

Elbow Angular Deformity

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Significant adverse sequale of distal humerus fracture in child

→ growth disturbance, AVN, position in healing

Normal

• Carrying angle

- The angle formed by the long axis of the humerus and ulnar with full extension
- Male : 11-14 degree, Female : 13~16 degree
- Remains same throughout life under normal condition
- Not altered by secondary sex development
- Formed by the orientation of the humeral articulation referable to the long axis of the humerus and the valgus angular relationship of the greater sigmoid fossa referable to the long axis of the ulnar

• Sagittal plane : Flexion, Extension deformity

• Coronal plane: Valgus, Varus deformity

• Horizontal plane: Rotational deformity

• Simple collapse or impaction of lateral column → cubitus valgus

Medial column → cubitus varus

Cubitus Varus

• Poorly tolerated cosmetic deformity

• Practically no functional impairment

• Formed by internal rotation of distal fragment and varus deformity

• Internal rotation

→ augment deformity with varus deformity

→ create moderate deformity with flexion contracture

→ removes the stability of fracture reduction

→ contribute to onset of ulnar nerve palsy

• Varus angulation → Most important factor

- Derangement of triceps mechanism
- Radiologic evidence
- AP view: angle of physis of lateral condyle is more horizontal than normal
- Lateral view: crescent sign → superimposition of capitulum on olecranon

The Goal of Corrective Surgery

- 1) Restore the upper Extremity alignment
- 2) Restore range of motion
- 3) Improve function near to pre injured state

Surgical Approach

- Medial approach
 - Advantage
 - Visualization and protect neurovascular bundles
 - Disadvantage
 - Difficulty in lateral osteotomy

- Posterior approach
 - Triceps-splitting, Triceps-tendon transecting, Triceps-sparing technique
 - Advantage
 - Excellent visualization of distal humerus
 - Disadvantage
 - Long incision and dissection → postoperative adhesion
 - Avascularity of distal fragment
 - Difficulty in intraoperative assessment of correction of carrying angle

- Lateral approach
 - Most frequently utilized
 - Advantage
 - Excellent exposure of distal humerus
 - Easy to osteotomy
 - Disadvantage
 - Proximity of radial nerve injury

- Hemiepiphysiodesis and growth alteration
 - A developing potency with medial growth arrest or troclear avascular necrosis
 - Not correct the angular deformity, but prevent increasing

- Osteotomy Technique

- Three basic type
 - Medial open wedge osteotomy with bone graft
 - Lateral closing wedge osteotomy
 - Oblique osteotomy with derotation
- Medial open wedge osteotomy with bone graft
 - Disadvantage
 - Increased length of medial column (more than 30 degree)
 - Ulnar nerve stretching → performed with nerve anterior transposition
 - Cause inherent instability
 - Require separated incision for graft bone harvest
 - Oblique Osteotomy
 - Can not correct rotational deformity
 - Lateral closing wedge osteotomy
 - Advantage
 - Easiest, safest, inherent most stable osteotomy
 - Correction of three component
 - Disadvantage
 - Lateral prominence of distal fragment → medially translation of fragment
 - Unequal width of proximal and distal fragment at lower end of humerus
 - Upon remodelling and appeared improved
 - Three-dimensional osteotomy
 - Advantage
 - Extensive surface contact for osseous bridging
 - Easy and secure correction of posterior tilt
 - Step-cut osteotomy
 - Advantage
 - Cortical spine allows cortical screw for fixation
 - Cut or trimmed to correct remaining flexion or extension deformity
 - The spike serve as a guide for rotational deformity
 - Multiple plane deformity correctable
 - Disadvantage
 - Nerve injury Ulnar and Radial nerve
 - Dome osteotomy
 - Advantage
 - Correction of malrotation
 - Avoid prominent lateral epicondylar region
 - Disadvantage
 - Not adress flexion/extension of distal fragment
 - Technically demanding

- Quadrilateral Displaced osteotomy
 - Advantage
 - Correction of carrying angle
 - Initial stability and early ROM exercise

- Fixation technique

- Smooth K-wire
 - Fixation less reliable to others
 - Greater incidence of loss of correction
- Tension band wiring
 - Used only good medial cortical integrity remains after wedge osteotomy
- Plate and screws
 - Used in older adolescent
 - In planned early range of motion after operation
- External fixation
 - Difficulty in pin tract care

- Complication

- Infection, loss of fixation, stiffness
- Nerve palsy, brachial artery aneurysm, lateral condylar prominence
- loss of correction to an unstable fixation (m.c.)
- delayed union at the osteotomy, unsightly scar

Cubitus Valgus

- Not for capitellar physis premature closure

- Nunion with proximal migration of the lateral condyle or pseudarthrosis
- Growth of distal humerus 20% of overall length of humerus
- Resultant angular deformity is mild compared with active physis

- Pure posterior angulation → valgus deformity ← normal valgus deformity of humeroulnar articulation
 - no deformity in coronal plane

- Onset of tardy ulnar nerve palsy

- 30-40 years later fracture of humeral lateral condyle
- Motor loss occurs first, sensory change
- Stretching of the nerve behind the medial epicondyle
- Ulnar nerve anterior transposition, simple relief of cubital tunnel

- Extension and flexion lag
- Slightly limitation of pronation and supination
- Limitation of motion

Bony deformity
Gross joint irregularity
Fibrosis of joint

- Prevention of valgus deformity
 - medial column fixed carefully → prevent tilting
 - lateral column fixed well → prevent its collapse
- Treatment modality
 - Corrective osteotomy with anterior transposition of ulnar nerve
 - Closing wedge medial osteotomy
 - Opening wedge lateral osteotomy
 - Osteosynthesis of nonunion
 - Milch type I nonunion with angulation
 - Corrected with medially based closing wedge osteotomy
 - Milch type II nonunion with angulation
 - More unstable : Ulnar deprived support laterally
 - Requires lateral translation → diminish the medial condyle prominence
 - Angulated nonunion treated in a staged fashion
 - Ulnar nerve transposition, lateral condyle is grafted and in situ fixation
 - Once healed and ROM return
 - Corrective osteotomy
 - Lengthening common extensor origin in malunited fracture

Flexion-Extension deformity

- Common but less noticeable
- Fishtail deformity
 - Avascular necrosis in distal humeral epiphysis
 - The defect is gap between medial and lateral epiphyseal fragments
- Two types
 - A sharp, deep, angulated type → Inadequate reduction
 - More smooth, gentle indentation type → osteonecrosis of troclear
 - stress riser for further fracture
- Disability is mild
- Complication of any fracture in childhood, except epicondylar fracture
- Severity of deformity bears no relation to displacement of fragment

- Functional impairment is variable
- No agreement about cause of deformity
- Presumably premature fusion of epiphyseal plate or avascular necrosis of trochlea
- Humeral defect → allow proximal migration of olecranon
 - coronoid process impinged in flexion
 - olecranon impingement in extension
 - severe case ; radial head subluxation
- Ant. or Post. Vessel to trochlear epiphysis disruption
 - disturbing central cartilage growth
- Medial and lateral side → muscle attachment preserve the growth
- Severity of disability is dependent on amount of trochlear loss

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