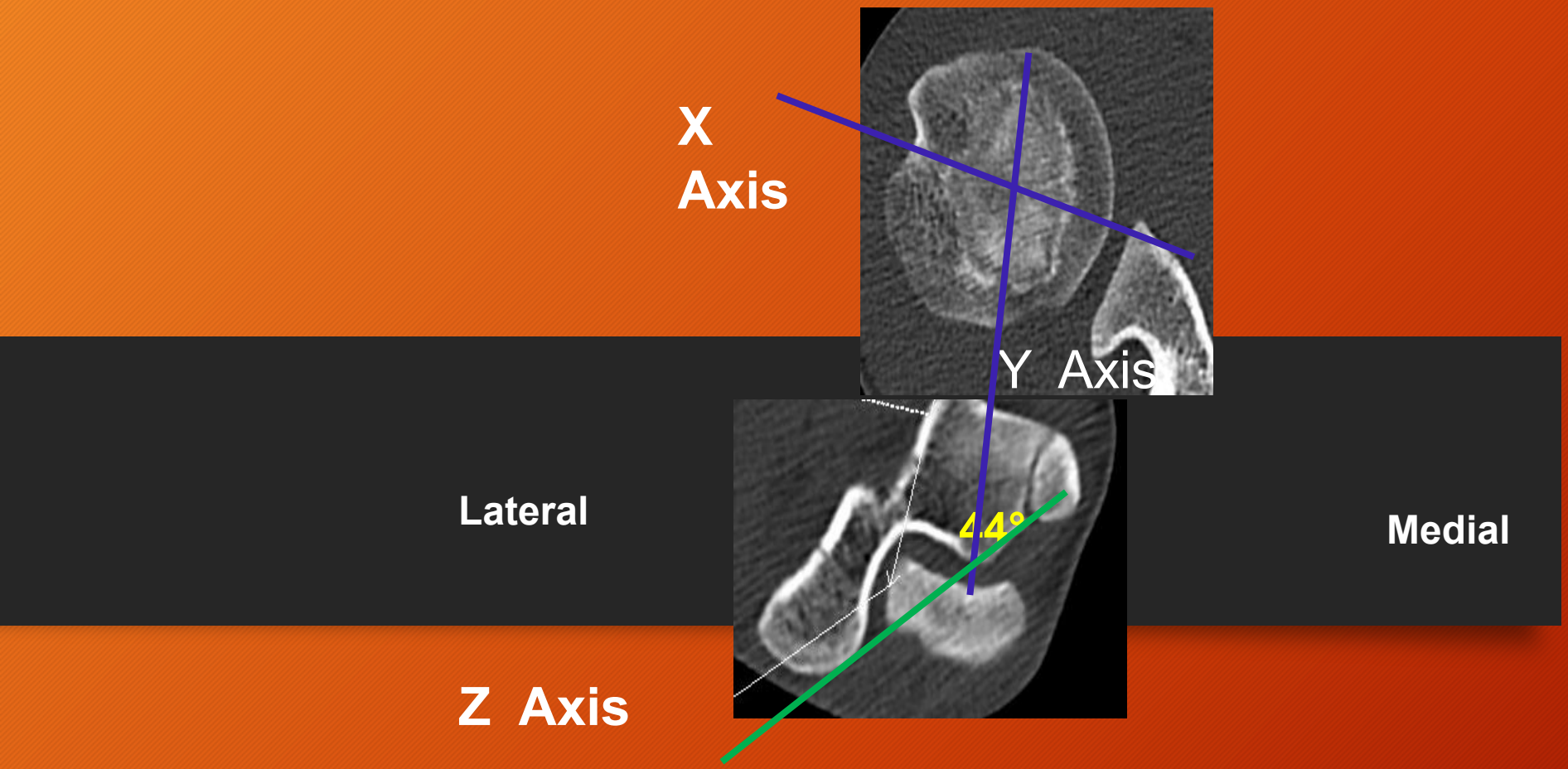


Fig. 3. — The lateral prominence index (LPI) = (AC – BC) × 100/AB.

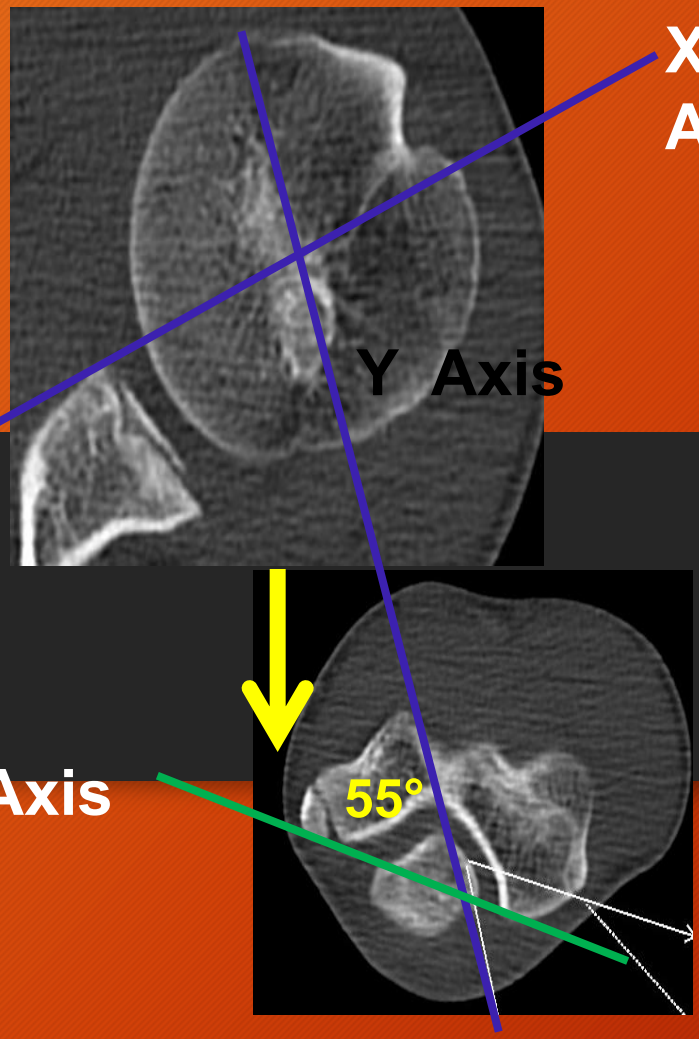
Measurement of Humeral Torsion (HT) on computed tomography (CT) in Normal elbow (Right)



X Axis is the transverse axis of the head of the humerus
Y Axis is perpendicular to the transverse axis of Head of Humerus
Z Axis is the transverse axis of distal end of Humerus.

The angle made between Y and Z axes show humeral rotation
(Normal value of HT is 44°)

Measurement of Humeral Torsion (HT) on computed tomography (CT) in Deformed elbow (Left)



In Cubitus Varus value of HT is 55°; The internal rotation from normal is 55 minus 44 =11°

III – Surgical technique

- Introduction
- Patients and Methods
- Surgical technique
- Results
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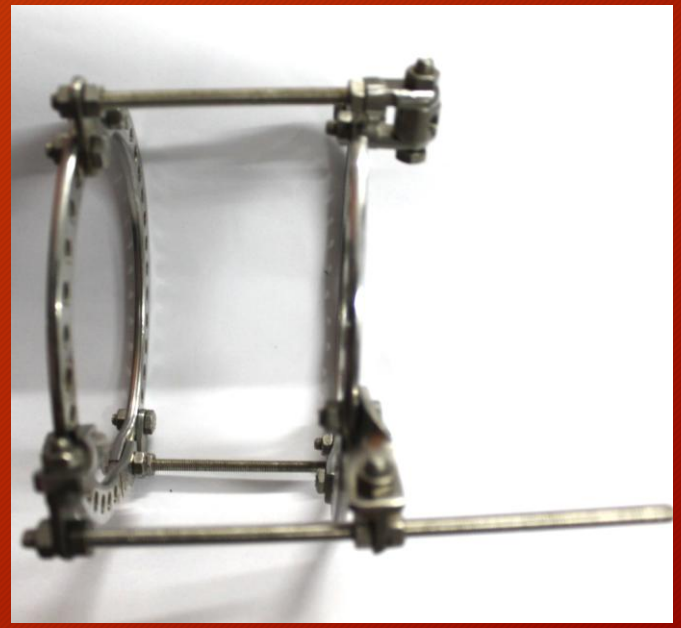
- Acknowledgements

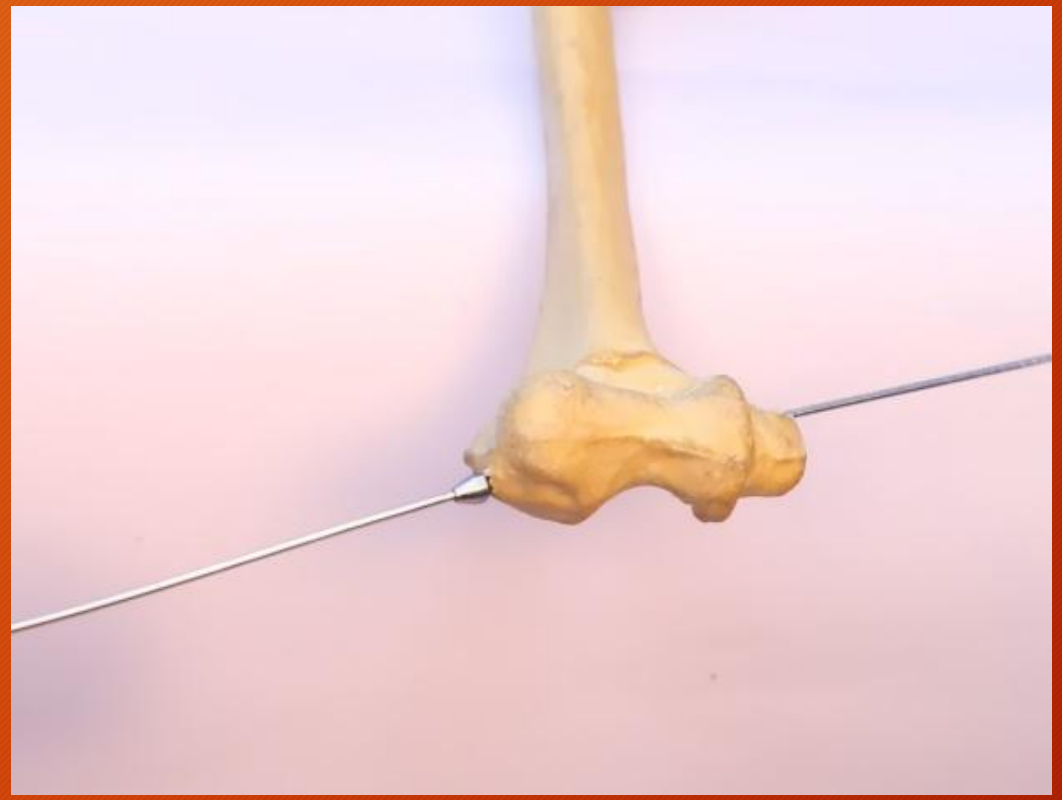
Surgical technique

Preconstructed frame

- 2 full rings of appropriate size
- Distal ring – at level of epicondyles
- Proximal ring – at level of anterior axillary fold
- Juxta articular hinges placed anteriorly and posteriorly in sagittal plane
- Hinges are loosened to position distal ring parallel to elbow joint line to mimic deformity
- Distraction rod on medial side



STEP 1

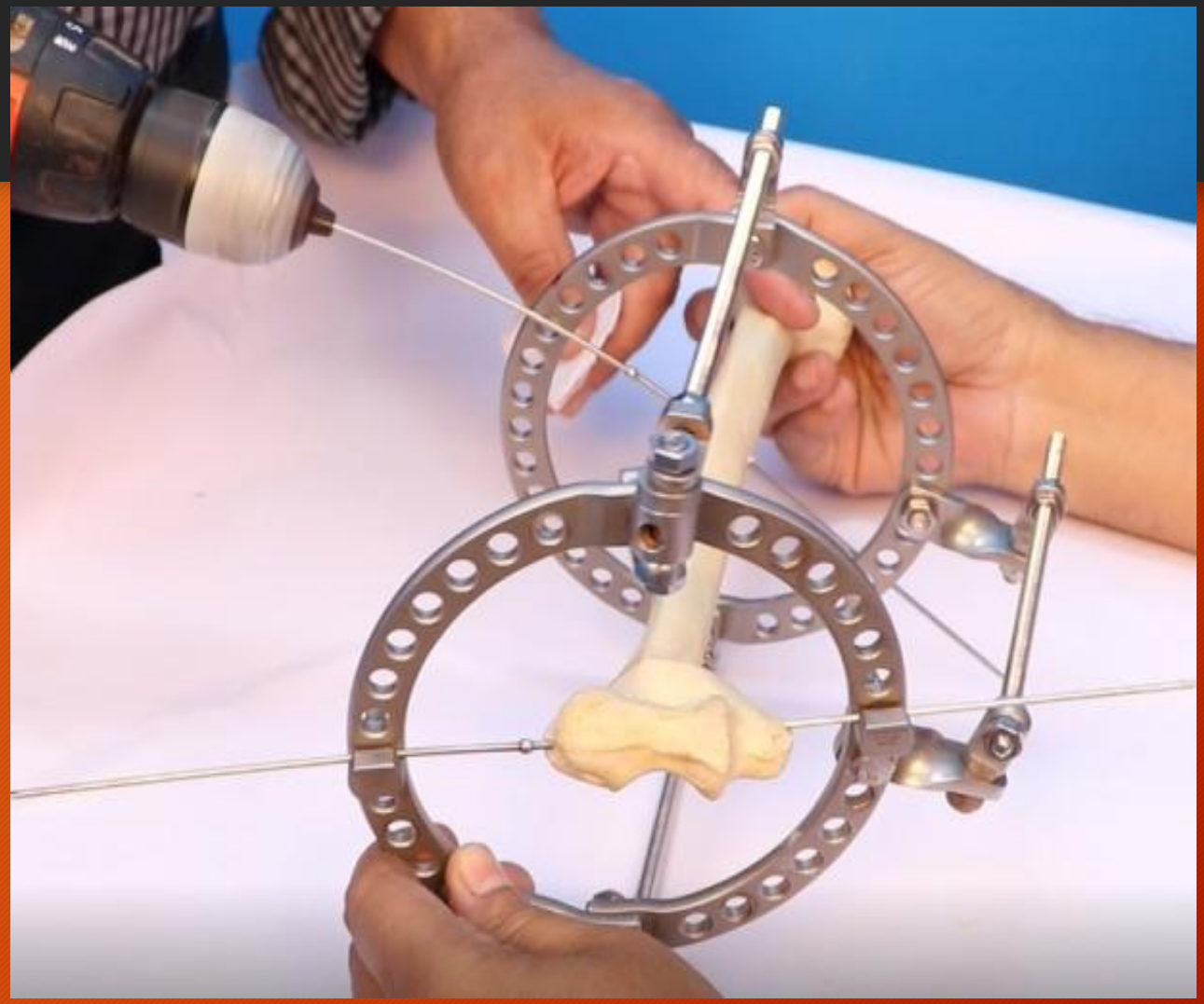


1st reference Olive wire is passed from postero lateral to antero medial surface

STEP 2

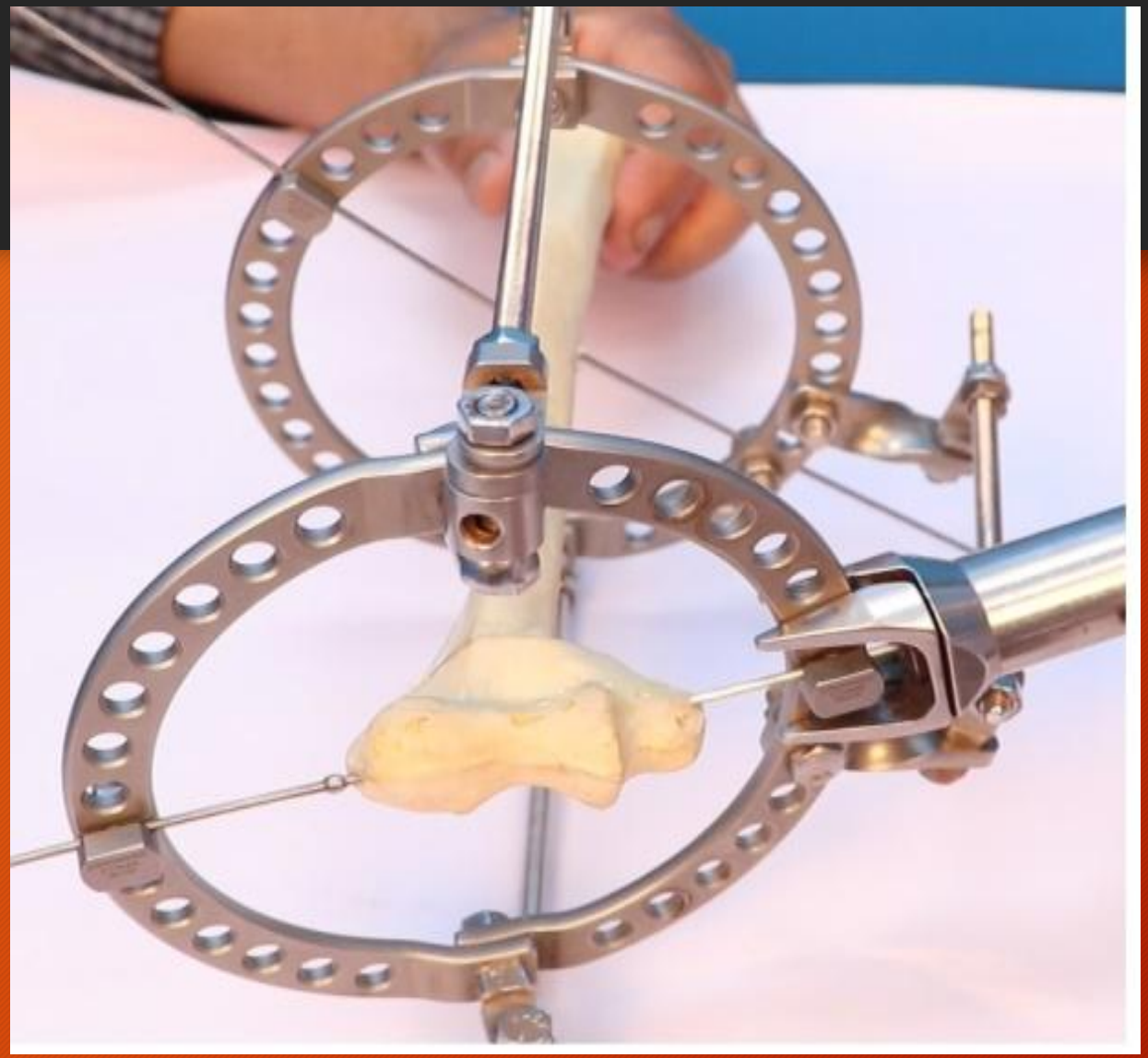
Pre constructed frame is attached to the First Olive Wire

STEP 3



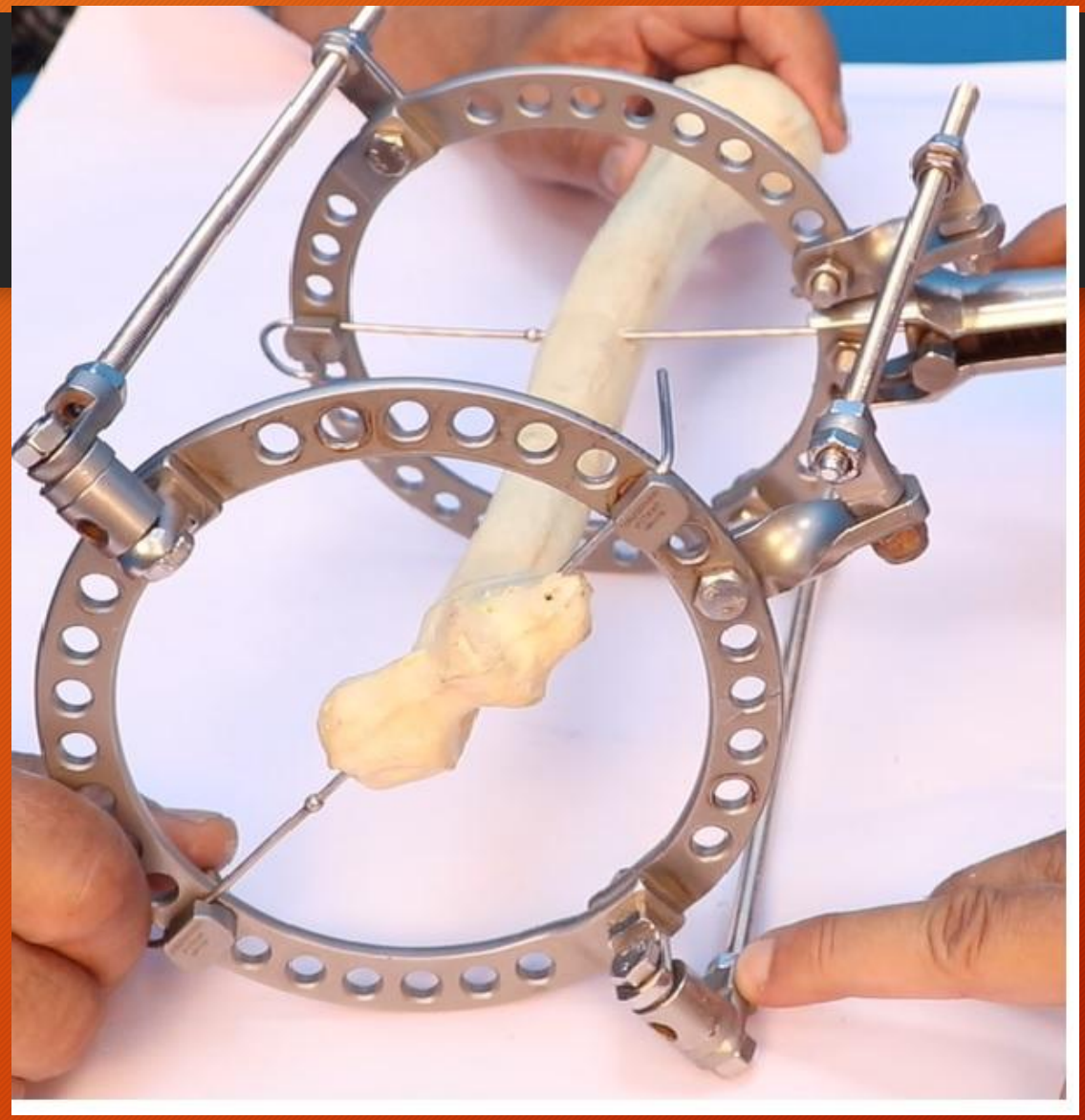
At the level of proximal ring, 2nd olive wire is passed from antero lateral to postero medial direction

STEP 4



Tensioning of First Olive Wire

STEP 5



Tensioning of the 2nd Wire

STEP 6

Insertion of third wire from medial epicondyle, direction postero medial to antero lateral, ulnar nerve palpated and pushed away

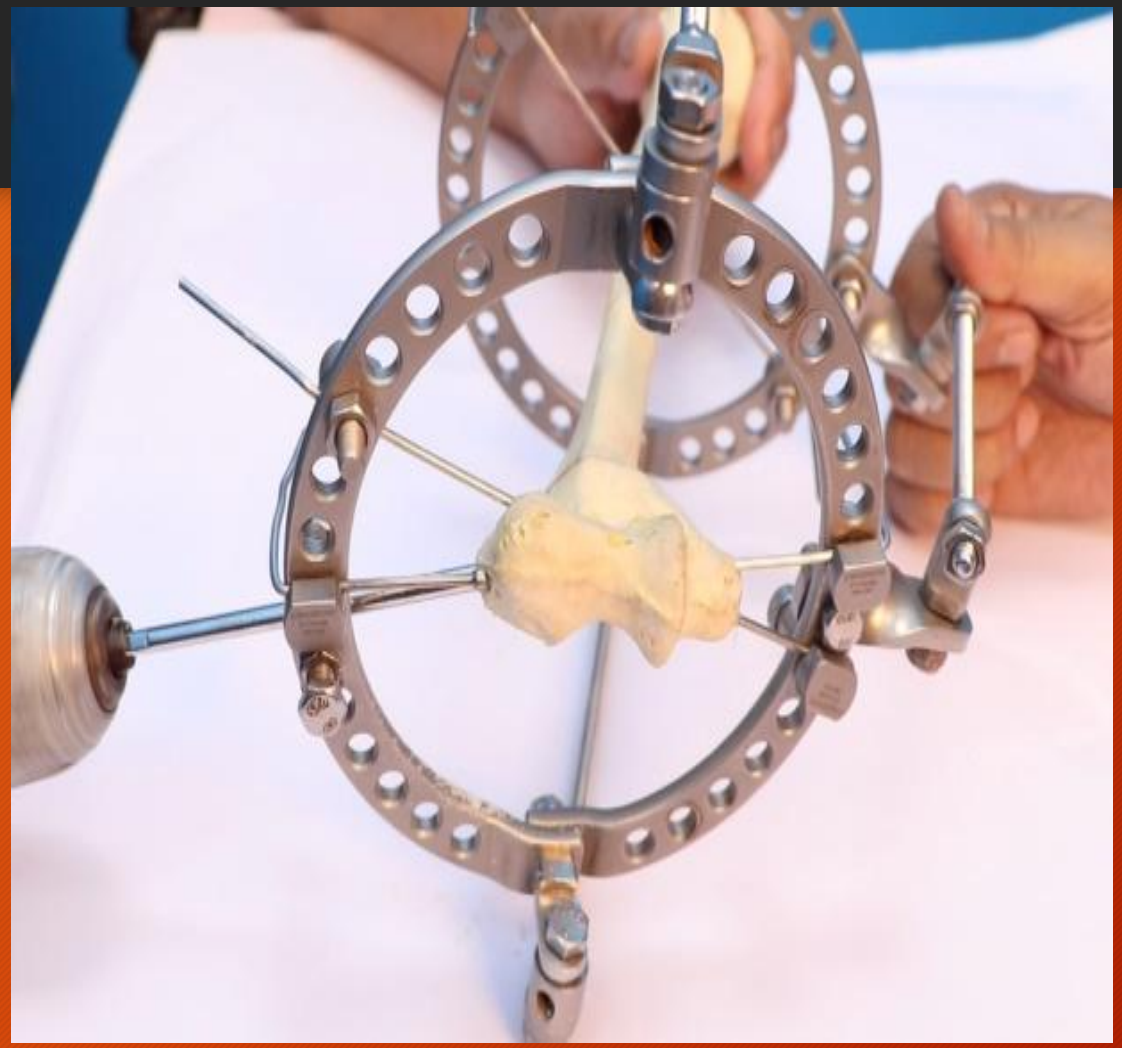
STEP 7

Tensioning of third wire

STEP 8 – pin application in distal ring

Drilling by 2.5 mm drill bit for half pin in the distal ring at lateral Condyle, posterolateral to anteromedial

STEP 9

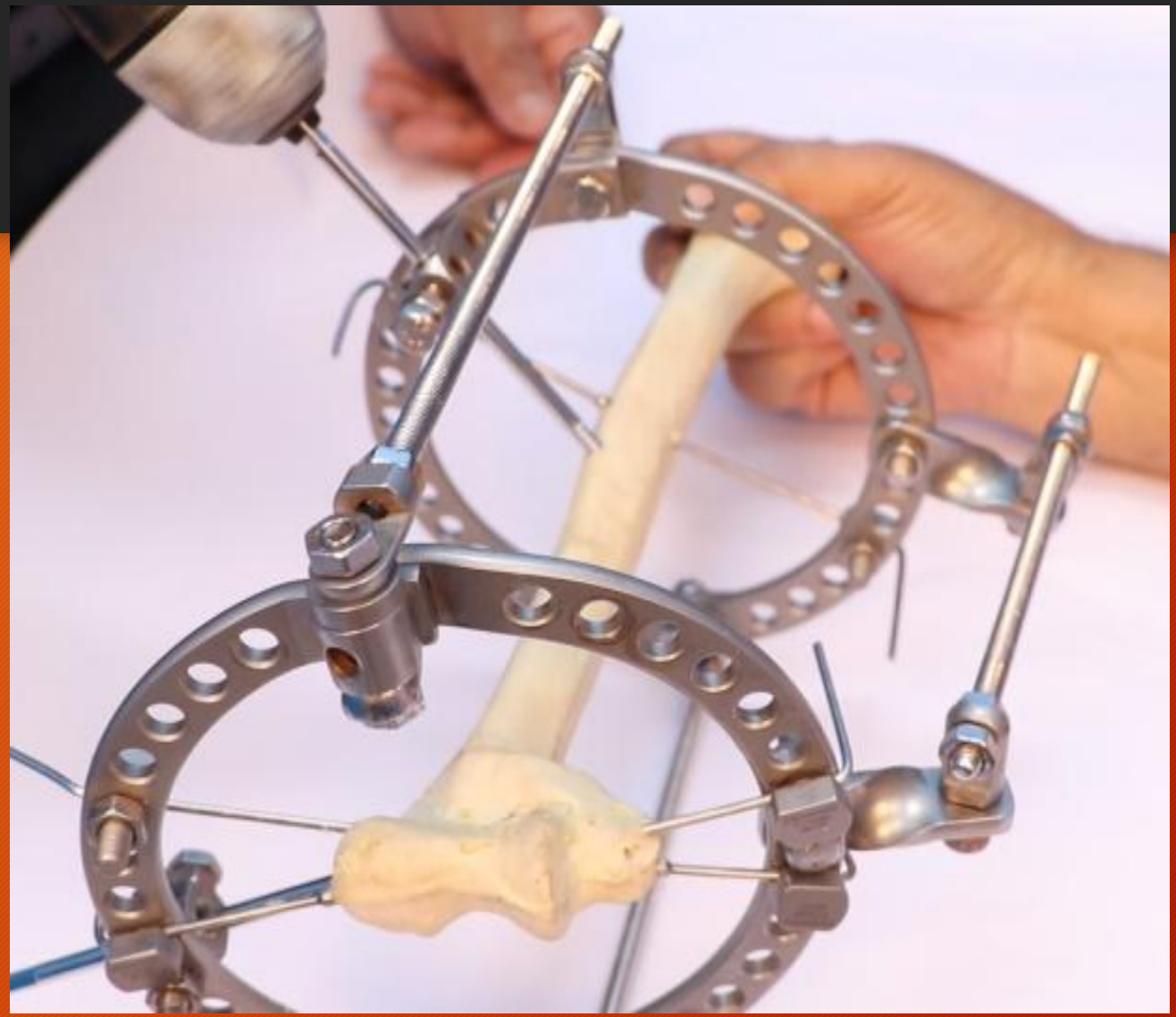


Insertion of 4 mm half pin at lateral Condyle, direction postero lateral to antero medial

STEP 10: pin application in proximal ring

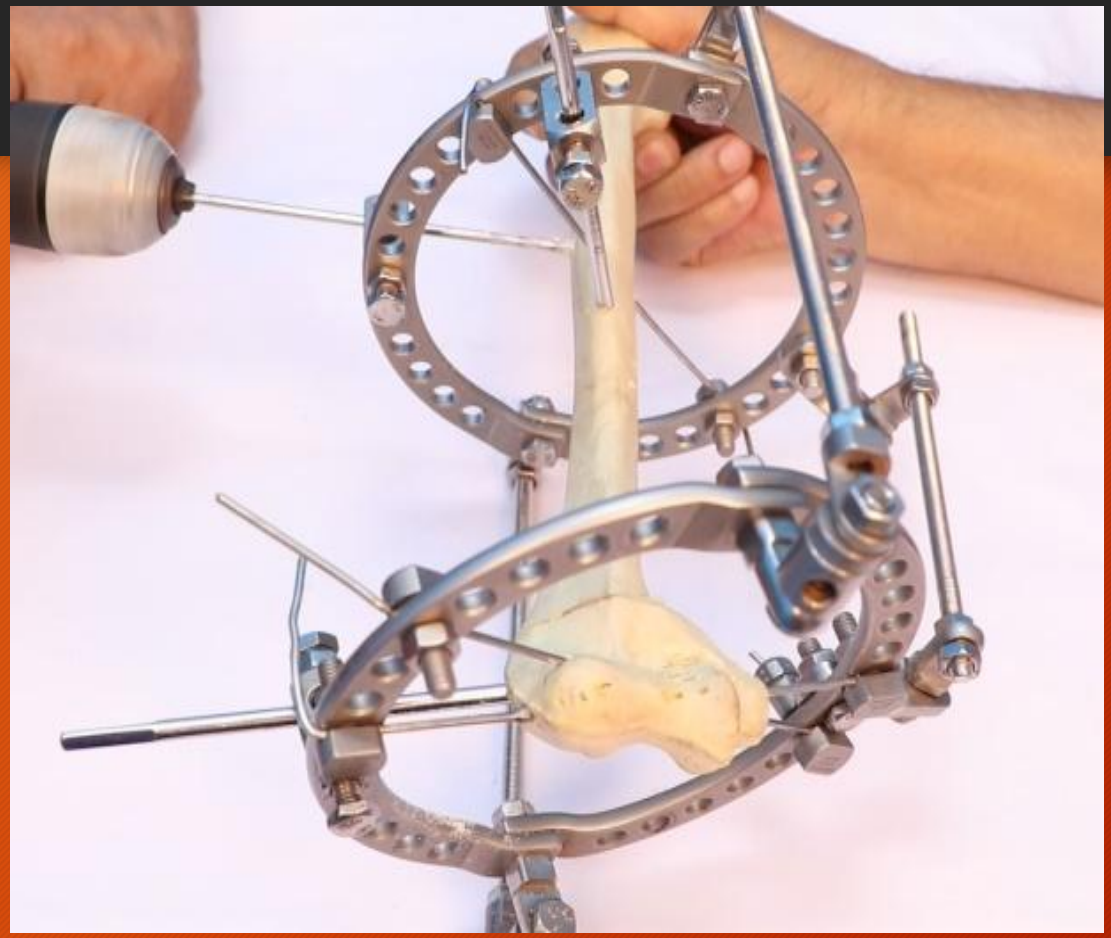
1 hole rancho block is attached downward to the proximal ring. Drilling by 2.5 mm drill bit through a protective sleeve, direction antero lateral to postero medial

STEP 11



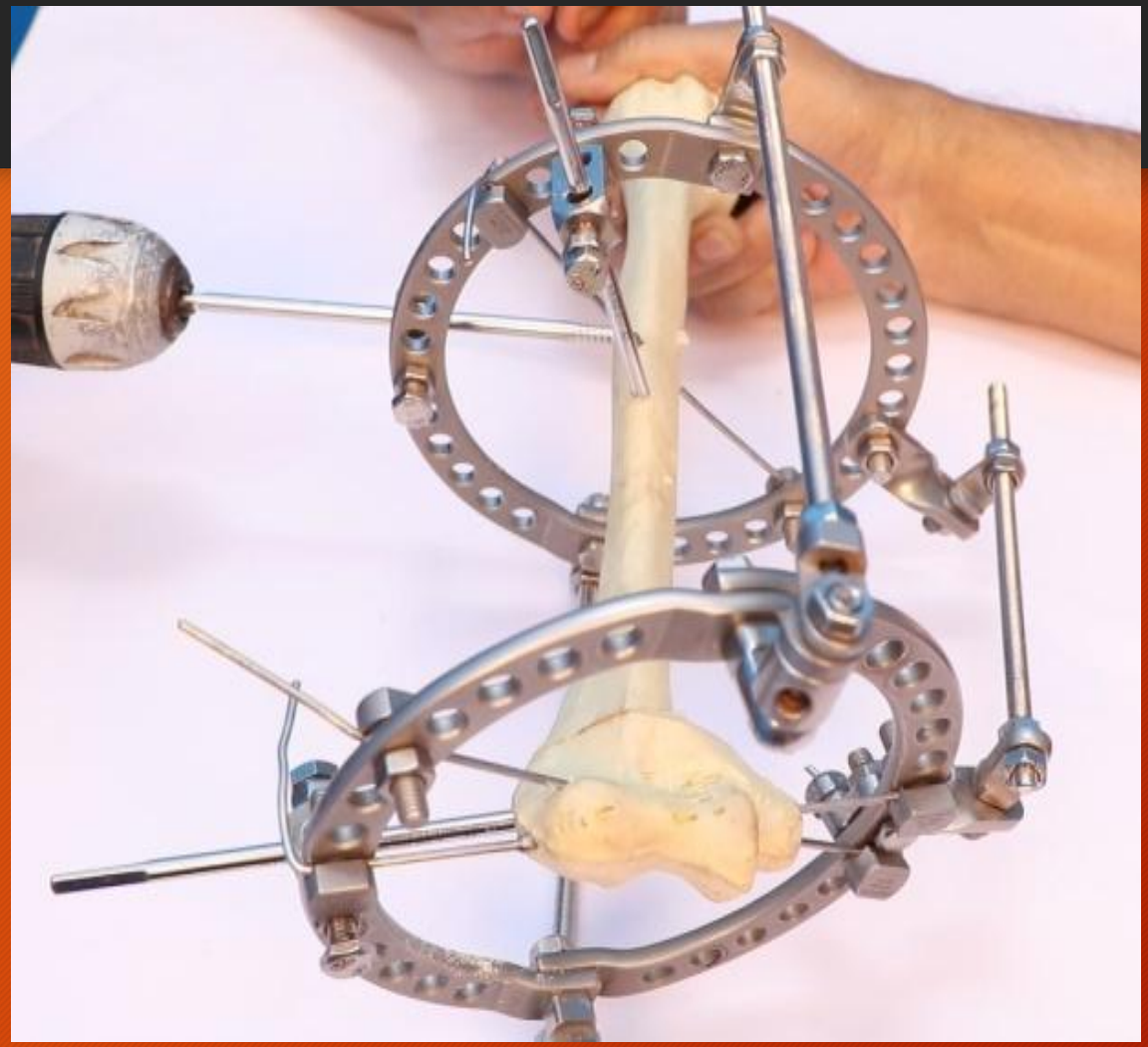
A 4 mm half pin is fixed to proximal ring, direction antero lateral to postero medial

STEP 12: 2nd half pin application in proximal ring



Two hole rancho block is attached upward to the proximal ring. Drilling by 2.5 mm drill bit through a protective sleeve, direction lateral to medial

STEP 13



Insertion of 4 mm half pin, direction lateral to medial

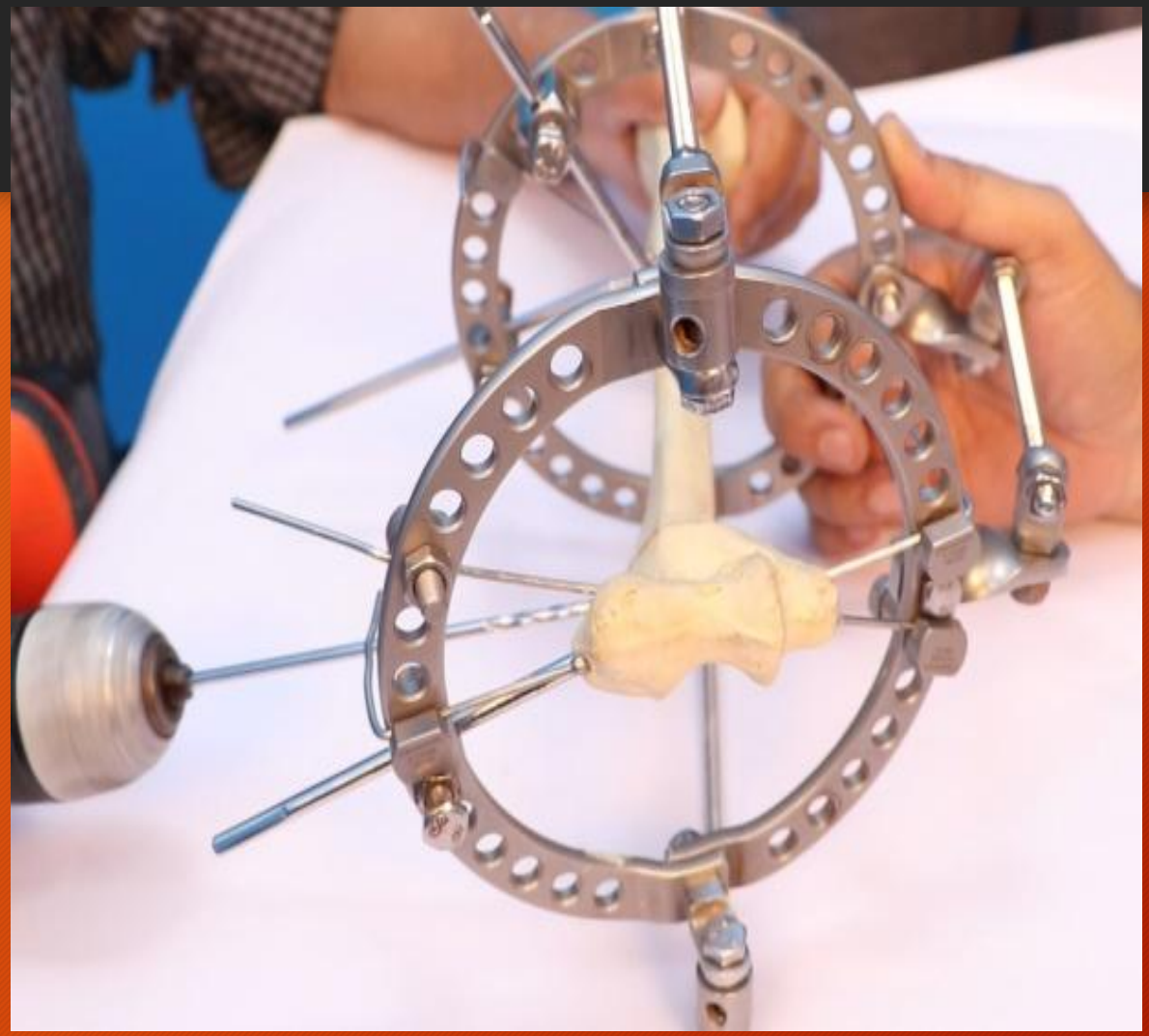
STEP 14

Loosening of anterior Hinge Before Osteotomy

STEP 15

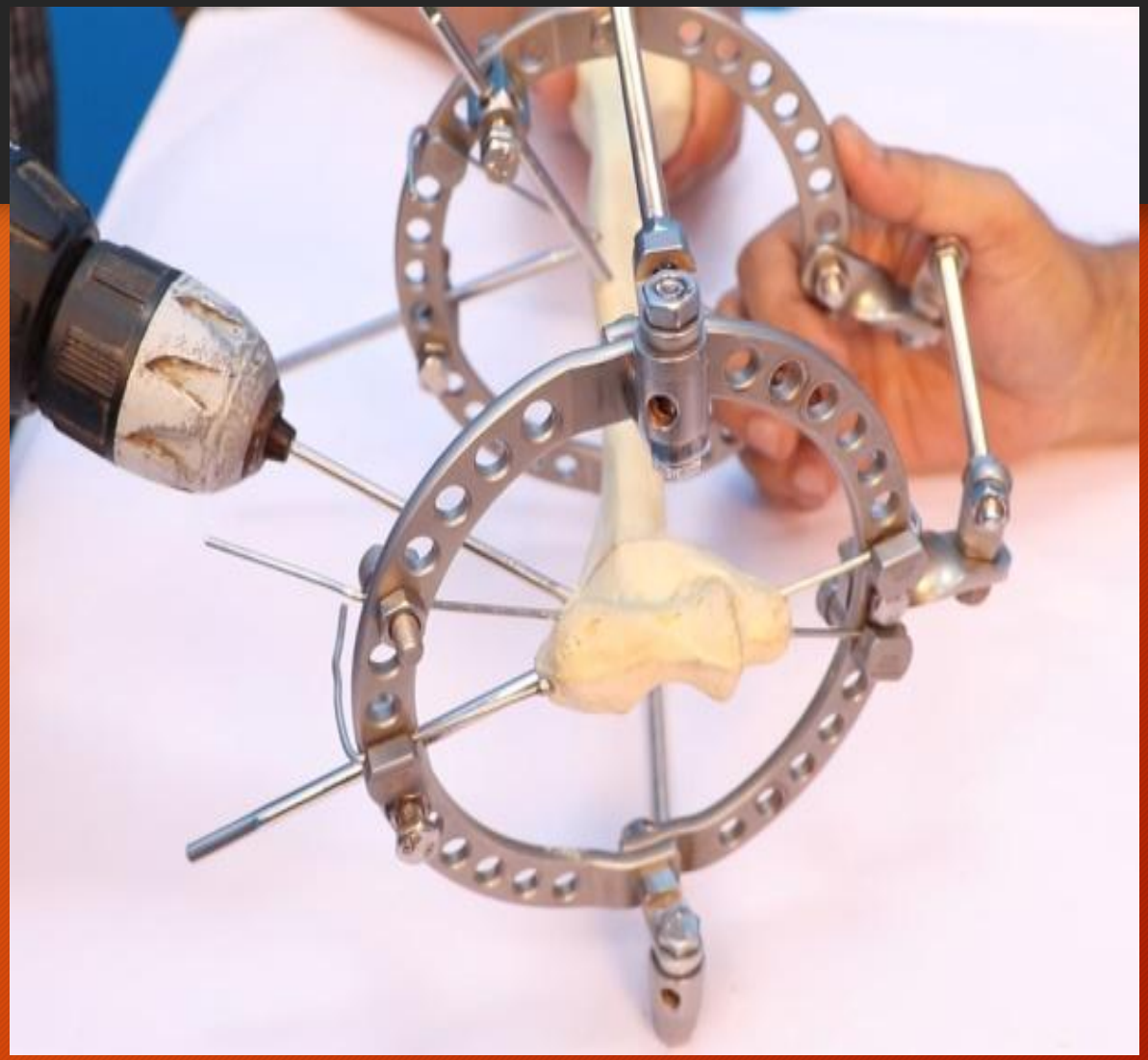
Loosening of Posterior Hinge

STEP 16: Osteotomy



Pre Osteotomy Drilling from lateral to Medial by 2.5 mm drill bit

STEP 17

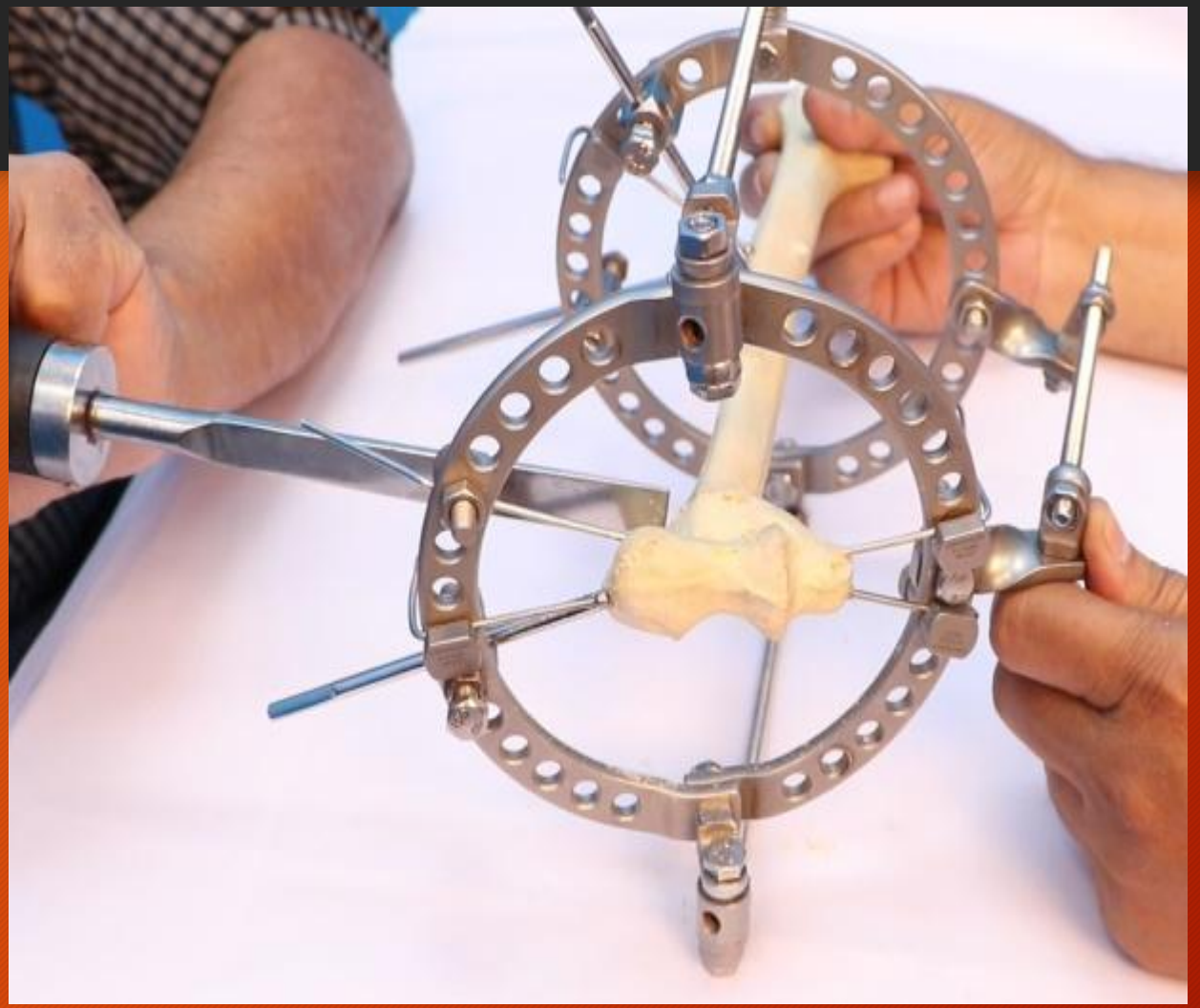


Drilling for Osteotomy, direction antero lateral to postero medial

STEP 18

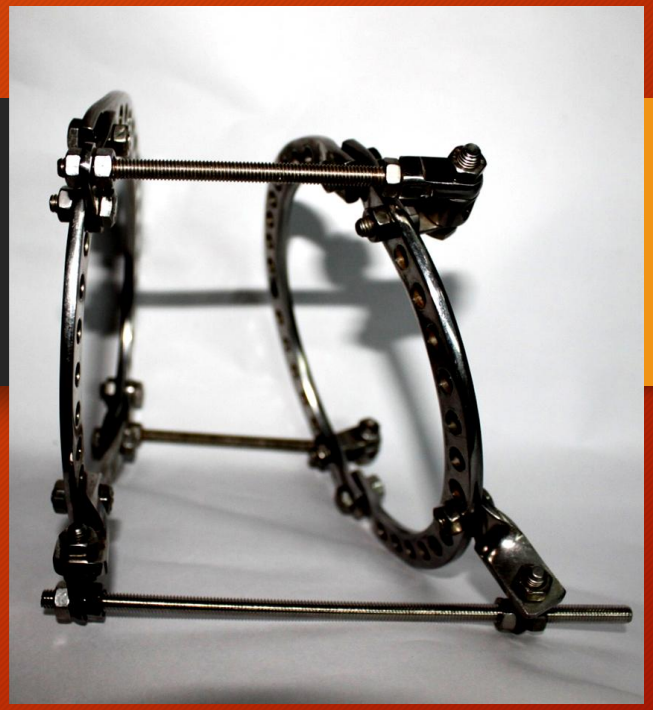
Drilling from postero lateral to antero medial

STEP 19



Supracondylar Osteotomy, Direction Lateral to Medial Cutting anterior and posterior cortex

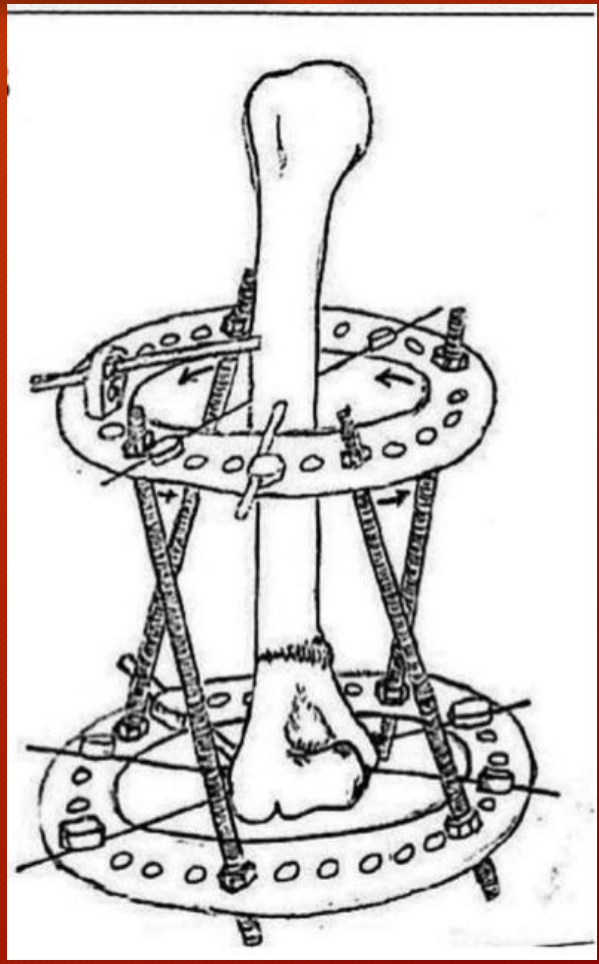
Postop protocol



- Pintract care
- Elbow and shoulder exercises from day1
- Varus correction –
  - Gradual distraction from day 5-7, four times/day
  - 3 mm/day distraction at motor unit roughly equals 1mm distraction at osteotomy site by rule of similar triangles

Internal Rotation

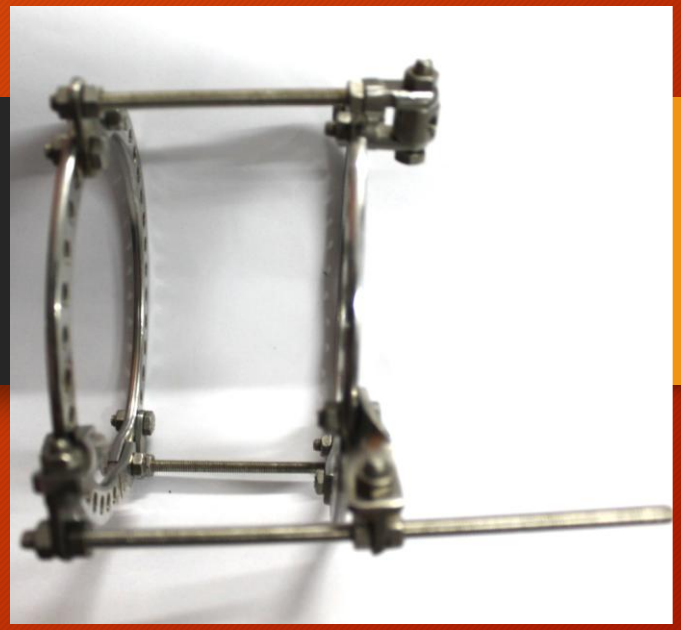
- Distal fragment derotated 10 degree by shifting all connecting rods of distal ring by one hole clockwise
- At 2 weeks after surgery after some callus formation
- Further 10 degree rotation after 1 week as needed

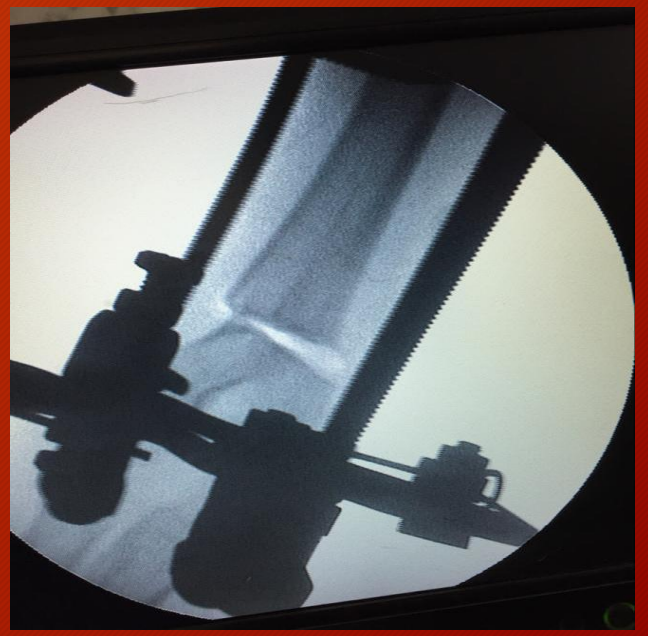


Postop protocol

Complete correction –

- Both rings become parallel
- Compensatory medial translation of distal fragment due to extraarticular hinges (Osteotomy rule 2)
- Motor unit replaced by straight threaded rods
- Axial compression
- Frame removed after healing is satisfactory radiologically (2-3 months)





Patients

Table 1 Demographic profile of patients and preoperative data

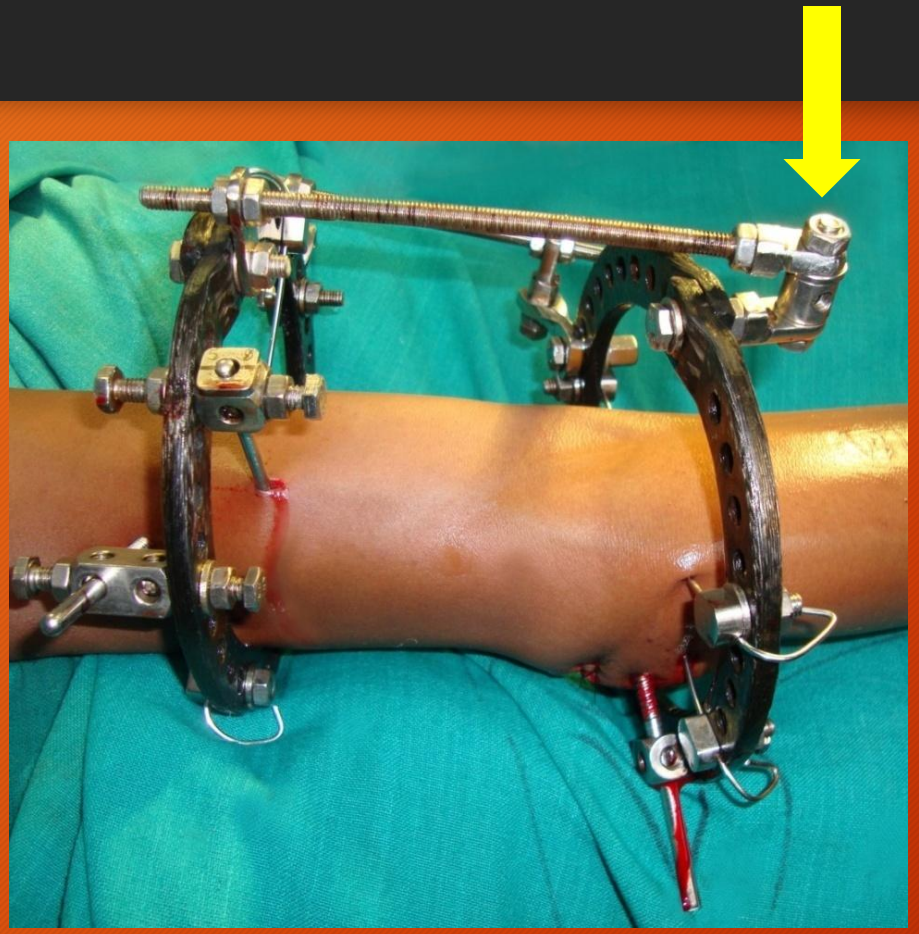
S No.	Age (years)	Sex	Affected side	Dominant hand	Initial injury[a]	Time since initial injury (years)	Initial management[b]	Preoperative HEW angle (° of varus)	Cause of deformity (probable)	Preoperative flexion (°)	Preoperative extension (°)
1	8	M	L	R	SCF, Type 3	1.00	CRPP	15	Loss of reduction	120	0
2	11	F	R	R	SCF, Type 3	5.00	CRPP	16	Inadequate reduction	120	0
3	10	M	L	R	SCF, Type 3	1.00	CRPP	30	Late presentation	125	−5
4	8.5	F	L	L	SCF, Type 3	1.00	CRPP	18	Loss of reduction	130	−10
5	11	F	R	R	SCF, Type 3	5.50	OR + pinning	15	Loss of reduction	120	−5
6	6	M	R	R	Unknown	2.00	A/E POP cast	15	Unknown	120	10
7	5	F	L	R	SCF, Type 2	2.50	A/E POP cast	16	Inadequate reduction	125	0
8	5	M	L	L	Unknown	1.50	Unknown	32	Unknown	120	10
9	8.5	M	L	R	SCF, Type 3	1.00	CRPP	10	Inadequate reduction	120	0
10	5.5	M	L	R	SCF, Type 3	1.00	OR + pinning	20	Loss of reduction	120	0
11	10	M	L	R	SCF, Type 3	1.50	CRPP	12	Loss of reduction	110	−20
12	6	M	R	R	SCF, Type 2	3.00	A/E POP cast	18	Loss of reduction	125	0
13	16	M	R	L	SCF, Type 3	10.00	OR + pinning	15	Loss of reduction	135	0
14	6	M	L	L	SCF, Type 3	1.00	CRPP	25	Inadequate reduction	115	0
15	9.5	F	R	R	SCF, Type 3	5.00	CRPP	30	Loss of reduction	120	−5
16	6	M	R	R	SCF, Type 3	2.25	CRPP	26	Late presentation	120	0
17	7.5	M	L	R	SCF, Type 3	2.00	OR + pinning	21	Loss of reduction	120	0
18	7.5	M	L	R	SCF, Type 3	2.00	A/E POP cast	28	Late presentation	115	−10
19	10	M	L	R	SCF, Type 3	1.00	CRPP	26	Loss of reduction	130	0
20	5.5	M	R	R	SCF, Type 3	1.00	CRPP	11	Loss of reduction	120	0
21	6.5	M	L	L	SCF, Type 3	1.00	CRPP	25	Inadequate reduction	125	−15
22	9	M	L	R	SCF, Type 3	2.00	OR + pinning	16	Loss of reduction	115	−20
23	11	M	R	R	SCF, Type 3	5.00	CRPP	23	Loss of reduction	125	0
24	14	M	L	L	SCF, Type 3	2.00	A/E POP cast	21	Late presentation	115	−5
25	12	M	L	R	SCF, Type 3	6.00	CRPP	24	Loss of reduction	125	−5
26	6.5	M	L	L	Unknown	3.00	A/E POP cast	13	Unknown	120	−5
27	11.5	M	R	R	SCF, Type 3	4.00	CRPP	18	Loss of reduction	125	−5
28	9.5	M	L	R	SCF, Type 2	1.00	A/E POP cast	12	Late presentation	125	−5
29	11	M	L	R	SCF, Type 3	5.00	CRPP	26	Inadequate reduction	120	0
30	18	M	L	R	SCF, Type 3	1.50	CRPP	25	Loss of reduction	125	−5
31	13.5	F	L	L	SCF, Type 3	3.00	OR + pinning	10	Loss of reduction	120	0
32	10	M	L	L	SCF, Type 3	1.00	CRPP	25	Loss of reduction	115	−10

[a]SCF: supracondylar fracture humerus; type according to the Gartland classification.
[b]A/E POP cast, above elbow plaster cast; CRPP, closed reduction + percutaneous pinning; OR, open reduction.

16 year-old male with Rt cubitus varus 38 degree

Pre-op photo

Pre-op X-ray

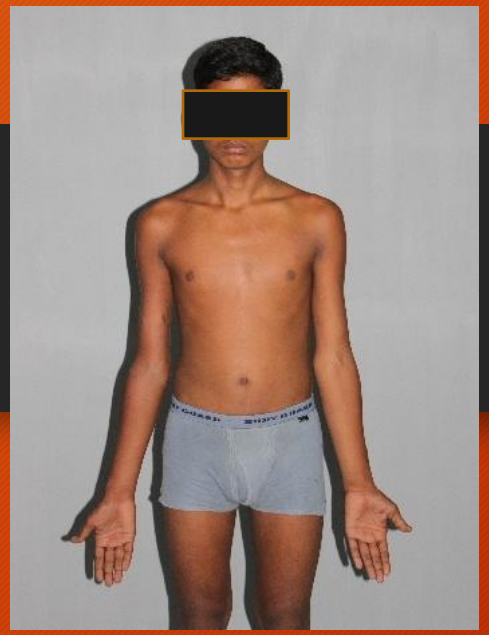


Operative photo

Post-op X-ray

Preop X-Ray

Final X-ray



Before

After

8-year-old male with left cubitus varus, 13 months post injury, 15° varus

Pre-op photo

Pre-op X-ray

Post-op X-ray

Final photo in extension

Final photo in flexion

Final X-ray

Before

After

11-year-old female with Rt cubitus varus 23°

Pre-op photo

Pre-op X-ray

Post-op photo

Post-op X-ray

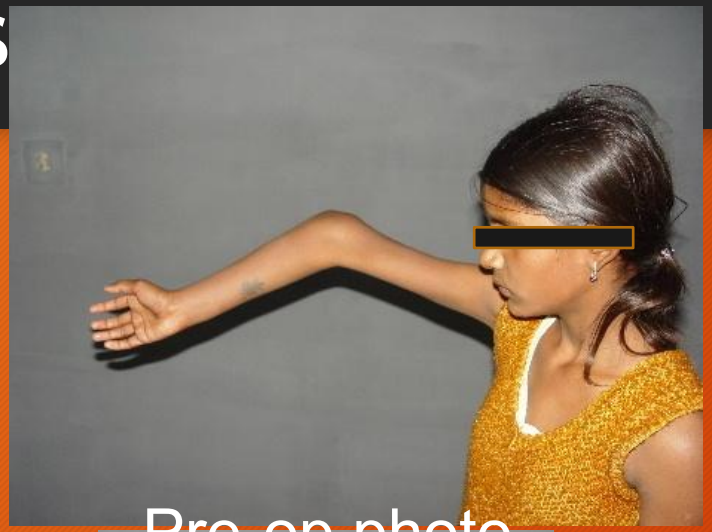
Final photo

Final X-ray

Before

After

14-year-old female with Rt cubitus varus



Pre-op photo

Pre-op X-ray

Final photo

Final X-ray

Before

After

IV Results

- Introduction
- Patients and Methods
- Surgical details
- Results
- Discussion
- Conclusion
- Acknowledgements

Results:

Functional Results: (Oppenheim's grading)

Interpretation:	Criteria:	Number of cases:
Excellent	1. Correction of varus to within 5°of contra lateral elbow 2. Motion to within 5°of pre-op flexion and rotation arcs 3. No peri-operative complications	25
Good	1. Valgus position 2. Motion within 10° of pre-op flexion and rotation arcs	2
Poor	1. Any complication 2. Residual varus 3. Loss of more than 10° in any plane of motion	5

Supracondylar Humeral Osteotomy for Traumatic Childhood Cubitus Varus Deformity

WILLIAM L. OPPENHEIM, M.D.,* TIMOTHY J. CLADER, M.D.,*
CHADWICK SMITH, M.D.,** AND MICHAEL BAYER, M.D.*

Results:

Pre Op Values:

- Mean HEW angle: 10°varus
- Mean flexion: 117.5°
- Mean extension: -3.5°
- Mean IR: 16.5 °

Post Op Values:

- Mean HEW angle at final follow-up: 6°of valgus
- Mean flexion: 124.5°
- Mean extension: -4°
- Mean LPI: -1.60

Results:

Mayo Elbow Performance Score: (Post-op)

Parameter:	Description:	Points:
Pain: (45 points)	• None • Mild • Moderate • Severe	45 30 15 0
Range of Motion: (20 points)	• Arc > 100° • Arc 15°-100° • Arc < 50°	20 15 5
Stability: (10 points)	• Stable • Moderately unstable • Grossly unstable	10 5 0
Function: (25 points)	• Able to comb hair • Able to feed • Able to perform hygiene • Able to put on shirt • Able to put on shoes	5 5 5 5 5

Score:	Grading:	Number of Cases:
90-100	Excellent	23
75-89	Good	7
60-74	Fair	2
<60	Poor	0

Validity of Observer-Based Aggregate Scoring Systems as Descriptors of Elbow Pain, Function, and Disability*

BY DIANA C. TURCHIN, M.D., F.R.C.S.(C)†, DORCAS E. BEATON, B.SC., O.T., M.SC.‡, AND ROBIN R. RICHARDS, M.D., F.R.C.S.(C)§, TORONTO, ONTARIO, CANADA

Investigation performed at Upper Extremity Reconstructive Service, St. Michael's Hospital and University of Toronto, Toronto

Complications:

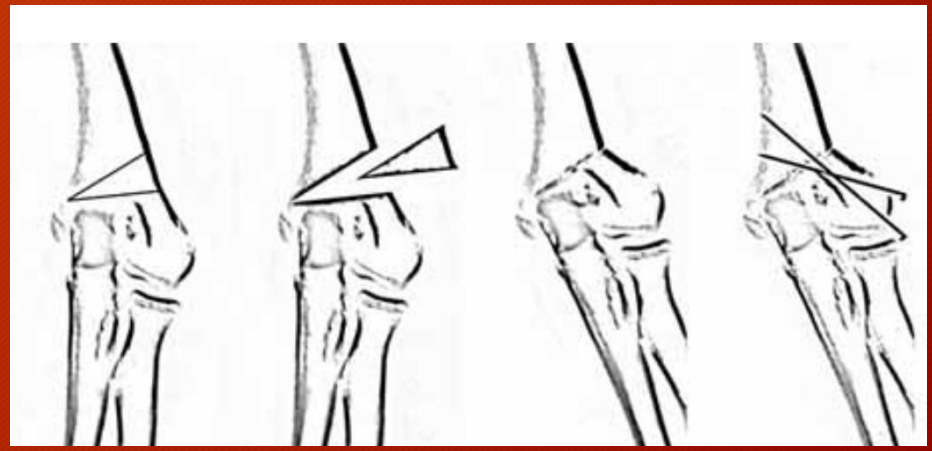
- Superficial pintract infections (Cheketts-Otterburn grade 2/3): 03/32
- Loss of terminal elbow flexion: 03/32
- Lateral condylar prominence: 01/32
- Valgus overcorrection: 01/32

VI Discussion

- Introduction
- Patients and Methods
- Surgical details
- Results
- Discussion
- Conclusion
- Acknowledgements

Discussion

- Traditionally – osteotomy and internal fixation
- No scope for postop correction
- Recurrence due to hardware failure
- Upto 30% poor results



Discussion

Similar studies of correction of Cubitus Varus by Ilizarov:

- Song et al
- Catagni et al
- Piskin et al
- Bari et al
- Karatosun et al
- Ozkan et al

SUPRACONDYLAR OSTEOTOMY WITH ILIZAROV FIXATION FOR ELBOW DEFORMITIES IN ADULTS

HAE-RYONG SONG, SE-HYUN CHO, SOON-TAEK JEONG, YOUNG-JUNE PARK, K.-H. KOO

From Gyeong-Sang National University School of Medicine, Chinju, Republic of Korea

The Journal of Bone and Joint Surgery. British volume, Vol. 89-B, No. 12 | Upper Limb

The management of cubitus varus and valgus using the Ilizarov method

Free Access

A. Piskin, Y. Tomak, C. Sen, L. Tomak

Published Online: 1 Dec 2007 | https://doi.org/10.1302/0301-620X.89B12.19361

Treatment of cubitus varus with open medial wedge osteotomy using ilizarov technique

Bari MM,[1] Shahidul Islam,[2] NH Shetu,[2] Mahfuzer Rahman,[2] Mashiur H Munshi,[3] Md Golam Mostofa,[2] Naima Ferdousi[3]

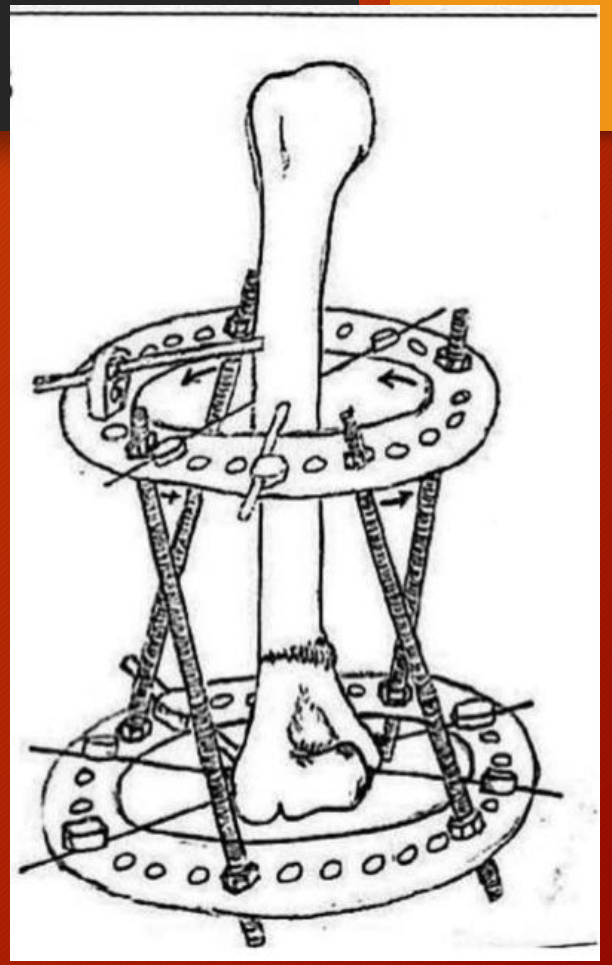
[1]Bari -Ilizarov Orthopedic Centre, Visiting and Honored Prof. Russian Ilizarov Scientific Centre, Bangladesh

[2]Bari-Ilizarov Orthopaedic Centre, Bangladesh

[3]National Institute of Traumatology and Orthopaedic Rehabilitation, Bangladesh

Discussion

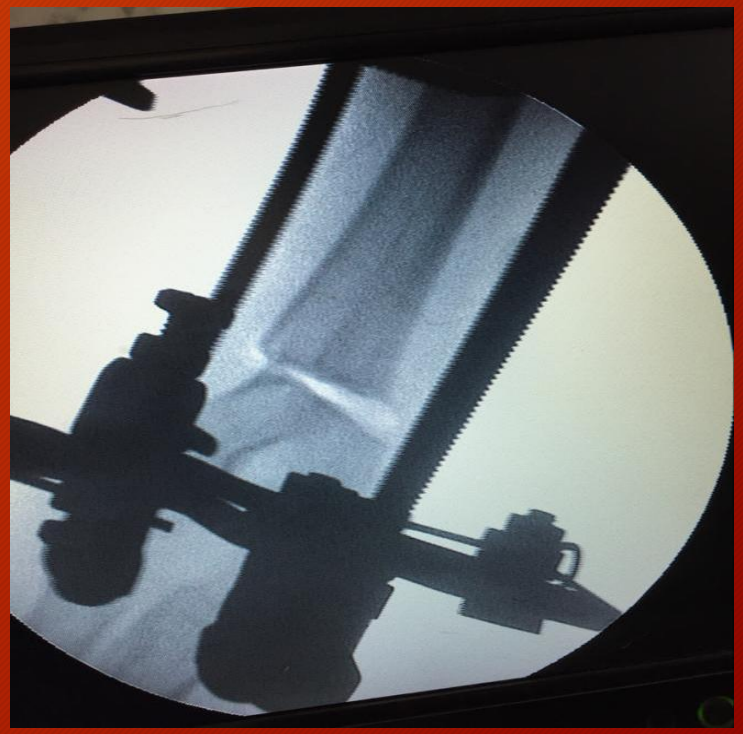
- Most of these Ilizarov studies have not addressed how rotational component was treated



VII - Conclusion

Ilizarov is an attractive alternative for correction of Cubitus Varus

- Minimally invasive
- Postop accurate correction
- Early mobilization
- No hardware removal



Thank You

Agrawal Orthopaedic Hospital & Research Institute, India

Fellow Wall

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