Anatomical Shoulder™ Inverse/Reverse System

Surgical Technique

From Anatomical to Inverse/Reverse

zimmer
Confidence in your hands®

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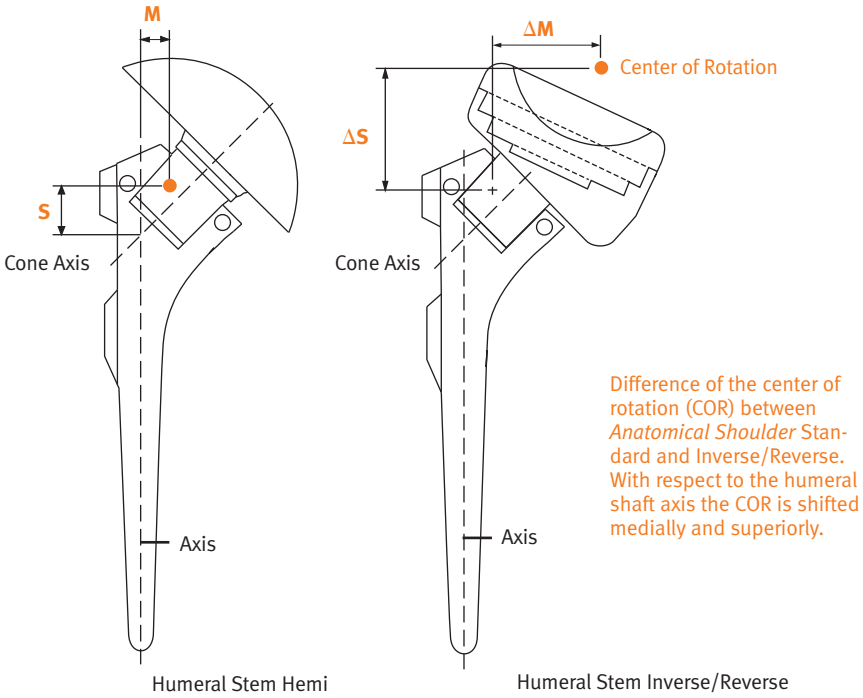
Foreword

Total shoulder replacement has evolved as a biomechanically logical reconstruction of the shoulder. Anatomical reconstruction using the *Anatomical Shoulder* System allows the potential for the surgeon to restore the geometry of a normal joint, thus ensuring good motion and pain relief, as well as durability of the reconstruction.

When there is severe distortion of osseous anatomy and loss of normal rotator cuff tendon structure, anatomical restoration of the glenohumeral joint is not possible. Such patients who have severe loss of rotator cuff function may present with a pseudoparalysis as well as with pain. In such situations reconstruction in order to restore function is possible using an inverse/reverse solution. The *Anatomical Shoulder* Inverse/Reverse option offers the ability for pain relief and restoration of function using the same humeral stem used for primary, revision, or fracture reconstructions.

Biomechanical Concept



Difference of the center of rotation (COR) between *Anatomical Shoulder* Standard and Inverse/Reverse. With respect to the humeral shaft axis the COR is shifted medially and superiorly.

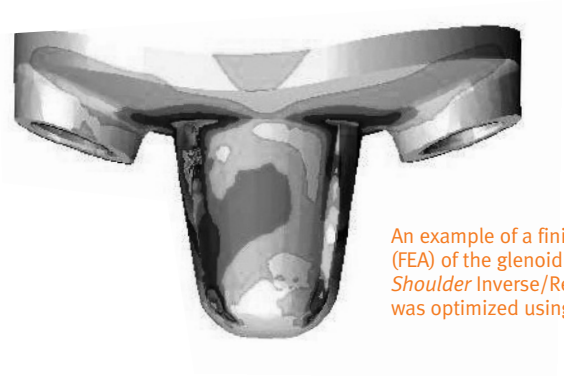
The *Anatomical Shoulder* Inverse/Reverse design is based on the principle of kinematic balancing of the shoulder based on a model initiated by Grammont [1]. The geometry reverses the normal relationship between scapular and humeral components, moving the center of rotation medially to increase the lever arm of the deltoid muscle, and lowers the humerus to increase tension of the deltoid. This allows the deltoid to compensate for rotator cuff deficiency, both in terms of joint stability and function.

Reference

1. Grammont P. M., Baulot E.; Delta Shoulder Prosthesis for Rotator Cuff Rupture; Orthopedics 1993; 16:65–68

Biomechanical Testing

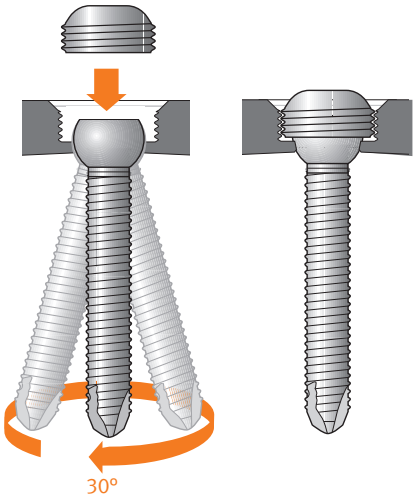
The complexity of the shape of the implants, the surface finish, the various manufacturing processes, and the range of mechanical properties of the materials require that we validate our products through mechanical testing, computer modeling and calculations. Computer modeling, especially finite element analysis (FEA), is also regularly used to optimize the design in the development process. This ensures a rapid development process and greatly increases the likelihood that a new implant will pass our stringent laboratory tests.



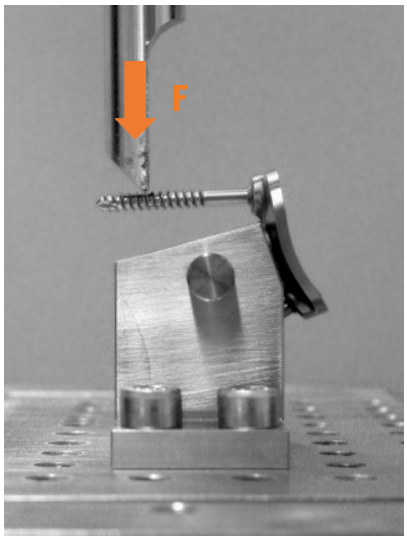
An example of a finite element analysis (FEA) of the glenoid fixation of the *Anatomical Shoulder* Inverse/Reverse System. The design was optimized using FEA.

Testing the Polyaxial Screw Connection

The unique polyaxial screw connection was introduced in the *Anatomical Shoulder* Inverse/Reverse Glenoid to allow adaptation of the screw position to the patient's anatomy. The screw position can be freely adjusted within 30° arc and will then be locked in the chosen position with a locking cap. The angular stability of this connection was tested using a static tilt test. The glenoid fixation was clamped to a fixture and the screw loaded vertically. The necessary force to cause a slip of the screw was measured. The force generated was greater then expected clinical loads and provides stable fixation.



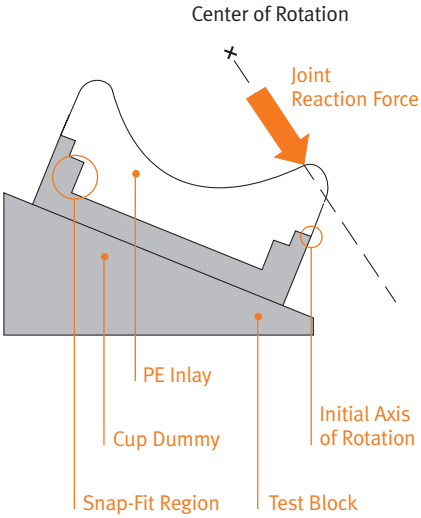
Polyaxial screw placement within 30° subsequent locking option for optimal system stability.

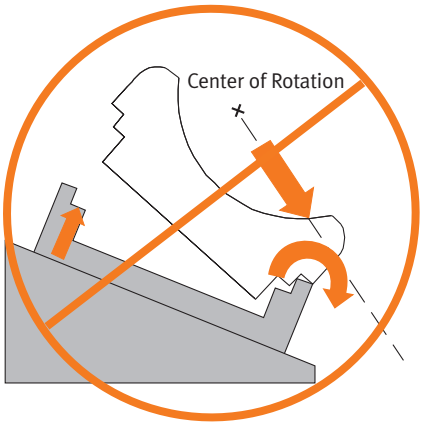


Experimental setup of the static tilt test

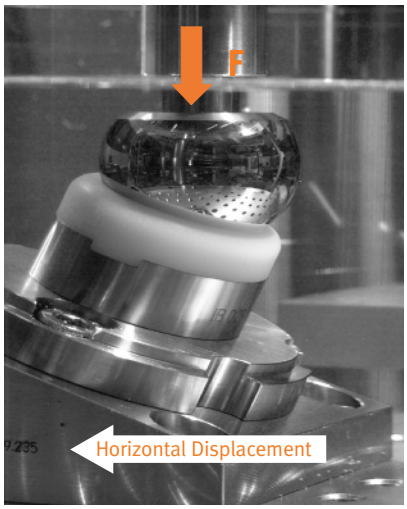
Testing of the Snap-Fit Connection

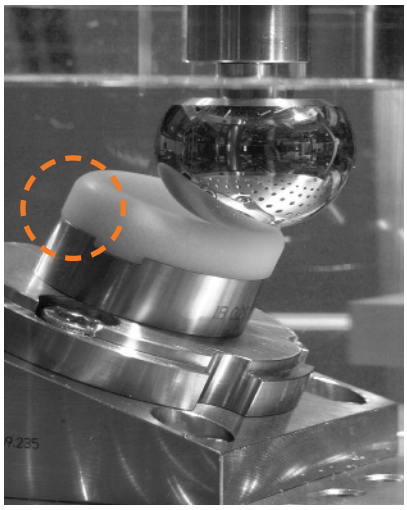
A joint reaction force pointing outside the humeral cup causes a tilting moment, which can lever out the inlay from the cup. The snap-fit connection of the *Anatomical Shoulder* Inverse/Reverse was optimized to prevent levering out of the PE inlay even under severe loading conditions like a subluxation. The static subluxation test simulated a single abduction with 2 kg hand load and then a subluxation was caused by applying a horizontal displacement. Abduction with less hand load might occur more often, therefore a dynamic subluxation test was carried out. 250,000 subluxation cycles simulating abduction with 1 kg hand load were applied to prove the stability of the snap-fit connection. All tests were performed in water at 37 °C [2,3].





Levering out of PE inlay due to edge loading. During such a loading situation the snap-fit connection must withstand an axial pull-out force.





Top picture showing the start position of the subluxation test. A vertical load was applied simulating worst-case loading conditions during abduction. A controlled horizontal displacement was then used to cause subluxation, i.e. a severe edge loading. The snap-fit connection is strong enough to keep the PE inlay in place even after 250,000 subluxation cycles (no lift-off, see circle on picture above).

References

2. Mroczkowski M.L.; Gronau N.; Kralovic B.J.; The Effect of Center of Rotation and Rotator Cuff Function on Reverse Shoulder Biomechanics; Data on file.
3. Gronau N.; Mroczkowski M.L.; Boss S.; Mechanical Testing of Reverse Shoulder Prosthesis Stability; Abstract submitted to SFB 2006

Description of the Implants

The standard *Anatomical Shoulder* Stem is also used for the *Anatomical Shoulder* Inverse/Reverse Prosthesis. This arrangement allows the surgeon the unique opportunity to revise a primary anatomical prosthesis to the inverse/reverse component without the need for stem removal. Such revision might be necessary in the setting of an irreparable rotator cuff tear. This will greatly simplify and shorten revision surgery since the need to remove a well-fixed stem is eliminated.

The *Anatomical Shoulder* Inverse/Reverse Humeral Cups can be placed onto the stem with the standard oval taper connection. The *Anatomical Shoulder* Inverse PE inlays will be locked into the humeral cups with a PE snap-fit solution.

On the glenoid side the *Anatomical Shoulder* Inverse Glenoid Fixation, with its convex design, preserves bone and has a central peg with antirotation fins for better primary stability. The superior and inferior threaded pegs will be used with the Inverse/Reverse Screw System. The central peg has an oval taper to seat the *Anatomical Shoulder* Inverse Glenoid Heads in place.

The implants must be combined as follows:
Combining different component sizes is not allowed.

Glenoid Head 36mm diameter with PE Inlay 36mm diameter
Glenoid Head 40mm diameter with PE Inlay 40mm diameter

Anatomical Inverse/Reverse Glenoid Heads

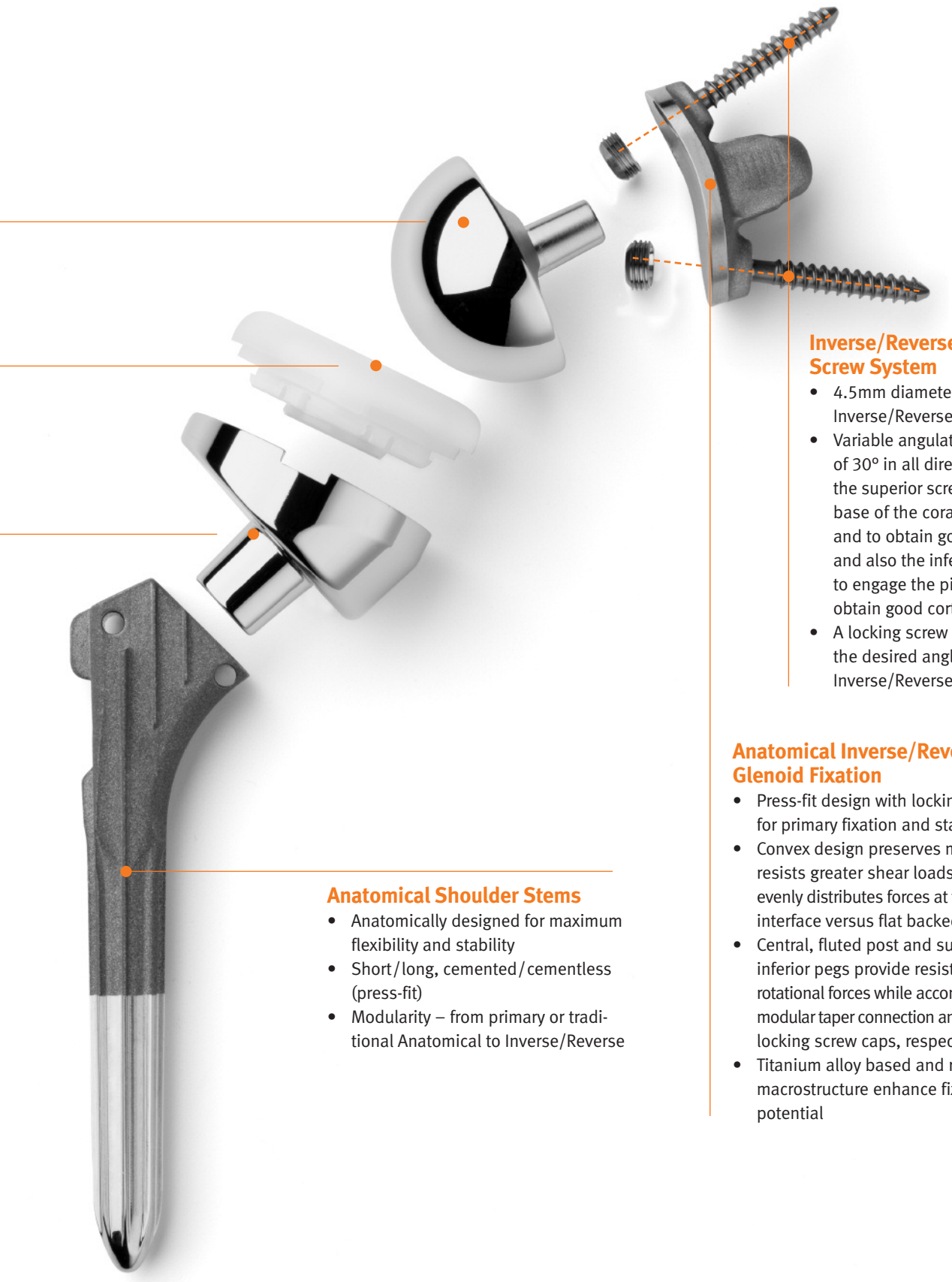
- 2 diameters: 36mm and 40mm
- Oval taper for secure fixation

Anatomical Inverse/Reverse PE Inlays

- 2 diameters: 36mm and 40mm
- 3 thicknesses: 0mm (standard) 3mm and 6mm
- Antirotational design

Anatomical Inverse/Reverse Humeral Cups

- 4 offset and 4 version cups cover range of lateralization, height and version adjustments
- 0° retroversion (Standard) cups have a centralized taper connection that places the humeral stem in a standard anatomical relationship with respect to the acromion
- 0° retroversion +6mm (Medial Offset) cups have a taper connection that is offset 6mm medial to the center of the cup. This places the humeral stem in a more medial position with respect to the acromion while increasing the height of the prosthesis
- Both 0° retroversion cups come in a +9mm height option that increases the height and lateralization of the prosthesis. Combined with the 3 polyethylene inlay options, 15mm of adjustment can be made to the lateralization/height of the construct in 3mm increments
- 4 additional version (control) humeral cups allows the intraoperative change or correction of stem version from +20° and –20°
- Oval taper inherently provides antirotation feature to a secure modular connection



Inverse/Reverse Screw System

- 4.5mm diameter self-tapping Inverse/Reverse Screws
- Variable angulations to a maximum of 30° in all directions for both, the superior screw in order to engage base of the coracoid process and to obtain good cortical fixation, and also the inferior screw in order to engage the pillar of the scapula to obtain good cortical fixation
- A locking screw will fix and secure the desired angle of each Inverse/Reverse Screw

Anatomical Inverse/Reverse Glenoid Fixation

- Press-fit design with locking screws for primary fixation and stability
- Convex design preserves more bone, resists greater shear loads and more evenly distributes forces at the fixation interface versus flat backed designs
- Central, fluted post and superior/inferior pegs provide resistance to rotational forces while accommodating modular taper connection and threaded locking screw caps, respectively
- Titanium alloy based and roughened macrostructure enhance fixation potential

Anatomical Shoulder Stems

- Anatomically designed for maximum flexibility and stability
- Short/long, cemented/cementless (press-fit)
- Modularity – from primary or traditional Anatomical to Inverse/Reverse

Overview of the Instruments

Anatomical Shoulder Inverse/Reverse Trays

The preparation and implantation of the *Anatomical Shoulder* Inverse/Reverse System should be carried out in a standardized manner. The technique has been developed to require a minimal number of instruments to prepare the humerus and glenoid for Inverse/Reverse applications. The correct use and handling of these instruments are a requirement for the success of the surgery.

Further instruments needed:

- *Anatomical Shoulder* Instrument Tray I
- *Anatomical Shoulder* Instrument Tray II
- *Anatomical Shoulder* Glenoid Tray

For revision surgery, the following is also needed:

- *Anatomical Shoulder* Revision Tray

Anatomical Shoulder Instrument Tray I

Anatomical Shoulder Instrument Tray II

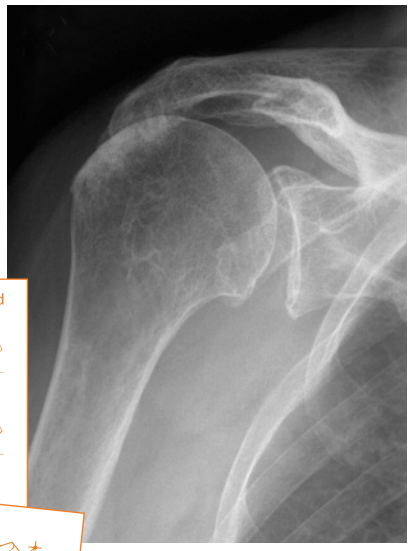
Insert *Anatomical Shoulder* Instruments Tray I

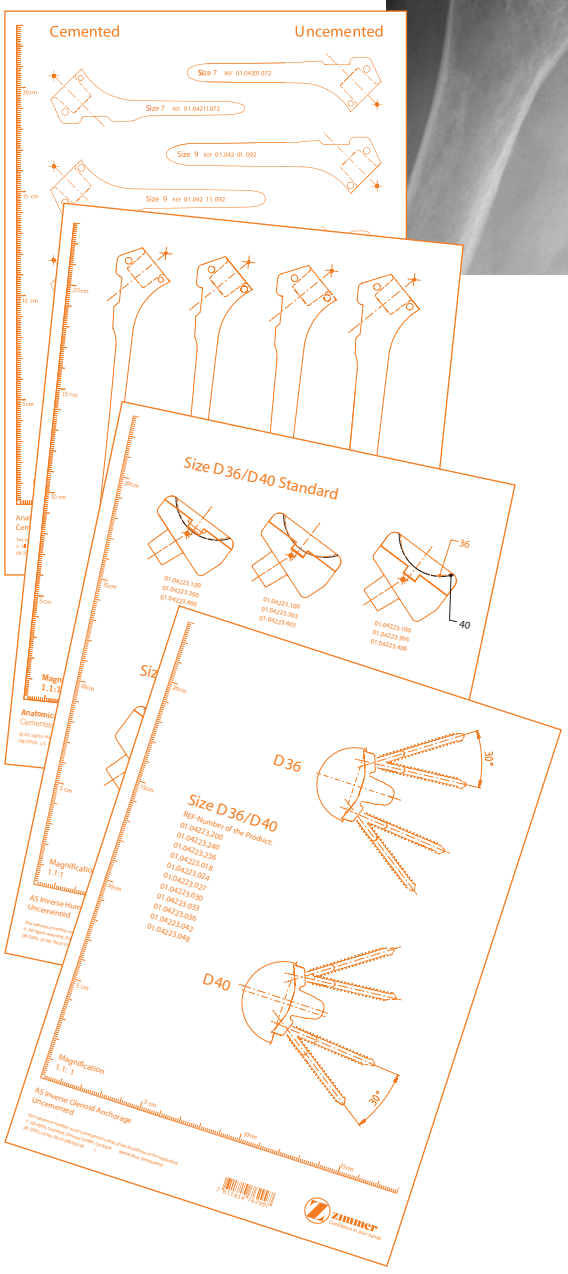
Anatomical Shoulder Glenoid Tray

Preoperative Planning

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

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





Preoperative Planning – Humerus

An initial assessment is made of the bone in the superior and inferior aspects of the glenoid, using radiographic and CT imaging, in order to determine the suitability of the patient's available bone stock for implant insertion.

Preoperative planning is also carried out, using AP and lateral shoulder radiographs of known magnification, along with templates to confirm the size and alignment of the implant.

Also see Preoperative Planning in the *Anatomical Shoulder* System Surgical Technique.

Preoperative Planning – Glenoid

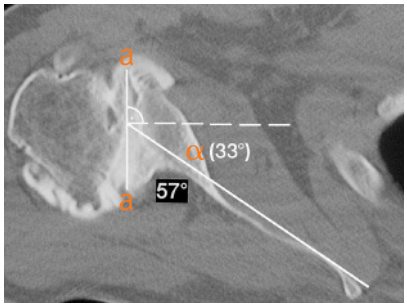
Most indications for inverse/reverse arthroplasty do not require correction of the version of the glenoid. Nevertheless the glenoid should be evaluated on CT scans. Preoperative CT investigation is recommended whenever a total shoulder prosthesis is used. If there is a severe defect in the posterior glenoid, this must be corrected either by corrective reaming or by bone reconstruction (using the resected head).

Glenoid version measured on the first horizontal CT section below the tip of the coracoid process (α) (any osteophytes must be identified and, since they will removed, taken into consideration). Now determine the correction angle on the basis of the measured glenoid version, knowing that the coronal (physiological) retroversion amounts to between 0° and 10° (retroversion).

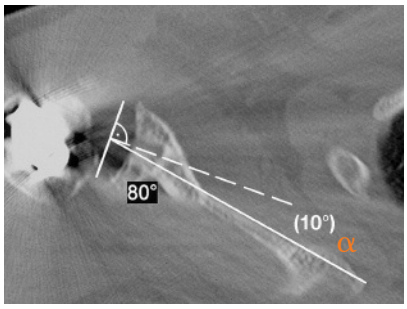
Enter the correction angle you have calculated on the glenoid positioning guide. Care must be taken both while drawing and during surgery, to ensure that the glenoid positioning guide lies on plane a–a.

Carry out cranio-caudal alignment of the Kirschner wire (K-Wire) under visual monitoring.

Then set this correction angle on the glenoid positioning guide, keeping in mind that one graduation mark corresponds to 5°.

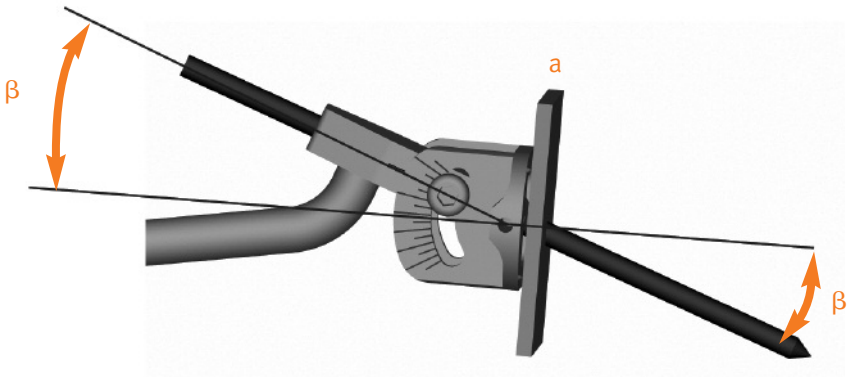


α preoperative



α postoperative

A preoperative CT scan is recommended for the purpose of determining the possible need for realignment of the articulating surface. The target value is a coronal (physiological) retroversion of between 0 and 10° (retroversion).



Glenoid guidance instrument (one mark = 5°)

β = α preoperative – α postoperative

Surgical Technique

Patient Positioning and Surgical Approach

The patient should be placed in a beach chair position on the edge of the operating table (Fig. 1).

The arm must be freely movable and it must be possible to extend it fully. An armrest is optional.

The *Anatomical Shoulder* Inverse/ Reverse System may be implanted using either a superior-lateral or delto-pectoral approach.

Superior-lateral or delto-pectoral approach depends primarily on surgeon preference and clinical parameters.

Revision surgery, for example, typically dictates a delto-pectoral approach as it allows a longer humeral incision when faced with a difficult removal of the humeral stem.

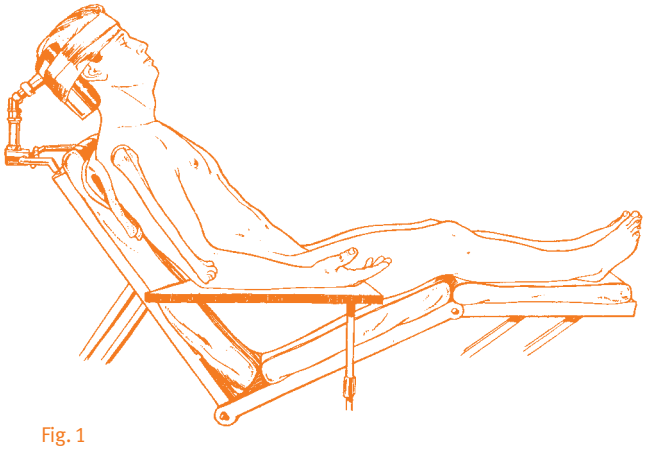


Fig. 1

Superior-Lateral Approach

The incision is made from the anterio-lateral acromial border downward approximately 4 cm.

Following subcutaneous dissection, the anterior and middle deltoid muscle bundles are separated opposite the lateral margin of the acromion, using blunt dissection. Care should be taken to avoid any damage to the axillary nerve, which is located approximately 4 cm distal to the acromion.

When the subacromial bursa is visible, gentle longitudinal traction in line with the limb will allow a retractor to be placed in the subacromial space.

The humeral head is dislocated by placing the arm in retroversion and internally rotated. To optimize the expo-sure, the anterior border and the rest of the superior cuff can be resected.

Delto-Pectoral Approach

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 the cephalic vein between the deltoid muscle and the pectoralis major muscle. Make the approach medial to the vein, to open the delto-pectoral groove.

The coracoid process is identified. The clavi-pectoral fascia is incised at the external border of the coraco-brachialis. The axillary nerve is then identified before subscapularis identification.

With adequate releases, the humeral head is dislocated into the delto-pectoral interval by abduction of the arm and progressive external rotation and extension.

Primary Implantation

Humeral Head Resection

The humeral head is now resected at the height of the anatomical neck with the aid of an oscillating saw – i.e. in the cartilage-covered section of the head. The resection is in the caudal direction. The Measurement and/or Resection Guides can be used for orientation or assistance (Fig. 2a and 2b).

After the osteotomy of the humeral head, the point of insertion of the reamer can be marked under the highest point of the resection, medial to the bicipital groove (Fig. 3a and 3b).

Preparation of the Proximal Humerus

Open the medullary cavity with a size 7 reamer by inserting the reamer into the shaft by hand or with a mallet (Fig. 4).

The medullary cavity is gradually widened, using reamers of increasing sizes as required – sizes 9, 10.5, 12 and 14. The depth of penetration is defined by the uppermost tooth. If a revision stem (long stem) is used, the additional marking on the reamer shaft is used as reference.

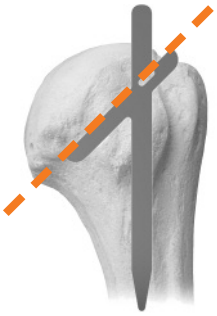


Fig. 2a Measurement Guide 135°

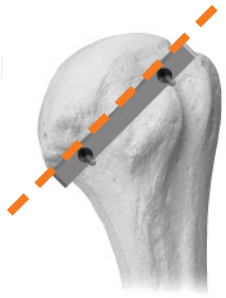


Fig. 2b Resection Guide

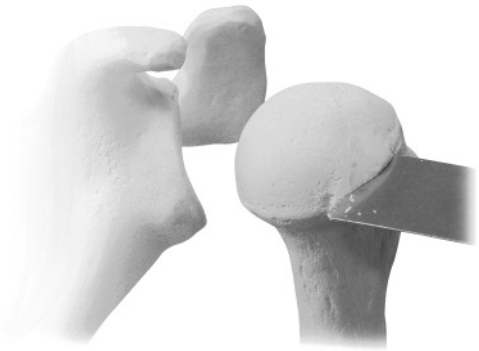


Fig. 3a

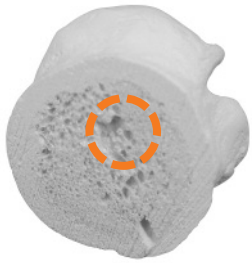


Fig. 3b

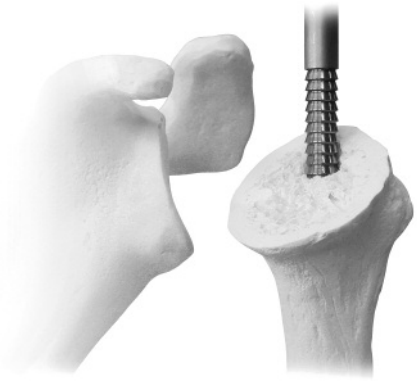


Fig. 4

After opening the medullary canal, the proximal section of the humerus is prepared with the aid of the Modular Rasp, starting with size 7 (Fig. 5).

The fin is directed towards a point approximately 9mm behind the bicipital groove. The proximal section of the humerus is then prepared step-wise with rasps of size 9, 10.5, 12 and 14, up to the size of the previously used reamer (Fig. 6a).

Care should be taken to ensure that the rasps are fully inserted into the humerus, i.e. until the movable cross pin is visible on top and contacts both anterior and posterior metaphyseal surfaces (no longer pivots) (Fig. 6b).

Note: Implant size is selected based on last Rasp used that seats fully in the cavity.

The Modular Rasp handle is now removed and the Modular Rasp is left in the humerus (Fig. 7).

Fig. 5

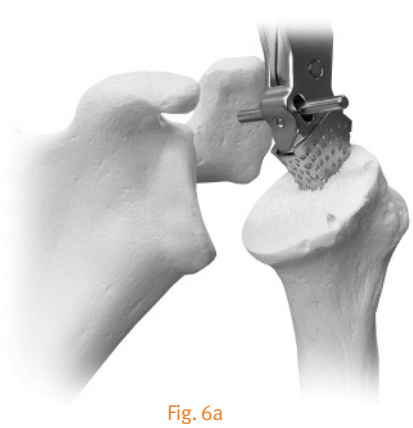


Fig. 6a

Fig. 6b

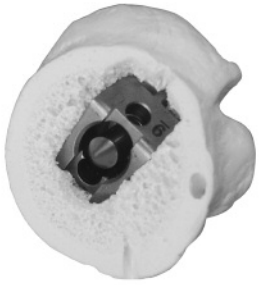


Fig. 7

Additional fixation of the modular rasp in the humerus is performed by inserting a rasp fixation screw into the Modular Rasp (Fig. 8).

Note: This is recommended if the fixation of the rasp is weak or questionable. This ensures that the rasp will not subside with further preparation.

Mount the Milling Cutter for humeral inverse with the Cannulated Handle and start reaming the resected humeral surface up to the pin in the Rasp (Fig. 9).

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.

The plane of the humeral resection can be protected with a disk-shaped protector (Fig. 10). Disks of 3 different diameters (40mm, 44mm and 48mm) are available. The pins of the lower side of the disks are inserted at the level of the incision.

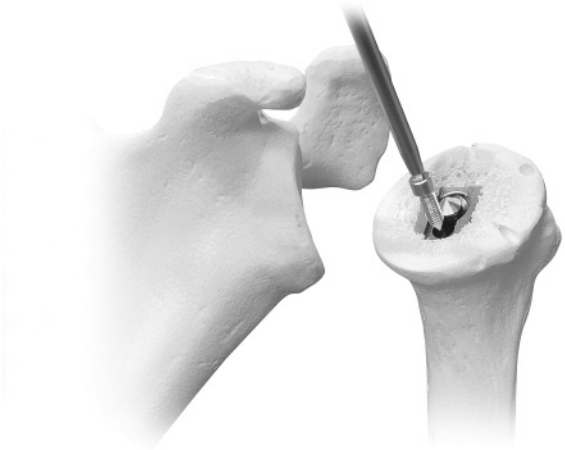


Fig. 8

Fig. 9

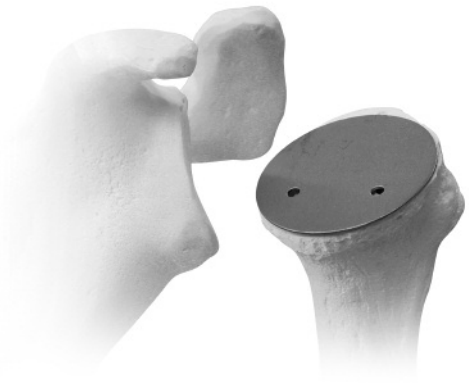


Fig. 10

Glenoid, Preparation and Implantation

To expose the glenoid, perform a capsulotomy and resect the remaining glenoid labrum. Position a retractor at the inferior border of the glenoid, seated on the scapular pillar for the supero-lateral approach or at the posterior part of the glenoid during the delto-pectoral approach. Use additional retractors, positioned anterior and posterior to the glenoid. Any peripheral osteophytes should be removed to restore the natural anatomic shape of the glenoid.

If necessary, set the correction of version determined from the preoperative CT scan on the Guiding Instrument for Glenoid Inverse (see page 12 – pre-operative planning – glenoid), identify the optimal position, the position of the inferior part of the Guiding Instrument for Glenoid Inverse should be at the inferior end of the articular surface, and vertical to the ground (Fig. 11). Introduce a 3mm K-wire guide pin into the guiding instrument for glenoid inverse. The laser marking on the K-wire must disappear slightly into the eyelet of this guiding instrument.

Remove the guiding instrument over the K-wire. The K-wire is now perpendicular to the required alignment of the articulating surface, which was determined preoperatively (Fig. 12a).

The Glenoid Reamer size S (small) and then the Cannulated Handle are mounted on the guide wire (Fig. 12a). For a sclerotic glenoid the separate sclerotic reamer (Fig. 12b) may be used to start the reaming process. Now ream the glenoid in the new alignment of the articulating surface (Fig. 13).

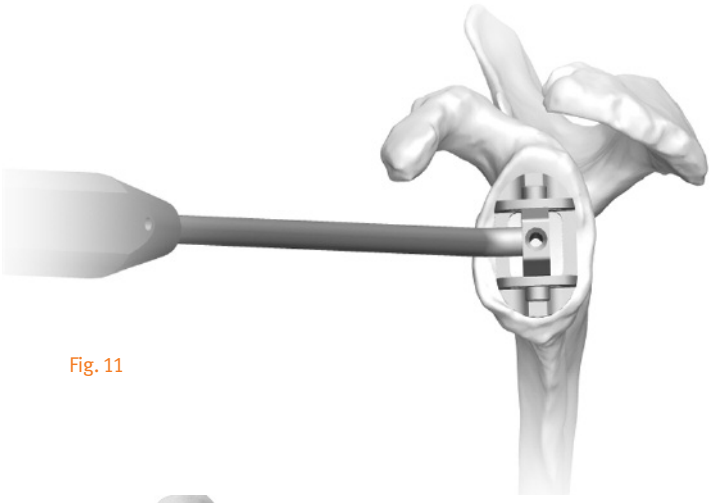


Fig. 11

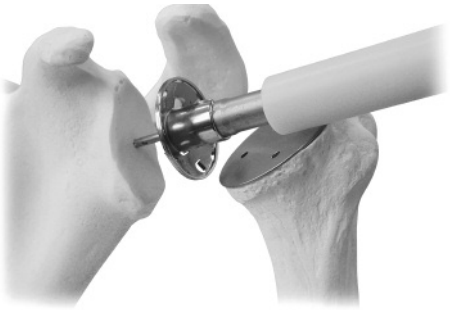


Fig. 12a

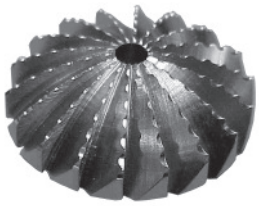


Fig. 12b

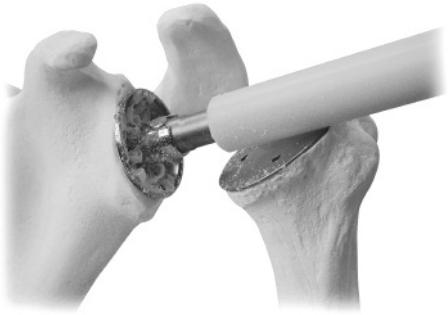


Fig. 13

NOTE: The *Zimmer® Trabecular Metal™* Reverse Shoulder System glenoid component assembly (i.e. base plate and glenosphere) is compatible with the PE-inlay, humeral cup, and humeral stem of the *Anatomical Shoulder* Inverse/Reverse System. Please refer to Appendix A at the end of this document for this alternate glenoid preparation and implant fixation.

If the complete surgical technique is desired, please refer to the follwing document and/or website.

Paper Copy: ***Zimmer® Trabecular Metal™ Reverse Shoulder System Surgical Technique (item number: 97-4309-003-00)***

Online Copy: ***www.zimmer.com***
Please select Medical Professional and then select surgical techniques.

Now use the reamer size L (large).

Note: The reamer size S (small) corresponds to the back surface of the *Anatomical Shoulder* Inverse/Reverse Glenoid Fixation. But the reamer size L (large) is needed to generate enough clearance for the backside of the *Anatomical Shoulder* Inverse/Reverse Glenoid Head.

Mount the Milling Cutter for glenoid inverse with the Cannulated Handle and ream over the guide wire until the collar is flush with the glenoid face (Fig. 14).

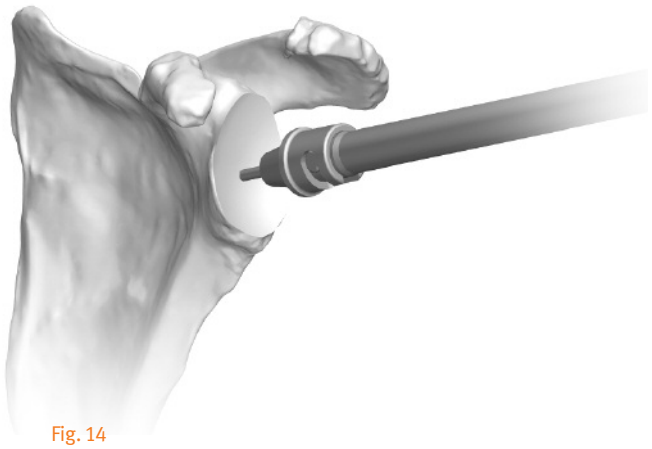


Fig. 14

Place the Drill Guide for Glenoid Inverse (Fig. 15) over the 3mm K-wire, flush with glenoid surface, and bore the inferior and the superior fixation holes. After drilling the inferior hole, place the Centering Pegs for Glenoid Inverse inside the hole, then drill the superior hole. Remove the Drill Guide, the Centering peg and also the K-wire guiding pin.

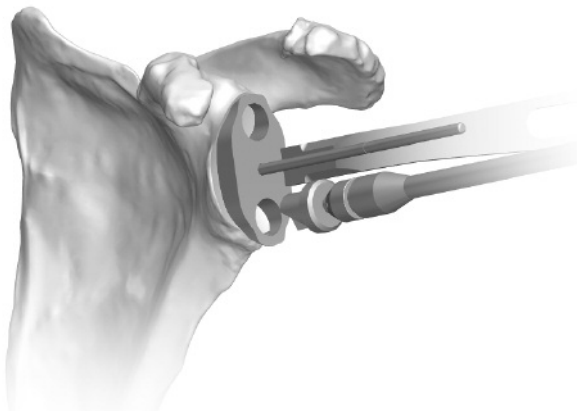


Fig. 15

The *Anatomical Shoulder* Inverse/Reverse Glenoid Fixation is available in one size for both 36mm and 40mm glenoid heads and is implanted without cement.

Positioning and Screw Fixation of the Anatomical Shoulder Inverse Glenoid Fixation

The *Anatomical Shoulder* Inverse/Reverse Glenoid Fixation is attached to the Holding Forceps for glenoid fixation. Place the glenoid fixation with the Central Peg into the previously drilled hole.

Start impacting with the Impactor for Glenoid Fixation, using controlled force. Once impacted, the glenoid fixation should seat fully on the glenoid. If not, impact until fully seated (Fig. 16).

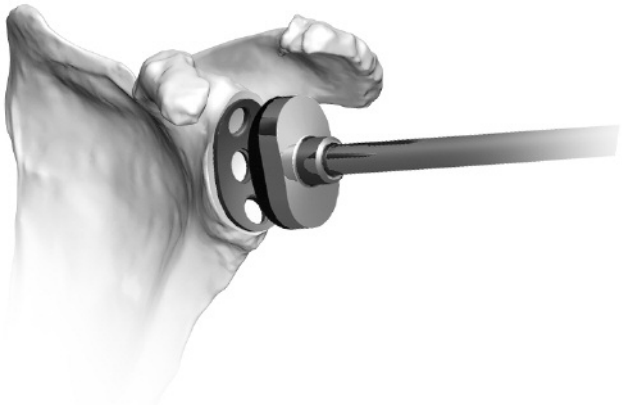


Fig. 16

Note: Care should be taken to correctly orient the superior/inferior peg position of the glenoid fixation, before impacting the glenoid fixation

The Impactor is removed and the Free Hand Drill Guide for Inverse/Reverse Screws is located in the inferior glenoid fixation hole. Both inferior and superior screw positions allow angulations of 30°. The Drill Guide for Inverse/Reverse Screws is used to set the most appropriate angle to ensure that each screw is located in reliable bone stock (Fig.17). Preferential position is usually chosen by palpating the inferior and superior aspects of the scapula as well as examining the radiographs and CT scans. The inferior hole is drilled with the 3.3 drill for Inverse/Reverse Screws. **Note: The screw lengths are laser marked on the drill, for use with the drill guide.** Remove the drill guide.

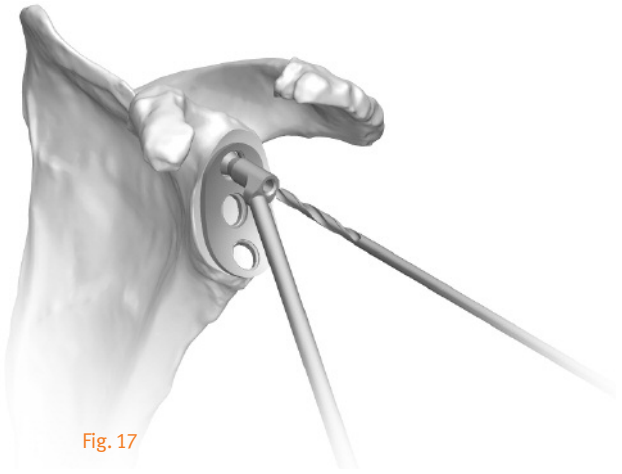


Fig. 17

The Inverse/Reverse Screw 4.5mm (available in lengths of 18 – 48mm is introduced into the inferior hole and fully tightened with the hexagonal screw driver. Next, prepare the superior hole in the same manner as the inferior hole.

Now secure the Inverse/Reverse Screw position by using the Inverse/Reverse Locking Screw. The locking screw is then fastened with the Torque Wrench, until the Torque Wrench slips or audibly clicks (Fig. 18).

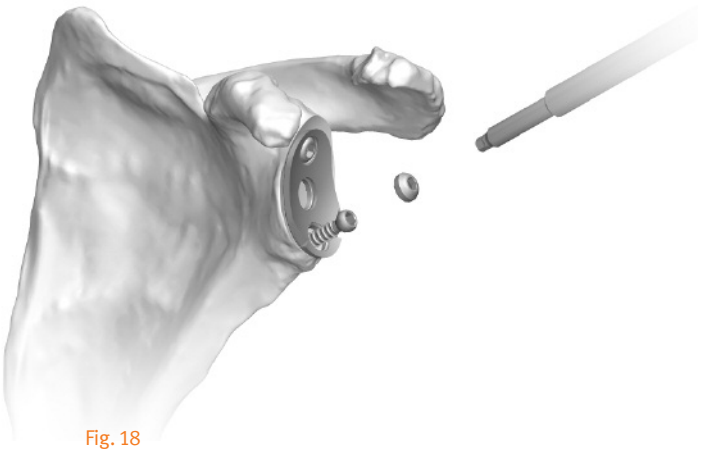


Fig. 18

Trial Reduction

The appropriate trial glenoid head 36 (green) or 40 (yellow) is attached to the glenoid fixation. The trial humeral cup is inserted into the rasp located in the humerus and a corresponding trial humeral PE inlay 36 (green) or 40 (yellow) is then inserted into the trial humeral cup.

Note: Three thicknesses of the humeral PE inlays are available: 0 (standard), +3mm and +6mm. In case of severe bone defects or inadequate deltoid tension, a +9mm humeral cup component can be used (possible humerus heights: standard 0 (standard), +3mm, +6mm, +9mm, +12mm and +15mm).

The shoulder is then reduced and assessed for a full range of movement.

If soft tissue tension is correct, the glenoid components will not impinge on the inferior rim of the resected humeral head, and the shoulder joint remains stable when the arm is adducted, with no indication of subluxation (Fig. 19).

To change the trial Humeral PE Inlays, a lexer chisel can be used to lever the inlays from the humeral cups.

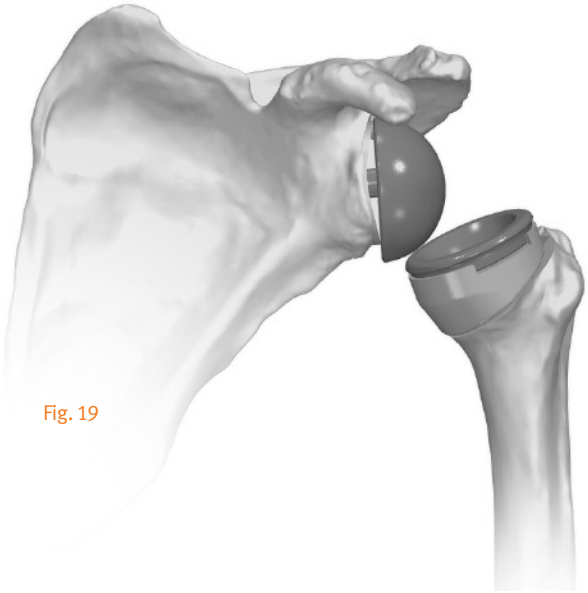


Fig. 19

Glenosphere Placement

The definitive *Anatomical Shoulder* Inverse/Reverse Glenoid Head is now unpacked. The size of the glenoid head has been defined by the previously used Trial Glenoid Head, 36mm or 40mm.

Note: The *Anatomical Shoulder* Inverse Glenoid Head has a laser mark for correct connection, this laser mark must face the acromion.

The Glenoid Head is now fitted onto the oval taper of the glenoid fixation (Fig. 20). Use three consecutive mallet strikes on the Impactor to seat the Glenoid Head the Glenosphere is now prepared.

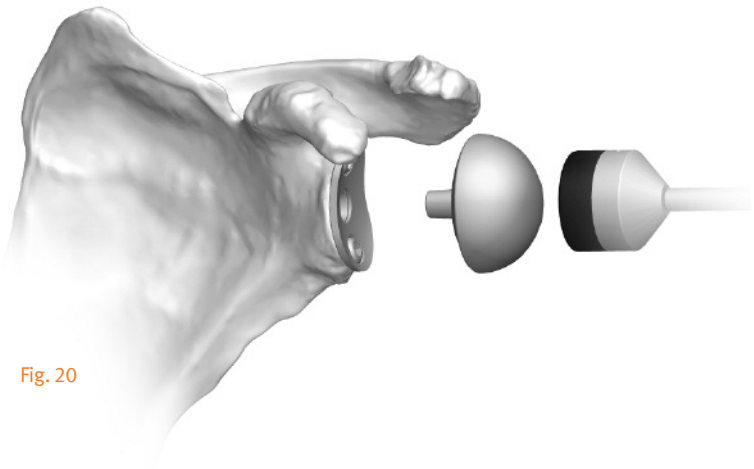


Fig. 20

Humeral Placement

Remove, if used, the optional rasp fixation screw from the rasp located in the humerus. Remove the rasp with the modular rasp handle. Unpack the definitive *Anatomical Shoulder* Humeral Stem (of the size determined by the last modular rasp used) cemented or uncemented (press-fit). Unpack the Inverse Humeral Cup. The size has been defined by the previously used trials.

The humeral implant stem (cemented or uncemented) is now placed into the stem holder of the assembled mounting block. The inverse humeral cup is now placed on the humeral implant stem, in the appropriate rotation and impacted onto the humeral implant stem with the aid of the Impactor (Fig. 21).

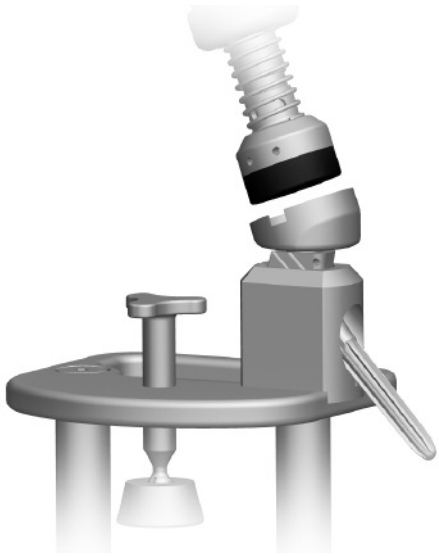


Fig. 21

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, by applying controlled force with the thumb on the humeral cup. The lateral stem fin is used as orientation. This is done until the lower side of the humeral cup is resting on the humerus. The implant is brought into final position with careful blows from the Impactor Inverse (Fig. 22). If the cement prosthesis is being used, excess cement is then carefully removed. *If desired, the deltoid tension can be checked again, with the Trial Humeral PE Inlays on the humeral cup implant.* Now insert the Inverse Humeral PE Inlay (with the snap in locking mechanism) with the help of the PE Inlay Impactor (Fig. 23).

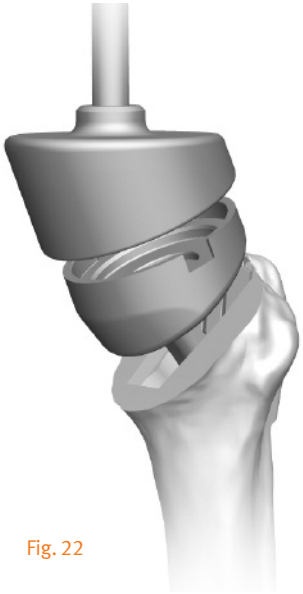


Fig. 22

Fig. 23

Reduction and Closure

The prosthesis is then reduced and stability is checked (Fig. 24). 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.

Postoperative Treatment

Appropriate postoperative physiotherapy has begun: The arm is put into a sling, but passive and active elevation to the front is allowed. Weight lifting and active elevation with the extended elbow are not allowed for 6 weeks.

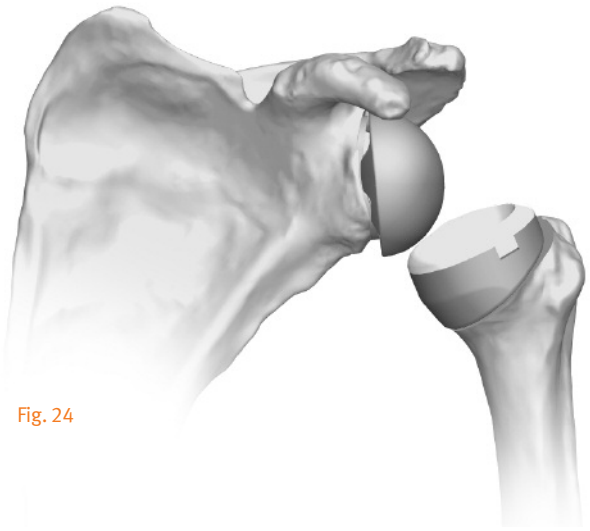


Fig. 24

From Anatomical to Inverse/Reverse

Removal of the Anatomical 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 Extraction Instrument is now applied to the humeral head and fixed with a two-edged screw (Fig. 26).

With the aid of the Extractor Instrument and the slide hammer weight, the humerus head is separated from the humeral stem parallel to the lower side of the humeral head (Fig. 26).

To remove the cement from the thread if the humeral stem is cemented, a drill jig is first inserted into the oval cone of the humeral stem and then used to guide the drill (Fig. 27).

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

Note: Instruments are from Revision Tray.

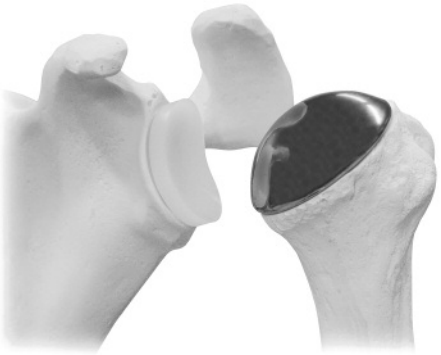


Fig. 25

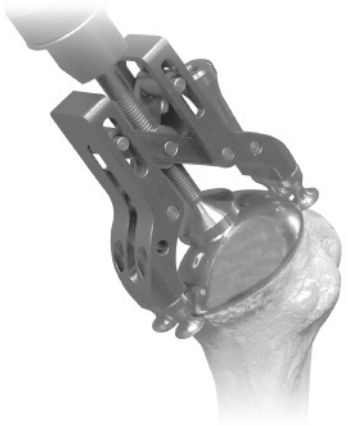


Fig. 26

Fig. 27

Any remaining cement is now removed from the thread of the stem with the Thread Reamer (Fig. 28).

The x-pin is now screwed into the humeral stem (Fig. 29a). 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.

To remove the cement above the oval cone, use the RH Reamer (Fig. 29b). Reaming is performed with the cannulated handle from the glenoid tray.

To prepare the humeral surface for the Inverse Humeral Cup, place a Bushing for Milling Cutter onto the humeral stem. The Bushing for Milling Cutter gets secured in the Humeral Stem with the Screw for Bushing for Milling Cutter (Fig. 30b). If the Bushing for Milling Cutter can not be placed onto the Humeral Stem, remove bone or cement with a Lexer chisel. Now attach the Cannulated Handle to the Milling Cutter and start reaming the Inverse/ Reverse humeral surface up to the Bushing for Milling Cutter in the Humeral Stem (Fig. 30b).

Note: Care should be taken to ensure that reaming is continued as far as possible up to the bushing in the humeral stem.

If necessary for a well prepared humeral resection area, use the oscillating saw for resection of the nonreamed humeral surface area.

Note: The Bushing for Milling Cutter comes in five different types (straight, ±10° retro and ±20° retro version). To help set the bushing for the milling cutter correctly onto the humeral stem, all bushings have a mark. This line always needs to face the lateral hole of the stem (Fig. 30a).

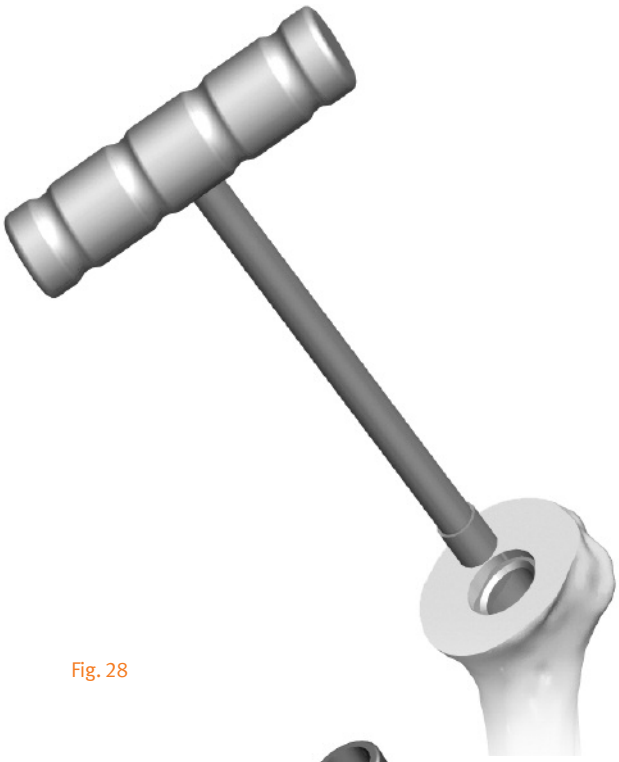


Fig. 28

Fig. 29a

Fig. 29b

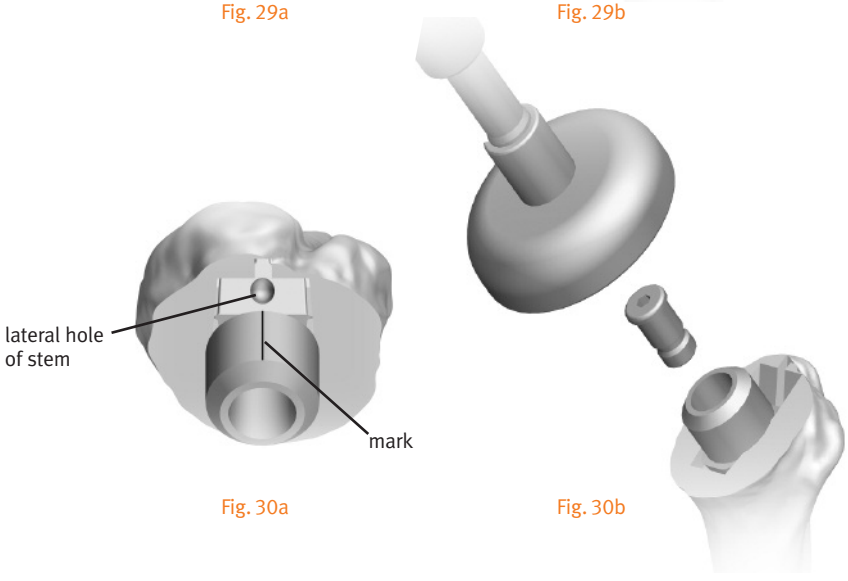


Fig. 30a

Fig. 30b

The plane of the humeral resection should be protected with a disk-shaped protector (Fig. 31). Disks of 3 different diameters (40mm, 44mm and 48mm) are available. The pins of the lower side of the disks are inserted at the level of the incision.

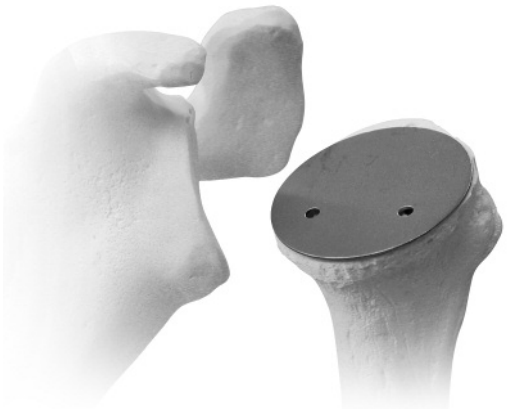


Fig. 31

Glenoid, Preparation and Implantation

Please see pages 17–20.

Humeral Placement

The inverse humeral cup is now finally impacted onto the humeral implant stem with the aid of the Impactor Inverse.

Insert the snap-in mechanism Inverse/ Reverse Humeral PE Inlay with the help of the PE Inlay Impactor (Fig. 32).

To check the deltoid tension again, use the Trial Humeral PE Inlays on the Humeral Cup Implant. To remove the Trial Humeral PE Inlay, a Lexer chisel or similar instrument can be used to dis-connect the Trial Humeral PE Inlay from the Humeral Cup Implant.

Fig. 32

Reduction and Closure

The prosthesis is then reduced and stability is checked (Fig. 33). 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.

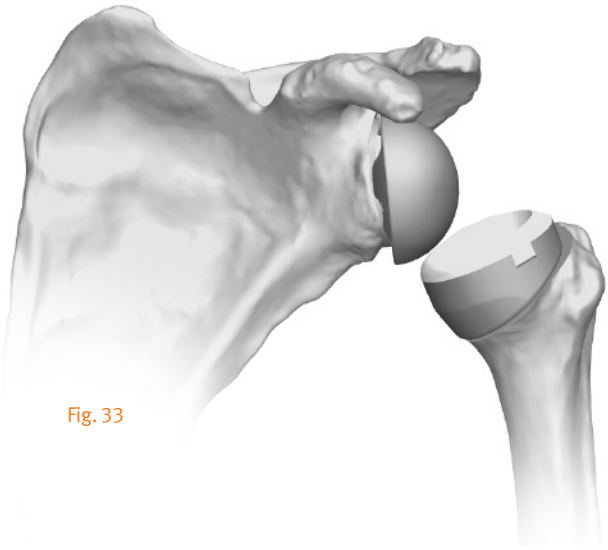


Fig. 33

Postoperative Treatment

Appropriate postoperative physio-therapy has begun: The arm is put into a sling, but passive and active elevation to the front is allowed. Weight lifting and active elevation with the extended elbow are not allowed for 6 weeks.

Anatomical Shoulder
Inverse/Reverse

Revision

Humeral Side

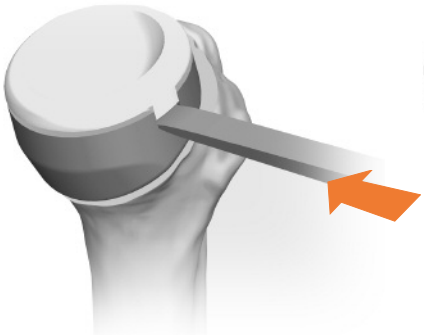


Fig. 34a

Fig. 34b

If the Humeral PE Inlay ever has to be removed from the Humeral Cup, slide a Lexer chisel underneath the Humeral PE Inlay and pry off (Fig. 34a).

Note: The Humeral PE Inlay cannot be reused after removal.

If the Humeral Cup ever has to be removed from the *Anatomical Shoulder* Stem, slide the Extractor Instrument for Humeral Cup between the humeral shaft and the under surface of the Humeral Cup. Firmly tap the movable part of the instrument to loosen the Cup (Fig. 34b).

Glenoid Side

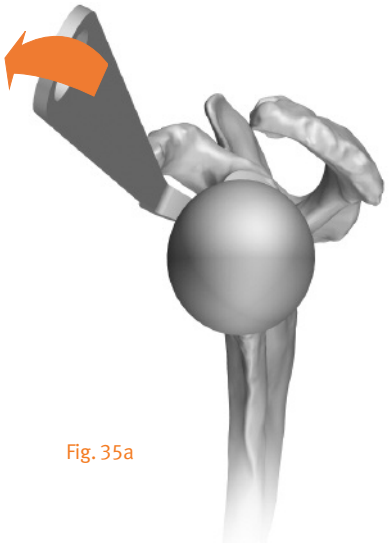


Fig. 35a

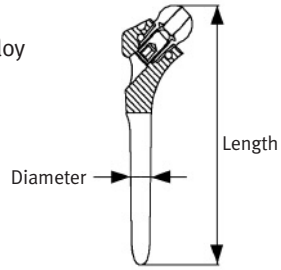
Fig. 35b

If the Glenoid Head ever has to be removed from the Glenoid Fixation, slide the Extractor Instrument for Glenoid Head between the back surface of the Glenoid Head and the front surface of the Glenoid Fixation. Tap the end of the instrument to loosen the Glenoid Head (Fig. 35a & 35b).

Implants

Anatomical Shoulder Standard Stem Cemented

CoCrMo Cast Alloy
ISO 5832-4
Cemented

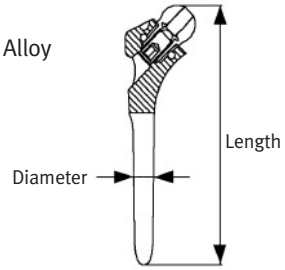


STERILE R

Part Number	Diameter (mm)	Length (mm)
01.04211.072	7	100
01.04211.092	9	110
01.04211.122	12	110
01.04211.142	14	110

Anatomical Shoulder Humeral Stem Uncemented

TiAlNb Wrought Alloy
ISO 5832-11
Uncemented



STERILE R

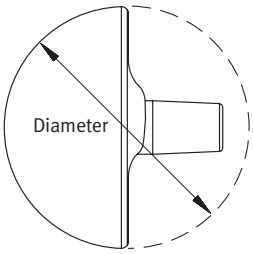
Part Number	Diameter (mm)	Length (mm)
01.04201.072	7	100
01.04201.092	9	110
01.04201.102	10.5	110
01.04201.122	12	110
01.04201.142	14	110

Anatomical Shoulder Standard Long Stems (Revision)

Part Number	Diameter (mm)	Length (mm)
01.04215.072	7	200
01.04215.092	9	210
01.04215.122	12	210
01.04215.142	14	210

Anatomical Shoulder Inverse/Reverse Glenoid Head

ISO 5832-12

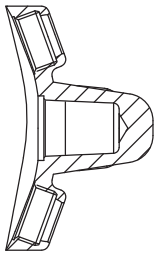


STERILE R

Part Number	Diameter (mm)
01.04223.236	36
01.04223.240	40

Anatomical Shoulder Inverse/Reverse Glenoid Fixation

ISO 5832-11

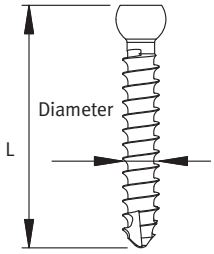


STERILE R

Part Number
01.04223.200

Inverse/Reverse Screw System

ISO 5832-3

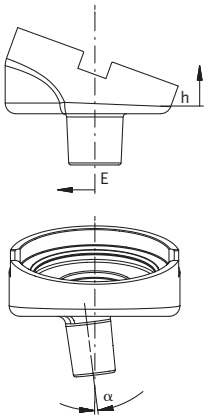


STERILE R

Part Number	Diameter (mm)	Length (mm)
01.04223.018	4.5	18
01.04223.024	4.5	24
01.04223.027	4.5	27
01.04223.030	4.5	30
01.04223.033	4.5	33
01.04223.036	4.5	36
01.04223.042	4.5	42
01.04223.048	4.5	48

Anatomical Shoulder Inverse/Reverse Humeral Cup

ISO 5832-11

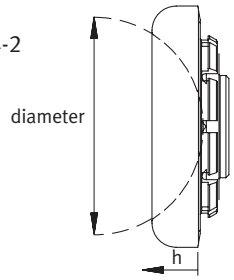


STERILE R

Part Number	h (mm)	E (mm)	α	Version
01.04223.100	0	0	0	0° retro
01.04223.106	0	6	0	0° retro +6 (medial offset)
01.04223.190	9	0	0	9mm 0° retro
01.04223.196	9	6	0	9mm 0° retro +6 (medial offset)
01.04223.110	0	0	+10	+10° retro
01.04223.111	0	0	−10	−10° retro
01.04223.120	0	0	+20	+20° retro
01.04223.121	0	0	−20	−20° retro

Anatomical Shoulder Inverse/Reverse Humeral PE-Inlay

ISO 5834-1/5834-2



STERILE R

Part Number	Diameter (mm)	h (mm)
01.04223.360	36	0
01.04223.363	36	3
01.04223.366	36	6
01.04223.400	40	0
01.04223.403	40	3
01.04223.406	40	6

Instruments

Anatomical Shoulder Inverse/Reverse Instrument Set
(complete) ZS01.04239.000

Contains the following:

Anatomical Shoulder Inverse/Reverse Lid
01.00029.031

Anatomical Shoulder Inverse/Reverse Base (empty)
01.04239.010

Screws for Bushing for Milling Cutter
01.04239.560

Inverse/Reverse Locking Screw Holder 3.5mm
02.00024.121

Inverse/Reverse Torque Wrench
02.00024.022

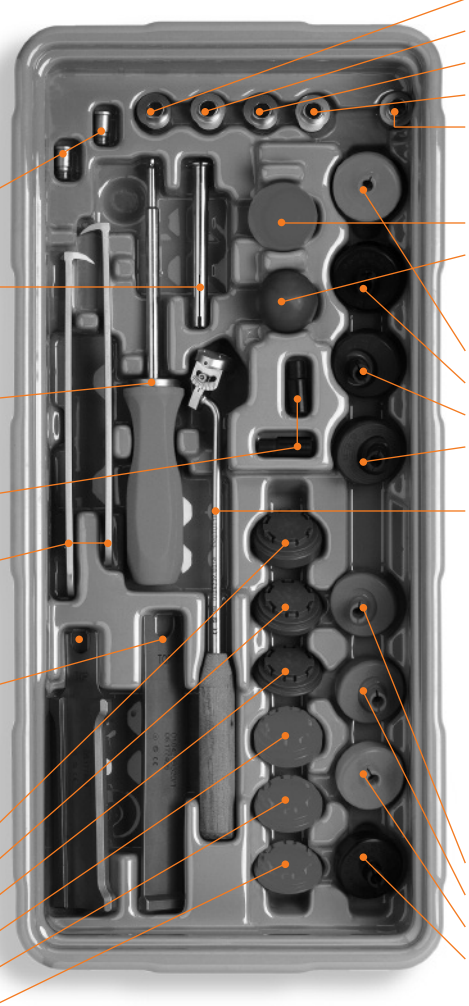
Centering Pegs for Glenoid Inverse
01.04239.135

Extractor Instruments for Glenoid Head 01.04239.160

Extractor Instrument for Humeral Cup
01.04239.320

Trial Humeral PE Inlays

36-6	01.04239.720
36-3	01.04239.710
36-0	01.04239.700
40-6	01.04239.750
40-3	01.04239.740
40-0	01.04239.730



Bushing for Milling Cutter

–20° retro	01.04239.550
+20° retro	01.04239.540
–10° retro	01.04239.530
+10° retro	01.04239.520
0° retro	01.04239.510

Trial Glenoid Heads

40	01.04239.810
36	01.04239.800

Trial Humeral Cups (Set 1)

+9 0° retro +6mm	01.04239.670
+9 0° retro	01.04239.660
–20° retro	01.04239.650
+20° retro	01.04239.640

Guiding Instrument for Glenoid Inverse 01.04239.100

Trial Humeral Cups (Set 2)

–10° retro	01.04239.630
+10° retro	01.04239.620
0° retro +6mm	01.04239.610
0° retro	01.04239.600

Anatomical Shoulder Inverse/Reverse Insert for Tray (empty)
01.04239.020

Drill Guide for Glenoid Inverse
01.04239.130

Milling Cutter for Humeral Inverse
primary 01.04239.400
revision 01.04239.500

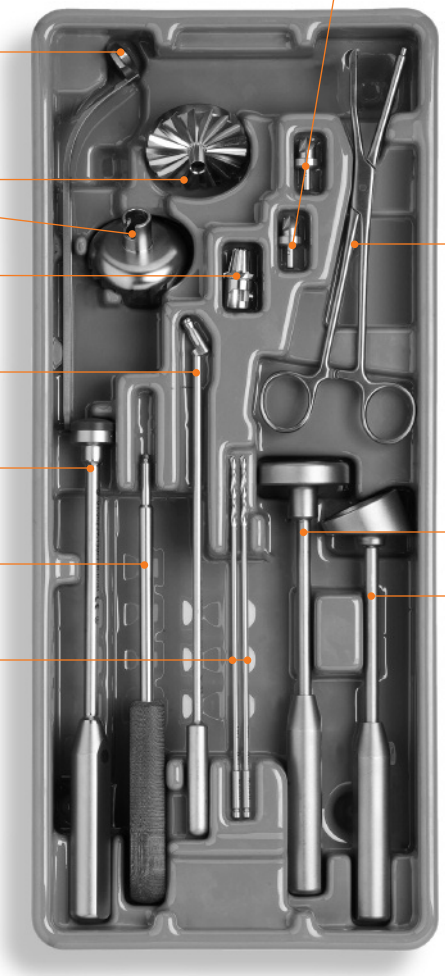
Milling Cutter for Glenoid Inverse
01.04239.110

Drill Guide for Inverse/Reverse Screws 01.04239.170

Impactor for Glenoid Fixation
01.04239.150

Hexagonal Screw Driver
02.00024.023

Drills 3.3 for Inverse/Reverse Screws 01.04239.180



Drill for Glenoid Inverse
01.04239.140

Holding Forceps for Glenoid Fixation
01.04239.120

Impactor PE Inlay 01.04239.310

Impactor Inverse 01.04239.300

Anatomical Shoulder Kit Numbers:

Anatomical Shoulder Removable Head Instrument Case 1 ANSH500
Anatomical Shoulder Removable Head Instrument Case 2 ANSH600
Anatomical Shoulder Pegged Glenoid Instrument Case 3 ANSH0100
Anatomical Shoulder Revision Instrument Case 4 ANSH700
Anatomical Shoulder Keeled Glenoid Instrument Case 5 ANSH0101
Anatomical Shoulder Inverse/Reverse Instrument Case ANSH800

Note: Standard *Anatomical Shoulder* Instruments are also required.

All instruments STERILE R

APPENDIX A:

Alternate Glenoid Preparation and Implant Fixation Using the Zimmer® Trabecular Metal™ Reverse Shoulder System

Straight-on exposure of the glenoid is necessary for proper reaming and component insertion. If the superior-lateral approach was utilized, a forked retractor or the *Zimmer* Shoulder Shoehorn Retractor (Fig. 36) can be placed inferiorly on the glenoid to retract the humeral head out of the way. If exposure is limited, re-evaluate the level of the humeral cut.

If the delto-pectoral approach was chosen, the proximal humerus is retracted posteriorly and inferiorly. Again if exposure is limited, re-check the humeral osteotomy level and ensure inferior capsular releases were thorough. Both approaches require circumferential exposure of the glenoid with labral excision. Inferiorly, the glenoid must be exposed to allow palpation of the inferior glenoid pillar and inferior positioning of the glenoid base plate.

Note: While preparing the glenoid, the placement of the proximal humerus and provisional along with retractors should be carefully considered. Their positions may allow for interference with glenosphere seating. Exposure should allow for straight-on engagement of the glenosphere on the base plate taper. Consider use of the Zimmer Shoulder Shoehorn Retractor as it has been designed to aid in retracting the humeral head and other soft tissue when placed on the posterior side of the glenoid (Fig. 37).

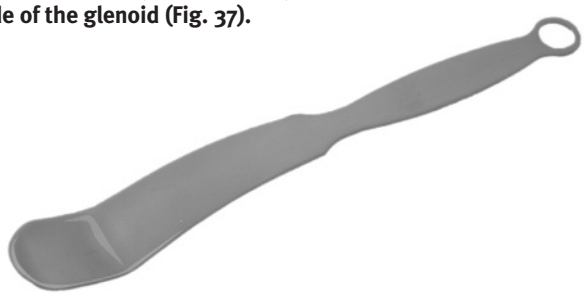


Fig. 36

Fig. 37

If desired, the Glenoid Scraper can be used to clean the glenoid face of any remaining articular cartilage or scar tissue. Assemble the Base Plate Drill Guide 1 by placing the face into the handle so that the two pieces mate and rotate into position (Fig. 38). Evaluate positioning of the base plate by placing the Base Plate Drill Guide 1 on the glenoid face. The outer rim of Drill Guide 1 is the same diameter as the base plate. The outer rim can be rotated relative to the handle to check coverage of the anterior, inferior and posterior edges of the glenoid. The drill guide should be placed so that the outer rim aligns with the inferior rim of the glenoid and is centered in the anterior/posterior direction (Fig. 39). This will place the glenosphere at the edge of the inferior glenoid bone.

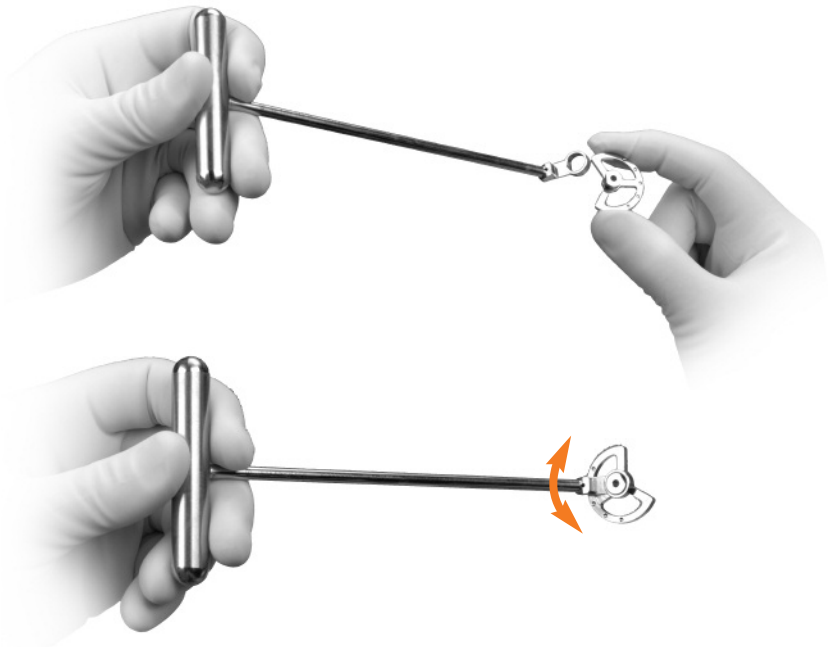


Fig. 38

Fig. 39

Note: Inferior placement of the glenosphere is critical and will help reduce the possibility of scapular impingement and notching.

Load the 2.5mm Pin into a K-wire driver or Jacobs chuck. The 2.5mm Pin is marked for the appropriate insertion depth (Fig. 40). Insert the 2.5mm Pin through Drill Guide 1 until the depth mark indicated on the pin meets the top of Drill Guide 1 (Fig. 41). Release the Pin from the K-wire driver or Jacobs chuck, and lift Drill Guide 1 from the glenoid leaving the 2.5mm pin in place.

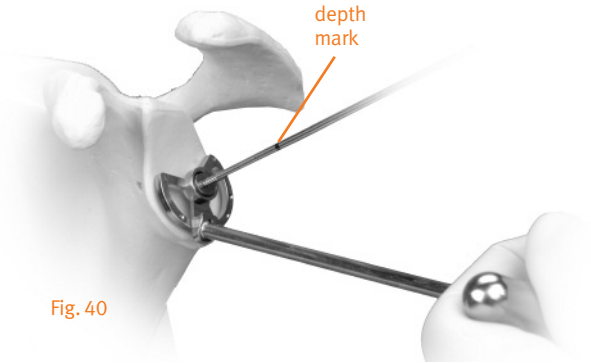


Fig. 40

Fig. 41

The 6mm Cannulated Drill is now used to create a pilot hole for the glenoid reamers. It is attached to the Cannulated Straight Driver by sliding the Driver tabs into rounded slots of the 6mm Cannulated Drill. Turn the Cannulated Straight Driver to retain the 6mm Cannulated Drill. Place the Cannulated Drill assembly over the 2.5mm Pin and drill until the housing collar is flush to the glenoid face (Fig. 42). The 6mm Cannulated Drill and the 2.5mm pin are now removed.

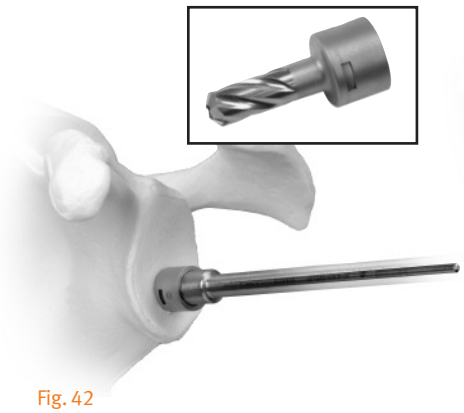


Fig. 42

Attach Base Plate Reamer 1 to the Cannulated Straight Driver assembly and hand ream to prepare the glenoid surface for the back of the base plate. This is a sharp reamer and power reaming may remove excessive bone. Ream until the reamer face is completely flush with the prepared surface and the subchondral bone is exposed inferiorly (Figs. 43 & 44).

Note: If necessary, remove any remaining prominent glenoid bone.

Fig. 43

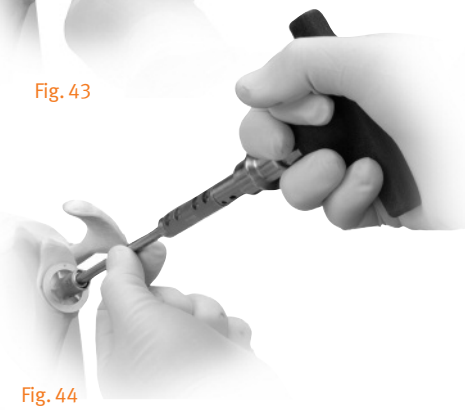


Fig. 44

Attach either the 36mm or the 40mm Base Plate Reamer 2 to the Cannulated Straight Driver assembly (Fig. 45). Ream until the spokes are flush to the previously reamed face. The outer cutting teeth of Base Plate Reamer 2 will ream the surrounding bone to provide clearance for the glenosphere head. Once the base plate implant is in place, surface reaming is not possible.

Fig. 45

Note: This step is necessary to ensure the glenosphere head will lock on the Glenosphere Base Plate properly. All reasonable efforts should be made to use the appropriate Base Plate Reamer 2. The size of base plate reamer corresponds to the glenosphere head to be used.

The base plate post hole must now be prepared. The system provides three tools, a 7.5mm Drill, a 7.5mm Cortex Drill and a 7.5mm Compression plug, to aid in post hole preparation based on bone quality and surgeon preference (Fig. 46). All three are used through the Base Plate Drill Guide 2 which is placed in the cavity created by the last Base Plate Reamer used.

7.5mm Drill | 7.5mm Cortex Drill | 7.5mm Compression Plug

Fig. 46

Poor Bone Stock:

When poor bone stock exists, use the 7.5mm Cortex Drill (Fig. 47) to remove only the first 3 to 4 mm of glenoid cortex. If a press fit of the distal end of the Glenosphere Base Plate post is desired, then the preparation is complete. If it is deemed appropriate to compress more bone, use the 7.5mm Compression Plug to compress the cancellous bone in the vault prior to implant insertion.

Note: The Compression Plug should not be used unless the 7.5mm Cortex Drill is first used. Otherwise there may be a risk of fracture.

Fig. 47

Good Bone Stock:

Only if there is good hard bone, use the 7.5mm Drill to ream bone for the full depth of the post of the base plate (Fig. 48).

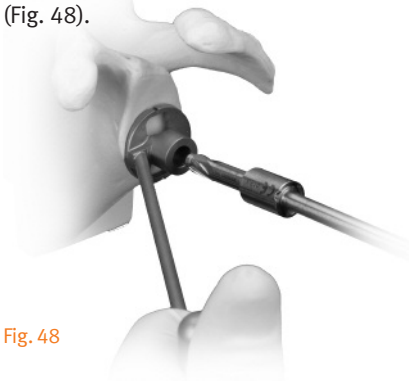


Fig. 48

Note: A small drill can be used to sound for confirming good bone quality. Drill Guide 2 has two reference marks to help aid in the superior/inferior placement of the Inverse/Reverse Screws. You may choose to make anatomical marks for the placement of the Inverse/Reverse Screws.

Base Plate Insertion

Before glenoid component insertion, carefully note and mark the inferior glenoid pillar. Place the Base Plate implant on the Base Plate Inserter and insert it into the preparation (Figs. 49 & 50). Achieve proper orientation by aligning the grooves on the base plate to the previously placed marks or anatomic reference points for placement of inferior and superior screws. The Base Plate is inserted by striking the Base Plate Inserter until the component is completely flush with the prepared surface (Fig. 51). Care should be taken to avoid tipping the Base Plate during insertion thus preventing circumferential contact.

Fig. 49

Fig. 50

Fig. 51

Screw Insertion

The 2.5mm Drill Guide is inserted into the screw holes and oriented to prepare for screw insertion (Fig. 52).The inferior screw should be oriented toward the inferior border of the scapula down the previously identified glenoid pillar. The superior screw should be oriented along the superior border of the scapula toward the coracoid.

Note: Do not aim the drill towards the central *Trabecular Metal* post.

Attach the 2.5mm drill to power and drill the screw holes through the 2.5mm drill guide and base plate at the desired orientation (Fig. 53). The 2.5mm drill has lines corresponding to the screw lengths available.

Fig. 52

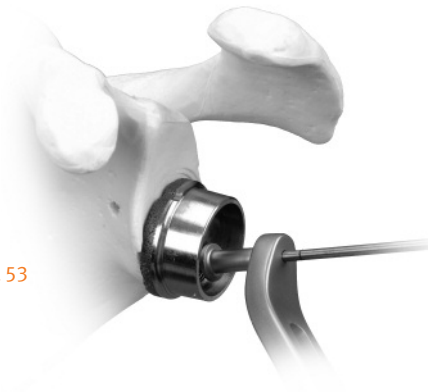


Fig. 53

Remove the drill and the drill guide. Assemble the Depth Gauge and insert into the screw holes to aid in selecting the proper screw length (Figs. 54 & 55).

Note: Screws are available in 18-48mm lengths.

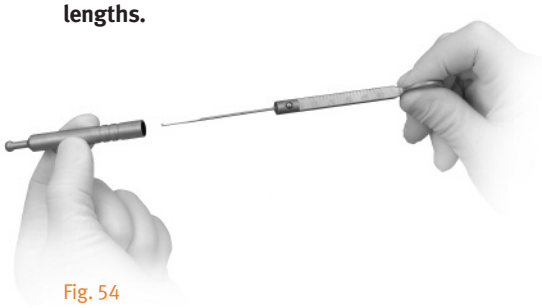


Fig. 54

Fig. 55

Inverse/Reverse Screws are adjustable within a possible 30° arc (Fig. 56) and thus can readily be angled to achieve good bone purchase. The screws are inserted through the inferior and superior screw holes with the Hexagonal Screw Driver, making sure good bone purchase is achieved (Fig. 57). If good bone purchase is not achieved, the screws should be removed and prepared at a new angle. The screws are then converted to a fixed angle by placing the locking screw caps on the Inverse/Reverse screws using the Inverse/Reverse Torque Wrench and Locking Screw Holder.

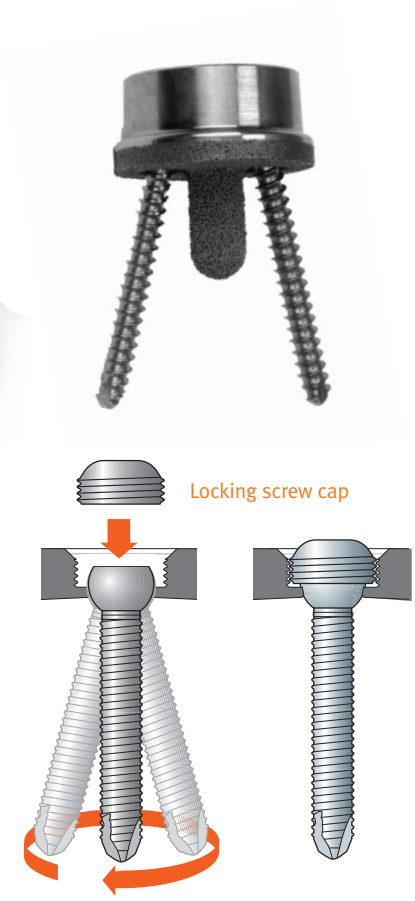


Fig. 56

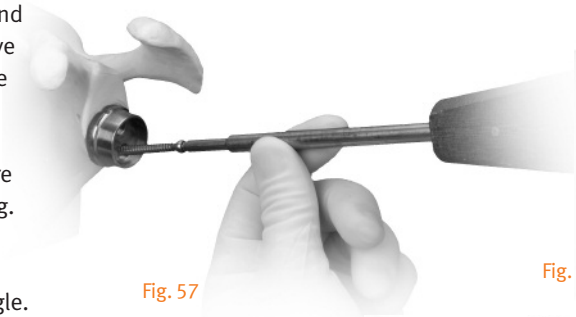


Fig. 57

To do this, the locking screws are placed onto the tip of the Inverse/Reverse Torque Wrench and the Locking Screw Holder is gently slid over the locking screws to secure them (Fig. 58). The locking screws are placed over the heads of the Inverse/Reverse Screws and the Locking Screw Holder is slid back (Fig. 59). Turn the locking screws in place until the Torque Wrench slips or an audible click is heard.

Note: The locking screws only engage in one orientation. The wider opening (Fig. 60) must be pointing toward the screw. Additionally, to avoid mis-threading, the screwdriver shaft should be perpendicular to the base plate to properly screw down the locking screw. Failure to slide back the Locking Screw Holder can block locking screw insertion.

Fig. 58

Fig. 59

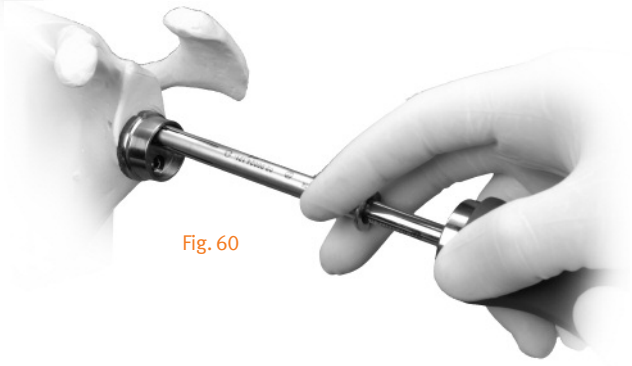


Fig. 60

Base plate Removal

Should the Base Plate ever need to be removed, the Locking Screws and Inverse/Reverse Screws are removed by utilizing the Hexagonal Screwdriver (Fig. 61). If removal is intraoperative, the Base Plate can be removed by levering with an osteotome. If removal is postoperative, standard osteotomes are first used to disassociate as much of the bone ingrowth area as possible from the implant. Each bolt of the Base Plate Remover is threaded into the Base Plate using the Hexagonal Screwdriver. This is done by moving the barrel over to one side, threading one bolt into a screw hole in the base plate, then moving the barrel to the other side and inserting the second bolt into the other screw hole (Fig. 62). Thread down the bolts until the instrument is securely attached.

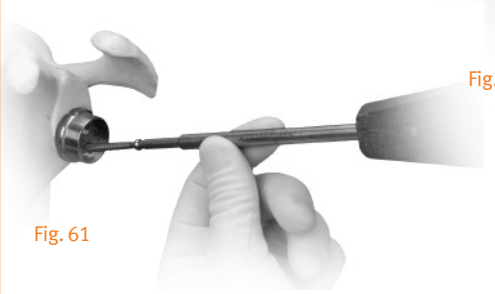


Fig. 61

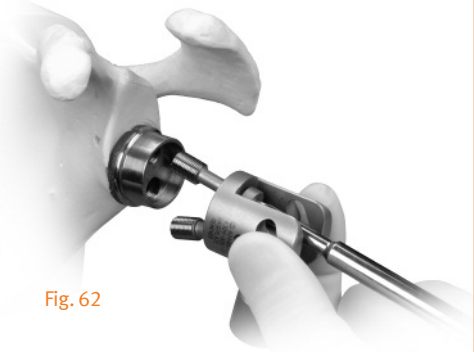


Fig. 62

A Standard Slaphammer should be screwed into the body of the Base Plate Remover (Fig. 63). Repeatedly impact until the Base Plate has been removed.

Fig. 63

If not placed previously, attach a Trial Glenosphere Head to the Base Plate by hand or with the Glenosphere Helmet (Fig. 64).

Fig. 64

Implant Insertion

Glenosphere Assembly

The glenosphere is typically inserted prior to humeral component final seating to maximize exposure of the glenoid and ease of insertion. Ensure all soft tissue is removed around the base plate to allow the glenosphere to completely seat.

Assemble the Glenosphere Helmet Inserter by threading the dual taper/spacer impactor into either the 36mm (green) or the 40mm (yellow) glenosphere helmet (Fig. 64). Insert the appropriate diameter glenosphere into the helmet by sliding it into the helmet so that the glenosphere is held in place by the body of the helmet and the tabs rest securely underneath the glenosphere (Figs. 65 & 66). Wipe the Base Plate taper clean of all fluids. Place the *Zimmer* Shoulder Shoehorn Retractor on the posterior side of the glenoid to aid in retracting the humerus and other soft tissue (Fig. 67). When approaching the base plate, a finger can be placed on top of the glenosphere to help guide and feel the glenosphere slide over the taper into position. **Note: While engaging the glenosphere, it is important to monitor the position of the proximal humerus and provisional along with retractors since they could interfere with glenosphere placement.** Once the glenosphere is seated evenly and circumferentially, use your free hand to press firmly on the glenosphere to secure it to the base plate. Keeping a finger on the glenosphere, remove the Glenosphere Helmet pulling the instrument away in the SAME DIRECTION used to insert the glenosphere (i.e. If an anterior approach was used to insert the glenosphere, remove the instrument by pulling it from the anterior direction). This will help minimize changes to the glenosphere placement on the base plate and damage to the glenosphere helmet itself.

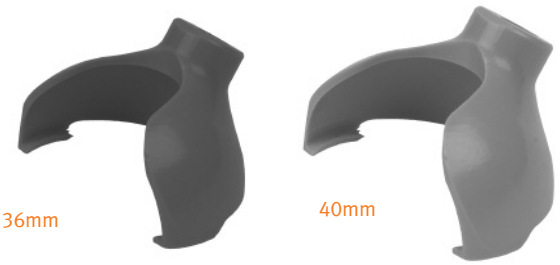


Fig. 64

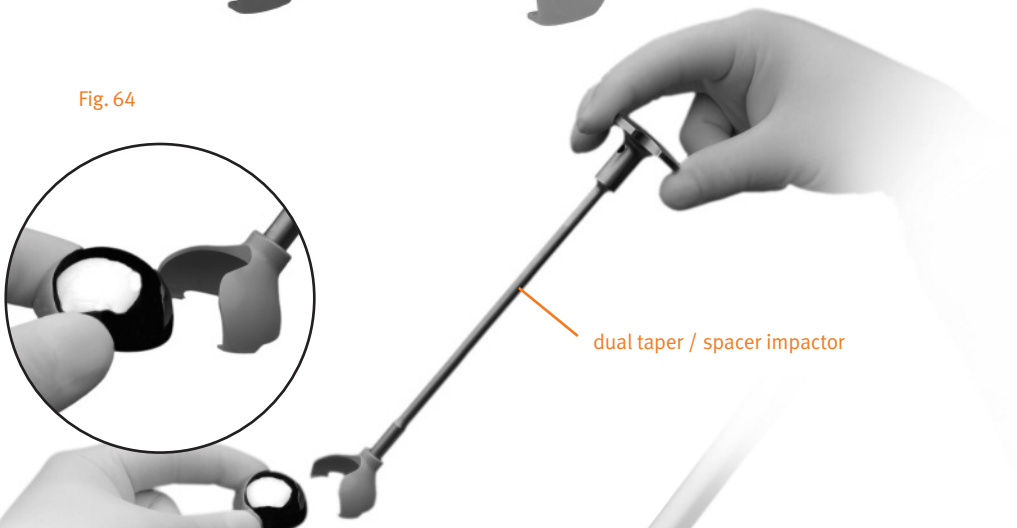


Fig. 65

Fig. 66

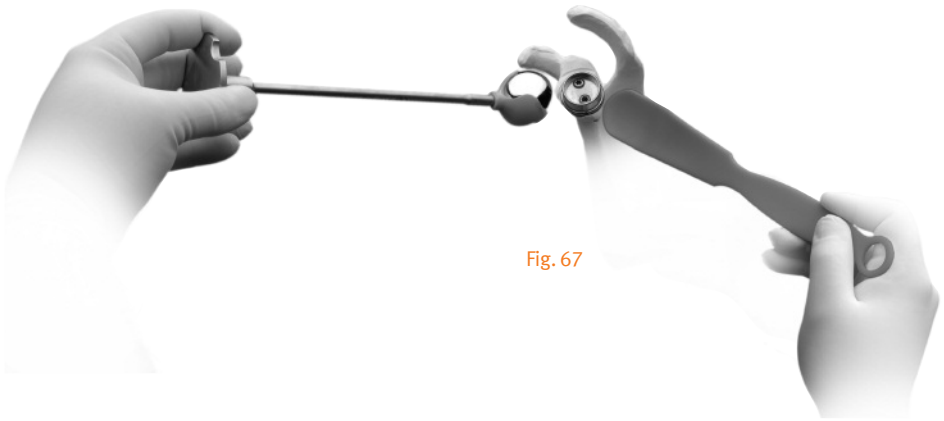


Fig. 67

Note: If unable to visually confirm an even, circumferential engagement of the glenosphere to the base plate, consider the use of a fluoroscope to aid in the confirmation. Seating of the glenosphere to the base plate can be examined in the axillary view or in a view parallel to glenoid version. The medial rim of the glenosphere should be parallel to the face of the base plate (Fig. 68).

Assemble Glenosphere Impactor Head to the Impactor Handle and place the Glenosphere Impactor Head on the Glenosphere. Strike the Glenosphere Impactor Head with 3 firm mallet strikes to engage the glenosphere on the base plate (Fig. 69). Pull on the glenosphere to verify the taper is locked. Reconfirm the circumferential engagement with the base plate. Reduce the joint and confirm and confirm range of motion.

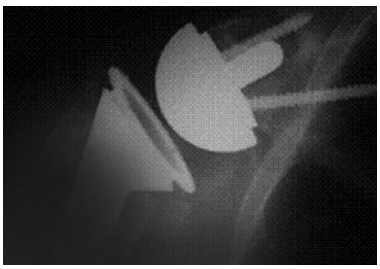


Fig. 68

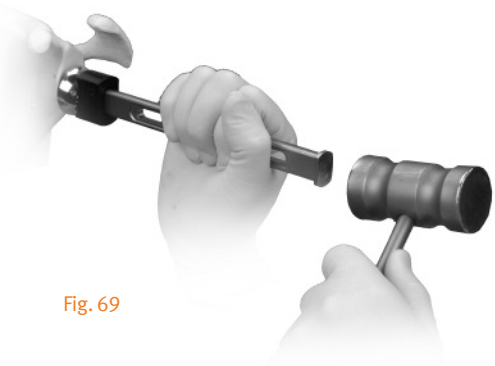


Fig. 69

Glenosphere Removal

Should it become necessary to remove the glenosphere, the Glenosphere Distractor can be used. Assemble the Glenosphere Distractor. Wedge the fin tip between the superior glenoid bone and the underside of the glenosphere (Fig. 70). There must be good contact on these two surfaces for disengagement to occur. Pull the Glenosphere Distractor trigger until it fires. The glenosphere head should be loose enough to gently remove by hand. If not, repeat the step making sure there is contact between the distractor tip, the glenoid bone surface and the glenosphere head. Reduce the joint and confirm range of motion.

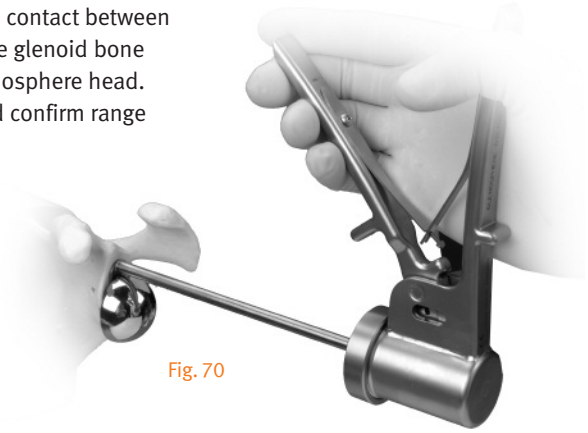


Fig. 70

Please refer to page 21 for humeral placement.

Please refer to the package inserts for complete product information, including contraindications, warnings, precautions and adverse effects.

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