Institute of Experimental Morphology and Anthropology

Acta morphologica et anthropologica, 8
Sofia • 2003

Capitello-trochlear Complex and its Significance in the Anatomy and Function of the Distal Humerus

*A. Katsarov, Y. Yordanov, A. Siddiqui**

Institute of Experimental Morphology and Anthropology, Bulgarian Academy of Sciences, Sofia
**JJ Group Hospital, Mumbai, India*

The past two decades witnessed great improvement in the techniques and equipment used in medicine in general and widened the means of the diagnostic imaging [1, 2, 13].

However the classic anatomical techniques of observation and experimentation did not loose their value.

We reveal normal anatomy and function of the distal humerus in human in the light of the Bicolumn theory and add our view for the significance of the distal articular structures of the humerus.

Key words: Humerus, capitello-trochlear complex, distal humerus.

As it is known humerus is the bone of the arm [1, 2, 3, 4,19]. It is a long bone divided into three parts. The central part is known as humeral body. It consists of cortical bone. Other parts are proximal and distal end, structured mainly of spongy bone covered by thin cortical layer.

The distal end of the humerus is widened and the external edges of the humeral body pass into the epicondyles - rounded processes of bone. Bigger one is the medial epicondyle and lesser one — lateral epicondyle [1,12,10,11,].

The most distal parts of the humerus are trochlea and capitellum [18].

In newborn the distal humeral epiphysis is completely built of cartilage. It does not differ from the distal humerus in the adult, in macro anatomic view [8].

Humerus ossifies from a single primary center and additional centers. They are visible at a different age, as it is shown on the figures 3 and 4.

There is a difference in the time of ossification of the distal humeral structures. In males lateral condyle ossifies during the 12^{th} year and in female during the 11^{th} year. Medial condyle in male - 7^{th} year and in female - 5^{th} year. Capitellum — male 5^{th} month, female — 4^{th} month. Trochlea in male — 9^{th} year and female — 5^{th} year [5,6]. This is the so-called "cross" rule.

Medial condyle lies extremely extra-articularly (Fig 3). The cortical layer of bone is thin. It differs from the adults by not passing over the entire anterior surface. It is deficient in the zone of coronoid fossa. This "defect" is covered by cortical bone during the growth [7, 9].

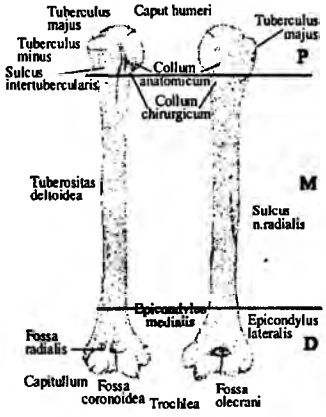

Fig. 1. Humerus — anatomy

Fig. 2. Skeletal development of a 6 months old fetus

Like an answer of the new trends entering the orthopedic surgery, Jupiter J. and Mehne D., created the Bicolumn theory in 1991 [15, 16, 17].

The idea is, when viewed from a posterior approach, the humeral shaft divides into medial and lateral columns longitudinally. These columns terminate distally where the transversely oriented trochlea connects between both columns.

By interconnecting with these divergent columns, the terminal part of the elbow joint most resembles triangle, which is fundamental in understanding of the proper mechanics of joint motion and the intra-articular fracture treatment.

With disruption of anyone of the three arms of the triangle, the entire construct is weakened, but it is more weakened if the disruption is on the base of the triangle.

Some authors believe that the trochlea and the capitellum are the articular surfaces of the condyles [9, 12, 19].

According to others, they are absolutely independent parts of the distal humerus [5, 7]. However,

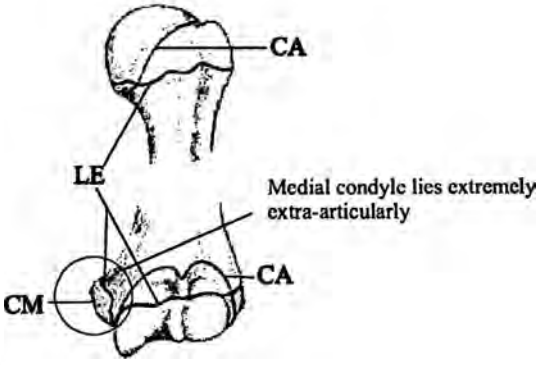

Fig. 3. Epiphyseal lines of the humerus — anterior view. CA — joint capsule line, LE — epiphyseal line, CM — medial condyle

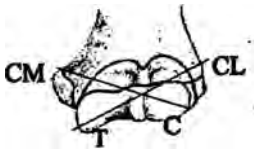

Fig. 4. "Cross rule" for the ossification of the distal humerus. CM — medial condyle, CL — lateral condyle, T — trochlea, C — capitellum

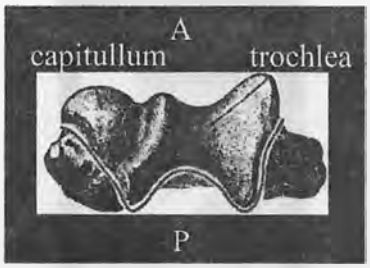

Fig. 5. "W" shaped outlook of intact distal end in coronal view

defining the distal humeral articulation as a triangle based in the trochlea ignores the capitellum.

As a result of long lasting observations, measurements and analyses, we reached the conclusion that the capitellum and the trochlea could be united in a complex — the capitello — trochlear complex (CTC) [14].

The CTC represents the intercolumnar "tie-rod". It has the form and comprises medial and lateral lips with an intervening sulcus. This sulcus articulates with the semi lunar notch of the proximal ulna. The adjacent lips offer medial and lateral stability to this articulation [15].

In coronary plan the CTC lies about 20° rotation in relation with the proximal part of the humerus. The angle is known as "torsion angle". It contributes for the total outlook of the humerus as a long bone.

We found that in the same coronary plan the outlines of the CTC resemble a "W" shape. This "W" sign is appearance of a norm and any disturbance of the shape speaks for intra-articular fracture (Fig. 5).

The CTC axis with the respect of the longitudinal axis of the humerus is approximately 94° in valgus in males and 98° in females. The normal valgus position of the elbow is commonly referred to as "carrying angle" of the elbow. Functionally, it allows the positioning to objects away from the body when they are held with the elbow in extension.

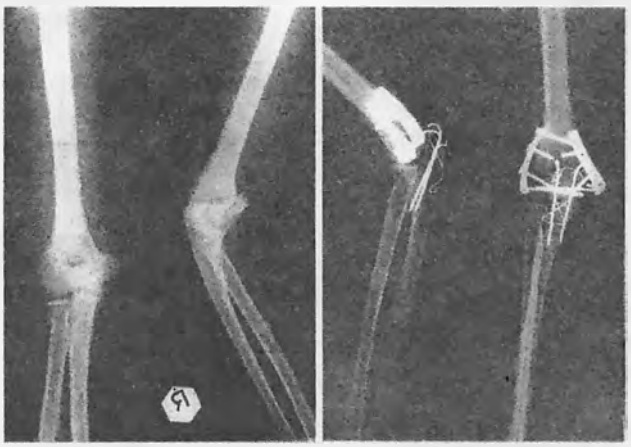

Fig. 6. Pre- and post-operational X-ray graphies of bicolumn fracture in 24 y.o. female

In addition the CTC axis is externally rotated between 3° and 8° with respect to a line connecting the medial and lateral epicondyles.

Traditional classifications of the fractures of the distal humerus have centered on the anatomic concept of the terminal end of the humerus, structured as condyles-hence the terms "condylar", "transcondylar" and "bicondylar" fractures.

The distal humerus could not be precisely described and understood as two diverging columns supporting an intercalary surface, rather as rounded projections (condyles) such as those found in the distal femur or head of the metacarpal bones.

Changing the term "condyle" to "column" more accurately describes as well as maintains the general categories.

As a confirmation of the Bicolumn theory created by Jupiter and Mehne, and the significance of the CTC, we show the diagnostic and post-operative X-ray graphies of a clinical case [17]. This is a bicolumnar fracture in 24 y.o. female and the CTC is separated.

Note that the two plates are oriented in perpendicular planes supporting the two columns and the situation of the transverse screws, which pass through the CTC in order to restore the base of the triangle (Fig. 6).

Intra-articular fractures of the distal humerus are big diagnostic and therapeutic problem. A new step in the solution of the problem is the Bicolumn theory, to which we add 3 supplements. We believe that will bring more serenity in the solution of the problem.

The so shown rational approach to the anatomy of the distal humerus is imposed because of the increasing need of adequate diagnostics and treatment of the fractures in this zone.

We hope that after mutual working of multidiscipline teams it will be sold in the nearest future.

References

1. Bergman, R., A. Afifi, R.Miyauchi. Illustrated Encyclopedia of Human Anatomic Variation: Opus V: Skeletal System, Electronic edition, 1999.
2. Clemente, C. Clemente Anatomy: A Regional Atlas of the Human Body. 4th edition. Lippincott, Williams & Wilkins, 1997, 83 — 192.
3. Grant, J. C. Boileau, Grant's Atlas of Anatomy. 9th edition. Springer, 1991, 299 — 482.
4. Gra,y H. Anatomy of the Human Body. Philadelphia: Lea & Febiger, , Renewed 20th edition, 1996, 123-157.
5. Jacobson, K. Hughston Clinic Sports Medicine book. Williams & Wilkins, 1995, 305 — 348.
6. McMinn, R. M. H., R.T. Huthchings, McMinn. Color Atlas of Human Anatomy, 4th edition Mosby-Year Book, 1998.
7. Moore, K., A. Dalley. Clinically oriented anatomy. II, Appleton & Lange, QS 4 M, 1999, 822 — 953.
8. Morrey, BF. Anatomy of the elbow joint. — In: The Elbow and its Disorders, Philadelphia, W.B. Saunders, Co., 1995, 16-52.
9. Sobotta, J. Atlas of Human Anatomy. 12th English edition. Lippincott, Williams & Wilkins, 1996, 120-204.
10. Terry, R. J. New data on the incidence of the supracondyloid variation. — Am. J. Phys. Anthropol., 9, 1926, 265-270,
11. Terry, R. J. A study of the supracondyloid process in the living. — Am. J. Phys. Anthropol., 4, 1921, 129-139.
12. Trotter, M. Septal apertures in the humerus of American whites and Negroes. — Am. J. Phys. Anthropol., 34, 1919,213 — 217
13. Walter, J. Basic atlas of sectional anatomy with correlated imaging, Lippincot. Williams&Willkins, 1998, 65-109.
14. Katsarov, A. Morphometric and morphologic characteristic of the distal humerus in recent Bulgarian. Acta mporphologica et anthropologica, 6, 2001, 98 — 103.
15. Jupiter, J. B., D. Mehne. Fractures of the distal humerus. — Journal of orthopedics, 15, 1992, No7, 825-833
16. Mehne, D K., J. Matta. Bicolumn Fractures of the adult Humerus. Presented at the 53rd Annual Meeting of the American Academy of the orthopedic surgeons (New Orleans, La), 1986.
17. Jupiter, J. B., D. Mehne. Fractures of the distal humerus. — In: Skeletal Trauma. Philadelphia, PA: W.B. Saunders; 1991, 1146-1176.
18. Синельников, Р. Д. Атлас Анатомии Человека, Второе издание. Т. I. М., Госуд. изд. мед. литературы, 1963, 122 — 125.
19. Ванков, В., Г. Гълъбов. Анатомия на човека. С., Медицина и физкултура. 1990, 125 — 185.