Anatomical Shoulder™ Inverse/Reverse

Surgical Technique

From Anatomical to Inverse/Reverse

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Surgical Technique Anatomical Shoulder Inverse/Reverse

Developed in conjunction with

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Foreword

Total shoulder replacement has evolved as a biomechanically logical reconstruction of the shoulder. Exact anatomical reconstruction using the *Anatomical Shoulder* System allows 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. This new option is the only one which offers relief of pain and restoration of function.

Prof. C. Gerber, MD, Zurich
Dr. J. JP. Warner, MD, Boston

Indications

The *Anatomical Shoulder* Inverse/ Reverse System is indicated for:

- Glenohumeral arthritis with massive rotator cuff disruption which is irreparable and associated with loss of glenohumeral stability such as severe static superior or anterior subluxation of the humeral head which is associated with loss of function.
- Failure of prior hemiarthroplasty or total shoulder arthroplasty with loss of rotator cuff function.

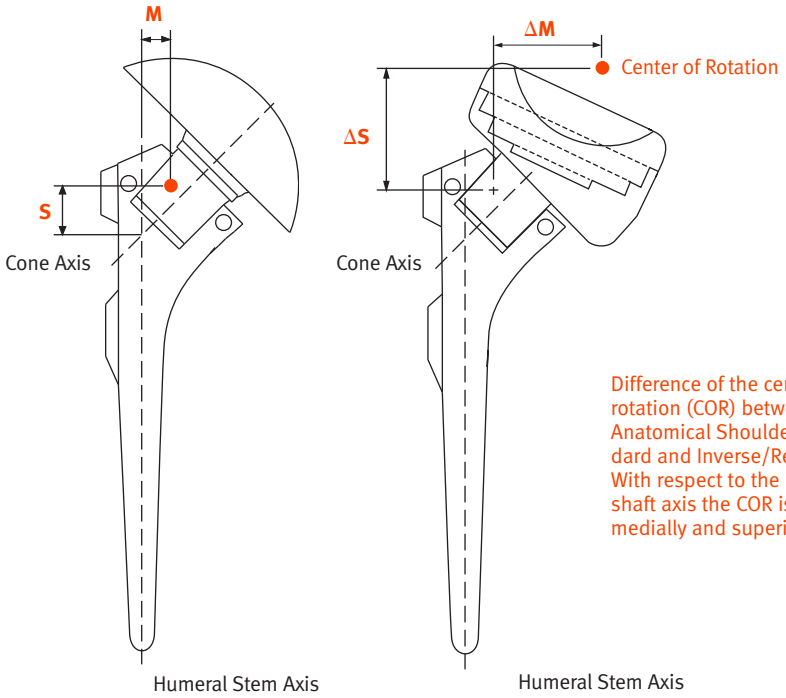
Contraindications

The *Anatomical Shoulder* Inverse/ Reverse System is not recommended for use in the following situations:

- Paralysis of the deltoid muscle
- Severe loss of humeral or glenoid bone
- Active infection

See also package insert

Biomechanical Concept

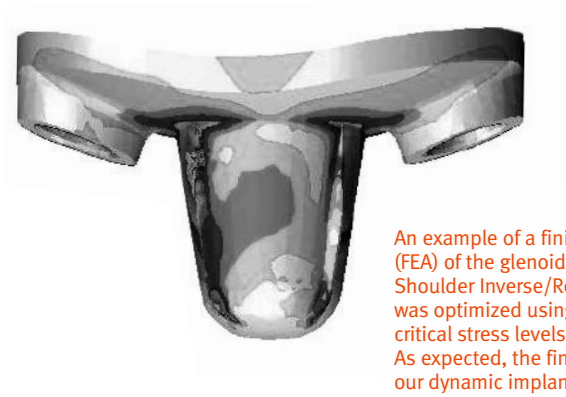


Difference of the center of rotation (COR) between Anatomical Shoulder Standard and Inverse/Reverse. With respect to the humeral shaft axis the COR is shifted medially and superiorly.

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.

Biomechanical Testing

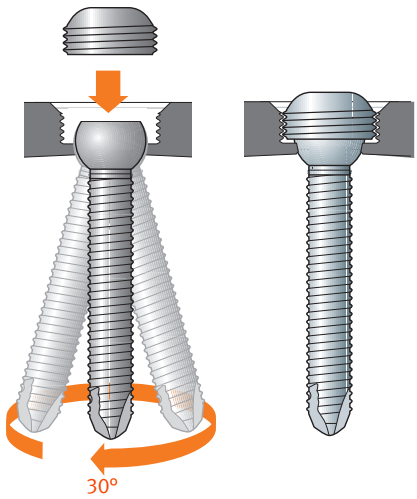
The complexity of the shape of the implants, the surface finish, the various manufacturing processes, and the range of mechanical properties of the materials require that we validate our products through mechanical testing, computer modelling and calculations. Computer modelling, especially finite element analysis (FEA), is also regularly used to optimize the design in the development process without actually having to manufacture a prototype. This ensures a rapid development process and greatly increases the likelihood that a new implant will pass our stringent laboratory tests.



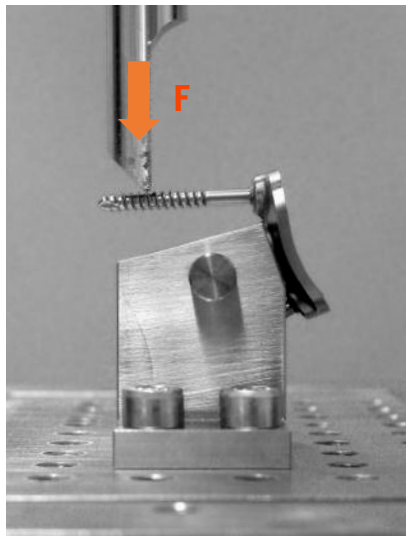
An example of a finite element analysis (FEA) of the glenoid fixation of the Anatomical Shoulder Inverse/Reverse System. The design was optimized using FEA until zones with critical stress levels disappeared.
As expected, the final design easily passed our dynamic implant test.

Testing the Polyaxial Screw Connection

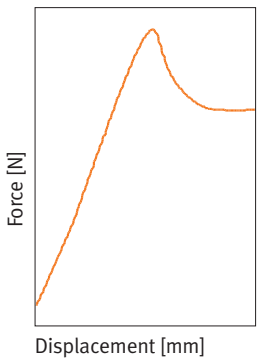
The unique polyaxial screw connection was introduced in the *Anatomical Shoulder* Inverse/Reverse Glenoid to allow adaptation of the screw position to the patient's anatomy. The screw position can be freely adjusted within 30° and will then be locked in the chosen position with a clamping screw. The 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.



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



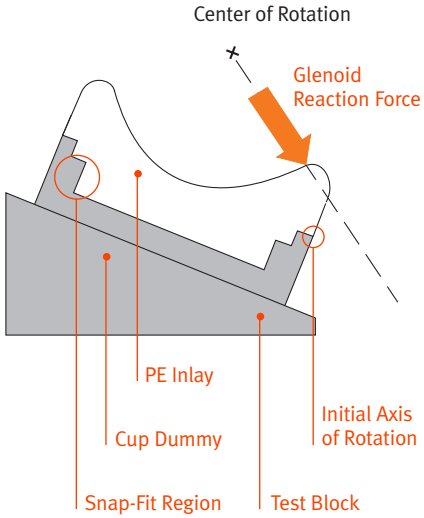
Experimental setup of the static tilt test

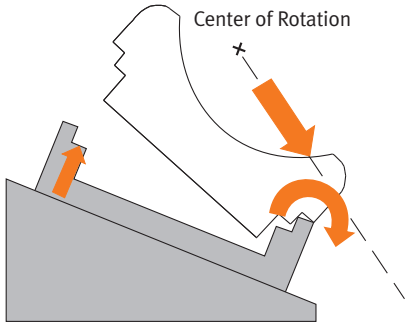


Typical load displacement curve measured during the static tilt test. At the peak force the screw starts to slip. Note that still ¾ of the peak force is necessary to cause further slipping of the screw. This means that in vivo the screw connection will be stable again, if a slip once occurred.

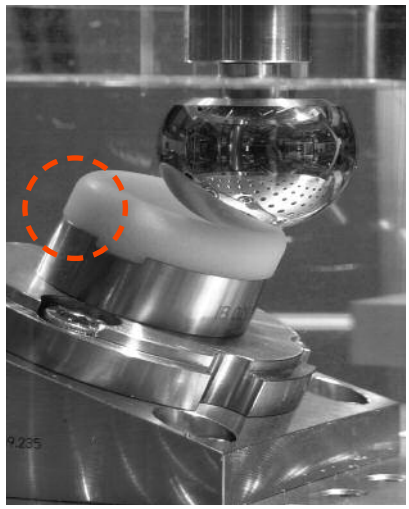
Testing of the Snap-Fit Connection

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.



Picture on the top 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 to the right).

References

1. Grammont P.M., Baulot E.; Delta Shoulder Prosthesis for Rotator Cuff Rupture; Orthopedics 1993; 16:65–68
2. Mroczkowski M.L.; Gronau N.; Kralovic B.J.; The Effect of Center of Rotation and Rotator Cuff Function on Reverse Shoulder Biomechanics; Abstract submitted to ORS 2006
3. Gronau N.; Mroczkowski M.L.; Boss S.; Mechanical Testing of Reverse Shoulder Prosthesis Stability; Abstract accepted at SFB 2006 (Society of Biomechanics)

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 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 this glenoid fixation has a central peg with antirotation fins for better primary stability. The superior and inferior threaded pegs will be used with the inverse/reverse locking screws. The central peg has an oval taper to seat the *Anatomical Shoulder* Inverse Glenoid Heads in.

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

Glenoid Head ∅ 36 mm	PE Inlay ∅ 36 mm
Glenoid Head ∅ 40 mm	PE Inlay ∅ 40 mm

Anatomical Inverse/Reverse Glenoid Heads

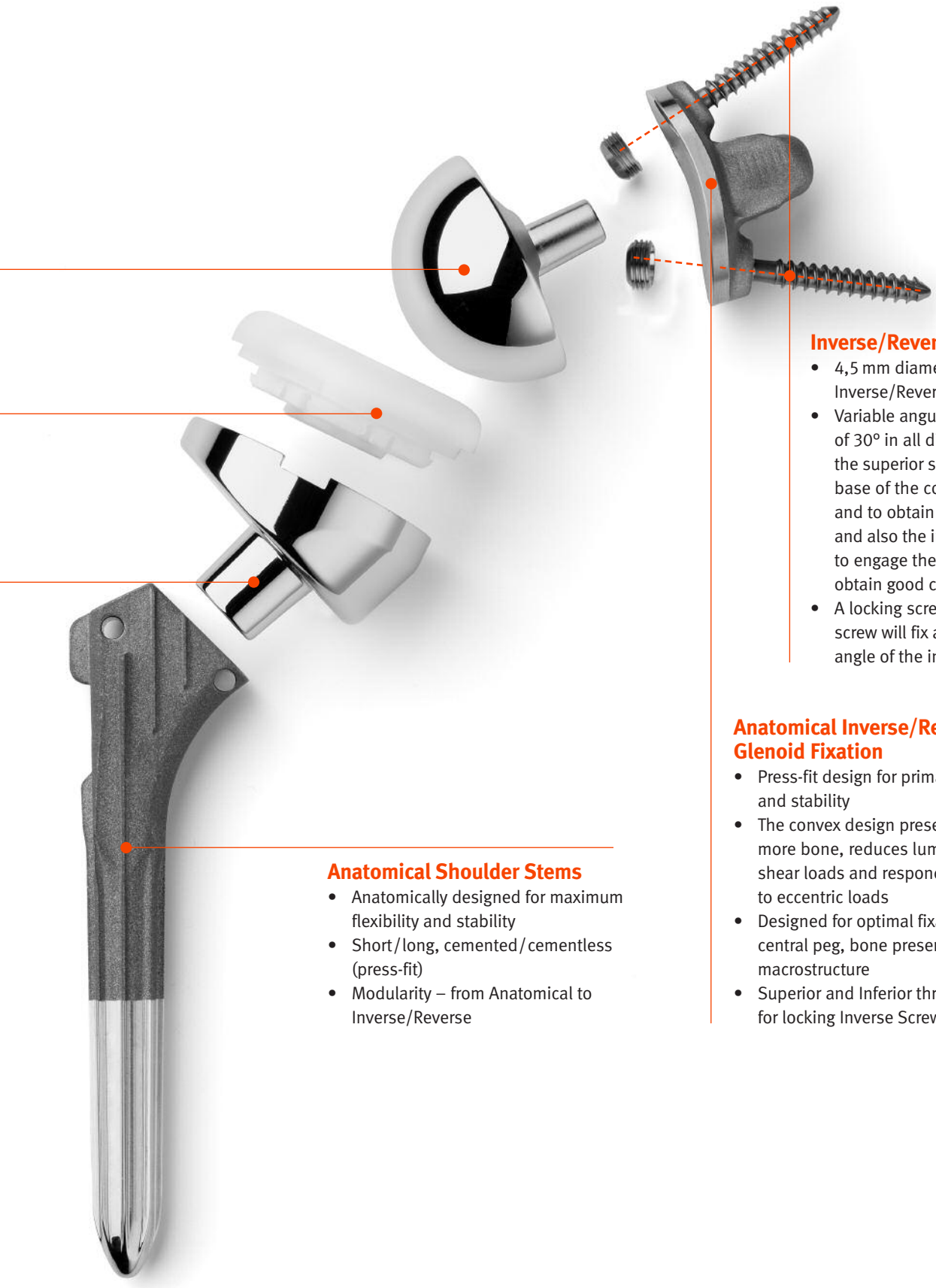
- 2 diameters: 36 mm and 40 mm
- Oval taper for secure fixation

Anatomical Inverse/Reverse PE Inlays

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

Anatomical Inverse/Reverse Humeral Cups

- 4 offset and 4 version cups cover range of lateralization, height and version adjustments
- 0° retroversion cups have a centralized taper connection
- 0° retroversion +6 mm (Medial Offset) cups have a taper connection that is offset 6 mm 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 +9 mm height option that increases the height and lateralization of the prosthesis. Combined with the 3 polyethylene inlay options, 15 mm of adjustment can be made to the lateralization/height of the construct in 3 mm increments
- 4 additional version (control) humeral cups allow the intraoperative change or correction of stem version from –20° or +20°
- Oval taper inherently provides anti-rotation feature to a secure modular connection



Inverse/Reverse Screw System

- 4,5 mm 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 head for each screw will fix and secure the used angle of the inverse screws

Anatomical Inverse/Reverse Glenoid Fixation

- Press-fit design for primary fixation and stability
- The convex design preserves more bone, reduces lumped and shear loads and responds better to eccentric loads
- Designed for optimal fixation with central peg, bone preserving and macrostructure
- Superior and Inferior threaded pegs for locking Inverse Screws

Anatomical Shoulder Stems

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

Overview of the Instruments

Anatomical Shoulder Inverse/Reverse Tray

The preparation and implantation of the *Anatomical Shoulder* Inverse/Reverse System should be carried out in a standardized manner. The special set of instruments has been logically developed. The required instruments have been limited to a minimum. The correct use and handling of these special devices are a requirement for the success of the surgery.

Further instruments needed:

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

For revision surgery the following is also needed:

- *Anatomical Shoulder* Revision Tray

Anatomical Shoulder Instruments Tray I

Anatomical Shoulder Instruments 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, and the available templates to confirm the size and alignment of the implant.

See also Preoperative Planning *Anatomical Shoulder* System Surgical Technique Lit.No. 06.01028.012x.

Template Options

- Anatomical Shoulder Humeral Stem Cemented/ Uncemented
  Lit. No. 06.01313.000.
- Anatomical Shoulder Revision Humeral Stem Cemented
  Lit. No. 01.00641.000.
- Anatomical Shoulder Inverse/Reverse Humerus Shell Standard
  Lit. No. 01.01310.000.
- Anatomical Shoulder Inverse/Reverse Humerus Shell Off-Center
  Lit. No. 01.01309.000.
- Anatomical Shoulder Inverse/Reverse Glenoid Anchorage
  Lit. No. 01.01308.000.

Lit. No. 06.01028.012x.

Preoperative Planning – Glenoid

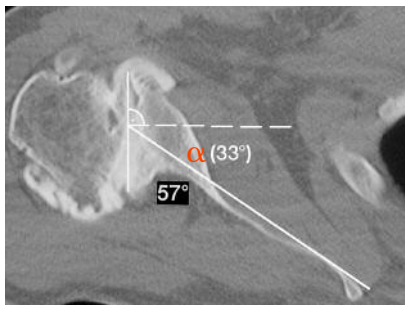
Most indications for inverse/reverse arthroplasty do not require correction of the version of the glenoid. Nevertheless the glenoid should be evaluated on CT scans. Preoperative CT investigation is recommended whenever a total shoulder prosthesis is used. If there is a severe defect in the posterior 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 not 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° (retro).

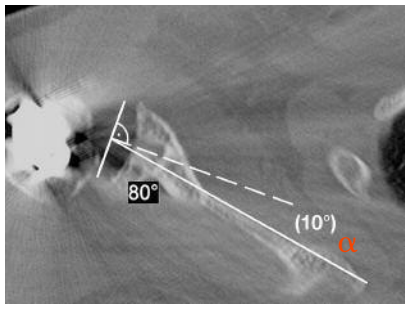
Enter the correction angle you have calculated on the glenoid positioning guide. Care must be taken both while drawing and during surgery, to ensure that the glenoid positioning guide lies on plane a–a.

Carry out cranio-caudal alignment of the Kirschner wire under visual monitoring.

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

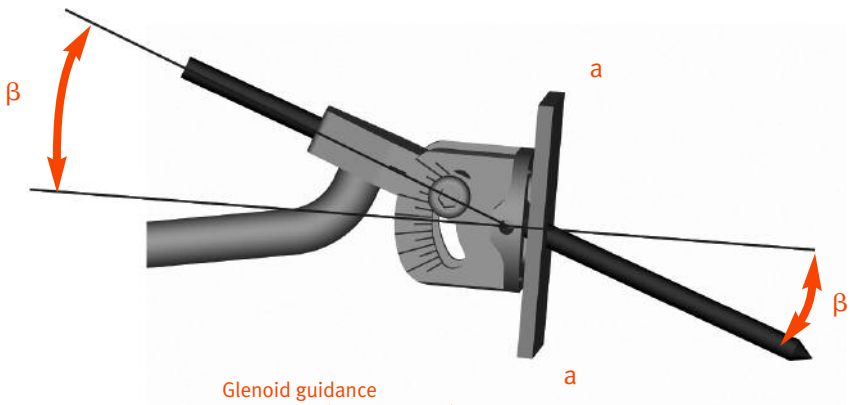


α preoperative



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° (retro).



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 freely possible to extend it fully. An armrest is optional.

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

Superior-lateral or delto-pectoral approach depends mainly on surgeons preference and clinical parameters.

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

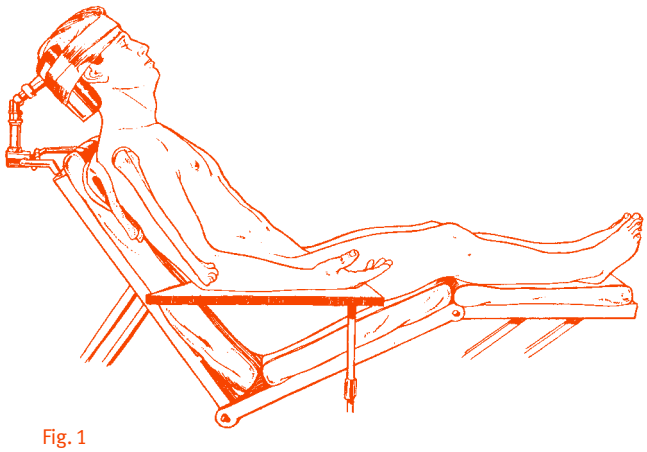


Fig. 1

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 identification of the subscapularis.

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

Anatomical Shoulder Inverse/Reverse

Primary Implantation

Humeral Head Resection

The humeral head is now resected exactly at the height of the anatomical neck with the aid of the 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, directly medial to the bicipital groove (Fig. 3a and 3b).

Preparation of the Proximal Humerus

Start reaming with size 7 to open the medullary cavity, as required (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 is used as reference.

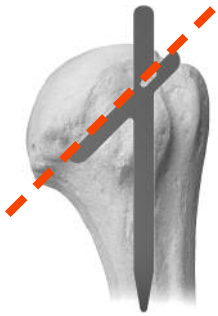


Fig. 2a Measurement guide 135°

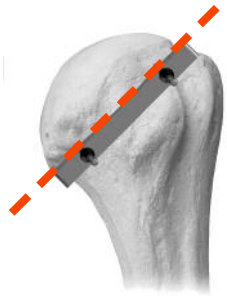


Fig. 2b Resection guide

Fig. 3a

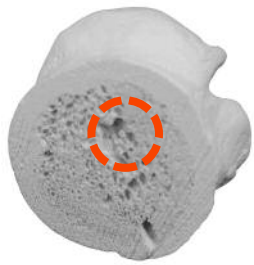


Fig. 3b

Fig. 4

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

The fin is directed towards a point approximately 9 mm 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. 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 (Fig. 6b).

If full insertion of the rasp to this extend is not successful, the uncemented (press-fit) humeral stem implant of this size may not be used.

The modular rasp handle is now removed and the modular rasp is left in the humerus (Fig. 7).

Fig. 5

Fig. 6a

Fig. 6b

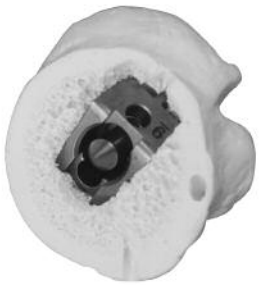


Fig. 7

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

This is recommended if the fixation of the rasp is weak. This ensures that the rasp will not subside for the further preparation.

Now mount the milling cutter for humeral inverse together with the cannulated handle and start reaming the resected humeral surface up to the pin in the rasp (Fig. 9).

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 (40, 44 and 48) are available. The pins of the lower side of the disks are inserted at the level of the incision.

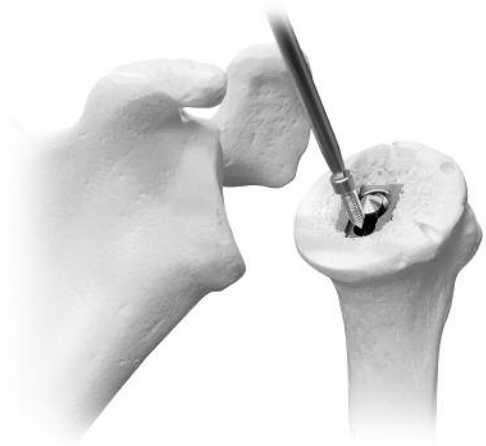


Fig. 8

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.

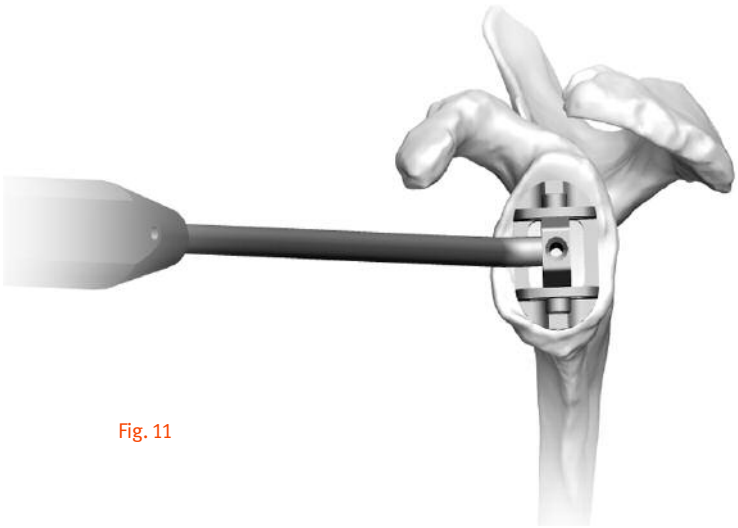


Fig. 11

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 the 3 mm 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.

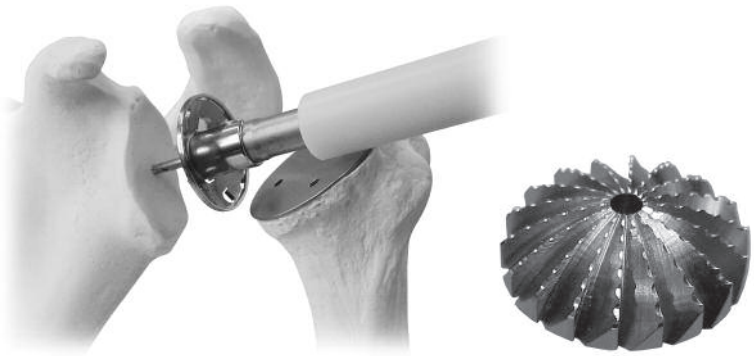


Fig. 12a

Fig. 12b

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).

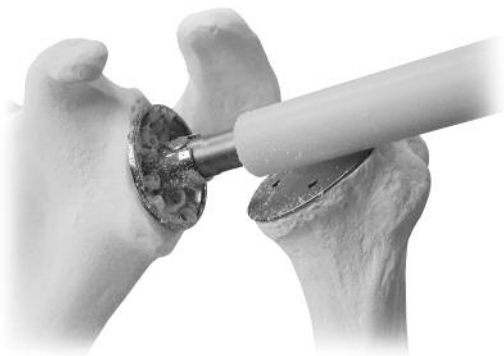


Fig. 13

Now use the reamer size L (large). The reamer size S (small) corresponds to the back surface of the *Anatomical Shoulder* Inverse Glenoid Fixation. But the reamer size L (large) is needed to generate enough clearance for the back-side of the *Anatomical Shoulder* Inverse Glenoid Head.

The glenoid surface preparation is done. Mount the milling cutter for glenoid inverse together with the cannulated handle and ream up to the guide wire the central hole until the cortical part is in (Fig. 14).

Fig. 14

Now guide the drill guide for glenoid inverse with the central hole along the 3 mm K-wire and place it on the surface of the glenoid (Fig. 15).

Use the drill for glenoid inverse (Fig. 15) and bore in the inferior and the superior fixation hole. After drilling the inferior hole, place the peg inside the hole and drill now the superior hole. Remove the drill guide, the peg and also the K-wire guiding pin.

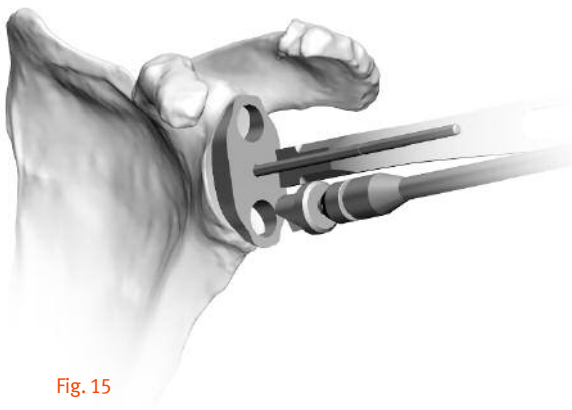


Fig. 15

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

Positioning and Screw Fixation of the Anatomical Shoulder Inverse Glenoid Fixation

The *Anatomical Shoulder* Inverse Glenoid Fixation is attached to the holding forceps for glenoid fixation. Bring the glenoid fixation with the central peg into the previously drilled hole.

Now start the 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 position of the glenoid fixation, before impacting the glenoid fixation

The impactor is removed and the free hand drill guide for screws is located in the inferior glenoid fixation hole. Both inferior and superior screws positions allow angulations of 30°. The drill guide for 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 x-rays and CT scans. The inferior hole is drilled with the drill 3,3 for screws. The screw lengths are laser marked on the drill, during the use with the drill guide. Now remove the drill guide.

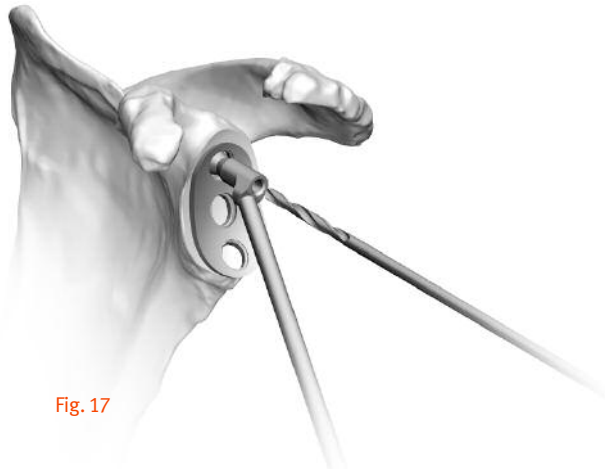


Fig. 17

The inverse screw 4,5 mm (available in length 18 – 48 mm in 6 mm incremental steps) is introduced into the inferior hole and fully tightened with the hexagonal screw driver.

Now secure the inferior inverse screw position by using the Inverse Locking screw. The locking screw is then fastened with the torque wrench, until it is tight (Fig. 18).

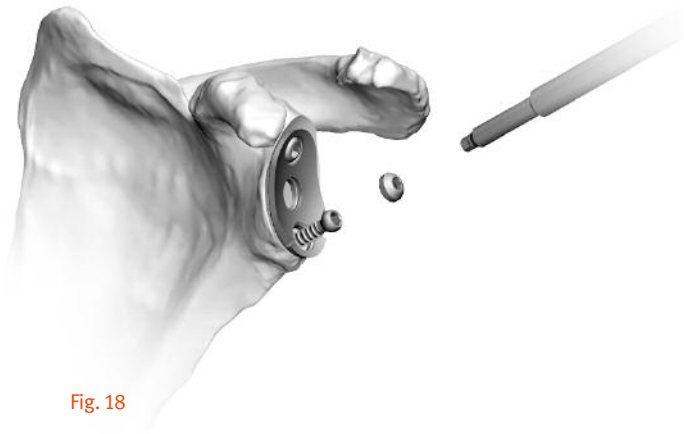


Fig. 18

Next, prepare the superior hole in the same manner as the inferior hole.

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.

3 thicknesses of the humeral PE inlays are available: standard 0, +3 mm and +6 mm. In case of severe bone defects or inadequate deltoid tension, a +9 mm humeral cup component can be used (possible humerus heights: standard 0, +3 mm, +6 mm, +9 mm, +12 mm and +15 mm).
The shoulder is then reduced and assessed for a full range of movement.

If soft tissue tension is correct, the glenoid bearing will not impinge on the inferior rim of the resected humeral head.

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 has to be used to disconnect the inlays from the humeral cups.

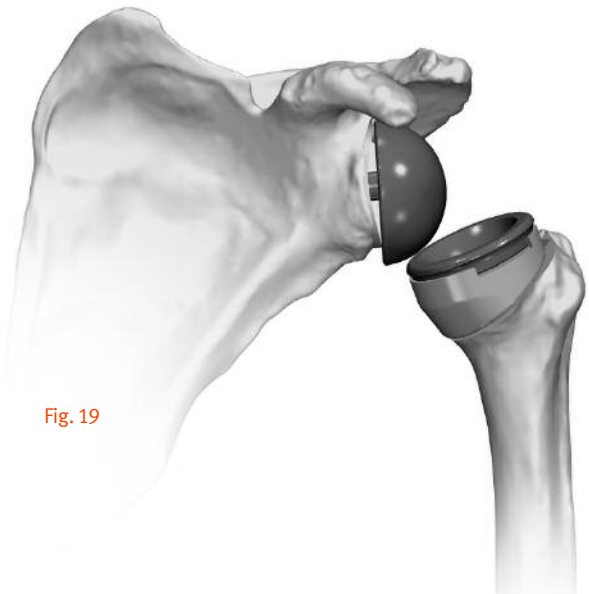


Fig. 19

Glenosphere Placement

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

The *Anatomical Shoulder* Inverse Glenoid Head has a laser mark for correct connection, this laser mark needs to face the acromion. The glenoid head is now fitted onto the oval taper of the glenoid fixation (Fig. 20). Use 3 consecutive defined impulses by hand for impaction. The glenosphere is now finally prepared.

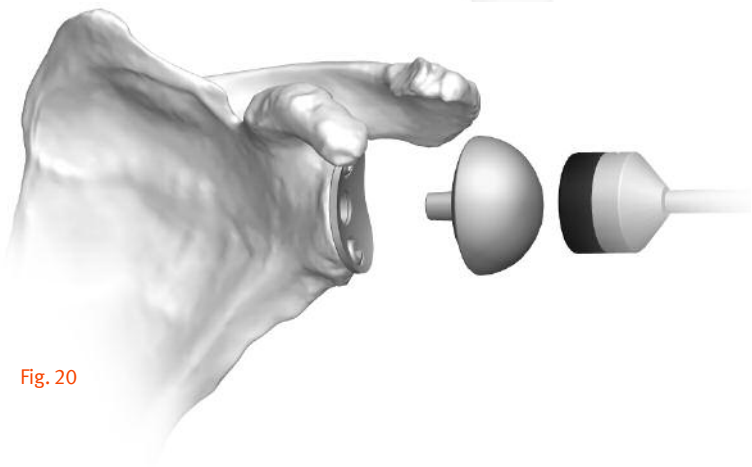


Fig. 20

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 used modular rasp) cemented or uncemented (press-fit). Unpack the inverse humeral cup and the inverse humeral PE inlay. The sizes have 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, after appropriate rotation (Fig. 21).

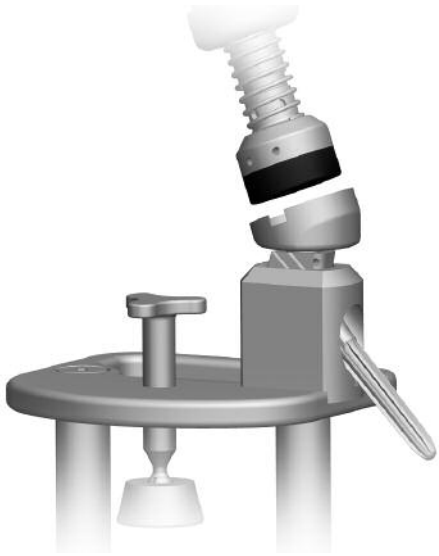


Fig. 21

The inverse humeral cup is now finally impacted onto the humeral implant stem with the aid of the impactor (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 the final position with careful blows from the humeral cup impactor (Fig. 22).
If the cement prosthesis is being used, excess cement is then carefully removed. Insert now with the snap-in mechanism the inverse humeral PE inlay with the help of the impactor PE inlay (Fig. 23).

Fig. 22

Fig. 23

If you want to check the deltoid tension again, you have also the possibility to use the trial humeral PE inlays on the humeral cup implant.

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 heaving and active elevation with the extended elbow are not allowed for 6 weeks.

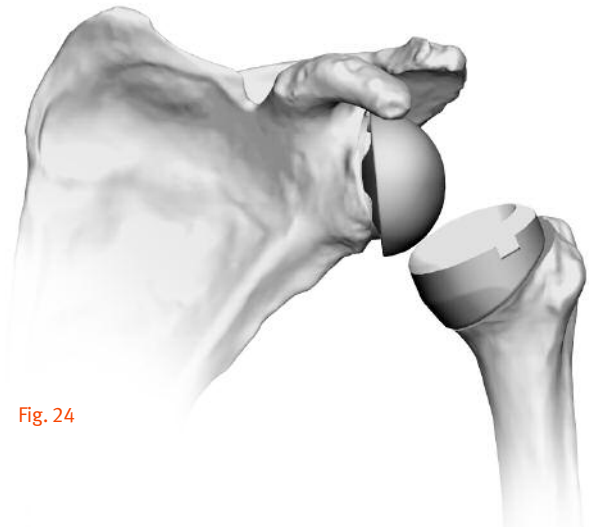


Fig. 24

Anatomical Shoulder
Inverse/Reverse

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).

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

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. 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 mount the milling cutter for humeral inverse together with the cannulated handle and start reaming the inverse/reverse humeral surface up to the bushing for milling cutter in the humeral stem (Fig. 30b). 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.

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

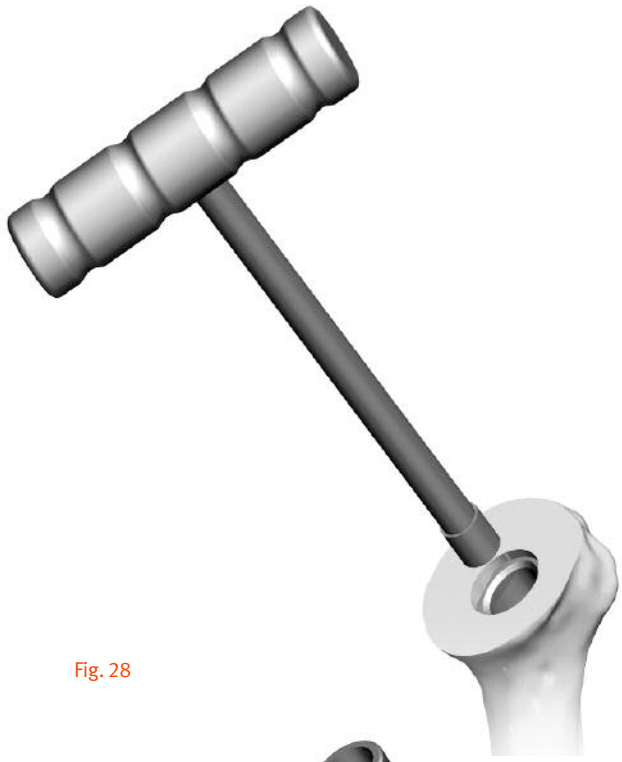


Fig. 28

Fig. 29a

Fig. 29b

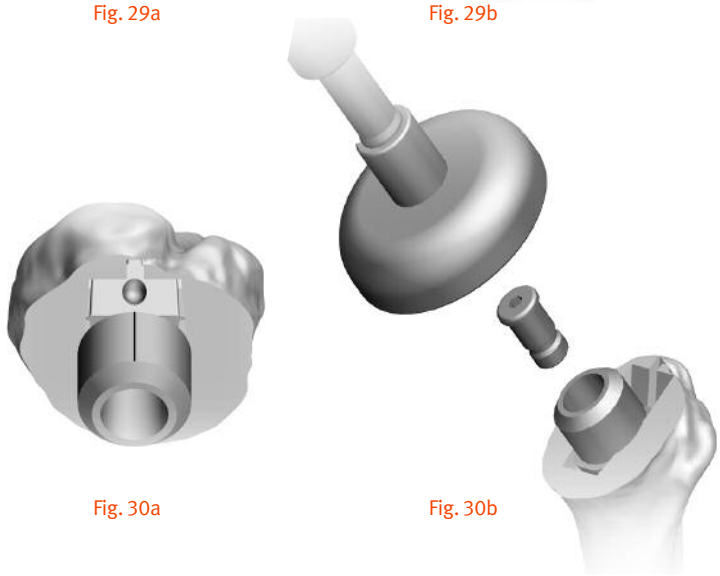


Fig. 30a

Fig. 30b

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

Glenoid, Preparation and Implantation

Please see pages 17–20.

Fig. 31

Humeral Placement

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

Insert the snap-in mechanism inverse humeral PE inlay with the help of the impactor PE inlay (Fig. 32).

If you want to check the deltoid tension again, you have also the possibility to use the trial humeral PE inlays on the humeral cup implant. To remove the trial humeral PE inlay, a Lexer chisel has to be used to disconnect 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.

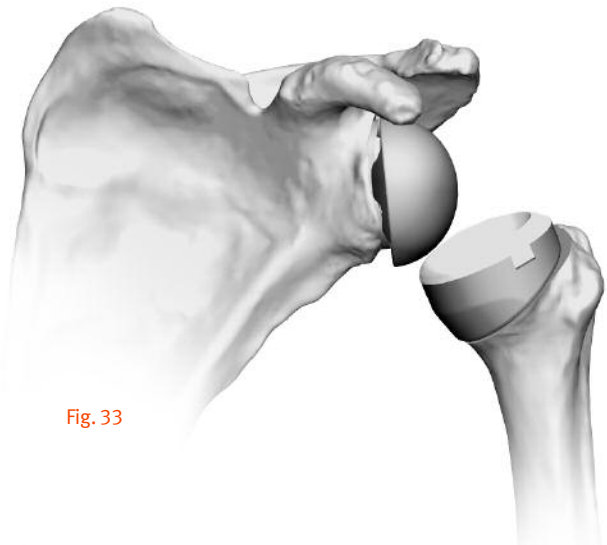


Fig. 33

Postoperative Treatment

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

Anatomical Shoulder
Inverse/Reverse

Revision

Humeral Side

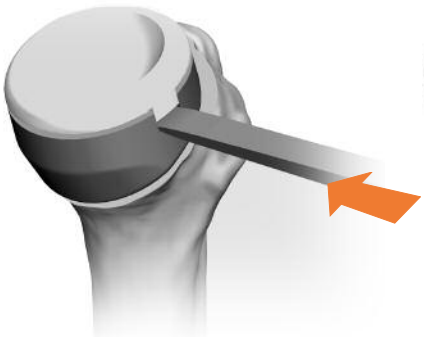


Fig. 34a

Fig. 34b

Should a Humeral PE Inlay ever have to be removed from the Humeral Cup, slide a lexer chisel underneath the PE Inlay and pry off (Fig. 34a).

Should a Humeral Cup ever have to be removed from the *Anatomical Shoulder* Stem, slide the extractor instrument for Humeral Cup between the humeral shaft and the undersurface of the Humeral Cup. Firmly tape the movable part of the instrument to loosen the Cup (Fig. 34b).

Glenoid Side

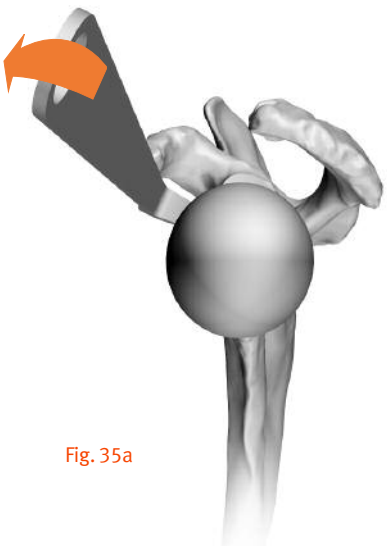


Fig. 35a

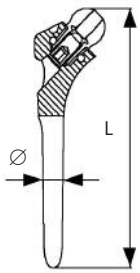
Fig. 35b

Should a Glenoid Head ever have 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 and 35b).

Implants

Anatomical Shoulder™ Standard Stems Cemented

Protasul®-1
ISO 5832-4
Cemented

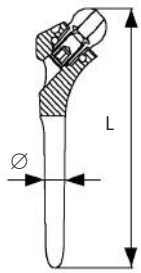


STERILE R

∅ mm	L mm	REF
7	100	01.04211.072
9	110	01.04211.092
12	110	01.04211.122
14	110	01.04211.142

Anatomical Shoulder™ Humeral Stem Uncemented

Protasul®-100
ISO 5832-11
Uncemented



STERILE R

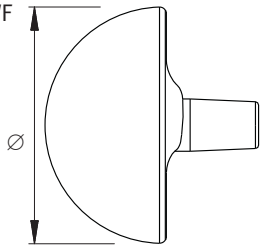
∅ mm	L mm	REF
7	100	01.04201.072
9	110	01.04201.092
10.5	110	01.04201.102
12	110	01.04201.122
14	110	01.04201.142

Anatomical Shoulder™ Standard Long Stems (Revision)

∅ mm	L mm	REF
7	200	01.04215.072
9	210	01.04215.092
12	210	01.04215.122
14	210	01.04215.142

Anatomical Shoulder™ Inverse/Reverse Glenoid Head

Protasul®-21WF
ISO 5832-12

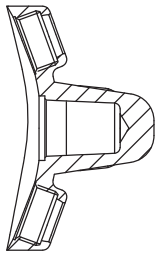


STERILE R

∅ mm	REF
36	01.04223.236
40	01.04223.240

Anatomical Shoulder™ Inverse/Reverse Glenoid Fixation

Protasul®-100
ISO 5832-11

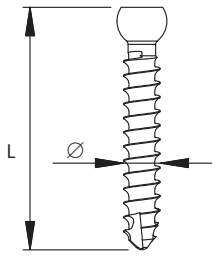


STERILE R

REF
01.04223.200

Inverse/Reverse Screw System

Protasul®-64WF
ISO 5832-3

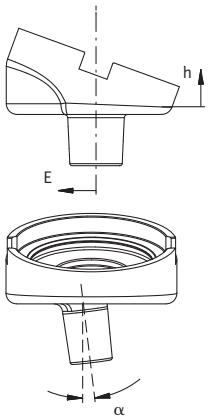


STERILE R

∅ mm	L mm	REF
4.5	18	01.04223.018
4.5	24	01.04223.024
4.5	30	01.04223.030
4.5	36	01.04223.036
4.5	42	01.04223.042
4.5	48	01.04223.048

Anatomical Shoulder™ Inverse/Reverse Humeral Cup

Protasul®-100
ISO 5832-11

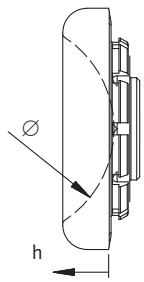


STERILE R

Version	h mm	E mm	α	REF
0° retro	0	0	0	01.04223.100
0° retro	0	6	0	01.04223.106
0° retro	+9	0	0	01.04223.190
0° retro	+9	6	0	01.04223.196
For Revision				
+10°retro	0	0	+10	01.04223.110
–10°retro	0	0	–10	01.04223.111
+20°retro	0	0	+20	01.04223.120
–20°retro	0	0	–20	01.04223.121

Anatomical Shoulder™ Inverse/Reverse Humeral PE-Inlay

Sulene®-PE
ISO 5834-1/5834-2

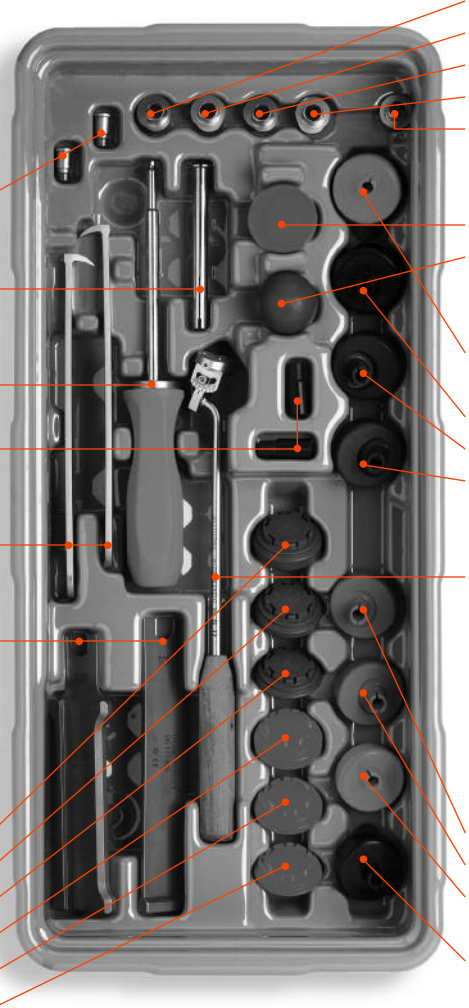


STERILE R

∅ mm	h mm	REF
36	0	01.04223.360
36	3	01.04223.363
36	6	01.04223.366
40	0	01.04223.400
40	3	01.04223.403
40	6	01.04223.406

Instruments

Article	REF
Anatomical Shoulder™ Inverse/Reverse Instrument tray (complete)	ZS01.04239.000



Anatomical Shoulder™ Inverse/Reverse Tray cover 01.00029.031

Anatomical Shoulder™ Inverse/Reverse Instrument Tray (empty) 01.04239.010

Screws for Bushing for Milling Cutter 01.04239.560

Locking Screw Holder 3.5 mm 02.00024.121

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

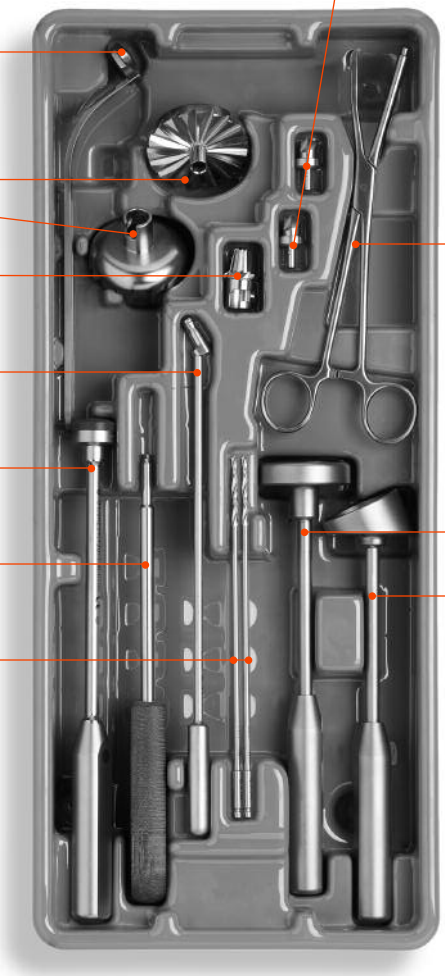
Article	REF
Bushing for Milling Cutter	
–20° retro	01.04239.550
+20° retro	01.04239.540
–10° retro	01.04239.530
+10° retro	01.04239.520
0° retro	01.04239.510
Trial Glenoid Heads	
40	01.04239.810
36	01.04239.800
Trial Humeral Cups (Set 1)	
+9° retro + 6 mm (medial offset)	01.04239.670
+9° retro	01.04239.660
–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 + 6 mm (medial offset)	01.04239.610
0° retro	01.04239.600

Article	REF
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 Screws	01.04239.170
Impactor for Glenoid Fixation	01.04239.150
Hexagonal Screw Driver	02.00024.023
Drills 3,3 for Screws	01.04239.180



Article	REF
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

All instruments not sterile

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