Anatomical Shoulder™ Fracture

Surgical Technique

Anatomical Meets Fractures

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Surgical Technique Anatomical Shoulder Fracture

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Foreword

Shoulder replacement has evolved to achieve as a biomechanical and anatomical reconstruction of the shoulder.

Precise anatomical reconstruction using the *Anatomical Shoulder* System allows the surgeon to restore the geometry of the normal joint, thus ensuring good motion and pain relief, as well as durability of the reconstruction.

The *Anatomical Shoulder* Fracture System is specialized for anatomical reconstruction in case of proximal three or four part fractures.

The goal of a hemiarthroplasty for fracture is to replace the humeral head with a prosthetic component and to restore rotator cuff function by reconstructing the tuberosities to both, the shaft and the prosthesis.

Peter Wendt, Director Development Extremities

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Indications

The *Anatomical Shoulder* Fracture System is indicated for:

- 4-part fracture of the proximal humerus
- 3-part or head split fractures

The goal of a hemiarthroplasty for fracture is to replace the humeral head with a prosthetic component and to restore rotator cuff function by reconstructing the tuberosity to both, the shaft and the prosthesis.

Description of the Implants

Specifically designed for anatomical reconstruction of articular proximal humerus fractures.

Anatomical Shoulder Fracture Base-Plate, Head and Screw

6 different versions delivered sterile in one box

Right	40R, 44R, 48R
Left	40L, 44L, 48L

Anatomical Shoulder Fracture Stem

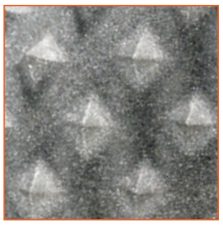
12 different versions delivered sterile in one box

Stem lengths	Short	Long	
	130 mm	170 mm	200 mm
Stem sizes	7, 8, 9, 10, 11, 12, 13, 14	7	9, 11, 13

Special Tuberosity Groove

Anatomical Design

- Anatomically designed proximal part
- The proximal volume of the prosthesis is optimized to restore the normal given humeral anatomy
- Round shaped heads
- Special tuberosity groove
- Bone fits anatomically below the head
- Prevention of impingement and tears



Special Fx Spikes

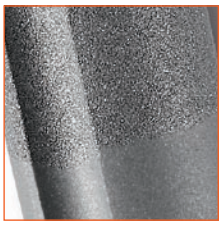
Special Fx Spikes

- For a fix and stable anchoring of the tuberosities to the stem
- Increase primary stability

Special Medial Clearance in Order to Preserve Remaining Humeral Bone

Effective Medial Base-Plate Design

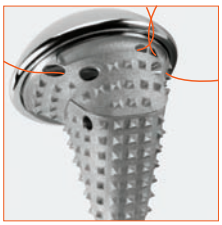
- The base-plate has a special medial clearance in order to preserve remaining humeral bone



Extra Rough Blasted Proximal Surface

Surface

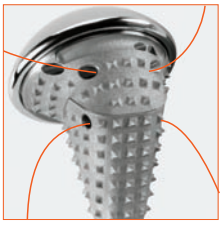
- Extrarough-blasted proximal surface with Fx spikes specially developed for proximal humeral bone
- Smooth-blasted distal surface
- Material: Optimized material composition, Ti Alloy, CoCr, with historical long-time experience
- Allows for cemented or non-cemented use



Special Fx Suture Holes

Special Fx Suture Holes

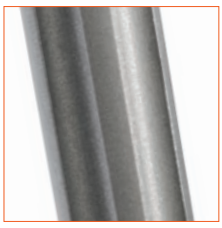
- Due to the position of the special Fx suture holes, an anatomical repositioning of the greater and lesser tuberosity below the head, back to the original anatomy is possible.
- Therefore reconstruction failures are minimized.
- Fx suture holes optimized for secure and safety fixation.
- High-end fluid ground and rounding Fx suture holes



Special Fx Suture Holes

Further Fx Suture Holes

- To provide final stable fixation of the tuberosities to the Anatomical Shoulder Fracture Stem.
- One medial, two additional lateral



Safety Distal Anchoring

Safety Distal Anchoring

- 3 grooves for rotational stability, press-fit or cemented
- The two lateral grooves are for defined orientation
- Tapered stem design, for stem removal and forces are distributed homogeneously

Convertible to an Anatomical Shoulder Inverse/Reverse System, without Stem Removal

Such revision might be necessary in case of irreparable rotator cuff tear. This will greatly simplify and shorten revision surgery since the need to remove a well-fixed stem is eliminated.

Right and Left Option

Right and Left Option

- In respect to the shoulder anatomy, physiology, and the greater and lesser tuberosities
- Continuous adjustment of retroversion

Overview of the Instruments

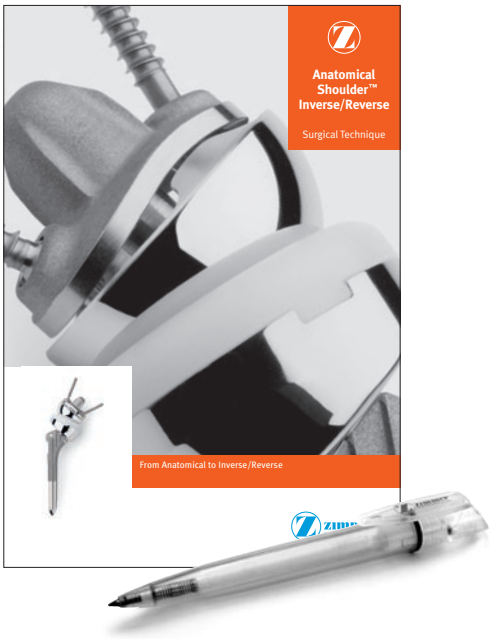
Anatomical Shoulder Fracture Tray

The preparation and implantation of the *Anatomical Shoulder* Fracture 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 of the success of the surgery.

To convert an *Anatomical Shoulder* Fracture System into an *Anatomical Shoulder* Inverse/Reverse System, without the need of stem removal, further instruments are needed:

- *Anatomical Shoulder* Inverse/ Reverse Tray
- *Anatomical Shoulder* Instrument Tray I and II
- *Anatomical Shoulder* Glenoid Tray

See Surgical Technique Anatomical Shoulder Inverse/Reverse (Lit. No. 06.01276.012).



Lit. No. 06.01276.012

Preoperative Planning

Template Options

- Anatomical Shoulder Fracture Head
  Lit. No. 06.01373.000
- Anatomical Shoulder Fracture Stem
  Lit. No. 06.01357.000
- Anatomical Shoulder Fracture Long Stem
  Lit. No. 06.01372.000

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 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 possible to extend it fully. An armrest is optional.

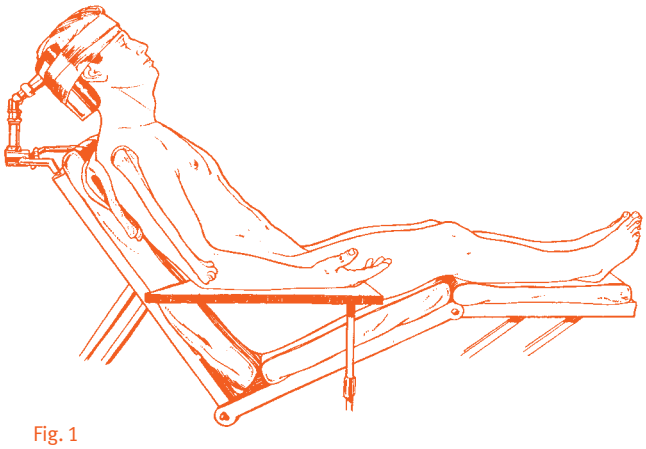


Fig. 1

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.

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. Even 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 supra-spinatus 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 and to each other at the time of closure.

Humeral Head Excision

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

Now compare its dimension with one of the 3 head sizes of the *Anatomical Shoulder* Fracture System.

If the humeral head is between available prosthetic head sized, select the smaller of the two. The most common mistake is to use a too large humeral head (Fig. 8).

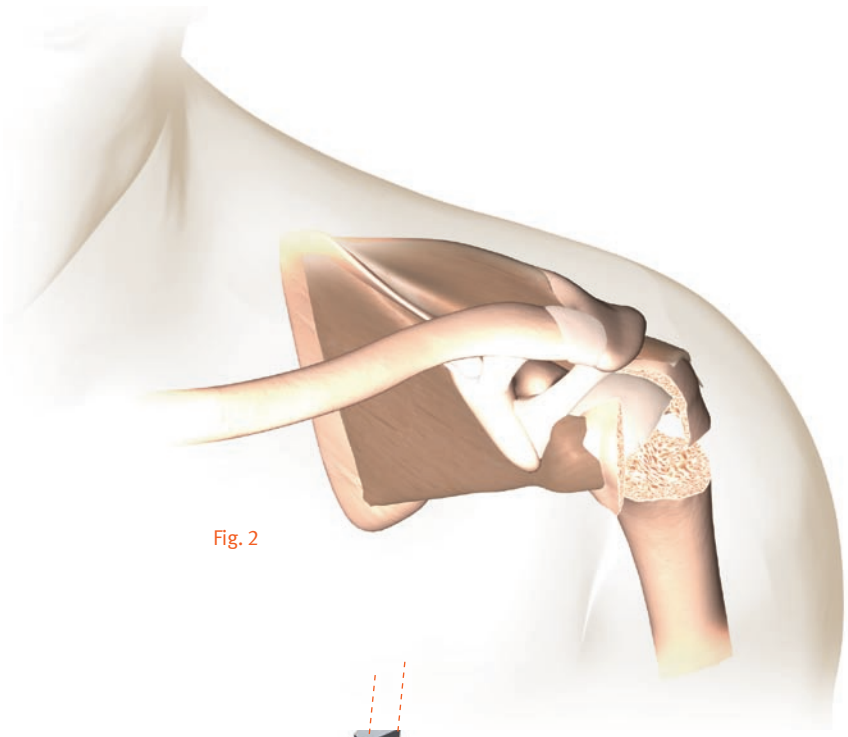


Fig. 2

Humeral Shaft Preparation

Insert the locking spring for rasp into the lateral slot of the rasp, for stabilizing height positioning during preparation (Fig. 3).

Now attach the Handle for rasp to the rasp (Fig. 4).

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

Ream 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.

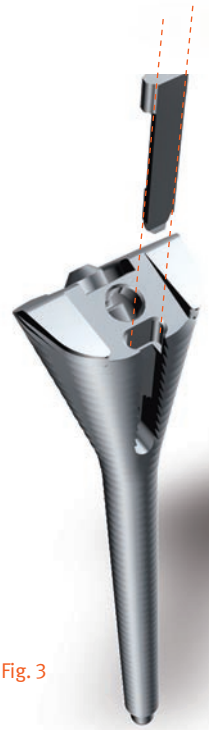


Fig. 3

Fig. 4

Optional Retroversion Adjustment Technique

Insert the alignment rod into the appropriate retroversion hole on the handle for rasp. 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).

Optional Height Adjustment Technique

The outer-shaped *Anatomical Shoulder* Fracture Heads are laser marked on the handle for rasp for height orientation during rasp procedure. The correct rasp deepness is reached, if you feel that the laser-marked head is in right high position (Fig. 6).

Attach the *Anatomical Shoulder* Fx Ruler to the Handel for Rasp for your height adjustment control. Now, use the pectoralis for height orientation. On the *Anatomical Shoulder* Fx Ruler you will find a laser-marked area of the upper border of the pectoralis major tendon.

Now control if the laser-marked head on the handle is placed in the right height and the laser-marked area of the pectoralis corresponds to the upper border of the pectoralis.

Sizing Convention and Consideration

AS Fx rasp size	Rasp extension	Cemented implant size and length	Press-fit, implant size and length
7p	yes	–	7-130, 7-170
8p	no	–	8-130
9p/7c	yes	7-130, 7-170	9-130, 9-200
10p/8c	no	8-130	10-130
11p/9c	yes	9-130, 9-200	11-130, 11-200
12p/10c	no	10-130	12-130
13p/11c	yes	11-130, 11-200	13-130, 13-200
14p/12c	no	12-130	14-130
13c	yes	13-130, 13-200	–
14c	no	14-130	–

p = press-fit (uncemented)
c = cemented

Fig. 5

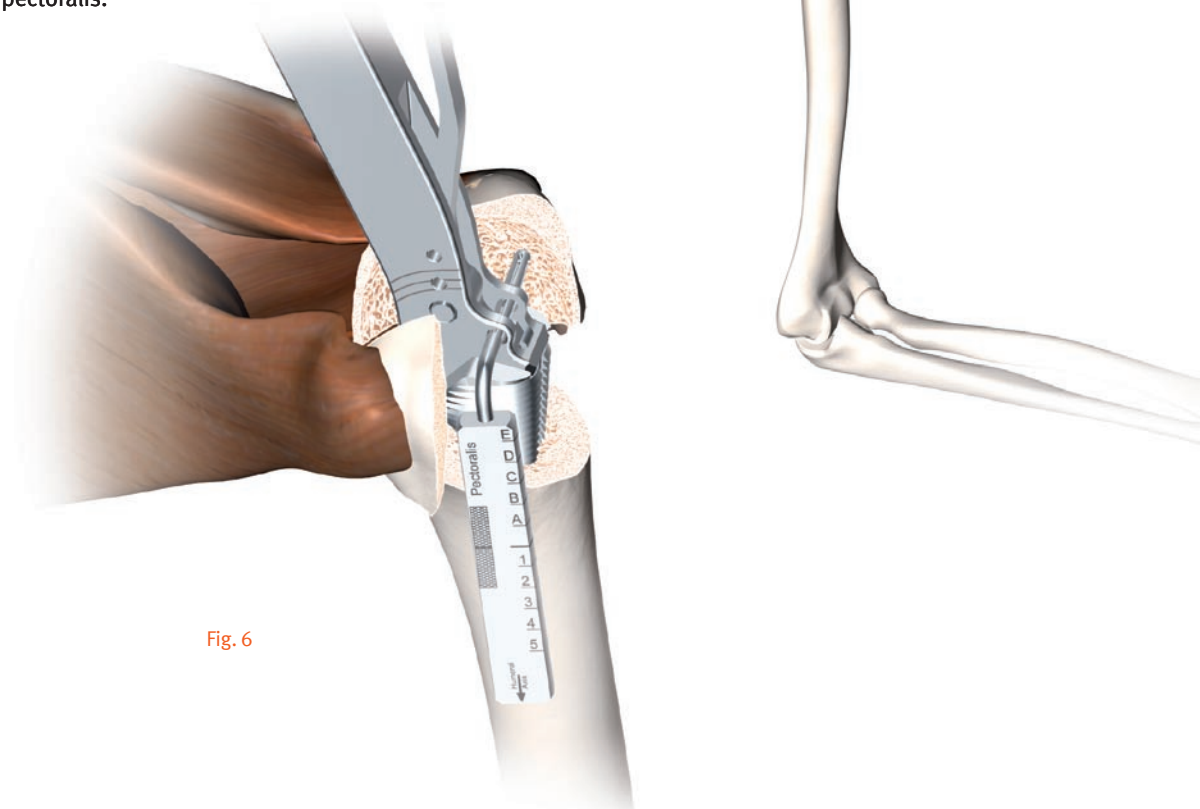


Fig. 6

Disconnect the handle for rasp and insert the screw for rasp with the help of the screwdriver.

The screw will press against the spring and the spring against the bone. Now, the rasp is fixed in the appropriated position, in height and retroversion, in the humeral shaft (Fig. 7).

Fig. 7

If the humeral head is between available prosthetic head sized, select the smaller of the two. The most common mistake is to use a too large humeral head (Fig. 8).

Use the right or left humeral trial head component for the corresponding shoulder side.

Then attach the selected trail head to the rasp, seated in the humeral shaft. With the screw for humeral trial head and the screwdriver prepare the stable fixation of the trial components (Fig. 9).

Fig. 8

Mobilizing the Tuberosities

When the proper height and torsion of the trial prosthesis has been determined, mobilize the tuberosities so that they can be approximated around the prosthesis, to one another and to the humeral shaft. Due to the position of the special Fx suture holes, an anatomical repositioning of the greater and lesser tuberosity below the head, back to the original anatomy is possible (Fig. 9).

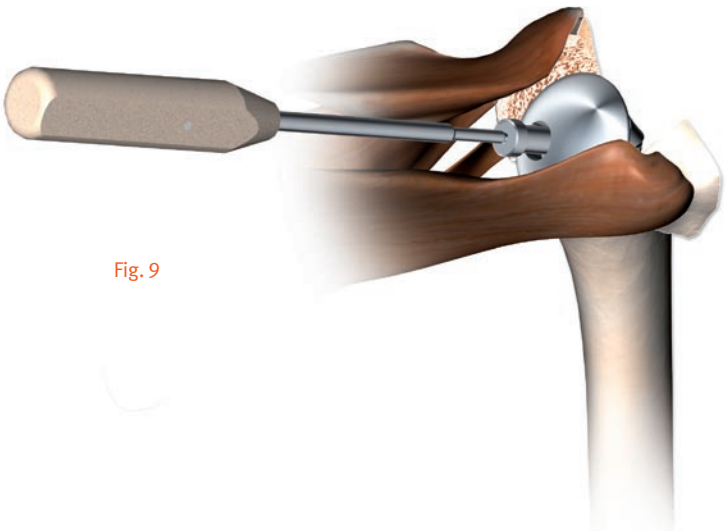


Fig. 9

The primary goal of tuberosity reattachment is to get as much contact with the stem and the proximal humeral shaft while rebuilding 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 Fx suture hole for the greater tuberosity and place it in the tuberosity groove under the round-shaped head (Fig. 10).

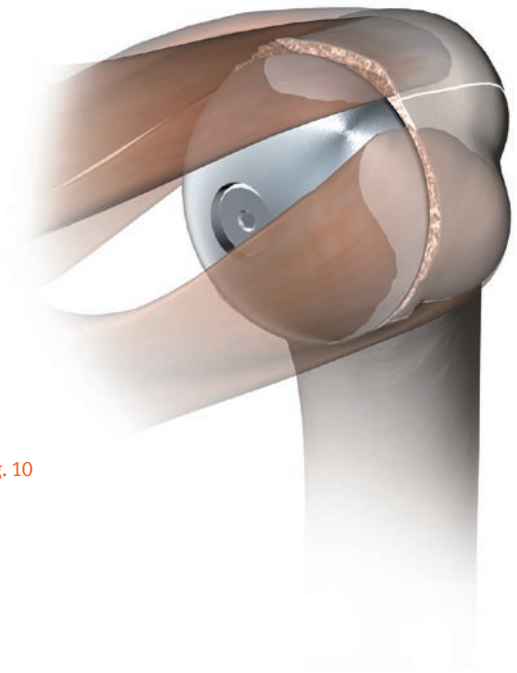


Fig. 10

Now, the height is tested to ensure it is correct:

- 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 must be located below the upper pole of the *Anatomical Shoulder* Fracture Head.
- There must be no diastasis or overlap between the greater tuberosity and the humeral diaphysis.

Now 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 Trails (rasp and trail head) are set, insert the *Anatomical Shoulder* Fx Ruler into the proximal-lateral suture hole of the head component and mark the position next to the associate laser mark on the *Anatomical Shoulder* Fx Ruler.

After reducing the joint, perform a final range of motion assessment (Fig. 10).

Now, remove the ruler, unscrew the *Anatomical Shoulder* Fracture Head Trial, remove the screw for rasp, attach the handle for rasp to the rasp and remove 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. These will be greater tuberosity and lesser tuberosity vertical sutures that will go up around the top of the bone segments through the rotator cuff-bone junction (Fig. **11**).

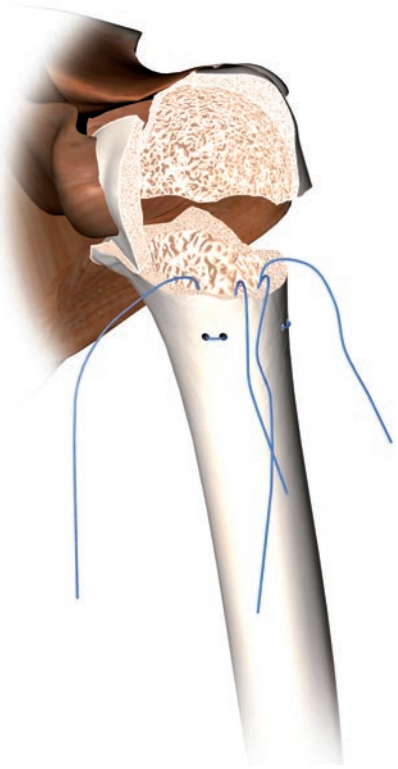


Fig. 11

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 12). Humeral head implant size is the same size and version (left or right) as the trial head chosen previously.

Connect and assemble the elected *Anatomical Shoulder* Fracture Base-Plate to the *Anatomical Shoulder* Fracture Stem with the locking screw (Fig. 12).

Note: Due to the ability to convert from anatomical to inverse/reverse, there has to be a gap between stem and base-plate.

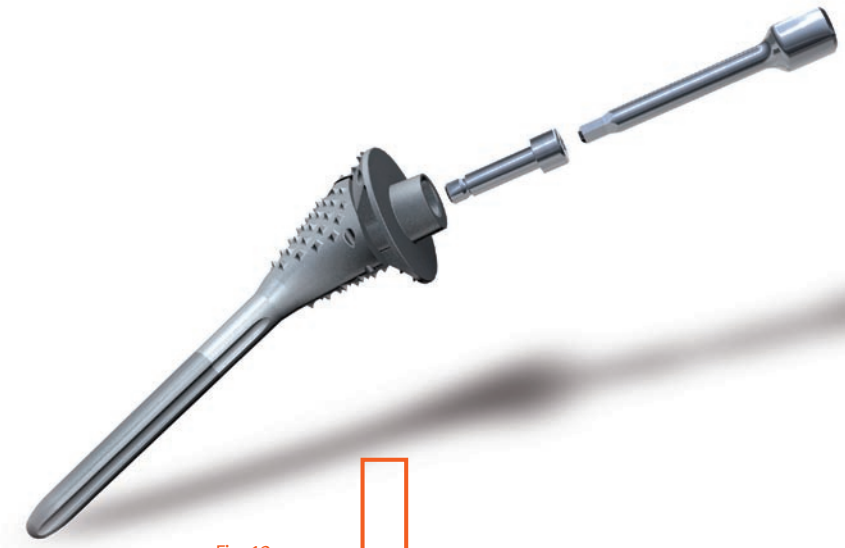


Fig. 12

First, connect the distal support to the Fx adapter (A).

Place the assembled stem into the special stem holder (Fig. 13) and close the adpter arm (B).

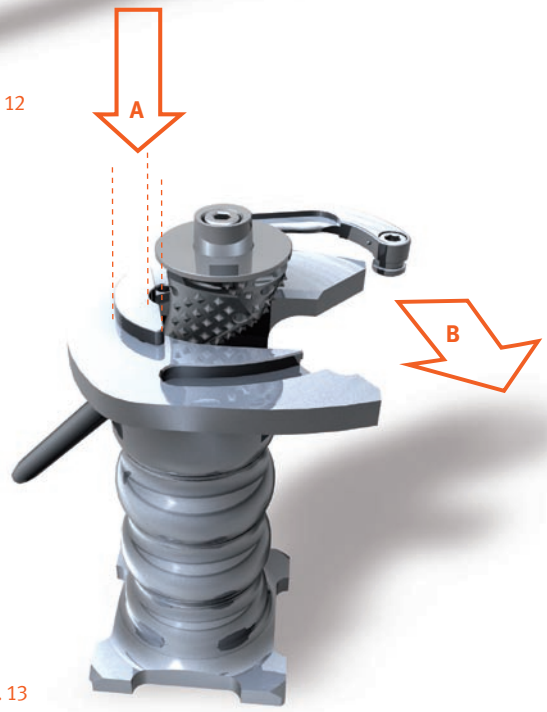


Fig. 13

Connect finally with the help of the torque wrench, stem with base-plate (Fig. 14).

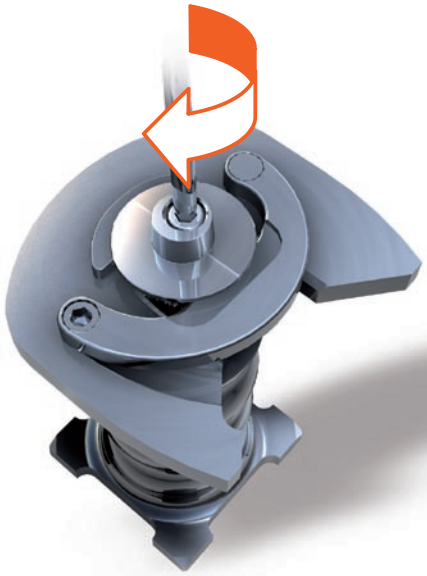


Fig. 14

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

Attach the *Anatomical Shoulder* Fx Ruler onto the *Anatomical Shoulder* Fracture Implant, by inserting the peg of the ruler into the superior hole of the base-plate.

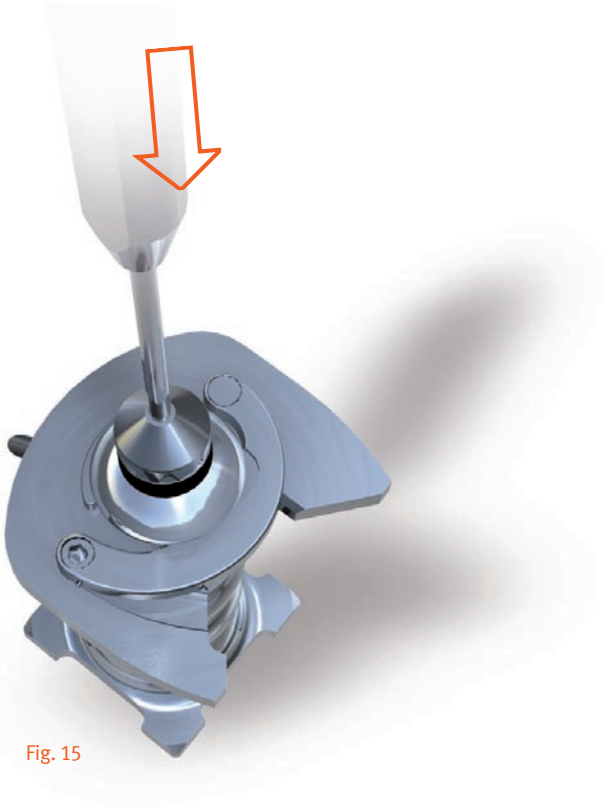


Fig. 15

Cementing the Prosthesis

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

Insert the *Anatomical Shoulder* Fracture Implant into the humeral canal to the same level of the *Anatomical Shoulder* Fx Ruler relative to the mark, marked earlier when the rasp and the trial head were used (Fig. 16). Use the head impactor for finally impaction.

If cemented, make certain that there is no excess cement extruding from the canal proximally above the humeral stem 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. 16).

Reattach 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 into the stem. The following description provides guidelines for using of the suture holes in the stem to provide proper fixation. Suture pattern and method can be modified based on the condition of the fracture. The primary goal of tuberosity reattachment is to get as much contact with the stem and the proximal humeral shaft while rebuilding into the anatomical position.

A suture should be placed in the special greater tuberosity suture hole (green), a second suture in the special lesser tuberosity suture hole (orange) (Fig. 16). 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), 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 greater tuberosity and anterior border of the supraspinatus tendon. This suture is then tied and reduces the greater tuberosity anatomically in an anatomic fashion.

The cerclage sutures will be passed through the subscapularis tendon, at its insertion, wrap around the lesser and greater tuberosities and pass through the infraspinatus and teres minor at the tendon insertions. These sutures will be tightened and tied off first.

The sutures placed in the humeral shaft lateral to the biceps groove, 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.

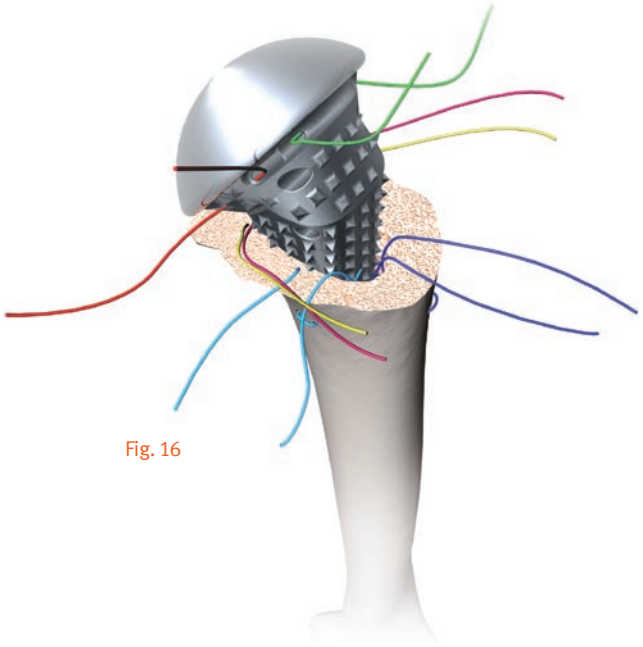


Fig. 16

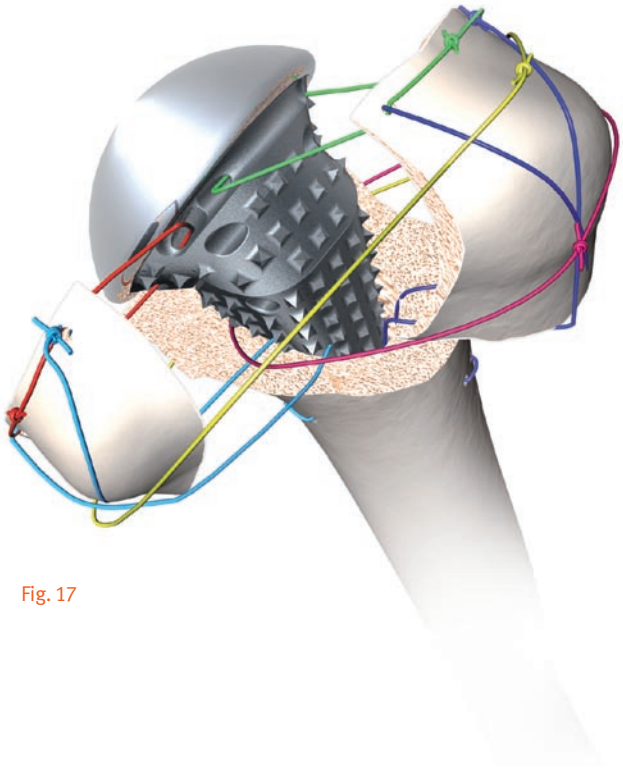


Fig. 17

The sutures placed in the humeral shaft medial to the biceps groove, 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.

The sutures placed in the middle of 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.

If necessary, a second suture from each hole 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 (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.

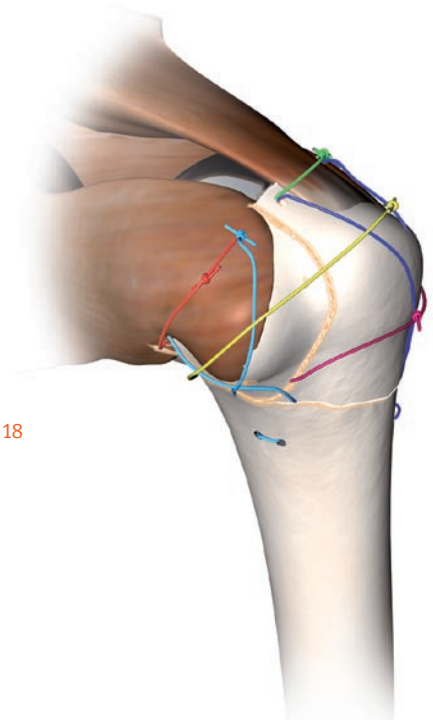


Fig. 18

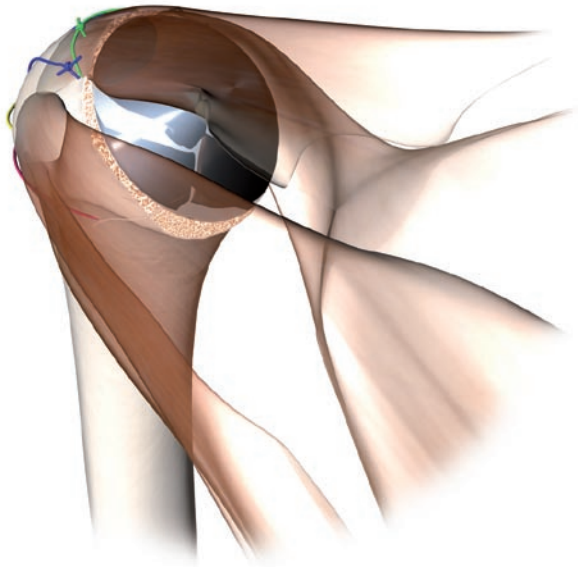


Fig. 19

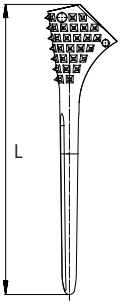
Closure

Close the subcutaneous layers, and then the skin.

Anatomical Shoulder™ Fracture Implants

Anatomical Shoulder™ Fracture Stems Cemented/Uncemented

Protasul®-100
ISO 5832-11
Cemented/Uncemented



STERILE R

Size	L [mm]	REF
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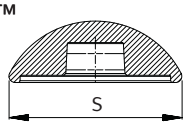
9	130	01.04207.092
10	130	01.04207.102
11	130	01.04207.112
12	130	01.04207.122
13	130	01.04207.132
14	130	01.04207.142

Anatomical Shoulder™ Fracture Long Stems Cemented/Uncemented

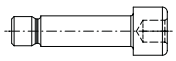
Size	L [mm]	REF
7	170	01.04217.072
9	200	01.04217.092
11	200	01.04217.112
13	200	01.04217.132

Anatomical Shoulder™ Fracture Heads

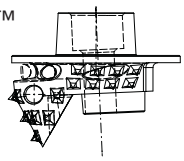
Anatomical Shoulder™
Fracture Head
Protasul®-21WF
ISO 5832-12



Anatomical Shoulder™
Fracture Screw
Protasul®-21WF
ISO 5832-12



Anatomical Shoulder™
Fracture Base-Plate
Protasul®-100
ISO 5832-11

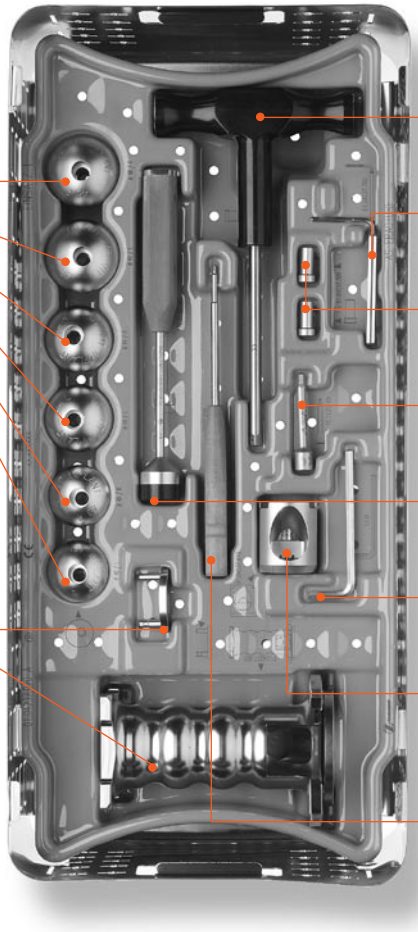


STERILE R

Size (S)	REF	
40	Left	01.04227.400
40	Right	01.04227.405
44	Left	01.04227.440
44	Right	01.04227.445
48	Left	01.04227.480
48	Right	01.04227.485

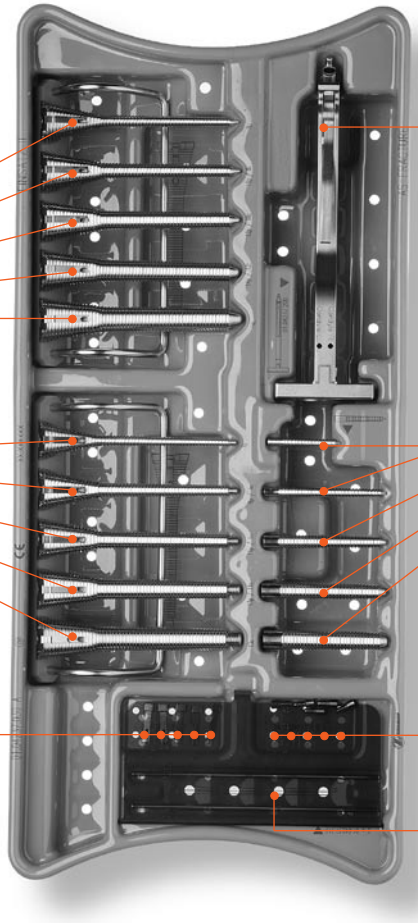
Instruments for Anatomical Shoulder™ Fracture

Article	REF
Anatomical Shoulder™ Fracture Instrument Tray (complete)	ZS01.04237.000
Tray Cover	01.00029.031
Anatomical Shoulder™ Fx Tray (empty)	01.04237.010
Anatomical Shoulder™ Fx Insert I for Tray (empty)	01.04237.020
Anatomical Shoulder™ Fx Humeral Trial Heads	
Left 48	01.04237.480
Right 48	01.04237.485
Left 44	01.04237.440
Right 44	01.04237.445
Left 40	01.04237.400
Right 40	01.04237.405
Anatomical Shoulder™ Fx Adapter	01.04237.600



Article	REF
Torque Wrench for Humeral Head	72.11.20-06
Anatomical Shoulder™ Fx Ruler	01.04237.700
Anatomical Shoulder™ Fx Screw for Humeral Trial Head	01.04237.500
Nut for Torque Wrench, 4,5 mm	72.11.20-09
Impactor for Humeral Stem	72.01.00-01
Hexagonal Wrench, 5 mm	5331
Anatomical Shoulder™ Fx Humeral Stem Setting Instrument	01.04237.610
Hexagonal Screwdriver, 2.5 mm	109.02.020

Article	REF
Anatomical Shoulder™ Fx Insert II for Tray (empty)	01.04237.030
Anatomical Shoulder™ Fx 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™ Fx 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™ Fx Springs for Rasp	01.04237.180



Article	REF
Anatomical Shoulder™ Fx Handle for Rasp	01.04237.200
Anatomical Shoulder™ Fx 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™ Fx Screws for Rasp	01.04237.190
Anatomical Shoulder™ Fx Alignment Rod	01.04237.310

Anatomical Shoulder Portfolio

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