Zimmer® Segmental System

Surgical Technique for Variable Stiffness Stems and Intercalary Segments

A step forward for challenging salvage cases

zimmer

Zimmer Segmental System Surgical Technique

for Variable Stiffness Stems and Intercalary Segments

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Introduction

The *Zimmer*® Segmental System is designed to address patients with significant bone loss often found in oncology, trauma, and/or multiple revisions. The initial release of the *Zimmer* Segmental System consisted of distal femoral components, a one-piece hinge post, tibial articular surfaces, male-female and male-male segments, fluted straight and bowed stems, and stem collars with either *Trabecular Metal*™ Material or a smooth titanium surface. Since the introduction of the initial system, additional components have been designed to broaden the operative options for surgeons addressing patients presenting with these conditions.

The additional components include a 130mm Straight Variable Stiffness Stem, a 190mm Bowed Variable Stiffness Stem, an Intercalary Segment with a female-female taper for mid-shaft defects, and 35mm and 45mm Segments with male-female tapers. The variable stiffness stems are available in diameters from 12mm to 19mm in 1mm increments. The Intercalary Segments are available in 45mm, 55mm, and 65mm lengths. These components are complemented by specific instruments designed to facilitate the surgical procedure, and are generally compatible with the initial components of the *Zimmer* Segmental System. Furthermore, components of the *Zimmer* Segmental System are intended to be compatible with specific components of the *Zimmer NexGen*® Complete Knee Solution Rotating Hinge Knee and the *MOST Options*® (Modular Options for Severe Bone Loss and Trauma) System.

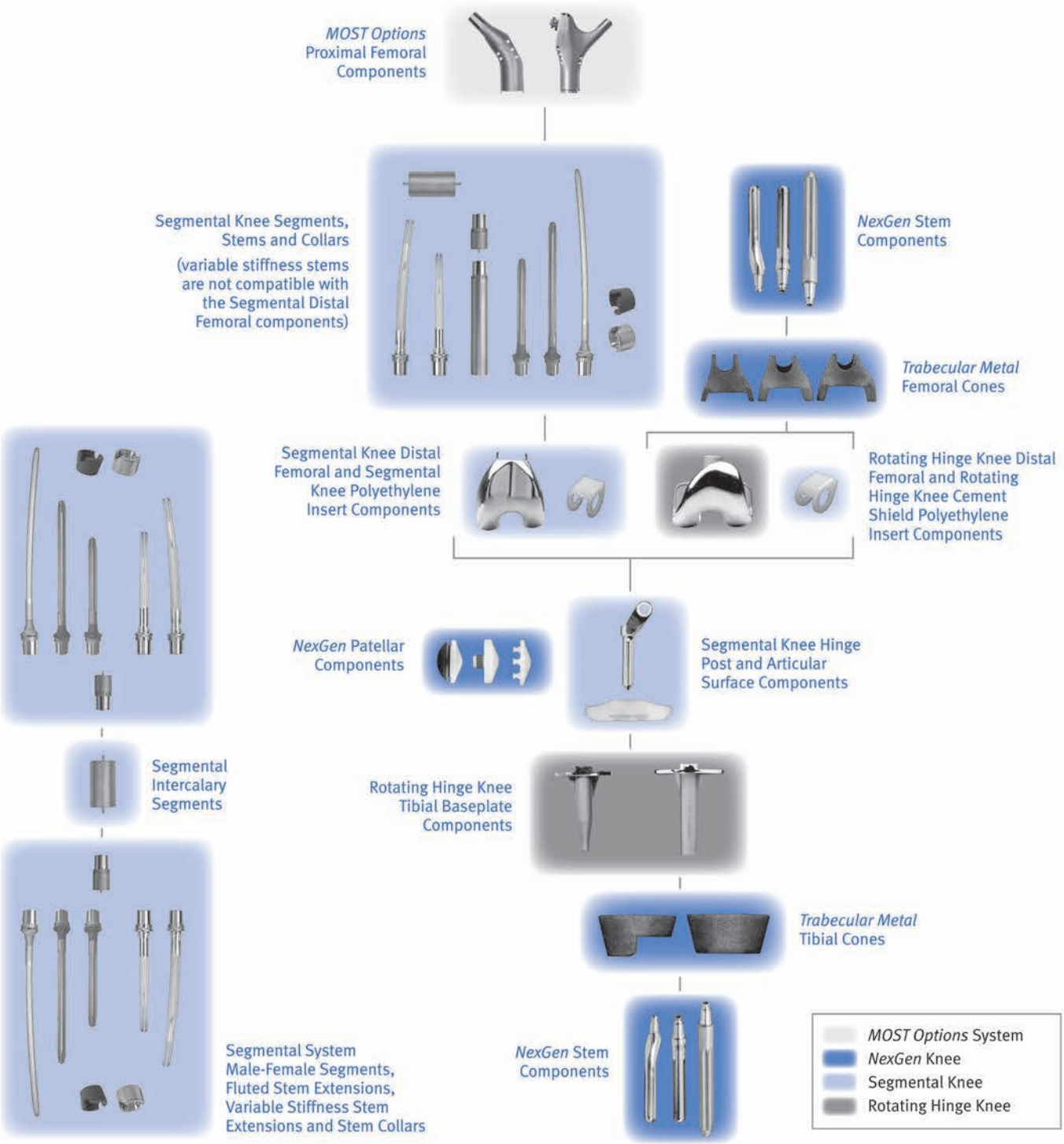
The scope of the *Zimmer* Segmental System encompasses applications in the distal femur, midshaft femur, and proximal femur. For distal femoral applications, the *Zimmer* Segmental System is indicated for cemented use only. The Segmental Variable Stiffness Stems are not indicated for use in the distal femur and, when used in mid-shaft and proximal femur applications, are indicated for uncemented use only. The 35mm and 45mm male-female segments allow for more length options with minimum length increments ranging from 3mm to 7mm.

This surgical technique is divided into sections that provide detailed descriptions of each step in a specific procedure (See Table of Contents). When implanting components from the Rotating Hinge Knee System, the *MOST Options* System, or components from the *Zimmer* Segmental System that are not discussed in this technique, the surgeon is referred to the appropriate technique—the *Zimmer* RH Knee System technique (97-5880-002-00), the *MOST Options* System technique (97-5010-002-00), or the original *Zimmer* Segmental System Surgical Technique (97-5850-002-00), which covers the components of the initial system. See *Zimmer* Segmental System package insert (part number 87-6203-755-01) for more information related to indications and re-sterilization information, if necessary.

Compatibility

Some implants and provisional components from the Segmental Knee System are compatible with the *NexGen* Rotating Hinge Knee System and/or the *MOST Options* System, and vice versa. However, some specific implants and provisional components are not to be used across systems. Do not use components from other knee systems (and vice versa) unless expressly labeled for such use.

Segmental System Scope/Compatibility Chart



Zimmer Segmental System Variable Stiffness Stems

The *Zimmer* Segmental System Variable Stiffness Stems are intended to be used in the proximal or mid-shaft portion of the femur. Available in both straight and bowed geometries, the stems are manufactured from *Zimaloy*® Cobalt-Chromium-Molybdenum Alloy.

The goal of the design was to establish a secure initial press fit while providing a gradual proximal-to-distal decrease in stem stiffness along the length of the stem. This gradation of stem stiffness is accomplished via a transition from a solid shank proximally to four troughs, and then to four slots that split the stem tip into four closely configured prongs.

The intramedullary length of the stem extension contains splines, providing a diametric press fit of up to 0.5mm.

The base of the stem extension is precoated with polymethyl methacrylate (PMMA) to enhance fixation of the cemented collars. Anteversion pockets at the base of the male taper fit with the tabs of mating components and allow for controllable anteversion adjustment in 20° increments.

Proximal Femur Replacement Using the MOST Options Proximal Femoral Component with the Segmental Variable Stiffness Stem

Proximal Femoral Options

Through its compatibility with the *MOST Options* System, the Segmental System offers two choices for proximal femoral components: the Basic Proximal Femur (Fig. 1) and the Proximal Femur with Tissue Attachments (Fig. 2).

The Basic Proximal Femur is used for attachment of soft tissue when the trochanteric bone cannot be salvaged. The soft tissues are sutured through the holes of the proximal femur for temporary fixation during the healing process.

When trochanteric bone can be salvaged, use of the Proximal Femur with Tissue Attachments may be considered. For possible improved abductor muscle function, the muscles are attached by the strongest possible means to the remaining lateral soft tissues, such as the iliotibial band. Optimal candidates for this method of fixation are those in whom a resection can be performed without removing more than 1cm of native abductor tendon. Sacrificing more than this amount may leave the abductor mechanism with insufficient tendon for fixation using the pronged washers.

Fig. 1 Basic Proximal Femur

Fig. 2 Proximal Femur with Tissue Attachments

Note: For more details on proximal femur procedures, see the *Zimmer MOST Options* System Surgical Technique (97-5010-002-00).

Step 1: Resect the Proximal Femur

After exposing the proximal femur, extend the leg in a reproducible position.

Femoral Measurement

To establish the resection level, determine the implant configuration and select the proper segment, if needed (Fig 4). Using a neutral offset head, segment lengths correspond to resection lengths in the table. (Example: If the safe margin for proximal femoral tumor removal is 142mm, use a 30mm segment with the stem to obtain a 144mm resection level.)

Then use the Proximal Femoral Template (Fig. 3) and a marker, osteotome, or electrocautery to make a horizontal line at the proposed resection level based on the appropriate segment length distal to the preoperatively determined femoral resection level. The template is used to better determine the components needed for trialing. If desired, make a vertical mark on the bone based on the natural femoral version, which can be used as a reference to assess rotational alignment during the trial reduction and final component implantation.

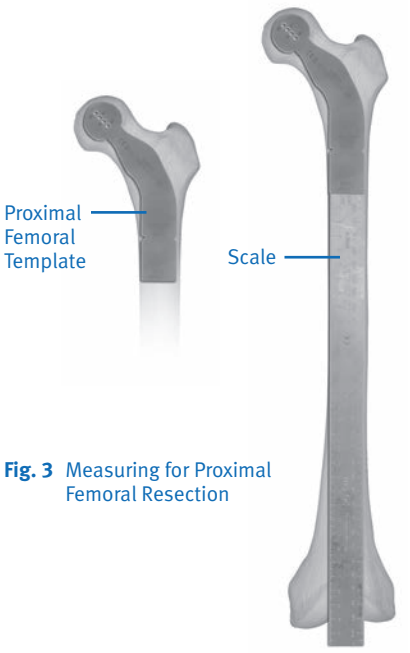


Fig. 3 Measuring for Proximal Femoral Resection

The minimum resection required to implant either type of proximal femoral component is 112mm.

Note: To improve the swing phase of the patient's gait, some surgeons choose to slightly shorten the limb.

Proximal Femoral Resection with Stems, Collars, and Segments

Proximal Femur	Stem/Collar	Segments	Total Length
80mm	30mm	None	112mm
		30mm	144mm
		35mm	149mm
		40mm	154mm
		45mm	159mm
		60mm	174mm
		35+30mm	181mm
		40+30mm	186mm
		40+35mm	191mm
		80mm	194mm
		40+45mm	201mm
		60+30mm	206mm
		60+35mm	211mm
		100mm	214mm
		60+45mm	221mm
		80+30mm	226mm
		80+35mm	231mm
		120mm	234mm
		80+45mm	241mm
		100+30mm	246mm
		100+35mm	251mm
		140mm	254mm
		100+45mm	261mm
		120+30mm	266mm
		120+35mm	271mm
		160mm	274mm
		120+45mm	281mm
		140+30mm	286mm
		140+35mm	291mm
		180mm	294mm
		140+45mm	301mm

Fig. 4 Proximal Femoral Resection with Stems, Collars, and Segments

Note: Each large taper connection adds 2 mm to the total length.

Note: When a bowed Segmental Stem (fluted or variable stiffness) is used with a *MOST Options* Proximal Femoral Component, the attachment of a Male-Female Segment is required because the bowed stem has only small slots. In this situation, the minimum resection is 144mm. If less resection is desired, use a straight Segmental Stem (reducing the minimum resection to 112mm) or consider the *ZMR*® Revision Hip Prosthesis and refer to the *ZMR* Revision Hip Prosthesis Surgical Technique (97-9990-002-00).

Femoral Resection

Resect the proximal femur approximately 0.5mm to 1.0mm proximal to the marked level. The additional amount is to compensate for slightly oblique cuts and femoral planing.

Step 2: Ream the Femoral Canal

Ream the femoral canal until the reamer contacts cortical bone in the isthmus. For a straight stem, use the straight reamers from the *VerSys*® Hip System. For a bowed stem, flexible reamers from the *Pressure Sentinel*® Intramedullary Reaming System are recommended: use the *Pressure Sentinel* Reamer Expanded Hip Set (00-2228-000-03) or the *ZMR* Flexible Reamer Set (00-9975-000-11). If preferred, the flexible reamers can also be used for a straight stem to allow for point contact of the stem in the canal. The intramedullary length of the straight Segmental Variable Stiffness Stems is 130mm, while the intramedullary length of the bowed Segmental Variable Stiffness Stems is 190mm. Ream to a depth greater than the intramedullary length to allow proper seating of the stem shoulder on cortical bone.

Note: The diameters indicated for the Segmental Variable Stiffness Stems represent the actual outer diameters of the stems, which include the height of the splines. The diameter of the reamed hole should be 0.5mm smaller than the labeled stem size to provide for apposition of the distal splines with the femoral canal (Fig. 5).

Note: When using a bowed variable stiffness stem it may be necessary to ream the intramedullary canal to a diameter equal to or slightly greater than the diameter of the stem to accommodate any difference between the bow of the stem prosthesis and the anatomy of the patient.

Stem Size (Variable Stiffness)	Ream Diameter
12mm	11.5mm
13mm	12.5mm
14mm	13.5mm
15mm	14.5mm
16mm	15.5mm
17mm	16.5mm
18mm	17.5mm
19mm	18.5mm

Fig. 5 Recommended reamer diameters

Step 3: Plane the Femoral Bone

Thread the appropriately sized Segmental Planer Pilot (130mm long) for the stem diameter selected onto the *MOST Options* Femoral/Tibial Planer (Fig. 6). If the anatomy requires the use of a shorter planer pilot, use the 75mm length Segmental Planer Pilots. A Planer Pilot 1-2mm smaller than the stem diameter chosen can be used to facilitate insertion into a curved medullary canal (Fig. 7). Attach the assembly to a power driver with a Zimmer adapter. Then plane the resected proximal femur until the cortical bone is smooth and flat.

To aid in removing the Planer Pilot from the Planer, insert the pin on the Segmental Collar Provisional Sizer through the cross-hole and, while securing the noncutting end of the planer, turn the shank counterclockwise.

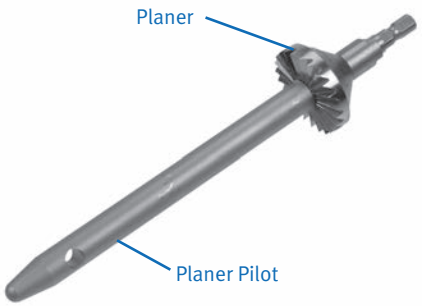


Fig. 6 Threading the Planer Pilot onto the Planer

Stem Size (Variable Stiffness)	Planer Pilot Diameter
12mm	11mm
13mm	12mm
14mm	13mm
15mm	14mm
16mm	15mm
17mm	16mm
18mm	17mm
19mm	18mm

Fig. 7 Recommended Planer Pilot diameters

Step 4: Counterbore the Femoral Canal

The full diameter of a Variable Stiffness Stem proximal to the splines will be 0.5mm greater than the reamed diameter of the femoral canal. Counterboring this proximal portion is required for proper insertion of the stem in the intramedullary canal.

Thread the appropriate size Counterbore Reamer Tip into the Counterbore Stop Plate (Fig. 8). Then insert the assembly into a power driver. Insert the pin on the Segmental Collar Provisional Sizer through the cross-hole of the Counterbore Reamer Tip and turn the collar to tightly secure it to the Counterbore Stop Plate (Fig. 9).

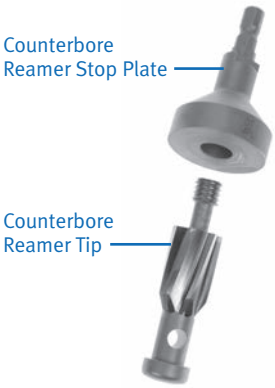


Fig. 8 Counterbore Reamer Tip and Counterbore Reamer Stop Plate

Insert the assembly into the reamed canal and counterbore the proximal canal (Fig. 10). The Counterbore Stop Plate will serve as a stop when the appropriate depth is achieved.

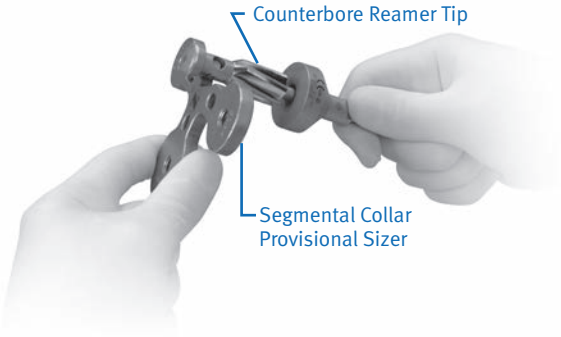


Fig. 9 Counterbore Reamer Tip and Counterbore Reamer Stop Plate Assembly

Fig. 10 Counterbore the Intramedullary Canal

Step 5: Perform a Trial Reduction

Use the Segmental Collar Provisional Sizer to select the collar size that provides the best coverage of the bone surface (Fig 11). If using a nonporous collar, only the 30mm outer diameter collar is available. As an option, the collar sizer may be attached to the selected Planer Pilot to facilitate collar selection. Confirm that the stem and stem collar sizes are compatible (Figs. 11 & 12).

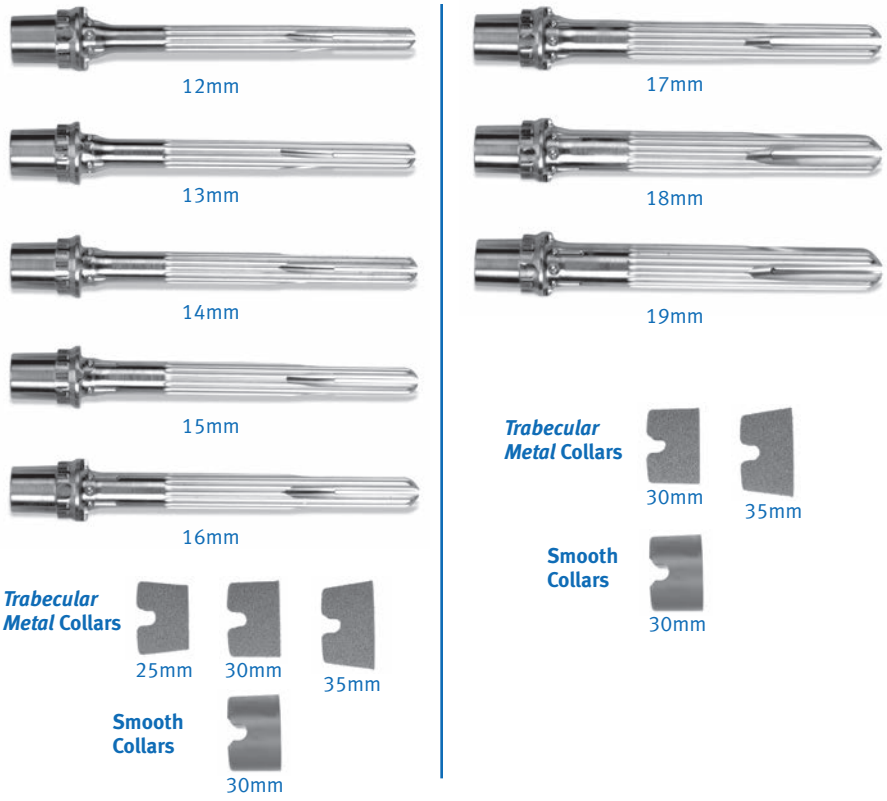


Fig. 11 Stem/Collar Compatibility

Note: The bowed stems (not shown) have the same compatibility with the collars.

Smooth Collar	TM Collar	Stem Diameter	Stem I/M Length
30mm*	25mm/30mm*/35mm*	12-16mm	130mm Straight 190mm Bowed
30mm*	30mm*/35mm*	17-19mm	

* Denotes a collar size that has a different inner diameter for stem sizes 12-16mm than for 17-19mm

Fig. 12 Variable Stiffness Stem Compatibility Table

Select the appropriate Segmental Stem Provisional that is 1mm smaller than the anticipated Variable Stiffness stem component size, e.g., if a 15mm stem will be implanted, use a 14mm stem provisional. Then thread the Segmental Collar Provisional onto the selected Segmental Stem Provisional (Fig. 13).

Note: The diameters of the Segmental Stem Provisionals represent the actual diameters of the stems, i.e. a 14mm stem provisional has a nominal 14mm outer diameter.

Note: The same Segmental Straight Stem Provisionals (130mm) are used for both the 130mm Segmental Fluted Straight Stem and the 130mm Variable Stiffness Straight Stem, although, when trialing, a diameter 1mm less than the stem to be implanted is recommended for the Segmental Variable Stiffness stems.

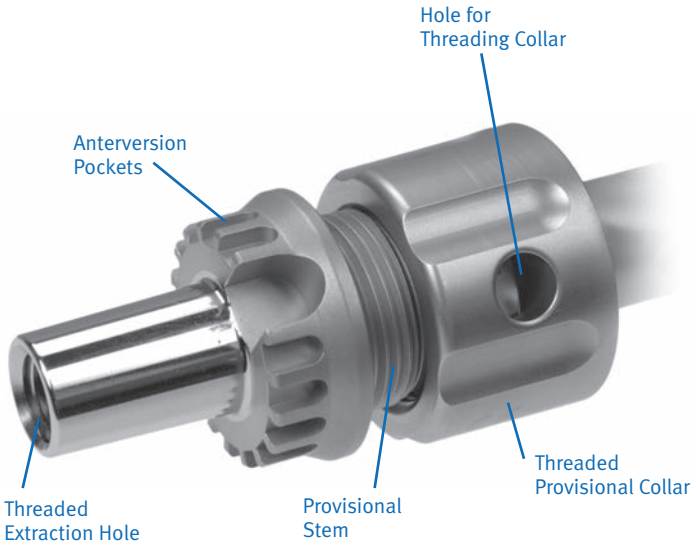


Fig. 13 Threading the collar provisional onto the stem provisional

Technique Tip: Check the stem provisional assembly by inserting it into the reamed canal. If the provisional assembly does not easily fit into a bowed canal, it may be necessary to perform additional reaming or to use the next smaller size stem provisional (Fig. 14).

Attach the Male-Female Segment Provisional, if used, and the *MOST Options* Proximal Femoral Provisional onto the stem provisional assembly. Ensure that all tabs on the provisional components are properly engaged in the corresponding pockets. It is not necessary to impact the provisional components together.

Stem Size (Variable Stiffness)	Segmental Stem Provisional Diameter
12mm	11mm
13mm	12mm
14mm	13mm
15mm	14mm
16mm	15mm
17mm	16mm
18mm	17mm
19mm	18mm

Fig. 14 Recommended stem provisional diameters

Insert the femoral provisional assembly into the femoral canal and evaluate the fit. Check the fit of the stem collar on the bone surface to determine if the stem is fully seated. Assess the orientation of the *MOST Options* Proximal Femoral Provisional and determine whether a rotation adjustment will be necessary.

If a bowed stem is being used, mark the femoral bone in line with the mark on the Segmental Bowed Variable Stiffness Stem Provisional to provide a reference point for proper orientation of the implant (Fig. 15).

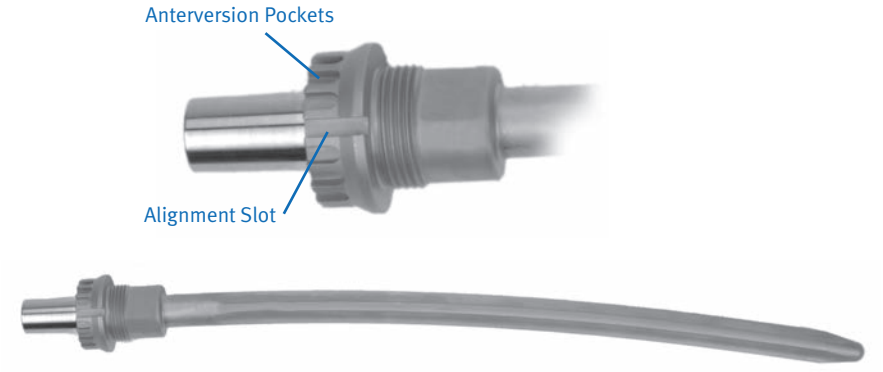


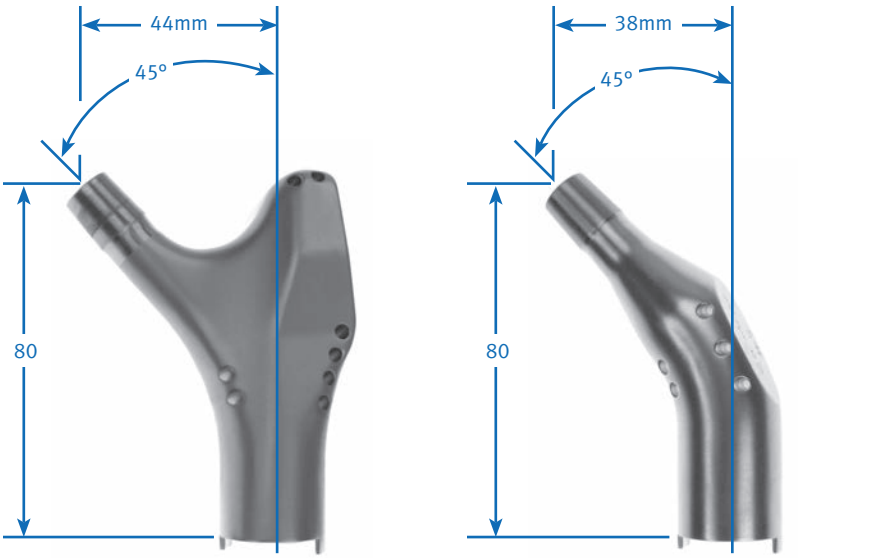
Fig. 15 Alignment Mark

Insert the appropriate femoral head and acetabular provisional components and perform a trial reduction. If leg length, alignment, range of motion, and stability are acceptable, proceed with the next step. If the joint is tight at full extension or during push-pull, try a shorter offset head provisional or recheck the cuts and remove bone from the femur as necessary. If the joint is loose at full extension or during push-pull, try the longer offset head provisional or recheck the cuts and try the next length segment provisional. Check stability while externally rotating the limb.

Note: The femoral neck offset for the *MOST Options* Basic Proximal Femur is 38mm while the offset for the Proximal Femur with tissue attachments is 44mm. The component height for both is 80mm (Fig. 16).

Note: Consider decreasing the amount of anteversion to reduce risk of anterior dislocation.

See the Zimmer Compatibility Website (www.productcompatibility.zimmer.com) for details on which components are compatible with the *MOST Options* Proximal Femoral components.



MOST Options Proximal Femur with Tissue Attachments

MOST Options Basic Proximal Femur

Fig. 16 *MOST Options* Proximal Femurs

Use caution not to over-lengthen the reconstruction in order to achieve longitudinal stability.

If a version adjustment is necessary, use the Segmental Taper Separator to disassemble the provisional taper. The anteversion pockets and tabs on the provisional components allow the component rotation to be adjusted in a controllable manner in 20° increments.

Note: When a bowed Segmental Stem (fluted or variable stiffness) is used with a *MOST Options* Proximal Femoral, the attachment of a Male-Female Segment is required because the bowed stem has only small slots. This allows the hip version to be adjustable in 20° increments without rotating the stem in the canal. When using a straight Variable Stiffness Stem, version can also be adjusted similarly without a Male-Female Segment being added to the construct.

Step 6: Disassemble the Provisional Components

Use the Segmental Taper Separator to disengage the Proximal Femoral Provisional and the Male-Female Segment Provisional, if used. Before employing the Segmental Taper Separator, make sure that the inside wedging portion of the instrument is fully retracted and centered within its housing. To orient the instrument correctly, insert the tabs of the separator into the anteversion pockets with the flat of the separator toward the anatomical joint as etched on the instrument. Slowly turn the handle clockwise until the tapers are disengaged, taking care not to pinch fingers against the rotating impactor cap. If necessary, lightly tap the impactor cap on the instrument to facilitate taper disassembly. See the original Segmental Surgical Technique (97- 5850-002-00) for further details as to how to use the Segmental Taper Separator.

Note: To protect the taper integrity of the femoral provisional components, use only the Segmental Taper Separator with the turning handle when disassembling the femoral provisional construct.

Thread the Provisional Slaphammer Adaptor (Fig. 17) onto the slaphammer and thread it into the stem provisional. Impact the slaphammer to remove the stem provisional.

Provisional Slaphammer Adapter (two grooves)

Implant Slaphammer Adapter (one groove)

Fig. 17 Slaphammer groove diagram

Step 7: Assemble and Implant the Final Implants

There are two options for assembling and inserting the final implants. The final construct can be completely assembled on the back table and inserted as a single unit. Alternatively, if preferred, the stem and collar can be assembled and inserted first, then the segment and proximal femoral component can be assembled and impacted onto the implanted stem.

Attaching the Stem Collar

All Segmental Stems must be used with collars, and all collars must be cemented to the stems. Be sure to verify compatibility of the collar with the stem size being used on the product label before the implant packages are opened.

Technique Tip: If cementing an acetabular component, consider using two mixes of bone cement. The first can be used to cement the collar to the stem. Once the cement has set, the femoral assembly can be implanted. The second mix can then be used to cement the acetabular component.

Note: If implanting the complete construct as a single unit, all components of the construct must be assembled and impacted together before cementing the collar to the stem. This prevents the assembly impaction force from being directly placed onto the cemented stem collar.

Apply cement in the doughy state to the base/taper end of the stem. Then slide the stem collar over the stem and advance it to the shank area where cement was applied. Clean off excess cement as the collar is advanced. Care should be taken to prevent cement from contacting the taper, the anteversion adjustment pockets, and the external surfaces of *Trabecular Metal* Material. Collars must be assembled to the stem with the pockets toward the hip joint and engaged into the tabs on the stem (Fig. 18). Allow the cement to fully harden before inserting the construct into the canal. The overall assembled Variable Stiffness stem/collar construct

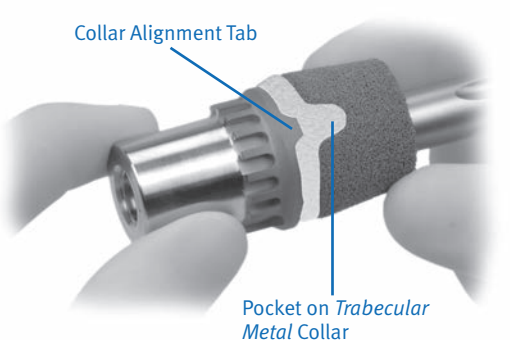


Fig. 18 Collar Assembly Detail

Fig. 19 Assembled (cemented) Variable Stiffness Stem and Collar construct

Implanting the Construct as a Single Unit

If using a Male-Female Segment, assemble it to the *MOST Options* Basic Proximal Femur or the *MOST Options* Proximal Femur with Tissue Attachment using the Segmental Proximal Femur Impactor for the *MOST Options* System (Fig. 20). Impact the assembly together with the Segmental Implant/Provisional Female Taper Impactor assembled to the Universal Impactor Handle. Use a mallet to firmly tap the tapers to the seated position.

When using a Variable Stiffness Stem with back-table assembly, the stem must be impacted onto the hip component or segment before inserting the collar onto the stem. With the hip component resting on the Segmental Proximal Femur Impactor for the *MOST Options* System on the back table, place the stem onto the hip component or segment, ensuring that the anteversion tabs are properly aligned. If using a bowed stem, the stem tip should extend anatomically posteriorly with respect to the proximal femur.

When impacting the Variable Stiffness Stem into the hip component or segment, the Variable Stiffness Stem Impaction Sleeve must be used to avoid damaging the prongs on the Variable Stiffness Stem tip. Slide the Variable Stiffness Stem Impaction Sleeve over the stem until the notches on the sleeve capture the collar alignment tabs on the stem base (Fig. 21). Use a mallet to solidly strike the impaction head of the sleeve. This will impact the stem into the hip component or segment.

Fig. 20 Segmental Proximal Femur Impactor for the *MOST Options* System

Fig. 21 Variable Stiffness Stem Impaction Sleeve slid over the Variable Stiffness Stem implant for taper impaction into the implant construct.

Note: Impacting the taper more than once may loosen the taper connection.

Note: Do not strike the tip of the Variable Stiffness Stem with any instrument, as this may damage the prongs created by the slots.

Note: For leg lengthening procedures, the segment anteversion tabs must be positioned in either the direct A/P or M/L direction. This will facilitate access for the Segmental Taper Separator (Fig. 22).

After cementing the collar onto the stem (see previous section "Attaching the Stem Collar" for details), insert the femoral construct into the femoral canal and use the Segmental Proximal Femoral Impactor for *MOST Options* hip (Fig. 23) and a mallet to tap the implant until fully seated. As the stem advances into the canal, use the vertical mark on the bone to assess the rotational alignment. If the stem fits too tightly in the bone, consider removing the stem and passing the last reamer used through the canal several more times. This can help to increase the hole diameter slightly, which will permit the stem to be more easily impacted into the bone.

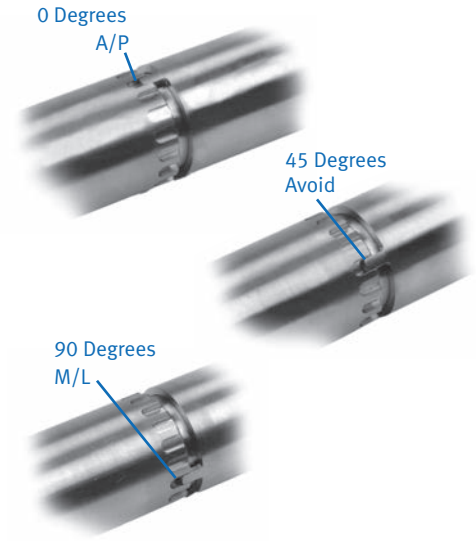


Fig. 22 Anteversion Tab Positioning

Fig. 23 Segmental Proximal Femur Impactor for *MOST Options* System (with Universal Handle).

When the construct is fully seated, attach the final femoral head component using a femoral head impactor.

Implanting the Stem/Collar Assembly and the Segment/Proximal Femur Assembly Separately

After cementing the collar onto the stem, insert the stem/collar assembly into the femoral canal and use the Segmental Implant/Provisional Male Taper Impactor (assembled to the Universal Impactor Handle) and a mallet to tap the stem implant until fully seated. As the stem advances into the canal, use the vertical mark on the bone to assess the rotational alignment. If the stem fits too tightly in the bone, consider removing the stem and passing the last reamer used through the canal several more times. This can help to increase the hole diameter slightly, which will permit the stem to be more easily impacted into the bone.

If using a segment, assemble it to the Proximal Femur using the Segmental Proximal Femur Impactor for the *MOST Options* System. Impact the assembly together with the Segmental Implant/Provisional Female Taper Impactor assembled to the Universal Impactor Handle. Use a mallet to firmly tap the tapers to the seated position.

Place the proximal femoral assembly onto the stem taper, and use the Segmental Proximal Femoral Impactor for *MOST Options* System (with Universal Handle) and a mallet to secure the two assemblies together.

When the construct is fully seated, attach the final femoral head component using a femoral head impactor.

See the Zimmer Compatibility Website (www.productcompatibility.zimmer.com) for details on which components are compatible with the *MOST Options* Proximal Femoral components.

Disassembly

If disassembly is necessary during surgery, the Segmental Taper Separator is designed to enable separation of the junctions between segments, stems, and femoral implants without damaging the tapers. Refer to "Step 6: Disassemble the Provisional Components" for instructions related to the Segmental Taper Separator. Alternatively, the Segmental Wedge Taper Separator may be used to disassemble the tapers on the implants.

For stem removal, thread the Implant Slaphammer Adaptor (Fig. 17) onto the slaphammer and thread it into the stem. Impact the slaphammer to remove the stem.

Step 8: Reattach the Greater Trochanter and Soft Tissues

To reattach the greater trochanter and soft tissues, see pages 45-46 of the *Zimmer MOST Options* System Surgical Technique (97-5010-002-00).

Step 9: Closure

Before closing, thoroughly cleanse the surgical site of bone chips, bone cement, and any other debris. Foreign particles at the articulating interface may cause excessive wear.

Zimmer Segmental System Intercalary Segments

The *Zimmer* Segmental System Intercalary Segments provide a means for reconstructing a midshaft defect or tumor in the femur.

The design of the Intercalary Segments incorporates a short shaft with a female taper on each end. They are manufactured from *Tivanium*® (Ti-6Al-4V) Alloy, and are available in three lengths: 45mm, 55mm, and 65mm. They can also be used in conjunction with Segmental Male- Female Segments to help restore leg length while accommodating larger defects, and as Female-Female segments in other Segmental applications. Both ends contain tabs that mate with the corresponding alignment grooves in compatible Segmental Stems or Segments.

The *Zimmer* Segmental System Intercalary Segments can be used with both Segmental Fluted and Variable Stiffness stems. Fluted stems must be cemented in the IM canal. Variable Stiffness Stems must be used uncemented in the IM canal.

Mid-shaft Femur Replacement with the Segmental Intercalary Segments

Note: Because preoperative planning cannot always predict the extent of a defect or tumor, the surgery may be changed to a distal, proximal, or total femur replacement if the condition of the bone dictates a resection that is too far proximal and/or distal to accept the length of the stem extensions (minimum intramedullary length on either side of the intercalary implant and stem collar is 130mm).

Note: Do not use a Segmental Intercalary Segment with *MOST Options* Stems. These components are not compatible.

Note: The Segmental Variable Stiffness Stem is not indicated for use with Segmental distal femoral components.

Step 1: Excise the Defective Femoral Bone

After exposing the femoral shaft at the defect, move the leg into a reproducible position. Then check leg length and alignment. Based on preoperative radiographic assessment, determine the implant configuration and select the proper components.

To establish the resection levels, measure the anticipated resection length across the bone defect/tumor that is appropriate for the implant configuration (Fig. 24). Use a marker, osteotome, or electrocautery to make horizontal lines marking the proposed resection space. To help assess the rotational alignment of the components, make vertical reference marks on the bone above and below the resection space.

Note: Each large taper connection adds approximately 2mm to the total length.

Femoral Resection Lengths

Intercalary Segments	Stem/Collar (Two Stems Required)	Male-Female Segments	Resection Length*
45mm	30+30mm	0	109mm
		30mm	141mm
		35mm	146mm
55mm	30+30mm	0	119mm
		30mm	151mm
		35mm	156mm
65mm	30+30mm	0	129mm
		30mm	161mm
		35mm	166mm
		40mm	171mm
		45mm	176mm

* Denotes the length of the implants (includes the 2mm added by each taper junction)

Fig. 24 Femoral Resection Lengths

Note: The minimum resection is 109mm.

Technique Tip: Resecting slightly more than the length of the assembled implants will make assembling the intercalary component easier and reduce the amount of distraction necessary; however, it will also cause the limb to be shortened and could reduce tissue tension.

Technique Tip: It may also be helpful to mark horizontal lines at a predetermined distance above and below the resection levels that can be used to assess leg length during trial reduction.

Resect the femur at or slightly inside (0.5mm-1.0mm) the marked resection space. Resecting the femur slightly inside the marks will help compensate for slightly oblique cuts and provide additional bone stock for planing the resected bone surfaces.

Step 2: Ream the Femoral Canal

Note: The diameters indicated for the Segmental Variable Stiffness Stems represent the actual diameters of the stems, which include the height of the splines. Therefore, the diameter of the reamed hole should be 0.5mm less than the labeled stem size to provide for additional apposition of the distal splines within the femoral canal. For a Segmental Fluted Stem, the diameter of the reamed hole should be 1-2mm greater than the labeled stem size to provide for an adequate cement mantel.

Note: When using Variable Stiffness Stems in an uncemented application, cement must still be used to attach the *Trabecular Metal* or Smooth Collar to the stem.

For a straight Variable Stiffness stem, use the straight reamers from the *VerSys* Hip System. For a bowed stem, flexible reamers from the *Pressure Sentinel* Intramedullary Reaming System are recommended: use the *Pressure Sentinel* Reamer Expanded Hip Set (00-2228-000-03) or the *ZMR*® Flexible Reamer Set (00-9975-000-11).
If preferred, the flexible reamers can also be used for a straight stem to allow for point contact of the stem in the canal.

Reaming for a Press-Fit Variable Stiffness Stem

Progressively ream the femoral canal until the reamer contacts cortical bone. Ream to a depth slightly greater than the length of the selected stem to allow proper seating of the stem shoulder on cortical bone. To achieve the press fit, under-ream the bone by 0.5mm and check the fit of the stem in the canal. If the stem fits too tightly in the bone, consider removing the stem and passing the last reamer used through the canal several more times. This can help to increase the hole diameter slightly, which will permit the stem to be more easily impacted into the bone.

For a straight stem using a straight reamer, do not increase the hole diameter to be equal to or greater than the diameter of the stem – this will eliminate the possibility of achieving a press fit (Fig. 25). For this reason, only *VerSys* straight reamers should be used (since they have 0.5mm increments), if using straight reamers. *NexGen* straight reamers should not be used, since they have 1mm increments. However, for a bowed stem or a straight stem in a flex-reamed bowed canal, it may be necessary to ream the medullary canal to a diameter larger than the stem to be implanted depending on how well the implant geometry matches the bow of the patient's femur. In such cases, the stem can achieve solid three-point fixation. If progressive reaming does not yield an appropriate press fit, consider using a different size implant or switching to a cemented application using a Segmental Fluted Stem.

Reaming for a Cemented Fluted Stem

Progressively ream the femoral canal until the reamer contacts cortical bone. Ream to a depth slightly greater than the length of the selected stem to allow proper seating of the stem shoulder on cortical bone and placement of a cement restrictor if desired. To allow for a cement mantle in the canal, select a stem 1-2mm smaller than the largest reamer size used to ream the canal. *NexGen* (or *VerSys*) straight reamers can be used for Segmental Fluted Stems, if desired.

Stem Size (Variable Stiffness)	Reamer Diameter
12mm	11.5mm
13mm	12.5mm
14mm	13.5mm
15mm	14.5mm
16mm	15.5mm
17mm	16.5mm
18mm	17.5mm
19mm	18.5mm

Fig. 25 Recommended reamer diameters

Step 3: Plane the Femoral Bone

Thread the appropriately sized Segmental Planer Pilot (130mm long) for the stem diameter selected onto the *MOST Options* Femoral/Tibial Planer (Fig. 6). If the anatomy requires the use of a shorter planer pilot, use the 75mm length Planer Pilots. A Planer Pilot 1-2mm smaller than the stem diameter chosen can be used to facilitate insertion into a curved medullary canal (Fig. 26). Attach the assembly to a power driver with a Zimmer adapter. Then plane the resected distal femur until the cortical bone is smooth and flat.

To aid in removing the Planer Pilot from the Planer, insert the pin on the Segmental Collar Provisional Sizer through the cross-hole and, while securing the noncutting end of the planer, turn the shank counterclockwise.

Stem Size (Variable Stiffness)	Planer Pilot Diameter
12mm	11mm
13mm	12mm
14mm	13mm
15mm	14mm
16mm	15mm
17mm	16mm
18mm	17mm
19mm	18mm

Fig. 26 Recommended Planer Pilot diameters

Step 4: Counterbore the Femoral Canal (for Variable Stiffness Stem applications only)

The full diameter of a Variable Stiffness Stem proximal to the splines will be 0.5mm greater than the reamed diameter of the femoral canal. Counterboring this proximal portion is required for proper insertion of the stem in the intramedullary canal.

Thread the appropriate size Counterbore Reamer Tip into the Counterbore Stop Plate (Fig. 27). Then insert the assembly into a power driver. Insert the pin on the Segmental Collar Provisional Sizer through the cross-hole of the Counterbore Reamer Tip and turn the shank to tightly secure it to the Counterbore Stop Plate (Fig. 28).

Insert the assembly into the reamed canal and counterbore the proximal canal (Fig. 29). The Counterbore Stop Plate will serve as a stop when the appropriate depth is achieved.

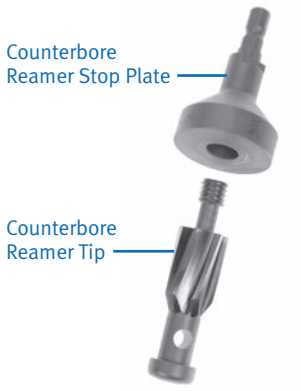


Fig. 27 Counterbore Reamer Tip and Counterbore Reamer Stop Plate

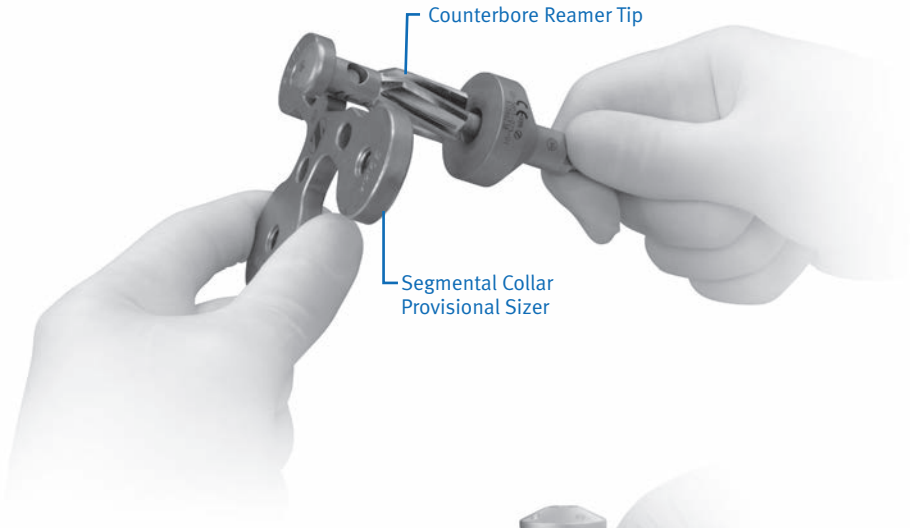


Fig. 28 Counterbore Reamer Tip and Counterbore Reamer Stop Plate Assembly

Fig. 29 Counterbore the Intramedullary Canal

Step 5: Assemble Provisional Components and Perform Trial Reduction

Stem Extension Provisional Assembly/Insertion

Use the Segmental Collar Provisional Sizer to select the collar size that provides the best coverage of the bone surface. If using a smooth collar, only the 30mm outer diameter collar is available. As an option, the collar sizer may be attached to the selected Planer Pilot to facilitate collar selection. Confirm that the stem and stem collar sizes are compatible (see figures 30 and 31).

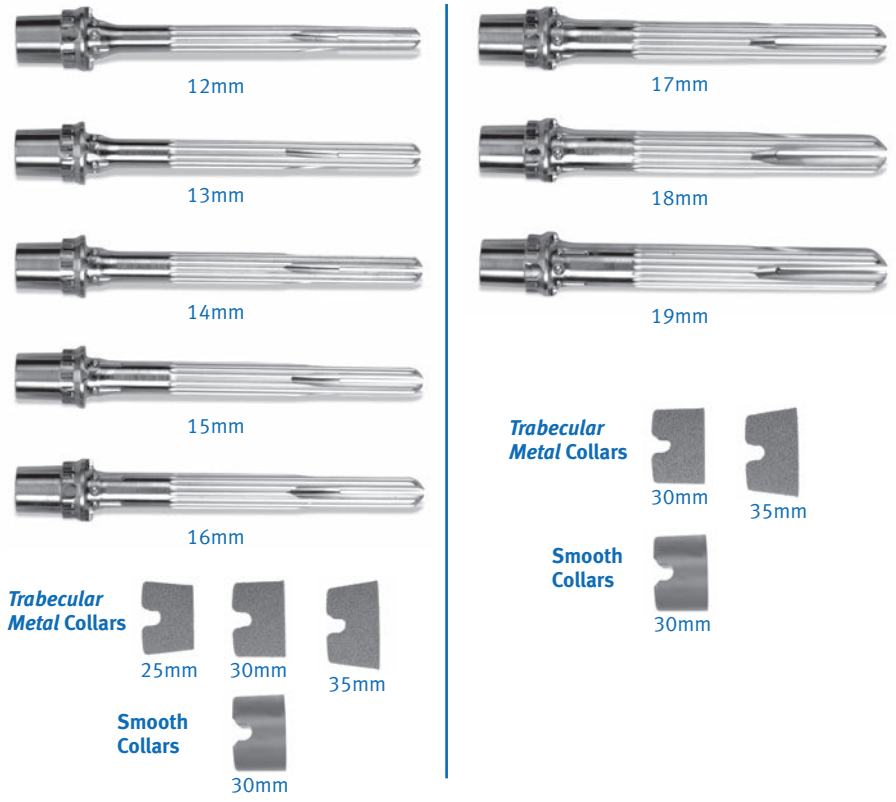


Fig. 30 Stem/Collar Compatibility

Note: The bowed stem (not shown) have the same compatibility with the collars.

Stem Collar Diameter

Smooth Collar	TM Collar	Stem Diameter	Stem I/M Length
30mm*	25mm/30mm*/35mm*	12-16mm	130mm Straight 190mm Bowed
30mm*	30mm*/35mm*	17-19mm	

* Denotes a collar size that has a different inner diameter for stem sizes 12-16mm than for 17-19mm.

Fig. 31 Variable Stiffness Stem Compatibility Table

For the Variable Stiffness Stem, select the appropriate Segmental Stem Provisional that is 1mm smaller than the anticipated Variable Stiffness stem component size, e.g., if a 15mm stem will be implanted, use a 14mm stem provisional. Then thread the Segmental Collar Provisional onto the selected Segmental Variable Stiffness Stem Provisional (Fig. 32).

Insert the stem provisional assemblies into the reamed canals and evaluate the fit. If a stem provisional does not easily fit into a bowed canal, it may be necessary to perform additional reaming or to use the next smaller size stem provisional. Check the fit of the stem collar on the bone surface to determine if the stem is fully seated.

If a bowed stem is being used, mark the femoral bone in line with the mark on the Segmental Bowed Variable Stiffness Stem Provisional to provide a locator for proper orientation of the implant (Fig. 33).

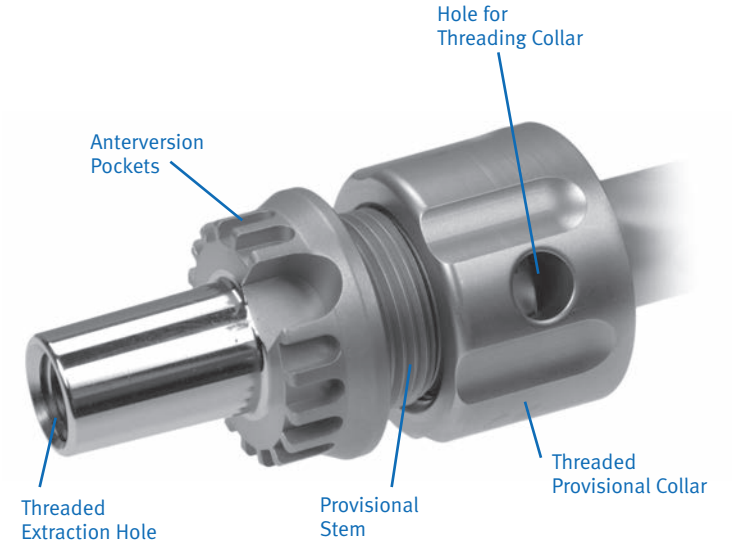


Fig. 32 Threading the collar provisional onto the stem provisional

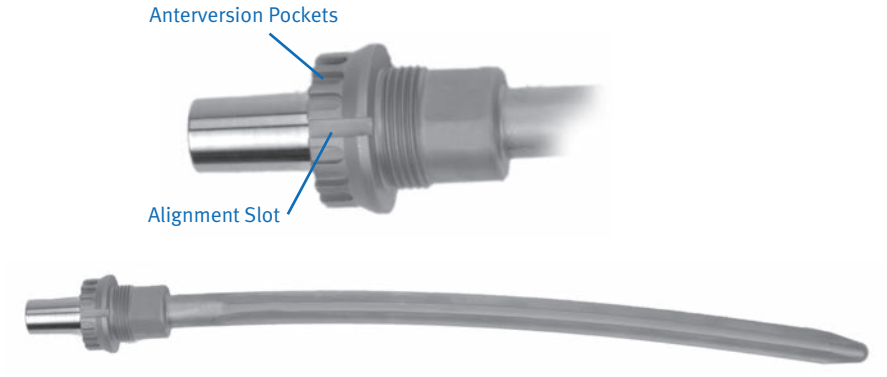


Fig. 33 Alignment Mark

Intercalary Segment Provisional Assembly/Insertion

After inserting the provisional stems, select the appropriate sized Intercalary Segment Provisional and Male-Female Segment Provisional, if used.

Note: The Male-Female Segment Provisionals have the same provisional taper as the rest of the Segmental System; however, to facilitate disassembly, the Segmental Intercalary Segment Provisionals are not designed for a taper fit with the mating provisionals.

If using a Male-Female Segment, place the appropriate Male-Female Segment Provisional onto the base of one of the two stem provisionals and use the Segmental Implant/Provisional Male Taper Impactor with the Universal Handle to impact the taper.

Connect the two halves of the Provisional Intercalary Segment Assembly together. One of the two intercalary provisional halves is designed with a slight boss to fit inside the other half (Fig. 34). Place the provisional into the jaws of the Segment Inserter/Remover and tighten the thumbscrew on the instrument (Fig. 35). The Segment Inserter/Remover will facilitate the assembly by providing leverage to manipulate the femur. Place one end of the intercalary provisional onto the base of one of the stem provisionals, or the Male-Female Segment Provisional. Then place the other end on the base of the other stem provisional, being careful to avoid distracting the leg more than necessary. This intercalary trialing technique provides a similar amount of distraction as the intercalary implantation would require.

Fig. 34 Provisional Intercalary Segments

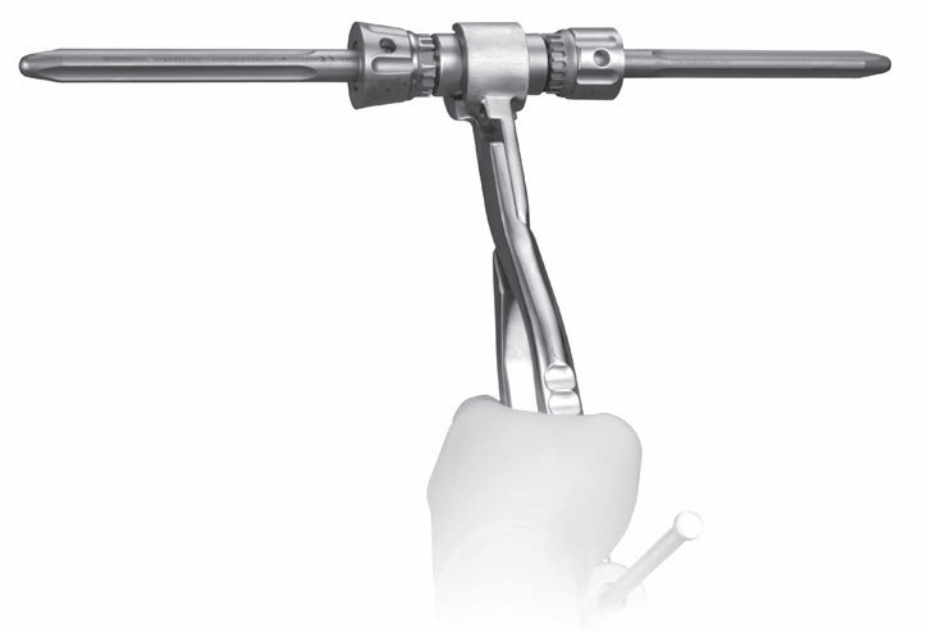


Fig. 35 Segment Inserter/Remover holding the Provisional Intercalary Segments together

A second intercalary provisional option is available if minimal distraction while trialing is desired without using a Male-Female Segment Provisional in the intercalary trial construct (Fig. 36). In this case, after inserting the Segmental Provisional Stems, slide the boss on the appropriately sized (45, 55 or 65mm) Provisional Intercalary Segment Spacer into one of the threaded holes on the end of the provisional stem. Then slide the other Provisional Intercalary Segment Spacer boss into the other Segmental Provisional Stem threaded hole (Fig. 37). The Segment Inserter/Remover can also be used to facilitate the assembly of this type of provisional construct. The amount of distraction required to assemble this provisional construct will be less than the amount of distraction required to assemble the implant, so the amount of soft-tissue tension should be noted for the final implantation.

Fig. 36 Provisional Intercalary Segment Spacer

Fig. 37 Provisional Intercalary Segment Spacer and Stem Provisional assembly

Ensure that all tabs on the provisional components are properly engaged in the corresponding pockets, when applicable. It is not necessary to impact the provisional components together.

Evaluate the fit of the provisionals and make adjustments as necessary. Check the leg length, alignment, and stability. Use caution not to over-lengthen the reconstruction in order to achieve longitudinal stability. If the soft tissues are too tight and the construct cannot be shortened, a soft tissue release or additional bone resection may be necessary. If additional bone is resected, it will also be necessary to perform additional reaming to ensure that the reaming depth is adequate.

Step 6: Disassemble the Provisional Components (if a Male-Female Segment Provisional was used)

Provisional Disassembly

Remove the provisionals by first removing the Segment Inserter/Remover. Distract the leg and disengage the two halves of the Provisional Intercalary Segment assembly or disengage the bosses of the Provisional Intercalary Segment Spacer. Then use the Segmental Taper Separator with the turning handle to disconnect any Male-Female Segment Provisionals, if used. This instrument will protect the taper integrity of the provisional components.

Before employing the Segmental Taper Separator, make sure that the inside wedging portion of the instrument is fully retracted and centered within its housing. To orient the instrument correctly, insert the tabs of the separator into the anteversion pockets with the flat of the separator toward the female side of the taper connection to be separated. Slowly turn the handle clockwise until the tapers are disengaged, taking care not to pinch fingers against the rotating impactor cap. If necessary, lightly tap the impactor cap on the instrument to facilitate taper disassembly.

If the stem components cannot be removed by hand, thread the Provisional Slaphammer Adapter onto the slaphammer and thread it into the stem provisional. Impact the slaphammer to remove the stem provisional.

Step 7: Prepare the Stems

All Segmental Stems must be used with collars, and all collars must be cemented to the stems. Verify compatibility of the collar with the stem size being used on the product label before opening the implant packages. See Figure 31 for more detail on stem and collar compatibility.

Apply cement in the doughy state to the base/taper end of the stem. Then slide the stem collar over the stem and advance it to the shank area where cement was applied. Clean off excess cement as the collar is advanced. Be careful to prevent cement from contacting the taper, the anteversion adjustment pockets, and the external surfaces of *Trabecular Metal* Material. Collars must be assembled to the stem with the pockets toward the anatomical joint and engaged into the tabs on the stem (Fig. 38). Allow the cement to fully harden before inserting the stem into a mating female taper.

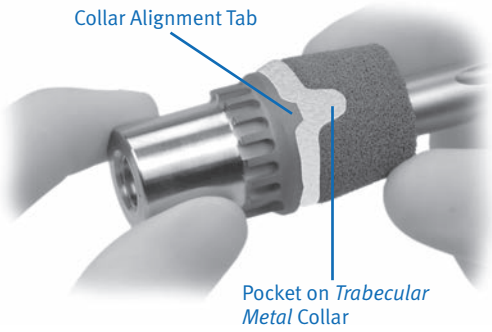


Fig. 38 Collar Assembly Detail

Step 8: Assemble and Implant the Final Components

Variable Stiffness Stem Implantation (Press-fit)

Insert each stem by hand into the corresponding medullary canal. When the stem can no longer be advanced by hand, assemble the Segmental Male-Female Taper Impactor to the Universal Handle and use a mallet to impact the stem.

Note: Cement is added to the base of the Smooth Collars.

If the fit of the stem is too tight, consider making additional reaming passes to increase the diameter of the medullary canal. Do not ream a straight stem to a diameter equal to or greater than the stem diameter if attempting to press fit the stem. This will eliminate the possibility of achieving a press fit in this application. When inserting a bowed stem it may be necessary to ream the canal to a diameter greater than the stem diameter to achieve adequate fixation and/or to fully insert the stem due to a mismatch between the natural bow of the femur and the bow of the prosthesis. In such cases, the stem can achieve solid three-point fixation.

Note: The Segmental Variable Stiffness Stem is not indicated for uncemented use with knee components.

Technique Tip: In some applications, particularly in cases with thin cortical walls, it can be beneficial to use cerclage wires to reduce the possibility of damaging the bone.

Fluted Stem Implantation (Cemented)

If desired, use a plastic cement restrictor to allow manual pressurization of the cement. Inject cement into each femoral canal. Apply cement to the shank of each stem to ensure adequate cement coverage at the implant/bone interface. Then insert each stem by hand into the corresponding medullary canal. Clean off excess cement as the stems are inserted and use care to keep cement off the external surfaces of the smooth or *Trabecular Metal* Collars, the entire surface of the tapers, and the crevices of the anteversion adjustment pockets. When the stem can no longer be advanced by hand, assemble the Segmental Male-Female Taper Impactor to the Universal Handle and use a mallet to impact the stem.

Note: Cement is added to the base of the Smooth Collars.

Intercalary Implantation

Position the proximal section of the femur so it is offset and at a slight angle to the distal section. If using a Male-Female Segment, insert the appropriate segment onto the taper of the proximal stem. Use the Segmental Implant/Provisional Male Taper Impactor (assembled to the Universal Handle) to impact the segment.

Place the Intercalary Segment into the jaws of the Segment Inserter/Remover and tighten the thumbscrew on the instrument. Insert the Intercalary Segment onto the proximal stem or Male-Female Segment, if used. Use the Segmental Implant/Provisional Female Taper Impactor (assembled to the Universal Handle) to impact the Intercalary Segment onto the mating component.

Note: If the intercalary device is being positioned near key anatomical structures, it may be necessary to insert the implant by hand.

Note: Excessive distraction of the limb may cause damage to surrounding soft tissue structures.

Distract the leg and insert the opposite end of the Intercalary Segment onto the taper of the distal stem. The Segment Inserter/Remover will facilitate the assembly by providing leverage to manipulate the femur. Check the vertical marks made earlier on the bones to ensure that the bone sections are rotationally aligned.

Seat the final taper connection by straightening the leg and pushing and/or gently hitting the heel of the patient with a hand. Tissue tension and the rotational tabs will help to ensure that the components do not separate.

Technique Tip: Resecting slightly more than the length of the assembled implants will make assembling the intercalary component easier and reduce the amount of distraction necessary; however, it will cause the limb to be shortened and could reduce tissue tension.

Note: For leg lengthening procedures, the segment anteversion tabs must be positioned in either the direct A/P or M/L direction. This will facilitate access for the Segmental Taper Separator (Fig. 39).

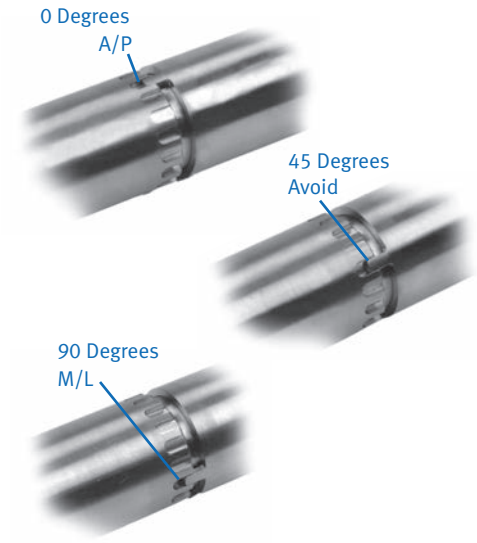


Fig. 39 Anteversion Tab Positioning

Rotational Adjustment

If rotational adjustment is necessary after the components are completely seated, use the Segmental Taper Separator to disassemble the taper. The anteversion pockets and tabs on the components allow the component rotation to be adjusted in a controllable manner in 20° increments.

Note: Do not use the Segmental Intercalary Segment with *MOST Options* stems. These are not compatible.

Disassembly Using the Segmental Taper Separator

Apply the Segment Inserter/Remover to the Intercalary Segment. Then use the Segmental Taper Separator to disengage the taper. Before employing the Segmental Taper Separator, make sure that the inside wedging portion of the instrument is fully retracted and centered within its housing. To orient the instrument correctly, insert the tabs of the separator into the anteversion pockets with the flat of the separator toward the female side of the taper connection to be separated. Slowly turn the handle clockwise until the tapers are disengaged, taking care not to pinch fingers against the rotating impactor cap. Then pull the holder/inserter in the direction necessary to separate the two components.

A secondary Taper Separator is also available, and can be used to disassemble the Intercalary Segment or a Male-Female Segment after the Intercalary Segment has been disconnected from one stem. To use this device, place the two tapered edges into the gap between the taper connections and impact the handle with a mallet. As the tapered edges advance, the tapers will be separated.

Removing the Stems

For stem removal, thread the Implant Slaphammer Adaptor onto the slaphammer and thread it into the stem. Impact the slaphammer to remove the stem.

Please refer to package insert for complete product information, including contraindications, warnings, precautions, and adverse effects.

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