



Anatomical Shoulder™ Fracture

Surgical Technique



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Surgical Technique Anatomical Shoulder Fracture

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Indications

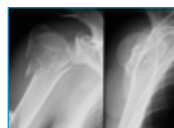
The *Anatomical Shoulder Fracture* System is intended for use in prosthetic replacement of the proximal humerus and the glenoid articular surface of the scapula during total-, hemi- and fracture shoulder arthroplasty in treatment of the following:

- 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.

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.

Preoperative Planning



example 1



example 2



example 3



example 4



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.

Template Options

X-Ray Templates for *Anatomical Shoulder Fracture Stems*, Lit.No. 06.02508.000

X-Ray Templates for *Anatomical Shoulder Fracture Heads*, Lit.No. 06.02510.000

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 be fully extended. 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. 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 and to each other at the time of closure (Fig. 2).

Humeral Head Excision

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

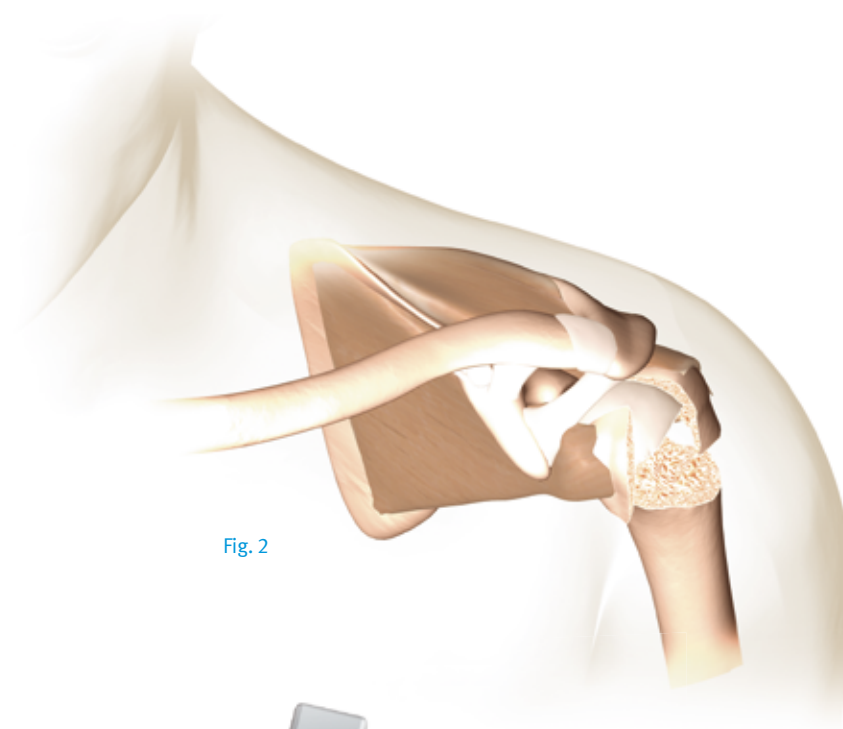


Fig. 2

Humeral Shaft Preparation

Attach the Handle for rasp to the rasp (Fig. 3).

Manually rasp the humeral canal using progressively larger rasps in 1 mm 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, 13, 15 and 17.



Fig. 3



Fig. 4

Optional

If additional Rasp stability is necessary, consider inserting the Locking Spring for Rasp into the lateral slot of the Rasp (Fig. 4).

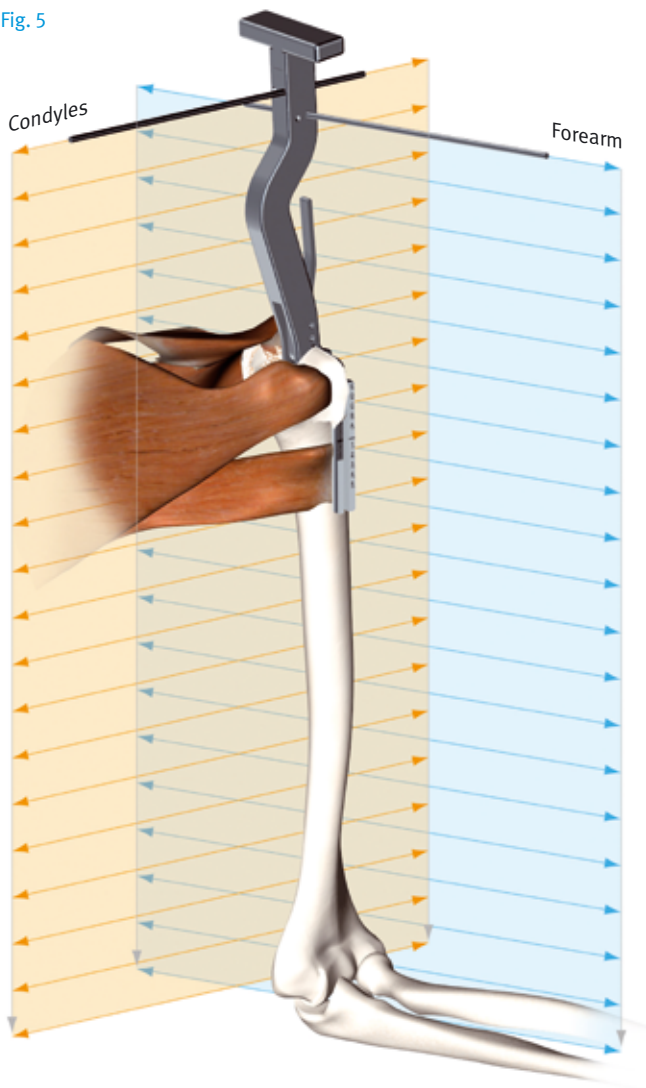
Using the Locking Screw with the Locking Spring Rasp will then provide additional stability

Optional 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° parallel to the axis of the epicondyle of the distal humerus. This automatically should give rise to an inclination of 130° and a retroversion of 18° .

Fig. 5



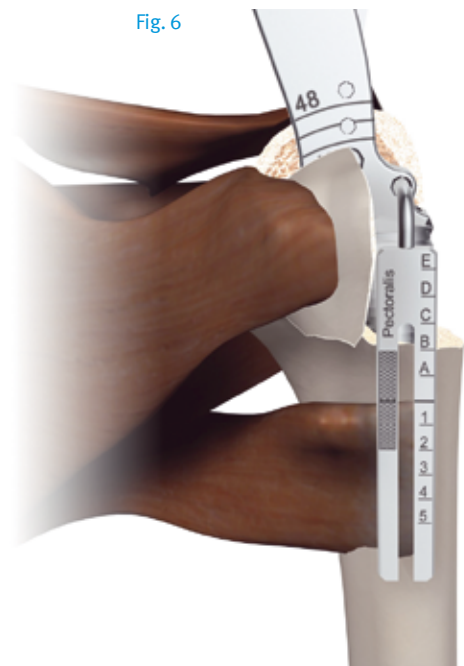
Optional Height Adjustment Technique

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

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

Now verify 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.

Fig. 6



Disconnect the Rasp Handle (Fig. 7).
The rasp is fixed in the appropriate
position, height and retroversion.

Fig. 7



Optional

If additional rasp stability is necessary,
consider inserting a screw through
the proximal opening of the Rasp that
will press the Locking Spring against
the bone (Fig. 7a).



Using the Locking Screw with the
Locking Spring of Rasp will then
provide additional stability.

Optional



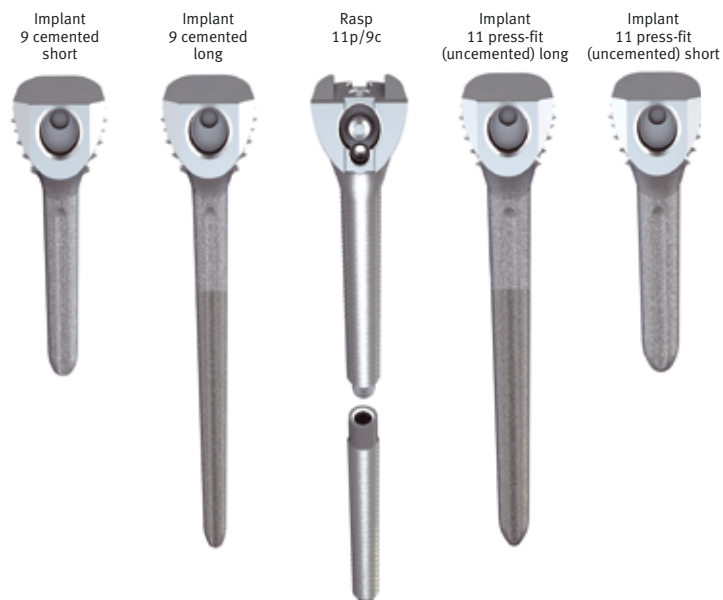
Fig. 7a

Sizing Convention and Consideration

	Rasp size	Rasp extension	[c] Cemented implant size and length	[p] Press-fit implant size and length	
 Anatomical Shoulder Fracture Stems slim	5p slim	no	–	5-90	p = press-fit (uncemented) c = cemented
	6p slim	no	–	6-90	
	7p/5c slim	no	5-90	7-110	
	8p/6c slim	no	6-90	8-110	
	7c slim	no	7-110	–	
	8c slim	no	8-110	–	
 Anatomical Shoulder Fracture Stems	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	
	15p/13c	yes	13-130, 13-200	15-130, 15-200	
	16p/14c	no	14-130	16-130	
	17p/15c	yes	15-130, 15-200	17-130, 17-200	
	18p/16c	no	16-130	18-130	
	17c	yes	17-130, 17-200	–	
	18c	no	18-130	–	



Example Convention and Consideration



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. One of the most common mistake is to use a too large humeral head (Fig. 8).

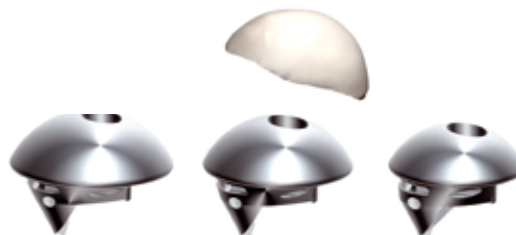


Fig. 8

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 and with the Screw for Humeral Trial Head and the Hexagonal screwdriver prepare the stable fixation of the trial components (Fig. 9).

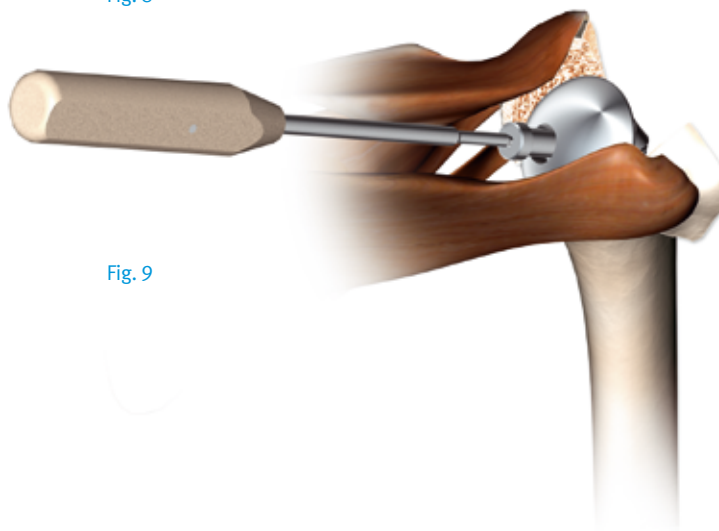


Fig. 9

Note:

If the Slim Fracture Rasp is used, take care to use the Slim Fracture Trial Heads. For the definitive Implants, the Slim Fracture Stem can only be used with the Slim Fracture Heads.

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 greater and lesser tuberosity below the head, back to the original anatomy should be possible (Fig. 10).

The primary goal of tuberosity reattachment is to obtain maximum contact with the stem and the proximal humeral shaft while placing 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 (Fig. 10).

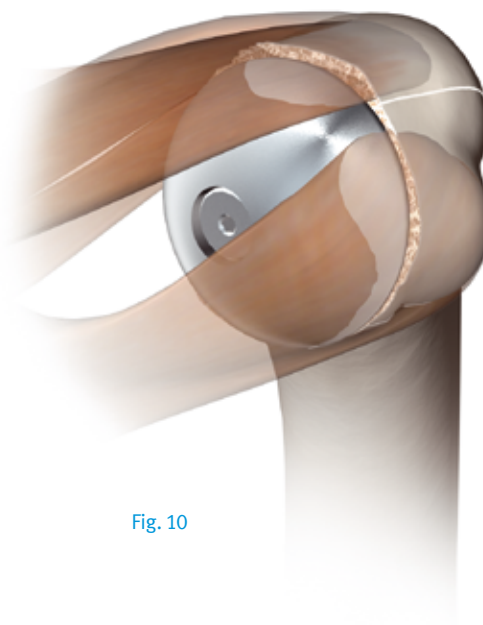


Fig. 10

Now, 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 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 Trial* (Rasp and Trial Head) are set, insert the *Anatomical Shoulder Fracture 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 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*, 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 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. 10a

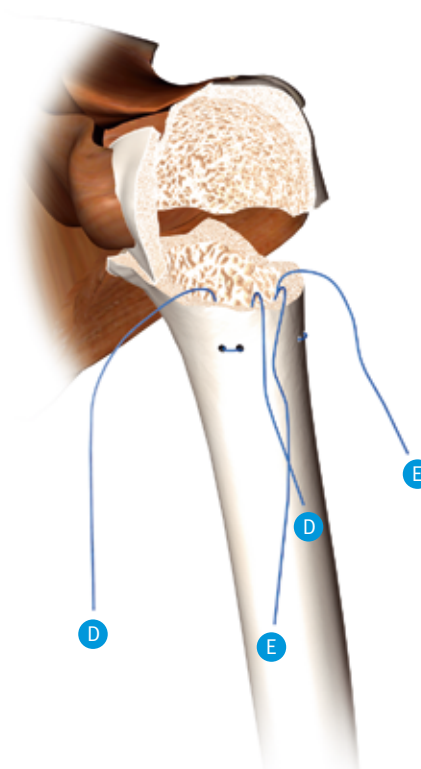


Fig. 11

Assembling the Anatomical Shoulder Fracture Implant

Humeral stem implant size is selected based upon desired technique and fixation. 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 9). 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 (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.

First, connect the Fracture Adapter to the Assembly Block (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 (C).

Connect the Stem with Base-Plate (D) using the Torque Wrench (Fig. 14).

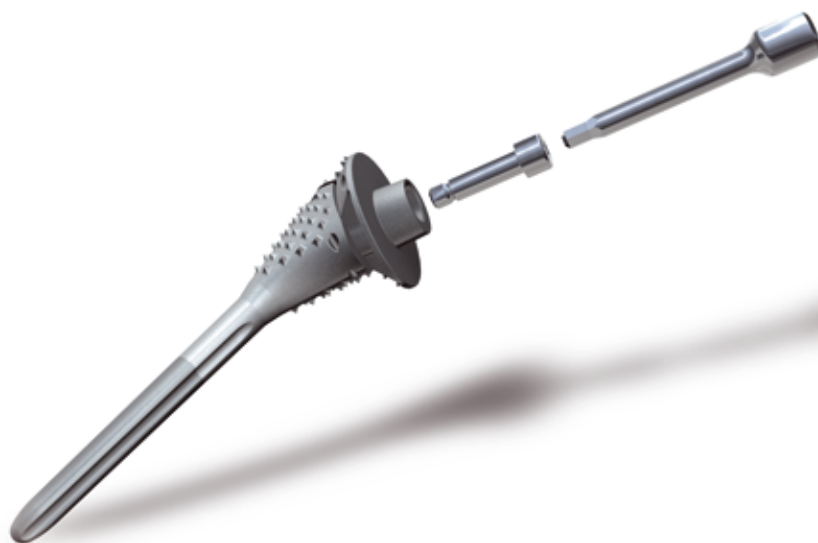


Fig. 12

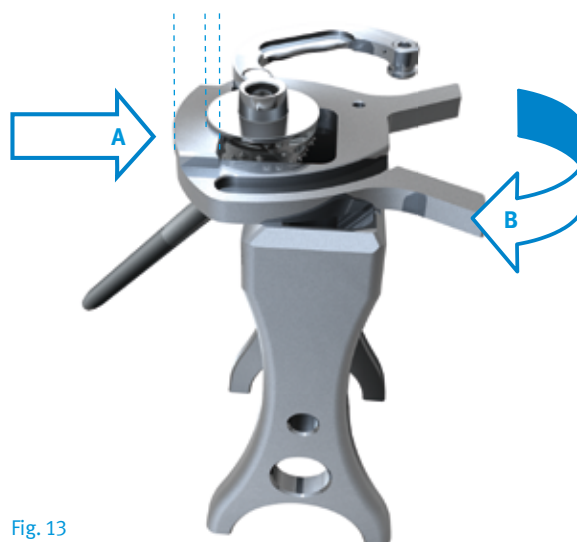


Fig. 13

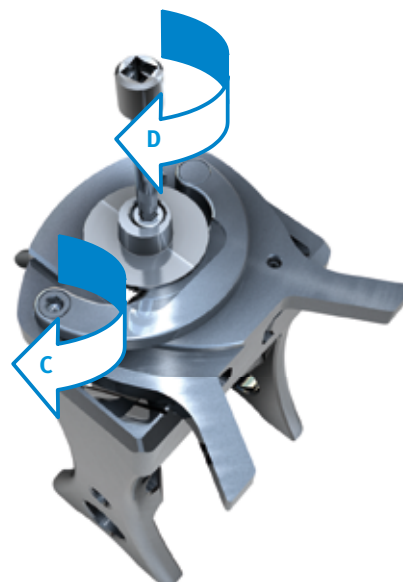


Fig. 14

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

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).



Fig. 15

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.

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

If cemented, make sure 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).

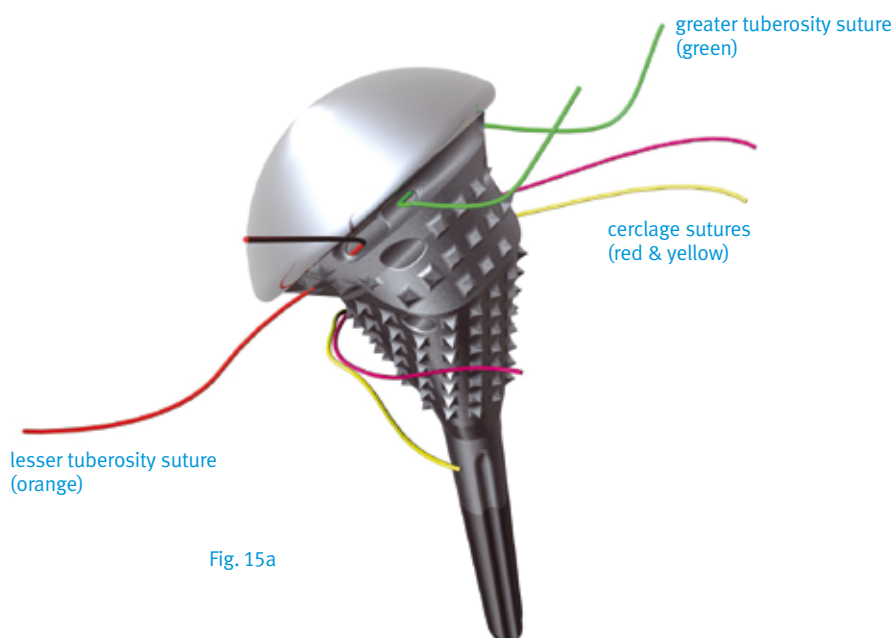


Fig. 15a

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 to the stem. The following description provides guidelines for using the suture holes in the stem to provide proper fixation. Suture pattern and method can be modified based on the condition of the fracture.

Retroversion and height Adjustment

Attach the *Anatomical Shoulder Fracture Ruler* onto the *Anatomical Shoulder Fracture Implant* (Fig. 16a), by inserting the peg of the ruler into the superior hole of the Base Plate to establish the proper Stem height. To assess retroversion, attach the peg of the Control Rod into the superior hole of the Base Plate.

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 of the junction 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, 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 suture placed in the humeral shaft lateral to the biceps groove (dark blue: 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).

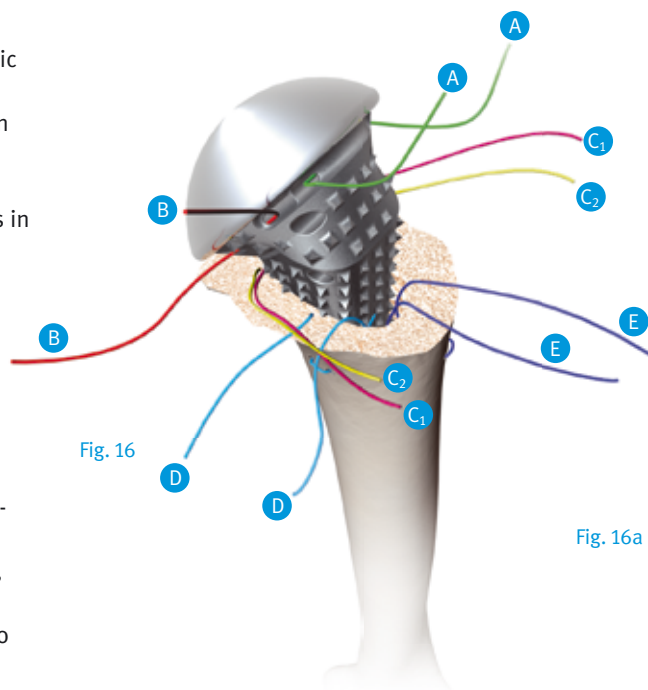


Fig. 16

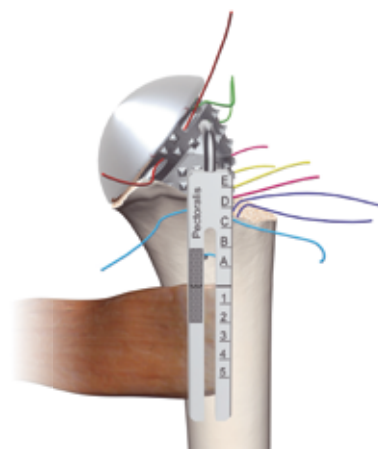


Fig. 16a

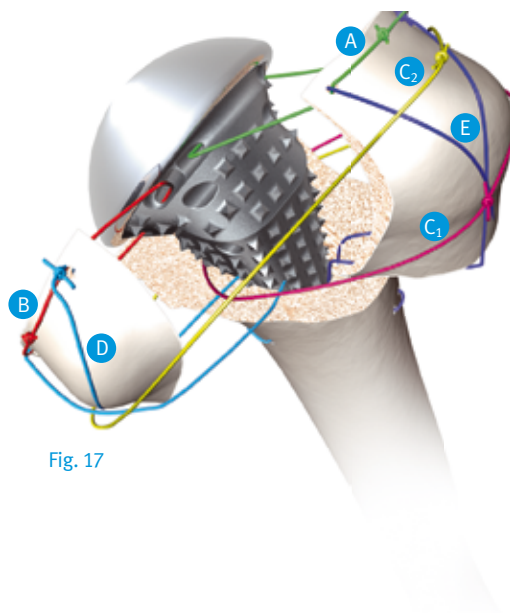


Fig. 17

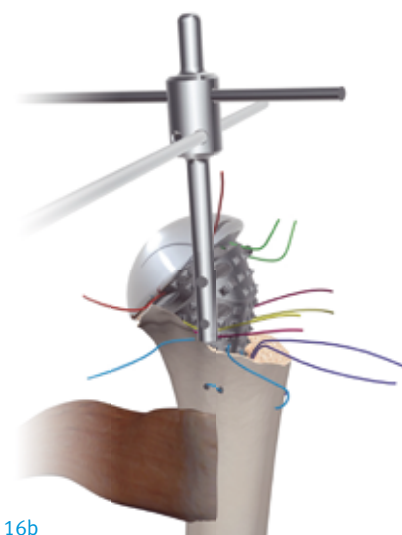


Fig. 16b

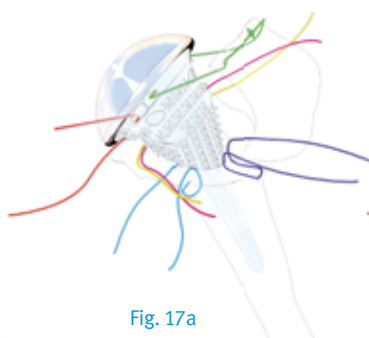


Fig. 17a

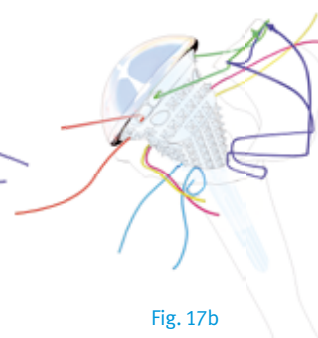


Fig. 17b



Fig. 17c

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 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).

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.

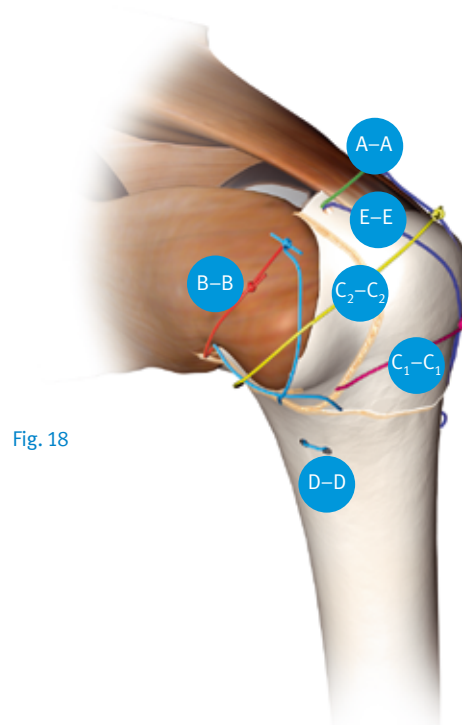


Fig. 18

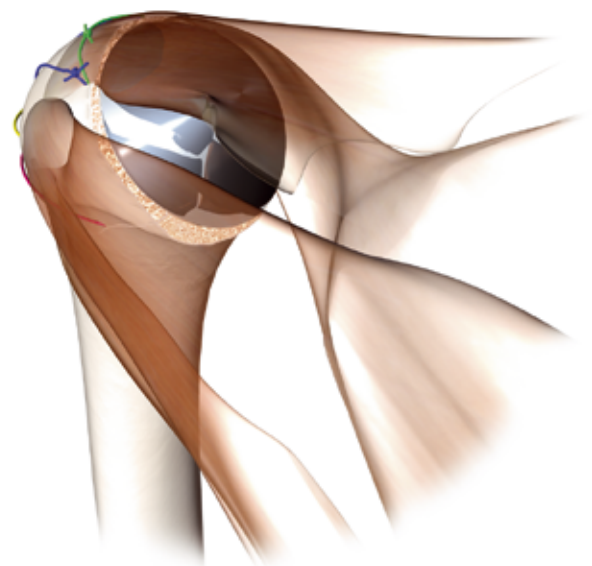


Fig. 19

Futher Possibilities

– Description, how to convert to an *Anatomical Shoulder* Inverse/Reverse system, see Surgical Technique of the Anatomical Shoulder Inverse/Reverse (LIT.NO.: 06.01276.012)

– Description, how to use an *Anatomical Shoulder* freely adjustable Humeral Head, see Surgical Technique of the *Anatomical Shoulder* Domlock System (LIT.NO.: 06.02651.012)

Postoperative Treatment

It is the responsibility of the doctor to decide which postoperative treatment is appropriate depending on each patient's health condition with the understanding that an uncemented implant will generally perform better when load activities in the first few weeks are not too aggressive.

Notes

Notes

Disclaimer

This document is intended exclusively for physicians and is not intended for laypersons.

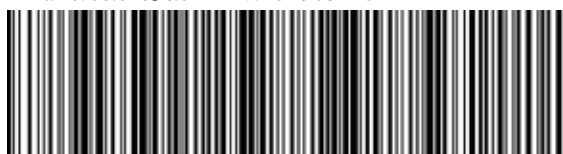
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