



Anatomical Shoulder™ Combined

Surgical Technique



Anatomical Shoulder Combined Surgical Technique

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Preoperative Planning

Three radiographic images of the shoulder joint are required for planning the operation:

1. Full-size anterior-posterior view with neutral rotation (0°), centered on the articular cavity
2. Axial view
3. CT scans for planning the glenoid insertion

Preoperative Planning – Humerus

After aligning the humeral stem on the anterior-posterior x-ray at 0°, place the humeral-head template on the stem template and determine the size of the head of the prosthesis.

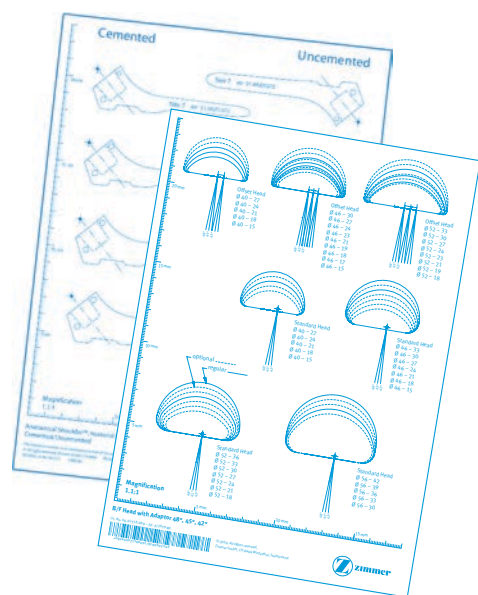
If there is marked deformation of the head, planning should be based on the healthy contralateral joint.

Estimate the size of the stem of the prosthesis on the basis of the anterior-posterior and axial x-rays.

The stem should approximately fill the medullary canal, both proximally and distally. Eccentricity and retrotorsion (i.e. retroversion) are adjusted intra-operatively.

The *Anatomical Shoulder Combined System* allows a defined inclination angle range of 42°, 45° and 48°. The eccentricity of the *Anatomical Shoulder Combined* heads is marked with 3 lines on the head x-ray templates.

For proximal fractures of the humerus, please use the *Anatomical Shoulder Fracture System*. See surgical technique Lit. No. 97-4223-003-00.



Template Options

Templates *Anatomical Shoulder System*

- *Anatomical Shoulder* Humeral Stem, cemented/uncemented (press-fit) Lit.No. 06.01313.000
- *Anatomical Shoulder* Humeral Stem Revision, cemented Lit.No. 06.00641.000
- *Anatomical Shoulder* Combined Humeral Head Lit.No. 06.02158.000

Anatomical Shoulder Combined Hemi Shoulder Replacement Surgery – Positioning of the Patient and Approach

The patient should be placed in a beach chair on the edge of the operating table (Fig. 1). The arm must be freely movable, and it must be able to extend fully. An armrest is optional.



Fig. 1

Make a skin incision in a straight line starting from the lateral edge of the coracoid as far as the insertion of the deltoid muscle. Seek out the cephalic vein between the deltoid muscle and the pectoralis major muscle. Make the approach medial to the vein (Fig. 2).

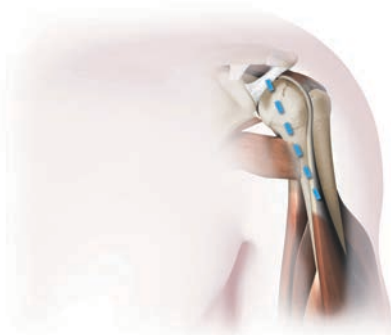


Fig. 2

After exposing the subacromial space, retract the deltoid muscle with a deltoid retractor.

Retract the common tendon of the short biceps and the coracobrachialis muscles with a Langenbeck retractor (Fig. 3).

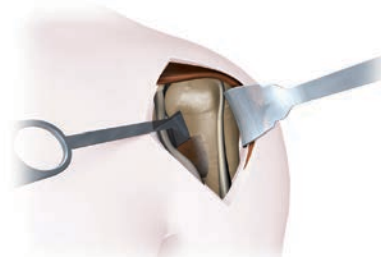


Fig. 3

Rotate the arm outwards as far as possible and bring the subscapularis muscle into the field of vision (Fig. 4).

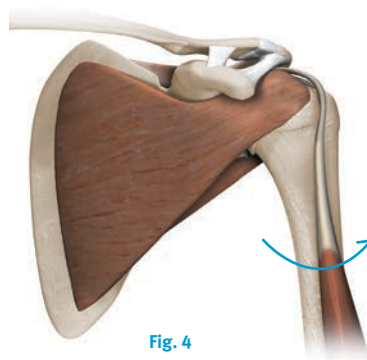


Fig. 4

Make a vertical incision 1cm lateral to the muscle tendon junction of the subscapularis, so that approximately 1cm of tendon remains attached to the muscle. Alternatively, it is possible to detach the tendon of the subscapularis muscle either subperiostally or with an osteotome from the lesser tuberosity, securing it back into place transosseously after the operation.

Mobilize the subscapularis muscle by means of a capsulotomy and looping 4 to 5 strong non-absorbable sutures around it (Fig. 5). An incision into the coracoacromial ligament should be made only in exceptional cases.

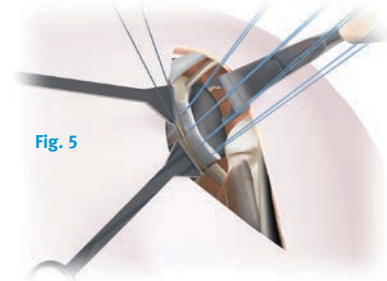


Fig. 5

Adduct the arm and put the humerus retractor (ring retractor) into place, so that the glenoid can be exposed. Pulling on the subscapularis muscle, to expose and protect the axillary nerve with the arm both adducted and flexed.

If there is pronounced internal rotation contracture, it may be necessary to undertake partial release of the subscapularis muscle from the fossa (Fig. 6).

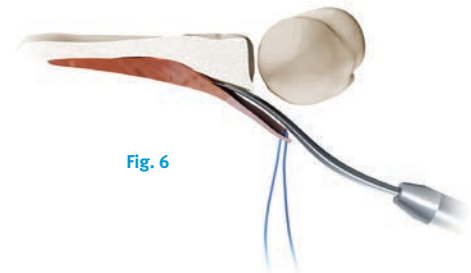


Fig. 6

After exposing the axillary nerve, remove the ring retractor and dislocate the humerus by rotating it externally. The proximal end of the humerus is now free. Keep the arm adducted, rotated externally, and extended. Place a blunt Hohmann retractor on the calcar and carefully remove all the osteophytes from the anatomical neck using a rongeur. Expose the attachment of the cartilage to the humeral head by inserting an 8mm hook behind the biceps tendon (Fig. 7).

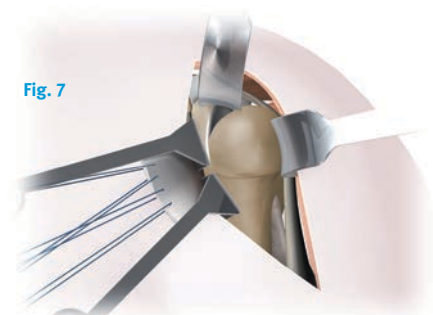


Fig. 7

Humerus Preparation Humeral Head Resection

The humeral head should be resected at the level of the anatomical neck. In the superior and anterior superior aspects, the anatomical neck corresponds to the insertions of the tendons of the cuff (supraspinatus and uppermost section of the subscapularis).

In the inferior aspect, there is a smooth transition between the cartilage of the head and the cortical bone of the humerus. In the posterior aspect, in the region of the infraspinatus and teres minor, is the sulcus, which is a groove of 6 to 8mm in length, without cartilage or attached tendons. The resection must start exactly on the cartilage. Do not resect the cartilage free area.



The resection guides (Fig. 8) are to measure the neck angle of the humeral bone. The resection guides are available in the same three angles as the adaptor (42°/132°, 45°/135° and 48°/138°). The correct resection guide can be chosen by holding it to the proximal humerus (Fig. 9) or by preoperatively comparing to the x-rays.



Fig. 8

The chosen resection guide is attached by the first pin exactly at the height of the anatomical neck (Fig. 9).



Fig. 9

The pin must be inserted perpendicular to the humeral shaft axis (Fig. 10).



Fig. 10

The proper angle of the resection guide can now be observed (Fig. 11).



Fig. 11

From a lateral view the post of the resection guide should now be in line with the humeral shaft axis. Now the second pin can be applied (Fig. 12). If a correction is necessary one of the other three holes in the resection guide can be used.



Fig. 12

The humeral head can now be resected by an oscillating saw. The top surface of the resection guide is used as a guiding plane (Fig. 13).



Fig. 13

Note

The oscillating saw must be perpendicular to the humeral shaft and the resection guide (Fig. 14).



Fig. 14

The humeral head is now resected. In this case the inclination angle is 48°/138° (Fig. 15).



Fig. 15

After resecting the humeral head, the point of insertion of the reamer can be marked with a 3mm awl under the highest point of the resection, directly medial to the bicipital groove (Fig. 16). For this purpose, the arm is externally rotated and extended, and the elbow is rested on the body.

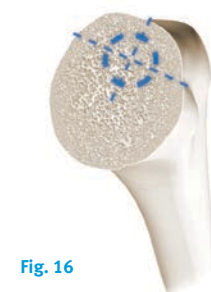


Fig. 16

After the point of insertion has been determined, the medullary cavity is opened, starting with a size 7 reamer (Fig. 17).



Fig. 17

The humeral canal is gradually widened, using reamers of increasing sizes as required – sizes 9, 10.5, 12 and 14.

Note

The depth of penetration is defined by the uppermost tooth. Care should be taken to ensure that the uppermost tooth of the reamers is fully inserted into the medullary cavity. If a revision stem is used, the reamer should be inserted all the way down to the black etch line.

Optional Humeral Head Resection with Trabecular Metal Humeral Head Cutting Guides

Note

Trabecular Metal Humeral Stem surgical technique Lit.No. 97-4309-102-00.

Additional needed instruments:
Trabecular Metal Humeral Instrument Set (KT-4309-000-00)
Bigliani/Flatow Humeral Instrument Set (KT-4300-000-02)

Optional instruments:

Anatomical Shoulder Combined Cutting Guide 45° (01.04255.145)
Anatomical Shoulder Combined Silhouette 45° (01.04255.245)

If an intramedullary resection guide is preferred, the *Bigliani/Flatow*® humeral reamers and *Trabecular Metal* Humeral 42° and 48° Cutting Guides can be used. A 45° Cutting Guide was also created. Refer to the *Trabecular Metal* Humeral Stem surgical technique (97-4309-102-00).

Ream until the flutes are buried in the bone. Remove the T-handle, but leave the reamer in the canal (Fig. 18) to interface with the Humeral Head Cutting Guide.

Once the humeral head is resected, final bone preparation must be completed with the *Anatomical Shoulder* rasps.

Reamer and Rasp table *Anatomical Shoulder* Combined

<i>Anatomical Shoulder</i> Cemented Stem	Size 7	Size 9	n/a	Size 12	Size 14
<i>Anatomical Shoulder</i> Uncemented Stem	Size 7	Size 9	Size 10.5	Size 12	Size 14
<i>Bigliani/Flatow</i> Reamer	Size 7	Size 9	Size 11	Size 12	Size 14
<i>Anatomical Shoulder</i> Reamer	Size 7	Size 9	Size 10.5	Size 12	Size 14
<i>Anatomical Shoulder</i> Rasp	Size 7	Size 9	Size 10.5	Size 12	Size 14

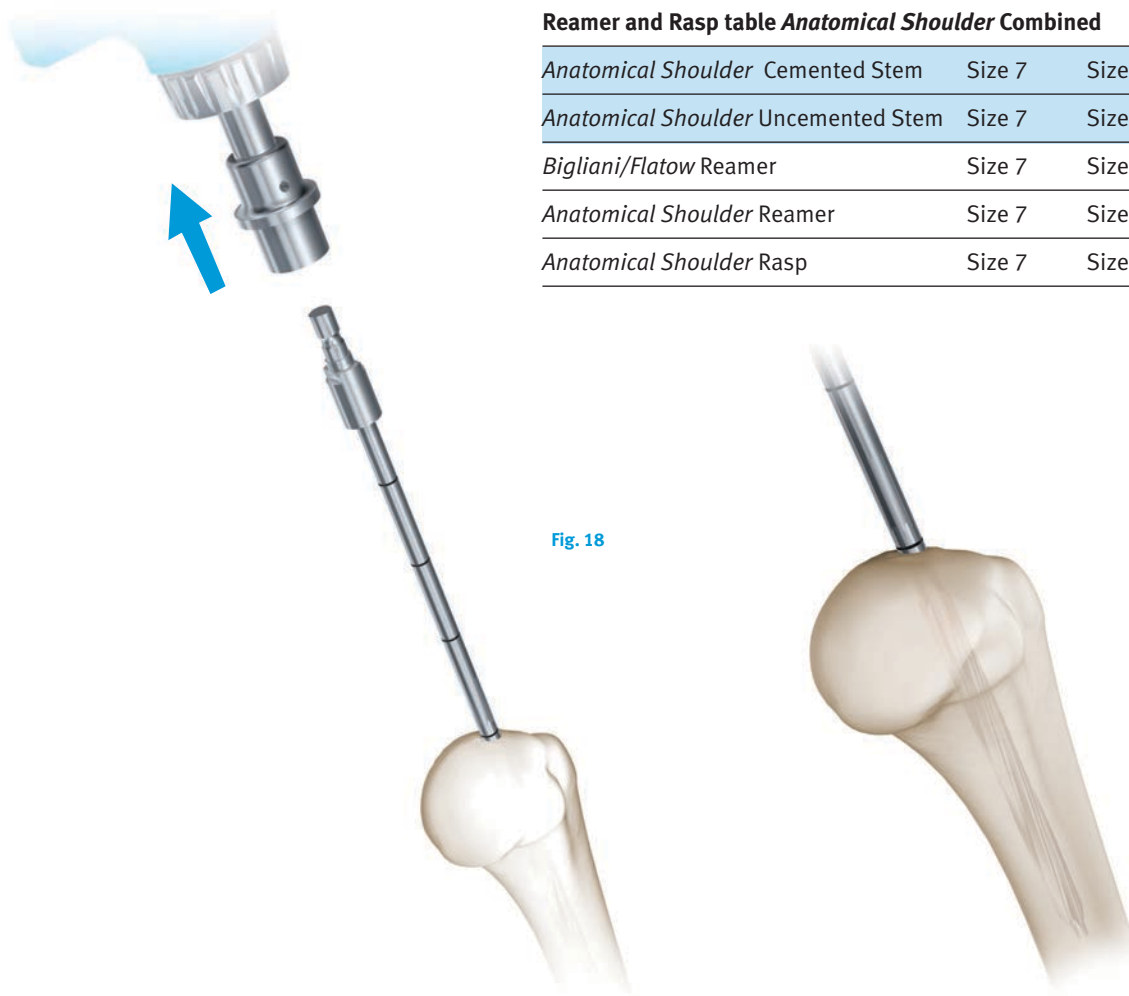


Fig. 18

After opening the medullary canal, the proximal section of the humerus is prepared with the aid of modular rasps, starting with rasp size 7 (Fig. 19).



Fig. 19

The fin is directed towards a point approximately 9mm behind the sulcus. The proximal section of the humerus is then prepared stepwise with rasps of size 9, 10.5, 12 and 14, up to the size of the previously used reamer (Fig. 20).

Note

The cemented stem is available in sizes 7, 9, 12 and 14. The uncemented (press-fit) stem is available in sizes 7, 9, 10.5, 12 and 14.

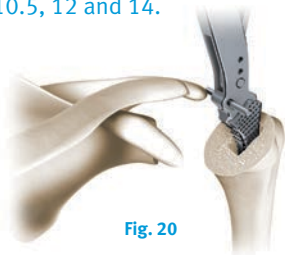


Fig. 20

Retroversion Adjustment Technique

Insert the Alignment Rod into the appropriate retroversion hole on the Rasp Handle. Use the right or left hole for the corresponding shoulder side and the preferred hole for orientation to the forearm or to the condyles (Fig. 21).



Fig. 21

Continue rasping with the elbow bent at 90° parallel to the axis of the epicondyle of the distal humerus. This sets the retroversion at 18°.

Optional

In order to perform a superior lateral approach the Straight Rasp Handle can be used (Fig. 22).



Fig. 22

Optional

Care should be taken to ensure that the rasps are fully inserted into the humerus, i.e. until the movable crosspin is visible on top and contacts both anterior and posterior metaphyseal surfaces (Fig. 23).

Note

If full insertion of the rasp to this extent is not successful, the uncemented (press-fit) shaft of this size may not be used.



Fig. 23

The movable crosspin should sit perpendicular to the shaft of the inserter. If the crosspin is too oblique than the retroversion must be corrected by rasping in the correct version (Fig. 24).



Fig. 24

The Rasp Handle is now removed and the modular rasp left in the humerus. The rasp is now seated 5mm below the resection line (Fig. 25). The rasped lateral fin is now visible posterior to the bicipital groove.

Cement mantle

The average thickness of the cement mantle is 1mm.

Press-fit

The average press-fit is 0.55mm. The distal fins generate the major part of the press-fit.

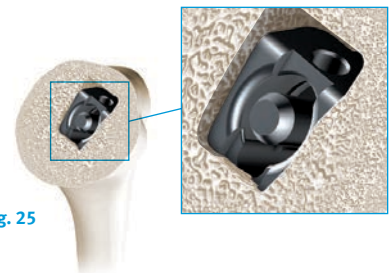


Fig. 25

Optional

Additional fixation of the modular rasp in the humerus can be performed by inserting a Rasp Fixation Screw into the modular rasp (Fig. 26) (this is recommended if poor bone quality). This ensures that the rasp will not subside when the humeral head is impacted onto it.

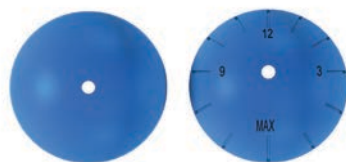


Fig. 26

The preparation of the humeral canal is now complete.

Humeral Head Selection

Choose a Humeral Head Provisional that best covers the prepared surface of the proximal humerus and fills the rotator cuff circumferentially. Twenty-four standard and 22 offset heads are available (Fig. 27).



Standard Head Offset Head
Fig. 27

The resected humeral head can be used as an initial reference for choosing the humeral head size (Fig. 28).



Fig. 28

Three provisional adaptors in different colors are available to perform a trial reduction in the resected angle (Fig. 29). If a Cutting Guide was used to resect the humeral head, then choose the provisional adaptor that corresponds to the same inclination as the Cutting Guide.

Yellow	42°/132°
Red	45°/135°
Brown	48°/138°



Fig. 29

First assemble the provisional adaptor to the provisional head and then apply it to the rasp in the body (Fig. 30). The lower part of the provisional head shall lie properly on the resection plane. The humeral head must at least reach or slightly overhang the calcar medially. In this case the resection has a 48° angle; a brown trial adaptor 48° is used.



Fig. 30

Note

The taper for the head portion of the trial and definitive adaptor must be applied in the superior direction (Fig. 31).



Fig. 31

If an offset head is used it can be rotated to cover the prepared surface of the proximal humerus and fill the rotator cuff circumferentially. If using an offset humeral head, rotate the head into the proper anatomical position. In this case the best coverage is achieved by having the 5 o'clock marking pointing distally to the shaft of the humerus. This 5 o'clock position will later be used to assemble the definitive implant adaptor to the head (Fig. 32).



Fig. 32

Reduce the joint and check the fit on both the superficial and deep surfaces. Applied pressure to the appropriate humeral head will sublux the head about 50 percent of its diameter posteriorly and inferiorly, falling back into place when the pressure is released. A head that does not fill the capsule will dislocate over the glenoid rim, and one that overstuffs the joint will not allow this “50–50” laxity assessment. Pull the subscapularis muscle over the joint. If the fit is too tight, release the tendon as necessary. Often, releasing the subscapularis from the anterior labrum and capsule will provide sufficient mobilization to the neck of the humerus. Remove the provisional components and perform any necessary soft tissue releases.

If the humeral component is placed too low, the greater tuberosity will be relatively prominent and may impinge under the acromion. This condition can limit the range of motion. In addition, the resulting vector forces will drive the humeral head down against the inferior margin of the glenoid and can contribute to rocking and possible loosening. Therefore, it is important to always check that the superior aspect of the humeral head is above the superior aspect of the greater tuberosity. If the humeral component is placed too high, the supraspinatus muscle will be under too much tension around the prominent lateral margin of the humeral head. In addition, the uncovered calcar can abut under the inferior margin of the glenoid component and may lead to glenoid rocking and possible loosening.

It is important to keep in mind the very precise relationship of the glenoid articular surface to the tuberosities and rotator cuff insertions so that contracture of the rotator cuff muscles and capsule do not eccentrically load the glenoid. The relationship of this entire complex to the acromion is also critical. The subacromial space should just accommodate the functional rotator cuff and tuberosities.

Unpack the definitive *Bigliani/Flatow* Head and *Anatomical Shoulder Combined* Adaptor. The marking on the *Anatomical Shoulder Combined* Adaptor must point to the clock marking on the *Bigliani/Flatow* Head as observed with the trial head. A pre-fixation of head and adaptor can be done by hand. In this case the clock marking shows the 5 o'clock position (Fig. 33).



Fig. 33



To achieve a strong connection between adaptor and head, use the Impactor for Adaptor and Head along with the Assembly Block and impact a minimum of three times with a mallet. The head must be fixed by hand while impacting (Fig. 34).



Fig. 34

Unpack the definitive *Anatomical Shoulder* Humeral Stem size determined by the size of the last modular rasp used cemented or uncemented (press-fit) (Fig. 35).



Fig. 35

The humeral implant stem (cemented or uncemented) is now placed into the stem holder of the assembled mounting block (Fig. 36). The head/adaptor is now finally impacted onto the humeral implant stem with the aid of the automated Impactor (Fig. 37).

For instructions on charging the impactor, see page 19.

Note

The *Anatomical Shoulder Combined* adaptor must be placed in superior direction into the stem. 2–3 impacts with the automated Impactor are recommended. Care should be taken to ensure that the Impactor is aligned to taper axis and up to the maximum compression of the spring before the three defined pulses are triggered. (Fig. 37a).



Fig. 36



Fig. 37



Fig. 37a

The modular rasp can now be removed from the humerus (Fig. 38). If the Rasp Screw has been used it must be removed first. The Rasp Handle cannot be mounted without removing this screw.

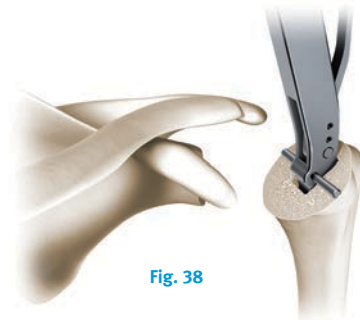


Fig. 38

If the Rasp Handle can not be attached, the modular rasp can also be removed from the humerus by means of the Rasp Extraction Instrument (Fig. 39).



Fig. 39

Implantation of the Prosthesis into the Humeral Shaft

With the cemented prosthesis, a cement restrictor can be inserted into the humerus, followed by the cement, in a relatively fluid consistency. The implant is now inserted into the humerus (Fig. 40) by applying controlled force with the thumb on the head.



Fig. 40

Note

If it is not possible to seat the implant with the thumb until you reach a maximum of 1cm distance (Fig. 41) between proximal humerus resection line and the bottom of the humeral head, extract the implant and re-ream with the last rasp size used. The lateral stem fin is used as orientation.



Fig. 41

The implant is brought into the final position with careful blows on the Impactor for Adaptor and Head (Fig. 42). This is done until the lower side of the Humeral Head is resting on the humerus. If the cemented prosthesis is being used, excess cement is then carefully removed.



Fig. 42

Cement Mantle

The average thickness of the cement mantle is 1mm.

Press-Fit

The average press-fit is 0.55mm. The distal fins generate the major part of the press-fit.

Total Shoulder Replacement Surgery

Glenoid Preparation

The plane of the humeral resection can be protected with a disk-shaped protector (Fig. 43). Disks of three different diameters (40, 44 and 48) are available. The pins on the lower side of the disks are inserted at the level of the incision (refer to *Bigliani/Flatow* or *Trabecular Metal* Glenoid surgical technique).



Fig. 43

Anatomical Shoulder Combined with Bigliani/Flatow Pegged or Keeled Glenoid see: *Bigliani/Flatow* The Complete Shoulder Solution surgical technique 97-4301-102-00, pages 11–20

Anatomical Shoulder Combined with Trabecular Metal Glenoid see: *Trabecular Metal* Glenoid surgical technique 97-4301-204-00

Revision Surgery

Removal of the Head

With a cemented humeral stem, remove cement from the lower side of the humeral head with a Lexer chisel, so that the extraction instrument can be applied.

The Humeral Head Extractor is now applied to the humeral head and fixed with a two-edged screw (Fig. 44).

With the aid of the Extractor instrument and the Slide Hammer Weight the humeral head is separated from the humeral stem parallel to the lower side of the humeral head (Fig. 44).

Connect the extractor instrument to the *Anatomical Shoulder Bigliani/Flatow* Extractor Instrument for Adaptor and slide over the *Anatomical Shoulder Bigliani/Flatow* Adaptor (Fig. 45). The adaptor is separated from the humeral stem by controlled force of the Slide Hammer in axial direction of the adaptor (Fig. 46).

Note

Instruments are from *Anatomical Shoulder Revision Tray (ANSH700)* and *Anatomical Shoulder Combined Tray (KTANSH900)*.

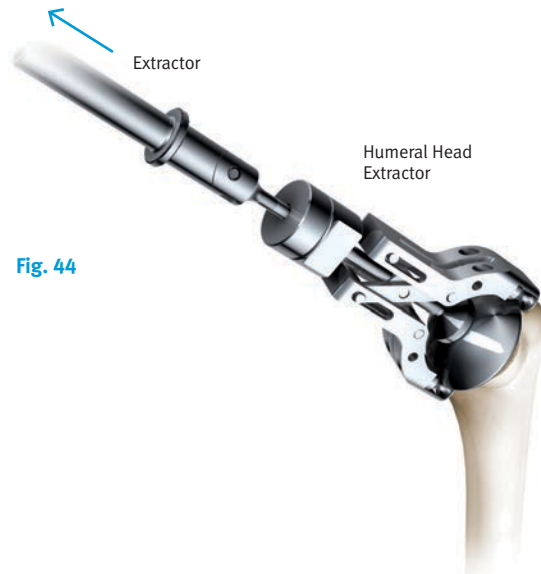


Fig. 44

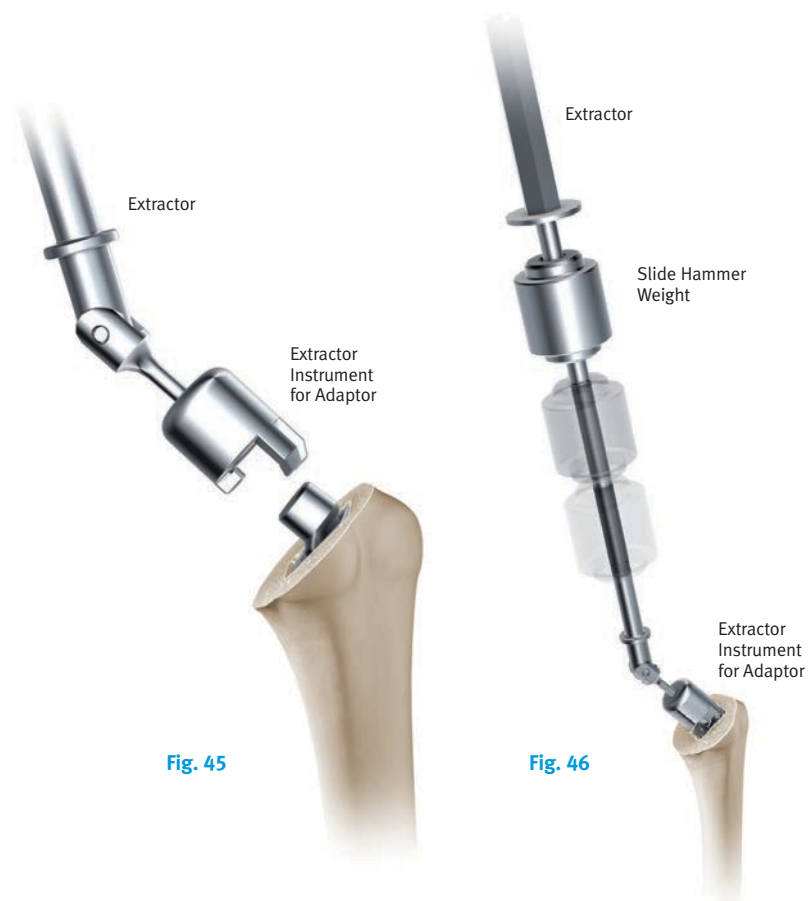


Fig. 45

Fig. 46

From Anatomical Shoulder Inverse/Reverse to Anatomical Shoulder Combined “last salvage”



To remove a Humeral Cup from the *Anatomical Shoulder Stem*, slide the two components of the Extractor together, then slide the Humeral Cup Extractor between the humeral shaft and the undersurface of the Humeral Cup. Firmly tap the movable part of the instrument to loosen the Humeral Cup (Fig. 47).



Fig. 47

Preparation and Cleaning of the Cemented Stem

To remove the cement from the thread if the humeral stem is cemented, a Drill Guide is first inserted into the oval cone of the humeral stem and then used to guide the Drill (Fig. 48).

Note

Care should be taken to ensure that drilling is continued as far as possible.

Note

Instruments are from *Anatomical Shoulder Revision Tray (ANSH700)* and *Anatomical Shoulder Inverse/Reverse Tray (ANSH800)*.

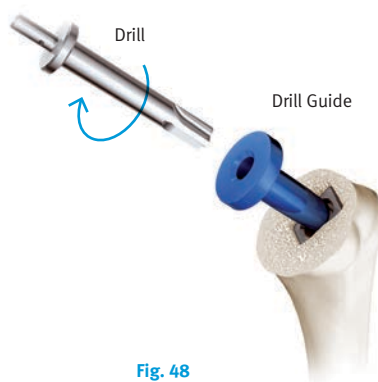


Fig. 48

Any remaining cement is now removed from the thread in the stem with the Thread Cutting Head (Fig. 49).



Fig. 49

The X-pin is now screwed into the humeral stem using the 2.5mm Hex Screwdriver (Fig. 50). The x-pin guides the reamer and is essential for directing and fixing the inverse humeral cup.

Note

Care should be taken to ensure that the X-pin is fully screwed in and that the oval internal cone is not damaged when this happens.



Fig. 50

Now mount the Humeral Inverse Milling Cutter together with the Cannulated Handle and start reaming the resected humeral surface up to the pin in the rasp (Fig. 51).

Note

The Cannulated Handle is located in the *Anatomical Shoulder Glenoid Tray (ANSH0100)*.

Note

Care should be taken to ensure that reaming is continued as far as possible up to the pin in the rasp.

To generate an even humeral resection area, use the oscillating saw for resection of the nonreamed humeral surface area.



Fig. 51

The plane of the humeral resection can be protected with a disk-shaped protector. Disks of three different diameters (40, 44 and 48mm) are available. The pins of the lower side of the disks are inserted at the level of the incision (Fig. 52).



Fig. 52

Glenoid Side

To remove the Glenosphere from the Glenoid Base Plate, slide the Glenosphere Extractor between the back surface of the Glenosphere and the front surface of the Glenoid Base Plate. Tap the end of the instrument to loosen the Glenosphere (Fig. 53).

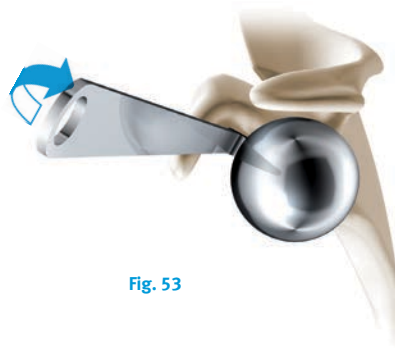


Fig. 53



To remove the Glenoid Base Plate, first remove the locking caps and then the screws (Fig. 54). The Base Plate can be removed by a chisel.

Note

For a loose Inverse/Reverse Base Plate, remove the locking caps and screws before pulling out the Base Plate.

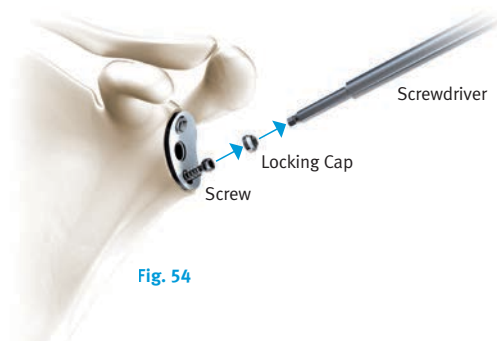


Fig. 54

Humeral Head Selection on Previously Implanted Stem

Choose a Humeral Head Provisional that best covers the prepared surface of the proximal humerus and fills the rotator cuff circumferentially. Standard or offset heads are available (Fig. 55).

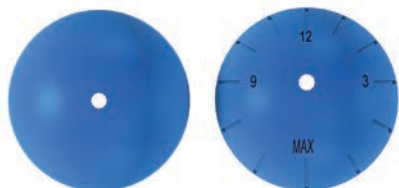


Fig. 55

Use the red 45°/135° provisional adaptor to perform a trial reduction in the resected angle (Fig. 56).

Red	45°/135°
-----	----------



Fig. 56

First assemble the provisional adaptor to the provisional head and then apply it to the rasp in the body. The humeral head must at least reach or slightly overhang the calcar medially.

Note

The trial adaptor must be applied in superior direction (Fig. 57).



Fig. 57

If an offset head is used it can be rotated to cover the prepared surface of the proximal humerus and fill the rotator cuff circumferentially. If using an offset head, rotate the head into the proper anatomical position. In this case the best coverage is achieved by having the 5 o'clock marking pointing distally to the shaft of the humerus. This 5 o'clock position will later be used to assemble the definitive implant adaptor to the head (Fig. 58).



Fig. 58

Reduce the joint and check the fit on both the superficial and deep surfaces.

Unpack the definitive *Bigliani/Flatow* Head and *Anatomical Shoulder* Combined Adaptor. The marking on the *Anatomical Shoulder* Combined Adaptor must point to the clock marking on the *Bigliani/Flatow* Head as observed with the trial head. A pre-fixation of head and adaptor can be done by hand. In this case the clock marking shows the 5 o'clock position (Fig. 59).



Fig. 59

To achieve a strong connection between adaptor and head, use Impactor for Adaptor and Head along with the Assembly Block and impact minimum three times with a mallet. The head must be fixed by hand while impacting (Fig. 60).



Fig. 60

The implant is now inserted into the stem by applying controlled force with a minimum of three adequate impacts on the head via the manual impactor (Fig. 61).

Note

- The adaptor must be oriented in the superior direction (Fig. 62).
- It is important to achieve a firm connection of the taper interfaces. If the bone quality is good, three strong mallet blows should be applied to achieve connection.
- If the bone is weak and there is a risk of humeral fracture during impaction, then four or more firm blows should be applied.
- All taper surfaces must be dry and clean to achieve a good taper connection.



Fig. 61



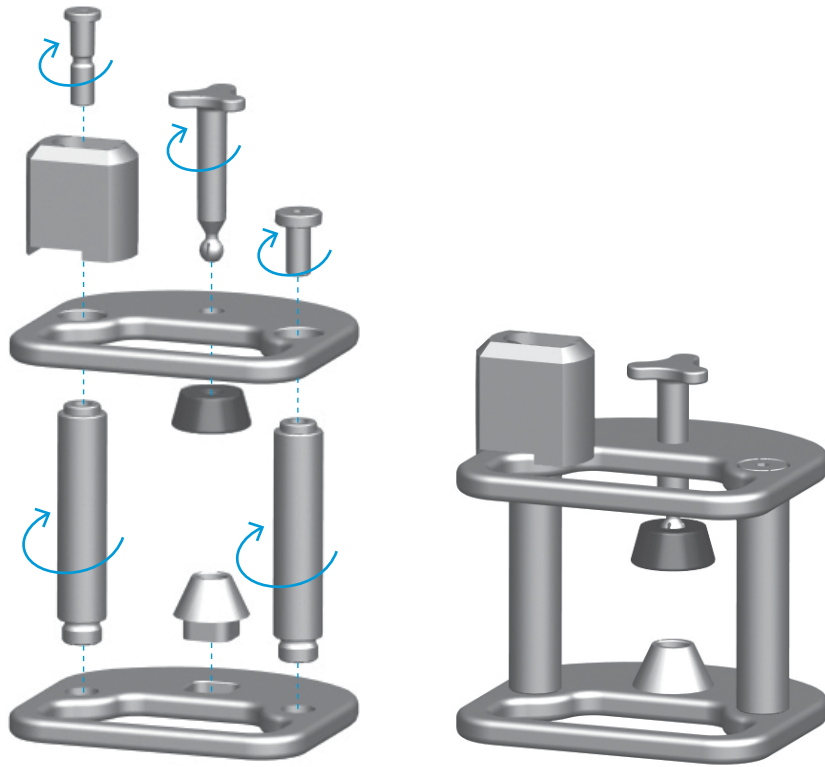
Fig. 62

Reduction and Closure

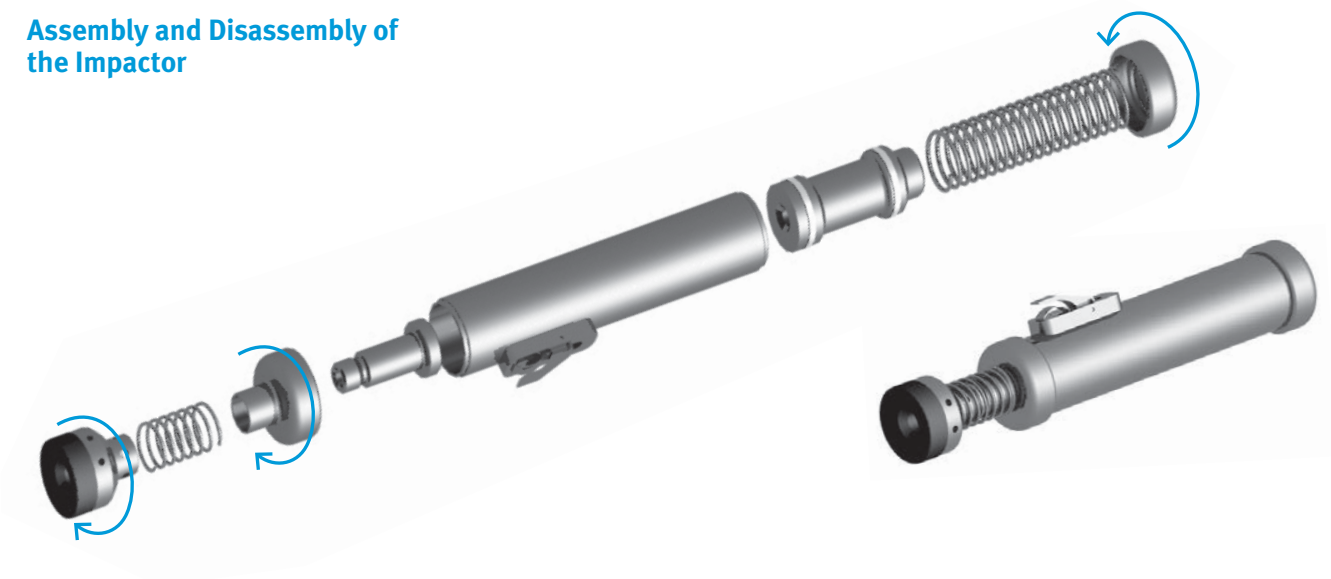
The prosthesis is then reduced and stability is checked. Once the joint space is irrigated and cleared of debris, a drain is left in place. Layered closure of the soft tissue normally leads to an adequate range of motion, without instability.

Preparation and Description of the Assembly of the Instruments

Assembly block for the humeral head and stem



Assembly and Disassembly of the Impactor



Charging the Impactor

Tense the Impactor with the help of the loading aid (Charger).

The Impactor is connected through the shaft of the Charger.

There are two possible procedures: Either the Charger is placed on the table (Fig. 63), or the Charger is held in one hand, the Impactor in the other (Fig. 64, 65), while the shaft of the Charger is inserted into the Impactor and tenses the Impactor.

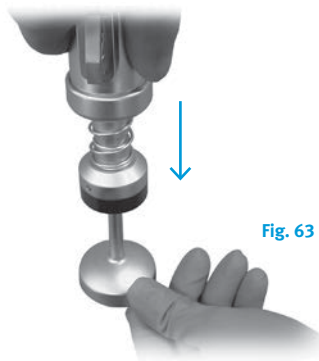


Fig. 63

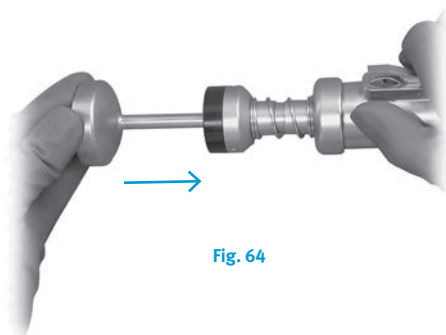


Fig. 64

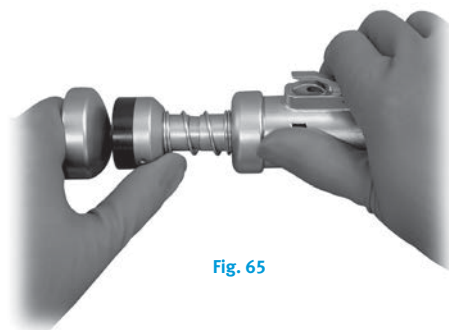


Fig. 65

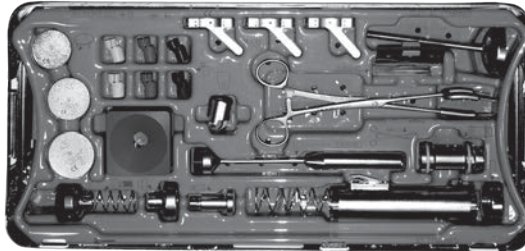
Review of the Instrument Trays

*Anatomical Shoulder
Instrument Tray I*
ANSH500



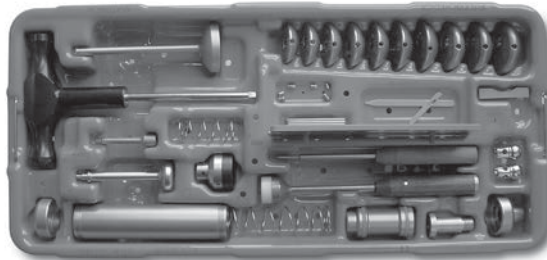
*Anatomical Shoulder
Combined Instrument
Tray*

KTANSH900



*Anatomical Shoulder
Instrument Tray II
(Optional)*

ANSH600

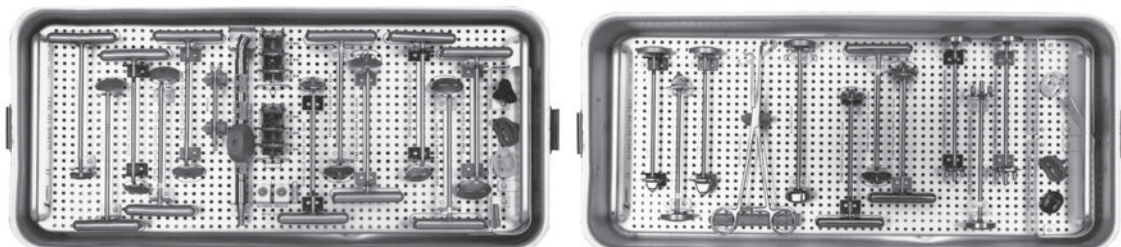


*Anatomical Shoulder
Pegged Glenoid Tray
(Optional)*

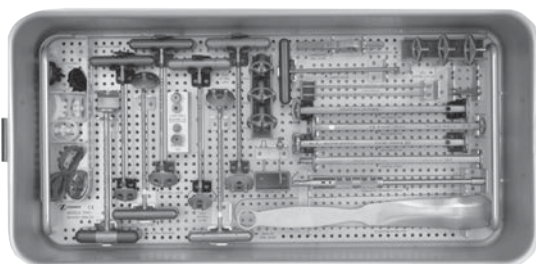
ANSH0100



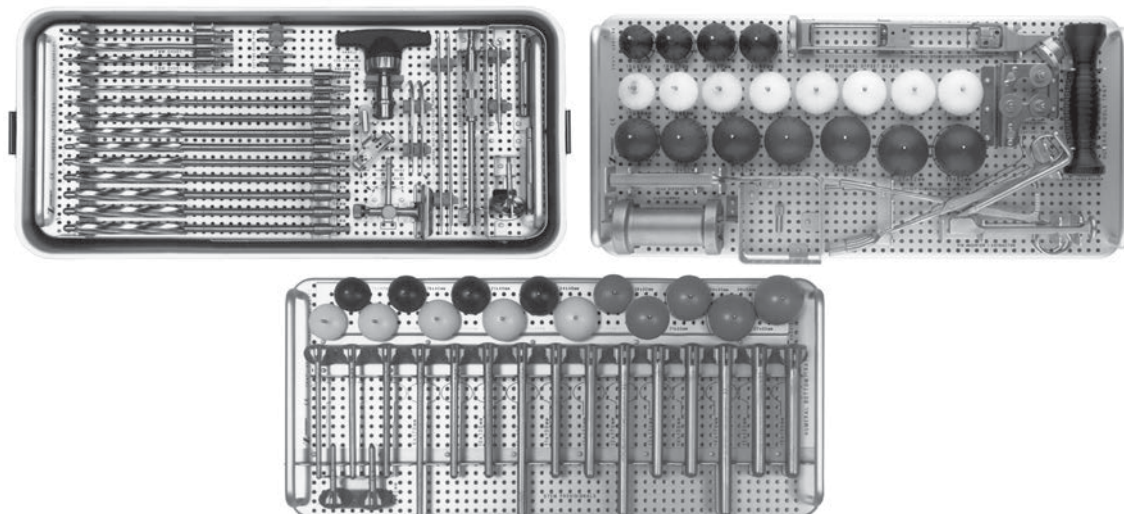
Bigliani/Flatow
Glenoid Trays
KT-4300-000-01



Trabecular Metal
Glenoid Tray
00-4327-000-02

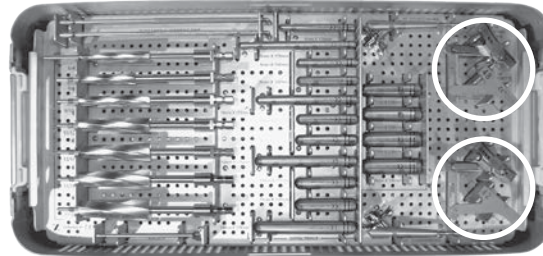


Bigliani/Flatow
Humeral Trays
KT-4300-000-02



***Trabecular Metal
Humeral Tray
(Optional*)***

KT-4309-000-00

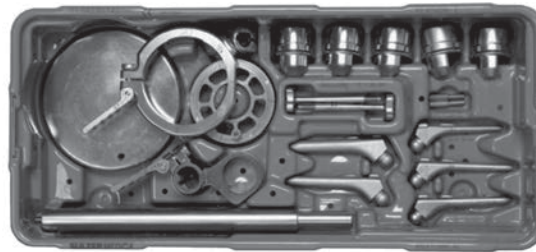


* Optional instruments: *Trabecular Metal* Humeral tray is only needed if surgeon chooses to use the *Trabecular Metal* Humeral Cutting Guides and Silhouettes.

For Revision Cases

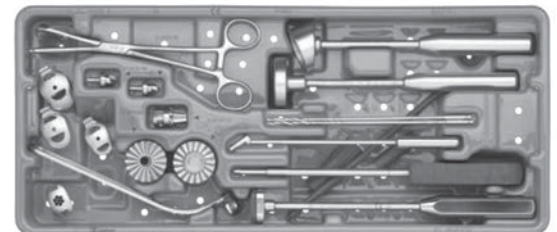
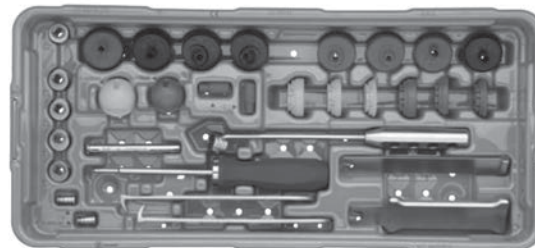
***Anatomical Shoulder
Revision Trays***

ANSH700



***Anatomical Shoulder
Inverse/Reverse Trays***

ANSH800



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