

Zimmer[®] Segmental System

Surgical Technique



A step forward for challenging salvage cases



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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 revision. The system components provide broad operative options for surgeons addressing patients presenting with these conditions.

The system includes distal femoral components, a one-piece hinge post, tibial articular surfaces, segments, cemented straight and bowed stems, and stem collars with either *Trabecular Metal*[™] Material or a smooth titanium surface. The one-piece Segmental Hinge Post, which is packaged with the corresponding size Segmental Articular Surface, ensures a minimum 40mm jump-height of the post for all sizes of Segmental Articular Surface. The system also includes specific instruments designed to facilitate the surgical procedure. The Zimmer Segmental System enables complementary intersystem assembly with some 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 Segmental Distal Femoral Component features the same condylarloading geometry as the Zimmer NexGen Rotating Hinge Knee, but will also allow both medial and lateral access to the hinge pin locking assembly.

This surgical technique is divided into sections that provide detailed descriptions of each step in a specific procedure (See Table of Contents). The main body of each procedure describes the steps that are specific to the Zimmer Segmental System. When implanting components from the NexGen Rotating Hinge Knee or the *MOST Options* System, some steps are the same as those detailed in the specific surgical techniques for those systems. For these steps, the surgeon is referred to the appropriate technique. The NexGen Rotating Hinge Knee Technique is part number 97-5880-002-00, while the MOST Options technique is 97-5010-002-00.

Patient Counseling Information

Due to the serious health issues normally seen with segmental implant recipients, complications and/or failure of total knee prostheses are more likely to occur. This is especially true of patients with concomitant diseases, unrealistic functional expectations, heavy patients, physically active patients, and/or with patients that fail to follow through with the required rehabilitation program. Excessive physical activity and injury can result in loosening, wear, and/or fracture of the knee implant. Additionally, the impact of total health status or treatment regime, (chemotherapy, radiation, etc.) may affect the stability and overall success of the implant. The patient must be instructed about all postoperative restrictions, particularly those related to occupational and sports activities and about the possibility that the implant or its components may wear out, fail, or need to be replaced. The implant may not, and is not guaranteed to, last the rest of the patient's life. Because prosthetic joints are not as strong, reliable, or durable as natural, healthy joints, all prosthetic knees may need to be replaced at some point.

Compatibility

Some implants and provisional components from the Segmental Knee System are compatible with the *Zimmer NexGen* Rotating Hinge Knee and/or the *Zimmer 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.

Using the Correct Polyethylene Insert

The Segmental System includes a Segmental Polyethylene Insert for use with the Segmental Distal Femur, while the NexGen Rotating Hinge Knee includes a Polyethylene Insert with Cement Shield for use when the onepiece Segmental Hinge Post is used with the NexGen Rotating Hinge Knee Distal Femoral Component (Fig. 1). This NexGen Polyethylene Insert with Cement Shield is packaged in the NexGen Rotating Hinge Knee Cement Shield Hinge Servicing Kit. The Segmental Polyethylene Insert is packaged individually for use with the Segmental Distal Femoral Component. It is very important to distinguish between these two polyethylene inserts.

When implanting a NexGen Rotating Hinge Knee Femoral Component, do not allow excess cement to contact the hinge components. Because of the proximity of cement to the hinge components, the polyethylene insert used with the NexGen Rotating Hinge Knee Femoral Component is designed with a cement shield to help protect the hinge components from cement intrusion. Be sure to use the appropriate polyethylene insert component. The Segmental Polyethylene Insert does not include the cement shield geometry on the component, and has a different wall thickness than the NexGen Polyethylene Insert with Cement Shield.

Using the Correct Hinge Post Provisional

Whenever a Segmental Articular Surface is used, the one-piece Segmental Hinge Post must be used. The same Segmental Hinge Post (packaged with the Segmental Articular Surface) is used with both the Segmental Distal Femoral Component and the *NexGen* Rotating Hinge Knee Distal Femoral Component; however, each is mated to a different polyethylene insert. The differences resulting from the polyethylene inserts have already been taken into account in the design of the Hinge Post Provisionals. The Segmental Hinge Post Provisionals (sizes B and C) are used with the Segmental Distal Femoral Components, while the Segmental/Rotating Hinge Knee Hinge Post Provisionals (sizes B, C, D, E, and F) are used with the NexGen Rotating Hinge Knee Distal Femoral Components. These two types of hinge post provisionals are not designed to be interchanged between the distal femoral component provisionals of the two systems because the difference in the polyethylene insert thickness is incorporated into the designs. They are easy to distinguish from one another in that the Segmental Hinge Post Provisionals have a gold color on their superior end, whereas the Segmental/ **Rotating Hinge Knee Hinge Post** Provisionals do not.

Groove on Segmental Polyethylene Insert

Fig. 1 Segmental polyethylene insert and NexGen polyethylene insert with cement shield

Segmental System Scope/ Compatibility Chart



Distal Femur Replacement Using the Segmental Distal Femoral Component

As part of preoperative planning, determine whether the hinge post will be locked to the femoral component before or after it is inserted through the Segmental Articular Surface. If locked before insertion through the articular surface, be sure that enough distraction across the joint space will be possible.

Note: The hinge post provisional used for trial reduction is available in one length which may be shorter than the final Segmental Hinge Post that will be implanted. The main purpose of the hinge post provisional is to bring the tibia into alignment with the mechanical axis directly under the femur. The Segmental Hinge Post plays a similar role; however, its length also accounts for the thickness of the Segmental Articular Surface and provides an additional 40mm of jump height to resist subluxation. Do not lock the hinge post to the femoral component before it is inserted through the articular surface if there is concern over distracting the joint beyond that used during trial reduction.

Step One Prepare the Femur

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

Distal Femoral Resection

Measuring from the articular surface of the distal femur, use a marker, osteotome, or electrocautery to make a horizontal line marking the proposed resection level based on preoperative planning and the implant configuration (Fig. 2).

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

Resect the distal femur at or slightly distal (0.5mm-1.0mm) to the marked resection level. Resecting the femur slightly below the mark will account for slightly oblique cuts and help accommodate femoral resection planning. Note: To improve the swing phase of the patient's gait, some surgeons choose to slightly shorten the limb.

Distal Femur	Stem Collar	Segments	Resection Length
		None	90mm
		30mm	122mm
		35mm	127mm
		40mm	132mm
		45mm	137mm
		60mm	152mm
		30 + 35mm	159mm
		30 + 40mm	164mm
		35 + 40mm	169mm
		80mm	172mm
		35 + 50mm	179mm
		30 + 60mm	184mm
		35 + 60mm	189mm
		100mm	192mm
		45 + 60mm	199mm
		30 + 80mm	204mm
		35 + 80mm	209mm
		120mm	212mm
		45 + 80mm	219mm
		30 + 100mm	224mm
		35 + 100mm	229mm
		140mm	232mm
C: D		45 + 100mm	239mm
SIZE B	30mm	30 + 120mm	244mm
5811111		35 + 120mm	249mm
		160mm	252mm
		45 + 120mm	259mm
		30 + 140mm	264mm
		35 + 140mm	269mm
		180mm	272mm
		45 + 140mm	279mm
		30 + 160mm	284mm
		35 + 160mm	289mm
		200mm	292mm
		45 + 160mm	299mm
		30 + 180mm	304mm
		35 + 180mm	309mm
		220mm	312mm
		45 + 180mm	319mm
		30 + 200mm	324mm
		35 + 200mm	329mm
		40 + 200mm	334mm
		45 + 200mm	339mm
		30 + 220mm	344mm
		35 + 220mm	349mm
		40 + 220mm	354mm
		45 + 220mm	359mm

** Size C Segmental Distal Femur is 60mm. Resect an additional 2mm beyond the resection length listed in the table above for the Size C.

Fig. 2 Distal Femoral Resection Table

Reaming for a Bowed Stem

Use a flexible reamer to ream the femoral canal until the reamer contacts cortical bone in the isthmus. Ream to a depth 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 cement fill in the canal, select a stem 2mm smaller than the largest reamer size used to ream the canal.

Reaming for a Straight Stem

Ream the femoral canal until the reamer contacts cortical bone in the isthmus. Ream to a depth 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 cement fill in the canal, select a stem 2mm smaller than the largest reamer size used to ream the canal. If preferred, use a flexible reamer to allow for point contact of the stem in the canal.

Planing the Femoral Bone

Thread the appropriate size Planer Pilot for the medullary canal onto the *MOST Options* Femoral/Tibial Planer (Fig. 3). A Planer Pilot 1-2mm smaller than the stem diameter chosen can be used to facilitate insertion into a curved intramedullary canal. Attach the assembly to a drill/driver with a Zimmer



Fig. 3 Threading the Planer Pilot onto the Planer

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 non-cutting end of the planer, turn the shank counterclockwise.

Step Two Prepare the Tibia

For the steps required to prepare the tibia for use with the *NexGen* Rotating Hinge Knee, refer to pages 9-20 of the *Zimmer NexGen* Rotating Hinge Knee Primary/Revision Surgical Technique (97-5880-002-00).

Step Three Prepare the Patella

If the patella will be resurfaced, refer to the steps required to prepare the patella, pages 59 and 64 of the *Zimmer NexGen* Rotating Hinge Knee Primary/Revision Surgical Technique (97-5880-002-00). Other surgical techniques that may be helpful are those for the *Zimmer* Patella Reamer, the Augmentation Patella, and the *Trabecular Metal* Primary Patella.

Step Four Assemble Provisional Components and Perform Trial Reduction

Stem Extension Provisional Assembly

Use the Segmental Collar Provisional Sizer to select the collar size that provides the best coverage of the bone surface. If using a nonporous collar, only the 30mm diameter collar is available. As an option, the collar sizer may be threaded onto the selected Planer Pilot to facilitate collar selection. Confirm that the stem and stem collar sizes are compatible (Figs. 4 & 5). Then thread the Segmental Collar Provisional onto the selected Segmental Stem Provisional (Fig. 6).

Technique Tip: Check the fit of the Stem Extension Provisional Assembly by inserting it into the reamed canal. For a bowed canal, it may be necessary to perform additional reaming, possibly causing the next smaller stem size to be utilized.



Fig. 4 Stem/Collar Compatibility

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

Stem Collar Diame	eter (against bone)	Stom Diamotor	Stem I/M Length	
Smooth Collar	TM Collar	Stelli Dialiletei		
30*mm	25, 30*, 35*mm	12-16mm	130mm Straight	
30*mm	30*, 35*mm	17-19mm	190mm Straight 250mm Bowed	

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



Fig. 6 Threading the collar provisional onto the stem provisional.

Femoral Provisional Assembly and Insertion

After verifying that all sizes are correct, assemble the provisional femoral components. The components can be assembled either on the back table or in vivo. For back-table assembly, place the Segmental Distal Femoral Provisional into the Segmental Condyle Impactor. If using a segment provisional, place the male taper into the female taper of the distal femoral provisional. Using the appropriate Segmental Implant/ Provisional Male or Female Impactor and the Universal Impactor Handle, impact the segment provisional onto the distal femur. Next attach the stem provisional to the segment provisional or femoral provisional using the appropriate impactor. Ensure that all tabs on the provisional components are properly engaged in the corresponding pockets. Use gauze to protect the stem tip and impact with a mallet.

Alternatively, the femoral provisionals may be assembled sequentially *in vivo*. If necessary, the Universal Impactor Handle can be threaded into the base of the Segmental Condyle Impactor (Fig. 7). Insert the femoral provisional assembly into the femoral canal and evaluate the fit. If necessary to achieve full seating, use the Segmental Condyle Impactor, the Universal Impactor Handle, and a mallet to lightly impact the distal end of the Segmental Distal Femoral Provisional (Fig. 7). Evaluate the fit of the stem collar on the bone surface to determine if the stem is fully seated. Assess the orientation of the distal femoral provisional and determine whether a rotation adjustment will be necessary. If desired, the femoral component can be slightly externally rotated based on the anterior femur and linea aspera to facilitate patellar tracking.

If a bowed stem is being used, mark the femoral bone in line with the alignment slot on the mediolateral side of the Segmental Bowed Stem Provisional to provide a locator for proper orientation of the implant (Fig. 8).

Femoral Version Adjustment

If a rotation 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-degree increments (Fig. 9).





Fig. 9 Close-up of anteversion pockets on segment provisional and tabs on femoral provisional.



Fig. 7 Universal Impactor Handle threaded into the base of the Segmental Condyle Impactor being used to impact the provisionals *in vivo*.

Fig. 8 Slot Alignment

Using the Segmental Taper Separator

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 (Fig. 10). 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.

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.

Tibial Provisional Assembly and Insertion

Assemble the *NexGen* Rotating Hinge Knee Tibial Provisional Components and *NexGen* Stem Extension Provisional, if applicable. Use the provisionals from the Rotating Hinge Knee Articular Surface Provisional Instrument Set (Kit# 00-5979-004-00). Remember that the size on the femoral provisional must exactly match the size of the articular surface provisional. The size on the tibial provisional must be appropriate for the size of the femoral provisional and tibial articular surface provisional (Fig. 11).

Interchangeability Chart 1 Segmental Knee System (using an RH Knee tibial component)

		Segmental Femoral Size			
		В	С		
	1	B/123456	C/123456		
RH Knee Tibial Size	2	B/123456	C/123456		
	3	B/123456	C/123456		
	4	B/123456	C/123456		
	5	B/123456	C/123456		
	6	B/123456	C/123456		



Fig. 11 Interchangeability Chart

Insert the tibial provisional construct into the tibial canal, and then insert the appropriate size articular surface provisional. Place the knee through a full range of motion to evaluate soft tissue tension and knee stability. A thicker articular surface provisional should be used if necessary to correctly balance the knee.

Note: The Segmental Distal Femoral **Component and the Rotating Hinge Knee** Tibial Components are linked, forcing the tibia to be in alignment directly under the femur (on the mechanical axis) by virtue of the one-piece hinge post that links the femoral and tibial components.

Trial Reduction

When assessing hyperextension during trial reduction, use only the Segmental Hinge Post Provisionals, which have gold color on their superior ends, with the Segmental Distal Femoral Provisional. This is important because these hinge post provisionals incorporate the thickness of the Segmental Polyethylene Insert into the design. Using a one-piece hinge post provisional, without the gold color on its end, will not provide an accurate assessment of hyperextension during trial reduction.

The Segmental Hinge Post Provisional can be attached to the distal femoral provisional first, and then inserted through the articular surface provisional and tibial provisional. However, if there is concern about overstretching nerves and vascular structures, insert the Segmental Hinge Post Provisional into the articular surface provisional and tibial provisional before attaching it to the femoral provisional.

The hinge post provisional must match the femoral provisional size. Use the Segmental Hinge Pin Aligner to align the hole in the hinge post provisional with those on each side of the femoral provisional. Then, while maintaining the position, remove the aligner, and insert the Segmental Distal Femoral Bolt Provisional using the 4.5mm Hex Driver to secure the bolt into the femoral provisional.

Note: If the joint is being distracted to insert the hinge post provisional, be aware that the length of the hinge post implant may be longer than the provisional, which will require additional distraction to insert the hinge post into the tibial component upon final implantation.

When using distraction, assembly is facilitated if the knee is in approximately 90° of flexion and the tibia is free to be moved mediolaterally for centering under the femur. If the Segmental Hinge Post Provisional will not line up with the hole in the articular surface provisional, it will be necessary to reposition the tibia under the femur. The femoral provisional rotation should also be evaluated and adjusted, if necessary. Leg holders should not be used during the assembly process.

Insert the appropriate patellar provisional if patellar resurfacing is being performed. Conduct a complete evaluation of range of motion. Evaluate the patellar tracking, and palpate the posterior soft tissues to ensure that there is not excessive tension. To avoid causing damage to nerve and vascular structures, do not pull too hard on the leg. Assess the rotation of the limb and, if necessary, adjust the rotation of the components. Then perform any necessary soft tissue releases.

Provisional Disassembly

Remove the patellar provisional, if used, Segmental Distal Femoral Bolt Provisional, Segmental Hinge Post Provisional, and articular surface provisional. Manually attempt to remove the femoral provisional, segment provisional, if used, and the stem provisional. If these components cannot be removed manually, use the Segmental Taper Separator to loosen the taper between the stem and the femoral provisional or segment provisional, if used. Thread the Provisional Slaphammer Adaptor (Fig. 12) onto the slaphammer and thread it into the stem provisional. Impact the slaphammer to remove the stem provisional. Then remove the tibial base plate provisional and associated extension provisional, if used.





Provisional Slaphammer Adapter (two grooves)

Implant Slaphammer Adapter (one groove)

Fig. 12 Slaphammer groove diagram

Step Five Assemble Implants

Distal Femoral Assembly

Before assembling the final components, verify the accuracy of the implants selected and the compatibility of all component sizes (Figs. 4 & 11). Assemble the femoral and tibial components as described in the provisional assembly step before mixing the cement. If segments will be used, rest the distal condyles of the femoral component on the Segmental Condyle Impactor (Fig. 13). Align the anteversion tabs, and then use the Segmental Implant/Provisional Male or Female Impactor, the Universal Impactor Handle, and a mallet to solidly impact the segment into the femoral component.

Note: Avoid notching, scratching, or directly striking the implants during assembly.



Fig. 13 Locating the Distal Femoral Component on the Femoral Condyle Impactor

Stem Extension Assembly

All Segmental Stems must be used with collars, and all collars must be cemented to the stems. Refer to Fig. 5 for an overview of stem and collar combinations. 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: 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 stem/collar assembly can be inserted as a unit. The second mix can be used to cement the stem/collar assembly, tibial component, and patellar component.

Technique Tip: Before cementing the collar, insert the stem implant into the intramedullary canal to confirm that the stem will fully seat. Clean off the stem prior to cementing the 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 anatomical joint and engaged into the tabs on the stem (Fig. 14). Allow the cement to fully



Fig. 14 Collar Assembly Detail

harden before inserting into the Distal Femoral Component.

With the femoral component resting on the Segmental Condyle Impactor on the back table, ensure that all anteversion tabs are properly aligned. Protect the end of the stem with gauze during impaction. Then use a mallet to solidly impact the stem into the femoral component or segment.

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

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. 15).



Fig. 15 Anteversion Tab Positioning

Proximal Tibial Assembly

To assemble the tibial component, refer to the *Zimmer NexGen* Rotating Hinge Knee Primary/Revision Surgical Technique (97-5880-002-00), pages 68-69.

Step Six Insert Implants

Before final implantation, verify that properly sized components (Segmental Polyethylene Insert, Segmental Hinge Pin, Segmental Hinge Post, Segmental Articular Surface, Segmental Stem, and Segmental Segments) have been used in the assemblies, as determined when using provisionals.

If desired, use a plastic cement restrictor to permit the cement to be manually pressurized. Inject cement into the femoral canal. Attach the Universal Impactor Handle to the Segmental Condyle Impactor. Apply cement to the shank of the stem to ensure adequate cement coverage at the implant/bone interface. Clean off excess cement as the femoral implant assembly is 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. Note: Cement is added to the base of the Smooth Collar.

To implant the tibial component, refer to the *NexGen* Rotating Hinge Knee Primary/Revision Surgical Technique (97-5880-002-00).

To implant the patellar component, refer to "Step Three: Prepare the Patella."

The articular surface provisional may be inserted and the knee placed in extension while the cement is setting to maintain compression on the components.

The size of the Segmental Polyethylene Insert must match the femoral size selected. Attach the Segmental Polyethylene Insert to the Segmental Hinge Post by spreading the sides of the polyethylene insert out slightly and pressing it over the hinge post until it snaps into place. The holes in the polyethylene insert must match the bosses on the hinge pin bushing to assure proper orientation (Fig. 16). If attached backwards, the Segmental Polyethylene Insert and Segmental Hinge Post will not fit easily within the Segmental Distal Femoral Component without interference.



Fig. 16 Segmental Polyethylene Insert/ Hinge Post Orientation

Once the cement has set, remove the articular surface provisional, if used. Insert the final Segmental Articular Surface. The Segmental Articular Surface is packaged with a mating hinge post that ensures a 40mm jump height. Do not use a hinge post from another articular surface size.

Warning: Do not use Segmental System components (such as the one-piece Segmental Hinge Post) with *NexGen* Rotating Hinge Knee articular surfaces. They were not designed to be compatible. If the joint can be distracted sufficiently, attach the hinge post assembly (with Segmental Polyethylene Insert snapped on) to the Segmental Distal Femoral Component. Follow the steps below to lock the hinge post to the femoral component. Then insert the hinge post into the tibial component.

If there is concern about overstretching nerves and vascular structures, insert the hinge post assembly (with Segmental Polyethylene Insert snapped on) into the tibial component before attaching it to the femoral component. Then follow the steps below to lock the hinge post to the femoral component.

 Groove faces anteriorly

Locking the Hinge Post to the Femoral Component

Use the Segmental Hinge Pin Aligner to align the hole in the hinge post with the holes of the femoral implant. Then remove the aligner. Use the 4.5mm Hex Driver to insert and thread the Segmental Hinge Pin through the hole of the femoral implant (Fig. 17). Make sure that the pin crosses through the hole in the hinge post bushing. The hinge pin may be inserted either medially or laterally into the femoral component. Use the Rotating Hinge Knee Torque Wrench with the blue handle and 4.5mm Hex Driver to tighten the hinge pin to 130in-lbs. While torquing, watch the stylus on the wrench until it reaches the 130 line, then stop (Fig. 18). Insert the Segmental Hinge Pin Set Screw on the same side as the hinge pin (Fig. 17) and use the Rotating Hinge Knee Torque Wrench with the blue handle and 4.5mm Hex Driver to torque the set screw to 130in-lbs. While torquing, watch the stylus on the wrench until it reaches the 130 line, then stop (Fig. 18).

Caution: Do not torque the hinge-pin or set screw beyond 130in-lbs or damage to the hex-drive or driver will occur.



Fig. 17 Femoral Assembly



Fig. 18 Torque Reading Detail

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 "Using the Segmental Taper Separator" under "Femoral Version Adjustment" in Step Four for instructions related to the Segmental Taper Separator. Alternatively, the Segmental Wedge Taper Separator may be used as a back-up to disassemble the tapers on the implants.

For stem removal, thread the Implant Slaphammer Adaptor (Fig. 19) onto the slaphammer and thread it into the stem. Impact the slaphammer to remove the stem.



Fig. 19 Slaphammer Adapter alignment when threading onto the slaphammer

Closure

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

Segmental Hinge Servicing Kit: A Segmental Hinge Servicing Kit (see Fig. 20) is available if a component is dropped or damaged during surgery. This kit is also used during revisions of the Segmental hinge. In addition, the Segmental Polyethylene Insert is also available as a separate package from the kit.



Fig. 20 Segmental Hinge Servicing Kit Components

Using the Segmental Hinge Post with the NexGen Rotating Hinge Knee

If using the Segmental Hinge Post with the *NexGen* Rotating Hinge Knee System for a primary or a complete revision arthroplasty, prepare the tibia, femur, and patella as indicated in Steps 1-10 of the *Zimmer NexGen* Primary/Revision Rotating Hinge Knee Surgical Technique (97-5880-002-00). Then continue with the following four steps.

If replacing the tibial articular surface and hinge post with a Segmental Articular Surface and Segmental Hinge Post in a patient with an existing NexGen Rotating Hinge Knee, remove the previous modular hinge component and articular surface. Refer to the Zimmer NexGen Primary/Revision Rotating Hinge Knee Surgical Technique (97-5880-002-00), Appendix G, pages 107-108. Use the Rotating Hinge Knee Articular Surface Provisionals, Rotating-Hinge Knee Segmental Hinge Post Provisionals, and Segmental/Rotating Hinge Knee Hinge Pin Aligner for trial range-of-motion evaluations. Then proceed to "Step Four - Assemble Segmental Hinge Post" (page 21) in this technique, and use the in vivo assembly technique.

As part of the preoperative planning, determine whether back-table (distractive) assembly or *in vivo*

assembly of the Segmental Hinge Post to the NexGen Rotating Hinge Knee Distal Femoral Component and NexGen Rotating Hinge Knee Tibial Component will be performed. In back-table assembly, the Segmental Hinge Post is cross-pinned to the NexGen Rotating Hinge Knee Distal Femoral Component before insertion into the patient. The distal femoral implant assembly (with Segmental Hinge Post) is inserted onto the chamfered distal femoral bone, and the cylindrical portion of the hinge post is inserted through the articular surface and into the tibia once enough distraction across the joint space is achieved. This technique is detailed in "Back- table (distractive) Assembly Technique" under "Step Four - Assemble Hinge Post" (page 23).

For *in vivo* assembly, the Segmental Hinge Post is cross-pinned to the *NexGen* Rotating Hinge Knee Distal Femoral Component through the medial trephine hole in the femoral bone. *In vivo* assembly is detailed in "*In vivo* Assembly Technique" under "Step Four – Assemble Segmental Hinge" (page 22).

Note: If needed please reference the Segmental System scope compatibility chart on page 4 for system crosscompatibilities.

Step One Prepare the Femur for the Segmental Hinge Post

Use the Segmental Rotating Hinge Knee Drill Guide Body that is the same size as the femoral component being implanted. Slide the Segmental Trephine Guide Bushing into the slot of the drill guide body such that the drill guide body will facilitate drilling of the medial side of the femur (Fig. 21). Thread the Universal Impactor Handle into the hole on the distal face of the Segmental/Rotating Hinge Knee Drill Guide Body and tighten to secure the guide bushing to the drill guide body. This instrument is intended for use with a primary procedure only. Utilize the NexGen Rotating Hinge Knee Hinge Pin Servicing Kit (Kit # 00-5979-005-00) for revisions, as described in Appendix G of the NexGen Primary/Revision Rotating Hinge Knee Surgical Technique (97-5880-002-00).



Fig. 21 Locating the Segmental Trephine **Guide Bushing**

NexGen Distal Femoral Augments and Posterior Femoral Augments are available for use with the NexGen Rotating Hinge Knee. Distal augments are available in 5mm, 10mm, 15mm, and 20mm sizes, and posterior augments are available in 5mm and 10mm sizes. NexGen Anterior Femoral Augments are not available for use with the NexGen Rotating Hinge Knee.



If the NexGen Distal Femoral Augments are being used on the lateral side of the femur, the distal augment provisionals must be attached to the underside of the drill guide body. If the augments are being used on the medial side of the femur, the distal augment provisionals should not be attached to the underside of the drill guide body as this could block the Trephine when drilling the access hole. In this case, it is important to confirm that the Trephine Drill Guide Body is flush against the distal and anterior chamfer cuts on the lateral side to ensure that the access hole will be drilled in the correct location (Fig. 22).



Fig. 22 Drill guide body flush against lateral side

Insert the drill guide assembly onto the prepared distal femur, and impact lightly with a mallet until it is flush with the resected distal surface.

Attach the Trephine to a drill/driver. Then use the Trephine to drill an access hole through the guide bushing and into the medial side of the femur. The Trephine has a built-in stop to limit the depth of drilling (Fig. 23).



Fig. 23 Trephine Guide Assembly

Step Two Assemble Provisional Components and Perform Trial Reduction

If augmentation is required, attach the appropriate *NexGen* Posterior Femoral Augment Provisionals to the Femoral Provisional/Cutting Guide (Fig. 24) on the lateral side. Then attach the *NexGen* Distal Femoral Augment Provisionals on the lateral side, if necessary. The augment provisionals simply snap into place. Assemble the Stem Extension Provisional to the Femoral Provisional/Cutting Guide (Fig. 25). If an offset stem extension will be used, fully thread the Offset Stem Locknut onto the appropriate size Offset Stem Provisional and tighten the locknut against the Stem Extension Bushing to lock the orientation. Slide the appropriate size Segmental Rotating Hinge Knee Modular Box Provisional onto the Rotating Hinge Knee Femoral Provisional/Cutting Guide and push the clip until it snaps into place (Fig. 26).



Fig. 24 Locating the Posterior Femoral Augments

Note: Do not attach Distal Femoral Augment Provisionals to the medial side of the Femoral Provisional/Cutting Guide as this may block access for crosspinning with the Segmental/Rotating Hinge Knee Hinge Pin Aligner.



Fig. 25 Stem Provisional Assembly

Rotating Hinge Knee Modular Box Provisional

Segmental

Rotating Hinge Knee Femoral Provisional Cutting Guide

Fig. 26 Cutting Guide Assembly

Insert the femoral provisional assembly onto the bone and impact if necessary to fully seat the provisional on the bone. The hole in the medial side of the box provisional should align with the access hole drilled into the medial side of the femur. If the hole is not aligned, the access hole should be re-drilled or additional bone removed with a burr until the hole is aligned.

Insert the correct size Rotating Hinge Knee Tibial Provisional with the selected Tibial Augment Provisionals and Stem Extension Provisional, if applicable. *NexGen* Tibial Augment Provisionals are available in full blocks (Rotating Hinge Knee-specific — 10mm), blocks (5mm, 10mm, 15mm, and 20mm), 16-degree half wedges, 26-degree half wedges, and 22-degree third wedges.

Note: The 7-degree tibial wedges (fullangled wedges) will not work with the *NexGen* Rotating Hinge Knee or the Segmental Knee.

Clip

Use the *NexGen* Rotating Hinge Knee Articular Surface Provisionals from the *NexGen* Rotating Hinge Knee Articular Surface Provisional Instrument Set (Kit # 00-5979-004-00) and insert the appropriate size provisional. The size of the articular surface provisional must match the size of the femoral provisional, and the size of the tibial provisional must be compatible with the size on the femoral provisional. Refer to the sizing chart (Fig. 27).

> Interchangeability Chart 2 Segmental Knee System (using RH Knee femoral and tibial components)

		RH Knee Femoral Size				
		В	С	D	E	F
	1	B/123456	C/123456	D/123456		
2	2	B/123456	C/123456	D/123456	E/23456	
RH Knee	3	B/123456	C/123456	D/123456	E/23456	F/3456
Size	4	B/123456	C/123456	D/123456	E/23456	F/3456
	5	B/123456	C/123456	D/123456	E/23456	F/3456
	6	B/123456	C/123456	D/123456	E/23456	F/3456



Fig. 27 Interchangeability Chart

Flex the knee through the full range of motion to evaluate soft tissue tension and knee stability. A thicker articular surface provisional should be used if necessary to correctly balance the knee.

Note: The Rotating Hinge Knee is a linked design that will force the tibia to be in alignment directly under the femur (on the mechanical axis) by virtue of the hinge post that links the femoral and tibial components. When assessing hyperextension during trial reduction, use only the one-piece Segmental Rotating Hinge Knee Hinge Post Provisionals, which do not have gold color on their superior ends, with the *NexGen* Rotating Hinge Knee Femoral Provisional Cutting Guide. This is important because these hinge post provisionals incorporate the thickness of the *NexGen* Polyethylene Insert with Cement Shield into the design. Using a one-piece hinge post provisional with a gold color on its end will not provide an accurate assessment of hyperextension during trial reduction. Select the appropriate Segmental Rotating Hinge Knee Hinge Post Provisional, and insert it through the post hole in the tibial provisional assembly. Then insert the proximal end of the hinge post provisional into the box provisional so the hole aligns with the medial hole in the box provisional. Insert the Segmental Rotating Hinge Knee Hinge Pin Aligner through the access hole drilled on the medial side of the femur, and through the holes in the insert provisional and hinge post provisional. If, after inserting the hinge post provisional into the tibial provisional assembly, the proximal end will not line up with the box provisional, it will be necessary to reposition the tibia under the femur. Assembly is facilitated if the knee is at approximately 90° of flexion, and the tibia is free to be moved mediolaterally to be centered under the femur. Movement of the knee from 90° of flexion to full extension may also facilitate assembly of the components. Use of leg-holders during the assembly process is not recommended.

Note: The provisional hinge post used for trial reduction is available in only one length, which may be shorter than the final hinge post implanted. The main purpose of the provisional hinge post is to bring the tibia into alignment with the mechanical axis directly under the femur. The Segmental Rotating **Hinge Knee Hinge Post Provisional** plays a similar role; however, its length also accounts for the thickness of the Segmental Articular Surface and provides an additional 40mm of jump height to resist subluxation. Do not proceed with back-table assembly if there is concern over distracting the joint beyond that used in trial reduction.

Perform any necessary soft tissue releases.

Patellar Tracking

Evaluate the tracking of the Patellar Provisional against the Femoral Provisional/Cutting Guide.

The patella must track centrally. Simulate closure of the capsule with either a single suture or by attaching a towel clip. If additional pressure is needed to hold the patella reduced, or if the patella tends to sublux or tilt laterally, perform a lateral retinacular release by a preferred technique. Be careful not to create any defect in the skin. Extend the release until the patella tracks satisfactorily. If a lateral retinacular release fails to correct patellar tracking, re-assess the rotation of the femoral and tibial components. Also check the orientation of the tibial tubercle.

Remove all provisional components.

Step Three

Assemble and **Insert Implants**

Preparation of the Femoral Component

The following sequence can be followed exactly in preparation for the in vivo assembly technique used in Step 4. Back-table assembly notes have been added where applicable. Check all component sizes to ensure that the distal femoral, articular surface, and hinge post components match (Fig. 27). Check that the size selected for the tibial component is compatible with the size of the distal femoral component.

The modular hinge post assembly that is pre-attached to and packaged with the Rotating Hinge Knee Femoral Component must be removed. Use the Hinge Pin Polyethylene Plug Removal Tool to remove the hinge pin plug. Then use the 4.5mm Hex Driver and LCCK Torque Wrench (black handle) to remove the hinge pin. When the hinge pin is removed, the hinge post and polyethylene insert can be removed and discarded. Next, re-insert the hinge pin and manually tighten. This will protect the thread in the femoral component during the cementing process.

Distractive Assembly Note: It will not be necessary to re-insert the original hinge pin (from the modular hinge post assembly) back into the femoral component because cementing will occur after the final hinge pin (from the NexGen Rotating Hinge Knee Cement Shield Service Kit) has already been assembled to the implant.

Cementing the Implants

If implanting a NexGen Stem Extension, refer to Appendix F in the Zimmer NexGen Rotating Hinge Knee Primary/Revision Surgical Technique (97-5880-002-00). Assemble the femoral and tibial components as indicated in the Zimmer NexGen Rotating Hinge Knee Primary/ Revision Surgical Technique (97-5880-002-00), pages 67-68. Insert the tibial base plate component first, and then implant the femoral component. If using the back-table assembly technique, implant only the tibial base plate component. Do not yet attach the posterior femoral augments and distal femoral augments on the medial side. Ensure that the medial side remains clear (Fig. 28) when applying cement and impacting the component. If needed, medial augments must be cemented in place after implanting the femoral component and assembling the hinge post mechanism as described in "Step Four – Assemble Segmental Hinge Post." After the cement has cured, use the 4.5mm Hex Driver through the medial access hole to remove the hinge pin. Then discard the hinge pin. A fresh pin is included in the NexGen Rotating Hinge Knee Cement Shield Service Kit described in Step 4.



Fig. 28 Medial side of implant during cementing

The articular surface provisional may be inserted and the knee placed in extension while the cement is setting to maintain compression on the components. Be careful to protect the articular surface from cement when implanting the distal femoral components.

Step Four Assemble Segmental Hinge Post

Before attaching the Segmental Hinge Post, verify that the appropriate size *NexGen* Rotating Hinge Knee Cement Shield Service Kit (Fig. 29) is used. At least two *NexGen* Rotating Hinge Knee Cement Shield Hinge Servicing Kits must be available in the operating room in case a component is dropped or otherwise rendered non-sterile. This kit is not the same as the *NexGen* Rotating Hinge Knee Hinge Servicing Kit or the Segmental Knee Hinge Servicing Kit.

Warning: Do not use the Segmental Polyethylene Insert with the *NexGen* Rotating Hinge Knee Distal Femoral Component. Only the items shown in Fig. 29 are to be used with the Segmental Hinge Post when it is being implanted with a *NexGen* Rotating Hinge Knee Distal Femoral Component. Also verify the appropriate size Segmental Articular Surface. It should be the same size as that used in the trial reduction. Check the compatibility of the tibial articular surface with the femoral and tibial base plate components (Fig. 27) before opening the implants.

Use only the Segmental Hinge Post packaged with the Segmental Articular Surface. Its length accounts for the thickness of the Segmental Articular Surface and includes an additional 40mm of jump height to resist subluxation. In addition, there is a Hinge Pin Bushing pre-assembled to the hinge post that prevents the polyethylene insert from being assembled backwards. This bushing should never be replaced with one from the modular *NexGen* Rotating Hinge Knee Hinge Post. Attach the proper size Rotating Hinge Knee Polyethylene Insert with Shield to the Segmental Hinge Post by spreading out the sides of the insert slightly and pressing it over the hinge post so the holes in the insert engage the bosses of the Segmental Hinge Pin Bushing. The holes in the polyethylene insert must match the bosses on the hinge pin bushing to ensure proper orientation (Fig. 30).



Correct Fit

Incorrect Fit

Fig. 30 Detail of Hinge Post Fit with *NexGen* Polyethylene Insert with cement shield

Note: If the polyethylene insert with shield is assembled backwards onto the hinge post, the insert will not sit flush against the lateral side of the hinge post due to a "no-fit" condition with the hinge pin bushing. This will cause the hinge post/polyethylene insert assembly to not fit without interference within the intercondylar notch of the NexGen Rotating Hinge **Knee Distal Femoral Component upon** assembly. Therefore, if the hinge post/ polyethylene insert assembly does not fit easily within the intercondylar notch, pull the assembly out, spread the sides of the polyethylene insert to remove it from the hinge post, reverse the polyethylene insert orientation, and reattach it. The polyethylene insert should then be flush against the lateral sides of the hinge post.



Fig. 29 NexGen Rotating Hinge Knee Cement Shield Hinge Servicing Kit

In vivo Assembly Technique

For *in vivo* assembly, the hinge post is attached to the femoral component after the femoral component, Segmental Articular Surface and the tibial component have been implanted. The cylindrical portion of the hinge post is first inserted through the Segmental Articular Surface and into the implanted tibial component. Then the proximal portion of the hinge post is attached to the implanted femoral component.

Attach the new hinge pin from the *NexGen* Rotating Hinge Knee Cement Shield Servicing Kit to the 4.5mm Expandable Extractor (Fig. 31). Do not use the hinge pin that was in place during the cementing process. The 4.5mm Expandable Extractor can be used to hold the hinge pin during insertion. Do not use this instrument to torque the hinge pin after it is fully inserted.

Insert the proximal end of the hinge post/polyethylene insert assembly into the intercondylar notch of the distal femur. Anteroposterior rotation of the hinge post/polyethylene insert assembly, in addition to moving the knee from 90° of flexion into extension, may facilitate seating of the assembly into the intercondylar notch. Align the holes to accept the hinge pin by first confirming alignment visually through the medial access hole, then insert the Segmental/ Rotating Hinge Knee Hinge Pin Aligner through the hole. If desired, confirm that the aligner has engaged the hole on the opposite side of the intercondylar notch by pulling distally on the hinge post by hand.



Fig. 32 LCCK Torque Wrench

If medial augments are required, pack cement into the medial pockets of the distal femoral component, and onto the resected distal and posterior medial femoral condyle. Insert the medial augments from the side, and fill any gaps with additional cement.

Note: If femoral augments are being used on the medial side of the *NexGen* Rotating Hinge Knee Distal Femoral Component, the augments will need to be removed to remove the hinge pin in a future revision.

Fig. 31 Expandable Extractor

Hold the knee steady, and remove the Segmental Rotating Hinge Knee Hinge Pin Aligner. Then insert and thread the new hinge pin (attached to the 4.5mm Expandable Extractor) through the medial access hole into the aligned holes of the femoral component and hinge post. Make sure that the hinge pin passes through the hinge pin bushing of the hinge post. If desired, confirm that the hinge pin has engaged the hole on the opposite side of the intercondylar notch by pulling distally on the hinge post by hand. Use the LCCK Torque Wrench (black handle) and 4.5mm Hex Driver to torque the hinge pin to 95in-lbs (Fig. 32). Then cover the hex with bone wax through the medial access hole.

Back-table (distractive) Assembly Technique

In back-table assembly, the hinge post is attached to the femoral component on the back table before the femoral component is implanted. The distal femoral implant assembly (with hinge post) is inserted into the femoral medullary canal as a complete construct. Then, after sufficient distraction has been achieved across the joint space, the cylindrical portion of the hinge post is inserted through the articular surface and into the tibia.

Back-table assembly requires that the Segmental Hinge Post, Rotating Hinge Knee Polyethylene Insert with Shield, Rotating Hinge Knee Hinge Pin, and Rotating Hinge Knee Distal Femoral Components be assembled on a padded, sterile surface on the back table.

Place the distal femoral component on the padded surgical table. Insert the Segmental Hinge Post/Polyethylene Insert with Shield assembly into the distal femoral component. Align the holes in the components by inserting the Segmental/Rotating Hinge Knee Hinge Pin Aligner through the medial hole of the femoral component and through the hole in the hinge post assembly. Then remove the hinge pin aligner and insert the hinge pin. Confirm that the hinge pin has engaged the hole on the opposite side of the intercondylar notch visually or by pulling distally on the hinge post by hand. Use the LCCK Torque Wrench (black handle) and 4.5mm Hex Driver to torque the hinge pin to 95in-lbs. Then cover the hex with bone wax or press the Hinge Pin Plug from the NexGen Rotating Hinge Knee Cement Shield Hinge Servicing Kit into place with a finger-tip or blunt tool to protect the hex of the hinge pin during cementing.

Insert the proper size Segmental Articular Surface (packaged with the Segmental Hinge Post) onto the implanted *NexGen* Rotating Hinge Knee Tibial Component.

Apply cement to the fixation surfaces of the distal femoral component, and to the stem extension. Insert the stem extension into the medullary canal and begin to advance the femoral component toward the prepared distal femur. As the attached hinge post approaches the tibial component, distract the joint and simultaneously engage the cylindrical portion of the hinge post into the tibial component while continuing to advance the femoral construct until it is flush against the resected femoral bone (Fig. 33).

Note: Be careful to protect the articular surface from cement when implanting the distal femoral/hinge post assembly.



Fig. 33 Post Insertion Diagram

Zimmer Segmental System Proximal Tibia Replacement*

Note: For Proximal Tibia replacement, use the *MOST Options* Proximal Tibia and *MOST Options* Distal Femur and Hinge. See *MOST Options* technique (97-5010-002-00).

Zimmer Segmental System Variable Stiffness Stems

Zimmer Segmental System Proximal Femur Replacement*

Note: *MOST Options* Proximal Femurs may be used in conjunction with Segmental hinges and stems.

Total Femur Replacement

For total femur replacement, the *Zimmer* Segmental System is compatible with certain components of the *Zimmer MOST Options* System and the *Zimmer NexGen* Rotating Hinge Knee.

Implant Configuration

In the event that a total femur is required, the procedures for a proximal femur replacement and distal femur replacement are essentially combined. The suggested procedures are performed after a routine approach has been performed for opening and exposing the acetabulum, femur, and proximal tibia. It is critical that leg length be checked and noted before any bone resection. Care should be taken during the reconstruction to avoid stretch injury to the neurovascular structures.

Note: if needed please reference again the Segmental System scope compatibility chart on p.4 for system cross-compatibilities.

Determine the implant configuration based on the bone replacement requirements (Fig. 34).

MOST Options Proximal Femur	Distal Femur	Segments	Total Length*
		80mm	222mm
		90mm	232mm
		80 + 30mm	254mm
		80 + 35mm	259mm
		90 + 30mm	264mm
		90 + 35mm	269mm
		90 + 40mm	274mm
		90 + 45mm	279mm
		80 + 60mm	284mm
		90 + 60mm	294mm
		80 + 80mm	304mm
		90 + 80mm	314mm
		80 + 100mm	324mm
		90 + 100mm	334mm
		200mm	342mm
		90 + 120mm	354mm
80mm	Size B	80 + 140mm	364mm
0011111	58mm**	200 + 30mm	374mm
		200 + 35mm	379mm
		200 + 40mm	384mm
		200 + 45mm	389mm
		90 + 160mm	394mm
		200 + 60mm	404mm
		90 + 180mm	414mm
		200 + 80mm	424mm
		90 + 200mm	434mm
		200 + 100mm	444mm
		90 + 220mm	454mm
		200 + 120mm	464mm
		200 + 140mm	484mm
		200 + 160mm	504mm
		200 + 180mm	524mm
		200 + 200mm	544mm
		200 + 220mm	564mm

* Note the first segment is a male-male segment, and the second segment is female-female in the chart.
** Size C Segmental Distal Femur is 60mm. Resect an additional 2mm beyond the resection length listed in the table above for Size C.

Fig. 34 Total Femur with Segments Table

Proximal Femur

There are two proximal femur options available in the *MOST Options* System; the Basic Proximal Femur and the Proximal Femur with Tissue Attachments.

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.

If trochanteric bone can be salvaged, use of the Proximal Femur with Tissue Attachments may be considered. For possible improved function of the abductors, attach them by the strongest possible means to the remaining lateral soft tissues, e.g., iliotibial band.

Optimal candidates for this method of fixation are those in whom a resection can be performed without sacrificing more than 1cm of native abductor tendon. Sacrifice of more than 1cm of abductor tendon may leave the abductor mechanism with insufficient tendon for fixation using the pronged washers in the *MOST Options* System.

Restriction of postoperative rehabilitation activity and/or bracing should be individualized for each case to prevent dislocation.

When a *MOST Options* System Femoral Component is used with a Segmental Femoral/Tibial Segment, anteversion adjustments can be made in 20-degree increments to enhance proximal joint stability using the anteversion adjustment features between the Segmental Distal Femoral Component and the Segmental Femoral/Tibial Segments.

Distal Femur

To replace the distal femur, refer to "Distal Femur Replacement Using the Segmental Distal Femoral Component" on page 5 of this surgical technique.

Proximal Tibia

To replace the proximal tibia, refer to pages 9-20 of the *Zimmer NexGen* Rotating Hinge Knee Primary/Revision Surgical Technique (97-5880-002-00).

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

Contact your Zimmer representative or visit us at www.zimmer.com





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