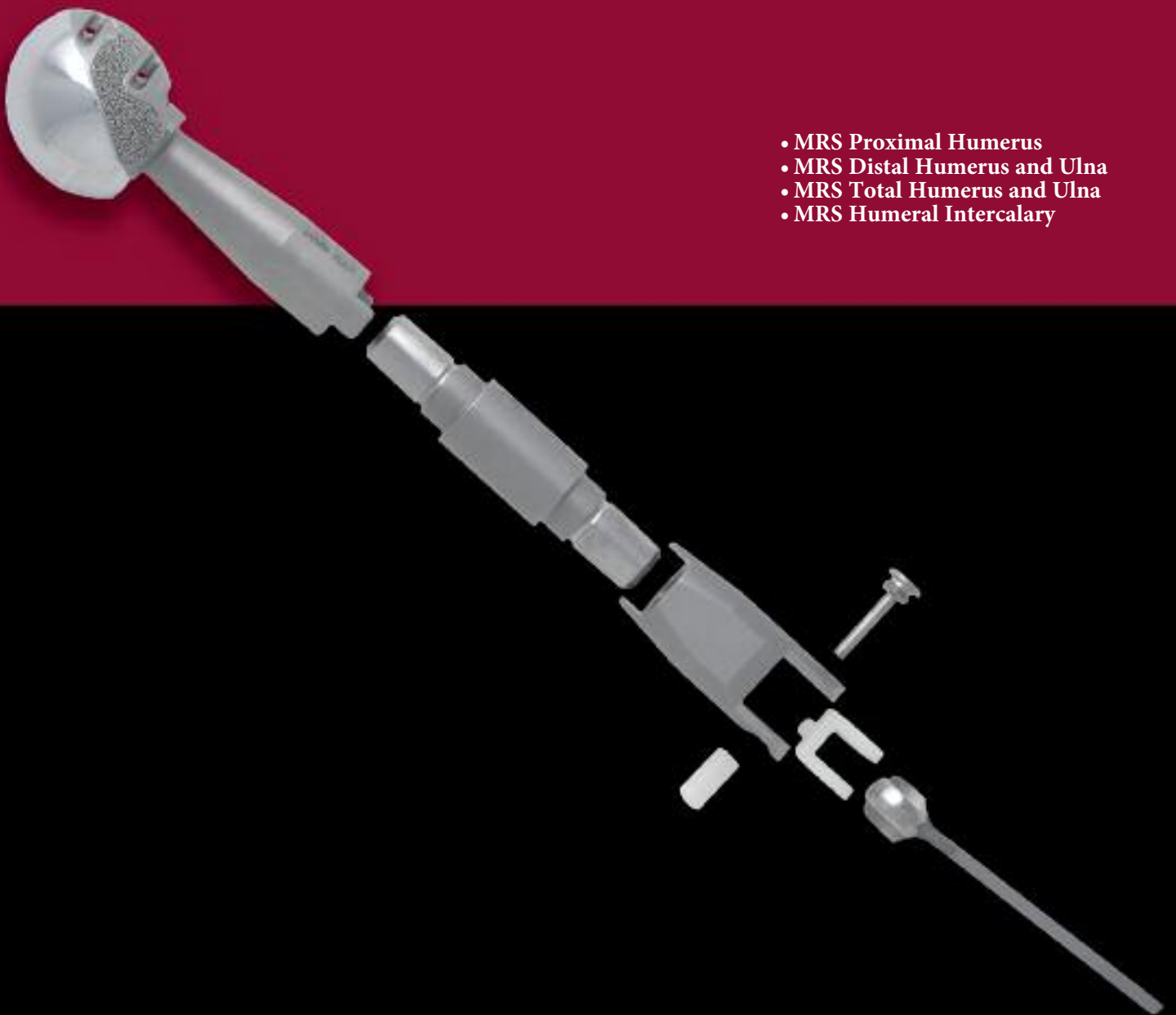


MRS Upper Extremity

Surgical Protocol

- MRS Proximal Humerus
- MRS Distal Humerus and Ulna
- MRS Total Humerus and Ulna
- MRS Humeral Intercalary



MRS Upper Extremity

Surgical Protocol

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Acknowledgments

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Martin Malawer, MD
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Image #'s 2, 6, 7, 8, 9 and 10: Cancer Surgery, Treatment of Sarcomas and Allied Diseases, Malawer M and Sugarbaker PH, Kluwer Academic Press, Dordrecht, Boston and London, 2001.

The MRS upper extremity components are marketed in the United States for use with bone cement.

Introduction

The Modular Replacement System, also known as the MRS was introduced in 1988. This brochure covers the Upper Extremity components of the MRS namely:

- ▶ Proximal Humerus
- ▶ Total Humerus and Ulna
- ▶ Distal Humerus and Ulna
- ▶ MRS Humeral Intercalary

Section 1: System Components

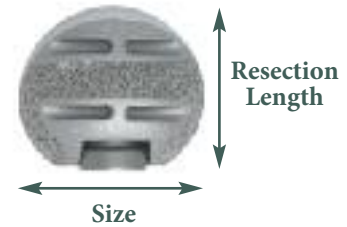
MRS Proximal Humerus

The MRS Proximal Humerus components are:

The Head

- ▶ Material: Cobalt-Chrome
- ▶ Taper: Morse

Size (mm)	Resection Length (mm)
40	29
44	31



The Bodies

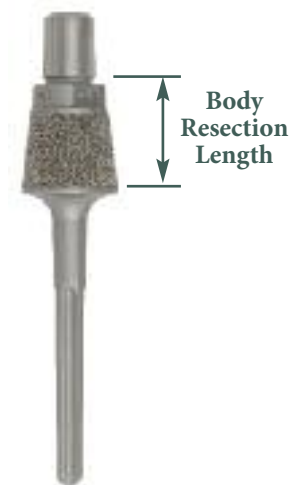
- ▶ Material: Titanium
- ▶ Body Lengths: 40, 60, 80, 100, 120, and 140mm
- ▶ Taper: Morse



The Stems

- ▶ Material: Cobalt-Chrome
- ▶ Polished cemented humeral stems
- ▶ Porous coating at prosthesis-bone interface:
 - Designed to transfer forces from the body of the prosthesis to the cortical bone
 - This is designed to reduce stress on the system and acts as a biological envelope

Stem Type (Only Cemented)	Body Resection Length (mm)	Stem Length (mm)	Stem Diameter (mm)
With Body (shown)	29	75 and 115	7, 9 and 11
Without Body/Bodiless	9	75 and 115	7, 9 and 11



- ▶ Stems with bodies (29mm) are only available with porous coating on the bodies
- ▶ Bodiless stems (9mm resection) are only available without porous coating

MRS Upper Extremity

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MRS Distal Humerus

The MRS Distal Humerus and Ulna system is designed for a universal fit with the MRS Proximal Humerus System and Solar Ulna components. The Distal Humeral System consists of:

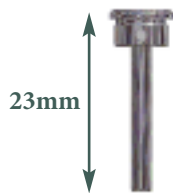


Distal Humeral Component

- ▶ Distal end accepts Bearing Insert, Axle Bushing and Axle Pin and provides an articulating surface for assembly to an ulna component
- ▶ Articulates with Solar Components – (See Section 8 for MRS and Solar component compatibility details)
- ▶ Has a female taper with two anti-rotation fins at proximal end – mates with male taper of Proximal Humerus bodies and stems
- ▶ Material: Titanium

Resection Length (mm)
40
45
50
55

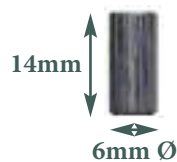
Axle Pin Bushing Kit



Composed of Bearing Insert, Axle Bushing Sleeve and Axle Pin

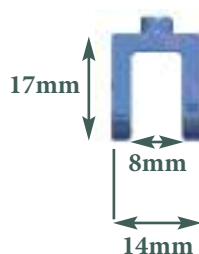
- ▶ The Axle Pin is designed for easy assembly of the elbow joint
- ▶ The Bearing insert and Axle Bushing can be assembled to the distal humerus
- ▶ The Bearing insert provides a polyethylene bearing surface
- ▶ The Bearing insert – universal fit with all sizes of the distal humeral component
- ▶ Elbow joint hinge-like movement between the humeral and ulnar components is provided by the axle pin
- ▶ Materials:

Axle Bushing Sleeve



- Axle Pin – Titanium
- Axle Bushing Sleeve and Bearing Insert – Ultra-high molecular weight polyethylene

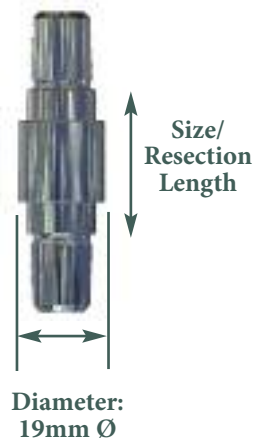
Bearing Insert



Humeral Connection Components

- ▶ Designed for use with MRS Humeral Components
- ▶ Male tapers on both ends
- ▶ Material: Titanium

Size/ Resection Length (mm)
35
45



MRS Ulna Component

- ▶ For use in distal humerus or total humerus surgeries
- ▶ Designed to provide fixation and anchorage when used with MRS Humeral Components
- ▶ Available in both Left and Right anatomic versions
- ▶ Material: Titanium

Size	Length (mm)
Small	80 (R & L)
Standard	100 (R & L)
Large	120 (R & L)



MRS Upper Extremity

Surgical Protocol

Section 2: Pre-Operative Planning

For Oncology Patients

- ▶ Imaging studies are required for oncology patients to determine anatomic location of the lesion. They are also needed to locate osseous and soft-tissue extent of the tumor and the relationship to the major vessels.
- ▶ Radiographs, Computed Tomography scan, Magnetic Resonance Imaging, arteriography and bone scintigraphy are useful imaging studies to help obtain critical information.
- ▶ Total resection length is determined using cross-sectional imaging and measuring tumor length with an additional 3-5cm margin before osteotomy.

For Non-Oncology Patients

- ▶ Radiography could potentially be the only evaluation tool used.
- ▶ In reconstruction and trauma patients, osteotomy can be performed at the end of the current cement mantle, or at the end of any fractures, if present.

Section 3: MRS Proximal Humerus: Resection and Reconstruction

Intra-Articular Approach

Dissection: The Deltopectoral (Henry) approach

- ▶ The Pectoralis major tendon is generally tagged and transected – yielding exposure to the neurovascular bundle medially. The circumferential vessels which attach the neurovascular sheath to the proximal humerus must be ligated. The axillary nerve is identified and usually preserved.
- ▶ These structures can then be retracted and protected.
- ▶ Most proximal humeral arthroplasty requires detachment of both heads of the bicep, which can again be tagged for later re-attachment.
- ▶ The subscapularis tendon and capsule can be taken down and the rotator interval opened to allow intra-articular exposure.
- ▶ The remaining rotator cuff can be taken off the humerus.
- ▶ The humeral head can then be lifted from the glenohumeral joint.
- ▶ Additional excision of the deltoid, lateral head of the triceps, latissimus dorsi and teres major is determined by the type of resection performed (tumor versus reconstruction) and by the final resection length.
- ▶ Humeral resection length is determined with imaging studies.

Patient Position

- ▶ Patients are usually supine, in a modified beach chair position, with their involved extremity on an arm board.
- ▶ Patients may also be positioned supine with a “bump” beneath the scapula, thus elevating the shoulder and allowing improved access to the shoulder.

Measuring Resection Length and Osteotomy

- ▶ Measure the tumor.
- ▶ Humeral osteotomy is made distal to the tumor extent to ensure an appropriate margin.



Figure 1: Preparation of the Humerus

Preparation of the Humerus

- ▶ Hand ream the canal of the remaining distal humerus carefully for placement of the largest diameter stem possible, accommodating for a 2mm cement mantle.

Note: If a 9mm reamer is used, a stem with a 7mm diameter should be used.

Note: In long humeral resections with short residual distal segments, care must be taken to not enter the olecranon or coronoid fossae to prevent cement extravasation into the elbow joint.

- ▶ A facing reamer (Figure 1) is used to create a 90 degree plane and a seat for stem-bone interface that protects the stem from bending stress in the remaining distal humeral bone.



Figure 2: Trialing

Trialing

- ▶ Perform trial reduction to check the prosthetic length and orientation.

MRS Upper Extremity

Surgical Protocol



Figure 3: Trialing

Trialing



Figure 4: Impaction and Assembly

Impaction and Assembly

- ▶ Reconstruct the resected bone length using the wide variety of stem and body options (see section 1 – System Components for list of stems and bodies available).
- ▶ Drape a cloth around all implants to make sure they do not get scratched during impaction.
- ▶ Impact the humeral body and humeral stem with several swift blows from a heavy mallet to lock the tapers.
- ▶ Next, the stem and humeral head construct is assembled to the humeral head using a heavy mallet.

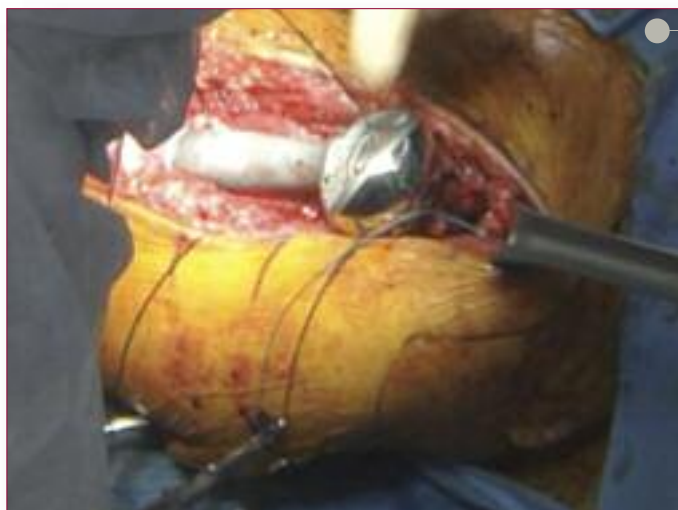


Figure 5: Implantation through intra-articular approach

Implantation

- ▶ The prosthesis is implanted and cemented while maintaining proper retroversion (about 20 degrees) of the humeral head.
- ▶ Stems are to be cemented and are available with or without extra-cortical porous coated body sections.



Figure 6: Dissection: Extra-Articular Approach

Extra-Articular Approach

Dissection

- ▶ When an extra-articular resection is performed by exposing the glenohumeral joint both anteriorly and posteriorly, the scapula is osteotomized medial to the coracoid along the distal portion of the clavicle.
- ▶ The resected specimen usually consists of the proximal one-half of the humerus, the glenohumeral joint and the distal clavicle en-bloc.

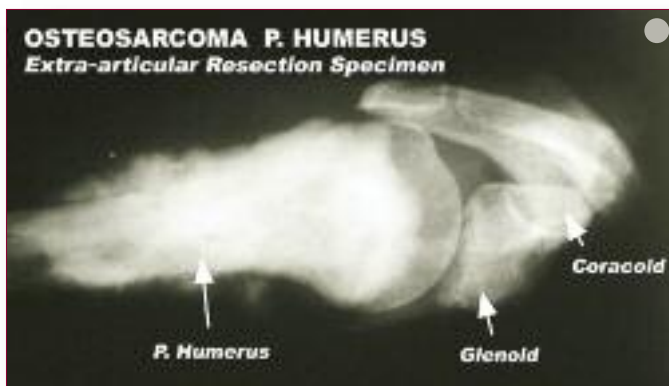


Figure 7: Dissection: Resected Specimen

Measuring Resection Length and Osteotomy

- ▶ The humeral osteotomy is made sufficiently distal to the distal extent of the tumor to ensure adequate tumor resection margins.
- ▶ The length of the upper extremity should be restored to normal and allow appropriate soft tissue coverage.
- ▶ Lengthening of the upper extremity should be avoided to prevent excessive traction on the neurovascular structures and to facilitate wound closure.

Rotational Alignment

- ▶ The head is centered in the glenoid so that there is maximal contact in internal and external rotation through a functional range of motion.

Preparation of the Humerus

- ▶ The canal of the remaining distal humerus is carefully hand reamed for placement of the largest diameter stem possible, accommodating for a 1-2mm cement mantle.
- ▶ In long humeral resections with short residual distal segments care must be taken to not enter the olecranon fossa to prevent cement extravasation into the elbow joint.
- ▶ A facing reamer (Figure 1) is used to create a 90° plane and a seat for stem bone interface that protects the stem from bending stress in the remaining distal humeral bone.

MRS Upper Extremity

Surgical Protocol

Trialing

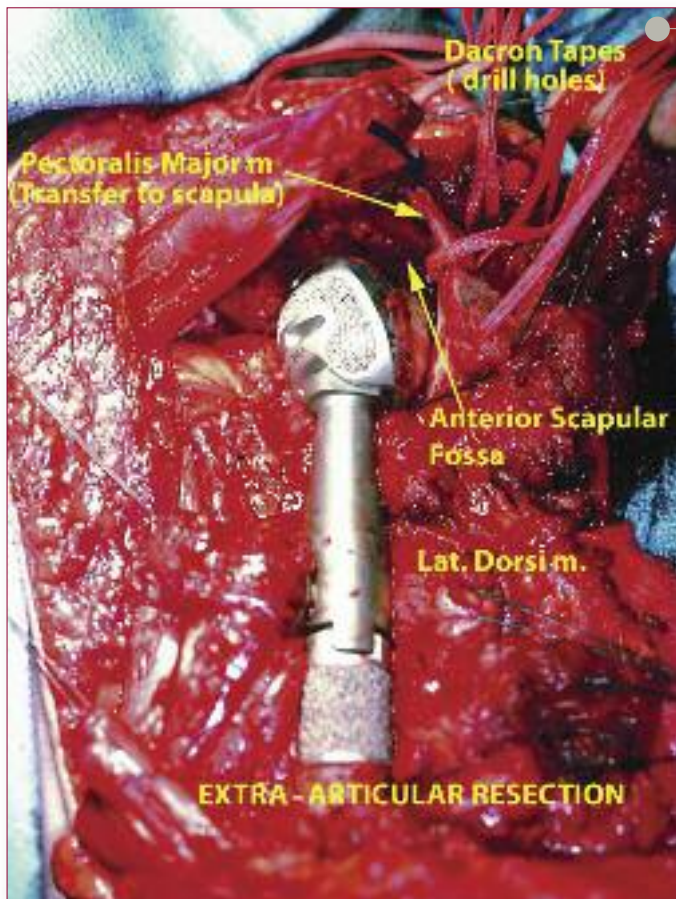
- ▶ Trial reduction is performed to check the prosthetic length and orientation (Figure 2).

Impaction and Assembly

- ▶ Reconstruct the resected bone length using the wide variety of stem and body options (see section 1 – System Components for list of stems and bodies available).
- ▶ Drape a cloth around all implants to make sure they do not get scratched during impaction.
- ▶ Impaction of the humeral body and humeral stem with several swift blows from a heavy mallet to lock the tapers.
- ▶ Next the stem and humeral head construct is assembled to the humeral head using a heavy mallet (Figure 4).

Proximal
Humerus

Distal
Humerus/Ulna



Implantation

- ▶ The prosthesis is implanted and cemented while maintaining proper retroversion (20 degrees) of the humeral head.
- ▶ Stems are to be cemented and are available with or without extra-cortical porous coated body sections.

Figure 8: Implantation through extra-articular approach

Section 4: MRS Distal Humerus/Ulna - Resection and Reconstruction

There are a variety of surgical approaches for a distal humeral surgery. Intra-articular and extra-articular surgical approaches can be used. There are three surgical options for the intra-articular surgical approach – posterior, anterior or modified surgical approach. **The choice is based on the surgeon preference as well as the necessary resection length.**

Generally, no extensive vascular dissection is required in this approach. If in an oncology situation the tumor requires extensive vascular dissection, an anterior approach should be considered

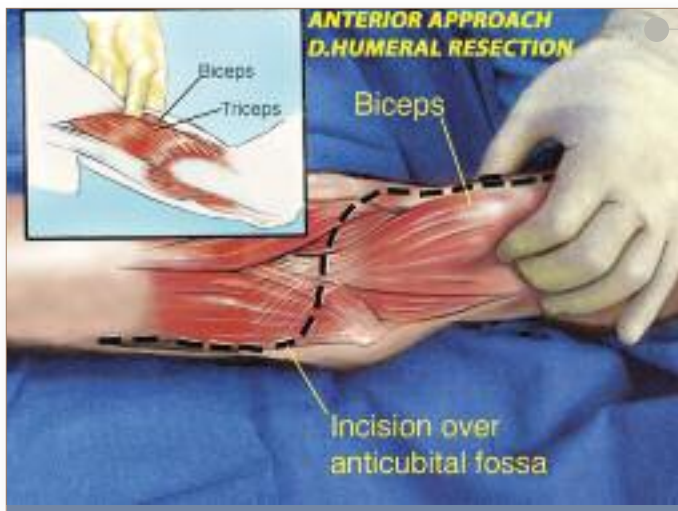


Figure 9: Anterior Approach

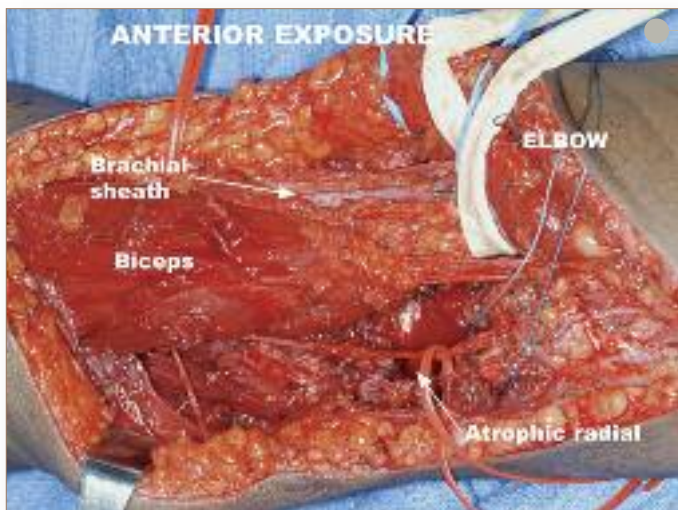


Figure 10: Anterior Exposure

Anterior Surgical Approach

The anterior approach to the distal humerus is the direct continuation of the deltopectoral approach to the proximal humerus.

It is also the appropriate approach for total humeral replacement.

- ▶ Patient Positioning: The patient is positioned supine, with the arm abducted on an arm board.
 - ▶ The anterior approach begins on the anterolateral aspect of the humerus, just medial to the deltoid insertion. It then continues distally to the antecubital fossa slightly medial to the lateral epicondyle. The incision is continued obliquely across the antecubital fossa to an area just medial to the midline of the forearm.
 - ▶ The biceps muscle is identified and retracted both medially and laterally, depending upon the direction of dissection.
 - In oncology cases, the brachialis may be left with the humerus as a soft tissue margin.
 - In reconstructive cases it is split longitudinally. Branches of the musculocutaneous nerve to the biceps should be preserved if possible.
 - ▶ Distally the brachialis is moved away from the joint capsule (either by splitting or transaction) and the capsule is opened.
 - ▶ Medially, the brachial artery and median nerve are dissected free and protected well into the forearm.
- The ulnar nerve can also be identified, and followed posteriorly. Releasing the capsule and ligaments facilitates cubital tunnel dissection from the front, and is frequently done later.
- ▶ Laterally, the interval between the brachialis and brachioradialis is exploited, and the radial nerve is identified with the deep humeral artery. Both are then dissected posterolaterally through the radiospiral groove, and suitably protected.

MRS Upper Extremity

Surgical Protocol

- ▶ If the resection length is cephalad to the brachioradialis origin, removing this origin from the humerus will facilitate radial nerve exposure.
- ▶ With the major neurovascular structures identified and protected, the collateral ligaments and capsule can then be transected. This allows the distal humerus to be elevated into the wound, and facilitates releasing the ulnar nerve from the cubital tunnel. The attachments of the triceps to the distal humerus will then become visible and can be released.
- ▶ Appropriate humeral osteotomy will then allow the bone to be removed.

Distal
Humerus/Ulna

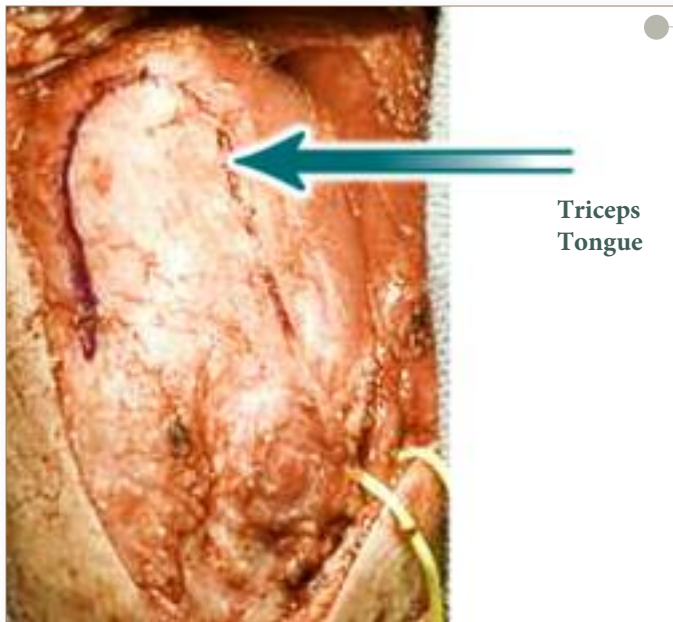


Figure 11: Posterior Approach: Triceps Tongue

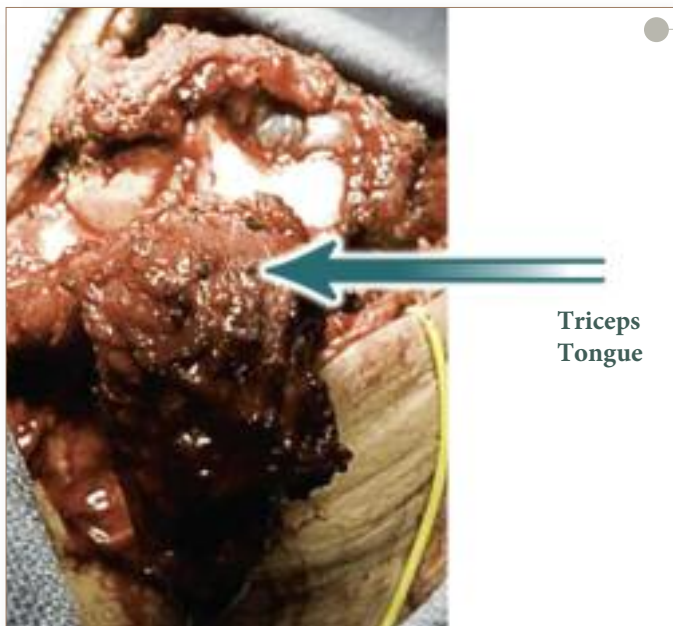


Figure 12: Posterior Approach: Triceps Tongue

Posterior Surgical Approach

- ▶ The posterior approach is suitable for resections involving the distal one-third of the humerus.
- ▶ Generally, no extensive vascular dissection is required in this approach. If in an oncology situation the tumor requires extensive vascular dissection, an anterior approach should be considered.
- ▶ Patient Positioning: laterally, with the arm draped over a padded rest.
- ▶ A posterior incision is made, curving laterally over the anconeus at the elbow.
- ▶ Fasciocutaneous flaps are created, and an ulnar nerve transposition is performed.
- ▶ Deeper exposure is via one of two methods: a triceps peel (Morrey) or a triceps tongue. The advantage to the triceps tongue is that the triceps enthesis is left intact.
- ▶ A V-shaped cut is made through the medial head of the distal triceps, preserving tendinous attachments on both sides.
- ▶ The olecranon fossa is then exposed, and the medial and lateral ulnohumeral ligaments are taken down, allowing the distal humerus to be dislocated slightly.
- ▶ Continued transection of the capsule laterally separates the humerus from the radial head, and allows the anterior capsule to be visualized and transected.
- ▶ Continued posterior translation of the humerus brings the brachioradialis origin, as well as the common origins of the forearm flexors and extensors into view. These can then be tagged and released from the humerus, further elevating the distal humerus from the elbow joint.
- ▶ An osteotomy at the appropriate resection length can then be performed.



Figure 13: Measuring Resection Length



Figure 14: Facing Reamer

Measuring Resection Length and Osteotomy

- ▶ The humeral osteotomy is made sufficiently proximal to the distal extent of the tumor to ensure adequate tumor resection margins, or to remove any cement, prostheses or fracture fragments.
- ▶ The length of the upper extremity should be restored to normal. Lengthening of the upper extremity should be avoided to prevent excessive traction on the neurovascular structures and to facilitate wound closure.

Rotational Alignment

- ▶ Lay arm in supine position.
- ▶ Rotational alignment is determined by the surgeon. If the patient is supine, elbow flexion with the shoulder in a neutral position should place the forearm perpendicular to the floor. In a lateral position, the supinated palm should be pointing directly toward the patient's head.

Preparation of the Distal Humerus

- ▶ The canal of the remaining distal humerus is carefully hand reamed for placement of the largest diameter stem possible, accommodating for a 2mm cement mantle.
- ▶ In long humeral resections with short residual proximal segments care must be taken to not enter the shoulder joint.
- ▶ A facing reamer is used to create a 90° plane and a seat for stem bone interface that protects the stem from bending stress in the remaining distal humeral bone.
- ▶ Appropriate rotation should be marked using the electrocautery.

MRS Upper Extremity

Surgical Protocol

Preparation of the Ulna

- ▶ An oscillating saw can be used to resect the ulnar joint surface.
- ▶ Alternately, a burr can be used for proximal ulnar preparation.
- ▶ In the preparation for the ulna stem component care must be taken to burr out the olecranon fossae initially to allow appropriate placement of the small reamers. If care isn't taken, a tendency to eccentrically ream the ulna and break-out through the dorsal cortex might occur.
- ▶ Once the ulnar canal is established, it is axially reamed with sequential reamers. Broaches are then used until a tight fit is achieved. These can then be used for length trialing.

Trialing

- ▶ Trial reduction is performed to check the prosthetic length and orientation.

Distal
Humerus/Ulna

Total
Humerus



Figure 15: Distal Humerus and Ulna Assembly

Impaction and Assembly

- ▶ Drape a cloth around all implants to make sure they do not get scratched during impaction.
- ▶ Impaction of the Distal humeral implant and the humeral stem with several swift blows from a heavy mallet to lock the tapers.
- ▶ Next assemble the ulna humeral joint stem and the distal humeral implant and components.
- ▶ Refer to Section 6 for Bearing Insert, Axle Bushing & Axle Pin assembly instructions.

Implantation

- ▶ Depending on the level of resection, stems are cemented in place with or without extra cortical porous coated body sections. Third generation cementation technique should be used, if possible.

Section 5: Total Humerus and Ulna – Resection and Reconstruction

Dissection

- ▶ For Humerus preparation, please refer to the MRS Proximal Humerus dissection section.
- ▶ For Ulna preparation, please refer to the MRS Distal Humerus/Ulna section under ‘Preparation of the Ulna’.

Measuring Resection Length and Osteotomy

- ▶ Remove entire humerus from the patient.

Rotational Alignment of Humerus

- ▶ Please refer to the MRS Proximal Humerus section.

Trialing

- ▶ Trial reduction is performed to check the prosthetic length and orientation.



Figure 16: Proximal Humerus: Head and Body

Impaction and Assembly

- ▶ Drape a cloth around all implants to make sure they do not get scratched during impaction.
- ▶ Impaction of the Humeral Head and the Humeral body with several swift blows from a heavy mallet to lock the tapers.



Figure 17: Proximal Humerus and Connection piece

- ▶ The Humeral Head and Humeral body construct is impacted on to the humeral connection using the mallet.

MRS Upper Extremity Surgical Protocol



Figure 18: Total Humerus

- ▶ Assemble the Distal Humeral implant with the Humeral Head, Humeral Body and Humeral connection construct.
- ▶ Finally assemble the ulna humeral joint stem with the distal humeral components (bearing insert, Axle Bushing & Axle Pin) and the rest of the total humerus construct.
- ▶ Details of bushing, bearing insert and axle pin instructions are in section 6.

Implantation

- ▶ Implant and cement the humerus and ulna as per the MRS Proximal Humerus and MRS Distal Humerus/Ulna sections taking care to maintain the proper retroversion of the humeral head. The axle pin can be inserted either from the lateral side or medial side.

Section 6: Bushing Kit Assembly Instructions

- ▶ A portion of the olecranon may need to be removed to allow better access to the ulnar canal for broaching.
- ▶ This can be accomplished by the use of a sagittal saw.
- ▶ A portion of the coronoid process can also be excised at this time to avoid impingement during range of motion once the prosthesis is in place.

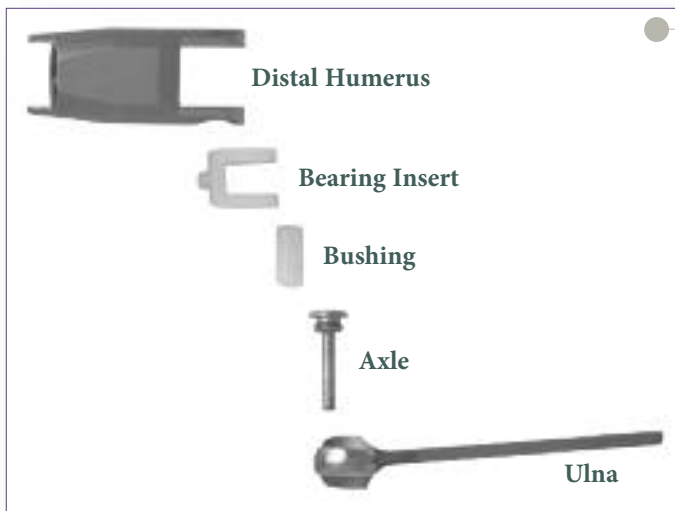


Figure 19: Distal Humerus Implants

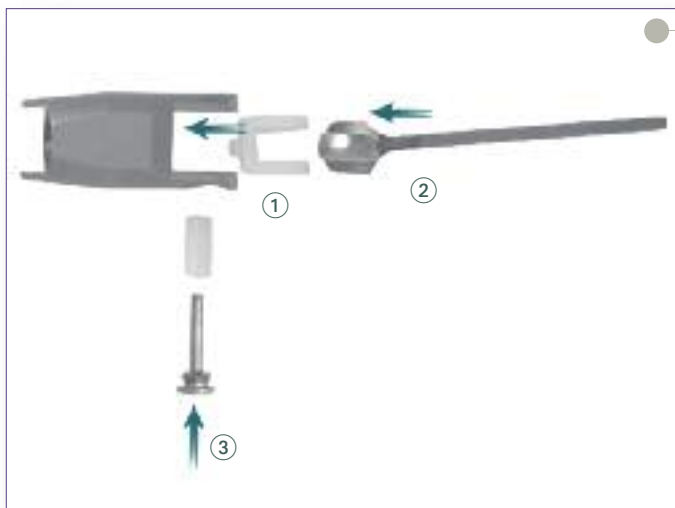


Figure 20: Bushing Kit Assembly

Bushing Kit Assembly

- ▶ Before you start: Connect an MRS Stem to the Distal Humeral Module.
- ▶ Step 1: Insert the symmetrical poly bearing insert into 'forked' end of the Distal Humerus implant.
- ▶ Step 2: Insert the selected ulna component (left or right) into the poly bearing insert and distal humerus component.
- ▶ Step 3: Seat Bushing through threaded larger axle hole of the Distal Humeral Module.
- ▶ Step 4: Insert Axle through bushing and threaded axle hole.

Note: Use Hex Screwdriver (5100-3601) and turn axle clockwise till tight.

MRS Upper Extremity

Surgical Protocol



Figure 21: Bone Removal

Section 7: Ulna Preparation

- ▶ Bone may be removed in the ulnar bearing area by using the awl included in the instrument kit.
- ▶ This will allow enough bone removal for broaching while still conserving as much bone as possible for support of the implant.



Figure 22: Reaming










- ▶ The starter reamer is then used to open up the canal to accept the ulnar broaches. Broaching is started by first using the small size broach/trial attached to the broach handle. It is impacted using the allotted mallet included in the instrument set.
- ▶ The canal is then broached progressively larger (if required) until the final size is reached.
- ▶ This method is recommended to help avoid fracturing the ulna during preparation (Figure 22).
- ▶ Once the final broach/trial has been placed to the appropriate depth, restoring the center of rotation, the handle may be removed.
- ▶ In the preparation for the ulna stem component care must be taken to burr out the olecranon fossa initially to allow appropriate placement of the small reamers. If care isn't taken, a tendency to eccentrically ream the ulna and break out through the dorsal cortex might occur.
- ▶ An intra-operative X-Ray is recommended to ensure accurate placement in the ulnar canal.

Section 8: MRS and Solar Elbow - Implant Compatibility

The MRS and Solar distal humeral components are compatible. The ulnas are all compatible with the distal humerus implants of both systems and depend on the right axle pins, bearing inserts and axle bushings to provide the right compatibility.

To use the compatibility charts below,

- ▶ Step 1: Pick the distal humerus your surgeon wishes to use from the three charts.
- ▶ Use the catalog numbers specified in the chart corresponding to your distal humerus for compatible implants. For example, if you pick the MRS distal humerus, you will need to look at Chart 1.

Chart 1: MRS Distal Humerus	Chart 2: Standard Solar Distal Humerus	Chart 3: Large Solar Distal Humerus
<p>Bushing Kit: 6487-K-001 Loaner Kit(s): MRSDHU</p> <p>Contents: <i>Bearing Insert:</i> 9000-0-BK1</p>  <p><i>Large Axle Pin:</i> 5005-3040</p> <ul style="list-style-type: none"> • Also found in the Large Solar Bushing Kit # 5005-3035  <p><i>Standard Axle Bushing</i> 5005-2050</p> <ul style="list-style-type: none"> • Also found in the Standard Solar Bushing Kit # 5005-2035 	<p>Bushing Kit: 5005-2035 Loaner Kit(s): 5005L or 5005R</p> <p>Contents: <i>Bearing Insert:</i> 5005-2030</p>  <p><i>Standard Axle Pin:</i> 5005-2040</p> <ul style="list-style-type: none"> • From Either the 5005L or 5005R Kit  <p><i>Standard Axle Bushing</i> 5005-2050</p> <ul style="list-style-type: none"> • Also found in the MRS Distal Humerus Bushing Kit 	<p>Bushing Kit: 5005-3035 Loaner Kit(s): 5005L or 5005R</p> <p>Contents: <i>Bearing Insert:</i> 5005-3030</p>  <p><i>Large Axle Pin:</i> 5005-3040</p> <ul style="list-style-type: none"> • Also found in the MRS Distal Humerus Bushing Kit  <p><i>Large Axle Bushing</i> 5005-3050</p> 

Total Humerus

MRS Upper Extremity

Surgical Protocol

Appendix: MRS Humeral Intercalary

Introduction

The lap joint feature of the intercalary helps prevent over-distraction of the radial nerve during assembly.

Indications

- ▶ For use in the management of segmental bone loss of the humerus in Oncology patients secondary to radical bone loss and/or resection due to tumors.
- ▶ When used with a proximal bone cap, this system is intended to be used in the management of shoulder girdle resections such as the Tikhoff-Lindberg procedure, which involves removal of the bone and soft tissues of the proximal humerus and shoulder girdle.
- ▶ This system is indicated for cemented use only.
- ▶ There is no glenoid component associated with this system.

Product Offerings

Stems:

- ▶ MRS Humeral Intercalary system available through National Loaners.
Implants: Kit Number S15
Instruments: Kit Number S15-I
- ▶ Material: Titanium
- ▶ Stems Type: Fluted. Stem Diameter: 9mm
- ▶ Stem Sizes and catalog numbers:

Catalog #	Stem Length (mm)	Body Length (mm)	Trial Catalog #
6487-5-076	75	25	6488-5-076
6487-5-101	100	25	6488-5-101
6487-6-076	75	50	6488-6-076
6487-6-101	100	50	6488-6-101
6487-7-076	75	75	6488-7-076
6487-7-101	100	75	6488-7-101
6487-8-051	50	100	6488-8-051
6487-9-051	N/A	50	6488-9-051

- ▶ Resection Length: Add body lengths of the two components the surgeon chooses.
- ▶ Minimum resection possible: 50mm; Maximum resection possible: 200mm.

Humeral End Cap:

- ▶ 50mm replacement length.
- ▶ Catalog # 6487-9-051. Trial: 6488-9-051.
- ▶ Also available when the entire proximal humerus must be resected.
- ▶ Includes suture holes for performing a Tikhoff-Lindberg resection.

Screws: Catalog #6487-5-010 (Surgeons will need 2 to connect the bodies).

Surgical Technique

Resection:

- ▶ Using a straight edge, mark a line above and below the tumor along the humeral axis for setting rotation. Resect tumor.

Reaming:

- ▶ Ream IM canal on proximal and distal segments using 11mm reamer to provide 2mm cement mantle.
- ▶ Use a facing reamer (MRS 9mm Facing Reamer: 6486-8-609) on both bone segments to prepare seat radius.

Trialing:

- ▶ Trial, verifying humeral length and rotation. Use engraved markings (90 degrees apart) to align trials.

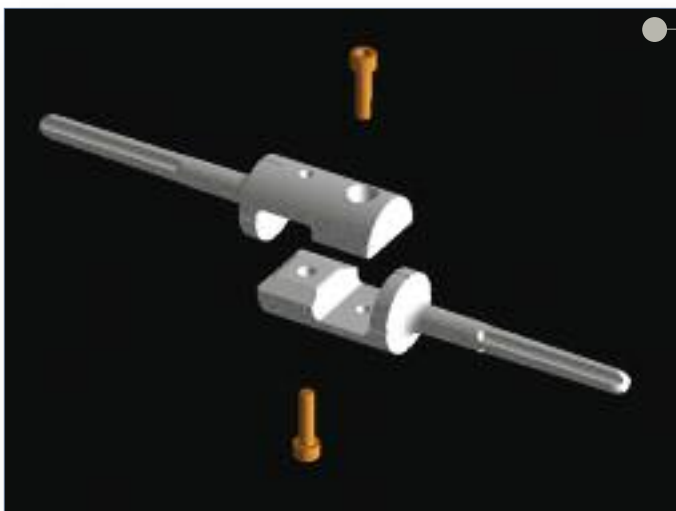


Figure 23: Humeral Intercalary Assembly

Assembly and Implantation

- ▶ Connect the two stems chosen for implantation by the surgeon using two screws, catalog number 6487-5-010 (Figure 23).
- ▶ Warning: Because engraved marks are 90° apart, remember to verify that the lap joint surfaces of the proximal and distal stems are aligned for subsequent assembly.



Figure 24: Humeral Intercalary Implantation

- ▶ Implant the selected stems into cement verifying that engraved lines align with marks on bone.
- ▶ Allow cement to cure. Hint: Two screws are required for assembly, which are inserted from opposite directions, 180 degrees apart. Verify that access to screw heads will be possible before the cement cures.
- ▶ Reduce implants and insert screws. Tighten screws using torque limiting screwdriver provided (6633-7-561).
- ▶ This will torque the screws to 60-80in/lbs.

MRS Upper Extremity

Surgical Protocol

Loaner Kits Needed

For MRS Proximal Humerus surgery: S8 (Implants) and S8-I (Instruments). For Flexible reamers - T19.

For MRS Distal Humerus: MRSDHU (Implants), MRSDHU-I (Instruments), S8-I (For Stem Trials) and SOLBOW (Solar Elbow Instruments).

For Total Humerus surgery: All of the above.

Catalog #	Description	Size
MRS Proximal Humerus Implants (Loaner Kit S8) Part Numbers		
6487-5-040	MRS Proximal Humeral Head	40mm
6487-5-044	MRS Proximal Humeral Head	44mm
6487-1-040	MRS Humeral Body, Male/Female Taper	40mm
6487-1-060	MRS Humeral Body, Male/Female Taper	60mm
6487-1-080	MRS Humeral Body, Male/Female Taper	80mm
6487-1-100	MRS Humeral Body, Male/Female Taper	100mm
6487-1-120	MRS Humeral Body, Male/Female Taper	120mm
6487-1-140	MRS Humeral Body, Male/Female Taper	140mm
6487-2-075	MRS Humeral Stem with body	7mm x 75mm
6487-2-115	MRS Humeral Stem with body	7mm x 115mm
6487-3-075	MRS Humeral Stem with body	9mm x 75mm
6487-3-115	MRS Humeral Stem with body	9mm x 115mm
6487-4-075	MRS Humeral Stem with body	11mm x 75mm
6487-4-115	MRS Humeral Stem with body	11mm x 115mm
6487-5-075	MRS Humeral Stem without body	7mm x 75mm
6487-5-115	MRS Humeral Stem without body	7mm x 115mm
6487-6-075	MRS Humeral Stem without body	9mm x 75mm
6487-6-115	MRS Humeral Stem without body	9mm x 115mm
6487-7-075	MRS Humeral Stem without body	11mm x 75mm
6487-7-115	MRS Humeral Stem without body	11mm x 115mm

Catalog #	Description	Size
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MRS Distal Humerus and Ulna Implants (Loaner Kit MRSDHU) Part Numbers

6487-H-040	MRS Distal Humeral Component	40mm
6487-H-045	MRS Distal Humeral Component	45mm
6487-H-050	MRS Distal Humeral Component	50mm
6487-H-055	MRS Distal Humeral Component	55mm
6487-K-001	MRS Distal Humeral Bushing Kit	
9000-0-BK1	Bearing Insert	
5005-3040	Axle Pin	Large
5005-2050	Axle Bushing	Standard
6487-C-035	Total Humeral Connection Piece - Male/Male Taper	35mm
6487-C-045	Total Humeral Connection Piece - Male/Male Taper	45mm
5005-U-080L	Ulna Component	80mm, Small, Left
5005-U-080R	Ulna Component	80mm, Small, Right
5005-U-100L	Ulna Component	100mm, Standard, Left
5005-U-100R	Ulna Component	100mm, Standard, Right
5005-U-120L	Ulna Component	120mm, Large, Left
5005-U-120R	Ulna Component	120mm, Large, Right
6487-5-040	MRS Proximal Humeral Head	40mm
6487-5-044	MRS Proximal Humeral Head	44mm
6487-1-040	MRS Humeral Body, Male/Female Taper	40mm
6487-1-060	MRS Humeral Body, Male/Female Taper	60mm
6487-1-080	MRS Humeral Body, Male/Female Taper	80mm
6487-1-100	MRS Humeral Body, Male/Female Taper	100mm
6487-1-120	MRS Humeral Body, Male/Female Taper	120mm
6487-1-140	MRS Humeral Body, Male/Female Taper	140mm
6487-2-075	MRS Humeral Stem with body	7mm x 75mm
6487-2-115	MRS Humeral Stem with body	7mm x 115mm
6487-3-075	MRS Humeral Stem with body	9mm x 75mm
6487-3-115	MRS Humeral Stem with body	9mm x 115mm
6487-4-075	MRS Humeral Stem with body	11mm x 75mm
6487-4-115	MRS Humeral Stem with body	11mm x 115mm
6487-5-075	MRS Humeral Stem without body	7mm x 75mm
6487-5-115	MRS Humeral Stem without body	7mm x 115mm
6487-6-075	MRS Humeral Stem without body	9mm x 75mm
6487-6-115	MRS Humeral Stem without body	9mm x 115mm
6487-7-075	MRS Humeral Stem without body	11mm x 75mm
6487-7-115	MRS Humeral Stem without body	11mm x 115mm

MRS Upper Extremity

Surgical Protocol

Catalog #	Description	Quantity
MRS Proximal Humerus Loaner Instrument Kit (Loaner Kit S8-I) Part Numbers		
6486-9-030	MRS Humeral Trial Case	1
6488-5-040	MRS Humeral Head Trial 40mm	1
6488-5-044	MRS Humeral Head Trial 44mm	1
5235-2-520	Alta Mallet	1
6486-8-500	MRS Taper Separator	1
6486-8-515	MRS Wrench for Taper Separator	1
6486-8-607	MRS Facing Reamer 7mm	1
6486-8-609	MRS Facing Reamer 9mm	1
6486-8-611	MRS Facing Reamer 11mm	1
6486-8-765	MRS Humeral V-block	1
6486-8-800	Impaction Tube Base	1
6486-8-807	Impaction Tube Head Assembly 7mm	1
6486-8-809	Impaction Tube Head Assembly 9mm	1
6486-8-811	Impaction Tube Head Assembly 11mm	1
6486-8-820	MRS Trunnion Impactor Base	1
6486-8-825	MRS Trunnion Impactor Insert Small	1
6486-8-907	Impaction Tube Insert 7mm	1
6486-8-909	Impaction Tube Insert 9mm	1
6486-8-911	Impaction Tube Insert 11mm	1
6486-9-015	MRS Reamer Instrument Case	1
6486-9-020	MRS Impaction Tube Instrument Case	1
6488-1-040	MRS Humeral Body Trial 40mm	1
6488-1-060	MRS Humeral Body Trial 60mm	1
6488-1-080	MRS Humeral Body Trial 80mm	1
6488-1-100	MRS Humeral Body Trial 100mm	1
6488-1-120	MRS Humeral Body Trial 120mm	1
6488-1-140	MRS Humeral Body Trial 140mm	1
6488-2-075	MRS Humeral Stem with Body Trial 7mm x 75mm	1
6488-2-115	MRS Humeral Stem with Body Trial 7mm x 115mm	1
6488-3-075	MRS Humeral Stem with Body Trial 9mm x 75mm	1
6488-3-115	MRS Humeral Stem with Body Trial 9mm x 115mm	1
6488-4-075	MRS Humeral Stem with Body Trial 11mm x 75mm	1
6488-4-115	MRS Humeral Stem with Body Trial 11mm x 115mm	1
6488-5-075	MRS Humeral Stem without Body Trial 7mm x 75mm	1
6488-5-115	MRS Humeral Stem without Body Trial 7mm x 115mm	1
6488-6-075	MRS Humeral Stem without Body Trial 9mm x 75mm	1
6488-6-115	MRS Humeral Stem without Body Trial 9mm x 115mm	1
6488-7-075	MRS Humeral Stem without Body Trial 11mm x 75mm	1
6488-7-115	MRS Humeral Stem without Body Trial 11mm x 115mm	1
6136-0-920	Universal Storage/Sterile Case Med	1
		Total Quantity 40

Catalog #	Description	Quantity
MRS Distal Humerus Loaner Instrument Kit (Loaner Kit MRSDHU-I) Part Numbers		
I-U0175UE05	MRS Distal Humeral Trial 40mm	1
I-U0175UE06	MRS Distal Humeral Trial 45mm	1
I-U0175UE07	MRS Distal Humeral Trial 50mm	1
I-U0175UE08	MRS Distal Humeral Trial 55mm	1
I-U0175UE10	Trial Axle Pin	1
I-U0175UE20	Humeral Connection Piece 35mm	1
I-U0175UE30	Humeral Connection Piece 45mm	1
I-U0182B08L	Ulna Broach/Trial Component 80mm, Small, Left	1
I-U0182B08R	Ulna Broach/Trial Component 80mm, Small, Right	1
I-U0182B10L	Ulna Broach/Trial Component 100mm, Standard, Left	1
I-U0182B10R	Ulna Broach/Trial Component 100mm, Standard, Right	1
I-U0182B12L	Ulna Broach/Trial Component 120mm, Large, Left	1
I-U0182B12R	Ulna Broach/Trial Component 120mm, Large, Right	1
I-K2306UL10	Distal Humeral Condyle Impactor	1
I-K2306UL00	Female Taper Impactor	1
I-U0182LOAN	Instrument Case	1
5100-3500	Impactor/Extractor Handle	1
6541-4-810	Triathlon Impaction Handle	1
		Total Quantity 18

Important Note: For stem trials, use kit S8-I.

MRS Upper Extremity

Surgical Protocol

Catalog #	Description	Size
MRS Humeral Intercalary Implants (Loaner Kit S15) Part Numbers		
6487-5-076	MRS Humeral Intercalary Stem	25mm body x 75mm stem length
6487-5-101	MRS Humeral Intercalary Stem	25mm body x 100mm stem length
6487-6-076	MRS Humeral Intercalary Stem	50mm body x 75mm stem length
6487-6-101	MRS Humeral Intercalary Stem	50mm body x 100mm stem length
6487-7-076	MRS Humeral Intercalary Stem	75mm body x 75mm stem length
6487-7-101	MRS Humeral Intercalary Stem	75mm body x 100mm stem length
6487-8-051	MRS Humeral Intercalary Stem	100mm body x 50mm stem length
6487-9-051	MRS Proximal Humeral End Cap	50mm
6487-5-010	MRS Humeral Intercalary Screw*	

*Note: Two screws will be provided in the loaner kit S15.

Catalog #	Description	Quantity
MRS Humeral Intercalary Instruments (Loaner Kit S15-I) Part Numbers		
6136-0-920	Universal Storage/Sterile Case Med	1
6486-8-609	MRS Facing Reamer 9mm	1
6488-5-010	MRS Hex Bit 3.5mm (3/8 Driver)	1
6488-5-076	MRS Humeral Intercalary Stem Trial 25mm body x 75mm stem length	1
6488-5-101	MRS Humeral Intercalary Stem Trial 25mm body x 100mm stem length	1
6488-6-076	MRS Humeral Intercalary Stem Trial 50mm body x 75mm stem length	1
6488-6-101	MRS Humeral Intercalary Stem Trial 50mm body x 100mm stem length	1
6488-7-101	MRS Humeral Intercalary Stem Trial 75mm body x 100mm stem length	1
6488-8-051	MRS Humeral Intercalary Stem Trial 100mm body x 50mm stem length	1
6488-9-051	MRS Proximal Humeral End Cap 50mm	1
6633-7-561	Monogram Slip Torque Wrench Handle	1
		Total Quantity 11

Indications

The Modular Replacement Elbow System is intended for use in Oncology patients requiring extensive reconstruction of the distal humerus, including the elbow joint and total humeral replacement, necessitated by extensive bone loss due to tumor resection. These prostheses are intended for use with bone cement as a means of intramedullary fixation. The Modular Replacement Elbow System is also intended for use in patients requiring extensive reconstruction of the distal humerus necessitated by trauma, failed previous prosthesis, distal humeral fracture and/or dislocation, and disabling joint disease of the elbow resulting from degenerative arthritis, rheumatoid arthritis or post-traumatic arthritis.

Contraindications

Not all bone tumors may be treated successfully by segmental resection. Any condition that may have already resulted in either local or distant spread of the tumor may be a contraindication. Examples of such conditions include:

- 1) Pathological fracture
- 2) Overt infection
- 3) Inopportune placement of biopsy incision; and,
- 4) Rapid disease progression beyond a respectable margin.

Each patient must therefore be individualized and carefully evaluated by appropriate staging techniques prior to consideration of segmental replacement.

Brief Description of Segmental Surgery

There are three major components of limb sparing surgery:

- 1) Oncologic resection or removal of bone fracture fragments,
- 2) Skeletal reconstruction and
- 3) Durable soft tissue coverage and joint stabilization.

Warnings and Precautions:

See package insert for warnings, precautions, adverse effects and other essential product information.

Patient Counseling:

Surgeons should discuss all relevant contraindications, adverse effects and the need for post-implantation protection with their patients.

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