

## **Development of the anatomical modular prosthesis**

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### **I - HISTORY**

"My philosophy is a near normal anatomy as possible. The average humeral head is normally 44 mm radius of curve and the cuff is repaired and rehabilitated around it". (C.S. NEER)

Doctor NEER is the father of the non constrained prostheses. His first prosthesis was designed in 1951 and the second, for used with cement, in 1972.

Results were good but some problems appeared. Sometimes it was difficult to adapt the anatomy of the humerus to the prosthesis and the range of motion was inferior to that expected. We undertook a cineradiographic study of the prosthetic shoulder and observed abnormal kinematics. Our hypothesis was these were due to distorsion of the normal anatomy and prompted us and other authors to study the three dimensional anatomy of the proximal humerus.

### **II - ANATOMICAL STUDY**

Surface measurements were made on 160 fresh human cadavers specimens using a digitized measuring system to allow three dimensional computerized modeling of the bones.

### **III - RESULTS**

→ The head is a part of one sphere.

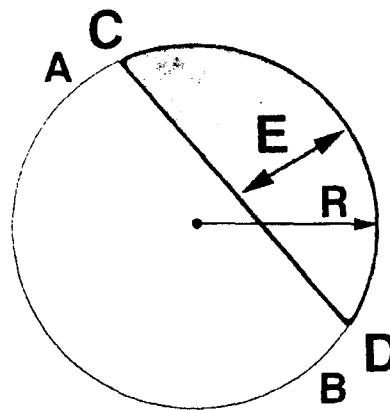
\* Variable articular surface diameter : range 36.5 mm to 51.7 mm

\* Variable head height : range 12.1 mm to 18.2 mm

\* Variable radius of curvature : range 18.5 mm to 28.5 mm

- However these three parameters are linked since the humeral head is a part of sphere : head height and articular surface diameter have a fixed relationship.

- AB : Sphere diameter
- CD : Articular surface diameter
- R : Radius of curvature
- E : Head height



- Variable inclination (head shaft angle) : range  $123^{\circ}$  to  $141^{\circ}$
- Variable retroversion with regard to the transepicondylar axis : range  $-6.7^{\circ}$  anteversion to  $+47.5^{\circ}$  retroversion
- Variable medial off-set : range 2.9 mm to 10.8 mm
- Variable posterior off-set : range -0.8 mm to 6.1 mm

#### IV - DISCUSSION

→ "For clinical conditions in which the anatomical derangement involves primarily the articular surfaces of the gleno-humeral joint (osteonecrosis and osteo arthritis) a prosthetic arthroplasty that most nearly restores the original geometry of the articular surfaces should allow for the most physiological motion. An anatomical reconstruction would maintain the excursion of the joint, preserve the original position of the center of rotation and place appropriate tension on the overlying soft tissues". (M. PEARL)

→ Anatomical and biomechanical studies have shown that small changes in the anatomy may have important biomechanical consequences :

- \* Increasing the thickness of the humeral head by only five millimeters, decrease the range of gleno humeral motion by about  $20^{\circ}$ - $30^{\circ}$  (D. HARRYMANN).

\* Decreasing the thickness of the humeral head by five millimeters theoretically reduces the gleno humeral excursion by 24° (Ch. JOBE).

→ If we keep the value of the head height and humeral head diameter in a fixed relationship and if we can vary inclination, retroversion, medial and posterior off-set, Pearl's computer study said that it is possible to replicate almost exactly the anatomy of each individual.

## V - CONCLUSION

To match the anatomy as near as possible you must :

1/ have a humeral head of variable size but keep head height and diameter a fixed relationship (modularity),

2/ have the possibility to vary inclination (head shaft angle), retroversion, medial and posterior off-set of the humeral head with regard to the humeral stem (adaptability).

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