



# Surgical Technique

Shoulder Prosthesis

Aequalis



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# TABLE OF CONTENTS

## TABLE OF CONTENTS

Aequalis

### 1. L'IMPLANT

p. 1

1. Concept of the Aequalis shoulder prosthesis
2. Modular humeral implant

### 2. SURGICAL TECHNIQUE

p. 4

1. A detailed radiological assessment will assist and improve surgery
2. Patient positioning
3. Delto-pectoral approach and subscapularis release
4. Identification of the axillary nerve
5. Section of subscapularis
6. Humeral Head Osteotomy
7. Choice of humeral inclination and retrotorsion
8. Positioning of the trial humeral implant
9. Humeral cut protector positioning
10. Glenoid phase of surgery
11. Positioning of the definitive humeral implant
12. Cementing of the definitive humeral implant
13. Reduction of the prosthesis - closure
14. Post-operative rehabilitation

### INSTRUMENTS

p. 24

### IMPLANTS

p. 26

# L'IMPLANT

## 1. L'IMPLANT

### ● 1. Concept of the Aequalis shoulder prosthesis

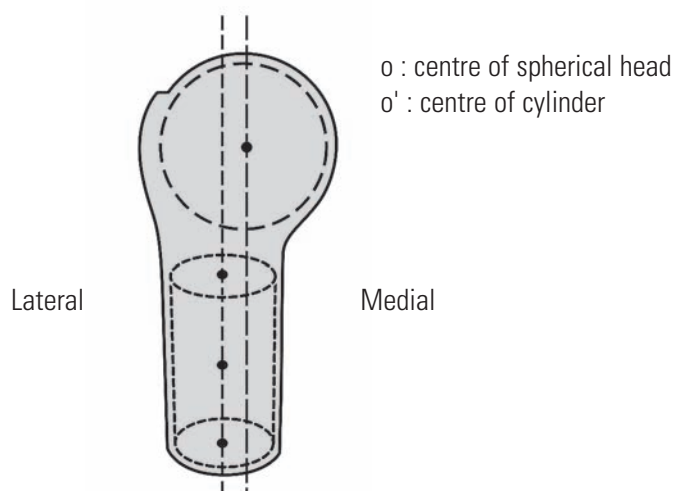
Reconstructive surgery of the gleno-humeral joint for degenerative or inflammatory arthritis is particularly challenging. Clinical experience and radiological studies of shoulders with non-constrained gleno-humeral prostheses have shown that optimum results are obtained when reconstructive surgery most closely matches the original anatomy. Therefore, it follows that not only the dimensions but also the shape of the proximal humerus, the glenoid and the scapula should be precisely assessed.

We reached the following conclusions from our anatomical studies, which were performed using a precision measurement instrument and computer-assisted integration software:

#### Proximal end of the humerus :

- we confirmed the sphericity of the humeral head: the variance of diameters was less than 1 mm in almost 90% of cases.
- the articular head is only part of the humeral sphere: there is a mathematical relationship between the diameter of the sphere, the diameter of the articular surface of the head and its thickness.
- the axis along which the humeral prosthesis may be inserted is that of the proximal metaphysis as a change in curvature occurs at the humeral diaphysis. It is therefore possible to identify a proximal metaphyseal humeral cylinder which will contain the prosthetic stem.
- the spherical humeral head does not sit directly on the base of this cylinder, but lies eccentrically in two planes :

The medial displacement of the humeral globe, the medial offset, is relatively constant. In practice this is characterised by the crossing of the proximal metaphyseal axis and the periphery of the articular head at a point which we have called the «critical point» or «hinge point». This medial displacement of the articular surface has never before been described and has never been included in the development of a humeral prosthesis

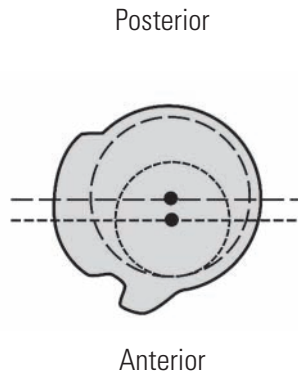


# L'IMPLANT

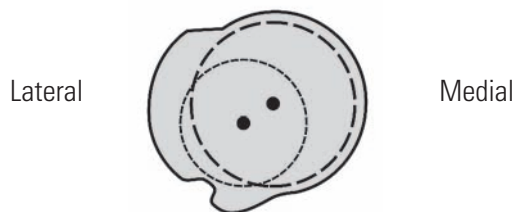
## 1. L'IMPLANT

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The posterior eccentricity of the spherical humeral head defines the posterior offset, a parameter which is more variable. This must also be included in the design of a humeral prosthesis, otherwise the surgeon may need to increase humeral retroversion during positioning of the implant.



The variable degree of medial and posterior offset is termed the combined offset.



- Humeral retroversion is much lower than traditionally reported in the surgical literature : the mean observed value between subjects was less than 20 degrees. Furthermore significant differences not only between subjects but between an individual's shoulder can be observed. It is essential therefore that retroversion is not defined arbitrarily, but determined in each case.

- Humeral inclination also varies from one subject to another. The «critical point» acts as a hinge around which the angle of attachment of the head surface may vary. Humeral retroversion for a given shoulder may be reproduced consistently by humeral inclination.

# L'IMPLANT

## 1. L'IMPLANT

### ● 2. Modular humeral implant

This consists of two parts (humeral stem and articular head) which, through their technological design and range of components adapts perfectly to the anatomy of the joint, rather than forcing the joint anatomy to adapt to the prosthesis.

The humeral stem has been shortened to adapt to the proximal metaphyseal humeral cylinder, before the change of curvature of the humeral diaphysis.

Three diameters of 6.5, 9 and 12 mm are available, all of the same length, which produce rotatory stability, ensured by the following:

- optimal metaphyseal filling,
- anterior and posterior grooves.

Each humeral stem diameter is available in 4 different inclination angles which allow the implant to be adapted to the slope of the humerus, which varies around the 'hinge point' defined by the intersection between the proximal metaphyseal axis and the highest point on the anatomical neck.

A range of seven articular heads has been devised to match the variation found in our study. Thickness and diameter are related.

A single head thickness is used for each diameter: 39-14, 41-15, 43-16, 46-17, 48-18. There are two available thicknesses for the largest 50 mm diameter (16 and 19mm) in order to compensate for the greater anatomical variation. An original system involving an eccentric dial on the inferior face of each head allows the combined offset to be reproduced.

Assembly of the combined prosthetic unit was designed in consideration of the fact that the shoulder is a highly mobile unconstrained joint :

- the articular head is fixed to the stem by a morse taper which can be secured with an optional screw.

# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### Aequalis

#### ● 1. A detailed radiological assessment will assist and improve surgery

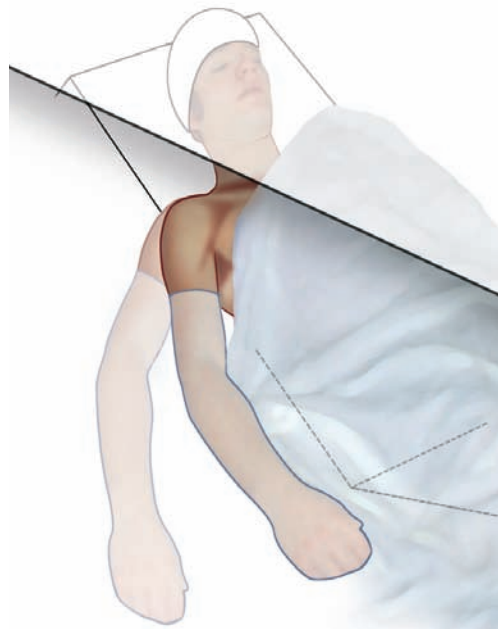
We suggest:

- three plain shoulder A-P x-rays: neutral, internal rotation, external rotation.
- arthrography with contrast to confirm integrity of the rotator cuff.
- a computerised tomography to assess gleno-humeral osteophytes, and the shape of the glenoid.

#### ● 2. Patient positioning

General anaesthesia, beach chair position.

The whole arm is draped free and prepared under sterile conditions.



# SURGICAL TECHNIQUE

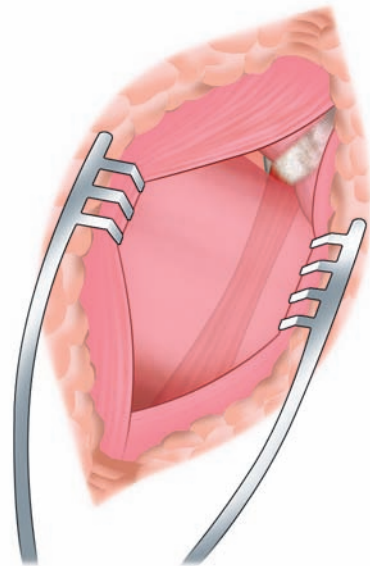
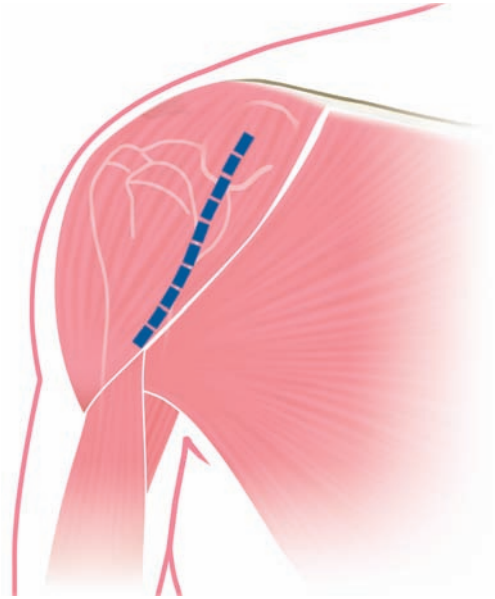
## 2. SURGICAL TECHNIQUE

### ● 3. Delto-pectoral approach and subscapularis release

An incision is made from the tip of the coracoid along the delto-pectoral groove, slightly laterally to avoid post-operative scars in the axillary folds.

The incision is deepened, pectoralis major identified and the deltoid and cephalic vein are retracted laterally to open the delto-pectoral groove.

The deltopectoral groove is opened inferiorly as far as the insertion of pectoralis major, preserving the deltoid insertion.



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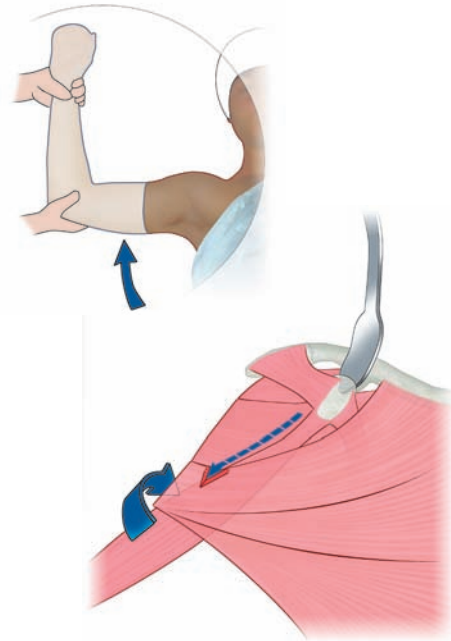
# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### Aequalis

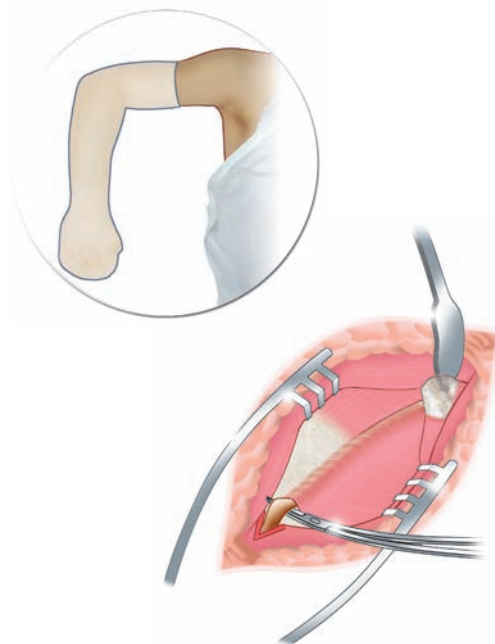
The upper border of the subscapularis is identified, after partial or total division the coraco-acromial ligament at the edge of the coracoid and incision of the clavi-pectoral fascia at the lateral border of the conjoined tendon of the coraco brachialis and short head of the biceps brachii muscles.

Arm in abduction, rotated externally with an angled retractor placed above the coracoid process.



- The external limit of the subscapularis insertion lies medial to the bicipital groove which should be identified.

Arm abducted and rotated internally.  
The long head of biceps is exposed in the lower part of the incision above the tendon of pectoralis major which occasionally needs to be sectioned for 1 or 2 cms.

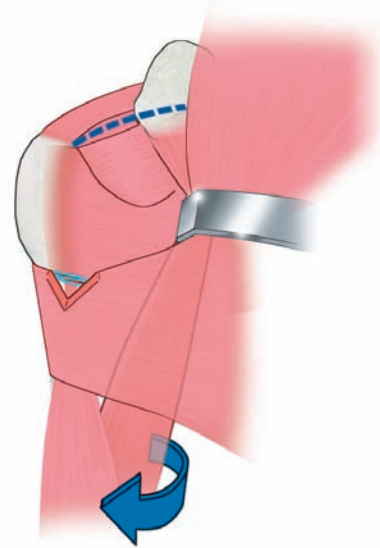


# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

- The upper limit of tendon of subscapularis, which is often covered by an extension of the subcoracoid serous bursa, lies immediately below the tip of the coracoid process.
- Its inferior border is defined by the anterior circumflex vessels.

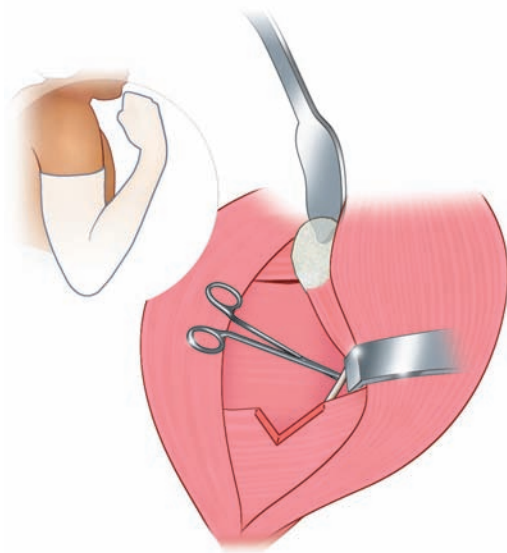
Arm externally rotated, elbow towards the body.  
The coraco-humeral ligament marks the upper border of subscapularis ; the lower border is defined by the anterior circumflex vessels.



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### ● 4. Identification of the axillary nerve

Arm in neutral rotation, elbow at side, with anterior flexion to loosen the anterior structure (coraco-biceps).



# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### Aequalis

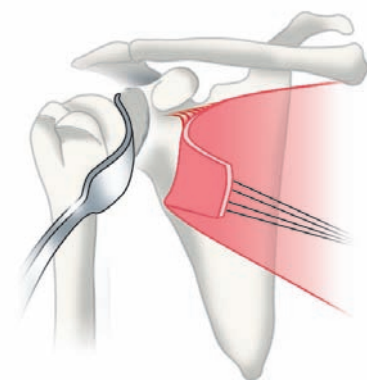
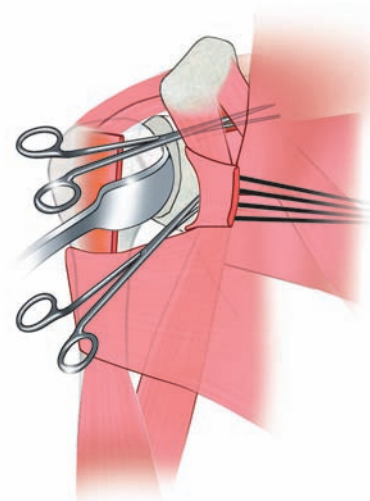
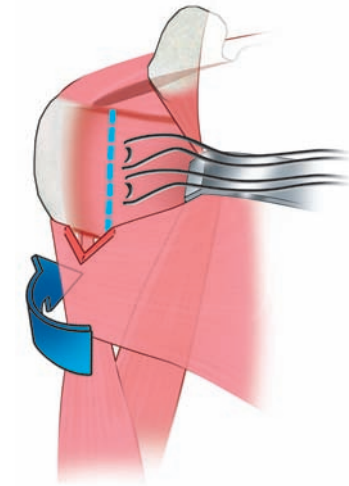
#### ● 5. Section of subscapularis

Two holding stitches are passed through the subscapularis muscle after superior arthrotomy. The subscapularis tendon is then incised with the joint capsule one and a half centimeter from the bicipital groove at the level of the anatomical neck up to the junction between the upper three quarters and the lower quarter of the muscle.

Superior arthrotomy: the coraco-humeral ligament is preserved.

- The muscle is released to produce a long flap of subscapularis which allows tension-free reinsertion following the procedure, regardless of the position of the arm.

A Fukuda type retractor is placed in the joint. The superior part of subscapularis is separated from its sub-coracoid attachments. An anterior capsulotomy with a release of the middle and inferior glenohumeral ligament enables the deep surface of the muscle to be released from the neck of the scapula. This process requires a careful identification of the axillary nerve.

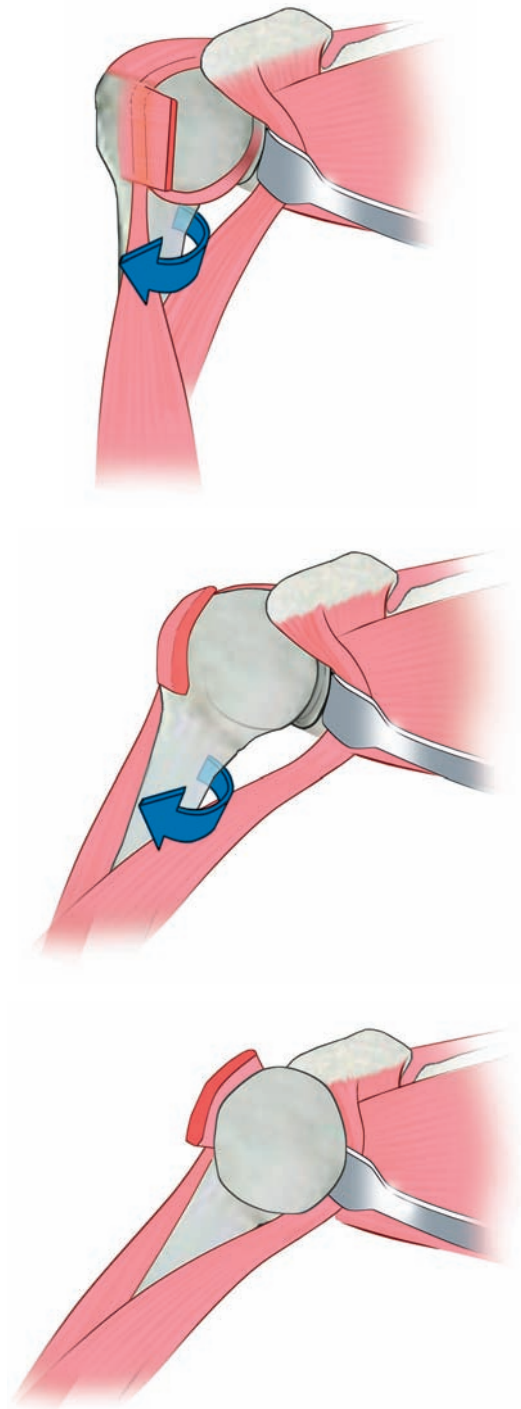


# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

The humeral head is then dislocated anteriorly by extension with the arm abducted and rotated externally.

An angled retractor is placed in the subscapularis fossa retracting conjoined tendon and subscapularis medially.



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# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### Aequalis

#### ● 6. Humeral head osteotomy

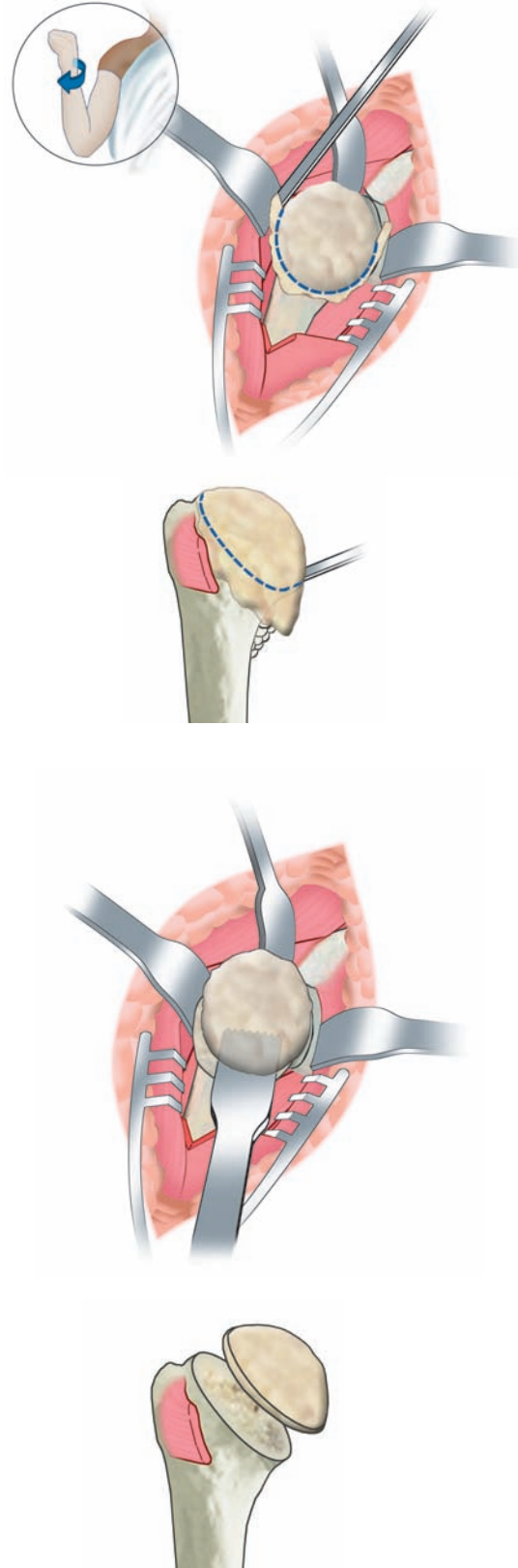
The proximal part of the humerus is exposed with the arm adducted and externally rotated, and extended. Osteophytes are trimmed away carefully around the humeral head, guided by the radiological assessment allowing to isolate the anatomical neck.

The key point is to locate the anatomical neck by trimming away all osteophytes using an osteotome and a rongeur. A cavity containing a small quantity of fat and soft tissue usually lies between cortical bone and osteophytes.

The humeral head is cut with an oscillating saw exactly at the limit of the anatomical neck. Superiorly and anteriorly, the anatomical neck contains the tendon insertions of the rotator cuff (supraspinatus and subscapularis), and inferiorly it is entirely continuous with the cartilage of the head and inferior cortical surface of the humerus. Posteriorly however, there is a 6 to 8 mm area which does not contain cartilage or tendon insertions: the cut should be made through the rim of the cartilage.

Once the anatomical neck has been identified, the humeral head is cut using a saw.

The amount of the bone resected is usually surprisingly small.



# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

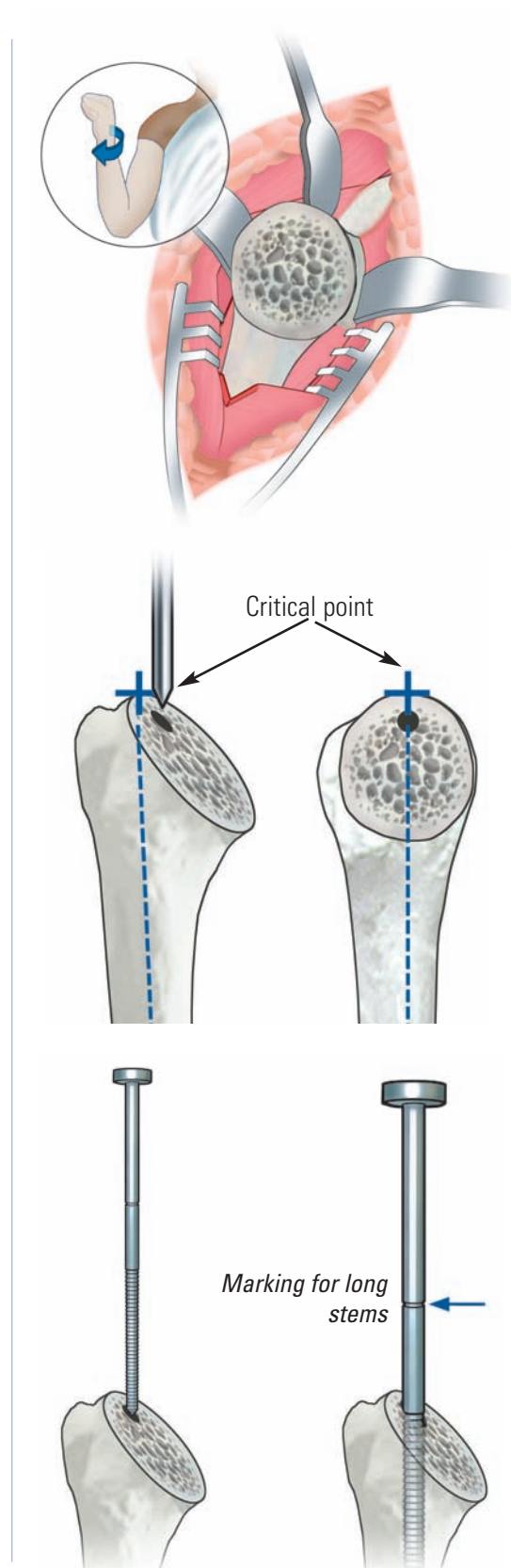
### 7. Choice of humeral inclination and retrotorsion

Accurate visualisation of the plane through which the humerus is cut (fig. 13) allows the «critical point» or «hinge point» to be located. Typically, the entrance point into the humeral canal is 3 mm inwards from this point (in order not to damage the greater tuberosity). (The «critical point» is defined as the intersection of the proximal metaphyseal humeral axis and the highest point of the cut described above)).

Arm in extreme external rotation, extended, elbow towards the body (careful progressive movements in order not to cause a spiral humeral fracture).

The humerus is reamed progressively using cylindrical reamers of increasing diameter from 6, 9 to 12 mm, which should be advanced up to the last ridge.

The final reamer used will determine the diameter of the inclination guide and the humeral stem.



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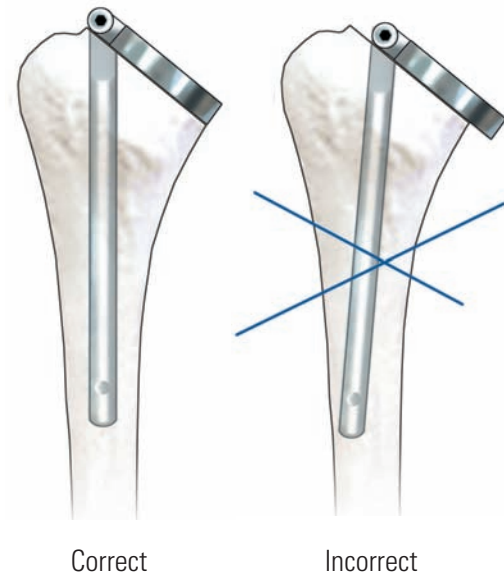
# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

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The inclination of the humerus is measured using the inclination guide, the diameter of which is determined by the final cylindrical reamer.

After introducing the inclination guide into the humeral medullary cavity, the mobile plate is positioned correctly (letter R upwards for a right humerus, letter L upwards for a left humerus) and exactly aligned with the humeral cut. The tightening screw should be positioned at the 'critical point' and tightened with the 4.5 mm hexagonal screwdriver.



# SURGICAL TECHNIQUE

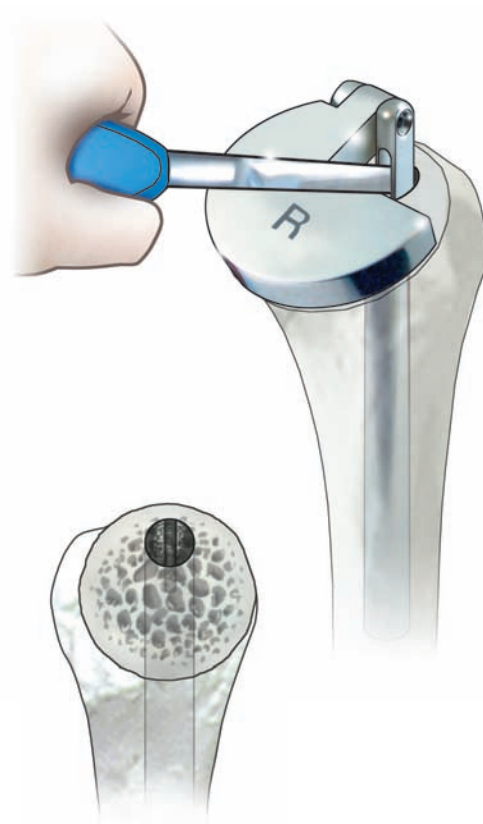
## 2. SURGICAL TECHNIQUE

Humeral retrotorsion is marked with the inclination guide in-situ by making a slot on the cancellous tuberosity with an osteotome, in the groove designed for this purpose. This slot represents the site for subsequent positioning of the humeral fin.

Marking of humeral retroversion and subsequent placement of the humeral fin.

The plane of section of the anatomical neck therefore determines inclination and retroversion of the humerus. The angle of humeral inclination is read directly after removing the trial inclination guide, using a template. There are four possible angles of inclination from 125° to 140°.

If an angle lies between two values, the lower should be chosen for the prosthesis. If for example the angle is between 135° and 140°, the 135° angle should be chosen.



INCLINATION GUIDE  
TEMPLATE



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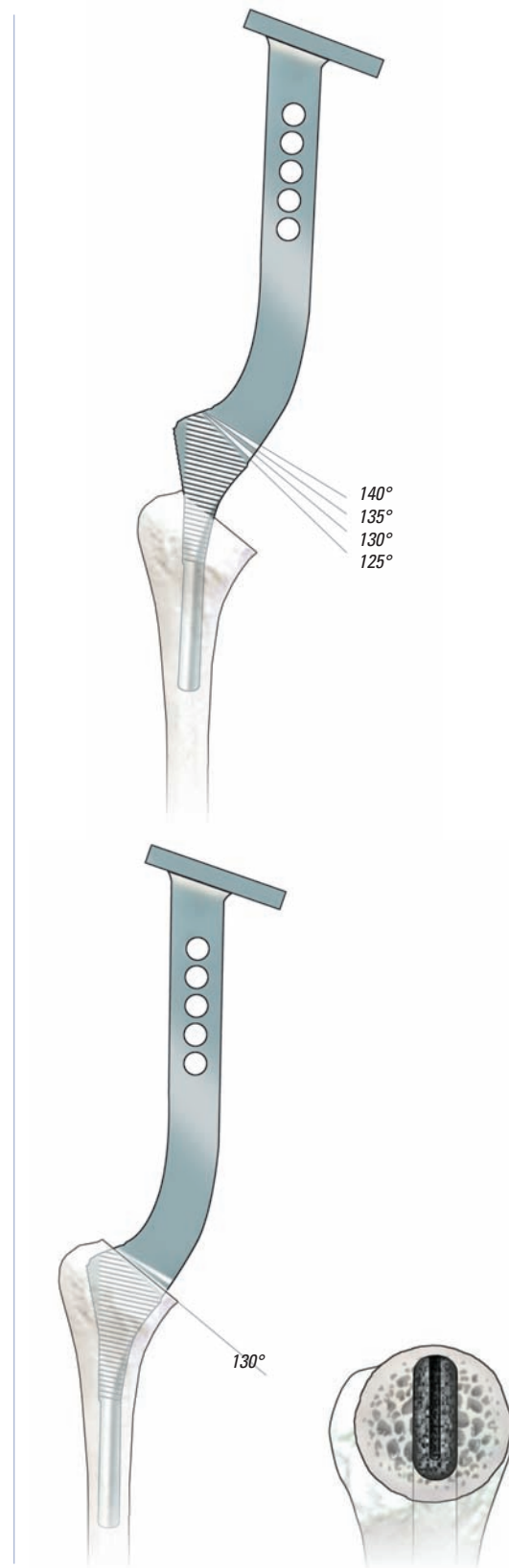
# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### Aequalis

Definitive broaching for the humeral stem is performed using the corresponding broach. Retrotorsion is observed by aligning the fin of the broach with the slot created by the osteotome described above. The broach should be advanced up to its last ridge for a 125° slope, or to one of three marks for slopes of 130°, 135° or 140°.

The broach is advanced forming the outline of the corresponding prosthetic humeral stem.



# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

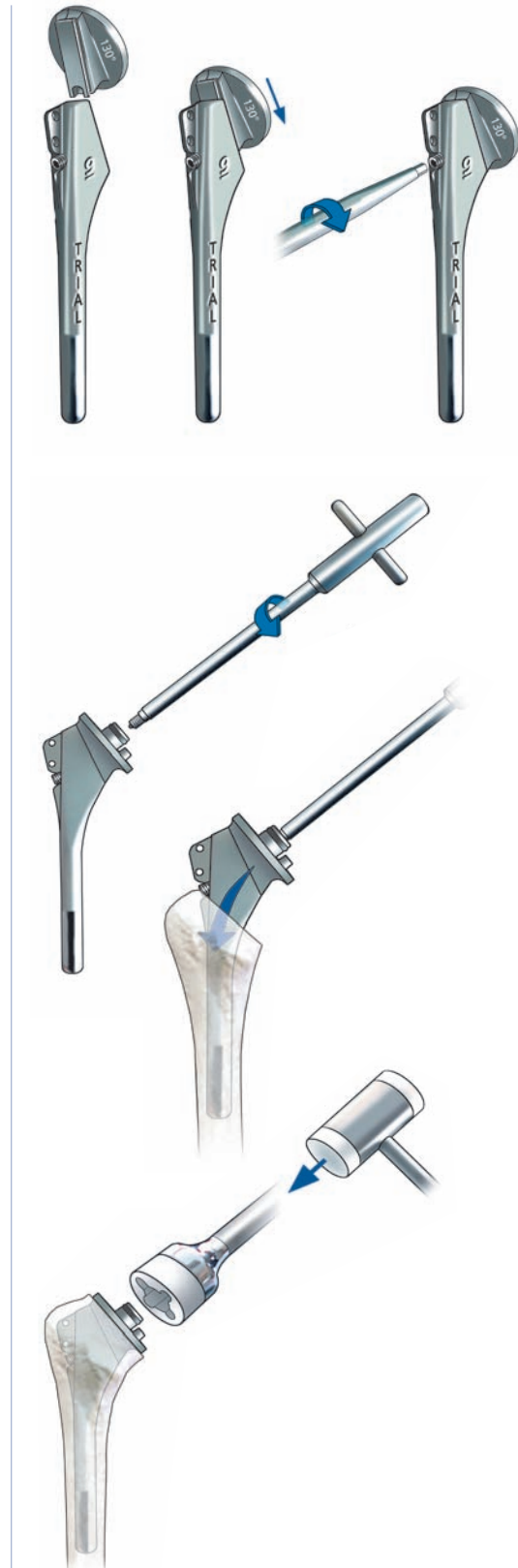
### ● 8. Positioning of the trial humeral implant

The humeral stem and neck are assembled.

The neck is slid on to the rail on the humeral stem. The system is secured by tightening the fixing screw with the 3,5 mm hexagonal screwdriver.

The stem-neck assembled unit is introduced into the humeral stem using the T-handle, observing the correct position for the fin. The unit is impacted using the stem-neck impacting hammer. The neck should not be forced into cancellous bone tissue.

Stem-neck impaction using the appropriate impactor.



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# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

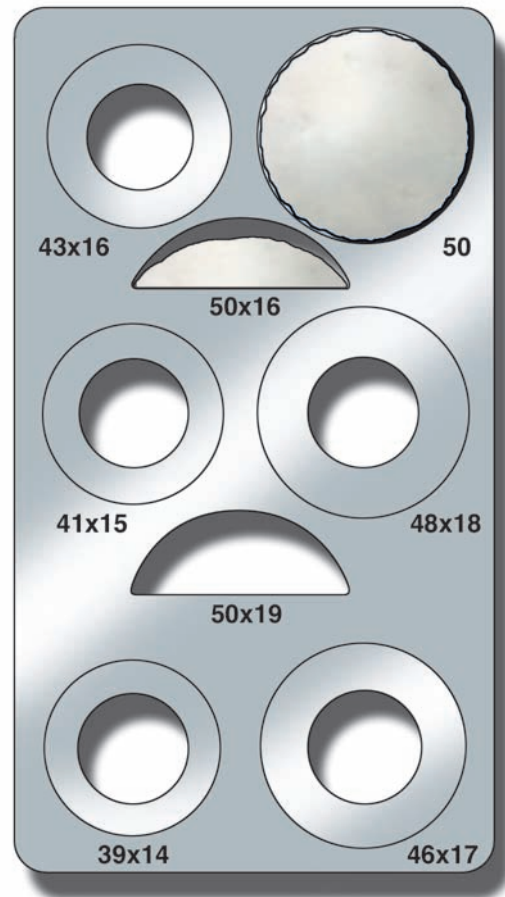
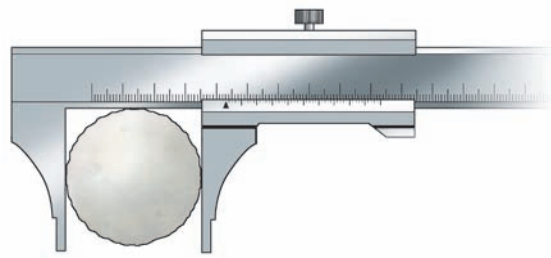
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Determination of humeral head size and choice of humeral head index

- either by caliper measurement of the diameter of the resected head (fig. 23) or directly on the cut humeral surface.

- either on the trial head template.

2 thicknesses (16 mm and 19 mm) are available for a 50 mm diameter head.



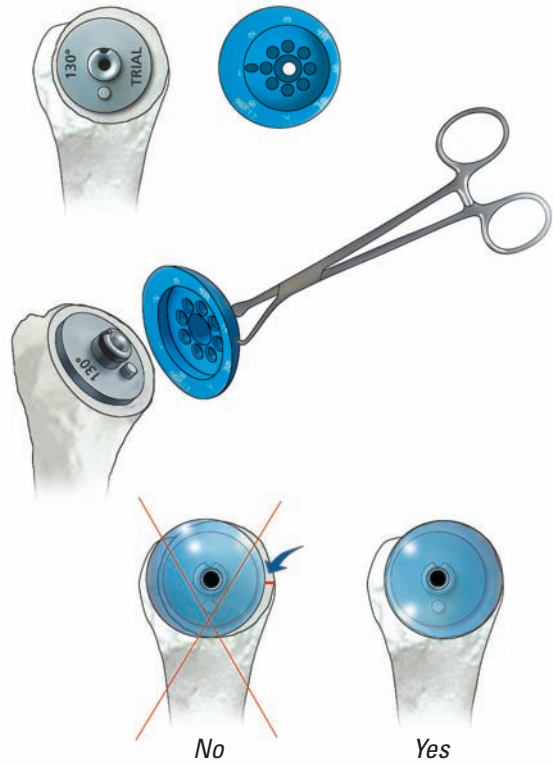
# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

The only remaining requirement is to reproduce any articular surface eccentricities using the original eccentric index system.

The trial head is held with the trial head forceps and placed over the male cylindrical part of the neck. The head may be rotated eccentrically around this cylinder and the ideal position selected to cover the cut humeral neck.

Posterior offset is respected by choosing the indexed position which allows perfect cover of the cut humeral surface.



# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

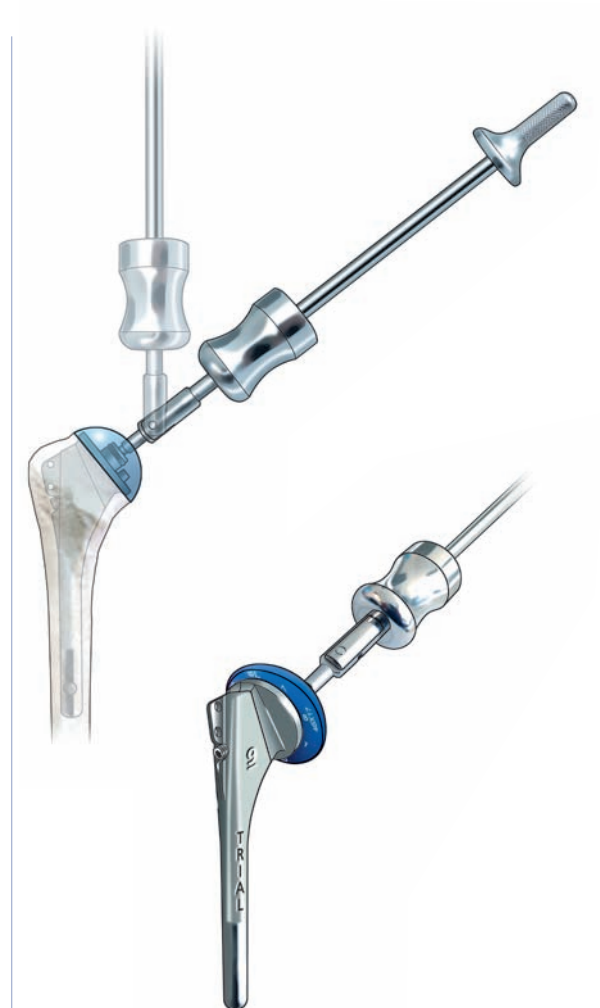
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The entire trial prosthesis is then removed using the extractor. The posterior face of each trial head is marked from 1 to 8, corresponding to 8 possible index positions. The appropriate figure is then read from the superior pole of the neck, to give the chosen anatomical index.

Direct reading of anatomical index after removal of trial prosthesis (in this case index n°4).

By this stage in the procedure, the following have been defined:

- diameter of the humeral stem
- inclination angle and retrotorsion
- size of head and anatomical offset



# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### ● 9. Humeral cut protector positioning

The humeral cut protector must be inserted into the humerus while working on the glenoid in order to facilitate the glenoid preparation.

The neck is removed (a) and then replaced by a humeral cut protector (b).  
Assembly and insertion of the stem-humeral cut protector.



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# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

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### ● 10. Glenoid phase of surgery

NOTE: For Total Shoulder Arthroplasty, glenoid component must be implanted prior to implanting definitive humeral prosthesis. Refer to glenoid surgical technique.

### ● 11. Positioning of the definitive humeral implant

After removing the trial humeral prosthesis, the definitive prosthetic parts are chosen using the predetermined parameters. The definitive head is positioned over the stem, aligning the offset number with its position, marked on the upper border of the neck.

Anatomical offset.

This unit should be assembled with clean gloves in dry surroundings.

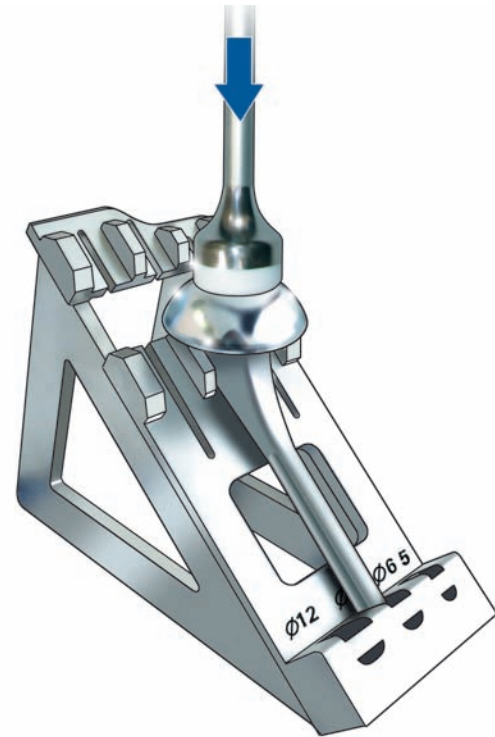


# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

The head is impacted onto the stem on the impaction support.

*The impactor must be aligned with the Morse taper.*



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# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### Aequalis

#### ● 12. Cementing of the definitive humeral implant

Cement is injected into the canal after diaphyseal obturation and drying. The definitive humeral implant is positioned and then impacted, taking care to align the prosthetic fin with its slot in the tuberosity.

#### ● 13. Reduction of the prosthesis - closure

After the joint has been washed and the prosthesis reduced, the stability and mobility of the shoulder are tested. The joint is closed by reinsertion of subscapularis to the coraco-humeral ligament, and to the subscapular remnant, allowing slight slipping of the subscapularis upwards. The wound is closed in planes over an aspiration drain.

Post-operatively the arm is immobilised in a simple sling.

# SURGICAL TECHNIQUE

## 2. SURGICAL TECHNIQUE

### ● 14. Post-operative rehabilitation

This is essential and is responsible for at least 50% of the final result. Rehabilitation begins on the evening of surgery by removing the sling and actively moving fingers, wrist and elbow. If the patient desires, his/her arm may be left along the length of his body putting no tension on the suture line.

The following day the patient begins active exercises of the fingers, wrist and elbow, helped by a physiotherapist, 5 to 6 times daily, each for a few minutes duration.

The patient is allowed to get out of bed with his/her arm in a sling. Once the drain is removed after 48 hours, the patient is encouraged to carry out brief pendular exercises throughout the day.

The fundamental principle which guides rehabilitation, either in the operative centre or as an outpatient, is maximal recovery of passive joint movement prior to any active motion. Passive elevation is begun by simple pendular movements followed rapidly by self-mobilisation with the patient in the dorsal decubitus position with elbow extended and this is helped by exhaling through the mouth, which adds a few degrees movement with each inspiration. It is preferable to perform a single smooth motion rather than repeated jerking movements. External rotation is performed using a stick, with the elbow against the body. Internal rotation is performed with the arm behind the back, helped by the other hand wherever possible.

Rehabilitation sessions should not be more than 5 minutes long and should be performed ideally hourly throughout the day. The time required for purely passive rehabilitation varies depending on pre-operative passive mobility.

- If good pre-operative mobility was present (unfortunately relatively rare), the amplitude of movement generally recovers after 45 days and active movement may be possible. In this case a few minutes of active movement should be performed mornings and evenings «running the joint in» in a swimming pool using arm movements for 10 to 15 minutes daily for 3 months.
- If a patient was highly restricted pre-operatively (forward elevation less than 90°), it should be understood that the total shoulder prosthesis is not a mobilising procedure. It is unlikely the patient will recover passive elevation beyond 130°. The patient should be asked to perform multiple daily passive stretching exercises and breast-stroke movement of his/her arms in a swimming pool throughout the first post-operative year, in order to obtain and maintain maximum mobility.

# INSTRUMENTS

## INSTRUMENTS YKAD22 & YKAD23

### Trial head clamp

Ref. MWA103



### Trial neck clamp

Ref. MWA104



### Trial glenoid clamp

Ref. MWA231



### Trial head

39 x 14	Ref. MWA239
41 x 15	Ref. MWA241
43 x 16	Ref. MWA243
46 x 17	Ref. MWA246

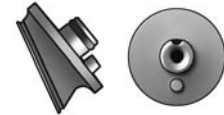
48 x 18	Ref. MWA248
50 x 16	Ref. MWA250
50 x 19	Ref. MWA251



### Trial neck

125°	Ref. MWA125
130°	Ref. MWA130

135°	Ref. MWA135
140°	Ref. MWA140



### Trial humeral stem

Ø 6/6,5	Ref. MWA626 (*MWA006)
Ø 9	Ref. MWA629 (*MWA009)
Ø 12	Ref. MWA632 (*MWA012)



### Trial glenoid

small	medium	large
Ref. MWA232	Ref. MWA234	Ref. MWA236



### T. handle

Ref. MWA106



### Glenoid impactor

Ref. MWA107



### Humeral prosthesis impactor

Ref. MWA108



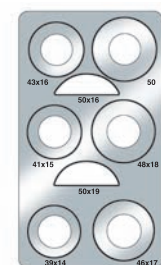
### Trial stem-neck impactor

Ref. MWA109



### Trial head template

Ref. MWA110



\* Former catalog number.

# INSTRUMENTS

## INSTRUMENTS YKAD22 & YKAD23

### Curved glenoid template gauge

Ref. MWA115



### Straight glenoid template gauge

Ref. MWA116



### Cylindrical reamers

Ø 6/6,5	Ref. MWA606 (*MWA046)
Ø 9	Ref. MWA609 (*MWA049)
Ø 12	Ref. MWA612 (*MWA052)



### Implant broaches

Ø 6/6,5	Ref. MWA025 (*MWA026)
Ø 9	Ref. MWA029
Ø 12	Ref. MWA032



### Inclination guide

Ø 6/6,5	Ref. MWA616 (*MWA066)
Ø 9	Ref. MWA619 (*MWA069)
Ø 12	Ref. MWA622 (*MWA072)



### Extractor hammer

Ref. MWA118



### Hexagonal screwdriver 4.5 mm

Ref. MWA119



### Hexagonal screwdriver 3.5 mm

Ref. MWA124



### Impaction support

Ref. MWA166



### Mallet

Ref. MWA122



### Retroversion Osteotome

Ref. MWA101



### Caliper - Ref. MWA102



### Posterior glenoid retractor

Ref. MWA117



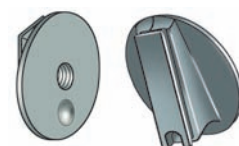
### 50 cm ruler

Ref. MWA 123



### Humeral cut protector

125°	Ref. MWA 151	135°	Ref. MWA 153
130°	Ref. MWA 152	140°	Ref. MWA 154



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# IMPLANTS

## IMPLANTS



### Head

Size	Ref.
39 x 14	DWB 239
41 x 15	DWB 241
43 x 16	DWB 243
46 x 17	DWB 246
48 x 18	DWB 248
50 x 16	DWB 250
50 x 19	DWB 251



### Stem

∅	125°	130°	135°	140°
6.5	DWB 061	DWB 062	DWB 063	DWB 064
9	DWB 091	DWB 092	DWB 093	DWB 094
12	DWB 121	DWB 122	DWB 123	DWB 124

### Extended sizes\*

Size	Ref.
52 x 19	DWB 252
52 x 23	DWB 253
54 x 23	DWB 254
54 x 27	DWB 255

\*available upon request only

**TORNIER**   
S U R G I C A L I M P L A N T S