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# Surgical Technique

## Anatomical Shoulder Fracture System

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## Indications

The **Anatomical Shoulder Fracture System** is intended for use in prosthetic replacement of the proximal humerus and the glenoid articular surface of the scapula during total-, hemi- and fracture shoulder arthroplasty in treatment of the following:

- Complex 3 and 4 part fractures of the proximal humerus with subluxation of the head fragment
- Complex 3 and 4 part fractures of the proximal humerus with loosening of the spongiosa in the head fragment
- Complex 3 and 4 part fractures of the proximal humerus with additional cross split of the head fragment
- Fracture instability after osteosynthesis of 3 and 4 fragments of the proximal humerus
- Posttraumatic necrosis of the humeral head
- Posttraumatic arthrosis after humeral head fracture

The **Anatomical Shoulder Fracture Stem** is intended for cemented or cementless use.

## Preoperative Planning

The following radiographic images of the shoulder joint are desired for preoperative planning:

- Full size true anterior-posterior view with neutral rotation (0°), centered on the articular cavity
- Axial view
- Y view
- CT scan

An initial assessment is made of the bone in the superior and inferior aspects of the shoulder, 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 using the available templates to confirm the size and alignment of the implant.
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 able to extend fully. An armrest is optional.

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 out the cephalic vein between the deltoid muscle and the pectoralis major muscle. Make the approach medial to the vein to open the deltopectoral groove.

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

In fracture cases, it is especially important to identify and protect the musculocutaneous and the axillary nerves.

Identification of the Lesser and Greater Tuberosities
The glenohumeral joint is exposed by extending the fracture line between the tuberosities, incising the rotator interval over the long head of the biceps tendon. The biceps tendon is an excellent landmark to identify the interval between the lesser and the greater tuberosity. If the biceps tendon has been ruptured, place the scissors in the bicipital groove and use them to open the interval between the subscapularis and the supraspinatus tendon. Next, free up the lesser tuberosity from the underlying humeral head and soft tissues. Now, in a similar manner, carefully identify and free up the greater tuberosity.

The greater and lesser tuberosity fragments must be sufficiently freed up so that they can be easily repaired around the Anatomical Shoulder Fracture stem and to each other at the time of closure (Fig. 2).
**Anatomical Shoulder Fracture System – Surgical Technique**

**Humeral Head Excision**
With the tuberosities retracted out of the way, use a clamp to retrieve the humeral head.

**Humeral Shaft Preparation**
Attach the Rasp Handle to the Rasp (Fig. 3).

Manually rasp the humeral canal using progressively larger Rasps in 1mm increments until slight resistance is felt from cortical contact in the canal.

Rasp to the appropriate depth for the selected stem lengths. The depth corresponds to the implant length to be used. If a long Anatomical Shoulder Fracture Stem is required, connect a Rasp Extension on the distal end of the Rasp.

Rasp Extensions are available for Anatomical Shoulder Fracture Stems sizes 7, 9, 11 and 13.

If additional Rasp stability is necessary, consider inserting the Locking Spring for Rasp into the lateral slot of the Rasp (Fig. 4). The Locking Spring will help maintain height positioning during preparation.

**Sizing Convention and Consideration**

<table>
<thead>
<tr>
<th>AS Fracture</th>
<th>Rasp extension</th>
<th>Cemented, implant size and length</th>
<th>Press-fit, implant size and length</th>
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<td>7p</td>
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<td>7-130, 7-170</td>
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<tr>
<td>8p</td>
<td>no</td>
<td>–</td>
<td>8-130</td>
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</tr>
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</tr>
<tr>
<td>14c</td>
<td>no</td>
<td>14-130</td>
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</tr>
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*p* = press-fit (uncemented)

| c = cemented |

Example Convention and Consideration

1. Implant 9 cemented short
2. Implant 9 cemented long
3. Rasp 11p/9c
4. Implant 11 press-fit (uncemented) long
5. Implant 11 press-fit (uncemented) short
**Retroversion Adjustment Technique**

Insert the Alignment Rod into the appropriate retroversion hole on the Rasp Handle. Use the right or left hole for the corresponding shoulder side and the preferred hole for orientation to the forearm or to the condyles (Fig. 5).

Carry out the rasping with the elbow bent at an angle of $90^\circ$ parallel to the axis of the epicondyle of the distal humerus. This gives rise to an inclination of $130^\circ$ and a retroversion of $18^\circ$.

**Height Adjustment Technique**

The outer-shaped Anatomical Shoulder Fracture Heads are laser marked on the Rasp Handle for height orientation during the rasp procedure. The correct Rasp depth is reached if you feel that the lasermarked head is in right height position (Fig. 6).

Attach the Anatomical Shoulder Fracture Ruler to the Rasp Handle for height adjustment control. Use the pectoralis for height orientation. On the Anatomical Shoulder Fracture Ruler you will find a lasermarked area of the upper border of the pectoralis major tendon (Fig. 6).

Now verify if the lasermarked head on the Handle is placed in the right height and the lasermarked area of the pectoralis corresponds to the upper border of the pectoralis.
Disconnect the Rasp Handle (Fig. 7). The Rasp is fixed in the appropriate position, height and retroversion.

If additional Rasp stability is necessary, consider inserting a Screw using the 2.5mm Hexagonal Screw Driver through the proximal opening of the Rasp that will press the Locking Spring against the bone (Fig. 7a).
Now compare the resected humeral head dimension with one of the three head sizes of the Anatomical Shoulder Fracture System. If the size of humeral head is between available prosthetic heads, select the smaller of the two (Fig. 8).

Use the left and right Humeral Trial Head component for the corresponding shoulder side.

Attach the selected Trial Head to the Rasp, which is seated in the humeral shaft.

With the Humeral Head Trial Screw and the 2.5mm Hexagonal Screw Driver, prepare the stable fixation of the trial components (Fig. 9).

**Mobilizing the Tuberosities**

When the proper height and torsion of the trial prosthesis has been determined, mobilize the tuberosities in order to approximate them around the prosthesis, to one another, and to the humeral shaft. Due to the position of the special fracture suture holes, an anatomical repositioning of the tuberosities below the head is possible (Fig. 10).

The primary goal of tuberosity reattachment is to obtain maximum contact with the stem and the proximal humeral shaft while rebuilding them into the anatomical position.

The initial reduction of the greater tuberosity enables both the height and the retroversion to be tested. The greater tuberosity is placed on the diaphysis and the prosthesis. Use the special fracture suture hole for the greater tuberosity and place it in the tuberosity groove under the round-shaped head.
Determining Definitive Height

The height is evaluated to ensure:

- The tension of the supraspinatus and the long head of biceps which must arch over the Anatomical Shoulder Fracture Head and the height of the acromio-humeral space.
- The top of the greater tuberosity should be located below the highest point of the Anatomical Shoulder Fracture Head.
- There must be no diastasis, or overlap, between the greater tuberosity and the humeral diaphysis.

Test the retroversion:

- Arm in neutral position – the Anatomical Shoulder Fracture Head must face the glenoid.

When the version and height of the Anatomical Shoulder Fracture Trials (Rasp and Trial Head) are set, insert the Anatomical Shoulder Fracture Ruler into the proximal-lateral suture hole of the Trial Head component and mark the position next to the associated laser mark on the Anatomical Shoulder Fracture Ruler to note the desired implant version. Additionally, the alphanumeric character that is closest to the fracture line is noted for reference in final implant placement (Fig. 10a).

Reduce the joint, and perform a final range of motion assessment.

Remove the Rasp by removing the Ruler, unscrewing the Anatomical Shoulder Fracture Head Trial with the 2.5mm Hexagonal Screw Driver, removing the Rasp Screw (if it was used attaching the Rasp Handle to the Rasp), and removing the Rasp from the humeral shaft.

Clean the fracture site at the shaft edges and place drill holes through the shaft, two lateral and two medial to the biceps groove. Place sutures through the shaft drill holes (Fig. 11 D/E). These are vertical sutures that go up around the top of the bone segments through the rotator cuff bone junction.
Assembling the Anatomical Shoulder Fracture Implant

Humeral stem implant size is selected based upon technique and fixation desired. For example, choose for Rasp size 11p/9c the implant stem 9 cemented. If a press-fit is desired, choose for Rasp size 11p/9c the implant stem 11 (refer to Sizing Convention and Consideration section for additional information, page 6). Humeral head implant size is the same size and version (left or right) as the Trial Head chosen.

Connect and assemble the elected Anatomical Shoulder Fracture Base Plate to the Anatomical Shoulder Fracture Stem with the Locking Screw by using the Torque Wrench Nut (Fig. 12).

Note: Due to the ability to convert from the Anatomical Shoulder System to an Anatomical Shoulder Inverse/Reverse System, a gap between Stem and Base Plate will be present.

Connect the distal support to the Fracture Adapter (A) (Fig. 13).

Place the assembled stem into the special Stem Holder (Fig. 13) and close the Adapter Arm (B).

Lock the Adapter Arm to the Stem Holder by tightening the screw using the Hexagonal Wrench.

Connect the Stem with Base Plate using the Torque Wrench Nut connected to the Torque Wrench (C) (Fig. 14).

Complete the Anatomical Shoulder Fracture Implant by impacting the Anatomical Shoulder Fracture Head to the stem (Fig. 15).

Warning: Only use the Anatomical Shoulder Impactors (either 01.04236.400 or 72.01.00-01) to assemble the humeral head and humeral stem of the Anatomical Shoulder Fracture System. Use of a generic mallet and impactor to assemble the humeral head and humeral stem may result in postoperative loosening of the humeral head from the humeral stem. Either Anatomical Shoulder Impactor (Fig. 15) can be found in the Anatomical Shoulder System Tray 2 (ANSH600).
**Final Suture Preparation of the Anatomical Shoulder Fracture Implant**

Insert the lesser tuberosity (orange), the greater tuberosity (green) and the cerclage sutures (red & yellow) (Fig. 15a).

**Cementing the Prosthesis**

Thoroughly irrigate the medullary canal to remove blood and other debris. Insert a cement plug at the appropriate depth in the medullary canal. If possible, use high-viscosity cement mixed under vacuum, and insert it with a cement gun.

**Retroversion and Height Adjustment**

Attach the *Anatomical Shoulder* Fracture Ruler onto the *Anatomical Shoulder* Fracture Implant (Fig. 16) by inserting the peg of the Ruler into the superior hole of the Base Plate to establish the proper stem height.

Insert the *Anatomical Shoulder* Fracture Implant by hand into the humeral canal to the same level of the *Anatomical Shoulder* Fracture Ruler relative to the mark, made earlier when the Rasp and the Trial Head were used.

To assess retroversion, attach the pegs of the Control Rod into the superior holes of the Base Plate (Fig. 16a). After removing the Control Rod, use the Head Impactor for final impaction.

If cemented, make sure there is no excess cement extruding from the canal proximally above the humeral stem and into the fracture site. This will interfere with the potential for bony union between the tuberosities, stem, and the diaphyseal fragment. Use a curette to remove any excess cement. It is important to keep the sutures separated to avoid confusion in tying the proper sutures (Fig. 16b).
Reattaching the Tuberosities

Fixation of the tuberosities is critical to the success of the procedure. Basic principles in fracture repair should be followed to provide stable fixation of the tuberosities to the stem. The following description provides guidelines for using the suture holes to provide proper fixation.

Suture pattern and method can be modified based on the condition of the fracture.

A suture should be placed in the special greater tuberosity suture hole (green: A–A) (Fig. 17a), a second suture in the special lesser tuberosity suture hole (orange: B–B) (Fig. 17c). These sutures will initially be used to position the tuberosities to the shaft in a cerclage fashion (Fig. 17).

The posterior end of the suture, passed to the greater tuberosity suture channel (green: A–A), is passed at the junction between posterior end of the supraspinatus tendon and greater tuberosity. The anterior part is passed inside out at the junction between the greater tuberosity and anterior border of the supraspinatus tendon. This suture is then tied and reduces the greater tuberosity in an anatomic fashion. The cerclage sutures will be passed through the subscapularis tendon (at its insertion), wrapped around the lesser and greater tuberosities and passed through the infraspinatus and teres minor at the tendon insertions. These sutures will be tightened and tied off first.

The suture placed in the humeral shaft lateral to the biceps groove (purple: E–E), will be passed through the supraspinatus tendon at its insertion and used to bring the distal edge of the greater tuberosity back down to the shaft (Fig. 17b).
The suture placed in the humeral shaft medial to the biceps groove (light blue: D–D) will be passed through the subscapularis (at the tendon insertion) and used to bring the distal edge of the lesser tuberosity back down to the shaft. These vertical sutures will be tightened and secured after the cerclage sutures are tied off (Fig. 17c).

The cerclage sutures placed in the Anatomical Shoulder Fracture Implant are used to further reduce or compress the fragments against the prosthesis, if necessary.

A suture from each hole will be passed posteriorly through infraspinatus and teres minor insertions, respectively. The suture, exiting anteriorly, will pass around the greater tuberosity fragment and be tied down onto the greater tuberosity (red: C₁–C₁) (Fig. 18).

A second suture will be passed posteriorly around the stem and the medial hole through the subscapularis at its insertion. The suture end, exiting anteriorly, will be wrapped around the lesser tuberosity and tied down against the lesser tuberosity (yellow: C₂–C₂) (Fig. 18 and 19).

Remove and discard any unused sutures. Close the rotator interval from the edge of the supraspinatus to the upper edge of the subscapularis tendon.

Check stability and range of motion. If necessary, place bone graft from the humeral head in and around the tuberosity shaft interface.

**Closure**

Close the subcutaneous layers and then the skin.
Revision Steps

Removal of the Anatomical Shoulder Fracture Implant Head

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

With a cemented humeral stem, use a Lexer Chisel to free the humeral head of cement so that the extraction instrument can be applied.

The Humeral Head Extractor is now applied to the Anatomical Shoulder Fracture humeral head and fixed with a two-edged screw. With the aid of the Extractor instrument and the Slide Hammer Weight, the humeral head is separated from the Anatomical Shoulder Fracture humeral stem (Fig. 20).

Removal of the Anatomical Shoulder Fracture Base Plate

Once the humeral head has been removed, the Locking Screw is removed by the Hexagonal 4.5mm Wrench (Fig. 21).

Note: Do not use the Torque Wrench. In order to generate the necessary holding force against the torque, the Base Plate must be held by the Forceps.

The Holding Forceps have the contour of the Base Plate and allow a tight contact during the removal procedure (Fig. 21). If necessary, use any adequate chisel in order to fully release the Base Plate.

Removal of the Anatomical Shoulder Fracture Humeral Stem

Once the humeral head and Base Plate have been properly removed, the Adaptor is positioned on the female taper of the stem (Fig. 22).

Using the original Locking Screw, fix the Adaptor to the humeral stem by screwing it into the thread of the stem. The Locking Screw is tightened with the Hexagonal 4.5mm Wrench.

The Extractor with Slide Hammer Weight and Extension Rod can now be screwed onto the Adaptor.

Apply moderate blows to the Extractor with Slide Hammer Weight to remove the implant stem.
Further Possibilities

Revision to a New Anatomical Shoulder Fracture Humeral Head
To use a new Anatomical Shoulder Fracture Humeral Head once the old humeral head is removed, see page 11.

Revision to an Anatomical Shoulder Adjustable Humeral Head
To use an Anatomical Shoulder adjustable humeral head with the Anatomical Shoulder Fracture stem, remove the humeral head, Locking Screw, and Fracture Base Plate according to the revision technique previously described.

In order to trial the humeral head, the Fracture X-pin, Expansion Cone, Ball-Taper, and Trial Humeral Heads with Grub Screws will be needed (Fig. 23). Insert the Fracture X-pin by hand into the Fracture stem. The Expansion Cone is then gently placed into the Ball-Taper component, using the Insertion Rod, and carefully placed over the top of the Fracture X-pin onto the Fracture stem.

The chosen humeral head is then inserted into the definitive Ball-Taper (with Expansion Cone already placed in the Ball-Taper) (Fig. 24). The humeral head is adjusted so that it covers the resection plane of the humerus. When the head is set parallel with the incision on the humerus and the head covers the resection plane in inclination, retroversion and offset, prefix the head to the Ball-Taper component using three consecutive defined impulses from the Impactor. The prefixed head component is now removed from the stem.

The head implant is then set in the assembly tower and lightly fixed with the Threaded Rod. Connect the Torque Wrench to the 4.5mm Nut. The Set Screw is then fastened with the Torque Wrench, using the 4.5mm Nut, until it is tight. The head prosthesis has now been permanently fixed and can be carefully removed from the assembly block.

Note: Before the head prosthesis can be placed on the stem prosthesis, the cones must be carefully cleaned of blood and possible other residues.

The Fracture X-pin is removed from the Fracture stem by hand. The head prosthesis is now placed on the stem prosthesis, after appropriate rotation. The head prosthesis is then impacted onto the humeral stem with the Humeral Head Impactor.

Please refer to the surgical technique (literature number 06.006.070.12) for complete, detailed instructions.

Converting to an Anatomical Shoulder Inverse/Reverse System
To convert the Anatomical Shoulder Fracture System to an Anatomical Shoulder Inverse/Reverse System, remove the humeral head, Locking Screw, and Fracture Base Plate according to the revision technique previously described.

The Fracture X-pin is inserted into the Fracture stem. The Fracture X-pin guides the reamer and is essential for directing and fixing the Inverse Humeral Cup.

To prepare the humeral surface for the Inverse Humeral Cup, place a Milling Cutter Bushing onto the Fracture stem. If the Milling Cutter Bushing can not be placed onto the Fracture stem, remove bone or cement with a Lexer Chisel.

**Note:** Care should be taken to ensure that the Expansion Cone does not come out of the Ball-Taper. Before inserting the Set Screw, confirm that the Expansion Cone is in the Ball-Taper.

The Trial Humeral Heads can be used along with the Grub Screws in order to assess the correct size of humeral head needed.
Now attach the Revision Humeral Inverse Milling Cutter together with the Cannulated Handle and start reaming the inverse/reverse humeral surface up to the Milling Cutter Bushing in the Fracture stem (Fig. 25).

**Note:** The Milling Cutter Bushing comes in five different types (straight, ±10° retro and ±20° retro version). To set the Milling Cutter Bushing correctly onto the Fracture stem, all bushings have a marking line. This line always needs to face the lateral side of the stem (Fig. 26).

The Fracture X-pin is removed from the Fracture stem. The plane of the humeral resection can be protected with a disk-shaped protector (Fig. 27). Disks of three different diameters (40, 44 and 48mm) are available. The pins of the lower side of the disks are inserted at the level of the incision.

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

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

For complete, detailed instructions, including trialing and implantation of the humeral cup, PE inlays, and glenoid components, please see *Anatomical Shoulder Inverse/Reverse Surgical Technique* (97-4223-102-00).
Assembly and Disassembly of the Impactor

Charging the Impactor

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

The Impactor is connected through the shaft of the Charger.

There are two possible procedures: Either the Charger is placed on the table (Fig. 28), or the Charger is held in one hand, the Impactor in the other (Fig. 29, 30), while the shaft of the Charger is inserted into the Impactor and tenses the Impactor.
Overview of the Instruments

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

To convert an Anatomical Shoulder Fracture System into an Anatomical Shoulder Inverse/Reverse System, without the need for stem removal, additional instruments are required:

- Anatomical Shoulder Inverse/Reverse Tray ANSH800
- Anatomical Shoulder Instrument Tray I and II ANSH500 and ANSH600
- Anatomical Shoulder Glenoid Tray ANSH0100
- Anatomical Shoulder Fracture Revision Tray KTANSH0310

Please see the Anatomical Shoulder Inverse/Reverse System Surgical Technique for additional information.
## Instruments

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<tr>
<td>Torque Wrench for Humeral Head</td>
<td>72.11.20-06</td>
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<tr>
<td>Anatomical Shoulder Fracture Ruler</td>
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<td>Anatomical Shoulder Fracture Humeral Trial Head Screws (2)</td>
<td>01.04237.500</td>
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<td>Torque Wrench Nut, 4.5mm</td>
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<td>Hexagonal Wrench, 5mm</td>
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<td>Anatomical Shoulder Fracture Humeral Stem Setting Instrument</td>
<td>01.04237.610</td>
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<tr>
<td>Hexagonal Screwdriver, 2.5mm</td>
<td>109.02.020</td>
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Anatomical Shoulder Fracture System – Surgical Technique

Insert II (empty) 01.04237.030

Anatomical Shoulder Fracture Rasps (Set 1)
- Size 7.5 [8p] 01.04237.075
- Size 9.5 [10p/8c] 01.04237.095
- Size 11.5 [12p/10c] 01.04237.115
- Size 13.5 [14p/12c] 01.04237.135
- Size 15.5 [14c] 01.04237.155

Anatomical Shoulder Fracture Rasps (Set 2)
- Size 6.5 [7p] 01.04237.065
- Size 8.5 [9p/7c] 01.04237.085
- Size 10.5 [11p/9c] 01.04237.105
- Size 12.5 [13p/11c] 01.04237.125
- Size 14.5 [13c] 01.04237.145

Anatomical Shoulder Fracture Rasp Springs (5) 01.04237.180

Anatomical Shoulder Fracture Rasp Handle 01.04237.200

Anatomical Shoulder Fracture Rasp Extensions
- Size 6.5 [7p] 01.04237.066
- Size 8.5 [9p/7c] 01.04237.086
- Size 10.5 [11p/9c] 01.04237.106
- Size 12.5 [13p/11c] 01.04237.126
- Size 14.5 [13c] 01.04237.146

Anatomical Shoulder Fracture Rasp Screws (5) 01.04237.190

Anatomical Shoulder Fracture Alignment Rods (2) 01.04237.310
# Anatomical Shoulder Fracture Revision Instrument Set

<table>
<thead>
<tr>
<th>Article</th>
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<tr>
<td>Anatomical Shoulder Fracture Revision Instrument Set  (complete set)</td>
<td>KTANSH0310</td>
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<tr>
<td>Anatomical Shoulder Tray Lid</td>
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<td>Anatomical Shoulder Fracture Revision Tray (empty)</td>
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<tr>
<td>Fracture Humeral Stem Extractor Adapter</td>
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<td>Humeral Provisional Extractor</td>
<td>72.01.00.02</td>
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<td>Extension Rod</td>
<td>01.04236.115</td>
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<tr>
<td>Fracture Holding Forceps</td>
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<tr>
<td>Slide Hammer Weight</td>
<td>01.04235.120</td>
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<tr>
<td>Anatomical Impactor</td>
<td>01.04236.400</td>
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- **Sclerotic Reamer**: 72.11.10.34
- **Large Glenoid Reamer**: 01.04236.540
- **Medium Glenoid Reamer**: 01.04236.537
- **Small Glenoid Reamer**: 01.04236.534
- **Humeral Head Impactor**: 72.01.00-01
- **Cannulated Milling Handle**: 72.09.01.30
- **Glenoid K-wire (2)**: 72.09.01.20
- **Fracture X-Pin**: 01.04237.186
- **Fracture Hexagonal 4.5mm Wrench**: 01.04237.720
- **Rigid Shaft**: 75.80.08
- **Flexible Shaft**: 75.80.04
- **Humeral Head Extractor**: 01.04235.010
- **Anatomical Charging Device**: 01.04236.410
Please refer to package insert for complete product information, including contraindications, warnings, precautions, and adverse effects.

The CE mark is valid only if it is also printed on the product label.

Contact your Zimmer representative or visit us at www.zimmer.com