Elbow Angular Deformity

충남대학교 의과대학 정형외과학교실

신 현 대

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 capitullum 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
Exellent 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
Exellent 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 seperated 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 colsure
Nounion 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 occures first, sensory change
Stretching of the nerve behind the medial epicondyle
Ulnar nerve anterior transposition, simple relief of cubital tunnel
Extnsion 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 attatchment preserve the growth
Severity of disability is dependent on amount of trochlear loss

REFERENCE

1. Morrey BF: The Elbow and Its Disorders. 3rd ed. Philadelphia: W.B. Saunders, 201-218, 2000.
2. Chess DG, Leahey JL, Hyndman JC: Cubitus varus: Significant factors. J Ped Orthop.14: 190-192, 1994.
3. Jain AK, Dhammi IK, Arora A, Singh MP, Luthra JS: Cubitus varus: Problem and solution. Arch Orthop Trauma Surg. 120: 420-425, 2000.
4. A Mitsunari, H Muneshige, Y Ikuta, T Murakami: Internal rotation deformity and tardy ulnar nerve palsy after supracondylar humeral fracture. J Shoulder Elbow Surg. 4: 23-29, 1995.
5. Derosa GP, Gregory P: A new osteotomy for cubitus varus. Clin Orthop. 236: 160-165, 1988.
6. Uchida Y, Ogata K, Sugioka Y: A new three-dimensional osteotomy for cubitus varus deformity after supracondylar fracture of the humerus in children. J Ped Orthop. 11: 327-331, 1991.
7. Boeck H, Smet P: Valgus deformity following supracondylar elbow fractures in children. Acta Orthop Belgica. 63-4: 240-244, 1997.
8. Raymond TM, Wilkins KE: Deformity following distal humeral fracture in childhood. J Bone Joint Surg. 66: 557-562, 1984.
9. Canal ST: Campbell' s operative orthopaedics. 10th ed. Philadelphia: Mosby, 2003.
10. Ippolito E, Moneta MR, D' Arrigo C: Post-traumatic cubitus varus. Long term follow up corrective supracondylar humeral osteotomy in children. J Bone Joint Surg. 72: 757-765, 1990.
11. A Kalenak: Ununited fracture of the lateral condyle of the humerus. A 50year follow-up. Clin Orthop. 124: 181-183, 1977.
12. Hasler CC, von Laer L: Prevention of growth disturbance after fractures of the lateral humeral condyle in children. J Ped Orthop. 10: 123-130, 2001.
13. Rick P, Peter MW: Posttraumatic reconstruction of the elbow in the pediatric patient. Clin Orthop, 370: 115-126, 2000.
14. Wilkins KE: Residuals of elbow trauma in children. Clin Orthop Nor Am. 21: 291-314, 1990.
15. Skak SV, Olsen SD, Mmaabrekke A: Deformity after fracture of the lateral condyle in children. J Ped Orthop. 10: 142-152, 2001.
16. Beaty JH, Kasser JR: Fractures in children. 5th ed. Philadelphia, LWW, 2001.