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Surgical Technique
The TITAN™ Modular Shoulder System was developed in conjunction with Joseph Abboud, MD; Phillip Duke, MB.BS, FRACS, FA(ORTH)A; William Geissler, MD; Sanford Kunkel, MD; Anand Murthi, MD; Matthew Ramsey, MD; Mark Ross, MB.BS, FRACS, FA(ORTH)A

Caution: Federal law restricts this device to sale by or on the order of a physician or practitioner.
Indications

Total Shoulder Arthroplasty or Hemiarthroplasty is indicated for:
• Severely painful and/or disabled joint resulting from osteoarthritis, traumatic arthritis or rheumatoid arthritis.
• Fracture-dislocations of the proximal humerus where the articular surface is severely comminuted, separated from its blood supply or where the surgeon’s experience indicates that alternative methods of treatment are unsatisfactory.
• Other difficult clinical problems where shoulder arthrodesis or resection arthroplasty are not acceptable (e.g. – revision of a failed primary component).

Shoulder Hemiarthroplasty is also indicated for:
• Ununited humeral head fractures.
• Avascular necrosis of the humeral head.
• Rotator cuff arthropathy.
• Deformity and/or limited motion.
• The humeral component is intended for cemented or uncemented use.
  The glenoid component is intended for cemented use only.

Contraindications

The following conditions are contraindications for total shoulder arthroplasty and hemiarthroplasty:
• Active local or systemic infection.
• Inadequate bone stock in the proximal humerus or glenoid fossa for supporting the components.
• Poor bone quality, such as osteoporosis, where there could be considerable migration of the prosthesis and/or a chance of fracture of the humerus or glenoid.

The following condition is a contraindication for total shoulder arthroplasty:
• Absent, irreparable or nonfunctional rotator cuff or other essential muscles.

Warnings

The use of a glenoid prosthesis in patients with cuff tear arthropathy could increase the risk of glenoid component loosening due to non-anatomic loading conditions. The following conditions tend to adversely affect shoulder replacement implants:

• Excessive patient weight
• High levels of patient activity
• Likelihood of falls
• Poor bone stock
• Metabolic disorders
• Disabilities of other joints

Precautions

• Do not reuse this device. Reuse of this product may result in infection or other systemic complication that may affect the patient’s overall health. Additionally, the reuse of this product could adversely affect function of the device. Any implant that has been damaged, mishandled, or removed from the sterile field may have surface damage that could result in implant fracture and/or particulate and should be discarded.
• The MR environment presents risks to patients with metal implants. Review of the available literature documents that metal implants may heat resulting in tissue damage and may migrate out of position. They may also cause artifact affecting image quality. Physicians should take these risks into consideration when recommending MRI imaging for patients with metal implants.

Note: The Titan™ Modular Shoulder System has not been evaluated for safety and compatibility in the MR environment. The Titan™ Modular Shoulder System has not been tested for heating or migration in the MR environment.
Surgical Technique – Visual Step By Step

Humeral Preparation

Exposure

Head Resection

Trialing Distal Stem and Proximal Body

Osteotomy, Evaluation & Head Trialing

Implant Assembly

Head Assembly

Final Humeral Implantation
Glenoid Preparation

Center Hole Preparation

Glenoid Reaming

Peripheral Hole Preparation

Peg Hole Evaluation

Trialing

Final Glenoid Implantation
Design Rationale – TITAN Modular Shoulder System

The TITAN Modular Total Shoulder System offers a bone-preserving option for patients needing total or hemi shoulder arthroplasty. The modularity of the system allows the surgeon to independently select distal stems and proximal bodies that best match patient anatomy and bone quality. The system is fully interchangeable – allowing all primary and fracture bodies to be used with either press-fit or cemented stems. There are 26 humeral head sizing options available, which are based on published anthropomorphic data of over 300 human humeri to provide anatomic fit.1,2 The system also offers multiple glenoid options for patients needing total shoulder replacement.

- Interchangeable proximal bodies and distal stems to accommodate varying patient anatomy.
- Multiple stem fixation options (press-fit vs cemented) to address varying bony quality.
  
  The glenoid component is for cemented use only.
- Well-fixed stem provides an intraoperative building platform and a pathway for revision.

Heads

26 Eccentric & Concentric Humeral Heads in Various Heights
- Anatomic osteotomy coverage and soft tissue balancing

Bodies

Textured Modular Bodies in Various Diameters and Heights
- Allow for intraoperative height adjustment
- Addresses varying patient anatomy
- Promotes initial and long-term bone fixation

Polished Suture Holes and Groove
- For added bone and soft tissue fixation and minimizes suture abrasion

Stems

Press-Fit Stem Option
- No need to remove cement in case of revision
- 1 mm incremental stem diameters
- 12 splines on stem contribute to enhanced press fit and anti-rotation for a well fixed stem

Cemented Stem Option to Address Varying Bone Quality
- Smooth, fluted stem allows for cement fixation and rotational control
- 5 stem diameters ranging from 6-14 mm to address varying humeral sizes
- Tapered, polished distal stem for ease of insertion

Glenoids

Pegged Glenoid
- Inline peg design for ease of insertion
- Grooved central peg allows for cement fixation

Keeled Glenoid
- Addresses glenoids with poor bone quality
- Grooves and hole allow for cement fixation

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TITAN Modular Shoulder Instrumentation

Glenoid Tray: Insert

1. Glenoid Sizers
2. Reamers
3. Peg Trials
4. Keel Trials
5. Guide Pins
6. Center Drill Guides
7. Peg Drill Guides

8. Glenoid Holder & Anti Rotation Peg Holder
9. Anti Rotation Pegs
10. Non Cannulated Drills
11. Solid Center Drill Bushing
12. Cannulated Drills
13. Pin Center Bushing

Glenoid Tray: Base

14. Straight Drill Shafts
15. 45° Drill Shaft (optional instrument, available upon request only)
16. Glenoid Impactor

17. Keel Punches
18. Peg Punches
19. Storage
Humeral Tray 1: Insert

1. Head Resection Guide
2. Starter Awl
3. T-Handle
4. Version Rods
5. Pin Puller
6. Fixation Pins
7. Cutting Templates & Handle
8. Cutting Depth Gauge
9. Head Sizing Gauge
10. Storage

Humeral Tray 1: Base

11. Stem Trial Handles
12. Humeral Trial Inserter/Extractor
13. Body Trials & Body Screws
14. Stem Trials
15. Calcar Planers
16. Taper Adapters
17. Taper Adapter Removal Handle
18. Taper Adapter Handle
19. Fracture Trial Inserter/Extractor
Humeral Tray 2: Insert

1. Ratcheting Screw Driver Handle
2. Osteotomy Sizing Discs
3. Eccentric Head Trials
4. Concentric Head Trials

Humeral Tray 2: Base

5. Head Impactor
6. Body Screw Hex Driver
7. Torque Limiter
8. Head Extractor
9. Implant Stand
10. Body/Stem Separator
11. Final Implant Inserter/Extractor
12. Stand Adapters
13. Body/Stem Impaction Stand
14. Body/Stem Impaction Handle
15. Slotted Mallet
Retractor Tray

1. Fukuda Retractors
2. Darrach Retractors
3. Deltoid Retractor
4. Curved Hohmann Retractors
5. Kolbel Retractor Frame
6. Kolbel Retractor Blades – Small, Large, Extra Large
7. Spiked Glenoid Retractors
Step 1 • Preoperative Templating and Patient Positioning

Preoperative evaluation of the humerus using the Modular Total Shoulder X-ray Templates helps determine the size of the prosthesis and level of the humeral head resection. The goal is to remove the humeral head at the anatomic neck using the patient’s own neck shaft angle, generally between 130-135°, and humeral version indicated by the patient’s natural version.

Hemi and Total shoulder arthroplasty can be performed using general anesthesia, regional anesthesia (i.e., interscalene block), or a combination. Place the patient in beach chair position. This position would have the patient supine with the hips flexed approximately 30°, knees bent approximately 30° and back elevated approximately 30°. Specialized headrests, such as the Mayfield or the McConnell, arm mounts or operating tables with breakaway side panels can facilitate further access to the top and back of shoulder.

Step 2 • Exposure

A deltopectoral approach is used to provide exposure to the anterior aspect of the glenohumeral joint, the upper humeral shaft and the humeral head. The initial incision line runs from the mid-clavicle, over the top of the coracoid and extends in a straight line down the anterior aspect of the arm. It should follow the path of the cephalic vein along the interval between the deltoid and the pectoralis major. The length of the initial incision along this line can vary, depending on the exposure needed to provide adequate access and visualization of the joint, and is determined by patient body habitus.

Once the initial incision is made, expose, incise and release the fascia. Locate the cephalic vein at the deltopectoral interval. Separate the deltoid and pectoralis major muscles so that the deltoid muscle is completely free from its origin to its insertion, especially along its deep surface. Abduct and externally rotate the arm. Gently retract the cephalic vein medially or laterally along with the deltoid and pectoralis muscle.

Incise the clavipectoral fascia lateral to the conjoined tendon. If needed, release the upper 25% of the pectoralis major tendon from its insertion on the humerus, using an electrocautery cutting blade. Place a Hohmann retractor over the top of the humeral head, pulling the upper part of the deltoid posteriorly.

Check that rotator cuff tendons are intact. Introduce self-retaining Weitlander and Kobel retractors underneath conjoined tendon and underneath the middle deltoid. It is important to always save or preserve the coracoacromial ligament.
However, a small triangle can be removed from the coracoacromial ligament which will allow visualization of the subscapularis and supraspinatus interval.

Release the biceps tendon from the bicipital groove and along the rotator interval down to its glenoid attachment. Resect the long head of the biceps at the origin of the superior glenoid. Open the rotator interval along the line of the biceps to define the superior margin of the subscapularis.

Isolate, clamp and ligate or coagulate the anterior humeral circumflex vessels lying across the anterior/inferior third of the subscapularis tendon.

It is important to be aware of the musculocutaneous nerve, which penetrates the coracobrachialis muscle 1-2 inches distally from the coracoid. The nerve may not be palpable within the surgical field, but remember its proximity to the conjoined tendon. Digitally locate the axillary nerve. Introduce a Hohmann retractor and carefully retract the nerve along with the latissimus dorsi tendon. This is especially important as it will protect the axillary nerve, define and expose the inferior capsule.

Step 3 • Subscapularis Tendon Management

**Lesser Tuberosity Osteotomy**

Locate the insertion of the subscapularis tendon onto the lesser tuberosity. Place the saw blade or osteotome just lateral to the subscapularis insertion point and resect approximately 4-5mm of the lesser tuberosity.

**Subscapularis Tenotomy**

Alternatively the tendon can be removed from its insertion with sharp dissection about 1cm medial to the lesser tuberosity. This will allow for tendon to tendon reattachment of the subscapularis.

Step 4 • Capsule Release and Humeral Head Dislocation

Using blunt dissection, separate the capsule from the subscapularis, inferiorly and medially. Release the rest of the anterior capsule from the subscapularis to the glenoid rim. Release the coracohumeral ligament from the base of the coracoid. Place traction sutures in the subscapularis tendon to control and mobilize it from the anterior glenoid neck. The subscapularis traction sutures will be utilized as a “shoe horn” to control the humeral head dislocation and relocation.

The ‘subscapularis tendon-capsule complex’ is dissected and elevated as one unit from the humerus at the medial aspect of the bicipital groove. If this complex is contracted, a superior 180° release of the subscapularis must be performed to mobilize the tendon to gain eventual external rotation.

Further humeral neck joint capsule release may be performed medially, anteriorly or inferiorly as needed. The posterior capsule is maintained to facilitate centralization and prevent posterior subluxation. Take care to protect the axillary nerve as it passes inferior to the subscapularis and capsule. The location of the axillary nerve should be kept in mind at all times during capsular release.
Note

If the capsule is tented over large inferior osteophytes, it may be safer to remove the osteophytes with an osteotome, moving away from the articular surface in an inferior direction. Once the osteophyte has been separated from the bone, it may be peeled off the capsule, and the capsular release can then be completed adjacent to the capsular attachment to the humerus. This decreases the risk of inadvertently damaging the axillary nerve when attempting to mobilize the capsule out from beneath large inferior osteophytes.

Step 5 • Humeral Head Preparation and Resection

Assess the humeral head and remove any unwanted osteophytes to return the proximal humerus to near native anatomy.

Freehand Head Resection Technique

Place the Head Cutting Template along the anterior aspect of the arm parallel to the shaft of the humerus, and mark the angle at which the humeral head will be resected with an oscillating power saw or mallet and large osteotome. There are two proximal holes on the Head Cutting Template for 3.2mm Fixation Pin placement, if preferred. A 30° threaded version hole for the Template Handle is also available to assess retroversion.

The saw or osteotome should enter the anterior surface of the humerus along the line of the anatomic neck and exit 2-3mm proximal to the posterior cuff attachment. Once complete, the resection should be at the level of the articular surface of the supraspinatus insertion site.
Head Resection with an Intramedullary Cutting Guide

5-2 Attach the T-Handle to the Starter Awl and create a pilot hole at the top of the humerus, in line with the long axis of the humerus just lateral to the articular surface of the head of the humerus and medial to the attachment of the rotator cuff.

**Note**
This surgical step should not be performed with power reamers or drills.

Leave the starter awl in place and clamp the Head Cutting Guide around the awl shank by tightening knob 1. The Version Rod is then passed through the holes in the cutting guide and is rotated into the desired retroversion. The holes denote 20°, 30°, and 40° of retroversion, in reference to the forearm axis. If more or less retroversion is required, use the orientation holes on the cutting guide collar and rotate the forearm to desired angle accordingly. Slide the cutting plate against the humerus and tighten knob 2. Then adjust the resection level by sliding the cutting plate up or down and tightening knob 3.

5-3 The Head Cutting Depth Gauge can be used to assess the cutting plane. The gauge should enter the anterior surface of the humerus along the line of the anatomic neck and exit 2-3mm proximal to the posterior cuff attachment. Before the oscillating saw blade (33 x 0.8mm) is placed along the flat surface of the cutting plate, drill two 3.2mm Fixation Pins through the cutting plate and into the underlying bone which will stabilize the guide. Remove the Cutting Guide-Starter Awl assembly by loosening knob 3 on the cutting plate and removing the Starter Awl out of the humerus. Use an oscillating saw through the capture to remove the humeral head. If additional head resection is needed, lower the blade to the next slot. This will remove 3mm of additional bone. After removing the humeral head, extract the Fixation Pins using the Pin Puller.

5-4 **Note**
For larger canals, it may be preferable to start impacting up, using the Stem Trials, until a solid fit is achieved in the canal. The cutting guide can then be attached to the Stem Trial Handle in the same manner as above.

Head Sizing

5-5 Use the Head Sizing Gauge to measure the resected head diameter and thickness. After measuring and selecting the humeral head size, place the humeral head on the back table to remove the cancellous bone. Use the cancellous graft later in the procedure if impaction bone grafting is needed for the metaphyseal body and humeral distal stem.
Step 6 • Humeral Canal Preparation

6-1 Attach the Stem Trial Handle to the 6mm Humeral Stem Trial. Place the tip of the stem trial at the most superior point on the resected humerus just behind the long head of the biceps groove, so that it is aligned with and ready to pass directly down the intramedullary canal. Using the Stem Trial, create a pilot hole and then sequentially trial/impact the medullary canal in line with its long axis. If extramedullary cutting guide was used the Starter Awl can be used to create the pilot hole. Continue sequential trialing/impacting, following the path created through the intramedullary canal, increasing the Stem Trial diameter in 1mm increments until a solid fit is achieved in the humerus. Note the laser lines and hole on the inserter handle. These correspond to the depth required for the Small, Standard, and Large Proximal Bodies. For the Standard Body place a 3.2mm Fixation Pin through the hole and drive the trial down until the pin sits flush on the osteotomy. Remove the pin and ensure the trial does not advance further. If trial advances, additional sequential trialing/impacting to a larger diameter is needed.

6-2 The laser etching below the hole is for the Small Proximal Body and the etching above the hole is for the Large Proximal Body. If using a Small or Large body height, impact until the appropriate laser etching is parallel with the osteotomy.

Tip
Note the final Stem Trial diameter. This will determine the size of the final distal stem implant.

Step 7 • Body/Stem Trial Insertion

7-1 Remove the Stem Trial and attach it to the closest corresponding Body Trial. Proximal Bodies are interchangeable and can be used with all stem sizes. If the Trial Stem is between Proximal Body sizes, it is suggested to start with the smaller diameter Body Trial and go up to the larger diameter Body Trial if needed. Attach the Body/Stem Trial construct to the Humeral Trial Inserter/Extractor by tightening the top of the Humeral Trial Inserter/Extractor until the Body/Stem Trial is secure.

Using the Slotted Mallet, carefully drive the Body/Stem Trial into the humerus, keeping in line with the long axis. Using the Version Rod on the Humeral Trial Inserter/Extractor (which is set at 30° of retroversion), impact the stem in the correct retroversion, which corresponds to the version set during the humeral head osteotomy. Seat the Body/Stem Trial until the Humeral Trial Inserter/Extractor sits on the resected surface. At this point, the Body Trial is seated flush to the resection. Remove the Humeral Trial Inserter/Extractor.

This system is a bone-preserving shoulder system. It utilizes a bone impaction technique vs. the traditional reaming systems. Bone impaction is achieved by using the stem trials and trial bodies to impact the cancellous bone in the humerus. This creates a secure envelope for the final implant.
Step 8 • Humeral Head Trial

Osteotomy Evaluation/Calcar Reaming

8-1 Place the Taper Adaptor onto the Body Trial with the Taper Adapter Shaft and Driver Handle or with fingers. There are two Calcar Planars, small and large. Attach the selected Calcar Planar onto the T-Handle.

8-2 Mount the Calcar Planar over the Taper Adaptor. The angle of the Calcar Planar when fixed onto the Taper Adaptor will be parallel to the standard neckshaft angle at 135°. Assess its relationship to the resected plane. If the angle diverges by only a few degrees then the Calcar Planar can be used to finalize the plane.

Note
Ensure all bony protrusions are clear before moving on to head trialing.

Osteotomy Sizing Template

8-3 Select the Head Sizing Plate that most closely covers the cut surface of the humeral osteotomy. After determining the diameter of the measured humeral head, use the Head Sizing Plate to determine if a concentric or eccentric head is necessary. Select the appropriate size Humeral Head Trial.

Head Trialing

8-4 This system measures its humeral heads using a base width x height measurement. A 46x17 head is 46mm wide x 17mm tall. This makes different spherical radii in one base width as height changes. Some systems use a spherical diameter measurement which keeps a constant spherical radii, yet this causes the base width to change as height changes. With this system, you choose the diameter that best fits your osteotomy, then choose the head height that best matches the glenoid component while allowing for adequate soft tissue balancing.

Once trial is selected, place the Concentric Head Trial onto the Taper Adapter on the Body Trial. Check that the head trial achieves appropriate coverage of cortical bone, with 5-8mm height above the greater tuberosity. Proper head thickness can be determined during trial reduction. If necessary, increase or decrease selected head size/type and reassess in place. A final decision will be made during trial reduction, with the glenoid component in place.
Eccentric Head Trials

If the Stem Trial is off-center in relation to the humeral osteotomy, the Eccentric Head Trial will allow the head to be rotated into the head position that allows maximum coverage of the proximal humerus.

Place the Eccentric Head Trial onto the Taper Adaptor on the Body Trial and rotate the head trial to the desired position. Once the Eccentric Head Trial position is selected, lock the Head Trial position with the Head Impactor. Mark the final position of the Eccentric Head Trial peripheral notch on the humeral surface for later reference with the final implant.

Note
If the Trial does not lock onto the Taper Adaptor, it may be necessary to Calcar plane further to clear any boney impingement.

Step 9 • Soft Tissue Balancing and Trial Removal

With the Body/Stem Trial and humeral head trial in place, use a burr or a rongeur to remove any residual osteophytes extending beyond the periphery of the humeral head. It is important to balance soft tissue tension with the appropriate trial humeral head in place. It should be possible to fully internally rotate the arm across the chest so that the hand of the involved shoulder easily rests on top of the opposite shoulder, without elevating the involved shoulder off the table. It should also be possible to externally rotate the arm 30-40° and still re-approximate the subscapularis tendons to the cut surface of the neck of the humerus. With the arm in neutral rotation, the humeral head should posteriorly sublux 50% or more but should spontaneously reduce when the posterior force is released. Remove the Head Trial/Taper Adapter construct by placing the Head Extractor tool under the trial head.

Stem Trial Removal

Mark the osteotomy in line with the laser etching on the back of the Body Trial. This will be used as a reference for matching rotation with the final implant. Extract Body/Stem Trial construct from the humeral canal using the Threaded T-Handle and Slotted Mallet.
Step 10 • Preparation for Repair of Subscapularis Tendon

If the subscapularis tendon was removed with a small portion of lesser tuberosity, two permanent sutures are passed through two sets of holes for later tension band suturing of the lesser tuberosity fragment to its native bed. In this circumstance, we recommend placing the sutures through the suture holes and/or around the stem of the prosthesis and pulling the slack out of the sutures just before the prosthesis is placed into its final seated position within the humeral canal.

If the subscapularis tendon was cut using sharp dissection a tendon to tendon repair can be performed after final prosthesis has been implanted.

Step 11 • Body and Stem Implant Assembly

Proximal Body and Distal Stem Assembly
Select and remove from their packaging the final sized Humeral Body and Humeral Stem that corresponds to the trials. Seat and secure the Humeral Body implant onto the Stem Impaction Stand. Place the Humeral Stem implant onto the Humeral Body with finger pressure. Place the Stem Impactor over the tip of the humeral stem and engage the tapers with a few mallet strikes.

Remove the Humeral Body Screw from its packaging and insert into the Humeral Body with the Driver Handle, Torque Limiter and 1/8 Hex Driver. Tighten the screw until the torque limiter clicks.

Note
The implant stand can be used to hold the implant while tightening the Humeral Body Screw. The torque limiter is designed to tighten the screw to 2nm.

Step 12 • Stem/Body Implantation and Head Assembly

The Modular Total Shoulder System is designed as a press-fit prosthesis, whereupon, the press-fit is achieved via the taper and splines of the distal stem. The use of cement is not necessary or recommended. In patients with a severe osteoporotic humerus, use small pieces of the resected head as bone graft, which can produce a firm press-fit of the final prosthesis.
Stem Insertion

12-1
Insert the assembled Body/Stem implant into the prepared humerus using the Humeral Implant Inserter/Extractor. Use the Version Rod on the Humeral Implant Inserter/Extractor to set the stem in the correct anatomic retroversion, which should match the version set at the time of the humeral osteotomy and trialing. The body has a laser mark that can be lined up with the previous mark placed on the osteotomy. Slowly impact the implant and stop once the stem is firmly seated and the top of the body is approximately 2-4mm above the osteotomy. This will ensure morse taper assembly with Humeral Head.

Note
Thoroughly clean and dry both tapers to ensure proper fit.

Humeral Head Assembly

12-2
Place the selected Humeral Head onto the clean and dry morse taper. If using an Eccentric Humeral Head you can place a mark on the articular surface of the Humeral Head reflecting the eccentric etching on the bottom of the Humeral Head. This will allow you to line up the mark on the head with the previously recorded position on the osteotomy. Once Humeral Head position is satisfactory, impact the head in line with the taper using the Head Impactor.

Note
The implant must be seated by impacting the head in line with the taper.

Remove any further osteophytes. The Humeral Head should be about 5mm above the top of the greater tuberosity. If a lesser tuberosity osteotomy was performed, there is often a portion of the anterior part of the humeral prosthesis that overhangs the bone. This is where the lesser tuberosity is going to fit. Now perform the final checks for range of motion, correct version and stability.
Step 13 • Glenoid Preparation and Implantation

Cannulated Center Drill/Cannulated Reaming

When exposure is deemed adequate, use the Glenoid Sizers and Glenoid Holder to size the glenoid. Also mark the center of the glenoid using the hole in the Glenoid Sizer and a skin marker. Attach the Pin Bushing onto the selected size Center Glenoid Drill Guide. Align with the center mark, and using the included 2.0mm Guide Pin, drive through the Pin Bushing until adequate purchase is achieved into the glenoid. If increased retroversion is noted on preoperative imaging studies, then orient the Center Glenoid Drill Guide to correct this retroversion by placing the drill guide in a plane that is anteverted from the native glenoid plane prior to Guide Pin insertion. Remove the Drill Guide/Pin Bushing. Place the Black Cannulated Center Starter Drill onto the Straight Drill Shaft and drill over the Guide Pin until drill stop reaches the glenoid. Now attach the appropriately sized Glenoid Reamer to the Straight Drill Shaft. Insert the nub of the reamer into the central hole. Start the Reamer before making contact with the bone. Ream accordingly until proper concavity has been achieved and cartilage has been removed. It is important to remember that over-reaming will both decrease the surface area of the glenoid face and reduce the depth of the glenoid vault. Excessive glenoid reaming should be avoided.

Note

Only straight drill shafts can be used with the cannulated instrumentation.

Alternative Non-Cannulated Center Drill/Reaming

When exposure is deemed adequate, use the Glenoid Sizers and Glenoid Holder to size the glenoid. Also mark the center of the glenoid using the hole in the Glenoid Sizer and a skin marker. Attach the Center Starter Drill Bushing onto the selected size Center Glenoid Drill Guide. Attach the Center Starter Drill to the Straight Drill Shaft. Using the Black Center Starter Drill and the Center Glenoid Drill Guide, align the Center Drill Guide hole with the Glenoid center mark created with the skin marker. Drill the central hole until it reaches the built-in depth stop. Attach the appropriately sized Glenoid Reamer to the Straight Drill Shaft. Insert the nub of the reamer into the central hole. Start the Reamer before making contact with the bone. Ream accordingly until proper concavity has been achieved and cartilage has been removed. It is important to remember that over-reaming will both decrease the surface area of the glenoid face and reduce the depth of the glenoid vault. Excessive glenoid reaming should be avoided. Angled Drill Shafts are optional instruments and available upon request.

Pegged/Keeled Glenoid Preparation and Implantation

Place a standard Fukuda Retractor or Toothed Glenoid Retractor posterior to the glenoid, resting on the osteotomy and Body Trial, and an anterior Bankart retractor in the front of the shoulder.

Position the humerus to allow for the best access to the glenoid. Remove any remnants of soft tissue, such as the biceps tendon and the superior and posterior labrum, to ensure the entire glenoid is visualized.
### Peg Drilling

13-2 Align the Glenoid Drill Guide with the current center hole and drill using the Silver Peg Drill. Place an Anti-rotation Peg in the center hole using the Anti-rotation Peg Holder. This will help stabilize the drill guide during the drilling of the peripheral peg holes. Rotate the drill guide to desired orientation and drill the peripheral peg holes.

13-3 After each peripheral peg hole is drilled, insert an Anti-rotation Peg to maintain alignment of the drill guide. The preferred scenario is drilling so as not to penetrate the scapula which will allow you to pressurize the cement mantle. Check the quality of the glenoid bone preparation by determining if the component is directly supported by precisely contoured bone, which should prevent the component from rocking, even when an eccentric load is applied to the rim of the implant.

### Implantation of the Pegged Glenoid Trial and Implant

13-4 Select the appropriate Glenoid Peg Trial and impact the trial onto the glenoid using the Glenoid Impactor. The trial matches the drill diameter and will give you a secure trial fit. Visualize that the trial component sits flush with the prepared glenoid surface through the slots in the trial. Remove the trial and irrigate the glenoid using pulsative lavage to remove blood and tissue debris from the three drill holes. A Glenoid Peg Punch is available to check hole positioning/depth, in addition to, be used as a cement pressurizer. Check each peripheral hole to determine whether it penetrates the scapula at its base. If penetration is detected consider bone grafting the hole. The Glenoid Peg Punch can be utilized to impact the graft.

13-5 Open the appropriately sized pegged glenoid implant. While cement is being prepared, obtain hemostasis by packing each of the peg holes with thrombin and surgical gauze or gel foam. Mix cement using manual or syringe application. The cement is placed into a 60cc Catheter/Toomey syringe. The end of the syringe is cut with scissors. The tip is inserted, and the cement pressurized into each of the peg holes. Further pressurize the cement using the Glenoid Peg Punch, remove the punch and refill the drill holes with cement. This will allow for cement pressurization as well as removal of any excess cement on the glenoid surface.

Apply cement to cover the entire backside of the pegged glenoid component, insert the implant, and use the Glenoid Impactor to seat the component until there is complete contact with the perimeter of the glenoid. Maintain pressure directly on the glenoid component until the cement has hardened.

**Note**
The Peg Punch is the same dimension as the final implant. Additional cement must be placed in the holes after pressurization or the implant will not be adequately cemented.
Step 13 • Glenoid Preparation and Implantation

13-6 Implantation of the Keel Glenoid Trial and Implant
If using the keel glenoid implant, prepare the glenoid as previously described. Size, then drill the central hole and ream the glenoid. Proceed with drilling the peripheral peg holes. Use a burr, rongeur or curette to connect the peg holes for the keel of the prosthesis. Excavate the bone in the base of the coracoid and down the lateral border of the scapula to help lock the keeled prosthesis with cement.

13-7 Use the Glenoid Keel Punch to impact the bone in the glenoid fossa for proper fit of the Glenoid Keel Trial. The glenoid keel trials have slots in them to visualize that the back of the prosthesis will sit flush on the bone of the glenoid fossa. Commence with trialing.

Open the appropriately sized keeled glenoid implant. While cement is being prepared, obtain hemostasis by packing the keel hole with thrombin and surgical gauze or gel foam. Mix cement using manual or syringe application. The cement is placed into a 60cc Catheter/Toomey syringe. The end of the syringe is cut with scissors. The tip is inserted, and the cement pressurized into the keel hole. Further pressurize the cement using the Glenoid Keel Punch, remove the punch and refill the keel hole with cement. This will allow for cement pressurization as well as removal of any excess cement on the glenoid surface.

Apply cement to cover the entire backside of the keeled glenoid component, insert the implant, and use the Glenoid Impactor to seat the component until there is complete contact with the perimeter of the glenoid. Maintain pressure directly on the glenoid component until the cement has hardened.

Note
The Keel Punch is the same dimension as the final implant. Additional cement must be placed in the holes after pressurization or the implant will not be adequately cemented.

Note the diagram and the chart below show the Radial Mismatch of the Humeral Head and Glenoid components. A radial mismatch between 4.0-8.5mm is recommended.

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<th>Radial Mismatch with Small Glenoid (59 Ø)</th>
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*38mm and 40mm Offset/Eccentric Head option only.
Step 14 • Wound Closure

Once final implant is in place, the subscapularis tendon repair can be completed with the sutures placed prior to implant seating.

Tendonese the biceps tendon to the humeral shaft prior to wound closure.

Thoroughly irrigate the wound with antibiotic solution. If a regional anesthetic is not used then infiltrate the soft tissue with a local anesthetic that will last 6-8 hours. A wound drainage system is recommended to prevent formations of postoperative hematoma.

The wound may be closed according to surgeon preference. Careful attention to wound closure will result in a cosmetically acceptable incision. After the dressing and shoulder immobilizer are in place, the use of a cold wrap is recommended. This pre-frozen wrap can be placed on the shoulder in the operating room and replaced with another unit every three hours. The combination of regional anesthetic or local anesthetic and the immediate cooling seems to decrease the amount of postoperative pain.

Revision Procedure

Removal of the humeral head and/or proximal humeral body during revision surgery can be achieved without disturbing a well-fixed distal stem.

Removing the Humeral Head

The Humeral Head can be removed using the Humeral Head Extractor. Place the two prongs of the extractor between the humeral head and the osteotomy surface so that the prongs will advance in each side of the linking component. Lift the head off the proximal humeral body taper by impacting the end of the extractor with the slotted mallet.

Removing the Proximal Humeral Body

The Humeral Body can be removed using the Body Separator and the final Implant Inserter/Extractor. Disengage the Humeral Body Screw and remove using the 1/8 Hex Driver. Unthread the inner rod from the Implant Inserter/Extractor and replace with the Body Separator. Place the Inserter/Extractor over the taper, and thread the Body Separator into the Humeral Body until resistance is felt. Grip the Inserter/Extractor firmly to control rotation of implant and continue to tighten the Body Separator to disengage the morse taper between the Humeral Body and Distal Stem. Remove the Humeral Body, which will be threaded onto the Body Separator.

Postoperative Therapy Protocol

The patient is placed in a comfortable immobilizer with arm at their side and regional block analgesia as preferred. Active pendulum exercises are not encouraged in order to prevent stretch of the anterior repair. However, supine passive range of motion within 24-72 hours of surgery is of the utmost importance. The limits to the extent of passive range of motion performed should not exceed the safe zone of rotation observed at surgery after subscapularis closure.

Supervised physical therapy program is recommended after 24-48 hours. Supervised active assisted and passive range of motion mobilization is suggested for the first 72 hours. Active assisted and passive assistance is recommended for 6 weeks after which terminal stretching and active range of motion is initiated. Home pulley system is initiated at 72 hours.

The sling immobilizer may be abandoned at approximately 6 weeks to protect the subscapularis repair. Most patients are able to perform all their exercises at home in a physician supervised therapy program. Supervision of all postoperative therapy is recommended. Therapy should be individualized and based on the status of the repaired tissues and muscle strength. Most importantly, protection of the subscapularis repair and/or rotator cuff repair will dictate the amount of stretching or resistance as well as the duration of immobilization. Progressive resistance for the rotator cuff including the subscapularis is initiated at 10-12 weeks depending on the quality of rotator cuff tissue and of the repair. Guarded loading of the shoulder should be observed for the first 4-6 months post-operatively. Complete recovery from surgery generally occurs at 9-12 months.
## Ordering Information and Implant Dimensions

### Press-Fit Stem Dimensions (mm), Ti

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### Glenoid Dimensions (mm), UHMWPE

For more information or to place an order, please contact:
Integra • 311 Enterprise Drive, Plainsboro, NJ 08536
877-444-1122 USA • 609-275-0500 outside USA • 866-800-7742 fax
integralife.com

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