Zimmer® Trabecular Metal™ Reverse Shoulder System

Surgical Technique

zimmer

Personal Fit. Renewed Life.™

Trabecular Metal™ Reverse Shoulder System Surgical Technique

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Foreword

Total shoulder replacement has evolved as a biomechanically logical reconstruction of the shoulder. Reconstruction using the humeral component of the *Trabecular Metal* Reverse Shoulder System in conjunction with the *Bigliani/Flatow*® glenoid component allows the potential for the surgeon to restore the geometry of a normal joint, thus ensuring good motion and pain relief, as well as durability of the reconstruction.

When there is severe distortion of osseous anatomy or loss of normal rotator cuff tendon structure, anatomical restoration of the glenohumeral joint is not possible. 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 a reverse solution. The *Trabecular Metal* Reverse Shoulder option offers the ability for potential pain relief and restoration of function using the same humeral stem for reverse or hemi-arthroplasty applications.

The Implant System

The assembled humeral component may be used alone for hemiarthroplasty or combined with the glenoid component or reverse components for total shoulder arthroplasty (conventional or reverse applications).

The *Trabecular Metal* Reverse humeral components are intended for either cemented or press-fit use. The reverse base plate requires two screws for fixation.

Patient Positioning

Patient positioning is especially important in shoulder surgery. Place the patient in a semi beach-chair position with the knees flexed (Fig. 1). Raise the head of the table approximately 25-30 degrees to reduce the venous pressure. Use a head rest that allows for the superior part of the table to be removed. Place two towels under the spine and the medial border of the scapula to raise the affected side. The torso should be at the edge of the table. The shoulder will be off the edge of the table. Attach a short arm board to the table, or use another arm support method that will allow the arm to be raised or lowered as necessary throughout the procedure.

Fig. 1

Incision and Exposure

There are two possible surgical approaches to the shoulder for reverse arthroplasty. The superior-lateral approach relies on a deltoid split similar to a rotator cuff procedure. It allows a more direct view and instrumentation of the glenoid. However, inferior positioning of the glenoid base plate may be more difficult and care to avoid excessive deltoid splitting is essential to minimize risk to the axillary nerve. The delto-pectoral approach will allow easier access to the proximal humerus if there are post-traumatic changes or prior arthroplasty. Additionally, it will allow easier access to the inferior portion of the glenoid.

The choice of approach is the surgeon's preference, but the delto-pectoral approach is typically preferred for revision surgery.

Superior-Lateral Approach

The incision is made from the anteriolateral acromial border downward approximately 4cm.

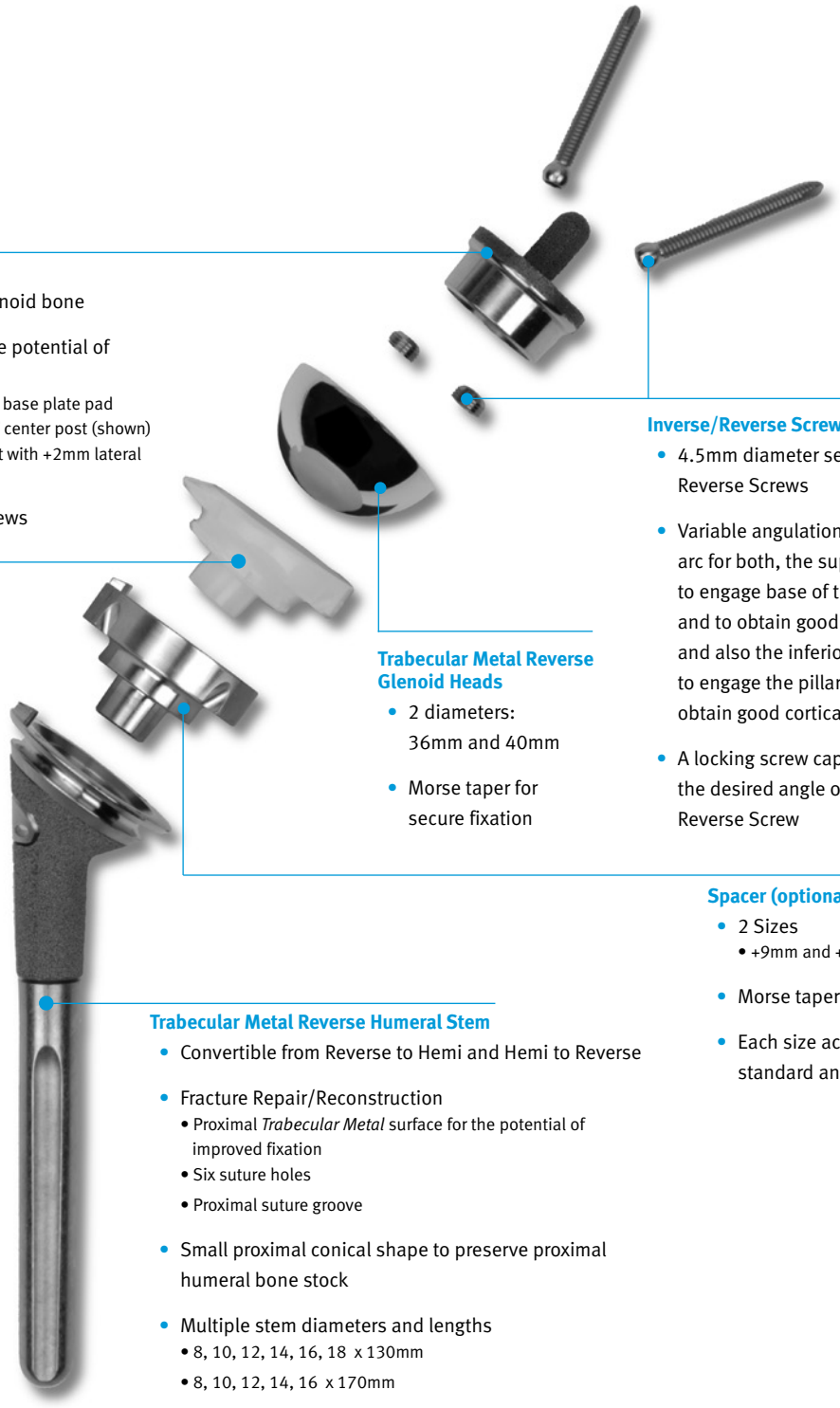
Following subcutaneous dissection, the anterior and middle deltoid muscle bundles are separated opposite the lateral margin of the acromion through the tendinous raphe. Care should be taken to avoid any damage to the axillary nerve, which is located approximately 5-7cm distal to the acromion.

After excision of the scarred and inflamed subacromial bursa, gentle longitudinal traction in line with the limb will allow an elevator to be placed into the joint. The humeral head is dislocated by herniating the proximal humerus through the rotator cuff defect. To optimize the exposure, the anterior border and the rest of the superior cuff can be released.

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. The cephalic vein can be taken either medially or laterally to open the delto-pectoral interval. The clavi-pectoral fascia is incised at the external border of the coracobrachialis. The axillary nerve is then identified just medial to the musculotendinous junction of the subscapularis. Often the subdeltoid bursa is inflamed and scarred and must be sharply excised for exposure.
The remnant of the subscapularis is released and tagged for potential later repair. The inferior capsule is then released allowing a traumatic dislocation of the humeral head by adduction of the arm with progressive external rotation and extension.

Description of the Implants



Trabecular Metal Base Plate

- Small diameter to preserve glenoid bone
- *Trabecular Metal* surface for the potential of improved fixation
  - 28mm diameter *Trabecular Metal* base plate pad
  - Standard 15mm *Trabecular Metal* center post (shown)
  - Available 25 or 30mm center post with +2mm lateral offset in Titanium substrate
- Accepts 2 Inverse/Reverse Screws

Trabecular Metal Reverse UHMWPE Liner

- 60° Standard Liner
  - 36mm and 40mm
  - 3 thicknesses: +0mm, +3mm, and +6mm
- 65° Retentive Liner
  - 36mm and 40mm
  - 3 thicknesses: +0mm, +3mm, and +6mm

Non-Porous Reverse Humeral Stem

- Titanium stem
- Cuff Tear Arthropathy with osteoarthitis
- Numerous stem diameters and lengths
  - 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18 x 130mm
  - 8, 10, 12, 14, 16 x 200mm
- Ability to use cemented or uncemented configurations

Trabecular Metal Reverse Glenoid Heads

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

Trabecular Metal Reverse Humeral Stem

- Convertible from Reverse to Hemi and Hemi to Reverse
- Fracture Repair/Reconstruction
  - Proximal *Trabecular Metal* surface for the potential of improved fixation
  - Six suture holes
  - Proximal suture groove
- Small proximal conical shape to preserve proximal humeral bone stock
- Multiple stem diameters and lengths
  - 8, 10, 12, 14, 16, 18 x 130mm
  - 8, 10, 12, 14, 16 x 170mm
- Ability to use cemented and uncemented configurations

Inverse/Reverse Screw System

- 4.5mm diameter self-tapping Inverse/Reverse Screws
- Variable angulations to a maximum 30° arc 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 cap will fix and secure the desired angle of each Inverse/Reverse Screw

Spacer (optional)

- 2 Sizes
  - +9mm and +12mm
- Morse taper for secure fixation
- Each size accepts both standard and retentive liners

Trabecular Metal Reverse Shoulder Sizing Chart

The sizing chart below shows the dimensions of the *Trabecular Metal* Reverse Stem, provisionals, and the reamers taken at four points along their bodies. Lines 1 and 2 correspond to locations prepared by the proximal reamer, whereas points 3 and 4 correspond to locations prepared by the distal reamer.

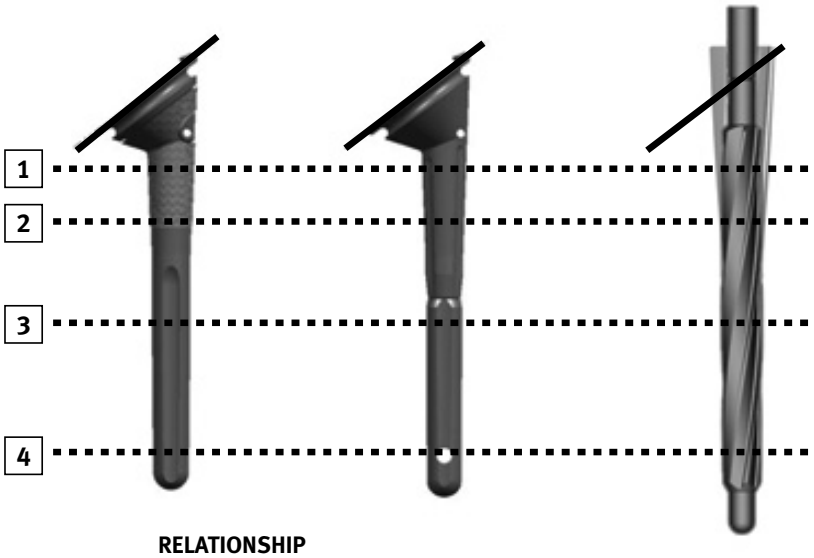
Under the "RELATIONSHIP" section, the dimensions of the A.) Provisional and B.) Stem are compared to those of the reamers. These numbers represent the amount of circumferential press-fit (+) or clearance-fit (-) expected in each zone.

Use this chart to determine the best size stem for press-fit and cemented applications. X-ray templates are also available (97-4309-050-00).

Note: All dimensions are in "mm". Implant sizes are 8, 10, 12, 14, 16, and 18mm in the 130mm length and are also available in 8, 10, 12, 14, and 16mm in the 170mm length.

The dimensions and the numbers listed in the RELATIONSHIP section of the sizing charts resulted when the appropriate reaming technique was followed.

- Distally reaming until the appropriate 130MM STEM or 170MM STEM marking is even with the center opening of the canal (Fig. 12a).
- Proximally ream to the **proximal-lateral edge** of the canal opening (Fig. 23).



		Stem Diameter	Provisional Diameter	Reamer Diameter	RELATIONSHIP A: Provisional to Reamer	RELATIONSHIP B: Stem to Reamer	
Size 8 Stem / 8 Distal Reamer and Pilot	1	11.9	11.4	11.6	-0.2	+0.3	*
	2	10.9	10.4	10.6	-0.2	+0.3	*
	3	8.5	7.8	8.7	-0.9	-0.2	
	4	7.2	7.2	8.0	-0.8	-0.8	
Size 8 Stem / 9 Distal Reamer and Pilot	1	11.9	11.4	11.6	-0.2	+0.3	*
	2	10.9	10.4	10.6	-0.2	+0.3	*
	3	8.5	8.8	9.7	-0.9	-1.2	
	4	7.2	8.2	9.0	-0.8	-1.8	
Size 10 Stem / 10 Distal Reamer and Pilot	1	12.0	11.4	11.6	-0.2	+0.4	
	2	10.9	10.4	10.6	-0.2	+0.3	
	3	10.0	9.8	10.7	-0.9	-0.7	
	4	9.2	9.2	10.0	-0.8	-0.8	
Size 10 Stem / 11 Distal Reamer and Pilot	1	12.0	11.4	11.6	-0.2	+0.4	
	2	10.9	10.4	10.6	-0.2	+0.3	
	3	10.0	10.8	11.7	-0.9	-1.7	
	4	9.2	10.2	11.0	-0.8	-1.8	

		Stem Diameter	Provisional Diameter	Reamer Diameter	RELATIONSHIP A: Provisional to Reamer	RELATIONSHIP B: Stem to Reamer
Size 12 Stem / 12 Distal Reamer and Pilot	1					
	2	13.9	13.4	13.6	-0.2	+0.3
	3	13.0	12.5	12.6	-0.1	+0.4
	4	12.0	11.8	12.7	-0.9	-0.7
Size 12 Stem / 13 Distal Reamer and Pilot	1					
	2	13.9	13.4	13.6	-0.2	+0.3
	3	13.0	12.5	13.6	-1.1	-0.6
	4	12.0	12.8	13.7	-0.9	-1.7
Size 14 Stem / 14 Distal Reamer and Pilot	1					
	2	16.0	15.5	15.6	-0.1	+0.4
	3	15.0	14.5	14.6	-0.1	+0.4
	4	14.0	13.8	14.7	-0.9	-0.7
Size 14 Stem / 15 Distal Reamer and Pilot	1					
	2	16.0	15.5	15.6	-0.1	+0.4
	3	15.0	14.5	15.6	-1.1	-0.6
	4	14.0	14.8	15.7	-0.9	-1.7
		13.3	14.2	15.0	-0.8	-1.7

*Size 8 stems use 9/10 proximal reamers

** For press-fit application, when trialing for the definitive stem, use the distal pilot that matches the definitive stem size.

				RELATIONSHIP A	RELATIONSHIP B
		Stem Diameter	Provisional Diameter	Reamer Diameter	Provisional to Reamer	Stem to Reamer
Size 16 Stem 16 Distal Reamer and Pilot	1	17.9	17.4	17.5	-0.1	+0.4
	2	17	16.5	16.8	-0.3	+0.2
	3	16	15.8	16.7	-0.9	-0.7
	4	15.3	15.1	16.0	-0.9	-0.7
Size 16 Stem 17 Distal Reamer and Pilot	1	17.9	17.4	17.8	-0.4	+0.1
	2	17.0	16.5	17.8	-1.3	-0.8
	3	16.0	15.8	17.7	-1.9	-1.7
	4	15.3	15.1	17.0	-1.9	-1.7
Size 18 Stem 18 Distal Reamer and Pilot	1	19.9	19.4	19.4	0	+0.5
	2	19.0	18.5	18.8	-0.3	+0.2
	3	18.0	17.8	18.7	-0.9	-0.7
	4	17.3	17.2	18.0	-0.8	-0.7
Size 18 Stem 19 Distal Reamer and Pilot	1	19.9	19.4	19.8	-0.4	+0.1
	2	19.0	18.5	19.8	-1.3	-0.8
	3	18.0	17.8	19.7	-1.9	-1.7
	4	17.3	17.2	19.0	-1.8	-1.7

Humeral Preparation

After dislocation of the humeral head, place a retractor medially between the humerus and the glenoid and laterally between the humeral head and deltoid. Release of capsule from the inferior aspect of the humeral neck may be needed to achieve dislocation. Before reaming the canal, it is important to remove all anterior and inferior osteophytes so that the true anatomical neck (junction of the articular cartilage and cortical bone) can be determined.

Technique Tip: *To facilitate access to the humeral canal, the shoulder should be off the table to allow complete extension of the arm and straight access down the canal.*

Note: In addition to the *Trabecular Metal* Reverse specific instrumentation, the *Bigliani/Flatow* Shoulder System instrumentation is also used in this technique.

Sizing Information

Trabecular Metal Reverse humeral stems are offered in 8, 10, 12, 14, 16 and 18mm distal diameters in 130mm lengths and in 8, 10, 12, 14 and 16mm distal diameters in 170mm lengths. The Non-Porous Reverse humeral stems come in 6, 8-16 (in 1mm increments) and 18mm distal diameters in 130mm lengths and 8, 10, 12, 14 and 16mm distal diameters in 200mm lengths. The instruments that are used exclusively for 200mm Non-Porous Reverse humeral stems are in a separate, dedicated instrument set. The size of your distal reamer will influence your distal fit. If cementing, larger size distal reamers can be used to provide the desired cement mantle size. However, proximal press fit may still be possible depending on the proximal humeral size and preparation as well as the amount of cement used. Refer to Sizing Chart on pages 4 and 5 for press-fit/clearance conditions.

Note: The stem has a 4˚ taper proximally to the mid-shaft and a 1˚ taper at the distal end of the implant. This maintains the *Bigliani/Flatow* Shoulder philosophy of a low profile, bone-conserving stem. Reaming of the canal provides an average press-fit of ½mm proximally and clearance distally.

Distal Humeral Preparation

Attach a short 6mm *Bigliani/Flatow* Intramedullary Reamer with a trocar point to the Ratchet T-Handle (Fig. 2). There are three positions marked on the collar of the T-Handle: FORWARD, LOCKED and REVERSE. To ream a starter hole, use the FORWARD position (Fig. 3). Place the trocar tip of the reamer just posterior to the bicipital groove and at the most superior point of the humeral head to allow straight reaming down the canal. Be careful as to not allow the absence of the normal cuff insertion on the tuberosity to mislead you into a lateral starting point. A mallet

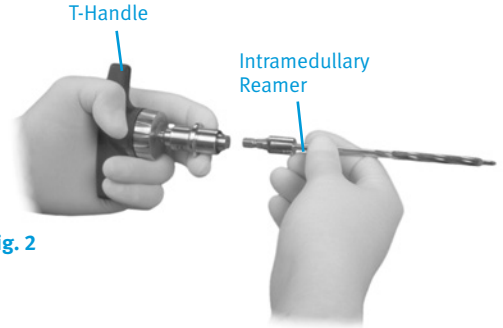


Fig. 2

Fig. 3

may be used to start the hole in hard bone. After using the 6mm short trocar reamer, use the longer, blunt-tipped 6mm Intramedullary Reamer and begin manually reaming the humeral canal. If pre-operative planning suggests the canal diameter is much wider than 6mm, then use the 8mm Intramedullary Reamer instead (Fig. 4). The longer reamers have a blunt tip to help guide them down the canal and prevent obtrusion into cortical bone. Use progressively larger reamers in 1mm increments until resistance is felt from cortical contact in the canal.

Continue reaming to the appropriate depth (either 130mm stem or 170mm stem) as indicated on the reamer shaft (Fig. 5). If implanting a 200mm Non-Porous Reverse humeral stem, there are dedicated Intramedullary Reamers in the 200mm Non-Porous Reverse instrument case. These reamers have an additional 200mm etch mark on the reamer shaft. Remove the T-handle, but leave the last reamer in the canal to interface with the Humeral Head Cutting Guide or the Superior Cut Guide.

Visualizing Humeral Resection Angle

Use the *Trabecular Metal* Reverse 53° Silhouette (Fig. 6) to aid in the visual assessment of the humeral resection angle.

Fig. 4

Fig. 5

Resect Humeral Head

Assemble the Standard *Trabecular Metal* Reverse Cutting Guide for either a left or right configuration. See “Assembling the *Trabecular Metal* Reverse Humeral Cutting Guide.”

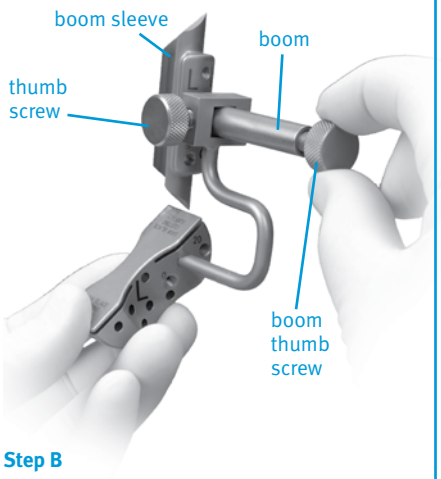
Fig. 6

Assembling the Trabecular Metal Reverse Humeral Cutting Guide

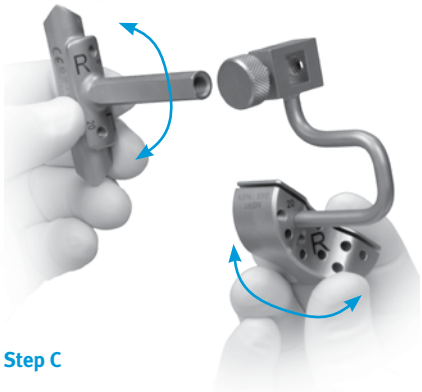
Select the cutting block side for the right or left humerus by referencing the R or L markings. With the thumb screw at the end of the boom pointed toward you, observe the various “R” and “L” etchings that indicate a right or left configuration. Push the cutting guide onto the boom sleeve (Step A). All of the etchings that are facing you now should be the same, either “R” or “L”.

Step A

To change the right/left orientation, remove the thumb screw at the end of the boom (Step B). Then loosen the second thumb screw on the box at the top of the boom stem. Slide the boom stem off the end of the boom. Rotate the sleeve (top to bottom) and turn the cutting guide so that the other side is facing forward. Reinsert the sleeve on the boom and push the cutting guide onto the sleeve (Step C).

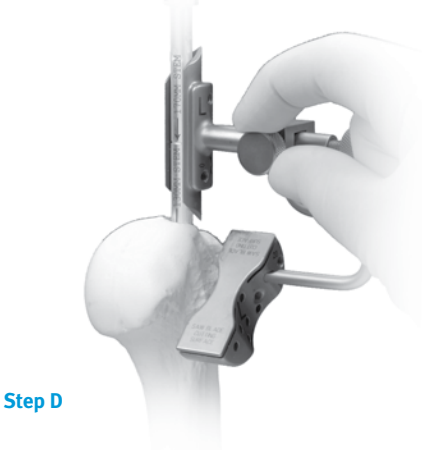


Step B



Step C

Retighten the thumb screw on the box at the top of the boom stem. Then reinsert and tighten the thumb screw at the end of the boom. Finally, verify that all the appropriate right or left etch marks are visible when the boom thumb screw is facing you (Step D).



Step D

Slide the boom sleeve over the reamer shaft (Fig. 7). Adjust the depth of cut by moving the sleeve up or down on the reamer shaft. Typically, the tip of the boom sleeve should be touching articular cartilage/bone surface. If the cut appears too low, the cutting guide can be moved to the correct height. Assessment of the level of the cut can be aided by use of the Humeral Head Cutting Guide Fingers to ensure that any remaining posterior rotator cuff is not inadvertently released by an excessive cut. Then, tighten the boom thumb screw, which is located on the end of the boom. Advance the boom stem and cutting block along the boom until the block contacts the bone. Tighten the second thumb screw, which is located at the junction of the boom and boom stem.

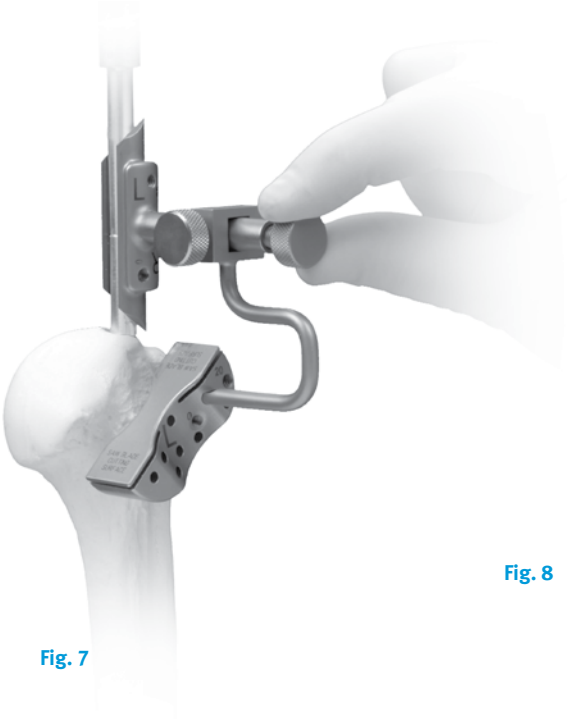


Fig. 7

To gauge the retroversion of the cut, insert Threaded Alignment Rods into the holes marked 0 degrees and 20 degrees on the boom sleeve. Optional placement for the Threaded Alignment Rods can be found on the cutting block. Then line up the rods with the forearm to assess the retroversion (Fig. 8). Retroversion can be adjusted by loosening both thumb screws and rotating the cutting guide about the axis of the Intramedullary Reamer. Then retighten the thumb screws.

Fig. 8

Assemble and drive a 3.2mm Threaded Pin or a disposable 48mm Headed Screw through the cutting block into the humerus (Figs. 9 & 10). At least 2 pins are required to stabilize the cutting block. If the cortex is very hard, predrill these holes using a drill with a diameter between 2.0mm and 2.7mm.

Fig. 9

Note: Use caution not to drill through the threaded version holes on the cutting block, as they are very close in proximity to the pin holes.

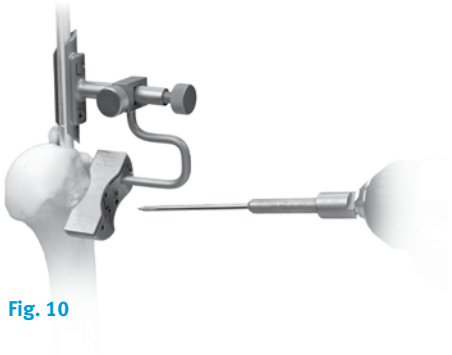


Fig. 10

Loosen both thumb screws on the guide and remove the boom, leaving the cutting block in place (Fig. 11). Set the T-handle to the **REVERSE** position. Attach the T-handle to the reamer and remove the reamer from the humeral canal. The Threaded Alignment Rods may be removed prior to making the cut. Use an oscillating saw to resect the humeral head (Fig. 12). Then remove the cutting block.

Fig. 11

Fig. 12

Fig. 12a

In order to account for the tapered geometry of the implant and any variations in head size, reinsert the final distal reamer after the humeral head is resected. Re-ream until the appropriate 130MM STEM or 170MM STEM marking is even with the center of the opening of the canal resulting in the "RELATIONSHIP" detailed in the Sizing Charts on page 4. If implanting a 200mm Non-Porous Reverse humeral stem, the dedicated distal reamer has an additional 200mm etch mark (Fig. 12a).

WARNING: Not re-reaming the canal may result in a press-fit in the mid to distal region of the provisional and/or implant.

Superior Cut Guide Assembly and Usage

An alternative approach to humeral head resection is to use the Superior Cut Guide. To use this guide, take the boom sleeve and orient it for the right or left humerus by rotating it so that either the R is up for a right humerus or the L is up for a left humerus (Fig. 13). Next, take the boom thumb screw (Fig. 14) and screw it down through both openings until bottomed out.

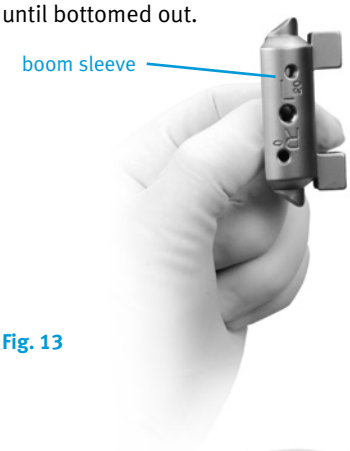


Fig. 13

Fig. 14

To engage the cut guide wings, place the cut guide wings on a flat surface and position the boom sleeve so that the inferior point of the boom sleeve is within the inner circle of the cut guide wings (Fig. 15). Next, take the boom thumb screw and engage the threads on the lateral edge of the cut guide wings (Fig. 15). The boom thumb screw should completely engage the cut guide wings. Screw downward until completely tight.

Fig. 15

Take the assembled construct and slide it over the reamer shaft with the cut guide wings wrapped around the proximal humerus (Fig. 16). Adjust the depth of cut by moving the sleeve up or down on the reamer shaft. Typically, the tip of the boom sleeve should be touching articular cartilage/bone surface. If the cut appears too low, the cut guide wings can be moved to the correct height. Once the appropriate height is determined, tighten the thumb screw to hold the boom sleeve and cut guide wings in place (Fig. 17).

Fig. 16

Fig. 17

To gauge the retroversion of the cut, insert Threaded Alignment Rods into the holes marked 0 degrees and 20 degrees on the boom sleeve. Line up the rods with the forearm to assess the retroversion (Fig. 18). If necessary, retroversion can be adjusted by loosening the thumb screw and rotating the boom sleeve about the axis of the Intramedullary Reamer. Then retighten the thumb screw. The point of the sleeve points to the bicipital groove.

Fig. 18

Assemble and drive a 3.2mm Threaded Pin or a disposable 48mm Headed Screw through the cut guide wings into the humerus (Fig. 19). At least 2 pins are required to stabilize the cut guide wings. If the cortex is very hard, pre-drill these holes using a drill with a diameter between 2.0mm and 2.7mm. **Insert the pins so that they are parallel with the hole in which they are inserted.** Once the cut guide wings are fixed, loosen both the boom thumb screws from the cut guide wings and the thumb screw on the middle of the boom sleeve. Remove the boom sleeve from the reamer shaft and leave the cut wings in place (Fig. 20). Set the T-handle to the **REVERSE** position, attach it to the reamer, and begin removing the reamer from the humeral canal. After using an oscillating saw to resect the humeral head (Fig. 21) you can then remove the cut wings from the proximal humerus.

Fig. 19

Fig. 20

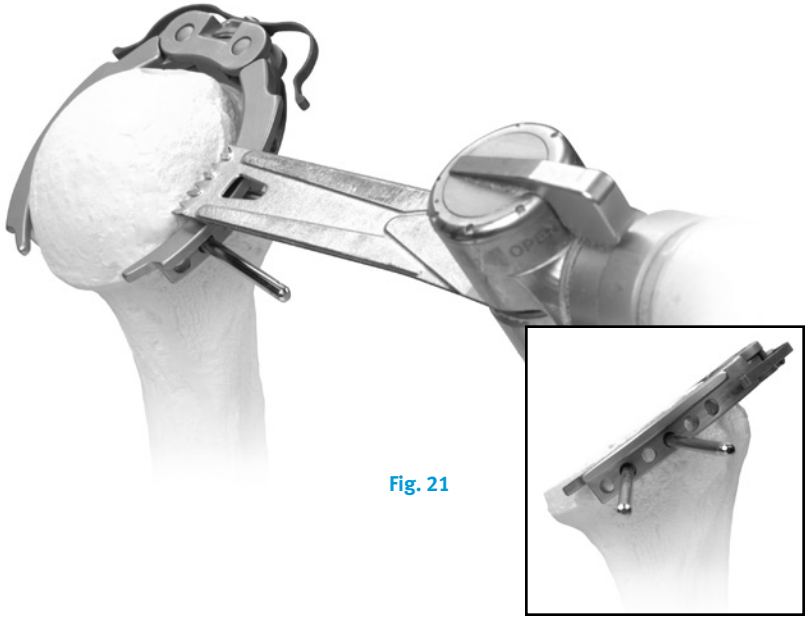


Fig. 21

Proximal Humeral Preparation

Reaming of the proximal humeral canal is done in two stages. First, select the appropriate Tapered *Trabecular Metal* Proximal Humeral Reamer, which are matched to the implant size.

Note: *Trabecular Metal* humeral implant sizes are 8, 10, 12, 14, 16 and 18mm in the 130mm length and are also available in 8, 10, 12, 14, and 16mm in the 170mm length. Non-Porous Reverse humeral implant sizes are 6, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 18mm in the 130mm length and 8, 10, 12, 14 and 16mm in the 200mm length.

Attach the Distal Pilot matching the reamed humeral canal to the Tapered *Trabecular Metal* Proximal Reamer. The Distal Pilot should spin freely. Ream the proximal humerus until the reamer is flush with the proximal-lateral edge of the canal opening (Figs. 22 & 23).

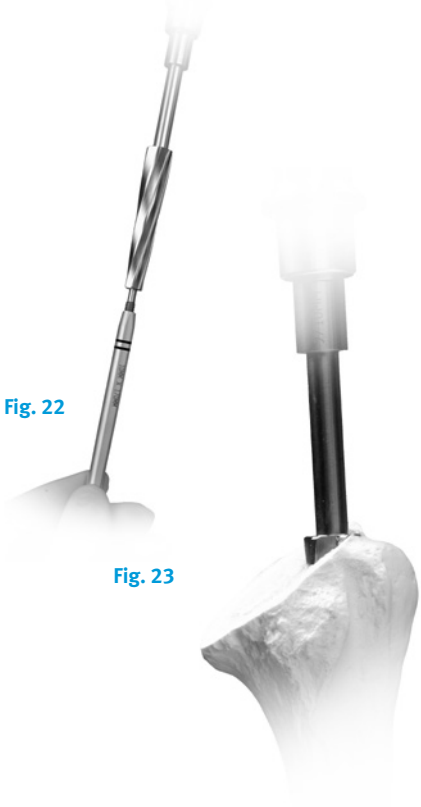


Fig. 22

Fig. 23

Note: If a size 8mm intramedullary reamer has been selected as the final reamer, use the 9/10mm Proximal Reamer with the 8mm Distal Pilot to prepare for the size 8mm TM Reverse humeral stem. If implanting a Non-Porous Reverse humeral stem, there is a dedicated 8mm proximal reamer.

Then, assemble the Conical Reamer to the Reamer Body Pilot which matches the *Trabecular Metal* Humeral Proximal Reamer last used (Fig. 24). Assemble the T-Handle onto the assembly and insert the assembly into the preparation. Place the Version Control Handle onto the shaft of the Conical Reamer (Fig. 25). The Alignment Rods may be threaded into the holes of the Version Control Handle. The Version Control Handle should be held parallel to the humeral shaft, allowing accurate use of the Alignment Rods and control of the Conical Reamer.

For a reverse application the assembly would typically be inserted with 0 to 20 degrees of retroversion. For hemi or total shoulder arthroplasty, the assembly would typically be inserted more towards 20 degrees of retroversion. The Version Control Guide Handle can also be referenced as 0 degrees of version. Ream the proximal humerus until the Conical Reamer is flush with the **proximal-lateral edge** of the canal opening (Fig. 26) (typically at the rotator cuff insertion). Remove the Conical Reamer assembly.

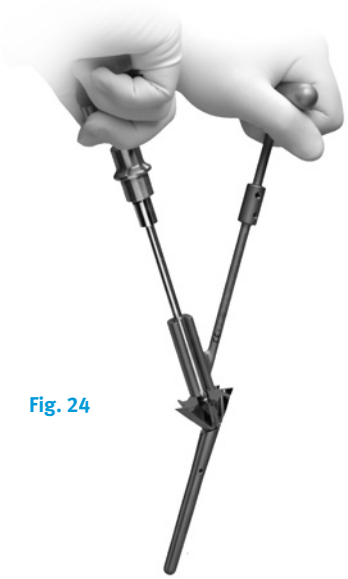


Fig. 24

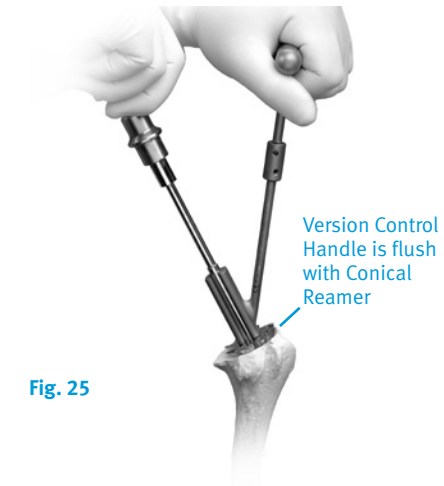


Fig. 25

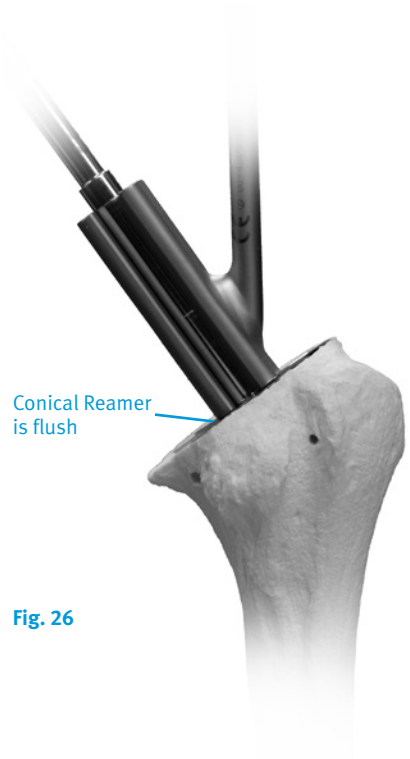


Fig. 26

Humeral Provisional Stem Assembly Insertion

Attach the appropriate Distal Pilot to the appropriate sized Proximal Trial (Fig. 27). For press-fit application, when trialing for the definitive stem, use the distal pilot that matches the definitive stem size. If cementing distally, the Intramedullary Reamer can be larger than the distal stem, and the larger Distal Pilot should be used.

Note: It is important that the Proximal Trial be sized to the last Proximal Reamer used to ensure an appropriate height of the implant in the bone (Fig. 27).

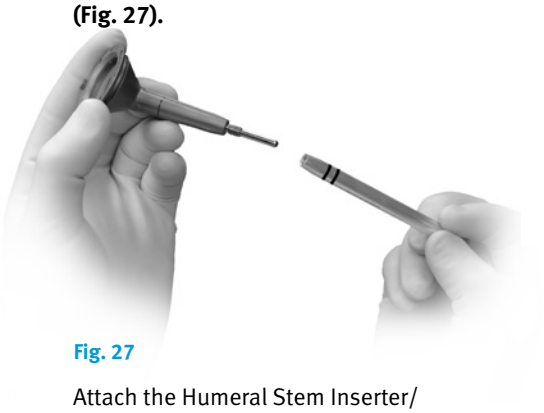


Fig. 27

Attach the Humeral Stem Inserter/Extractor to the trial assembly by opening the handle all the way, inserting the Inserter/Remover end into the proximal opening in the assembly, and closing the handle to lock the inserter in place (Fig. 28).

Note: The Inserter has a cut-out that aligns with the boss on the proximal lateral face of the trial to orient the rotational position (Fig. 29).

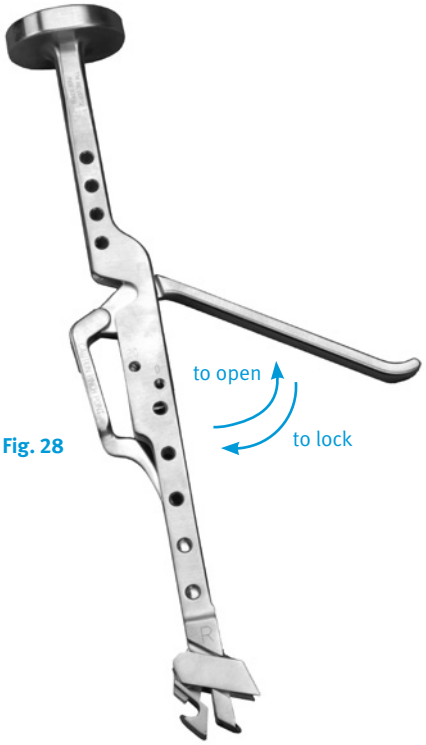


Fig. 28

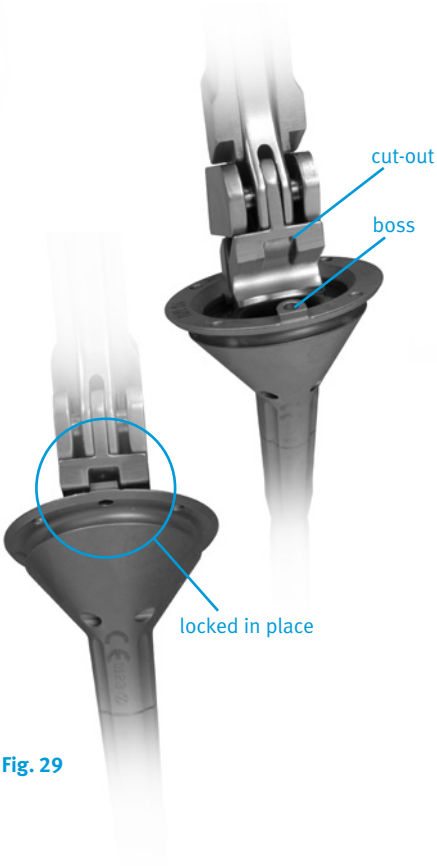


Fig. 29

There are 0 and 20 degree holes on the Inserter/Extractor to allow for verification of the stem retroversion using the Threaded Alignment Rods, if desired. The Alignment Rods may be removed prior to impacting the trial assembly. Impact the assembly into the canal until the rim is flush with the cut surface (Fig. 30).

Note: While inserting the stem, care should be taken not to rotate the stem.

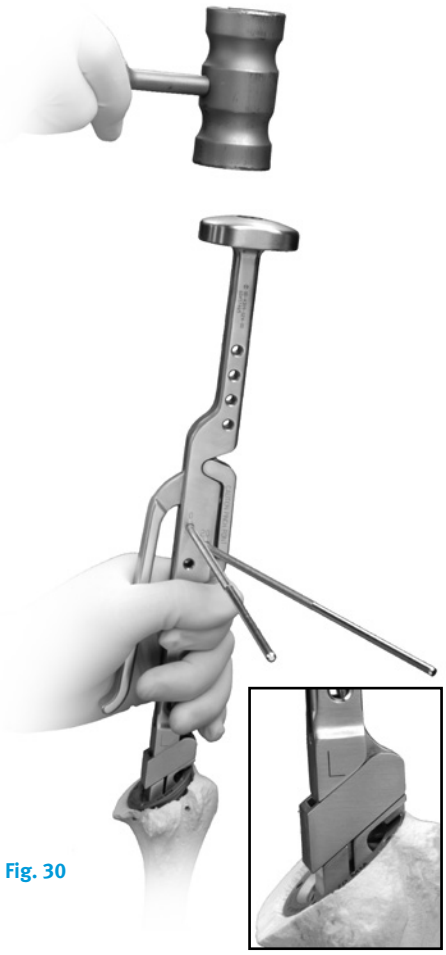


Fig. 30

The Dual Taper Trial may now be placed on top of the stem (Fig. 31). For a reverse application it will protect the taper during the remaining preparation. For a hemi or total application it will accept the trial humeral head and be used for a trial reduction.

Fig. 31

For a reverse application, continue on to the next section (Glenoid Preparation).

For a hemi or total application, skip ahead to the Hemi-Arthroplasty / Total-Arthroplasty Section (see page 26).

Glenoid Preparation

Before implanting the base plate, it is essential to thoroughly evaluate the bony architecture of the glenoid vault. CT Scan or MRI is optimal pre-operative imagery to assess glenoid vault depth, presence and amount of glenoid fossa erosion, and existence of defects.

Straight-on exposure of the glenoid is necessary for proper reaming and component insertion. If a superior-lateral approach was utilized, a forked retractor or the *Zimmer* Shoulder Shoehorn Retractor (Fig. 32) can be placed posteriorly-inferiorly on the glenoid to retract the humeral head out of the way. If exposure is limited, re-evaluate the level of the humeral cut.

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

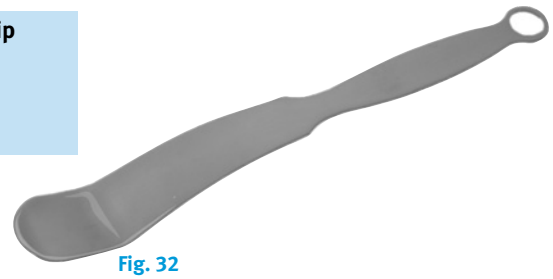


Fig. 32

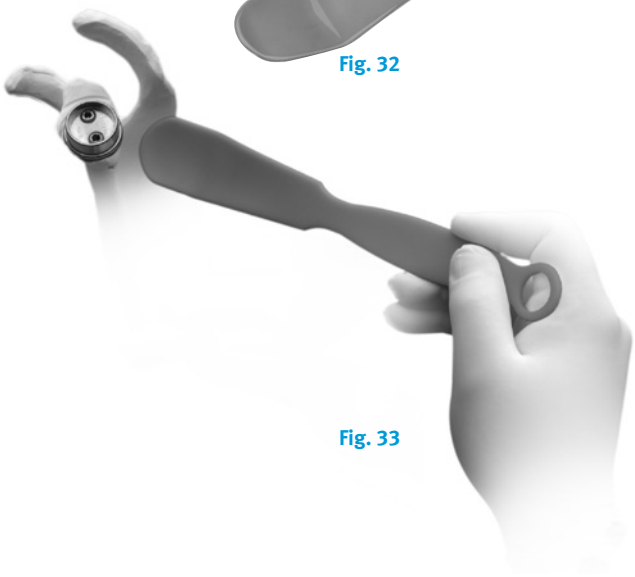


Fig. 33

NOTE: While preparing the glenoid, the placement of the proximal humerus and provisional along with retractors should be carefully considered. Their positions may allow for interference with glenosphere seating. Exposure should allow for straight on engagement of the glenosphere on the base plate taper. Consider use of the *Zimmer* Shoulder Shoehorn Retractor as it has been designed to aid in retracting the humeral head and other soft tissue when placed on the posterior side of the glenoid (Fig. 33).

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

If the complete surgical technique is desired, please refer to the following documents and/ or websites:

Paper Copy:
Anatomical Shoulder Inverse/Reverse System (item number: 97-4223-102-00)

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

Non-Cannulated Technique for 15mm Base Plate

If desired, the Glenoid Scraper can be used to clean the glenoid face of any remaining articular cartilage or scar tissue. Assemble the Base Plate Drill Guide 1 by placing the face into the handle so that the two pieces mate and rotate into position (Fig. 34). Evaluate positioning of the base plate by placing the Base Plate Drill Guide 1 on the glenoid face. The outer rim of Drill Guide 1 is the same diameter as the base plate. The outer rim can be rotated relative to the handle to check coverage of the anterior, inferior and posterior edges of the glenoid. The drill guide should be placed so that the outer rim aligns with the inferior rim of the glenoid and is centered in the anterior/posterior direction (Fig. 35). This will place the glenosphere at the edge of the inferior glenoid bone.

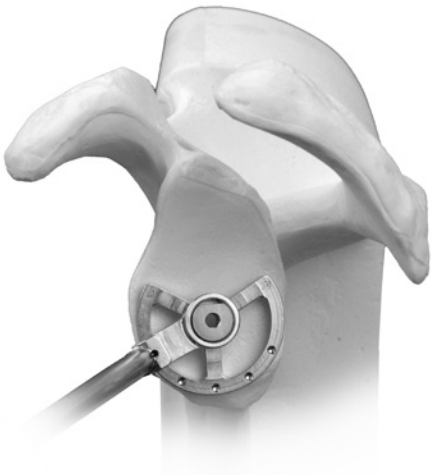


Fig. 35

Note: Guide pin placement is critical as it determines base plate/glenosphere position on the face of the glenoid and orientation in the saggital plane. The Drill Guide should be centered anteriorly/posteriorly, and align to inferior border of the glenoid. Avoid placing the Guide Pin with superior tilt, as this may result in a superiorly-tilted base plate/glenosphere and increase the risk of scapular notching.

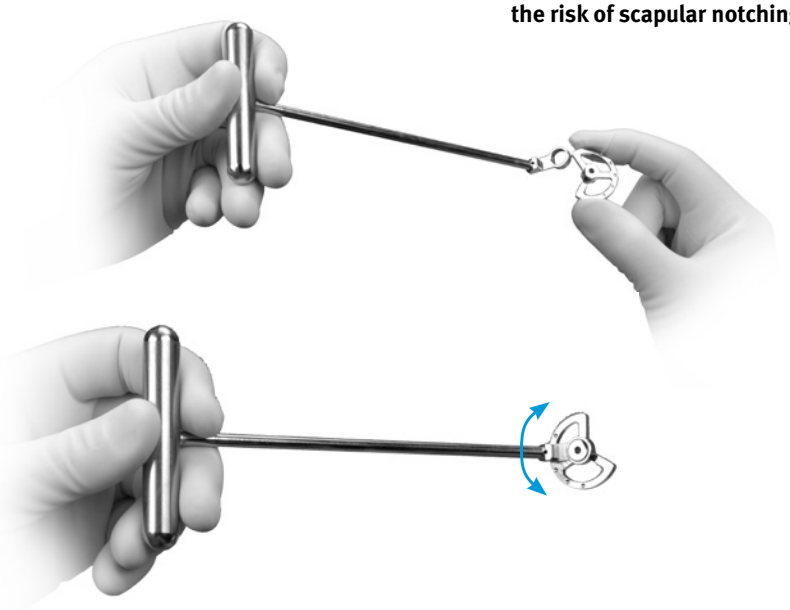


Fig. 34

Load the 2.5mm Pin into a K-wire driver or Jacobs chuck. The 2.5mm Pin is marked for the appropriate insertion depth (Fig. 36). Insert the 2.5mm Pin through Drill Guide 1 until the first etch depth mark indicated on the pin meets the top of Drill Guide 1 (Fig. 37). Do not use excessive force when driving the 2.5mm Pin into bone as this may cause it to bend or fracture. Release the Pin from the K-wire driver or Jacobs chuck, and lift Drill Guide 1 from the glenoid leaving the 2.5mm pin in place.

Note: The instrumentation includes size-specific 6mm Cannulated Drills and 7.5mm non-cannulated Drills. Care must be taken to maintain size consistency between these drills and the final implant center post length to ensure proper medial vault preparation.

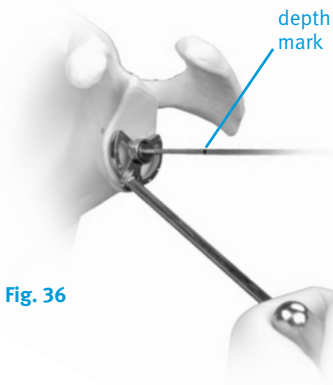


Fig. 36

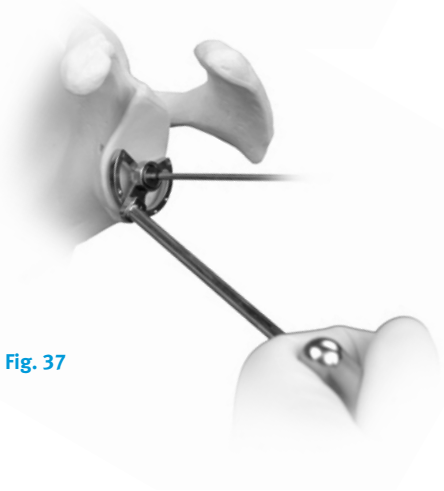


Fig. 37

Drill Center Hole

Select the appropriately-sized 6mm Cannulated Drill to create a pilot hole for the glenoid reamers. The 6mm Cannulated Drill comes in 15mm, 25mm and 30mm lengths which correspond to the base plate center post length. The length is etched on the Drill collar to distinguish size. The 6mm Cannulated Drill attaches to the Cannulated Straight Driver by sliding the Driver tabs into rounded slots of the 6mm Cannulated Drill. Turn the Cannulated Straight Driver 90° clockwise to retain the 6mm Cannulated Drill. Place the Cannulated Drill assembly over the 2.5mm Pin and drill until the housing collar is flush to the glenoid face (Fig. 38).

Remove the 2.5mm Pin.

Ream Glenoid Bone

Attach the Ratchet T Handle to the Cannulated Straight Driver, then attach the Cannulated Base Plate Reamer 1 to the Cannulated Straight Driver assembly. This reamer has a piloted tip which includes a cannulation hole, so it can be used with or without cannulation. Turn the Cannulated Straight Driver 90° clockwise to retain Reamer 1. Place the Reamer assembly into the pilot hole created by the 6mm Cannulated Drill. Hand ream, do not power ream, to prepare the glenoid surface for the back of the base plate. This is a sharp reamer and power reaming may remove excessive bone. Do not use excessive force when reaming the bone as this may cause the instrument to bend or fracture. Ream until the reamer face is completely flush with the prepared surface and the subchondral bone is exposed inferiorly (Figs. 39 & 40).

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

Depending on which size glenosphere will be implanted, select the appropriately sized Cannulated Base Plate Reamer 2. This reamer has a piloted tip which includes a cannulation hole, so it can be used with or without cannulation.

Rotate the Ratchet T Handle collar to the centered, locked position. Attach either the 36mm or the 40mm bow-tie shaped Cannulated Base Plate Reamer 2 to the Cannulated Straight Driver assembly. Ream by hand, using an oscillating motion (Fig. 41), until the spokes are flush to the previously reamed face. The outer cutting teeth of Cannulated Base Plate Reamer 2 will ream the surrounding bone to provide clearance for the glenosphere head. Once the base plate implant is in place, surface reaming is not possible. In the event that Cannulated Base Plate Reamer 2 will not fit through the tissue envelope, then alternatives include use of a Rongeur or Burr to clear any peripheral bone which may inhibit full seating of the Glenosphere.

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

Proceed to the Non-cannulated and Cannulated section on Page 17 for final glenoid preparation.

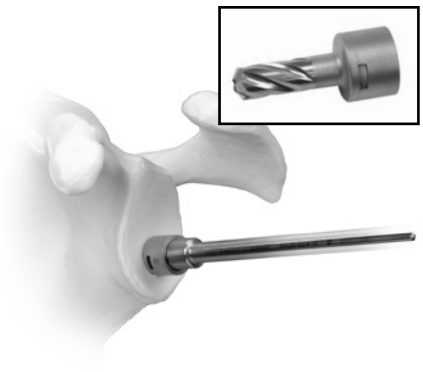


Fig. 38

Fig. 39

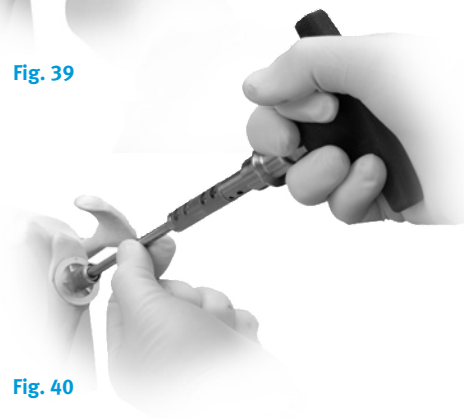


Fig. 40

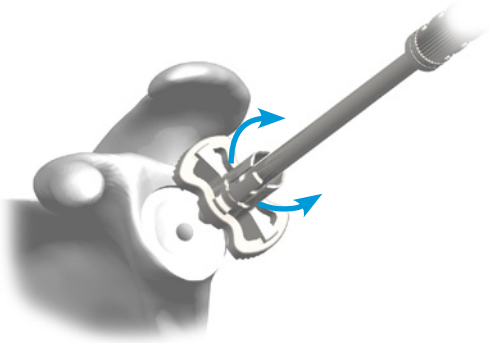


Fig. 41

Cannulated Technique for All Sizes

If desired, the Glenoid Scraper can be used to clean the glenoid face of any remaining articular cartilage or scar tissue. The instrument set includes a Cannulated Drill Guide which references the anterio-medial area of the scapula to aid in Guide Pin placement through the center of the glenoid vault. Alignment of this Guide Pin is particularly important to ensure that any medial perforation of the glenoid does not impinge the posterior rib cage when implanting a Base Plate with 25mm or 30mm center post length.

The cannulated technique can be used for all base plate sizes.

NOTE: If the Guide Pin comes out of the bone during any of the cannulation steps, then proceed through the reaming steps as described in the non-cannulated technique.

Cannulated Drill Guide Assembly

Thread the Dual Taper Spacer Impactor into the Drill Guide Body (Fig. 42). Snap the rotating Drill Guide Base onto the Drill Guide (Fig. 43). The Base has several tines which will snap into the Drill Guide and allow the Base to rotate freely around the Drill Guide. Place the Drill Guide Bushing into the superior hole of the Drill Guide.

Fig. 42

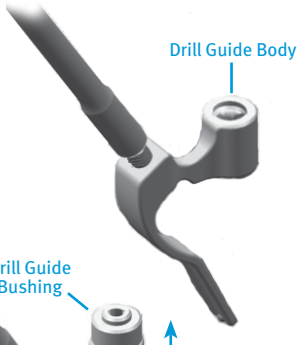
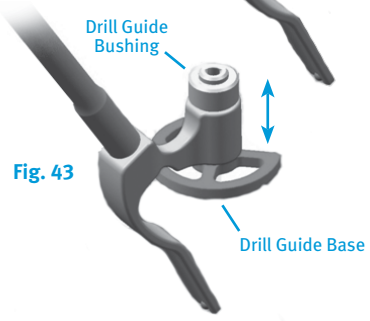


Fig. 43

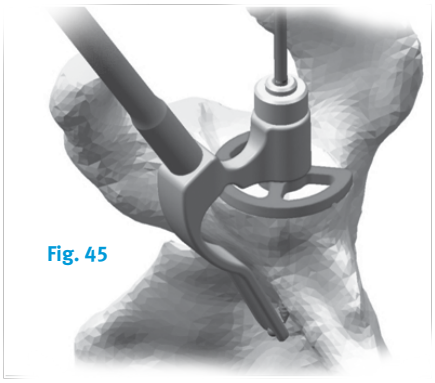


Position the assembled Cannulated Drill Guide along the anterior surface of the scapula so that the arm is at 3 o'clock (right shoulder) / 9 o'clock (left shoulder) and the Bushing is centered on the glenoid articular surface (Fig. 44). If, due to large size of the glenoid bone, the Bushing cannot reach the center of the articular surface, then an XL version of the Drill Guide Arm is available.

The Cannulated Drill Guide should be centered anteriorly/posteriorly, and align to inferior border of the glenoid. Insert a 2.5mm Pin into a wire driver or Jacobs chuck. The 2.5mm Pin is marked for the appropriate insertion depth. Insert the 2.5mm Pin through the Cannulated Drill Guide until the second etch mark indicated on the Pin meets the top of Cannulated Drill Guide (Fig. 45). Do not use excessive force when driving the 2.5mm Pin in the bone as this may cause it to bend or fracture. Release the Pin from the wire driver or Jacobs chuck, and use a kocher or small clamp to grip the Bushing and slide

Fig. 44

Fig. 45



it over the Guide Pin. To disengage the remaining Cannulated Drill Guide, rotate the Base so that cut-out is positioned posteriorly and aligned with the posterior cut-out in the Drill Guide Arm (Fig. 46). Move the Assembled Drill Guide anteriorly to release it from the Guide Pin.

Leave the 2.5mm Pin in place.

Fig. 46

Drill Center Hole

Select the appropriately-sized 6mm Cannulated Drill to create an initial center hole. The 6mm Cannulated Drill comes in 15mm, 25mm and 30mm lengths which correspond to the base plate center post length. The length is etched on the Drill collar to distinguish size. Attach the appropriately-sized 6mm Cannulated Drill to the Cannulated Straight Driver by sliding the Driver tabs into the rounded slots of the Drill. Turn the Cannulated Straight Driver clockwise by 90° to capture the Drill. Place the Drill over the 2.5mm Pin and drill until the collar is flush to the glenoid face.

Leave the 2.5mm Pin in place.

Ream Glenoid Bone

Attach the Ratchet T Handle to the Cannulated Straight Driver, then attach the Cannulated Base Plate Reamer 1 to the Cannulated Straight Driver. Turn the Cannulated Straight Driver 90° clockwise to retain Reamer 1. Slide the Reamer over the 2.5mm Pin (Fig. 47). Hand ream to prepare the glenoid surface. This is a sharp reamer and power reaming may remove excessive bone. Ream until the Reamer face is completely flush with the prepared surface and the subchondral bone is exposed inferiorly.

Leave the 2.5mm Pin in place.

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

Depending on which size glenosphere will be implanted, select the appropriately sized Cannulated Base Plate Reamer 2. Rotate the Ratchet T Handle collar to the centered, locked position. Attach either the 36mm or the 40mm bow-tie shaped Cannulated Base Plate Reamer 2 to the Cannulated Straight Driver assembly. Ream by hand, using an oscillating motion (Fig. 48) until the spokes are flush to the previously reamed face. The outer cutting teeth of Cannulated Base Plate Reamer 2 will ream the surrounding bone to provide clearance for the glenosphere head. Once the base plate implant is in place, surface reaming is not possible. In the event that Cannulated Base Plate Reamer 2 will not fit through the tissue envelope, then two alternatives include use of a Rongeur or Burr to clear any peripheral bone which may inhibit full seating of the Glenosphere.

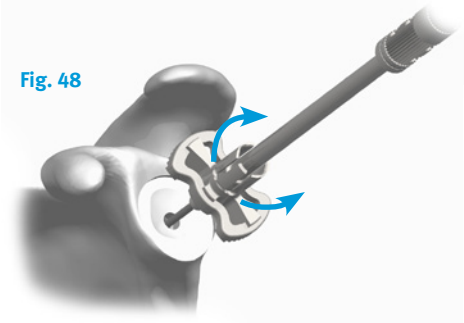


Fig. 48

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

Remove the 2.5mm Pin.

Non-Cannulated and Cannulated Techniques

Enlarge Center Hole

The final glenoid preparation step is to enlarge the center post hole using a 7.5mm drill. When implanting a Base Plate with 15mm center post, the instrument set provides three drill types: A 7.5mm Drill, a 7.5mm Cortex Drill, or a 7.5mm Compression Plug. Choose the appropriate drill based on bone quality and surgeon preference (Fig. 49). These drills must be used with the Base Plate Drill Guide 2 to avoid drilling too far medially. When implanting a Base Plate with 25mm or 30mm center post, the instrument set includes size-specific 7.5mm Drills (there are not 25mm and 30mm versions of the Cortex Drill or Compression Plug). These 7.5mm Drills can be distinguished by a “25mm” or “30mm” etch mark on the collar. Ensure that the etch mark corresponds to the base plate center post length which will be implanted.

Poor Bone Stock:

When implanting a 15mm Base Plate into poor bone stock exists, use the 7.5mm Cortex Drill with Drill Guide 2 (Fig. 46) to remove only the first 3 to 4mm of glenoid cortex. If a press fit of the distal end of the Glenosphere Base Plate post is desired, then the preparation is complete. If it is deemed appropriate to compress more bone, use the 7.5mm Compression Plug with Drill Guide 2 to compress the cancellous bone in the vault prior to implant insertion.

Fig. 49

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

Good Bone Stock:

When implanting a 15mm Base Plate into good hard bone, use the 7.5mm Drill with Drill Guide 2 to ream bone for the full depth of the post of the base plate (Fig. 50). When implanting a 25mm or 30mm Base Plate, use the 7.5mm Drill length that corresponds to center post length.

Fig.50

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

Base Plate Insertion

Note: Bone cement should not be used to secure the base plate to the glenoid bone. Initial base plate fixation will come from 0.5mm interference fit along the center post and superior/inferior compression screw fixation.

Prior to base plate insertion, carefully note and mark the inferior glenoid pillar. Attach the final Base Plate implant to the Base Plate Inserter and insert it into the prepared glenoid. Prior to implantation, confirm the base plate size. The base plate center post length comes in three sizes (15, 25 and 30mm) and the final implant size must match the length of 6mm Cannulated Drill and 7.5 Drill used to prepare the glenoid vault. Orientation of the base plate can be established either by aligning the inferior screw hole to the inferior scapular pillar or by aligning the superior screw hole to the base of the coracoid Fig. 51). The Base Plate is implanted by striking the Base Plate Inserter with a mallet until the component is completely flush with the prepared surface (Fig. 52). Care should be taken to avoid tipping the Base Plate during insertion, as this may prevent circumferential contact. Once the base plate is fully seated on the glenoid bone, avoid rotating the base plate or levering the Base Plate Inserter during disengagement as this may disrupt circumferential bony contact around center post. Disengage the Base Inserter from the fully seated Base Plate implant.

Fig. 48

Screw Insertion

The Base Plate and 2.5mm Drill Guide were designed to enable polyaxial screw placement flexibility. The 2.5mm Drill Guide has a ring stop (Fig. 53) to prevent Drill Guide orientation at an angle which might prevent full seating of the screw head and locking cap. Insert the 2.5mm Drill Guide into the inferior screw hole. The inferior screw should be oriented medially towards the scapula, either parallel to center post or with a slight inferior divergence to maximize screw length. The superior screw should be oriented towards the base of the coracoid.

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

Attach the 2.5mm drill to power and drill the screw holes through the 2.5mm Drill Guide and Base Plate at the desired orientation (Fig. 54). The 2.5mm drill has lines corresponding to the screw lengths available.

Fig. 51

Fig. 52

Warning: When drilling the screw holes, care should be taken to avoid bending the 2.5mm Drill when it is inside the Drill Guide. This creates resistance between the Drill and Drill Guide which may cause the drill to fracture. If unsatisfied with the resulting screw trajectory or length: Remove the drill entirely from the glenoid bone, reorientate the drill guide, and then slowly reintroduce the drill into the glenoid bone ensuring a more desirable screw placement.

Remove the drill and the drill guide. Assemble the Depth Gauge and insert into the screw holes to confirm screw length (Figs. 55 & 56). Screws are available in 18-48mm lengths. Inverse/ Reverse Screws are adjustable within

Fig. 53

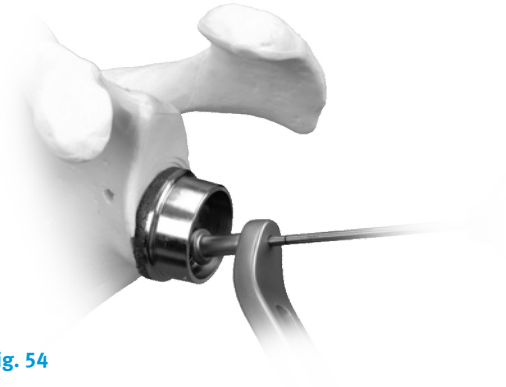


Fig. 54

a possible 30° arc (Fig. 57) and thus can readily be angled to achieve good bone purchase. Attach the screw to the Hexagonal Screw Driver, making sure good bone purchase is achieved (Fig. 58). If good bone purchase is not achieved, the screw should be removed and prepared at a new angle. To rigidly lock the screw in place, affix a locking cap to the Reverse Torque Wrench with rounded surface facing lateral, and gently slide the Locking Screw Holder over the locking cap (Fig. 59). The locking cap and Reverse Torque Wrench should be orientated perpendicular to the base plate surface. Slide back the Locking Screw Holder (Fig. 60) and turn the locking cap in place until the Torque Wrench slips or an audible click is heard.

NOTE: The locking cap only engage in one orientation. The flat surface must be pointing toward the screw (Fig. 61). To avoid mis-threading, the screwdriver shaft should be perpendicular to the base plate to properly seat the locking screw. Failure to slide back the Locking Screw Holder can impede locking cap insertion.

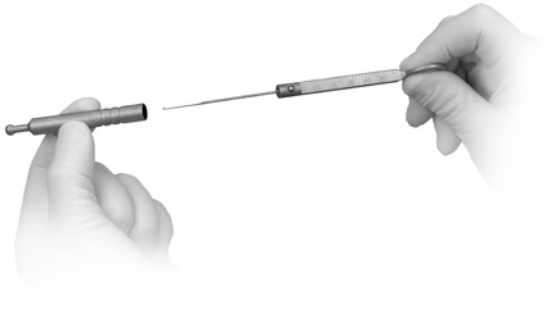


Fig. 55

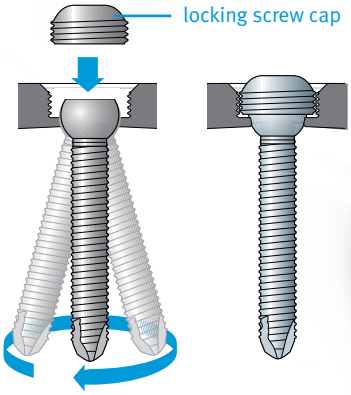


Fig. 57

Fig. 59

Fig. 56

Fig. 60

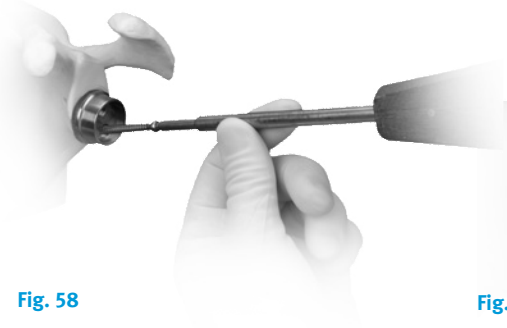


Fig. 58

Fig. 61

Base Plate Removal

Should the Base Plate ever need to be removed, the Locking Screws and Inverse/Reverse Screws are removed by utilizing the Hexagonal Screwdriver (Fig. 62). If removal is intraoperative, the Base Plate can be removed by levering with osteotome. If removal is postoperative, standard osteotomes are first used to disassociate as much of the bone ingrowth area as possible from the implant. Each bolt of the Base Plate Remover is threaded into the Base Plate using the Hexagonal Screwdriver. This is done by moving the barrel over to one side, threading one bolt into a screw hole in the base plate, then moving the barrel to the other side and inserting the second bolt into the other screw hole (Fig. 63). Thread down the bolts until the instrument is securely attached.

Fig. 63

A Standard Slaphammer, such as the *VerSys*® Slaphammer (00-6551-006-00), should be screwed into the body of the Base Plate Remover (Fig. 64). Repeatedly impact until the Base Plate has been removed.

Fig. 62

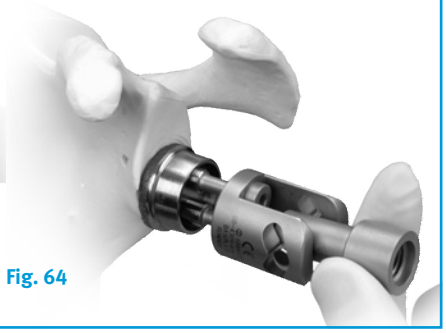


Fig. 64

Component Selection and Trial Reduction

Utilize the Liner and Glenosphere Trials to evaluate range of motion and joint retention. There are two angle options for the Trial Liners: Standard (Fig. 65a) and 65° Retentive (Fig. 65b). Each trial liner option is available in both 36mm and 40mm diameters and each is offered in 3 different thicknesses: +0mm, +3mm, and +6mm. The use of the Standard Liner Trial makes the implant neck angle 60° while the Retentive Liner Trial increases the implant neck angle to 65°. The Standard Liner Trial is typically used; however, if more stability is necessary, the Retentive Liner Trial may be used. Trial Spacers are available in +9mm and +12mm sizes thus providing size combinations ranging from +0mm to +18mm.

Fig. 65a Standard Liner Trials (60°)

Fig. 65b Retentive Trials (65°)

Note: The Trial Liners can also be used on the actual stem if you prefer to make this determination off of the final stem position and with the actual glenosphere head.

Note: The suture holes exist on the Proximal Trial to help visualize where they will be during final implantation. If desired, these locations can be marked to facilitate trial placement.

If not placed previously, attach a Trial Glenosphere Head to the Base Plate by hand (Fig. 66) or with the Glenosphere Helmet. If used, remove the Dual Taper Trial from the proximal humerus and place a Poly Trial Liner on the humerus (Fig. 67). Reduce the joint and perform a range of motion assessment (Fig. 68). The joint should be stable throughout the range of motion. If the construct dislocates, varying thickness Trial Liners and/or Trial Spacers should be used to obtain the proper joint stability (Fig. 69. Over-tensioning the joint may cause increased shear force at the base plate/glenoid bone interface. This may lead to implant micromotion and long-term loosening of the glenoid components. Care should be taken when selecting Liner and/or Spacer thicknesses to avoid excessive joint tension. Trial Glenospheres are available in either 36 or 40mm diameters.

Fig. 66

Note: The 36mm is typically used while the 40mm is used in larger patients to provide additional stability if needed, or to avoid bone impingement due to bone overhang.

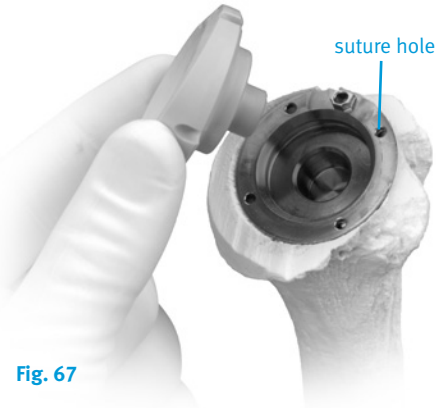


Fig. 67

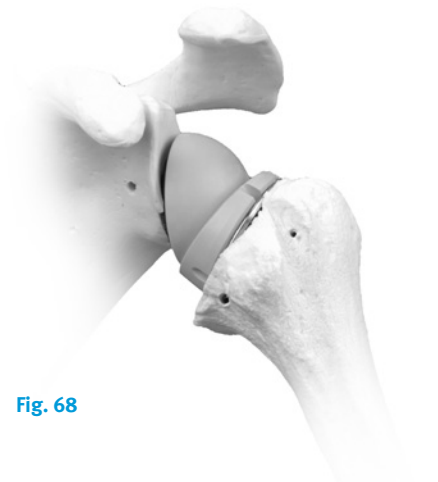


Fig. 68

Fig. 69

Provisional Removal

Remove the Glenosphere Trial, Poly Liner Trial and Spacer Trial (if used). Attach the Humeral Stem Inserter/Extractor to the Stem Trial. Apply the Slaphammer Weight to the Humeral Stem Inserter/Extractor and repeatedly impact until the Stem Trial is removed from the canal (Fig. 70).

Fig.70

Note: If desired, a Retaining Bolt may be threaded through the handle into the body of the Inserter/Extractor to prevent the handle from opening while applying the Slaphammer Weight.

Implant Insertion

Glenosphere Assembly

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

Assemble the Glenosphere Helmet Inserter by threading the Dual Taper/Spacer Impactor into either the 36mm (green) or the 40mm (yellow) Glenosphere Helmet (Fig. 71). Insert the appropriate diameter Glenosphere into the helmet by sliding it into the helmet so that the Glenosphere is held in place by the body of the helmet and the tabs rest securely underneath the Glenosphere (Figs. 72 & 73). Wipe the Base Plate taper clean of all fluids and inspect the taper to ensure it is free of screatches or damage. Place the *Zimmer* Shoulder Shoehorn Retractor on the posterior side of the glenoid to aid in retracting the humerus and other soft tissue (Fig. 72). When approaching the Base Plate, a finger can be placed on top of the Glenosphere to help guide and feel the Glenosphere slide over the taper into position.

Note: While engaging the Glenosphere, it is important to monitor the position of the proximal humerus and provisional along with retractors since they could interfere with Glenosphere placement. Alternatively, a bone hook can be placed on the humeral provisional to draw the humerus laterally to provide clearance for the glenosphere. It's important to feel the mechanical resistance of taper engagement before proceeding to impaction.

Once the Glenosphere is seated evenly and circumferentially, use your free hand to press firmly on the Glenosphere to secure it to the Base Plate. Keeping a finger on the Glenosphere, remove the Glenosphere Helmet pulling the instrument away in the SAME DIRECTION used to insert the Glenosphere (i.e. If an anterior approach was used to insert the Glenosphere, remove the instrument by pulling it from the anterior direction). This will help minimize changes to the Glenosphere placement on the Base Plate and damage to the Glenosphere Helmet itself.

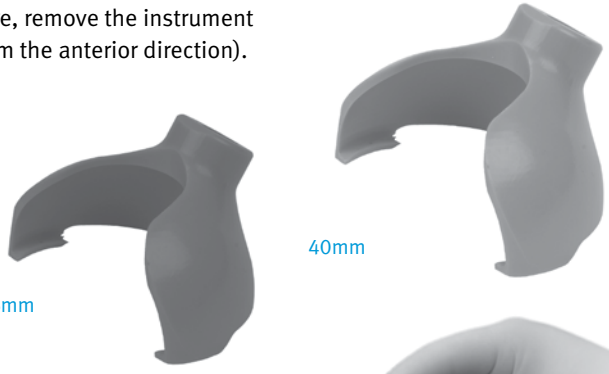


Fig. 71

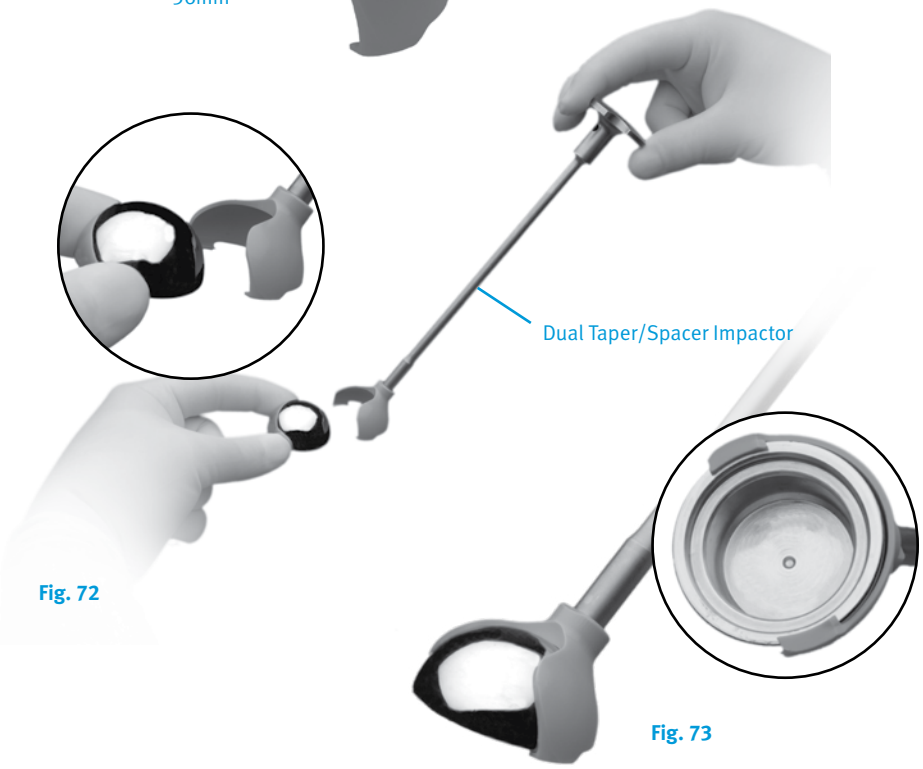


Fig. 72

Fig. 73

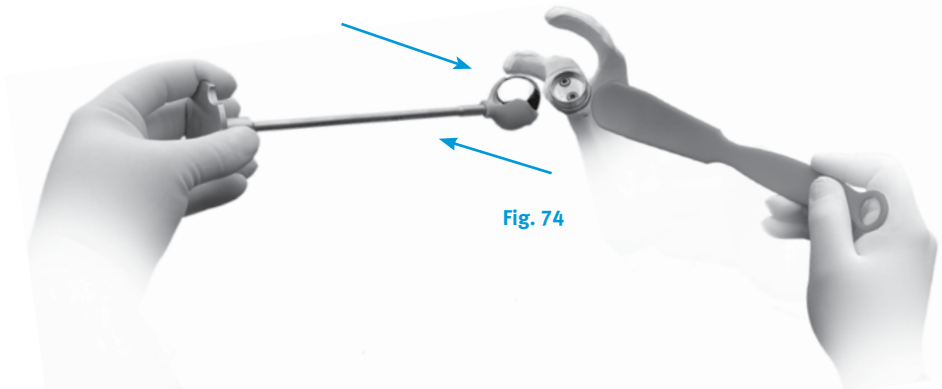


Fig. 74

Note: If unable to visually confirm an even, circumferential engagement of the Glenosphere to the Base Plate, consider the use of a fluoroscope to aid in the confirmation. Seating of the Glenosphere to the Base Plate can be examined in the axillary view or in a view parallel to glenoid version. The medial rim of the glenosphere should be parallel to the face of the Base Plate (Fig. 75).

Assemble Glenosphere Impactor Head to the Impactor Handle and place the Glenosphere Impactor Head centrally on the Glenosphere. Strike the Glenosphere Impactor Head with 3 firm mallet strikes to engage the Glenosphere on the Base Plate (Fig. 76). Pull on the Glenosphere to verify the taper is locked. Reconfirm uniform engagement between the Base Plate and Glenosphere by using a small angled or 90 degree clamp to assess for malalignment gaps anterior to posterior, as well as inferior to superior.

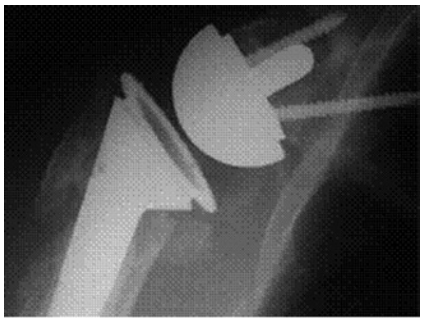


Fig. 75

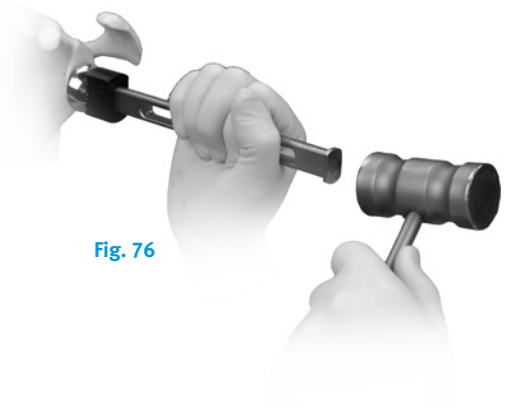


Fig. 76

Glenosphere Removal

Should it become necessary to remove the Glenosphere, the Glenosphere Distractor can be used. Assemble the Glenosphere Distractor. Wedge the fin tip between the superior glenoid bone and the underside of the Glenosphere (Fig. 77). There must be good contact on these two surfaces for disengagement to occur. Pull the Glenosphere Distractor trigger until it fires. The Glenosphere head should be loose enough to gently remove by hand. If not, repeat the step making sure there is contact between the distractor tip, the glenoid bone surface and the Glenosphere head. Trial if necessary and implant the final Glenosphere as described on pages 19-21. Reduce the joint, and confirm range of motion. If all is satisfactory, continue on to the Closure Section.

Fig. 77

Humeral Stem Insertion

The final humeral preparation for a 130mm length *Trabecular Metal* humeral stem may be identical to a 130mm length Non-Porous Reverse humeral stem, allowing intra-operative flexibility between the two as a final implant. This includes preparation for the 10, 12, 14, 16 and 18mm sizes. When implanting an 8mm humeral stem, there are distinct proximal reamers for the two respective stems. The 8mm Non-Porous Reverse proximal reamer is marked with an etch reading "8MM NP" on the reamer shaft to differentiate it from the proximal reamer used for an 8mm *Trabecular Metal* humeral stem. The proximal geometry of the 8mm Non-Porous Reverse humeral stem is smaller than the 8mm *Trabecular Metal* humeral stem.

Cemented Technique
Humeral Preparation

If using a Cement Restrictor Plug, insert the plug one centimeter distal to the tip of the Humeral Stem. Thoroughly clean and dry the canal. Inject cement into the humeral canal. Use a finger to thoroughly pack the cement.

Note: Stem size is chosen based on cement mantle desired and the last reamers used.

Technique Tip: Be careful to avoid contact between the cement and the Trabecular Metal *material as the cement will interfere with the biological ingrowth properties of the material.*

Note: To avoid risk of a periprosthetic fracture, ensure the final humeral stem implant is not larger than the last Intermedullary Reamer used. Similarly, to avoid an overly loose canal fit, ensure the final humeral stem implant is not smaller than the last Intramedullary Reamer used.

Press-fit Technique

The Humeral Stem can be press-fit by sizing to the reamed diameter. Refer to sizing chart on page 4 for press-fit/clearance conditions.

Insertion for Cemented and Press-fit Techniques

Before inserting the final humeral component, drill any desired suture holes through the proximal neck of the humerus. Attach the Humeral Stem Inserter/Extractor to the Humeral Stem Implant by opening the handle all the way, inserting the stem inserter end into the proximal opening in the assembly, and closing the handle to lock the inserter in place (Fig. 78).

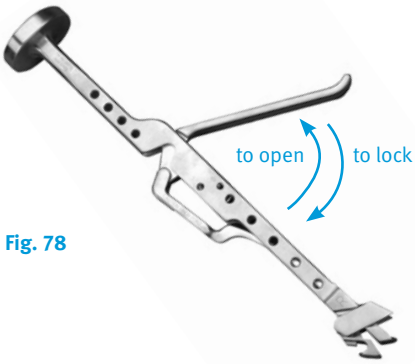


Fig. 78

Fig. 79

Humeral Stem Cemented Techniques

If cementing the humeral stem, select a final implant size of smaller diameter than the last Intramedullary Reamer used, depending on desired cement mantle thickness. For example, if the last Intramedullary Reamer was a size 13mm and the final Non-Porous Reverse humeral stem is a size 12mm, then the diametrical cement mantle thickness will be 1mm. If a final Non-Porous Reverse humeral stem is a size 11, then the diametrical cement mantle thickness will be 2mm.

Note: The Humeral Stem Inserter/ Extractor has a cut-out that aligns with the small post on the proximal lateral face of the stem to orient your rotational position (Fig. 79).

There are 0 and 20 degree holes on the inserter to allow for verification of the stem retroversion using the Threaded Alignment Rods. Thread the Alignment Rods into the inserter. The Rods may be removed prior to impacting the stem.

Fig. 80

Impact the Humeral Stem into the canal until the rim is flush with the cut surface (Fig. 80). While inserting the stem, care should be taken to not rotate the stem and lose the desired version.

If it was determined during the trial reduction to utilize a Humeral Spacer, it should be impacted on the stem implant

Fig. 81

Fig. 82

now. Prior to impacting the Humeral Spacer onto the stem, inspect the taper to ensure it is free of scratches or any damage. To accomplish this, the Dual Taper/Spacer Impactor (Fig. 81) is threaded into the Humeral Spacer and the Spacer is impacted into the stem with at least three forceful blows of a mallet (Fig. 82).

Note: The +9mm and +12mm spacers can not be assembled together.

Next, place the desired Poly Liner (Standard or 65° Retentive) onto the Humeral Stem (Fig. 83). Complete Poly Liner insertion by snapping the appropriate 60° (Standard) or 65° (Retentive) Poly Liner Impactor to the Poly Liner Impactor Handle. Then, place the Poly Liner Impactor on the Poly Liner articular surface and forcefully strike the Poly Liner Handle with a mallet.

Fig. 83

Note: The polished surface of the Poly Liner Impactor should be inspected to ensure surface integrity.

Note: Be sure to use the Poly Liner Impactor that corresponds to the appropriate Poly Liner implant. (i.e. Use a 60° Poly Liner Impactor with a Standard 36mm or 40mm Poly Liner. Use the 65° Poly Liner Impactor with a 36mm or 40mm 65° Retentive Liner.) Also make sure that the guide pin on the Poly Liner Impactor is aligned into the post on the lateral side of the stem face prior to impacting (Fig. 84).

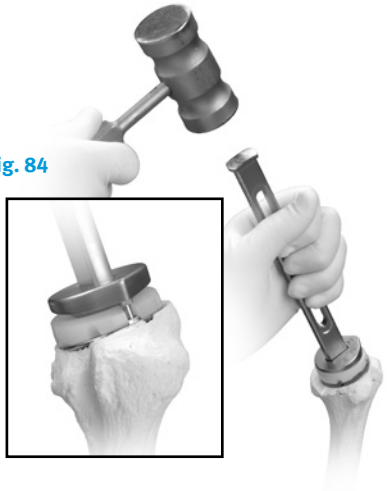


Fig. 84

Note: If not using a spacer, the 2.5mm Drill should be inserted into the post and drilled between 2-4mm deep to prevent sticking of the Poly Liner Impactor in the proximal humeral bone.

It is necessary to support the humerus laterally during impaction. A Brown retractor can be placed around the humerus for additional support.

After fully seating the Poly Liner, inspect the articular surface to ensure it is free of scratches or any damage.

For closure and postoperative management instructions, please see page 28.

Poly Liner Inserter

An alternative approach to locking the Poly Liner into the stem is to use the Poly Liner Inserter. The use of this instrument is based upon implanting the definitive humeral stem into the prepared humerus, correctly positioning the Poly Liner Implant on the Humeral Stem Implant, and properly placing the correct Poly Liner Impactor on the Poly Liner Implant.

To use this instrument, you will first need to screw the Push Rod into the Poly Liner Inserter and attach a Ratchet T-handle to the Push Rod (Fig. 85). (Make sure that the T-handle is in the forward position.) Next, grab the Poly Liner Inserter by the lower wings, compressing them so that the hooks at the distal portion of the Poly Liner Inserter move outward (Fig. 86). While compressing the lower wings, place the Poly Liner Inserter over the implanted humeral stem and position the hooks just under the proximal rim of the implanted stem (Fig. 87). It may be necessary to burr away bone around the proximal rim of the stem to allow the hooks to engage under the rim. Next, take your free hand and compress the upper wings, tightening the hooks under the implanted stem. While keeping the pressure on the upper wings, start ratcheting down the Push Rod with the T-handle (Fig. 88). While ratcheting the Push Rod down into the Poly Liner Impactor, make sure that the push rod engages the circular center of the Poly Liner Impactor (Fig. 89). Continue to ratchet down the Push Rod into the Poly Liner Impactor until the pressure snaps the Poly Liner into the implanted stem. Upon successful insertion of the Poly Liner, release the upper wings and detach the instrument from the implant.

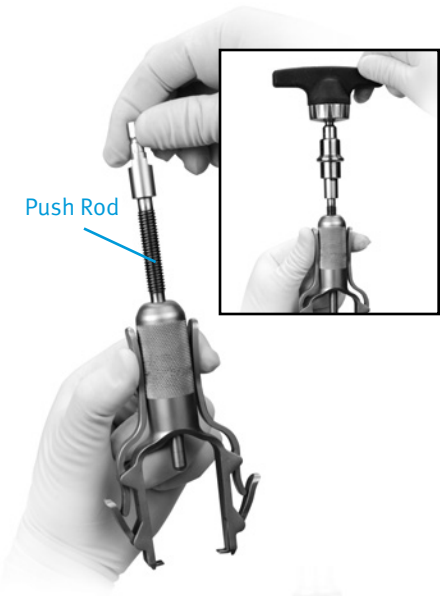


Fig. 85

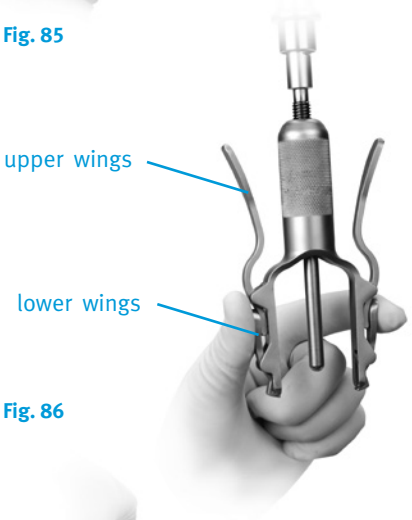


Fig. 86

Fig. 87

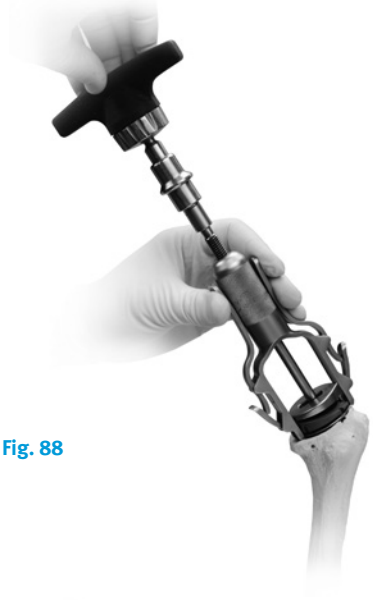


Fig. 88

Fig. 89

Note: If a 9mm or 12mm Spacer is required, please impact the Spacer into the implanted stem before using the Poly Liner Inserter.

Removal of Liner and Humeral Stem Spacer

Should it become necessary to remove the Poly Liner after it has been impacted, place the Poly Liner Extractor over the Poly Liner so that the feet are between the Poly Liner and the stem. The handle is turned clockwise until the Poly Liner is levered out of the stem (Fig. 90). If desired, the Wrench can be placed in the handle for additional leverage.

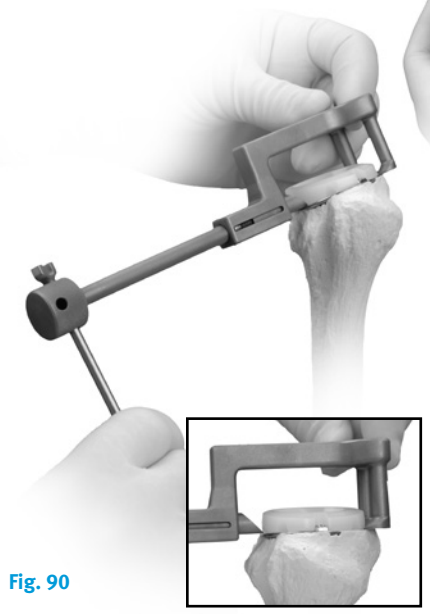


Fig. 90

Note: The Liner cannot be used after it has been inserted and then removed.

If used, the Humeral Stem Spacer can be removed by screwing the Taper Removal Bolt onto the Dual Taper/Spacer Impactor (Fig. 91). Next, screw the assembly clockwise through the center of the part of the Humeral Stem Spacer until it bottoms out in the stem and lifts the Spacer out (Fig. 92).

Fig. 91

Fig. 92

Hemi-Arthroplasty or Total Arthroplasty Application

The Dual Taper implant allows the *Trabecular Metal* Humeral Stem to be converted from a reverse stem component to a standard humeral stem component.

Humeral Head Provisional Selection

If not already seated, place the Dual Taper Trial onto the selected Stem Trial (Fig. 93).

Fig. 93

Choose the *Bigliani/Flatow* Humeral Head Provisional that best covers the prepared surface of the proximal humerus and fills the rotator cuff circumferentially. Standard and offset humeral heads are available. The resected humeral head can be used as an initial reference for choosing the humeral head provisional and implant size. Insert a metallic Capture Pin into the Humeral Head Provisional (Fig. 94).

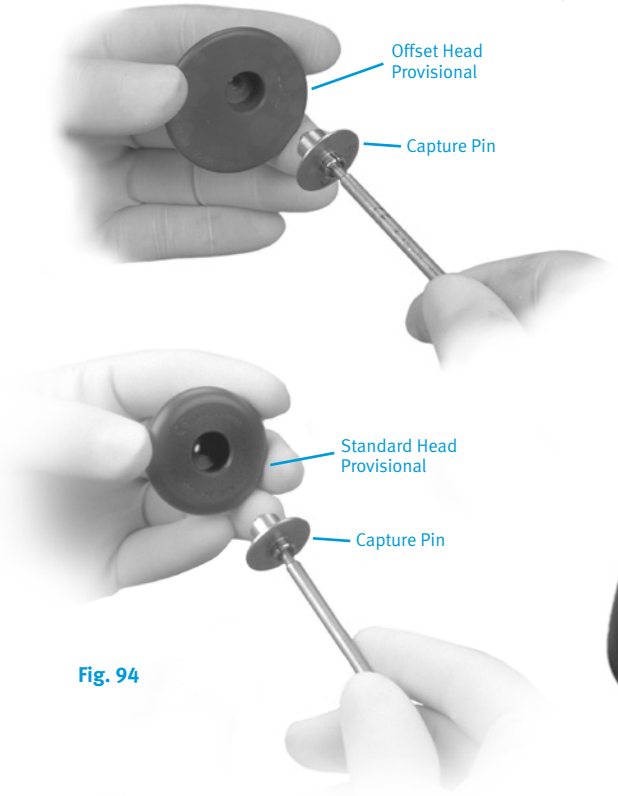


Fig. 94

With the Dual Taper Trial in place, set the Humeral Head Provisional on the Humeral Stem Provisional to the point where the head is at the level of the rotator cuff insertion. The humeral head must at least reach or slightly overhang the calcar medially (Fig. 95). If using an offset head, rotate the head into proper anatomical position and mark the position on the bone at the etched line labeled "MAX" (Fig. 96).

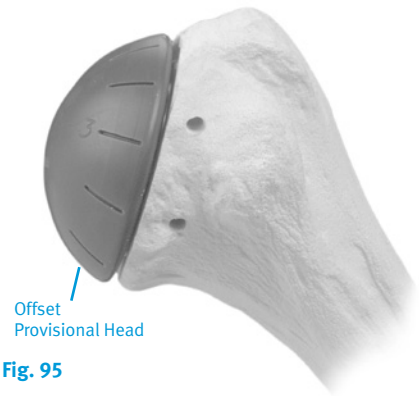


Fig. 95

Fig. 96

Reduce the joint and check the fit on both the superficial and deep surfaces. Applied pressure to the appropriate humeral head will sublux the head about 50 percent of its diameter posteriorly and inferiorly, falling back into place when the pressure is released.

A head that does not fill the capsule will dislocate over the glenoid rim, and one that overstuffs the joint will not allow this "50-50" laxity assessment. Pull the subscapularis muscle over the joint. If the fit is too tight, release the tendon as necessary. Often, releasing the subscapularis from the anterior labrum and capsule will provide sufficient mobilization to the neck of the humerus. Remove the provisional components and perform any necessary soft tissue releases.

If the humeral component is placed too low, the greater tuberosity will be relatively prominent and may impinge under the acromion. This condition can limit the range of motion. In addition, the resulting vector forces will drive the humeral head down against the inferior margin of the glenoid and can contribute to rocking and possible loosening. Therefore, it is important to always check that the superior aspect of the humeral head is above the superior aspect of the greater tuberosity.

If the humeral component is placed too high, the supraspinatus muscle will be under too much tension around the prominent lateral margin of the humeral head. In addition, the uncovered calcar can abut under the inferior margin of the glenoid component and may lead to glenoid rocking and possible loosening.

It is important to keep in mind the very precise relationship of the glenoid articular surface to the tuberosities and rotator cuff insertions so that contracture of the rotator cuff muscles and capsule do not eccentrically load the glenoid. The relationship of this entire complex to the acromion is also critical. The subacromial space should just accommodate the functional rotator cuff and tuberosities.

Provisional Removal

Once the humeral head size is chosen, remove the provisional head and the Dual Taper Trial. Attach the Humeral Stem Inserter/Extractor to the Stem Trial. Apply the Slaphammer Weight to the Humeral Stem Inserter/Extractor and repeatedly impact until the Stem Trial is removed from the canal (Fig. 97).

Fig. 97

Note: If desired, a Retaining Bolt may be threaded through the handle into the body of the Inserter/Extractor to prevent the handle from opening while applying the Slaphammer Weight.

Implant Insertion

Cemented Technique Preparation

If using a Cement Restrictor Plug, insert the plug one centimeter distal to the tip of the Humeral Stem. Thoroughly clean and dry the canal. Inject cement into the humeral canal. Use a finger to thoroughly pack the cement.

Note: Stem size is chosen based on cement mantle desired and the last reamers used.

Technique Tip: *Be careful to avoid contact between the cement and the* Trabecular Metal *material as the cement will interfere with the biological ingrowth properties of the material.*

Press-fit Technique

The Humeral Stem can be press-fit by sizing to the reamed diameter.

Insertion for Cemented and Press-fit Techniques

Before inserting the final humeral component, drill any desired suture holes through the proximal neck of the humerus. Attach the Humeral Stem Inserter/Extractor to the *Trabecular Metal* Reverse Humeral Stem by opening the handle all the way, inserting the inserter end into the proximal opening in the stem, and closing the handle to lock the inserter in place.

Note: The Inserter has a cut-out that aligns with the boss on the proximal lateral face of the trial to orient the rotational position.

There are 0 and 20 degree holes on the Inserter to allow for verification of the stem retroversion using the Threaded Alignment Rods. Thread the Alignment Rods into the inserter. The Rods may be removed prior to impacting the stem.

Impact the Humeral Stem into the canal until the rim is flush with the cut surface. While inserting, care should be taken to not rotate the stem and lose the desired version.

Intraoperative Stem Removal

Should the *Trabecular Metal* Reverse Stem ever need to be removed during initial implantation surgery, a Slaphammer can be used, as described earlier in the Provisional Removal section. Apply the Slaphammer Weight to the Inserter/Extractor and repeatedly impact until the stem is removed from the canal. If necessary, standard femoral slap hammers may be attached by threading into the proximal end of the Inserter/Extractor.

Dual Taper Insertion

Thread the Dual Taper/Spacer Impactor into the Dual Taper and impact (Fig. 98) the Dual Taper onto the stem with a mallet (Fig. 99).

Fig. 98

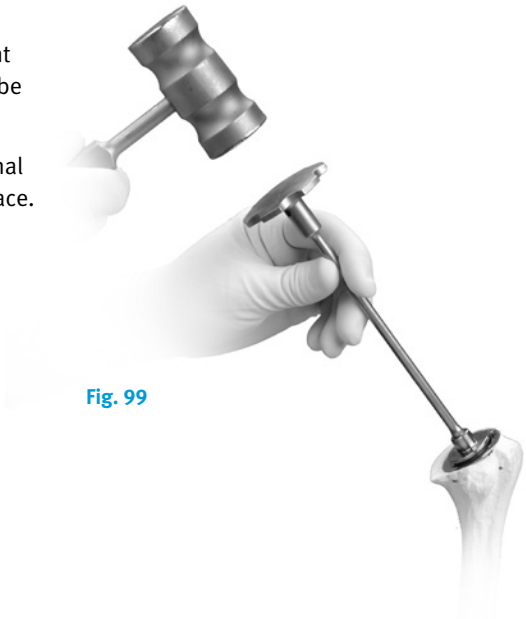


Fig. 99

Dual Taper Removal

Should it become necessary, the Dual Taper can be removed by screwing the Taper Removal Bolt onto the Dual Taper/Spacer Impactor (Fig. 100). Screw the assembly clockwise through the center of the part of the Dual Taper until it bottoms out in the stem and lifts the Dual Taper out (Fig. 101).

Fig. 100

Fig. 101

Humeral Head Selection and Insertion

Note: If the stem was cemented then the humeral head may be assembled to the implanted stem only after the cement has been allowed to cure. Select the appropriate *Bigliani/Flatow* humeral head implant. Thoroughly clean the Dual Taper component taper that will attach to the head. If using an offset humeral head, attach the Offset Humeral Head Component to the Offset Humeral Head Inserter so the single prong is positioned at the "MAX" or previously marked indication. Make sure protective sleeves are properly in place on the prongs of the Offset Humeral Head Inserter. Insert the final humeral head component so the single prong is at the mark made earlier (Fig. 102). If using a standard head, assemble the taper by hand. Apply the Humeral Head Pusher to the head and impact it with a mallet (Fig. 103). Make sure that the head is firmly attached. Then reduce the joint and assess stability.

Fig. 102

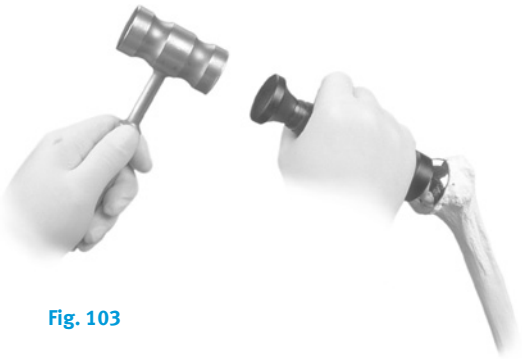


Fig. 103

Note: If a Total Shoulder Replacement will be conducted, utilize a glenoid implant from the *Bigliani/Flatow* Shoulder system and follow the corresponding surgical techniques (97-4301-204-00 for *Trabecular Metal* Glenoid or 97-4301-102-00 for *Bigliani/Flatow* All-Poly Glenoid).

Humeral Head Removal

Should a humeral head ever have to be removed, slide the Head Distractor between the collar of the humeral stem and the undersurface of the humeral head. Firmly tap the end of the instrument to loosen the head. This instrument can be used to remove either provisional heads or implants (Fig. 104).

Fig. 104

Closure

After the definitive prosthesis has been securely implanted, irrigate the wound. Retrieve any previously prepared sutures and complete suturing process. Insert a *Hemovac*® Wound Drainage Device being careful to avoid the axillary nerve. Close the deltoid and the subcutaneous layers, then close the skin.

Postoperative Management

Total or Hemi- Shoulder Arthroplasty

On the first postoperative day, the patient typically begins hand and elbow motion and passive shoulder range of motion. For a hemi or standard total arthroplasty, therapy should include pendulum exercises, elevation exercises, and external rotation exercises with a stick in the supine position and the arm slightly abducted. Passive elevation in the plane of the scapula is performed by the surgeon, a therapist, or a trained family member to a predetermined limit. The limits of postoperative motion are determined intraoperatively.

For a hemi or standard arthroplasty, if the tuberosities are fragmented and osteoporotic, elevation in the scapular plane should be limited to about 90 or 100 degrees, and gentle external rotation is allowed to about 10 or 20 degrees. If the tuberosity repair is more secure, elevation to 140 degrees may be allowed. Motion is passive, and pulley exercises are usually avoided as these tend to cause some active use of the rotator cuff. Internal rotation, which can add tension to the greater tuberosity repair, should be avoided. Patients should continue exercises as an outpatient. At six to eight weeks, when some tuberosity healing is evident on radiographs, active exercises can begin, as well as increased range of motion stretches, including internal rotation.

Reverse Shoulder Arthroplasty

With severe rotator cuff damage and the use of the Reverse System the arm is often placed in a brace with the elbow close to the body in neutral or internal rotation. An abduction cushion can be used especially in cases of deltoid detachment or if the superior-lateral approach was performed. Passive pendulum motion is the focus of initial rehabilitation.

NOTE: For a reverse surgery patient, external and internal rotation arm motion should be avoided.

Resistive strengthening exercises are gradually added. These exercises should emphasize stretching and balancing the range of motion. Strengthening is a secondary concern that need not be achieved until several months postoperatively.

Appendix A

Alternate Glenoid Preparation and Implant Fixation Using the Anatomical Shoulder Inverse/ Reverse System

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 superior-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.

Identify the optimal position for the Glenoid Adapter. Three different Glenoid Adapters are available, Small, Medium, and Large. Use the size of the Glenoid Adapter that best covers the glenoid surface (Fig. A1).

Note: Fig. A2 illustrates an incorrect size Glenoid Adapter used. The Glenoid Adapter chosen here is too large and overhangs the glenoid surface in all directions.

Now use the appropriate Glenoid Adapter to cover the glenoid surface and press the hook of the instrument against the inferior border of the glenoid and vertical to the ground (Fig. A1). Introduce the 3mm Kirschner Wire into the chosen Glenoid Adapter (Small, Medium, or Large) (Fig. A3). The laser marking on the Kirschner Wire (a) must disappear slightly into the eyelet of the Glenoid Adapter Positioning Guide.

Remove the Glenoid Adapter over the Kirschner Wire. The Kirschner Wire is now perpendicular to the required alignment of the articulating surface, which was determined preoperatively.

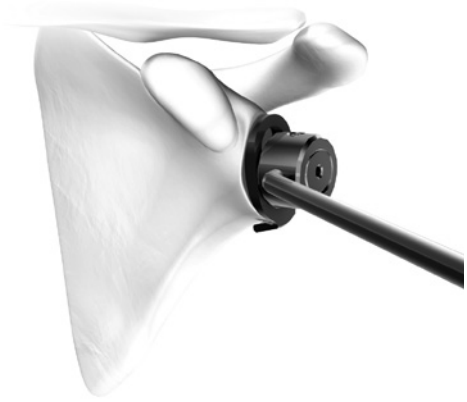


Fig. A1 (correct size)

Fig. A2 (incorrect size)

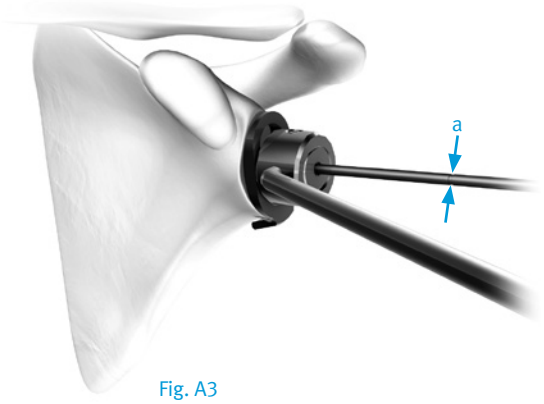


Fig. A3

Anatomical Shoulder Glenoid Adapter Revision

The Glenoid Adapter Revision (Fig. A4) might be helpful in cases where the surgeon is not completely satisfied with the Kirschner Wire position, after using the Glenoid Adapter Small, Medium or Large. In such cases, while leaving the initial Kirschner Wire in place, insert a new Kirschner Wire into another hole in order to correct the initial Kirschner Wire placement.

Remove the old Kirschner Wire and continue the glenoid preparation as the Glenoid Adapter Revision will prevent the new wire from skiving off into the initial hole.

Fig. A4

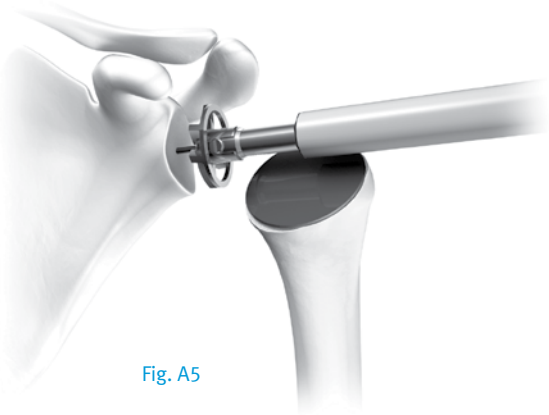


Fig. A5

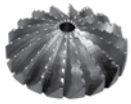


Fig. A6
Sclerotic Reamer

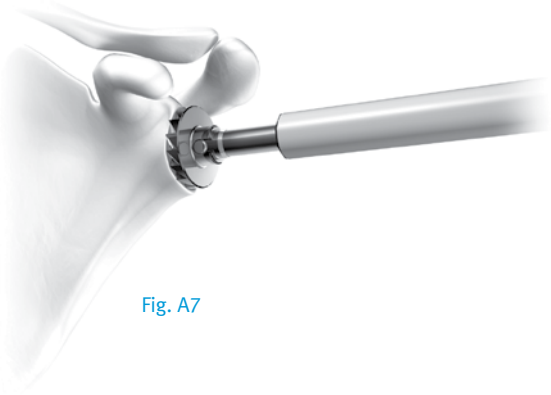


Fig. A7

The glenoid reamer size S (small) and the Cannulated Handle are mounted on the Kirschner Wire (Fig. A5). For a sclerotic glenoid the separate Sclerotic Reamer (Fig. A6) may be used to start the reaming process. Now ream the glenoid in the new alignment of the articulating surface (Fig. A5/A7).

Now use the reamer size L (large).

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

Now mount the Glenoid Inverse Drill Guide with the central hole on the 3mm Kirschner Wire, and place it on the surface of the glenoid (Fig. A8). Ensure that the Drill Guide is seated flush onto the glenoid face.

Use the Glenoid Inverse Drill (Fig. A8) to prepare the inferior and the superior Base Plate holes. The Drill can be used with either the Flexible or the Rigid Shaft. These shafts have an A.O. coupling but can also be used with a chuck. After drilling the inferior hole, place the Peg inside the hole to set as an anti-rotation pin. Now drill the superior hole. Remove the Drill Guide and the Peg.

Mount the Glenoid Inverse Milling Cutter together with the Cannulated Handle and ream over the Kirschner Wire to create the central hole until the collar is flush with the glenoid surface (Fig. A9).

Stop reaming until the full diameter of the reamer marks the glenoid surface (Fig. A10). Remove the Kirschner Wire.

The *Anatomical Shoulder* Inverse Glenoid Base Plate is available in one size for both 36mm and 40mm glenospheres and is implanted without cement.

Note: The Kirschner Wire, Reamers, Cannulated Handle, Flexible Shaft, and Rigid Shaft are located in the *Anatomical Shoulder* Glenoid Tray.

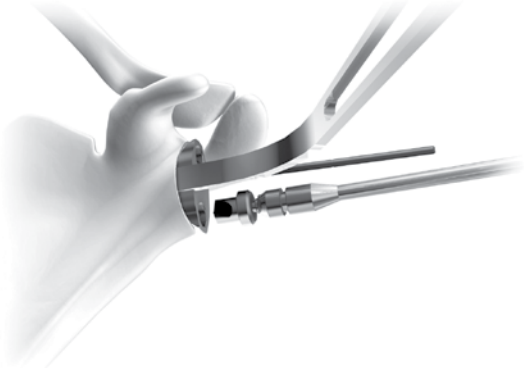


Fig. A8

Fig. A9

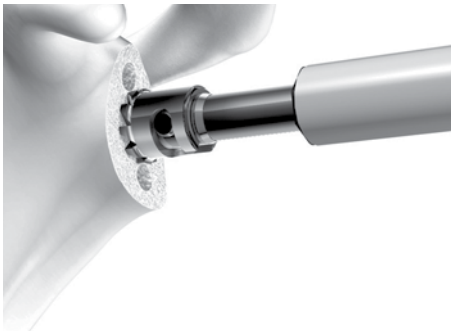


Fig. A10

Positioning and Screw Fixation of the Glenoid Base Plate

The *Anatomical Shoulder* Inverse Glenoid Base Plate is attached to the Holding Forceps. Align the glenoid Base Plate with the central peg into the previously drilled center hole.

Start the impacting with the Base Plate Impactor, using controlled force. Once impacted, the glenoid Base Plate should seat fully on the glenoid. If not, impact until fully seated (Fig. A11).

The Impactor is removed, and the Drill Guide for screws is located in the inferior glenoid Base Plate hole. Both inferior and superior screw positions allow angulation of 30°. The Drill Guide is used to set the most appropriate angle to ensure that each screw is located in reliable bone stock (Fig. A12). Preferential position is usually determined 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 3.3mm drill. The screw lengths are laser marked on the Drill, for use with the Drill Guide. Remove the Drill Guide.

The 4.5mm screw (available in lengths 18 – 48mm in 6mm incremental steps) is introduced into the inferior hole and fully tightened with the Hexagonal Screw Driver.

Now secure the inferior screw position by using the Locking Screw Cap. The Locking Screw Cap is then fastened with the Torque Wrench, until the Torque Wrench slips or audibly clicks (Fig. A13).

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

Fig. A11

Note: Care should be taken to correctly orient the superior/inferior position of the glenoid Base Plate before impacting it.

Fig. A12

Fig. A13

Trial Reduction

The appropriate Trial Glenosphere 36 (green) or 40 (yellow) is attached to the glenoid Base Plate.

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.

Glenosphere Placement

The Glenosphere is typically inserted prior to the humeral component to maximize exposure of the glenoid and ease of insertion. Ensure all osteophytes and soft tissue are removed around the Glenoid Base Plate to allow the Glenosphere to completely seat.

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

Note: The *Anatomical Shoulder* Inverse Glenosphere has a laser mark for correct connection. This laser mark must face the acromion.

The Glenosphere is now fitted onto the oval taper of the glenoid Base Plate by hand while ensuring that the laser mark is facing the acromion. Use three consecutive mallet strikes on the Impactor to seat the Glenosphere (Fig. A14). The Glenosphere is now prepared.

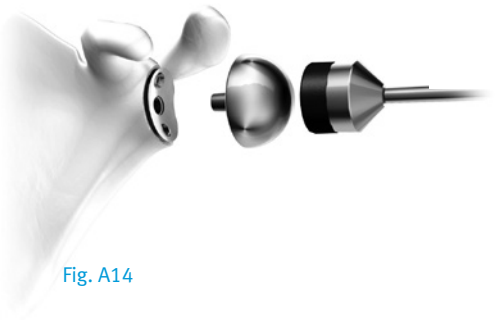


Fig. A14

Glenosphere Placement: Using the Optional Suction Cup Inserter

Press the suction cup onto the appropriate diameter Glenosphere so that the Glenosphere is held in place by the body of the suction cup (Fig. A15). Now, place the Glenosphere onto the Glenoid Base Plate with the help of the Suction Cup Inserter. When approaching the Glenoid Base Plate, a finger can be placed on top of the Glenosphere to help guide and feel the Glenosphere slide over the oval taper into position. Once the Glenosphere is seated evenly and circumferentially, remove the suction cup from the Glenosphere by pulling up on the clear tab. Using the Glenosphere Impactor, use three consecutive mallet strikes on the Impactor to seat the Glenosphere to the Base Plate.

Fig. A15

Note: The Suction Cup Inserter must be disassembled for cleaning and sterilization.

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