djosurgical™

Turon™ Modular Shoulder System

Surgical Technique

PIEMCA

DJO GLOBAL

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Indications

Joint replacement is indicated for patients suffering from disability due to:

- noninflammatory degenerative joint disease including osteoarthritis and avascular necrosis of the natural humeral head and/or glenoid;
- rheumatoid arthritis;
- correction of functional deformity;
- humeral fracture.

This device may also be indicated in the salvage of previously failed surgical attempts. The glenoid components are indicated for cemented use only.

Contraindications

Joint replacement is contraindicated where there is:

- infection or sepsis;
- insufficient bone quality which may affect the stability of the implant;
- muscular, neurological or vascular deficiencies, which compromise the affected extremity;
- alcoholism or other addictions;
- materials sensitivity;
- loss of ligamentous structures;
- high levels of physical activity (e.g. competitive sports, heavy physical labor)

Patient Preparation and Positioning

The patient is placed in the beach chair semi-sitting position with the trunk flexed 30° to 60°, depending on the surgeon's preference (Figure 1). There are three primary methods to immobilize the patient's head during total shoulder arthroplasty:

1) Support the head with a commercially available head positioner that allows the top portion of the table to be removed.
2) Certain arthroscopy head support systems work well for shoulder arthroplasty, as they have a removable plate behind the operative shoulder.
3) Patients may be positioned on a standard OR table. However, this method is least likely to allow proper positioning and access throughout the procedure.

Regardless of the positioning method, the entire shoulder girdle must lie completely free in the operative field. The key in all these approaches is the medial border of the scapula, which must be positioned lateral to the edge of the table. This is particularly the case if a standard OR table is used. This will allow the surgeon to adduct, hyperextend, and externally rotate the shoulder— all of which are critical maneuvers to properly expose the entire glenohumeral joint. The patient must be moved to the ipsilateral edge of the operative table, and a hip post is frequently required to support the patient. This position also frequently results in the patient leaning slightly toward the floor. In these instances, the bed may be tilted clockwise or counter clockwise away from the operative arm so that the patient remains parallel to the floor. Finally, care must be taken to neither hyperextend nor hyperflex the cervical spine.

After the patient is properly positioned, the legs are flexed at the knee either by flexing the operative table or by placing pillows under the knees. Secure the legs with a thigh strap so that the legs do not slide down or off the table. If the procedure is going to be lengthy, a urinary catheter may be considered. The choice of anesthesia is dictated by the surgeon. The procedure may be performed under general anesthesia, with or without the use of an interscalene block. Some surgeons may prefer that the procedure be done under interscalene block alone.

The entire upper extremity is prepped with the surgeon's solution of choice. The arm should be draped free first with an impermeable adhesive drape and then with the surgeon's preferred top drape. Take care that the drapes do not impose on the surgical field. Two iodoform drapes— one in the axilla and one on the surgical site and posterior shoulder— may be applied.

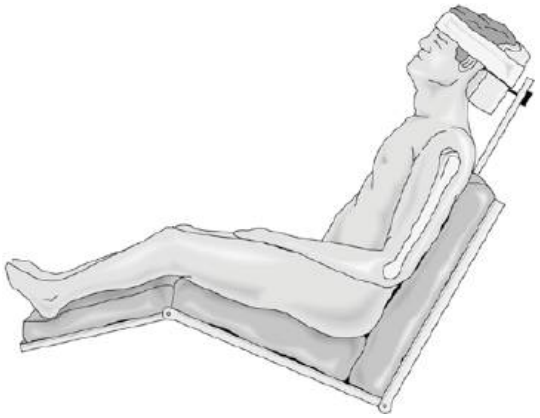

Figure 1

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Surgical Approach

A deltopectoral incision is the recommended approach for total shoulder arthroplasty. Make a 12 to 17 cm incision that extends from the distal clavicle through the lateral coracoid process, down to the mid proximal humerus at the level of the deltoid insertion (Figure 2).

The cephalic vein is identified and preserved. The vein may be retracted with the deltoid or the pectoralis major, depending on surgeon preference. Tributaries from the opposite side are ligated or cauterized.

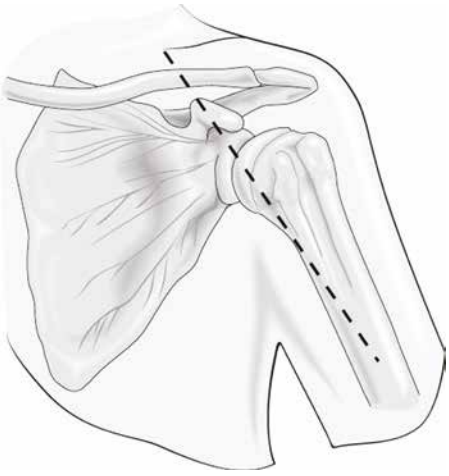

Figure 2

Humeral Approach

A Gelpi retractor is used to retract the deltopectoral interval. Use scissors, electrocautery, or blunt dissection to carefully release adhesions at the subcoracoid, subacromial, and subdeltoid recesses. Place a Brown Deltoid Retractor under the deltoid and acromion to retract the deltoid laterally and push the humeral head into the wound. The Gelpi retractor is now placed deep to the deltopectoral interval in order to retract the conjoined tendon medially and the deltoid laterally. The coracoacromial (CA) ligament may be released for added exposure, but care should be taken to preserve a portion of the CA ligament as a safeguard against humeral escape.

If the pectoralis major is contracted or its proximal insertion impedes visualization, release the proximal 10-15mm of the pectoralis major tendon at its humeral insertion.

Adduct and externally rotate the arm to displace the axillary nerve medially and expose both the subscapularis tendon and anterior circumflex vessels. The axillary nerve should be palpated and a "Tug Test" performed to determine its position relative to the surgical field (Figure 3). The nerve can be protected either by finger retraction and or with a narrow Darrach retractor. The circumflex vessels may be cauterized or ligated if necessary.

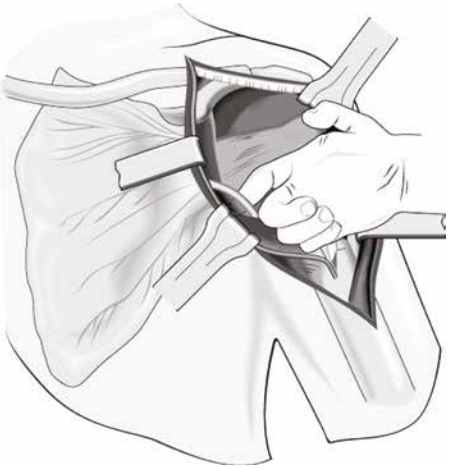

Figure 3

The Subscapularis Tendon and Capsule

There are two preferred approaches for exposing the glenohumeral joint and humeral head:

1) In the Subscapularis Tenotomy Technique, the subscapularis and capsule are divided as a single unit longitudinally 1 to 1.5 cm medial to the subscapularis insertion into the lesser tuberosity. The tenotomy begins proximally at the rotator interval and extends distally and slightly medially - thus ensuring an adequate lateral flap at the distal portion of the tenotomy. The tenotomy/capsulotomy is then carried down along the humeral neck in an "inside out" fashion, which will completely expose the humeral neck and associated inferior osteophytes. Place a tagging suture at the supero-lateral corner of the capsulotendinous complex, thus marking the area for later anatomic repair (Figure 4).

2) The Lesser Tuberosity Osteotomy Technique has recently been popularized as an improved method of humeral exposure, with superior biomechanical characteristics and improved subscapularis healing. Healing of the osteotomy can be monitored by observing the position of the lesser tuberosity on routine post operative axillary radiographs.[1]

   The biceps groove is identified, and the transverse ligament is released to expose the biceps tendon. The biceps is then mobilized and tenodesed in-situ to the pectoralis tendon or transverse ligament remnant with #2 non-absorbable suture. Tenotomize the biceps proximal to the tenodesis site and lift it out of the groove. Dissect the biceps proximally through the rotator interval, incising the interval to expose the biceps at its proximal insertion, where it is transected. Continue to release the rotator interval capsule to the base of the coracoid process. Once the rotator interval has been defined, the osteotomy can then be performed under direct visualization. The lesser tuberosity osteotomy is performed utilizing an oscillating saw and osteotome. Care is taken to avoid propagation of the osteotomy into the articular portion of the humeral head or into the humeral shaft.

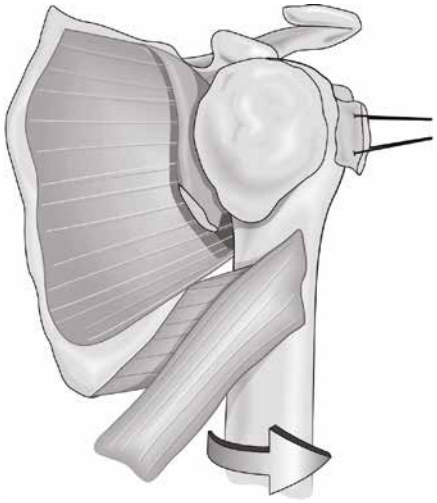

Figure 4

In order to dislocate the humeral head, the dissection should be directed to the medial humeral neck. To accomplish this requires that the arm is externally rotated and the capsule is released from anterior to posterior along the medial humeral neck. A sharp Hohmann retractor placed around the humeral neck will assist in this step and facilitate capsular release. The humeral head may now be dislocated for humeral head preparation. The axillary nerve is protected during this approach as long as the capsule is released directly from the bone. The surgeon must maintain awareness of the surgical plane and be vigilant of axillary nerve position throughout the procedure.

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Techniques to Improve Excursion of the Subscapularis

Patients who have undergone surgical treatment for instability or trauma may have contracture of the shoulder capsule and fibrosis and shortening of the subscapularis. Prior to surgery these patients have significant deficits in external rotation.

Options to improve excursion of the subscapularis include:

1) Inferior Capsulectomy

The capsule is dissected free from the subscapularis and excised. To accomplish this requires that meticulous dissection is carried out with the curved Mayo scissors to free the capsule from the anterior neck of the glenoid and the subscapaularis. Care is taken to avoid incising the subscapularis muscle belly and a retractor is placed to prevent injury to the axillary nerve.

2) Tendon Release off the Lesser Tuberosity

When the subscapularis tendon is released directly off the lesser tuberosity (rather than 10-15mm medial to its insertion) the surgeon can ensure more length is gained for subscapularis tendon repair. The tendon can be "medialized" on the humeral neck during repair. Each centimeter of subscapularis medialization will result in an additional 20 degrees of glenohumeral external rotation.

Humeral Exposure

Dislocate the head anteriorly by carefully externally rotating and extending the arm. Gentle leverage from a Darrach or Hohmann retractor facilitates humeral head dislocation and helps retract the medial soft tissues of the subscapularis, pectoralis major, and conjoined tendon. The previously described soft tissue releases are critical to successful humeral head dislocation, and difficulty during the dislocation maneuver may indicate incomplete release of the soft tissues along the inferior humeral neck. Once dislocated, osteophytes are circumferentially excised from the entire humeral head. A Darrach or Hohmann retractor may be placed in the joint to retract the anterior soft tissues and expose the posterior humeral osteophytes. Rotator cuff integrity is assessed at this point. The supraspinatus insertion has a characteristic attachment approximately 14mm wide just posterior to the biceps groove. In most osteoarthritic patients, the rotator cuff is intact. Patients with inflammatory arthropathies or a history of previous surgery — especially rotator cuff repair — have a higher incidence of rotator cuff insufficiency.

To reduce the incidence of intra-operative humeral shaft fracture, gentle external rotation and humeral extension should be used to deliver the humeral head. A Darrach or Hohmann retractor at the posterior surface of the humeral head can be used as a skid to lever the head out of the joint. These retractors provide gentle anterior translation on the head and retract the medial soft tissues.

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Humeral Head Osteotomy

The greater tuberosity and rotator cuff insertion must be visualized so that the appropriate amount of bone can safely be removed. An aggressive head cut could undermine the rotator cuff insertion leading to failure of the procedure. The Humeral Osteotomy Guide provides a 135-degree neck shaft angle. This has been standardized for consistency. Free hand cuts are not recommended as they may significantly alter the neck shaft angle.The inferior-medial point of the osteotomy often lies medial to the inferior osteophytes. The superior-lateral point of the osteotomy should be at the junction of the anatomic neck and the greater tuberosity (Figure 5a and 5b). Version is established with the Humeral Osteotomy Guide and Retroversion Alignment Rod (Figure 6). The Alignment Rod, when parallel or collinear with the forearm, will provide the surgeon with an osteotomy in 30-degrees of retroversion. Rotating the guide can modify the amount of retroversion to suit the patient's unique anatomic requirements.

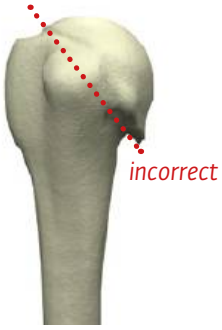

Figure 5a

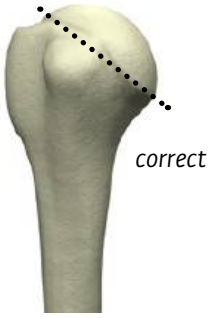

Figure 5b

Instrumentation

Humeral Osteotomy Guide, Right/Left
[804-00-046_047]

Retroversion Alignment Rod
[803-01-057]

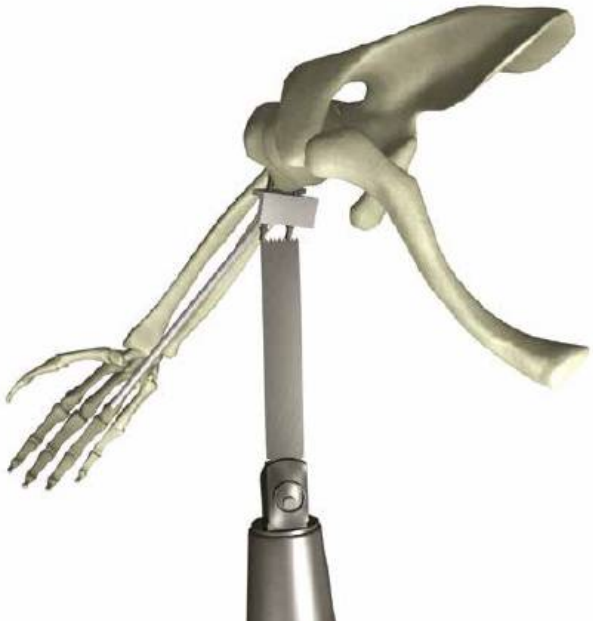

Figure 6

The Humeral Osteotomy Guide with attached Alignment Rod is secured to the humerus using the 3.2 mm Drill Bit and Bone Pins (Figure 7). The rotator cuff must be protected with a small Hohmann retractor prior to the final head cut. The amount of bone resected is generally less than anticipated. This is particularly the case in flattened, deformed, or necrotic humeral heads. The cancellous bone from the removed head segment can often be harvested for later use as autogenous bone graft for the humeral stem or lesser tuberosity osteotomy repair.

Note: *A well done humeral osteotomy requires that the surgeon make the osteotomy cut at or very near the patient's anatomic neck and avoids an aggressive cut which could destabilize the rotator cuff.*

The Humeral Osteotomy Guide is then removed using the Pin Extractor to facilitate retrieval of the Bone Pins. A rongeur is used to trim any residual osteophytes especially those along the inferior and posterior neck.

Note: *Failure to remove the posterior osteophytes can result in a difficult glenoid exposure.*

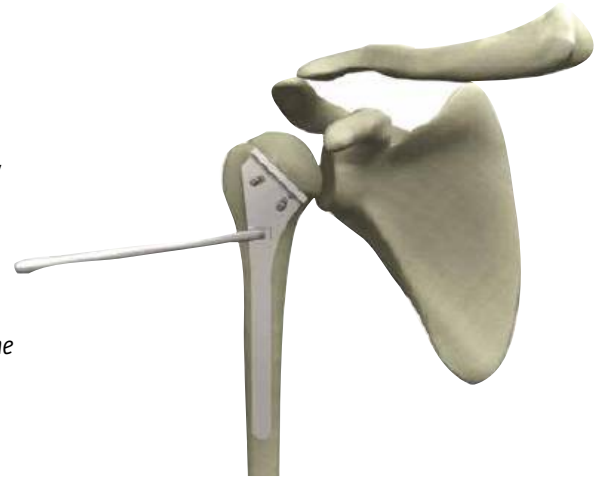

Figure 7

Humeral Canal Reaming

The humerus must be extended and adducted to avoid the patient's head while accessing the medullary canal. Use the T-Handled Starter Reamer (6mm) to sound the medullary canal (Figure 8). Ream the canal with sequentially larger reamers until cortical chatter is present. Hand reaming is preferred in the majority of patients and is imperative in patients with osteoporosis or inflammatory arthritis, as these conditions affect bone quality. Assemble the Humeral Reamer to the detachable T-Handle. For primary, press-fit applications, the Humeral Reamers should be inserted into the humerus such that the top of the flutes is level with the top of the greater tuberosity. For cemented applications, there are depth lines on the Humeral Reamers marked "Primary" and "Revision" that should line up with the top of the greater tuberosity (Figure 9). The canal is then irrigated to remove loose cancellous bone or fat in the metaphyseal region.

Figure 8

Figure 9

Instrumentation

Humeral Osteotomy Guide, Right/Left
[804-00-046_047]

Retroversion Alignment Rod
[803-01-057]

3.2mm Drill Bit
[801-01-020]

Bone Pin Driver
[800-01-339]

3" Quick Release Bone Pins
[800-01-338]

Pin Extractor
[800-01-035]

T-Handled Starter Reamer (6mm)
[804-00-002]

Detachable T-Handle
[803-00-047/804-05-257]

Humeral Reamers
(6mm/8mm/10mm/12mm/14mm/16mm)
[804-05-086_091]

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Humeral Canal Broaching

An assistant should support the arm and provide a counter-force as the broaches are introduced into the humeral canal. The elbow can also be placed on a well padded Mayo stand to support the humerus during broaching. The Alignment Rod can be inserted into the Humeral Broach Handle to maintain the appropriate degree of retroversion. It is preferred to align the rod with the forearm in the majority of cases. (Figure 10).

Figure 10

The Humeral Broach is secured to the Humeral Broach Handle by placing the taper on the distal end of the handle into the reverse taper of the Broach and aligning the tab on the handle with the scallop on the Broach (Figure 11).

The Alignment Rod should be parallel to the forearm during broaching to maintain the proper retroversion angle (Figure 12). If desired, the surgeon can change the proximal humeral version angle by rotating the broach to the desired position.

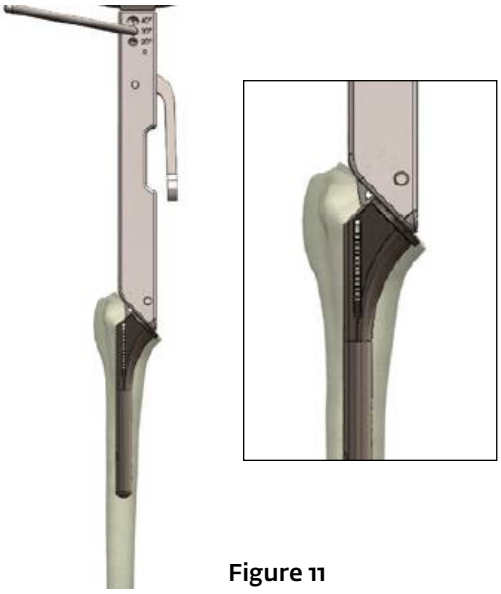

Figure 11

Instrumentation

Retroversion Alignment Rod
[803-01-057]

Humeral Broach Handle
[804-05-007]

Turon Humeral Broach, (6mm - 16mm)
[804-05-106_116]

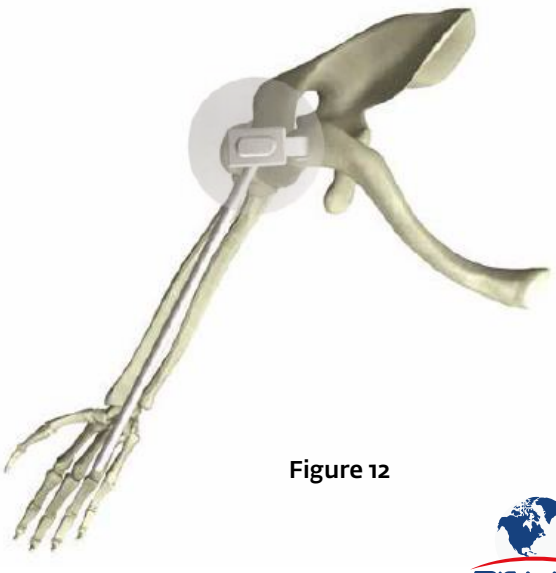

Figure 12

Note: *Please note the correct final position when seating the broach.*

Broaching is performed in a sequential manner starting with the smallest size and increasing until the correct size is obtained. Avoid broaching in varus by obtaining a far lateral starting point and ensuring that the canal is broached up to the largest size that is safely attainable. Avoid excessive force when seating the broach. Impact the broach until the bottom of the "collar" is flush with the osteotomy (as shown to the right). The distance between the bottom of the "collar" and the top face of the Humeral Broach is 2.5 mm. This is the height that should be above the osteotomy after fully seating the broach. Once the desired broach is fully seated, scrutinize it for proper press fit. The handle attached to the broach can be used to rotate the broach in the humeral canal. If the broach rotates or deforms the proximal humeral cancellous bone, then the surgeon may elect to increase one size on the broach to achieve a better press fit. Alternatively, the surgeon may decide that the patient's particular anatomy is not conducive to a stable press fit and use bone cement to secure a smaller implant.

Should the glenoid surface require resurfacing, assemble the appropriately sized Proximal Humeral Protector to the broach. The Proximal Humeral Protector will protect the proximal humerus from the forces of the posterior glenoid retractor during glenoid preparation, thus avoiding fractures or defects at the anterior humeral neck (Figure 13).

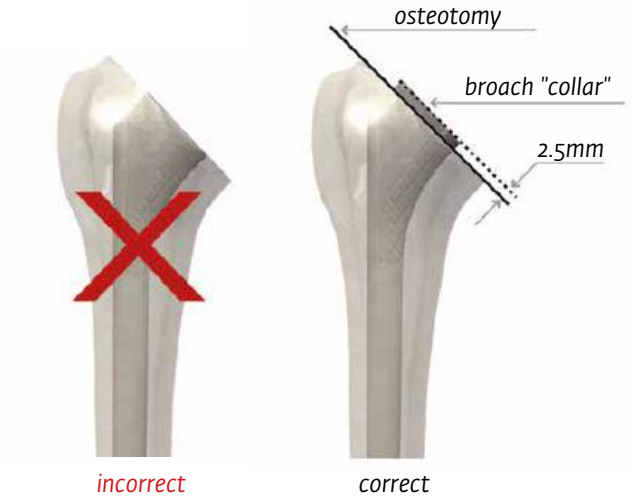

Figure 13

Instrumentation

Turon Humeral Broach, (6mm - 16mm)
[804-05-106_116]

Proximal Humeral Protector, (Small/Large)
[804-05-148_149]

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Glenoid Exposure

There are several keys to adequate glenoid exposure. The most important is to abduct the arm on a well-padded Mayo stand which greatly improves exposure of the glenoid fossa. Inadequate visualization of the glenoid generally arises from inadequate humeral preparation. Subsequently Humeral osteophytes, especially those along the posterior humeral neck, must be removed. This will allow for a greater degree of posterior translation of the humeral shaft. In addition, all of the tight anterior structures must be released. Retractor placement and arm position are critical for adequate visualization of the glenoid.

To displace the humerus posteriorly a retractor is positioned on the posterior inferior rim of the glenoid. We prefer either a Darrach or site-specific retractor such as the Cofield glenoid retractor.

A second retractor is placed along the anterior neck of the glenoid. A cobra retractor or glenoid neck retractor is placed to expose the anterior glenoid rim. In certain instances, the subscapularis recess is contracted or obscured by adhesions, which makes retractor placement difficult. In these instances, the subscapularis recess may be developed with sharp dissection or electrocautery.

Place a standard, sharp Hohmann retractor just superior to the base of the coracoid. The Hohmann retractor exposes the superior portion of the glenoid fossa.

In some cases, the exposure is compromised due to proliferative tissues which obscure the inferior surgical field. In this circumstance, a Hohmann retractor can be placed to improve visualization.

Glenoid Faceplate Preparation

Assemble the Glenoid Drill Guide Handle to the Glenoid Sizing/Drill Guide. The handle should be threaded into the hole that corresponds to the same side as the operative shoulder (Figure 14).

Note: *The Glenoid Drill Guide Handle has a "spring-loaded" threaded tip. To ensure proper assembly, the "spring-loaded" tip must be flush against the Glenoid Sizing/Drill Guide prior to engaging the threads. The "spring-loaded" tip is designed to help prevent cross-threading and secure a tight fit.*

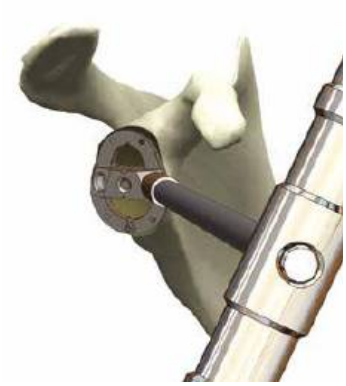

Figure 14

Confirm the size of the glenoid component by selecting the appropriate Drill Guide that gives the best coverage of the glenoid faceplate. A slightly undersized glenoid component is preferred to one that produces overhang. With the Drill Guide in position, the 3.2 mm drill bit is seated to about one-half the depth of the drill bit threading or approximately the length of the Glenoid Reamer's center guide pin (Figure 15). If preferred, the center hole can be marked with electrocautery or a marking pen, then drilled "free hand" without the guide. Start with the 38 mm Glenoid Reamer and sequentially ream up to the size that gives the best coverage. Center the guide pin of the Glenoid Reamer into the pre-drilled hole and ream the glenoid surface (Figure 16).

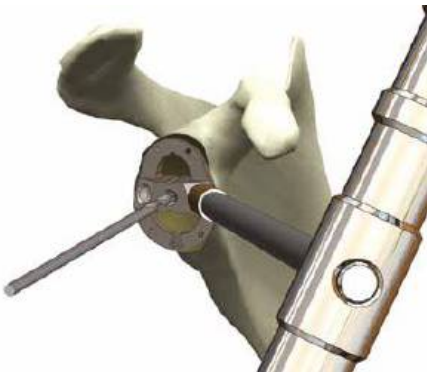

Figure 15

Note: *Correction of glenoid version should rarely exceed 10 degrees as this could compromise bone stock. If greater degrees of correction are necessary, it may be prudent to use a keeled component.*

When preparation of the glenoid surface is complete, verify that the central hole is in the desired location. The position of the center hole can be modified prior to expanding the hole to its final size.

The 5.0 mm Stop Drill is used to expand the center hole to its final size (Figure 17). Note the laser/depth marker on the Stop Drill. Drill up to the line.

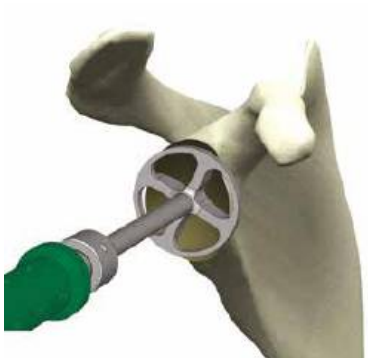

Figure 16

Instrumentation

Handle, Glenoid Drill Guide
[804-25-040]

Glenoid Sizing/Drill Guide, (38mm - 54mm)
[804-25-101_105]

3.2mm Drill Bit
[801-01-020]

Glenoid Reamer, 3.2mm Guide Pin, (38mm - 54mm)
[804-25-142_146]

5.0mm Turon Stop Drill
[804-25-147]

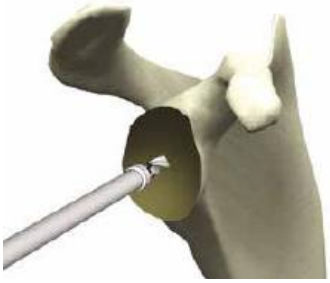

Figure 17

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Pegged Glenoid Technique

Assemble the Glenoid Guide Handle to the Peg Drill Guide.

Note: *The Glenoid Drill Guide Handle has a "spring-loaded" threaded tip. To ensure proper assembly, the "spring-loaded" tip must be flush against the Glenoid Drill Guide prior to engaging the threads. The "spring-loaded" tip is designed to help prevent cross-threading and secure a tight fit.*

Note: *The inferior pegs of the 38 mm Pegged Glenoid are shorter than to the other Pegged Glenoid sizes. This is why there is a separate 38 mm Peg Drill Guide.*

Place the Peg Drill Guide over the reamed glenoid surface, inserting the center peg of the guide into the pre-drilled center hole (Figure 18). Use the plastic-tipped Drill Guide Pusher to seat the Peg Drill Guide securely onto the face of the glenoid (Figure 19).

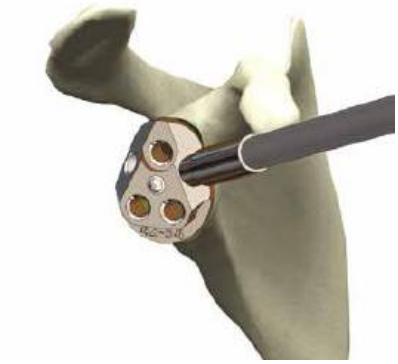


Figure 18

Ensure that the Peg Drill Guide is aligned properly on the face of the glenoid. Using the 5.0 mm Stop Drill, drill the superior peg hole (Figure 20). Drill until the hard stop.

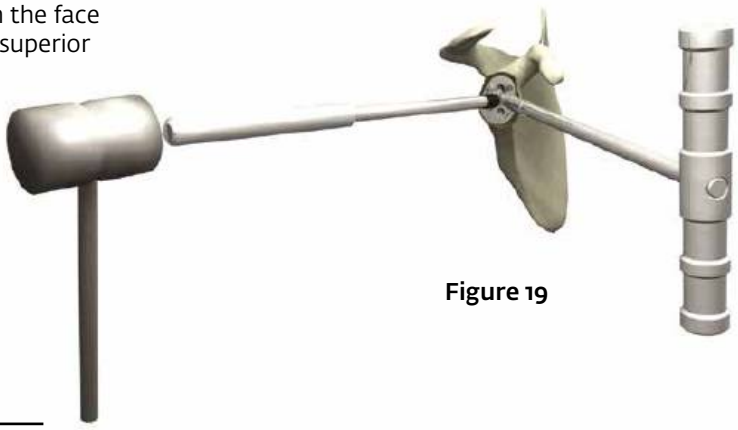


Figure 19

Instrumentation

Handle, Glenoid Drill Guide
[804-25-040]

Peg Drill Guide, (38mm, 42mm - 54mm)
[804-25-124_125]

Drill Guide Pusher
[804-25-132]

5.0mm Turon Stop Drill
[804-25-147]

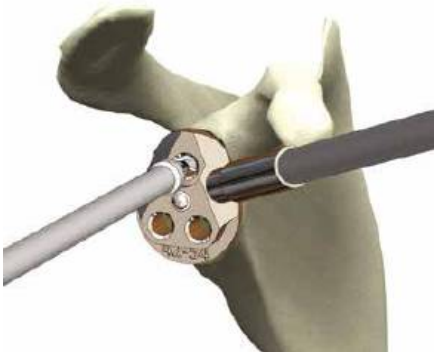


Figure 20

Utilizing the lug inserter/extractor, place a Drill Guide Lug into the superior hole (Figure 21). At least one lug is recommended to serve as an anti-rotation stop while drilling the two inferior peg holes. Finally, drill the remaining two inferior peg holes and use the Lug Inserter/Extractor to remove the lugs (Figure 22).

Place the corresponding Pegged Glenoid Trial into the prepared glenoid using the Glenoid Inserter (Figure 23). Ensure that the trial sits flush on the prepared glenoid surface. Proper glenoid preparation should result in a glenoid trial that does not "rock" in any direction — this indicates that the surface between the final pegged prosthesis and glenoid have an identical radius of curvature. Because the trial pegs are slightly undersized, some movement may be felt.

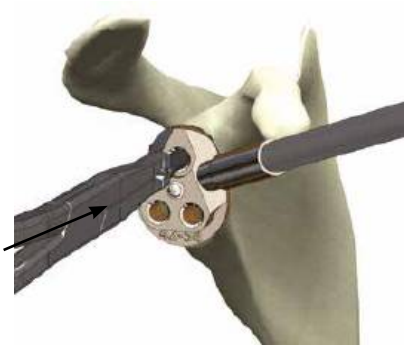


Figure 21

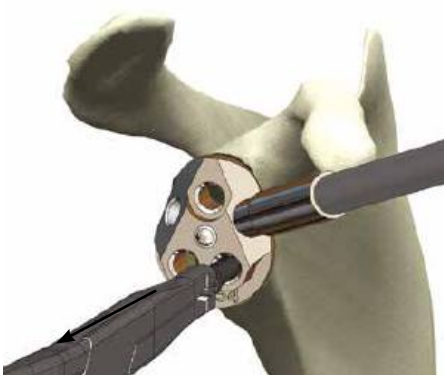


Figure 22

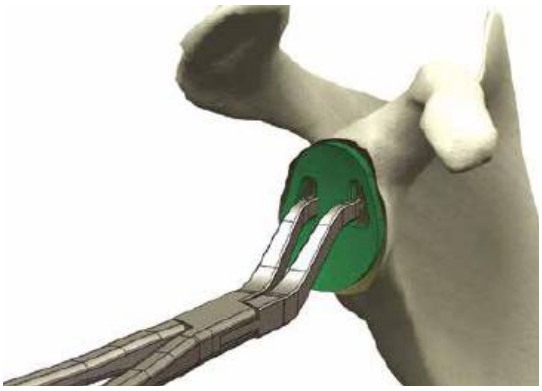


Figure 23

Instrumentation

Lug Inserter/Extractor
[804-25-130]

Drill Guide Lug
[804-25-129]

Trial, Glenoid, Pegged, (38mm - 54mm)
[804-25-106_110]

Glenoid Inserter
[804-25-134]

Surgical Technique

Turon™ Modular Shoulder System

Keeled Glenoid Technique

Assemble the Glenoid Guide Handle to the Keel #1 Drill Guide.

Note: *The Glenoid Drill Guide Handle has a "spring-loaded" threaded tip. To ensure proper assembly, the "spring-loaded" tip must be flush against the Glenoid Drill Guide prior to engaging the threads. The "spring-loaded" tip is designed to help prevent cross-threading and secure a tight fit.*

Place the Keel #1 Drill Guide over the reamed glenoid surface, inserting the center peg of the guide into the pre-drilled center hole (Figure 24). If necessary, use the plastic-tipped Drill Guide Pusher to fully seat the drill guide against the glenoid surface.

Ensure that the Keel #1 Drill Guide is aligned properly on the face of the glenoid. Drill the superior hole using the 5.0 mm Stop Drill (Figure 25) Drill until the hard stop.

Note: *Ensure the 5.0mm Stop Drill is in proper "in-line" alignment with the Glenoid Drill Guides and free from any soft tissue interference. Improper alignment can lead to stripping and/or binding of the drill against the drill guide.*

Utilizing the Lug Inserter/Extractor, place a Drill Guide Lug into the superior hole (Figure 26). Drill the inferior hole and then remove the lug using the Lug Inserter/Extractor.

Instrumentation

Handle, Glenoid Drill Guide
[804-25-040]

Keel Drill Guide 1
[804-25-126]

Drill Guide Pusher
[804-25-132]

5.0mm Turon Stop Drill
[804-25-147]

Lug Inserter/Extractor
[804-25-130]

Drill Guide Lug
[804-25-129]

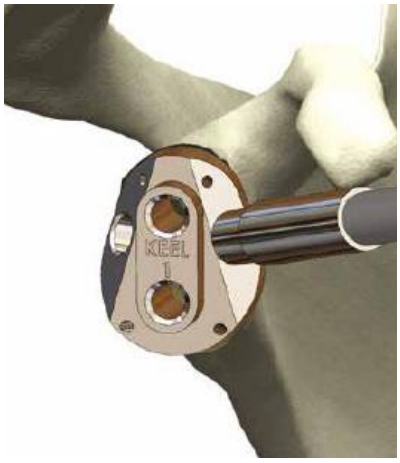


Figure 24

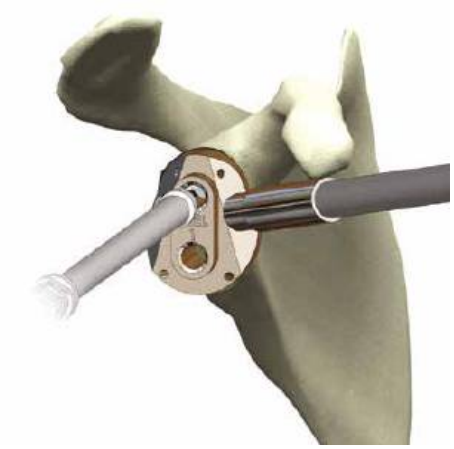


Figure 25

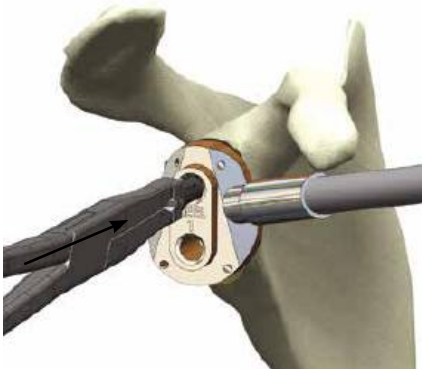


Figure 26

Remove the Glenoid Guide Handle from the Keel #1 Drill Guide and assemble the handle to the Keel #2 Drill Guide. Insert the pegs of the Keel #2 Drill Guide into the holes drilled by the previous guide (Figure 27). If necessary, use the plastic-tipped Drill Guide Pusher to fully seat the drill guide against the glenoid surface. Using the 5.0 mm Stop Drill, drill the superior hole of the Keel #2 Drill Guide until the hard stop (Figure 28) Drill the inferior hole, and remove the lug and the Keel #2 Drill Guide. Insert the Keel Bone Chisel into the drilled glenoid and lightly tap with a mallet to compress and complete the shape of the keel hole (Figure 29).

Place the appropriately sized Keeled Glenoid into the prepared glenoid using the Glenoid Inserter (Figure 30). Ensure that the trial sits flush on the prepared glenoid surface. Proper glenoid preparation should result in a glenoid trial that does not "rock" in any direction — this indicates that the surface between the final keeled prosthesis and glenoid have an identical radius of curvature. Because the trial keel is slightly undersized, some movement may be felt.

Figure 27

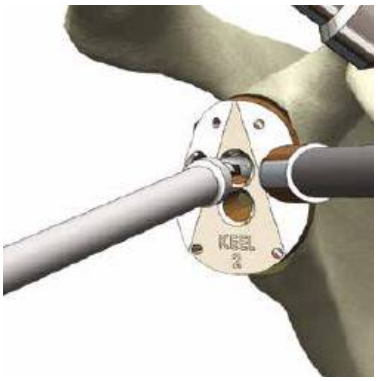


Figure 28

Instrumentation

Handle, Glenoid Drill Guide
[804-25-040]

Keel Drill Guide 2
[804-25-127]

Drill Guide Pusher
[804-25-132]

5.0mm Turon Stop Drill
[804-25-147]

Lug Inserter/Extractor
[804-25-130]

Drill Guide Lug
[804-25-129]

Keel Bone Chisel
[804-25-128]

Trial, Glenoid, Keeled, (38mm - 54mm)
[804-25-111_115]

Glenoid Inserter
[804-25-134]

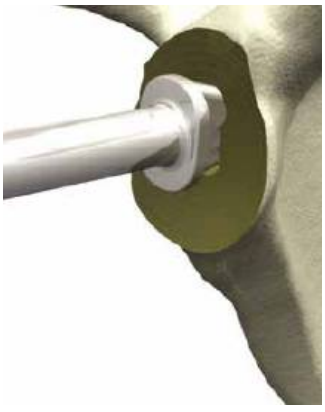


Figure 29

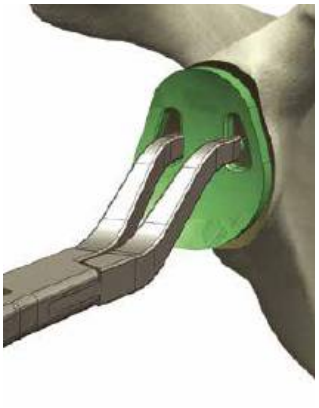


Figure 30

Surgical Technique

Turon™ Modular Shoulder System

Cementing the Glenoid Implant

Remove the glenoid trial component using the Glenoid Inserter. The peg holes or keel is irrigated with antibiotic solution and thoroughly dried, using thrombin, epinephrine, or gelfoam, as preferred. A Toomey syringe with a catheter tip is filled with a single dose of bone cement, and the glenoid peg holes or keel is filled with cement. Cement should also be applied to the back of the glenoid implant. The cement should be in a doughy state when applied. Attach the Glenoid Pressurizer/Pusher Handle to the Pegged or Keeled Cement Pressurizer and pressurize the glenoid cement, applying more cement to the peg holes or keel as deemed necessary (Figure 31). Using the Glenoid Inserter, place the implant in the prepared bone (Figure 32a). Remove excess cement from the component edges. Remove the Glenoid Pressurizer/Pusher Handle from the cement pressurizer and attach to the Glenoid Pusher. With a mallet, lightly tap the pusher to ensure that the glenoid implant sits flush. The Glenoid Pusher is also used to maintain pressure on the component while the cement cures (Figure 32b). Once glenoid preparation is complete, visually inspect, palpate, and irrigate the joint to remove any loose pieces of cement.

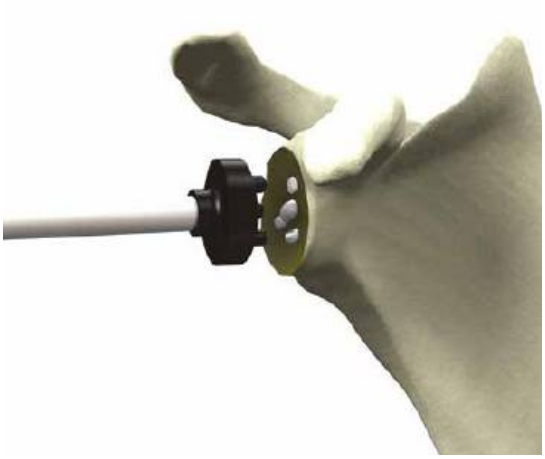


Figure 31

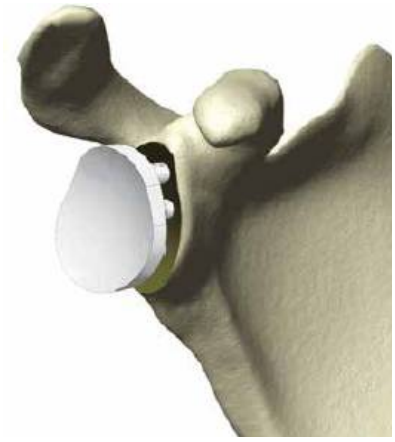


Figure 32a

Instrumentation

Glenoid Inserter
[804-25-134]

Handle, Glenoid Pressurizer/Pusher
[804-25-037]

Glenoid Pressurizer, Pegged
[804-25-035]

Glenoid Pressurizer, Keeled
[804-25-041]

Glenoid Pusher
[804-25-136]

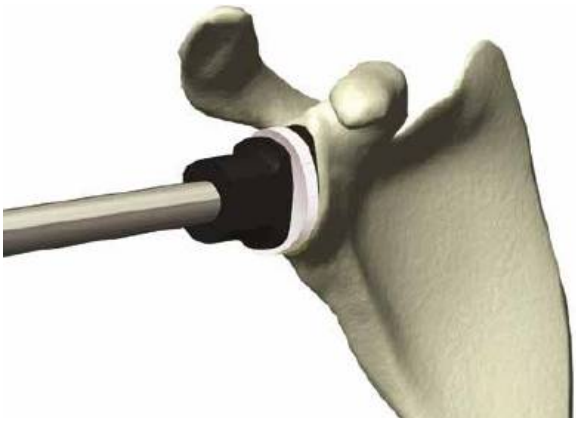


Figure 32b

Humeral Head Osteotomy Evaluation

Remove the Proximal Humeral Protector and attach the Straight Neck Planer Guide to the broach. Select the appropriate size Humeral Planer Disk by matching it to the diameter of the osteotomy cut. Mount the planer over the planer guide. Assure the selected sized planer has sufficient clearance relative to the rotator cuff insertion. The angle of the planer when fixed onto the planer guide will be perpendicular to the standard neck shaft angle of 135 degrees. Assess its relationship to the resected plane.

If the angle diverges by only a few degrees then the planer can be used with the Straight Neck Planer Guide to level the humeral osteotomy.

Assemble the Humeral Planer Disk to the Humeral Planer Driver and attach the Humeral Planer Driver to power (if preferable, hand plane by attaching the Humeral Planer Driver to the detachable T-Handle). Use the planer to level the humeral osteotomy (Figure 33). In some instances the anatomy dictates that an angle neck be utilized. In these circumstances the Angled Neck Planer Guide must be used to ensure proper preparation the surface. Note that humeral planing can also be performed once the final stem is implanted to ensure proper seating of the humeral head prosthesis to the humeral stem.

Figure 33

Instrumentation

Planer Guide, Straight Neck
[804-05-052]

Planer Guide, Angled Neck, (7.5 degrees)
[804-05-053]

Humeral Planer Disk, (Small/Medium/Large)
[804-05-117_119]

Humeral Planer Driver
[804-05-120]

Detachable T-Handle
[803-00-047]

Surgical Technique

Turon™ Modular Shoulder System

Humeral Head Trialing

Remove the Straight Neck or Angled Neck Planer Guide and assemble the Straight Neck or Angled Neck Trial to the broach (Figure 34). Starting with the Humeral Head Trial that corresponds to the size of the glenoid implant, assemble the appropriate Humeral Head Trial to the Humeral Neck Trial and tighten the center screw using the Straight Hex Driver and Ratcheting Handle (Figure 35). Once the Humeral Head Trial is assembled to the Humeral Neck Trial, the Humeral Head Impactor and Impactor Handle can be used to seat the taper on the Humeral Neck Trial to ensure it stays seated during trial reduction. If an Offset Humeral Head Trial is desired, keep the screw loose enough to rotate the trial to the final position before completely tightening. The Offset Humeral Head Trials have numerical markings on the peripheral rim to serve as reference in recording the optimal offset position. Each Offset Head has a 4 mm offset of the female taper, allowing for rotation of the head into unlimited head positions to provide optimum coverage of the proximal humerus.

Figure 34

Coverage, height, and retroversion of the humeral head prosthesis are confirmed prior to reduction. The undersurface of the trial head should seat flush against the humeral metaphysis. Check for bony interferences on the underside of the Humeral Head Trial. The superior margin of the prosthetic humeral head should sit approximately 5-10mm above the greater tuberosity. The Turon system includes variable thickness heads to optimize medial-lateral offset and soft tissue tension. Upon reduction, an appropriately sized prosthetic head is confirmed when, during posterior translation of the trial head on the glenoid, the head trial translates approximately 50% of its diameter. Once the desired position of the offset head is confirmed, correlate the position of the broach's anterior fin relative to the humeral head trial as a point of reference to determine the final humeral head implant position.

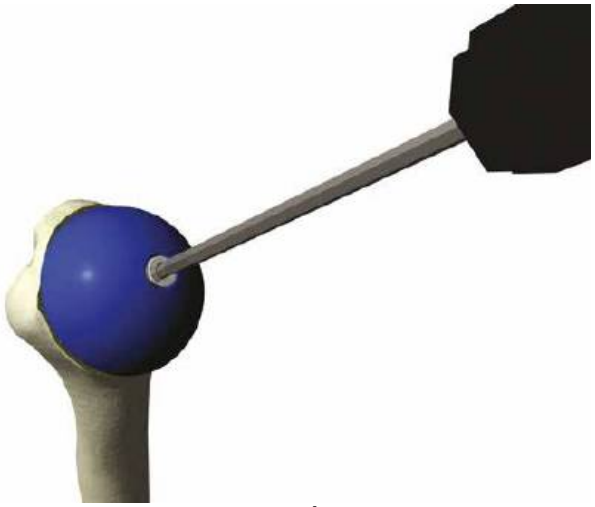


Figure 35

Note: *Depending upon whether a Straight or an Angled Neck is used, there are certain humeral head and stem configurations that are not compatible and may cause head/stem interferences. A listing of these head/stem interferences is provided.*

Instrumentation

Trial Neck, Straight
[804-15-006]

Trial Neck, 7.5 Degree Angled
[804-15-005]

Trial, Humeral Head, Neutral, (38x14mm - 54x26mm)
[804-38/42/46/50/54-014/016/018/020/022/024/026]

Trial, Humeral Head, Offset, (38x18mm - 54x26mm)
[804-38/42/46/50/54-116/118/120/122/124/126]

Hexdriver, Straight
[803-05-167]

Handle, Ratcheting
[803-05-163]

Humeral Head Impactor
[804-00-010]

Impactor Handle
[800-01-018]

Head/Stem Interferences

Stem	Straight Neck	Angled Neck
Size 6		38 mm x 18 mm Offset
Size 8		38 mm x 18 mm Offset
Size 10		38 mm x 18 mm Offset
Size 12	38 mm x 18 mm Offset	38 mm x 18 mm Offset 42 mm x 16 mm Offset
Size 14	38 mm x 18 mm Offset 42 mm x 16 mm Offset	38 mm x 18 mm Offset 42 mm x 16 mm Offset
Size 16	38 mm x 18 mm Offset 42 mm x 16 mm Offset 42 mm x 20 mm Offset 46 mm x 16 mm Offset	**38 mm x 14 mm Neutral** 38 mm x 18 mm Offset 42 mm x 16 mm Offset 42 mm x 20 mm Offset 46 mm x 16 mm Offset

When trialing with the Angled Neck Trial in combination with an Offset Humeral Head Trial, be sure to note the position of the Angled Neck Trial and the Offset Humeral Head Trial relative to the osteotomy surface. There is a laser mark on the superior surface at the minor most aspect of the Angled Neck Trial that serves as a point of reference. This laser mark is independent of the numerical markings on the superior peripheral rim of the Offset Humeral Head Trials. It is recommended to dial in and record the desired position of the Angled Neck Trial prior to recording the determined position of the Offset Humeral Head Trial.

Once the proper broach size, head size, and head offset have been determined, the trial head implant is removed and the humeral metaphysis is marked at the area corresponding to the "six o'clock" position on the broach. This will assist the surgeon in reproducing stem position with the final implant. The trial broach is then removed and the humerus is prepared for final prosthetic implantation.

Note: *If preferred, humeral head trialing may be performed off the final stem. After glenoid implantation, the surgeon may desire to proceed immediately to final humeral stem implantation and perform humeral head trialing off the final stem.*

Note: *For instances when the Trial Necks are difficult to remove, the Humeral Neck Extractor can be used.*

Instrumentation

Humeral Neck Extractor
[804-15-003]

Surgical Technique

Turon™ Modular Shoulder System

Humeral Head and Glenoid Radius of Curvature Mismatch

Note: *The Turon system is designed with a radius of curvature mismatch between the humeral heads and the glenoid components. The mismatch is different in the A/P and I/S planes to optimize stability while allowing translational articulation.*

I/S Radius of Curvature Mismatch (mm)

Glenoids	Humeral Heads				
	Size 38	Size 42	Size 46	Size 50	Size 54
Size 38	**8***	6	4	2	0
Size 42	10	**8**	6	4	2
Size 46	12	10	**8**	6	4
Size 50	14	12	10	**8**	6
Size 54	16	14	12	10	**8**

A/P Radius of Curvature Mismatch (mm)

Glenoids	Humeral Heads				
	Size 38	Size 42	Size 46	Size 50	Size 54
Size 38	**12***	10	8	6	4
Size 42	14	**12**	10	8	6
Size 46	16	14	**12**	10	8
Size 50	18	16	14	**12**	10
Size 54	20	18	16	14	**12**

*Size pairing in bold represent recommended mismatch

Proximal Humeral Preparation for Lesser Tuberosity or Subscapularis Repair

If the surgeon has performed a lesser tuberosity osteotomy or removed the entire subscapularis from the lesser tuberosity, drill holes will be required to re-approximate the subscapularis to the proximal humeral metaphysis. Six paired, 2.5mm drill holes are placed in the anterior metaphyseal bone for the passage of multiple #5 polyester sutures or tapes. The holes from the two previously placed bone pins of the Humeral Cutting Guide may also be used for trans-osseous suture passage.

Note: *It is preferred to stagger drill holes to avoid fracture of the greater tuberosity.*

To optimize subscapularis repair, it is recommended that a suture loop be left outside the canal, through which the surgeon may pass the stem. Looping the sutures around the stem, rather than merely through the metaphyseal bone, substantially improves the subscapularis load to failure after shoulder arthroplasty.

To facilitate subscapularis repair at the completion of the procedure, leave the needles attached to each suture and tag the sutures individually with a small clamp.

PIEMCA

Humeral Stem Press-fit Technique

For press-fit applications, the stem size chosen will be the same as that of the final broach. The final humeral component is slightly larger than its corresponding broach, which ensures a secure press-fit. If the broach rotates or deforms the proximal humeral cancellous bone, the surgeon may opt to increase the size of the broach and corresponding stem. To improve the press-fit, bone harvested from the native humeral head can be impacted into the medullary canal. Once the decision is made to press-fit the humeral component, gently irrigate the canal with antibiotic solution. Assemble the humeral component to the Broach Handle. The humeral stem is aligned as previously determined during broach technique (Figure 36). The Retroversion Alignment Rod can be used to confirm and assist with maintaining proper retroversion. If utilizing trans-osseous suture loops, insert the stem through the suture loops and into the canal. Tighten the suture loops prior to engaging the humeral metaphysis. Once the metaphysis is engaged, the Broach Handle is carefully tapped with a mallet, making sure that the component progresses slightly with each successive tap of the mallet. Once the metaphysis of the component begins to lock into the patient's proximal metaphyseal bone, do not rotate or tilt the stem, as this can compress the proximal cancellous bone and compromise the press-fit fixation.

If desired, use cancellous bone from the resected humeral head to perform impaction bone grafting or to bone graft any small defects and ensure a secure press-fit.

Figure 36

Humeral Stem Cement Technique

For patients with severe osteoporosis, inflammatory arthritides, or those in which, a press fit cannot be achieved, a cemented humeral stem may be preferred. A humeral prosthesis one size smaller than the last broach used should be chosen for implantation; this will allow for the desired 2 mm cement mantle. Insert a cement restrictor down the intramedullary canal and gently tap it to approximately 1 cm distal to the tip of the prosthesis.

The canal is brushed, irrigated with an antibiotic solution using pulsatile lavage, and thoroughly dried. At the same time, vacuum-mix two packages of bone cement and load into a cement gun. Inject the cement in a retrograde fashion, ensuring complete fill of the intramedullary canal. Attach the Humeral Stem to the Broach Handle and align the stem as previously determined during the broach technique. The Retroversion Alignment Rod can be used to confirm and assist with maintaining proper retroversion. If utilizing trans-osseous suture loops, insert the stem through the suture loops and into the canal. Tighten the suture loops prior to engaging the humeral metaphysis. Once the metaphysis is engaged, the broach handle is carefully tapped with a mallet, making sure that the component progresses slightly with each successive tap of the mallet. Once the component is fully seated, it is held firmly in position until the cement has fully cured. Excess cement is removed.

Instrumentation

Humeral Broach Handle
[804-05-007]

(Optional) Retroversion Alignment Rod
[803-01-057]

Surgical Technique
Turon™ Modular Shoulder System

Humeral Implant Assembly

When utilizing the Straight Humeral Neck, it is preferable to pre-assemble the neck implant to the Humeral Head. The Back-Table Assembly Fixture can facilitate this in one of two methods.

The first method involves using the scalloped neck recess built in to the fixture on the side engraved with "38mm – 42mm" (Figure 37). Insert the bottom or smaller male tapered end of the straight neck implant into the scalloped recess so that the large male tapered end is facing up. Place and finger press the humeral head implant onto the humeral neck to initiate the Morse taper. For instances when an Angled Humeral Neck is used in combination with an Offset Humeral Head, be sure to position or dial in the desired position of the Angled Humeral Neck relative to the Offset Humeral Head prior to initiating the Morse taper. Assemble the Humeral Head Impactor to the Impactor Handle, and use the impactor to gently tap the humeral head thus locking it with the humeral neck.

Figure 37

The second and alternative method is to position the Humeral Head in the appropriate sized humeral head concavity on the Back-Table Assembly Fixture. There are two concavities, one on each side of the fixture, engraved with "38mm – 42mm" and "46mm – 54mm", respectively. Insert the straight neck implant into the female taper of the humeral head implant. Finger press the humeral neck into the humeral head to initiate the Morse taper. Position the Humeral Head Impactor over the humeral neck and humeral head construct. While cupping the humeral neck and head implants and the impactor tip, engage the Morse taper of the neck implant into the humeral head implant by gently tapping to form and complete a secure Morse taper lock (Figure 38)

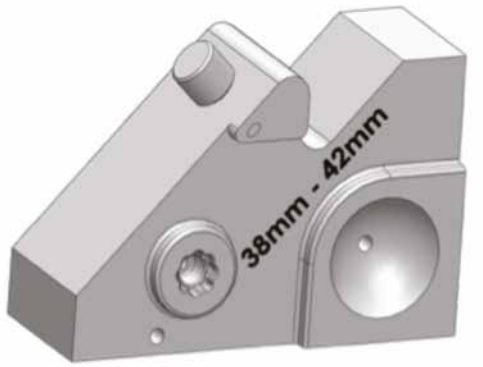


Figure 38

For final implant assembly, place the determined sized Humeral Stem in the impaction fixture. The Stem Locking Screw is available to secure the humeral stem in the proper position and to facilitate implant assembly. Insert the humeral neck and humeral head construct in the desired position into the scalloped female taper of the humeral stem. Using the humeral head impactor, engage the Morse taper of the humeral neck and stem.

For in situ assembly with the final humeral stem, finger-press the humeral neck into the humeral stem and tap it lightly with the Humeral Head Impactor to engage the Morse taper. Pass sutures around the humeral neck to avoid pull-out of the subscapularis tendon during repair and closure. When using the Angled Humeral Neck, be sure to dial in the desired position prior to finger pressing and initiating the Morse taper. This also applies when using the Offset Humeral Heads.

Instrumentation

Fixture, Back-Table Assembly
[804-15-102]

Impactor, Humeral Head
[804-00-010]

Impactor Handle
[800-01-018]

PIEMCA

Humeral Head Implantation

Thoroughly irrigate and dry the female taper of the proximal Humeral Stem. Insert the preassembled Humeral Head and Humeral Neck into the stem's female Morse taper to match the offset previously determined during humeral head trialing. Use the Humeral Head Impactor to gently tap the humeral head, thus locking the Humeral Neck into the Humeral Stem. Test the Morse taper to assure no bony interferences.

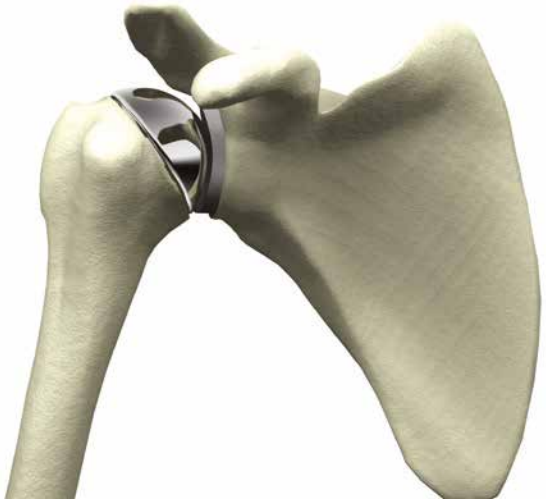
Reduce the glenohumeral joint and again ensure that the head translates approximately fifty percent of its diameter. Thoroughly irrigate the joint and remove loose fragments of bone or cement.

Subscapularis or Lesser Tuberosity Repair

Use the previously placed trans-osseous sutures or tape to reattach the subscapularis to the proximal humeral metaphysis. If a lesser tuberosity osteotomy was performed, the sutures or tape may be passed just medial to the tuberosity. The lesser tuberosity is then reduced and secured. Any additional inferior humeral sutures can be used to secure the subscapularis to the humeral neck. Finally, place two #2 polyester sutures in the lateral rotator interval to approximate the lateral subscapularis and supraspinatus margins. The rotator interval is then closed.

Deltopectoral and Superficial Closure

Perform a final irrigation of the surgical wound. The deltopectoral interval is loosely approximated with a running, absorbable, #1 suture. The deep dermis is closed with interrupted #2-0 absorbable suture, and the superficial dermis is closed with either #3-0 absorbable monofilament suture or staples. The wound is then dressed and a sling with immobilizing strap is applied.



Surgical Technique

Turon™ Modular Shoulder System

Rehabilitation

Patients are typically discharged on the first or second post-operative day. While in the hospital, patients are instructed on a home program that includes gentle wrist and elbow range of motion and pendulum exercises. During the initial post-operative period, shoulder motion is discouraged except for hygiene. Patients are instructed to wear a shoulder immobilizer at all times.

During the first post-operative clinic visit — usually 10-14 days after hospital discharge — sutures are removed. Gentle range of motion for the elbow, wrist and hand is encouraged. Pendulum exercises are performed for hygiene only. Formal therapy is not initiated until the second postoperative visit which occurs 6 weeks after the operation. Patients and therapists are instructed to discontinue the immobilizer, and begin active-assisted range of motion and isometric strengthening. Light strengthening with elastic bands and small hand weights may begin post-operative at weeks 10-12. Terminal range of motion exercise and shoulder girdle strengthening continue for 3-5 months post-operatively. At the conclusion of the supervised outpatient physiotherapy program, the patient is instructed to perform an independent home exercise program for long-term shoulder conditioning.

Revision

Removal of the Humeral Head and Humeral Neck can be achieved without disturbing a well-fixed Humeral Stem.

The humeral head implant can be removed using the Head Distractor. Place the two prongs of the distractor between the humeral head implant and the osteotomy surface. Gently tap the distractor to disengage the Morse taper.

The humeral neck implant can be removed using the Humeral Neck Extractor. Attach the Humeral Neck Extractor to the Ratcheting Handle. Thread the tip of the extractor into the threaded hole of the humeral neck implant. The threaded tip will bottom out against the humeral stem and disengage the Morse taper.

For instances when the humeral stem requires removal, the Humeral Broach Handle and Stem Extractor can be used. Remove any residual osteophytes and soft tissue debris from the proximal surface and supero-lateral aspect of the humeral stem, and attach the Humeral Broach Handle. Gently tap the humeral stem out from the shaft until the collar of the humeral stem is sufficiently clear from the osteotomy surface. There is a medial notch beneath the collar of the humeral stem where the tip of the Stem Extractor engages. The Stem Extractor greatly facilitates humeral stem removal. Place the tip of the Stem Extractor into this notch and gently tap in an upward motion to complete the humeral stem removal.

Instrumentation

Head Distractor
[804-05-046]

Humeral Neck Extractor
[804-15-003]

Handle, Ratcheting
[803-05-163]

Humeral Broach Handle
[804-05-007]

Stem Extractor
[804-05-047]

Surgical Technique

Turon™ Revision/Long Stem

Humeral Canal Reaming

The humerus must be extended and adducted to avoid the patient's head while accessing the medullary canal. Use the T-Handled Starter Reamer (6mm) to sound the medullary canal (Figure 39). Ream the canal with sequentially larger reamers until cortical chatter is present. Hand reaming is preferred in the majority of patients and is imperative in patients with osteoporosis or inflammatory arthritis. Assemble the Humeral Reamer to the detachable T-Handle. For revision/long stem applications, the Humeral Reamers should be inserted into the humerus such that the "Revision" line is level with the top of the greater tuberosity (Figure 40). The canal is then irrigated to remove loose cancellous bone or fat in the metaphyseal region.

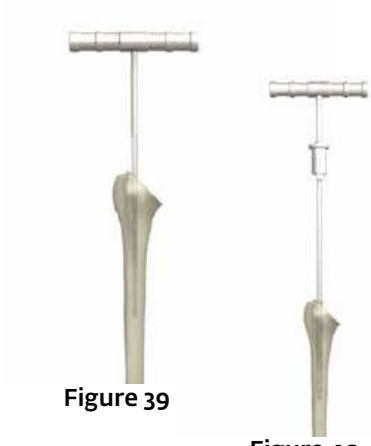


Figure 39

Figure 40

Humeral Canal Broaching

An assistant should support the arm and provide a counterforce as the broaches are introduced into the humeral canal. The elbow can also be placed on a well padded Mayo stand to support the humerus during broaching. The alignment rod can be inserted into the broach handle to maintain the appropriate degree of retroversion. It is preferable to align the rod with the forearm in the majority of cases (Figure 41).

Figure 41

The Humeral Broach is secured to the Broach handle by placing the taper on the distal end of the handle into the reverse taper of the Broach and aligning the tab on the handle with the scallop on the Broach (Figure 42).

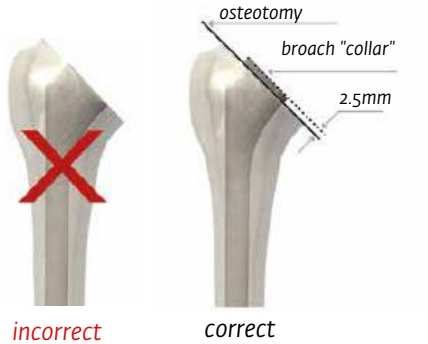
Figure 42

The Alignment Rod should be parallel to the forearm during broaching to maintain the proper retroversion angle (Figure 43). If desired, the surgeon can change the proximal humeral version angle by rotating the broach to the desired position.

Figure 43

Note: *Please note the correct final position when seating the broach.*

Broaching is performed in a sequential manner starting with the smallest size and increasing until the correct size is obtained. Avoid broaching in varus by obtaining a far lateral starting point and ensuring that the canal is broached up to the largest size that is safely attainable. Avoid excessive force when seating the broach. Impact the broach until the bottom of the "collar" is flush with the osteotomy (as shown to the right). The distance between the bottom of the "collar" and the top face of the Humeral Broach is 2.5 mm. This is the height that should be above the osteotomy after fully seating the broach. Once the desired broach is fully seated, scrutinize it for proper press fit. The handle attached to the broach can be used to rotate the broach in the humeral canal. If the broach rotates or deforms the proximal humeral cancellous bone, then the surgeon may elect to increase one size on the broach to achieve a better press fit. Alternatively, the surgeon may decide that the patient's particular anatomy is not conducive to a stable press fit and use bone cement to secure a smaller implant.



Instrumentation

T-Handled Starter Reamer (6mm) [804-00-002]	Retroversion Alignment Rod [803-01-057]
Detachable T-Handle [803-00-047]	Humeral Broach Handle [804-05-007]
Humeral Reamers (6mm/8mm/10mm/12mm/14mm/16mm) [804-05-086_091]	Turon Humeral Broach (6mm - 16mm) [804-05-106_116]

Humeral Stem Press-fit Technique

For press-fit applications, the revision/long stem diameter size chosen will be the same as that of the final broach diameter size. The final humeral component is slightly larger than its corresponding broach, which ensures a secure press-fit. If the broach rotates or deforms the proximal humeral cancellous bone, the surgeon may opt to increase the size of the broach and corresponding stem. To improve the press fit, bone harvested from the native head can be impacted into the medullary canal. Once the decision is made to press-fit the humeral component, gently irrigate the canal with antibiotic solution. Assemble the humeral component to the Broach Handle. The revision/long humeral stem is aligned as previously determined during broach technique (Figure 44). The Retroversion Alignment Rod can be used to confirm and assist with maintaining proper retroversion. If utilizing trans-osseous suture loops, insert the stem through the suture loops and into the canal. Tighten the suture loops prior to engaging the humeral metaphysis. Once the metaphysis is engaged, the Broach Handle is carefully tapped with a mallet, making sure that the component progresses slightly with each successive tap of the mallet. Once the metaphysis of the component begins to lock into the patient's proximal metaphyseal bone, do not rotate or tilt the stem, as this can compress the proximal cancellous bone and compromise the press-fit fixation.

Figure 44

Humeral Stem Cement Technique

For patients with severe osteoporosis, inflammatory arthritides, or those with unique humeral anatomy, a cemented humeral revision/long stem may be preferred. A humeral prosthesis one size smaller than the last broach used should be chosen for implantation; this will allow for the desired 2mm cement mantle. Insert a cement restrictor down the intramedullary canal and gently tap it to approximately 1cm distal to the tip of the prosthesis.

The canal is brushed, irrigated with an antibiotic solution using pulsatile lavage, and thoroughly dried. At the same time, vacuum-mix two packages of bone cement and load into a cement gun. Inject the cement in a retrograde fashion, ensuring complete fill of the intramedullary canal. Attach the revision/long humeral stem to the Broach Handle and align the stem as previously determined during the broach technique. The Retroversion Alignment Rod can be used to confirm and assist with maintaining proper retroversion. If utilizing trans-osseous suture loops, insert the stem through the suture loops and into the canal. Tighten the suture loops prior to engaging the humeral metaphysis. Once the metaphysis is engaged, the broach handle is carefully tapped with a mallet, making sure that the component progresses slightly with each successive tap of the mallet. Once the component is fully seated, it is held firmly in position until the cement has fully cured. Excess cement is removed.

Surgical Technique

Turon™ Modular Shoulder System

Notes

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1. Christian Gerber, Scott D. Pennington, Edward H. Yian, Christian A.W. Pfirrmann, Clément M.L. Werner and Matthias A. Zumstein. Lesser Tuberosity Osteotomy for Total Shoulder Arthroplasty. Surgical Technique.J. Bone Joint Surg. Am. 88:170-177, 2006. doi:10.2106/JBJS.F.00407

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CAUTION: Federal Law (USA) restricts this device to sale by or on the order of a physician.

See package insert for a complete listing of indications, contraindications, warnings, and precautions.

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