

LPS™ Limb Preservation System

Surgical Technique



Introduction

Significant bone loss requiring extensive reconstruction around the hip and knee is often required following the treatment of malignant bone tumors, aggressive benign bone tumors, infection, multiple revised and failed joint replacements and massive trauma, particularly in the elderly osteoporotic patient. Limb-preserving techniques, using modular segmental endoprostheses, are developed to provide a reliable, functional reconstruction for these patients.

Due to unpredictable and difficult conditions encountered with the remaining bone, muscle and soft tissues, the prosthetic construct must perform under severe conditions. DePuy Synthes Joint Reconstruction Revision Solutions offers both surgeons and patients a comprehensive portfolio of products for managing the many challenges of total joint arthroplasty. The DePuy Synthes Joint Reconstruction LPS™ Limb Preservation System is designed with these considerations in mind to allow for versatility and predictability in such difficult reconstructions.

Other limb-preserving techniques include allograft-prosthetic composites, osteoarticular allografts, intercalary allograft, resection arthrodeses, rotationplasties or resection arthroplasties. Each technique has its specific indications, advantages and disadvantages, and must be chosen based on the individual patient's functional and psychological needs and the surgeon's prior experience and training.

Table of Contents

Proximal Femur Replacement	4
Total Femur Replacement	18
Distal Femur Replacement with LPS Stem	26
Distal Femur Replacement with Metaphyseal Sleeve	40
Proximal Tibia Replacement	50
Mid-Shaft Femur Replacement	62
Appendix 1: Technique to Disassemble Implant Tapers	72

Indications

The DePuy LPS is intended for use in replacement of the mid-shaft portion of the femur, proximal, distal and/or total femur, and proximal tibia, especially in cases that require extensive resection and replacement. Specific diagnostic indications for use include:

- Malignant tumors (e.g., osteosarcomas, chondrosarcomas, giant cell tumors, bone tumors) requiring extensive resection and replacement;
- Patient conditions of noninflammatory degenerative joint disease (NIDJD), e.g. avascular necrosis, osteoarthritis, and inflammatory joint disease (IJD), e.g. rheumatoid arthritis, requiring extensive resection and replacement;
- Revision cases for a failed previous prosthesis requiring extensive resection and replacement;
- Severe trauma requiring extensive resection and replacement.

The LPS is also intended for use in bone loss post-infection, where the surgeon has elected to excise the bone and replacement is required.

The S-ROM tibial tray and the non-porous coated straight and bowed stems are intended for cemented use only.

The porous-coated metaphyseal sleeves are intended for either cemented or cementless applications.

Contraindications

1. Active local or systemic infection.
2. Loss of bone or musculature, osteoporosis, neuromuscular compromise or vascular deficiency in the affected limb in sufficient degree to render the procedure unjustifiable (e.g., absence of musculoligamentous supporting structures, joint neuropathy).

NOTE: Diabetes, at present, has not been established as a contraindication. However, because of the increased risk for complications such as infection, slow wound-healing, etc., the physician should carefully consider the advisability of knee replacement in the severely diabetic patient.

Pre-operative Planning

Reconstruction of the proximal femur due to significant bone loss or trauma can be performed utilizing the LPS System. The following technique reviews the intended design and use of the instruments and implants for this procedure and provides a general framework. Surgeons should utilize techniques that best meet the individual needs of each patient. Consider the following recommendations:

- Perform pre-operative planning and radiographic analysis for every case. Use the LPS System Templates (Cat. No. 2987-99-000) in pre-operative planning to assess the approximate resection level; position the proximal femoral body replacement and segmental component(s) (if needed) to restore leg length and offset; and determine the femoral stem extension diameter and length that could be used to provide adequate fixation and stability in the remaining host femoral diaphyseal bone. Although leg length restoration is ideal, in cases where soft-tissues are resected for oncologic purposes, extremity shortening may be necessary to allow for soft tissue closure around the prosthesis.
- Evaluate the acetabulum to decide if acetabular reconstruction should be made based on the disease process, the degree of bone loss and the necessity of either an intra- or extra-articular resection margin in oncological resections.



Proximal Femur Replacement

Exposure and Intra-operative Planning

Perform the surgical approach so that every attempt is made to preserve as much of the abductor mechanism and iliotibial band as possible while achieving a wide resection of the tumor and the biopsy tract in oncology cases. Secure closure of these structures at the end of the procedure is necessary to provide stability and improve function. First complete acetabular preparation when required, followed by femoral preparation. Consider using a constrained liner if necessary (if abductors are deficient).

There are many methods to determine the resection length. The following is one method. Mark points of reference and measure between the pelvis and an area distal to the appropriate resection level as determined in pre-operative planning. After proximal femur and acetabulum exposure, mark a horizontal line on the femur 1 cm below the proposed resection level to allow for any slight cut obliquity, blade thickness and subsequent femoral resection planing. Make all marks using an osteotome, electrocautery, marking pen or methylene blue. An option is to place a Steinmann pin in the ilium, superior to the acetabular midline. Measure the distance between the Steinmann pin and the horizontal line on the femur with the leg in a neutral position with no flexion and record it prior to any bone resection (Figure 1.1).

Another option is to use the actual trials and overlay them over the bone. Align the center of the host bone to the center of the head on the trial and then mark the level of resection on the bone at the distal end of the trial body (Figure 1.2).

Rotational alignment is critical to restoring proper anteversion and maintaining hip joint stability. It can be determined using several methods.

- Mark the anterior femoral cortex with a vertical line at a site distal to the resection line and perpendicular to the horizontal line previously created.
- The linea aspera on the femur's posterior aspect can act as a guide to the rotational orientation of the femur.

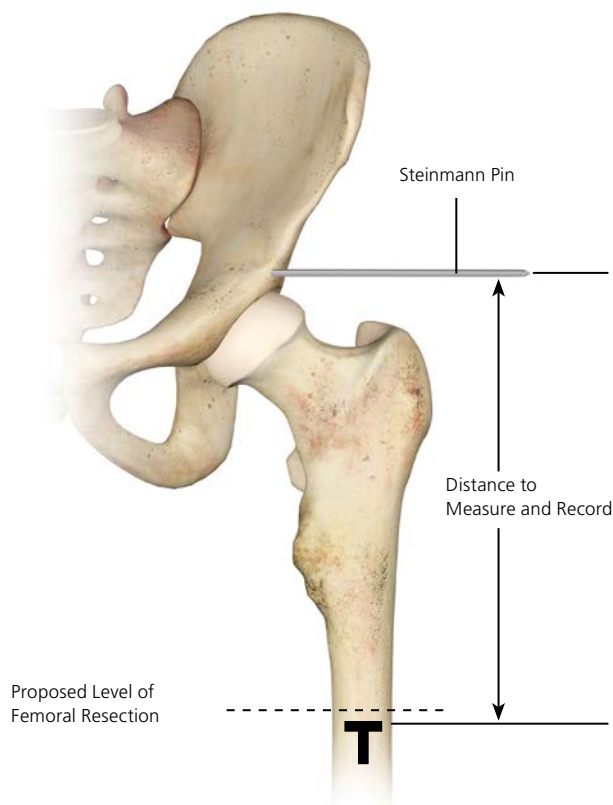


Figure 1.1



Figure 1.2

Another method at the beginning of the procedure involves performing a secondary leg length check to verify the medial malleoli position of the operative and non-operative legs and to ensure the same relationship following trial implant insertion. The resection level should be at a level where healthy native diaphyseal bone is available for stem insertion. If performing the reconstruction for primary bone sarcoma, review the pre-operative imaging studies, such as plain radiographs, CT scans and MRI of the femur to determine a safe resection level.

The minimum proximal femoral resection level is 90 mm from the center of the femoral head, using the +1.5 mm femoral head. This minimum resection level includes the 70 mm proximal femoral replacement body length plus the 20 mm stem component collar height (Figure 1.3).

If additional replacement length is needed, the 25 mm segmental component is the shortest segment available, making 115 mm the next resection level (Figure 1.4).

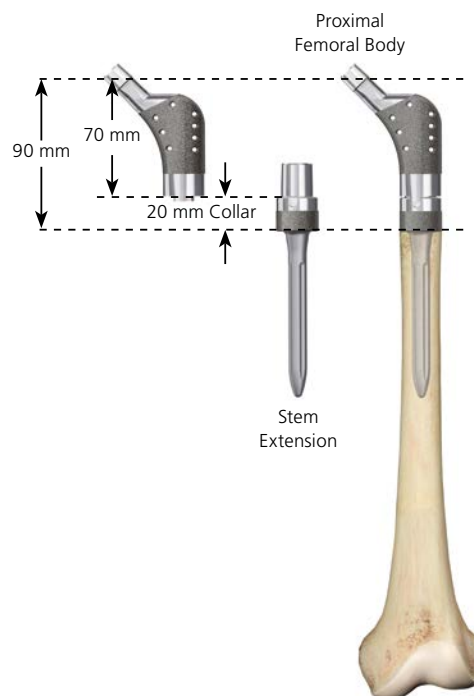


Figure 1.3

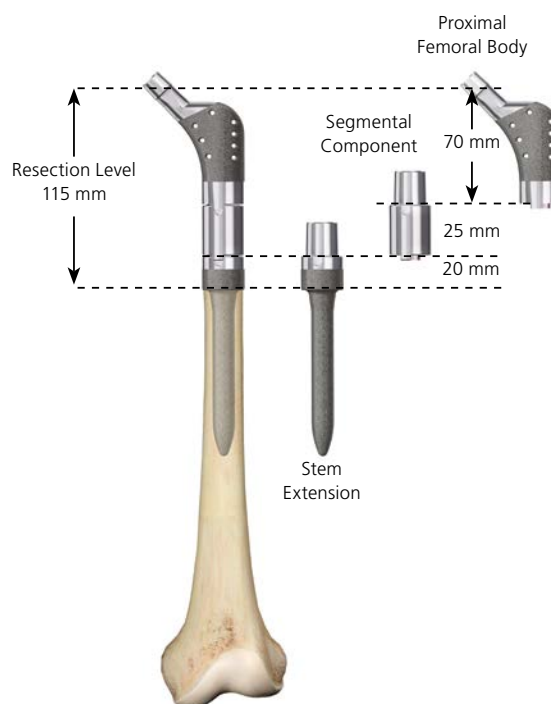


Figure 1.4

Segmental components are then available in 5 mm increments alone or in combination with other segmental components to adjust leg length (Figure 1.5).

The illustration and chart to the right demonstrate the segmental component lengths available, along with the combination capabilities to replace bone in 5 mm increments.

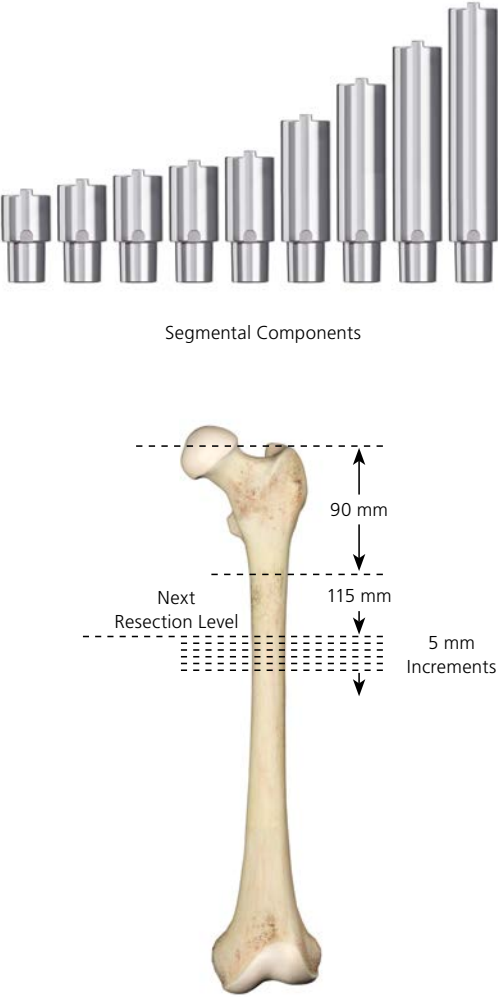


Figure 1.5

Cemented Stems (Straight)	
Remaining Gap (mm)	Segmental Components (mm)
25	25
30	30
35	35
40	40
45	45
50	25 + 25
55	25 + 30
60	25 + 35
65	65
70	25 + 45 or 30 + 40
75	30 + 45 or 35 + 40
80	35 + 45
85	85
90	25 + 65
95	30 + 65
100	35 + 65
105	105
110	25 + 85 or 45 + 65
115	30 + 85
120	35 + 85
125	125
130	25 + 105 or 45 + 85
135	30 + 105
140	35 + 105
145	40 + 105
150	25 + 125 or 45 + 105
155	30 + 125
160	35 + 125
165	40 + 125
170	45 + 125
175	125 + 25 + 25
180	125 + 25 + 30
190	125 + 65
195	125 + 25 + 45
200	125 + 35 + 40
205	125 + 35 + 45
210	125 + 85
215	125 + 25 + 65
220	125 + 30 + 65
225	125 + 35 + 65
230	125 + 105
235	125 + 25 + 85
240	125 + 30 + 85
245	125 + 35 + 85
250	125 + 40 + 85

Femoral Resection

Resect to healthy femoral diaphyseal bone and remove the entire proximal femur, particularly in oncology cases, so it can be measured and used later as a reference for building the trial construct (Figure 1.6). In non-oncological cases, consider leaving a sleeve of bone with the soft tissue deltoid attachments, which can be reattached with cables through the lateral aspect of the proximal body at the end of the procedure. When resecting the femur, two Bennett retractors can be placed circumferentially around the femur prior to making the osteotomy. This protects the neurovascular structures.

Femoral Medullary Canal Preparation

Following femoral resection, prepare the remaining femoral canal for the appropriate stem extension. Prior to reaming, consider placing a cable or cerclage wire around the femur to lessen the risk of fracturing the bone during the procedure. (When cutting the wire/cable, it may be helpful to leave a small portion of the wire as a "tail" to use it as a retractor during the case to elevate the femur). A flexible intramedullary (IM) reamer is recommended for the bowed stem extension and a straight IM reamer is recommended for the straight stem extension. AML™ Total Hip System Reamers are recommended for straight IM reamers, as they will prepare the bone with a line-to-line fit (e.g. a 9 mm AML Total Hip System Reamer has an actual diameter of 9 mm). To determine the appropriate reaming depth, hold the desired stem trial next to the reamer and note the corresponding depth mark (Figure 1.7).

Note: M.B.T. Revision Reamers are undersized 0.4 mm from their listed size. For example, a 9 mm M.B.T. Reamer has an actual diameter of 8.6 mm. This surgical technique assumes the use of AML Total Hip System Reamers. Therefore, when a 9 mm reamer is called out, it is assumed that the prepared canal will be exactly 9 mm in diameter.



Figure 1.6



Figure 1.7

Cemented Stem Application Options

If using a cemented stem, choose a smaller final stem than the last IM reamer used to allow for a circumferential cement mantle around the stem. For example, if a 15 mm IM reamer was the final reamer used, an 11 mm stem would provide a 2 mm cement mantle per side. Using a 12 mm stem would allow for a 1.5 mm cement mantle per side while a 13 mm stem would have a 1 mm cement mantle per side.

Note: Do not ream the femoral canal to cortical bone for a cemented application. Leave some cancellous bone for cement interdigitation.

Porous Stem Application Options

When using a porous stem, the reaming technique utilized will depend on a number of factors such as the patient age, bone quality, curvature of the remaining femur, etc. The following are general guidelines, as the surgeon will need to choose the technique based on individual patient needs.

When using a straight porous stem, under ream by 0.5 mm for press-fit application using a straight reamer. If the remaining bone is fragile, consider line-to-line reaming.

When using a bowed porous stem, under-reaming by 0.5 mm with a flexible reamer for press-fit application is a technique that can be considered. Line-to-line reaming may be indicated, if needed, to allow the implant to pass through the remaining femur's curvature or if the remaining bone is fragile (see Implant Insertion section on pages 14-17 for additional insight).

The LPS System Stem Extensions are available in 100 and 125 mm straight or 150 and 200 mm bowed lengths in cemented and porous-coated designs (see the chart on the right).

Note: Reference the LPS System Pocket Reference Guide, (Cat. No. 0612-35-050 Rev. 6), for complete ordering information.

Stem Extensions

Cemented Stems (Straight)
10 mm diameter x 100 mm length
11 mm diameter x 100 mm length
12 mm diameter x 100 mm length
12 mm diameter x 125 mm length
13 mm diameter x 125 mm length
14 mm diameter x 125 mm length
15 mm diameter x 125 mm length
16 mm diameter x 125 mm length
17 mm diameter x 125 mm length

Porous Stems (Straight)
11.5 mm diameter x 100 mm length
12.5 mm diameter x 100 mm length
13.5 mm diameter x 100 mm length
13.5 mm diameter x 125 mm length
14.5 mm diameter x 125 mm length
15.5 mm diameter x 125 mm length
16.5 mm diameter x 125 mm length
17.5 mm diameter x 125 mm length
18.5 mm diameter x 125 mm length

Cemented Stems (Bowed)
11 mm diameter x 150 mm length
12 mm diameter x 150 mm length
13 mm diameter x 150 mm length
14 mm diameter x 150 mm length
15 mm diameter x 150 mm length
16 mm diameter x 150 mm length
17 mm diameter x 150 mm length
11 mm diameter x 200 mm length
13 mm diameter x 200 mm length
15 mm diameter x 200 mm length
17 mm diameter x 200 mm length

Porous Stems (Bowed)
12.5 mm diameter x 150 mm length
13.5 mm diameter x 150 mm length
14.5 mm diameter x 150 mm length
15.5 mm diameter x 150 mm length
16.5 mm diameter x 150 mm length
17.5 mm diameter x 150 mm length
18.5 mm diameter x 150 mm length
12.5 mm diameter x 200 mm length
14.5 mm diameter x 200 mm length
16.5 mm diameter x 200 mm length
18.5 mm diameter x 200 mm length

Finish Preparation Using the Calcar Planer/Bevel Reamer

Once intramedullary reaming is completed, prepare the osteotomy surface to help assure the stem extension's proper fit. The calcar planer/bevel reamer is designed to produce an even, perpendicular surface and to cut an angled relief (bevel) in the bone to match the stem extension flare under the collar. This helps to assure complete femoral stem extension seating on the prepared diaphyseal bone surface (Figure 1.8). Use the calcar planer and insert a bevel reamer with a pilot that is at least 1 mm smaller than the last IM reamer used and position it in the femoral canal. Use the appropriate adapter to attach the assembled planer and bevel reamer with pilot to a power drill reamer. The calcar planer/bevel reamer should be under power prior to planing the resection cut. This will reduce any resected bone chipping caused by the calcar planer cutting blades. To prepare the remaining bone, sequentially use the calcar planer/bevel reamer according to the following recommendations for use of porous or cemented stems:

For a porous stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the intended stem extension size. (For example, if a 15.5 mm stem is the chosen implant, the final bevel reamer with a pilot will also be 15.5 mm).

For a cemented stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the final IM reamer size used. (For example, if the last IM reamer used was 15 mm, the 15 mm bevel reamer pilot will be the final bevel reamer used, irrespective of the stem size chosen, to allow for an adequate cement mantle).

Note: The shaft of the bevel reamer is undersized by 0.5 mm per side from the stated size.

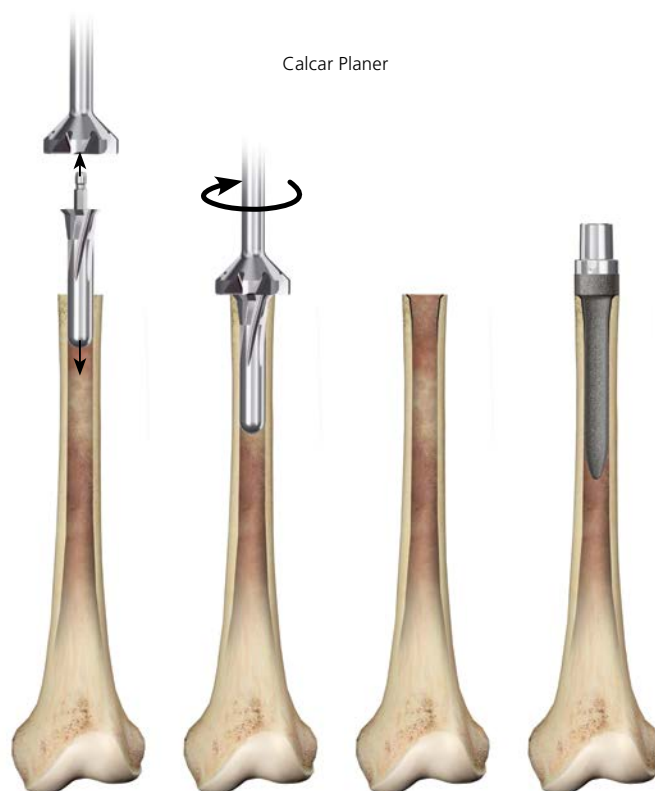


Figure 1.8

Trial Reduction

Following femoral preparation for the stem extension, perform a trial reduction. Assemble the appropriate proximal femoral body, segmental component(s) (if needed) and distal stem trial that would fill the missing bone gap based on previous estimates.

If the proximal femur is available in one piece, overlay the trial construct to assess the replacement for adequate support.

These estimate methods, as previously discussed, provide a multitude of cross checks when evaluating the amount of bone to be replaced. The trial components are designed to snap together and match the length of the implant components (Figure 1.9). The trial stem should closely match the last IM reamer or can be 1–2 mm smaller depending on the fit.

Utilize the properly sized stem trial to provide enough stability to prevent “spinning” when performing a trial reduction.

Note: Insert all trial constructs by hand and do not impact them into the canal.

The 150 and 200 mm trial stems are bowed and need to be inserted in proper orientation to match the femur’s anterior bow. Insert the trial construct into the remaining proximal femur and use it to assess fit, leg length, offset, joint stability, soft tissue tension and range of motion (Figure 1.10).



Figure 1.9

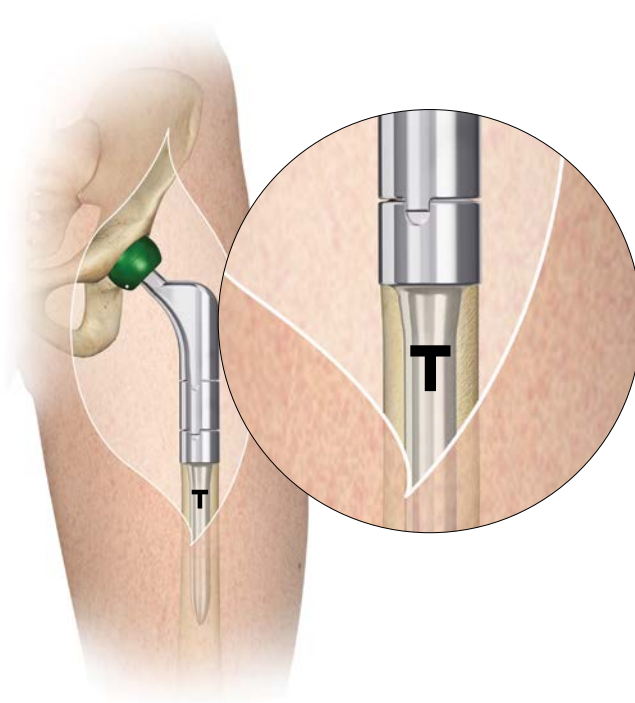


Figure 1.10

If the soft tissues are tight, the leg length is slightly long and the implant's offset is excessive, evaluate the use of a shorter femoral head trial. If the soft tissues are tight and the leg length is long, but the femoral offset is acceptable, try reducing the vertical height/leg length by adjusting the segmental trials.

If the segmental trials used are at the minimum length of 25 mm and the leg length is long, consider recutting the femoral osteotomy to adjust for the leg length discrepancy. If the femoral cut is revised, re-ream the femur distally and finish the prepared surface with the calcar planer/bevel reamer. If this is not done, the stem's distal end may encounter unreamed bone and an intra-operative fracture may occur. If the soft tissues are loose and the femoral offset is inadequate, try a longer femoral head trial.

Be aware that the ability to judge soft tissue tension is compromised when the abductor musculature attachment has not yet been reconstructed. One test for excessive soft tissue tension is to extend the hip and try flexing the knee. If the hip flexes when the knee flexes, the soft tissue tension may be excessive.

At this point, another way to intra-operatively check leg length estimate is to compare the medial malleoli. Use the trial construct to assess proper femoral anteversion. This is not difficult if a straight stem is used. In this case, use the neutral femoral body and rotate the entire construct within the femur to obtain the required femoral anteversion (usually 10–15 degrees).

Once proper anteversion orientation is established, use the anti-rotation slot (tab) on the trial as a reference to mark the femur (Figure 1.11). This final mark will serve as an alignment guide when inserting the implant. If a bowed stem is used, the surgeon has much less control over the stem's rotation within the femur. This situation is where the anteverted 15 degree proximal femoral body should be considered.

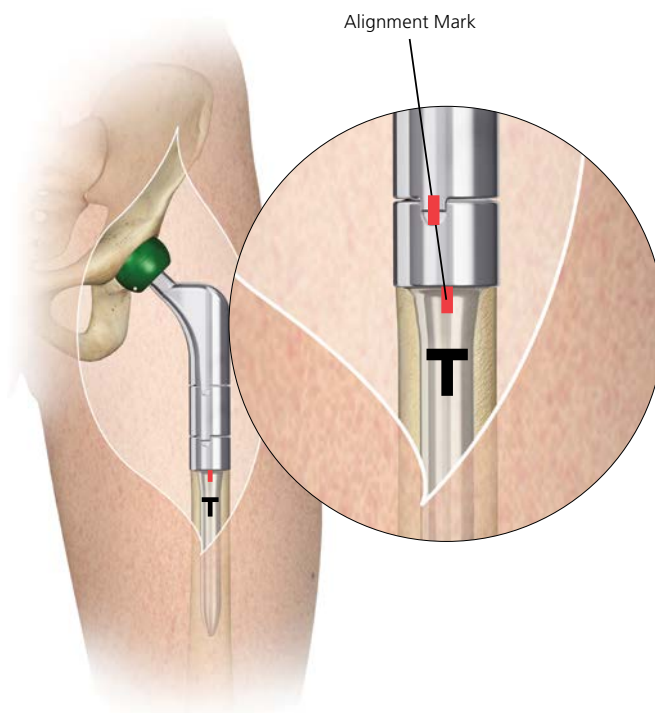


Figure 1.11

Implant Assembly

Once the trial segments have yielded a satisfactory result with the trial reduction, assemble the appropriate implant components using the femoral impaction stand. This helps to stabilize the implant components for assembly and impaction.

It is important to orient the implant components along the same axis as the trial components, particularly when using a bowed stem. The implant components use a Morse-taper design for locking. Assemble the components by hand and place the impaction cap over the stem component. Then impact them together using a mallet to securely seat the tapers together (Figure 1.12).

There should be approximately a 1 mm gap between component bodies.

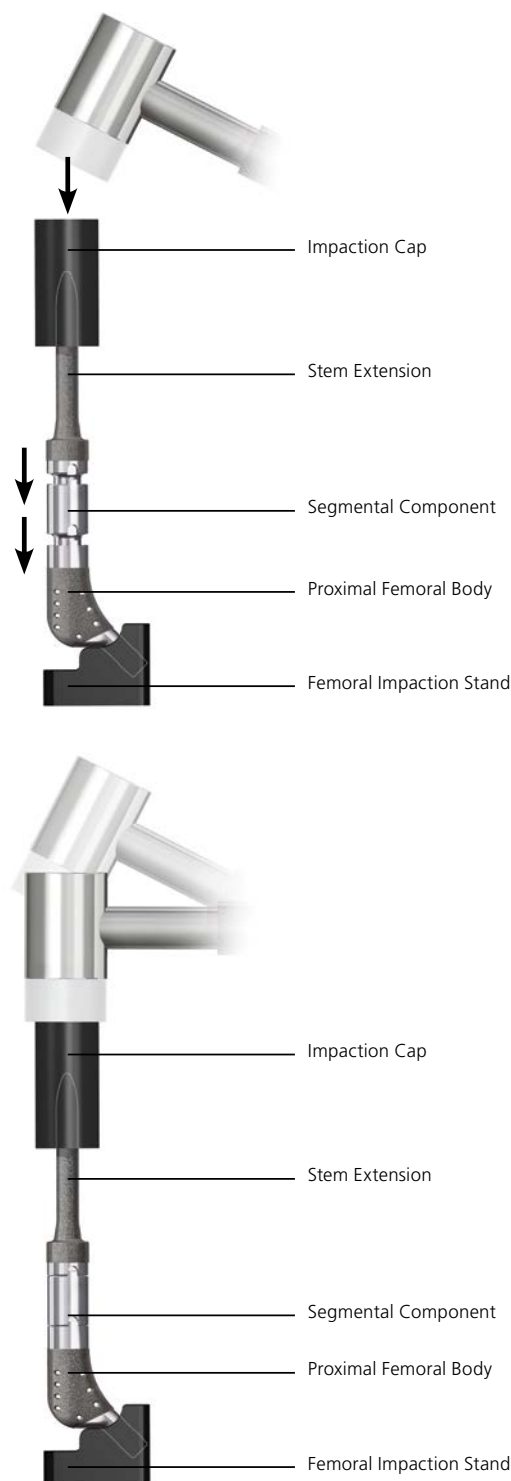


Figure 1.12

Implant Insertion

If using SMARTSET™ MV (Medium Viscosity) Bone Cement to affix the distal femoral stem extension to host bone, follow the manufacturer's recommended procedures to mix, deliver and pressurize the bone cement.

Note: Placement of a “prophylactic” cerclage wire around the proximal end of the remaining diaphysis may potentially decrease the risk of intra-operative fracture during press-fit insertion of the porous stem extension, particularly with fragile bone.

Use the inserter/extractor with the version guide and the implant construct to assist in the insertion of the implant into the femoral canal. Thread the inserter into the proximal femoral body and place the version guide around the neck of the implant (Figure 1.13).

Make certain that the inserter threads are completely seated and that no threads are showing before impacting the femoral component.

To determine the implant's proper orientation, use the alignment mark previously placed on the femur and the implant's anti-rotation slot (tab) (Figure 1.14).

Note: The 150 and 200 mm stems are bowed and the correct bow-to-femur orientation must be accomplished.

Place the stem by hand into the canal until it gets tight. Ideally, about 1 cm of implant should remain proud of the bone. You can then advance the construct with gentle mallet strikes to fully seat the component. It may take close to 100 gentle mallet strikes to fully seat the component. This is a good indication that the stem is initially well fixed. If more than 1 cm of the stem is proud of the bone, then consider reaming another 0.5 mm greater than the last reamer used and then advance the reamer further into the host bone to accommodate the amount of the implant that is more than 1 cm proud. Advance the reamer by hand until it sticks, presumably in the same place as the implant. Then ream far enough to accommodate for how far the stem is still proud. Take care to not overream. Ream a bit, place the implant back in place, then check and repeat as needed. If

the stem advances completely by hand, consider increasing the stem's diameter. If cement is used, remove any excess cement from around the implant collar during insertion and after final seating. If the stem's diameter increases, repeat the bony preparation steps involving the calcar planer and bevel reamer from page 10.

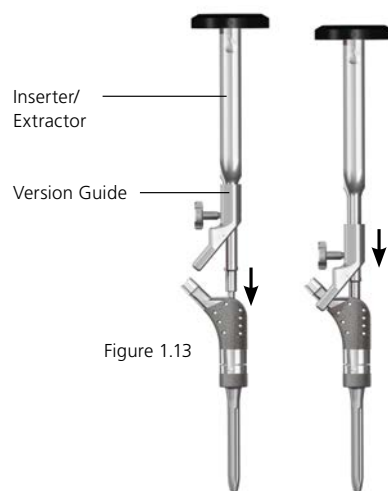


Figure 1.13

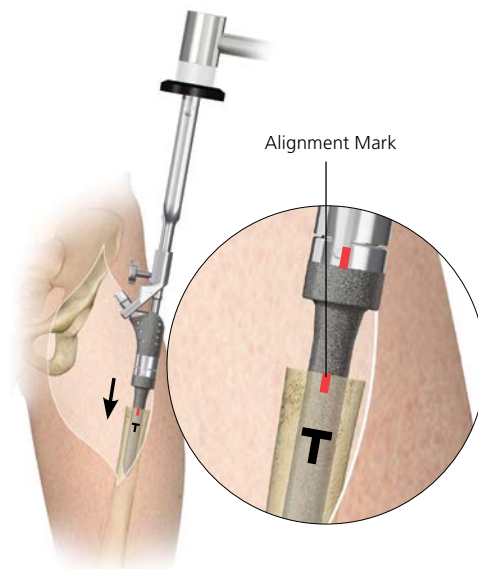


Figure 1.14

Proximal Femur Replacement

The stem extension shoulder should be flush to the femur's cut surface (Figure 1.15). Give meticulous attention to the stem position. Failure to align the stem in proper version may potentially result in instability.

When using a bowed porous stem, curvature of the remaining bone in comparison to the implant needs to be appraised especially for the impact of mismatch conditions. Under reaming by 0.5 mm with a flexible reamer is a technique that can be considered.

Insertional feel and non-advancement with component impaction should be an indication to remove the construct and try to pass the same flexible reamer another four to six times and evaluate the insertional feel again. If the construct still presents with non-advancement, line-to-line reaming should be considered. The construct should then be inserted into the medullary canal and attention to insertional feel and advancement assessed again.

Should the implant construct with a porous stem not advance and become lodged in the femoral canal, there are two methods for removal. First, try to remove the implant by using the mallet to strike the platform of the inserter to extract the construct. If this fails, disassemble the implant construct from the stem extension using the disassembly tool (see disassembly technique on page 72). The exposed porous stem extension taper is threaded. Remove the version guide from the inserter/extractor. Place the slap handle through the inserter/extractor. Completely thread the inserter/extractor into the porous stem thread until it is fully seated.

Use the slap handle to provide the extraction force to the lodged porous stem extension until it is removed from the femoral canal (Figure 1.16). An LPS System Extension Adapter (Cat. No. 2987-72-045) is also available for use with the slap hammer and rod from the Moreland Hip Revision Instrument Set (Cat. No. 2420-30-000) when additional force is required. Evaluate the need to re-ream the canal. Reassemble the components making sure the tapers are clean and dry before assembly. Reinsert the implant construct.

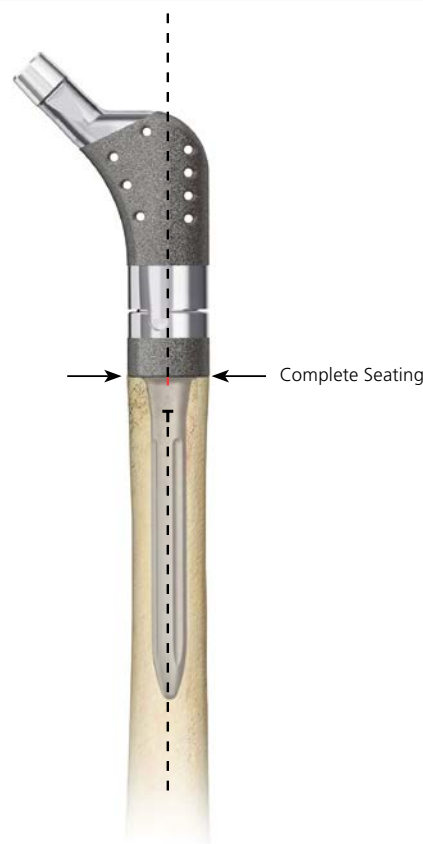


Figure 1.15



Figure 1.16

Perform a final trial reduction with the implant to fine tune soft tissue balancing. Make alterations using either longer or shorter trial femoral heads as needed. Check leg length restoration against the initial recorded measurement (Figure 1.17).

Closure

Soft tissue reconstruction is one of the most important aspects of this procedure. Restoration of the abductor musculature attachment is important for post-operative hip stability and gait. The proximal femoral replacement segment holes allow for soft tissue reattachment using sutures or MERSILENE® Polyester Fiber Suture (Figure 1.18) but the long-term stability of soft tissues using this method is uncertain. Another method is to use the suture holes to assist in securing a tenodesis between the abductor tendons and the adjacent iliotibial band.

Use the proximal femoral body replacement component to reattach the greater trochanter, when present (Figure 1.18). This feature works by utilizing the reattachment holes provided in the proximal femoral body component. Attach the greater trochanter and abductors with either heavy sutures or MERSILENE Suture.

If the abductors are extensively shortened, use the proximal femoral replacement body with trochanteric build-up for reattachment (Figure 1.19).

Note: If the trochanteric build-up is used in a situation with a "normal" length abductor, it could potentially cause bursitis. Only use the trochanteric build-up if the abductor length is shortened and requires the use of the trochanteric build-up.

Abductor function is enhanced if at the time of initial resection the abductors and vastus lateralis are taken together in one layer and the abductors are not detached. Do this whenever possible from the oncological point of view. This is very similar to the trochanteric slide or vastus slide approaches used in revision total hip arthroplasty.

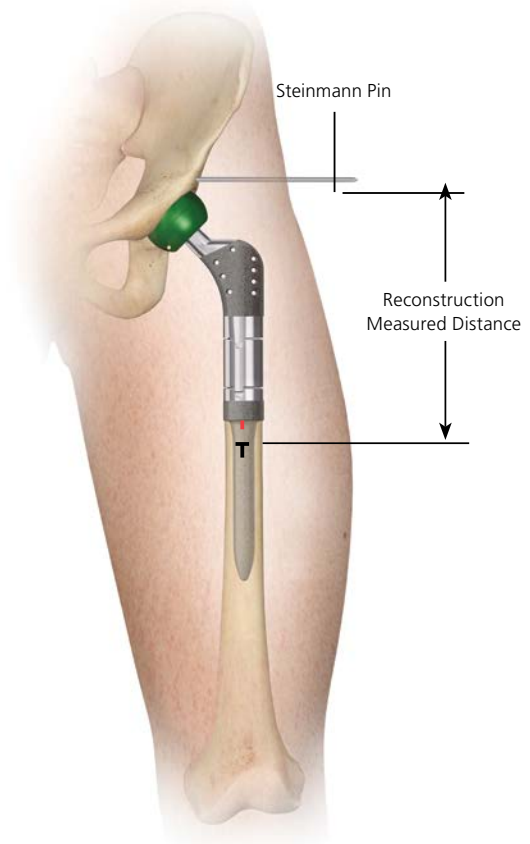


Figure 1.17

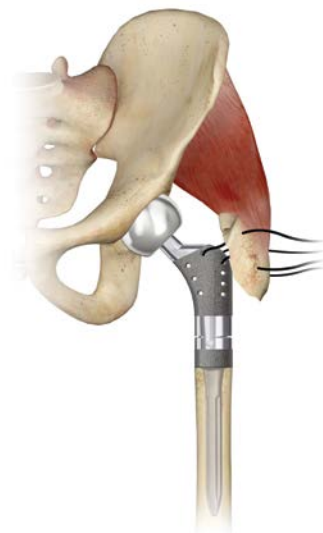


Figure 1.18

Place the selected femoral head implant onto the implant neck taper and then impact it with a head impactor and mallet using a sharp blow. Use the acetabular component (i.e., bipolar cup, fixed cup, cage, etc.) based on the specific patient's needs.

Complete the operation with a multi-layer soft tissue closure over drains. Meticulous closure is important to reduce the possibility of post-operative hematoma formation, which is possible with a large dissection. Use the standard closure over drains and soft tissue reattachment procedures.

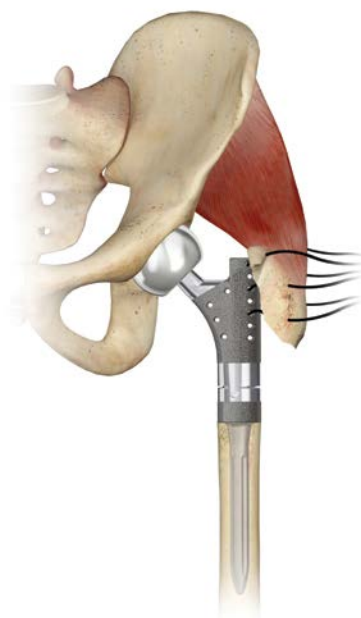


Figure 1.19

Total Femur Replacement

Pre-operative Planning

The LPS System can be used to replace the entire femur. The following technique reviews the intended design and use of the instruments and implants for this procedure and provides a general framework. Utilize techniques that best meet the needs of each case, since each is unique and has specific challenges. Consider the following recommendations:

- Using pre-operative templating, use the full lower extremity radiographs to help determine the length of femur to be replaced by the prosthesis and if there are any special needs in reconstructing the acetabulum and proximal tibia.
- The minimum total femoral construct when using the X-small distal femoral component is 185 mm, which includes the proximal femoral body (70 mm), total segmental (55 mm) and distal femoral (60 mm) components (Figure 2.1). The minimum total femoral construct when using the XX-small distal femoral component is 175 mm, which includes the proximal femoral body (70 mm), total segmental component (55 mm) and distal femoral (50 mm) component (Figure 2.2). Use additional segmental components to replace missing femoral bone.

Refer to the chart on page 7 for information on which segmental components to use for varying lengths of missing bone.

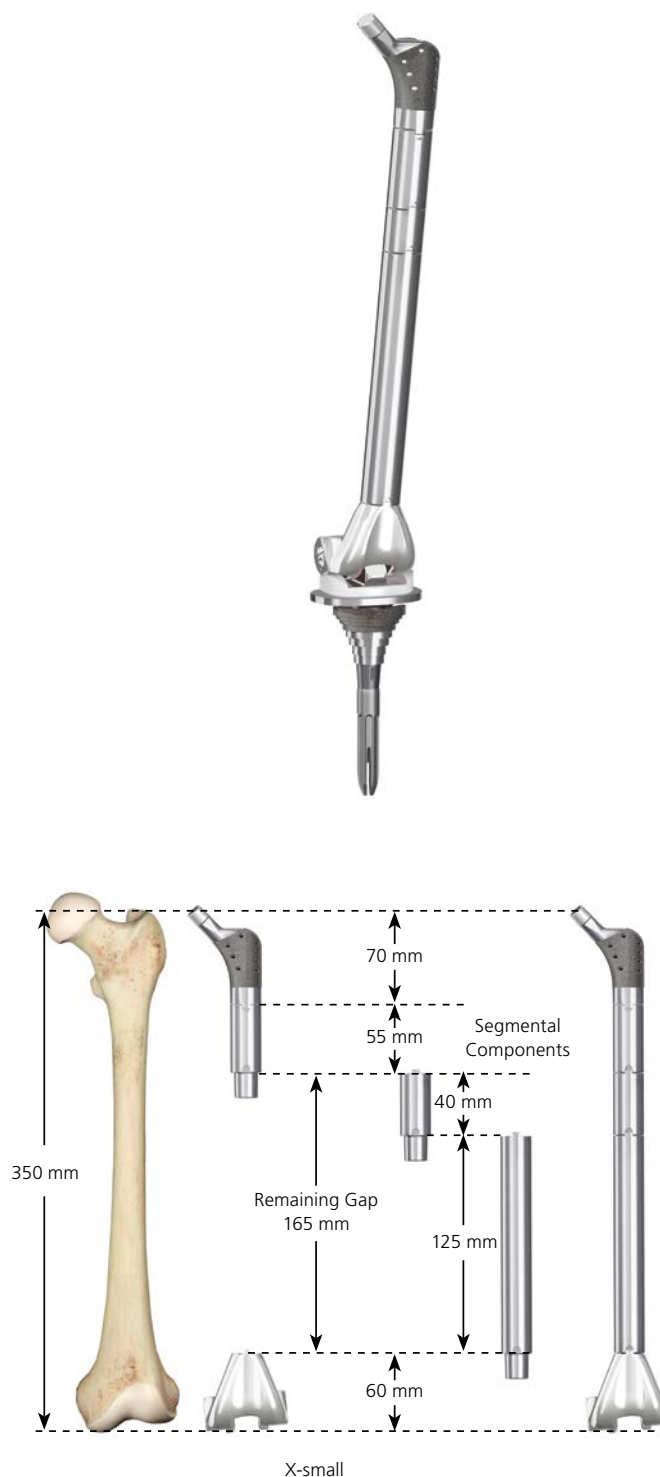


Figure 2.1

Exposure and Intra-operative Planning

Use the surgical approach based upon the surgeon's pre-operative plan and exposure preference. During the reconstruction, take care to avoid stretch injury to the neurovascular structures in this extensive procedure. Perform the acetabular reconstruction as required. If using a fixed acetabular component, consider using the PINNACLE® Revision Acetabular Cup System Standard or Deep Profile Revision Cups with GRIPTION™ Coating which are designed to allow for rim screws and/or domed screws. This will allow for additional fixation. Also consider using a large femoral head (>32 mm), a constrained liner or a tripolar construct for stability.

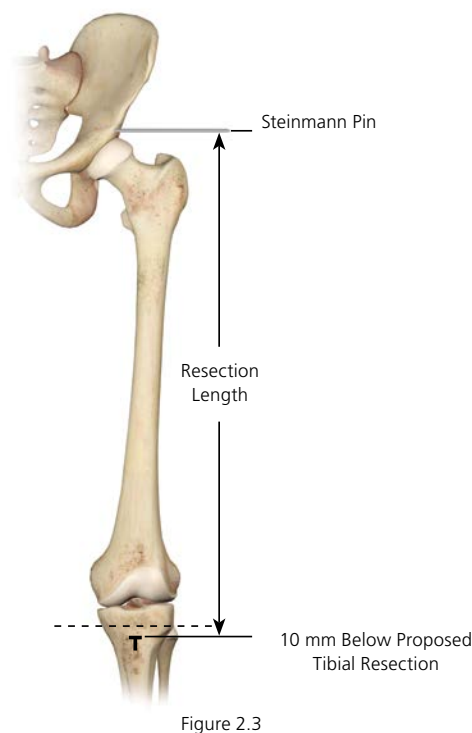
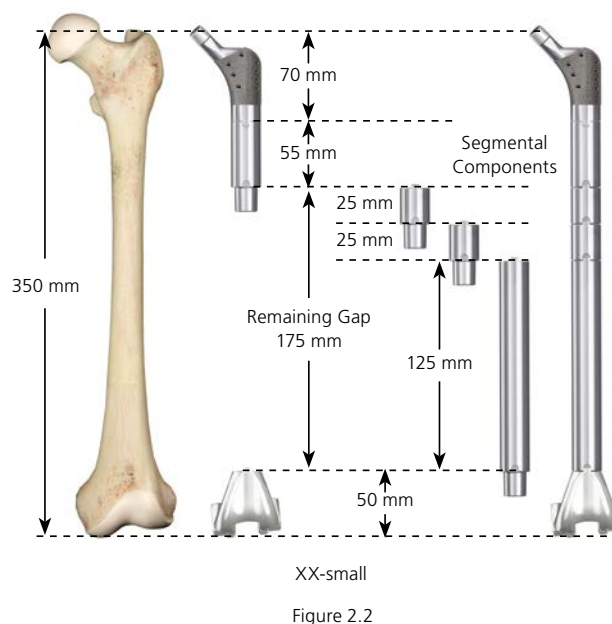
Leg length estimate is important for a successful surgical outcome. An example of one estimate method utilizes a horizontal line made 1 cm below the proposed tibial resection level using an osteotome, electrocautery, marking pen or methylene blue.

Another estimate method is to get an X-ray of the contralateral leg, measure the length with a ruler, and then match the length of the operated leg to that estimate.

This is a constrained system so the goal is to recreate the leg with the knee's joint line in the proper position. Establish the proper joint line for the knee, match the leg length to the contralateral leg, and use constraint at the hip so you don't overlengthen the patient. To determine joint line in the knee, use the patella to make sure you don't end up with a patella baja or alta.

Place a Steinmann pin in the ilium, superior to the acetabulum midline. Extend the limb and measure the distance between the pin and marked horizontal line on the tibia and record the length prior to any resection (Figures 2.2 and 2.3). It is important to measure the knee in full extension. Avoid estimate with the knee in flexion for consistency of measurement results. Remove the Steinmann pin and mark the hole with an electrocautery or marking pen so the Steinmann pin location can be found and reinserted later during the trial reduction process.

Excise the femur according to standard oncologic principles for a neoplasm or as dictated by the underlying pathology, such as post infection, end-stage revision arthroplasty, etc.



Tibial Preparation

Prepare the proximal tibia as described in the SIGMA® Knee Revision and M.B.T. Revision Tray Surgical Technique (Cat. No. 0612-51-506 Rev. 5).

When using the M.B.T. Revision Tibial Tray, only use the LPS Universal Tibial Hinge Insert Bearing. Use only the LPS Universal Tibial Hinge Insert Bearing sizes that match the size of the distal femoral replacement component being used.

Resurface the patella using the SIGMA Knee dome patella component.

Trial Reduction

Assemble the total femoral trial components for an initial trial reduction to check for the correct approximation of the femoral replacement. The trial construct consists of a proximal femoral body, total femoral segmental, segmental and distal femoral replacement trial components (Figure 2.4).

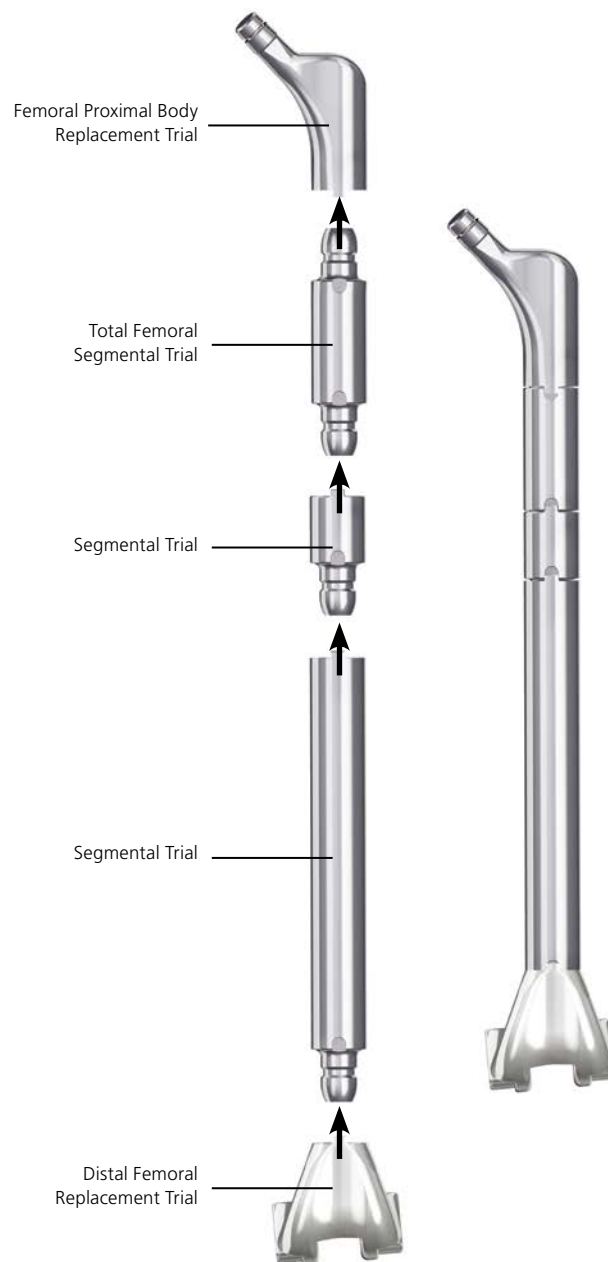


Figure 2.4

Perform trial reduction after assembling the femoral trial and tibial trial components (Figure 2.5).

The trial hinge pin may be inserted either medially or laterally. It may be easier to insert the hinge pin through the insert trial first and then place the insert trial into the tibial tray trial. Use the proximal femoral body trial with 15 degree built-in anteversion to evaluate the proper total femur replacement version.

Insert the Steinmann pin into the previously drilled hole in the ilium. Check the femur's length against the estimate recorded prior to the resection, using whatever method previously selected. Make femoral length changes by changing the segmental trial lengths, which offer 5 mm increment capability. Compare the knee joint line to the opposite side for proper height. Alternatively, the medial malleoli may be compared on each leg to evaluate leg length.

The joint line is determined by the level of the distal surface of the distal femoral component. Take the knee through a range of motion from extension to flexion and take note of patella tracking. Adjust the segmental components accordingly to ensure proper patellar tracking. Assess proper anteversion (Figure 2.6) and stability.

Make fine adjustments to leg length using the range of different femoral head lengths. Use varying tibial insert polyethylene heights to provide joint stability and to adjust leg length.



Figure 2.5

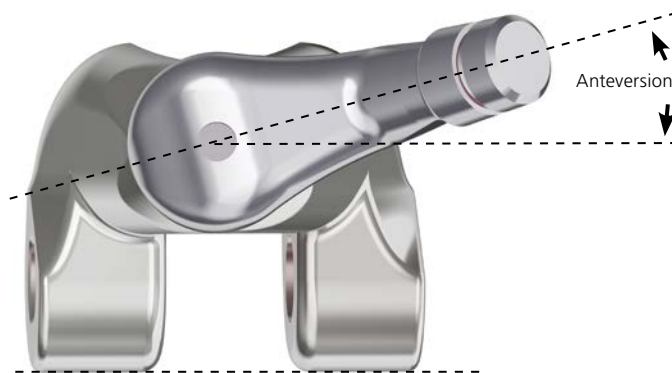


Figure 2.6

Implant Assembly

After trial reduction, assemble the implants using the femoral impaction stand on the back table. The implant component alignment should duplicate the trial component's orientation so that femoral anteversion and proper femoral/tibial construct alignment is correct. Place the distal femoral replacement component on the femoral impaction stand.

Stack the component tapers to assemble the total femoral and segmental components and the proximal femoral body replacement component. Use the impaction cap to impact on the proximal femoral replacement body to impact the tapers together (Figure 2.7). There should be approximately a 1 mm gap between the component bodies.

Implant Insertion

If using SMARTSET MV Bone Cement, mix and deliver according to the manufacturer's recommendation. Impact and hold the cemented tibial tray component until the cement is cured.

Place the total femur implant construct into the remaining femoral soft tissue envelope. Reduce the femoral replacement into the chosen acetabular and tibial components. Trial femoral heads and trial tibial inserts can be evaluated to make assessments in choosing final implant sizes.

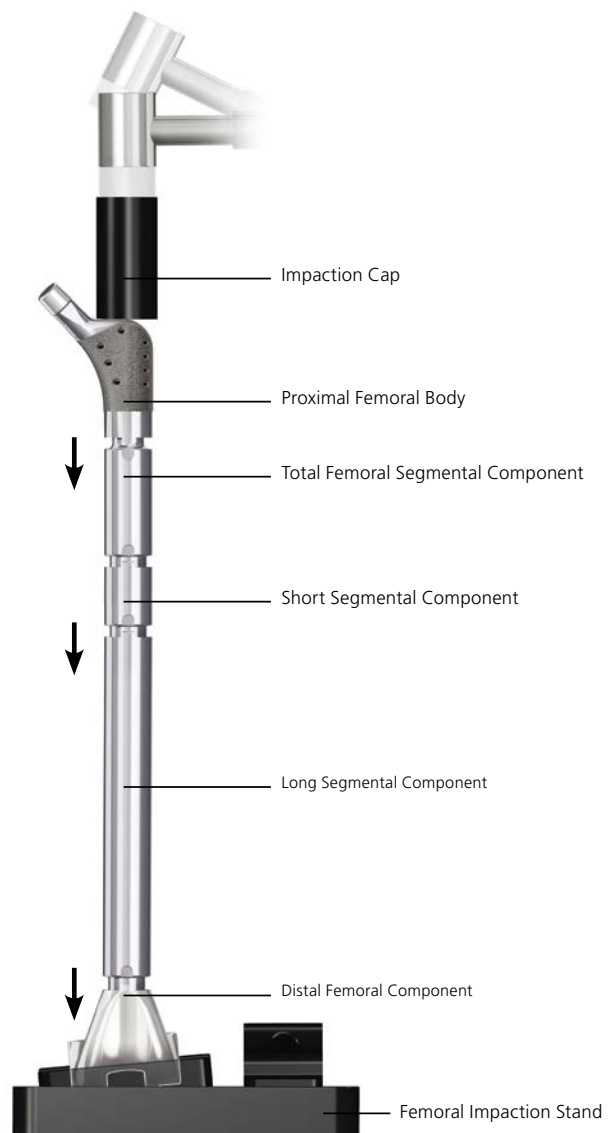


Figure 2.7

Total Femur Replacement

Once the final trial reduction is accomplished, connect the total femoral construct to the LPS Hinged Tibial Insert Bearing using the hinge pin, which is passed through the distal femoral replacement component and the bushings of the hinged tibial insert bearing (Figure 2.8).

Note: The hinge pin can be inserted from either the medial or lateral side.

One method that can be used to secure the hinge pin uses manual pressure to push the hinge pin through until it “clicks” and locks into place.

Another method uses a rongeur or a pair of pliers to squeeze the hinge pin while pushing the pin until it is completely seated in the square cut-out in the distal femoral component. Pressure is released from the rongeur or pliers. Once the pin is securely locked, push the hinge pin from the opposite side of insertion and confirm that it is captured and locked.

Note: It may be easier to insert the hinge pin into the insert first and then place the insert into the tibial tray.

Take care that the foot is in the proper plane when running the leg through its range of motion (because it is a rotating platform implant). Place the patella in its anatomic position first then run the leg through its range of motion. Make sure that the tibia does not become externally rotated during this process.



Figure 2.8

Once the total prosthesis is positioned in-vivo, perform the final leg length and joint line checks with a trial femoral head (Figure 2.9).

Also evaluate the range of motion to make sure there is no impingement of the acetabulum. Now is the time to reposition the parts before proceeding with the operation. Check the version to make sure it is correct.

Remove the trial femoral head, place the selected femoral head onto the proximal femoral body taper and impact it with a mallet blow, engaging the Morse taper. Reduce the femoral replacement into the acetabular component.

Closure

With the components securely in place, soft tissue closure is important to successful procedure completion. If the hip capsule is present, place a purse-string suture around the residual capsule and secure it over the chosen bipolar or acetabular component. Use the proximal femoral body replacement component to reattach the greater trochanter when present. This feature works by utilizing the reattachment holes provided in the proximal femoral body component. Attach the greater trochanter and abductor with either a heavy suture or MERSILENE Suture. If the abductors are extensively shortened, use the proximal femoral replacement body with the trochanteric build-up for reattachment.

If possible, suture the gluteus medius muscle to the lateral femoral muscles and then fasten the fascia lata to the proximal femoral replacement component holes. This assists in securing the gluteus musculature until scar tissue is formed with the surrounding soft tissue protecting against early subluxation.

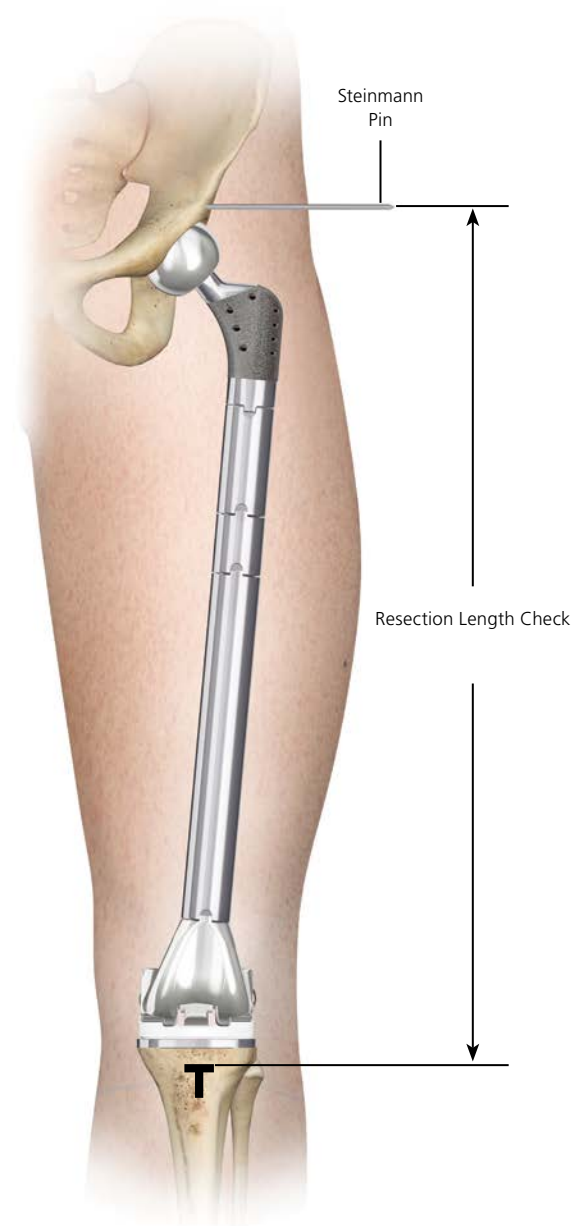


Figure 2.9

Total Femur Replacement

Suture the iliopsoas muscle, if desired, to the holes in the medial aspect of the proximal femoral body replacement component. Reattach the vastus lateralis to the intermuscular septum, the fascia lata and knee joint capsule, if present.

If, due to grossly inadequate soft-tissue integrity, knee flexion beyond 90 degrees causes luxation of the hinged insert bearing out of the tibial component base, the patient must have a knee brace post-operatively to limit flexion to 90 degrees. In such cases, consider closing the wound with the knee in full extension. Close the knee joint and skin in layers after inserting a suction drain.

Distal Femur Replacement with LPS Stem

Pre-operative Planning

Reconstruction of the distal femur due to significant bone loss or trauma can be performed utilizing the LPS System. The following technique reviews the intended design and use of the instruments and implants for this procedure and provides a general framework. Utilize techniques that best meet the needs of each case, since each case is unique and with its own challenges. Consider the following recommendations:

- Perform pre-operative planning and radiographic analysis for every case. Use the LPS System Templates (Cat. No. 2987-99-000) for pre-operative planning to assess the approximate resection level; position of the distal femoral replacement and segmental component(s) (if needed) to restore the joint line; and determine the diameter and length of the femoral stem extension that could be used to provide adequate fixation and stability in the remaining host femur diaphyseal bone.
- Evaluate the tibia to assess any deficiencies or abnormalities that may be present and to choose the implant system used to reconstruct the tibia. Replacement options include the M.B.T. Revision Tray or M.B.T. Revision Thick Tray with stems and/or metaphyseal sleeves. In extreme cases, the proximal tibia replacement may be required. Please refer to page 50 for more information on the proximal tibia replacement.



Exposure

Use a surgical approach that best achieves the exposure needed for extensive removal of bone in the distal femur and proximal tibia areas. Leg length estimate and alignment are important checks to be done prior to any bone resection. During surgery, take care to avoid stretch injury to the neurovascular structures. If performing the reconstruction for primary bone sarcoma, the pre-operative imaging studies, such as plain radiographs, CT scans and MRI of the femur, must be reviewed to determine a safe resection level.

Intra-operative Planning

The minimum distal femur resection level is 80 mm when using the X-small distal femoral replacement component with LPS Stems (Figure 3.1).

The minimum distal femur resection is 70 mm when using the XX-small distal femoral replacement component. This minimum resection level includes the distal femoral replacement component lengths of 50 mm and 60 mm respectively plus the 20 mm stem component collar height (Figure 3.2).

For selecting a size for the femoral component, it is important to consider the soft tissue envelope which must be closed. If the soft tissue envelope is extremely tight, use the size XX-small. If there is large amount of dead space around the joint, consider using the X-small distal femoral component.

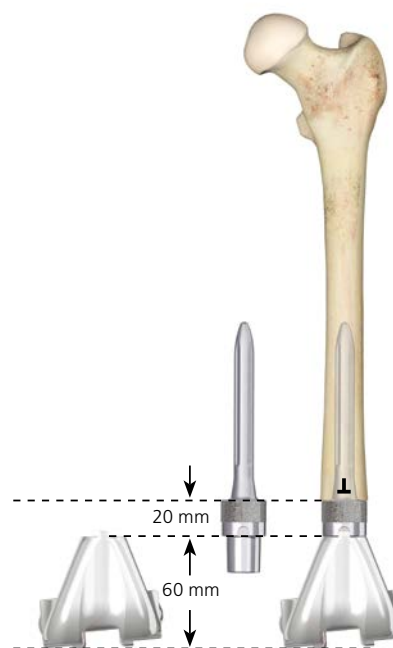
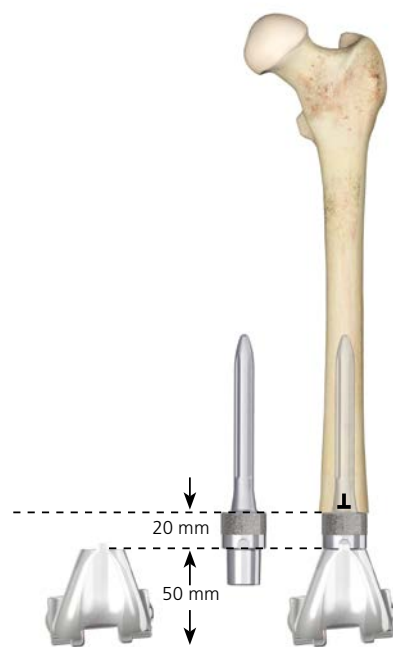


Figure 3.1



XX-small Distal Femur

Figure 3.2

Additional replacement length is often needed. The 25 mm segmental component is the shortest segment available, which means the minimum resection level with a segment is 95 mm for a size XX-small femoral and to 105 mm for a size X-small femoral component (Figure 3.3).

Note: For a size X-small, add 10 mm to the minimum resection height.

After the initial 25 mm segmental component, segmental components are available in 5 mm increments alone or in combination with other segmental components to adjust leg length 5 mm at a time.

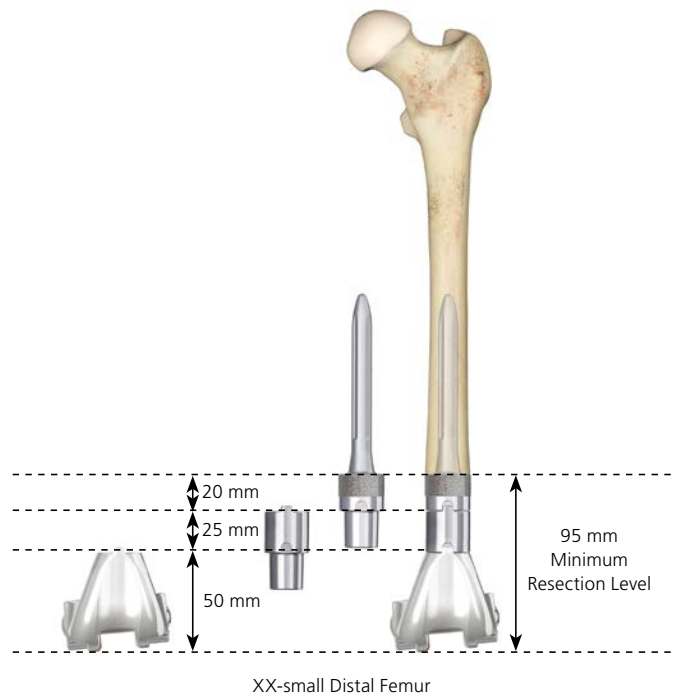


Figure 3.3

This chart demonstrates the segmental component lengths available along with the combination capabilities to replace bone in 5 mm increments.



Segmental Components

Segmental Stack Chart	
Remaining Gap (mm)	Segmental Components (mm)
25	25
30	30
35	35
40	40
45	45
50	25 + 25
55	25 + 30
60	25 + 35
65	65
70	25 + 45 or 30 + 40
75	30 + 45 or 35 + 40
80	35 + 45
85	85
90	25 + 65
95	30 + 65
100	35 + 65
105	105
110	25 + 85 or 45 + 65
115	30 + 85
120	35 + 85
125	125
130	25 + 105 or 45 + 85
135	30 + 105
140	35 + 105
145	40 + 105
150	25 + 125 or 45 + 105
155	30 + 125
160	35 + 125
165	40 + 125
170	45 + 125
175	125 + 25 + 25
180	125 + 25 + 30
190	125 + 65
195	125 + 25 + 45
200	125 + 35 + 40
205	125 + 35 + 45
210	125 + 85
215	125 + 25 + 65
220	125 + 30 + 65
225	125 + 35 + 65
230	125 + 105
235	125 + 25 + 85
240	125 + 30 + 85
245	125 + 35 + 85
250	125 + 40 + 85

After achieving distal femur and proximal tibia exposure, mark the proposed distal femur resection level with the extremity fully extended in a reproducible position. Avoid estimating with the knee in flexion for consistency of measurement results. Make a horizontal line on the femur 1 cm above the proposed resection level as a reference for use in leg length measurement. Then mark a perpendicular vertical line on the anterior cortex midline in line with the femoral trochlear groove. This mark serves as a reference for correct femoral prosthesis rotational alignment (Figure 3.4).

If applicable, consideration of prophylactic banding using a 1.7 mm DePuy Synthes Trauma Cable,

1-2 cm above the proposed level of resection, is possible. The cable may help lessen the risk of a stress riser as you are working inside the femur. Using the appropriate technique (Cat. No. J2848G) and cable passer, wrap the cable around the bone, avoiding the neurovascular bundle, and tension the cable to the desired level. Confirm the placement of the crimp on the bone, complete crimping, and cut the cable as close to the cable crimp as possible. The crimp may be used as a guide or landmark to help set femoral rotation throughout the operation.

Tibial Preparation

Prepare the proximal tibia as described in the SIGMA Revision and M.B.T. Revision Tray Surgical Technique (Cat. No. 0612-51-506 Rev. 5).

Note: Femur may be excised first to make more room for the tibial preparation.

When using the M.B.T. Revision Tibial Tray, or the proximal tibial component, only use the LPS Universal Tibial Hinge Insert Bearing. Use only the LPS Universal Hinged Tibial Insert Bearing size that matches the size of the distal femoral replacement component being used. (e.g. X-small insert mates with the X-small femoral component).

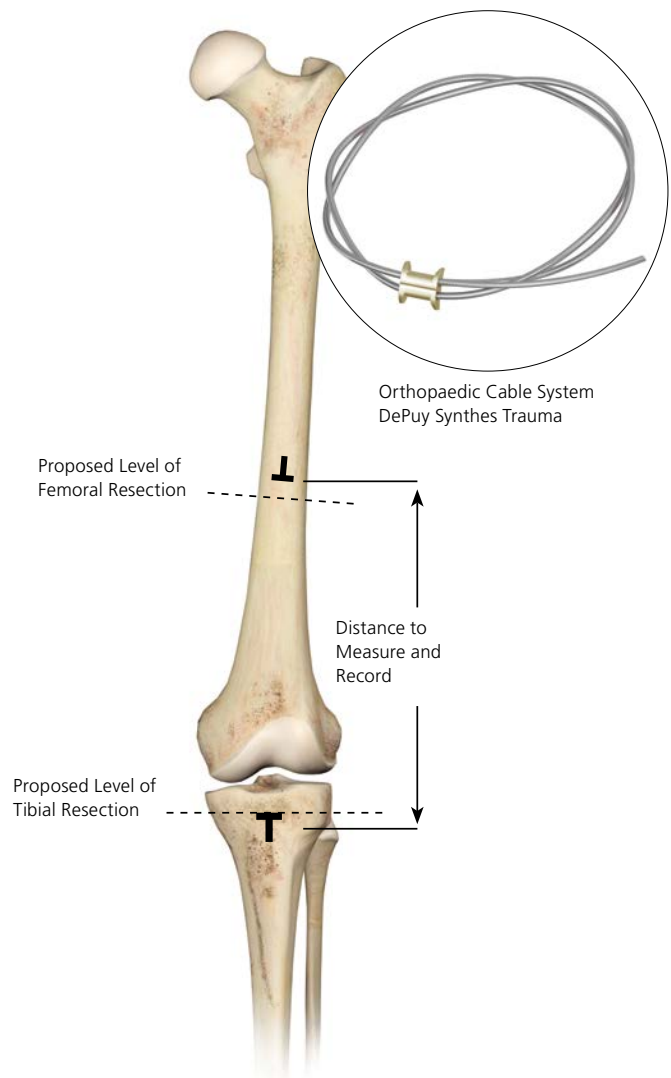


Figure 3.4

Femoral Canal Preparation - Distal Femur Resection

When a distal femoral tumor resection is required, excise the tumor and affected soft tissue prior to any tibial bone resection, except in the case of an extra-articular resection. In this case, it is technically easier to osteotomize or resect the patella first, then cut the tibia and finally cut the femur. Once the bone and soft tissue resection have been performed, prepare the remaining host femur.

Femoral Medullary Canal Preparation

Following femoral resection, prepare the remaining femoral canal for the appropriate stem extension. A flexible IM reamer is recommended for the bowed stem extension and a straight AML System Reamer is recommended for the straight stem extension.

Cemented Stem Application Options

If using a cemented stem, choose a final stem that is smaller than the last reamer used to allow for a circumferential cement mantle around the stem. For example, if a 15 mm IM reamer was last used, an 11 mm stem would have a 2 mm cement mantle per side.

Note: Do not ream the femoral canal to cortical bone for a cemented application. Leave some cancellous bone for cement interdigitation.

Porous Stem Application Options

When using a porous stem, the reaming technique utilized will depend on a number of factors such as the patient age, bone quality, curvature of the remaining femur, etc. The following are general guidelines, as the surgeon will need to choose the technique based on individual patient needs.

When using a straight porous stem, under ream by 0.5 mm for press-fit application using a straight reamer. For an 11.5 mm porous straight stem, it is recommended to stop reaming with an 11 mm reamer. If the remaining bone is fragile, consider line-to-line reaming.

When using a bowed porous stem, under reaming by 0.5 mm with a flexible reamer for press-fit application is a technique that can be considered. Line-to-line reaming may be indicated if needed to allow the implant to pass through the remaining femur's curvature or if the remaining bone is fragile (see Implant Insertion section on pages 37-39 for additional insight).

The LPS System Stem Extensions are available in 100 and 125 mm straight or 150 and 200 mm bowed lengths in cemented and porous-coated styles (see the chart on page 33).

Finish Preparation Using the Calcar Planer/Bevel Reamer

Once reaming is completed, prepare the osteotomy surface to help assure the stem's proper fit. The calcar planer/bevel reamer is designed to produce an even cut surface and an angled relief (bevel) in the bone to match the stem extension flare under the collar. This helps to ensure complete stem extension seating on the prepared diaphyseal bone surface.

Use a calcar planer and insert a bevel reamer with a pilot that is at least 1 mm smaller than the last IM reamer used (Figure 3.5) and insert it into the femoral canal. Sequential use of the bevel reamer with the pilots prepares the bevel in the remaining bone with more efficiency and precision. Attach the assembled planer and bevel reamer with a pilot to a power drill reamer using the appropriate adapter. The calcar planer/bevel reamer should be under power prior to planing the resection cut. This will reduce any resected bone chipping by the calcar planer cutting blades.

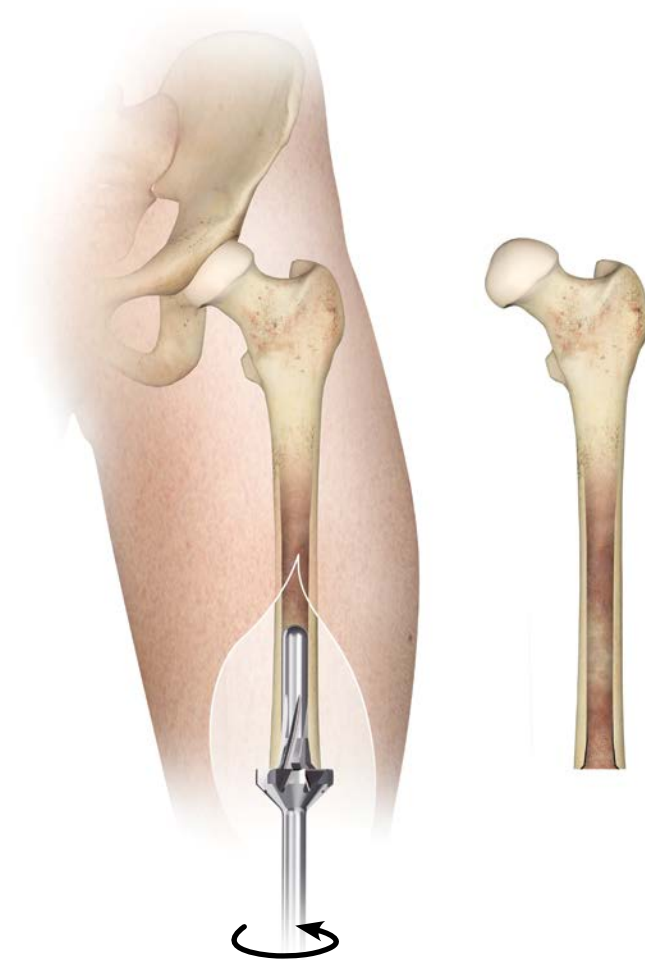


Figure 3.5

The following are recommendations for the calcar planer/bevel reamer for use with cemented or porous stems:

For a porous stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the intended stem extension size. (For example, if a 15.5 mm stem is the chosen implant, the final bevel reamer with a pilot will also be 15.5 mm).

For a cemented stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the final IM reamer size used. (For example, if the last IM reamer used was 15 mm, the 15 mm bevel reamer pilot will be the final bevel reamer used, irrespective of the stem size chosen, to allow for an adequate cement mantle).

Note: The shaft of the bevel reamer is undersized by 0.5 mm per side from the stated size.

Resurface the patella using the SIGMA Knee dome patella component.

Trial Reduction

Following the femur's preparation for the stem extension, perform a trial reduction. Replace the missing bone from the distal femur resection to the expected joint line level. Utilizing this measurement, assemble the appropriate distal femoral replacement component, segmental component(s) and distal femoral stem trials that would fill the missing bone gap (see the chart on page 29).

Note: Reference the LPS System Pocket Reference Guide, (Cat. No. 0612-35-050 Rev. 5), for complete ordering information.

Stem Extensions

Cemented Stems (Straight)
10 mm diameter x 100 mm length
11 mm diameter x 100 mm length
12 mm diameter x 100 mm length
12 mm diameter x 125 mm length
13 mm diameter x 125 mm length
14 mm diameter x 125 mm length
15 mm diameter x 125 mm length
16 mm diameter x 125 mm length
17 mm diameter x 125 mm length

Porous Stems (Straight)
11.5 mm diameter x 100 mm length
12.5 mm diameter x 100 mm length
13.5 mm diameter x 100 mm length
13.5 mm diameter x 125 mm length
14.5 mm diameter x 125 mm length
15.5 mm diameter x 125 mm length
16.5 mm diameter x 125 mm length
17.5 mm diameter x 125 mm length
18.5 mm diameter x 125 mm length

Cemented Stems (Bowed)
11 mm diameter x 150 mm length
12 mm diameter x 150 mm length
13 mm diameter x 150 mm length
14 mm diameter x 150 mm length
15 mm diameter x 150 mm length
16 mm diameter x 150 mm length
17 mm diameter x 150 mm length
11 mm diameter x 200 mm length
13 mm diameter x 200 mm length
15 mm diameter x 200 mm length
17 mm diameter x 200 mm length

Porous Stems (Bowed)
12.5 mm diameter x 150 mm length
13.5 mm diameter x 150 mm length
14.5 mm diameter x 150 mm length
15.5 mm diameter x 150 mm length
16.5 mm diameter x 150 mm length
17.5 mm diameter x 150 mm length
18.5 mm diameter x 150 mm length
12.5 mm diameter x 200 mm length
14.5 mm diameter x 200 mm length
16.5 mm diameter x 200 mm length
18.5 mm diameter x 200 mm length

If the distal femur is available in one piece, an alternate method is to estimate the resected bone from the osteotomy to the end of the condyles. Then assemble the trial components and from the joint line to the resection line, evaluate the match of the trial to the resected bone (Figure 3.6).

The trial components are designed to snap together and match the length of the implant components (Figure 3.7). Utilize the properly sized stem trial to provide enough stability to prevent “spinning” when performing a trial reduction.

The stem trial should closely match the last IM reamer used or it can be 1–2 mm smaller depending on fit.

Insert trial constructs by hand. Do not impact them into the canal.



Figure 3.6



Figure 3.7

The 150 and 200 mm trial stems are bowed and need to be inserted in proper orientation to match the femur's anterior bow. Insert the trial construct into the remaining distal femur and use it to assess fit, joint line, joint stability, soft tissue tension and range of motion (Figure 3.8).

If the soft tissues are tight and are adversely affecting the range of motion, consider soft tissue releases. However, if the leg is excessively tight in extension, reducing the length of the segmental components or the tibial polyethylene insert can help this, but the proper joint line must be maintained. The leg length can be adjusted with the segmental trials, which allows for 5 mm increments of correction.

When the knee is balanced in full extension, confirm that the joint line is in the proper place.

- If there is a patella baja, use less tibial poly and longer distal segmental components
- If the patella is in the proper position, continue on with the procedure
- If there is a patella alta, use more tibial poly and shorter distal segmental components, or consider the use of an M.B.T. Revision Thick Tibial Tray

If the femoral component needs to be shortened a few millimeters and removing segmental components is not an option, consider cutting a few millimeters off of the remaining proximal femoral bone. Consider the need to prepare the canal again by re-reaming with straight reamers and bevel reamers to adequately prepare for the chosen construct. Use the trial construct to assess proper component rotational orientation. Once proper orientation is established, use the anti-rotation slot (tab) on the trial as a reference to mark the femur. This mark serves as an alignment guide when inserting the final implant (Figure 3.8).

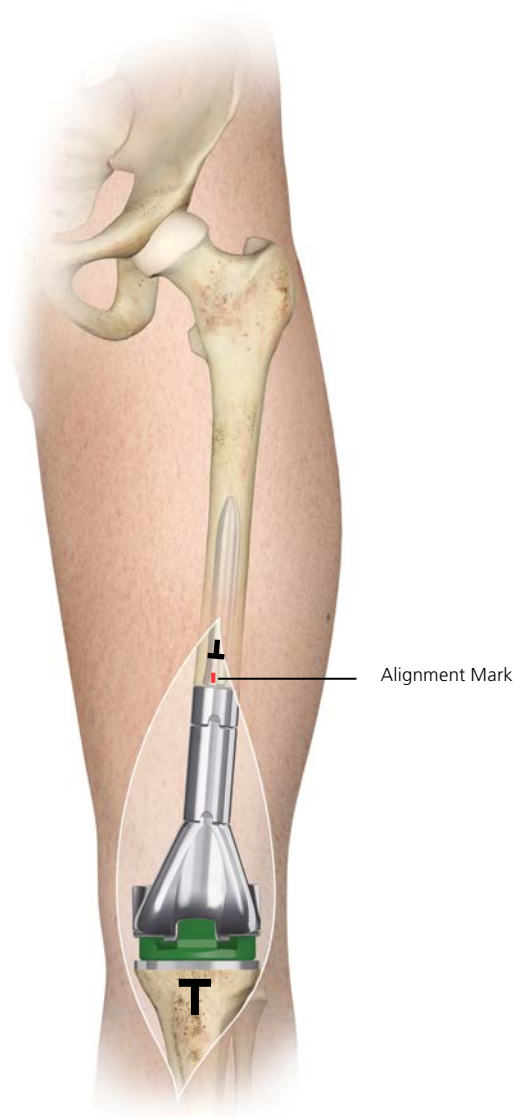


Figure 3.8

Implant Assembly

Once the trial segments yield a satisfactory result with the trial reduction, assemble the appropriate implant components. Use the femoral impaction stand to help stabilize the implant components for assembly and impaction. It is important to orient the implant components along the same axis as the trial components. The implant components use a Morse-taper design for locking. Assemble the implant components by hand and place the impaction cap over the stem component. Then impact the components together using a mallet to securely seat the tapers together (Figure 3.9). There should be approximately a 1 mm gap between the component bodies.

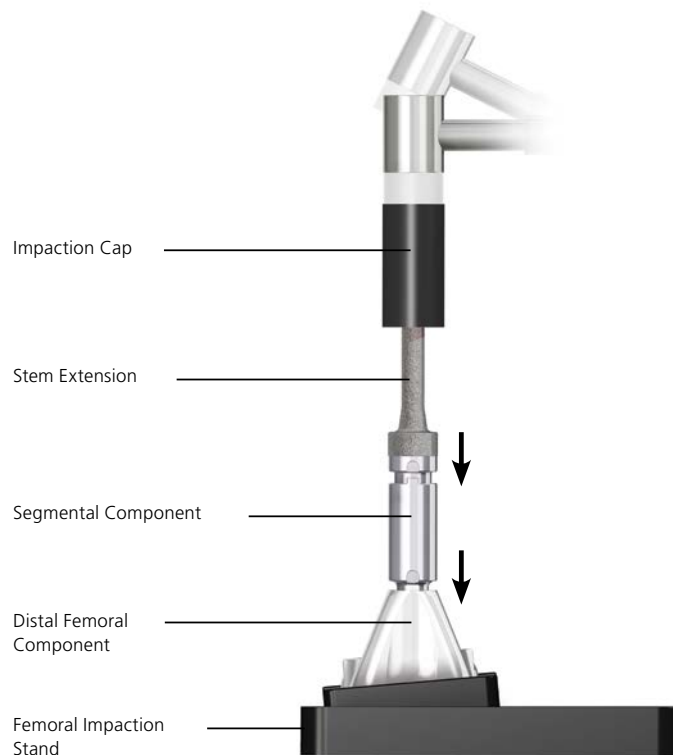


Figure 3.9

Implant Insertion

If using SMARTSET MV Bone Cement to fix the distal femoral stem extension to host bone, follow the manufacturer's recommended procedures to mix, deliver and pressurize the bone cement.

Use the distal femoral impactor with the implant construct to assist in the insertion of the implant into the femoral canal. The distal femoral impactor mates with the distal femoral replacement component. Use a mallet to impact the assembled construct (Figure 3.10).

Give meticulous attention to the distal femoral component's rotation. If it is internally rotated, it may potentially result to patellar instability. Use the alignment mark previously placed on the femur and the implant's anti-rotation slot for proper implant orientation. Note that the 150 and 200 mm stems are bowed and the correct bow-to-femur orientation must be accomplished.

Note: Placement of a "prophylactic" cerclage wire around the proximal end of the remaining diaphysis may potentially decrease the risk of intra-operative fracture during press-fit insertion of a porous stem extension, particularly with fragile bone.

If using a porous stem, hand place the construct in the canal until the stem engages the canal. At this point, the stem should be roughly 1 cm proud of the cut surface of the bone. If it has engaged the femoral canal properly, impact the construct into place using a mallet to strike the inserter and align the anti-rotation tab with a mark on the femur for proper alignment (Figure 3.10). Roughly 100 gentle mallet strikes should be used to fully seat the porous stem. If the stem engages the canal and is more than 1 cm proud, consider re-reaming the bone to get the stem to seat further. If the stem contacts the bone without the porous stem engaging solidly, the stem's diameter should be increased.

If using a cemented stem, insert it and align it as noted above. Use a curette to remove excess bone cement from around the implant collar.

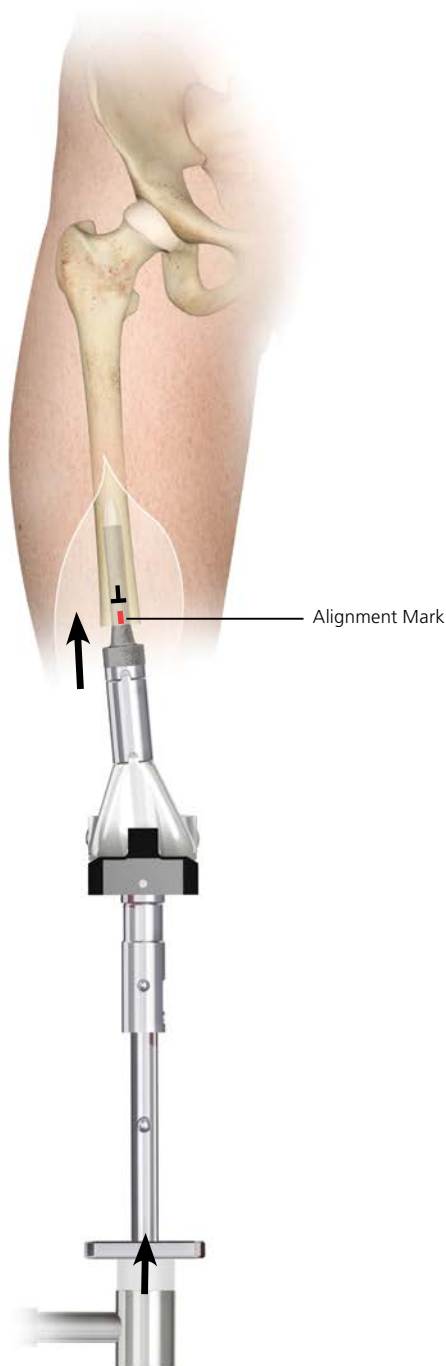


Figure 3.10

When using a bowed porous stem, curvature of the remaining bone in comparison to the implant needs to be appraised especially for the impact of mismatch conditions. Under reaming by 0.5 mm with a flexible reamer is a technique that can be considered.

Insertional feel and non-advancement with component impaction should be an indication to remove the construct and try to pass the same flexible reamer another four to six times and evaluate the insertional feel again. If the construct still presents with non-advancement, line-to-line reaming should be considered. The construct should then be inserted into the medullary canal and attention to insertional feel and advancement assessed again.

Should the implant construct with a porous stem not advance and become lodged in the femoral canal, there is a technique for removal. Disassemble the implant construct from the stem extension using the disassembly tool (see disassembly technique on page 72). The exposed porous stem extension taper is threaded. Place the slap handle through the inserter/extractor. Completely thread the inserter/extractor into the porous stem thread until it is fully seated. Use the slap handle to provide the extraction force to the lodged porous stem extension until it is removed from the femur. Make sure the tapers are clean and dry before re-assembly. Reinsert the implant construct after re-reaming.

The stem extension shoulder should be flush to the femur's cut surface when using either the cemented or porous stem extension (Figure 3.11).

Give meticulous attention to the distal femoral component's rotation. If it is internally rotated, it may potentially result to patellar instability. Perform a final trial reduction. Evaluate stability and leg length adjustments by using the LPS Universal Insert Bearing Trials prior to choosing the final insert component.

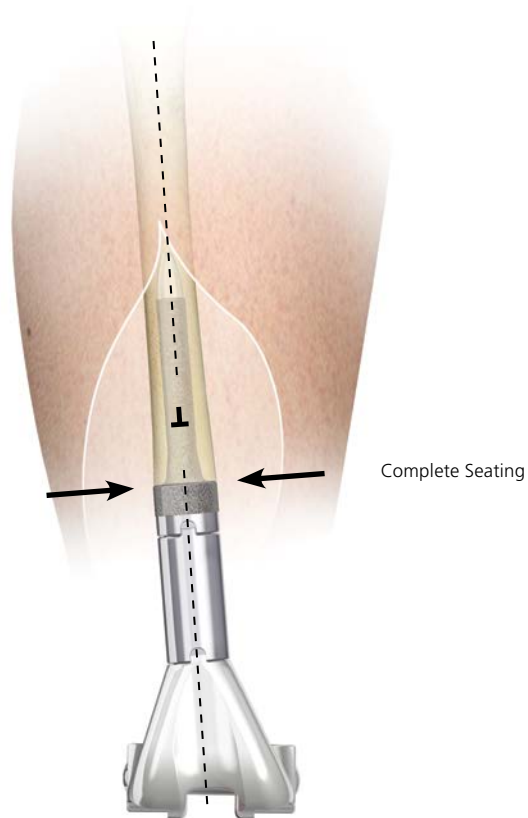


Figure 3.11

Use the hinge pin to mate the distal femoral component to the tibial bearing through the LPS Universal Tibial Hinge Insert Bearing. Pass the hinge pin through the distal femoral replacement component and the hinged tibial insert-bearing bushings (Figure 3.12). The hinge pin may be inserted through the medial or lateral side.

One method to secure the hinge pin uses manual pressure to push the hinge pin through until it “clicks” and locks into place. Another method uses a small rongeur or pliers to squeeze the hinge pin while pushing the pin until it is completely seated in the square cut-out in the distal femoral component. Once the pin is seated, release the pressure from the small rongeur or pliers. Once the pin is securely locked, push the hinge pin from the opposite side of insertion and confirm that it is captured and locked.



Figure 3.12

Distal Femur Replacement with Metaphyseal Sleeve

Femur Preparation - with Metaphyseal Sleeve

Make the appropriate distal resection as required. The minimum distal resection is 50 mm for a size XX-small femoral and 60 mm for a size X-small femoral component.

Note: Since the metaphyseal sleeve will not be fully seated into the remaining bone stock, it may be necessary to take slightly more bone than 50 or 60 mm. Typically the sleeve sits proud by about 5-15 mm. Additionally, this metaphyseal sleeve technique does NOT use LPS Stems. Instead, it uses universal press-fit stems, so the M.B.T. Revision reamers should be utilized.

Prepare the femoral canal with the M.B.T. Revision reamers. Begin with the introductory reamer and subsequently ream to larger sized reamers until the desired fit is achieved. The reamers are available in 1 mm increments, beginning at a diameter of 10 mm. The final reamer must be even sized to match the final Universal stem size. Use reamers to prepare the canal. When using the press-fit Universal stems, line-to-line reaming is suggested (for example, use a 16 mm reamer for a 16 mm press-fit Universal stem) (Figure 3.13).

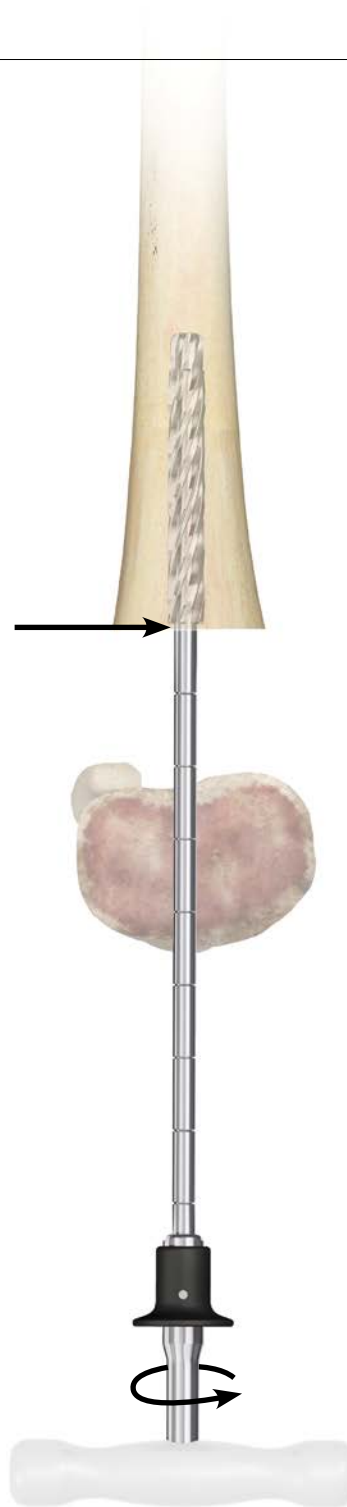


Figure 3.13

Distal Femur Replacement with Metaphyseal Sleeve

If power reaming, it will be necessary to attach the modified Hudson adapter to the straight reamer. Note that the reamer shaft contains markings in 25 mm increments to accommodate the various Universal stem/sleeve length combinations. Another option to determine reamer depth is to estimate the trial assembly against the reamer.

After reaming the intramedullary canal, attach the threaded shaft to the broach reamer and then to the appropriate stem trial as determined by straight reaming (Figure 3.14). Ream as appropriate to open the canal to accept the smallest femoral broach.

Consider sinking the broach reamer halfway into the host bone to ensure that the metaphyseal sleeve can be left a bit proud.

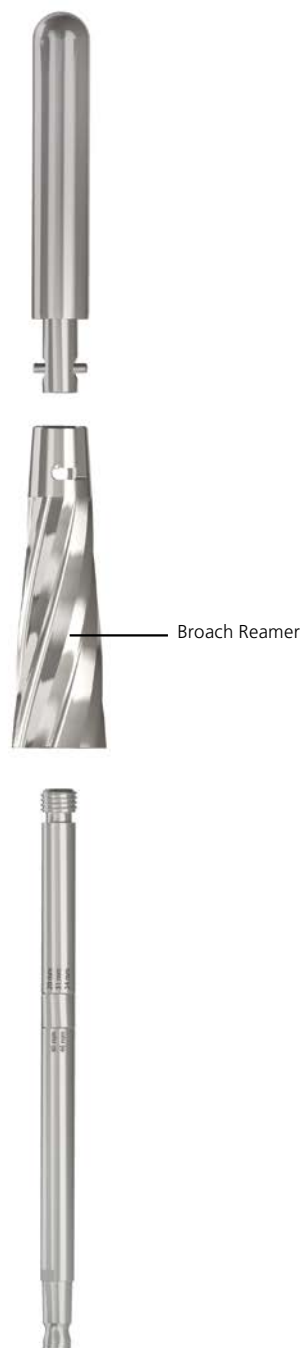


Figure 3.14

The broach reamer will be necessary when utilizing a 20 mm sleeve and for the beginning of larger sequential broaching when a 31 mm or larger sleeve is used. After broach reaming has been completed, attach the 31 mm broach to the broach impactor (Figure 3.15). Attach the appropriate stem trial to the broach as determined by straight reaming.

Note: The medial side of the broach should be oriented toward the medial side of the femoral bone.

Sequentially broach to the desired dimension of 31, 34, 40, or 46 mm. At each size, assess the broach's rotational stability. If the stability of the broach is unsatisfactory, move up to the next larger broach size. The last broach used will be the femoral sleeve size. The sleeve can be prepared to sit slightly proud depending on the amount and quality of remaining bone.

If the broach sits completely flush with the cut surface of the distal femur, there is a risk of the sleeve "stove-piping" and migrating up the canal over time. Leaving the broach a few millimeters proud (approximately 5-15 mm, with no more than half of the broach left proud) will help to prevent this migration. A fully porous sleeve is recommended in such instances.



Figure 3.15

Trialing

After broaching is complete, the femoral bone is ready for trialing. There are three corresponding trials for the offset sleeve adapters, corresponding to the 0, 5, and 10 mm offset adapter options. These offset adapters will adjust the amount of distal offset of the final component by either 0 mm, 5 mm, or 10 mm respectively. These trials have the same spring-coil lock trialing system as the rest of the LPS System Instrumentation.

The offset sleeve adapters can connect a distal femoral component to a femoral sleeve or can mate with a segmental component to connect the construct to a femoral sleeve. Utilize the Universal Femoral sleeve trials located in the SIGMA Knee Femoral Adapter case and M.B.T. stem trials located in the M.B.T. stem trial case.

Note: The 0 mm offset adapter is not compatible with the 20 mm cemented Femoral sleeve.

The 0 mm offset adapter will mate with any of the porous sleeves, but the locking tabs on the distal femoral component will not allow for independent rotation of the femoral component. How you orient your femoral broach will lock in the rotation of your femoral component if this offset adapter is utilized.

If flexibility in determining femoral rotation after broaching is desired, consider the use of a 5 mm or 10 mm offset adapter.

To change the offset adapter, completely thread the inserter/extractor into the offset adapter thread until it is fully seated, and pull on the handle to disengage the offset adapter from the distal femoral or segmental components (Figure 3.16).



Figure 3.16

Insert trial constructs by hand. Do not impact them into the canal. If the stem trial will not advance into the canal, consider reaming the canal again or decrease the size of the stem trial. Insert the trial construct into the distal femur and use it to assess fit, joint line, joint stability, soft tissue tension and range of motion. If the soft tissues are tight and are adversely affecting the range of motion, consider soft tissue releases. However, if the leg has been excessively lengthened, reducing leg length will correct the problem. The leg length can be adjusted with the segmental trials, which allow for 5 mm increments of correction.

Once full extension has been achieved, next check the joint line of the knee. Compare the knee joint line to the opposite side for proper height. As an additional check, flex the knee to determine the anatomic position of the patella. If a patella baja exists, where the patella is impinging on the poly, bring down the joint line by increasing the length of the offset adapter or the segmental components, and use a thinner polyethylene insert to match. If a patella alta exists, add more tibia (thick tray or a thicker polyethylene insert) and decrease the length of the offset adapters or the segmental components to match.

If the segmental trials used are at the minimum length of 25 mm and the joint line is too far distal, consider recutting the femoral osteotomy to adjust for the discrepancy. If the femoral cut is revised, re-ream the femur more proximally and re-broach the bone to prepare the bone for a femoral sleeve. If re-reaming is not performed, the stem's distal end may encounter unreamed bone and an intra-operative fracture may occur. Use the trial construct to assess proper component rotational orientation. Once proper orientation is established, use the anti-rotation slot (tab) on the trial as a reference to mark the femur. This mark serves as an alignment guide when inserting the final implant (Figure 3.17).

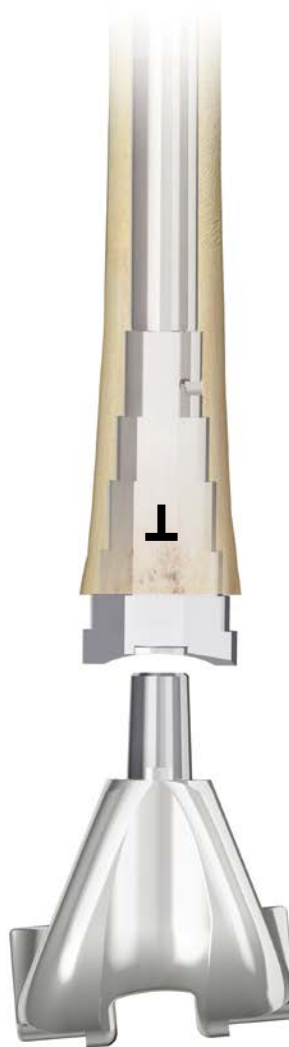


Figure 3.17

Implant Assembly

Once the trial segments yield a satisfactory result with the trial reduction, assemble the appropriate implant assembly components. Use the femoral impaction stand to stabilize the implant components for assembly and impaction (Figure 3.18). The implant components use a Morse-taper design for locking.

First assemble the distal femoral replacement component, any segment components (if necessary) and offset sleeve adapter. Once impacted together, assemble the chosen Universal stem to the Universal femoral sleeve by threading the stem onto the sleeve (Figure 3.19).



Figure 3.18



Figure 3.19

Implant Assembly

Grasp the sleeve with the revision sleeve clamp and use the stem extension wrench to grasp the Universal stem. Tighten as shown (Figure 3.20). Apply sufficient force to both wrenches to secure the stem.



Figure 3.20

Distal Femur Replacement with Metaphyseal Sleeve

Then assemble the sleeve/stem to the chosen distal femoral component construct and impact using the femoral stem/sleeve impactor found in the Femoral Adapter instrument case (Figure 3.21).

Final assembled components will look like those in Figure 3.22.



Figure 3.22

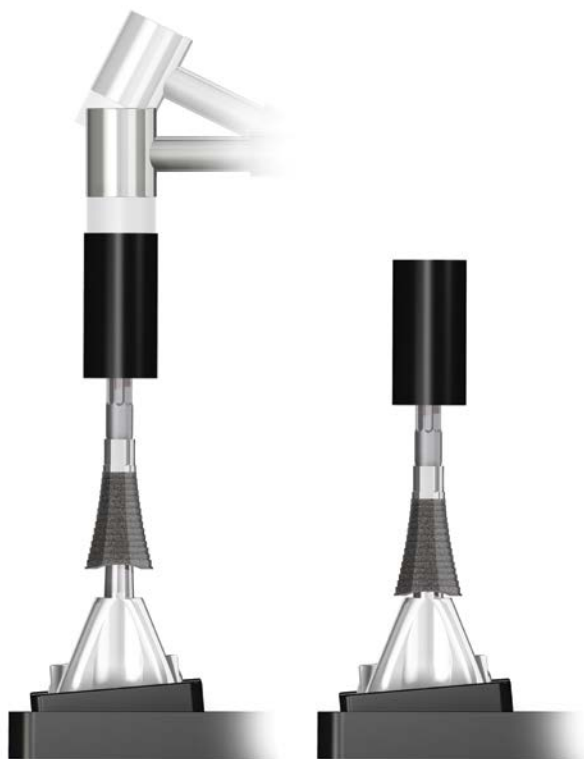


Figure 3.21

Implant Insertion

Use the alignment mark previously placed on the femur and the implant's anti-rotation slot for proper implant orientation. Placement of a "prophylactic" cerclage wire around the proximal end of the remaining diaphysis may potentially decrease the risk of intra-operative fracture during press-fit insertion of a porous femoral sleeve particularly with fragile bone.

Use the S-ROM® Modular Total Knee System Femoral Driver attached to the S-ROM Knee Universal Handle to impact the femoral component into the host bone. Impact the component gently to advance the construct, striking it 75-100 times if necessary. Several sharp blows with a mallet may increase the risk of fracturing the host bone during implantation. The sleeve should seat to the level that was prepared by the broach and replicated with the femoral sleeve trial.

Perform a final trial reduction. Evaluate stability and leg length adjustments by using the LPS Universal Tibial Hinge Insert Bearing Trials prior to choosing the final insert component.

Use the hinge pin to mate the distal femoral component to the tibial bearing through the hinged tibial insert bearing. Pass the hinge pin through the distal femoral replacement component and the hinged tibial insert-bearing bushings (Figure 3.23). The hinge pin may be inserted through the medial or lateral side.

One method to secure the hinge pin uses manual pressure to push the hinge pin through until it "clicks" and locks into place. Another method uses a small rongeur or pliers to squeeze the hinge pin while pushing the pin until it is completely seated in the square cut-out in the distal femoral component. Once the pin is seated, release the pressure from the small rongeur or pliers. Once the pin is securely locked, push the hinge pin from the opposite side of insertion and confirm that it is captured and locked.

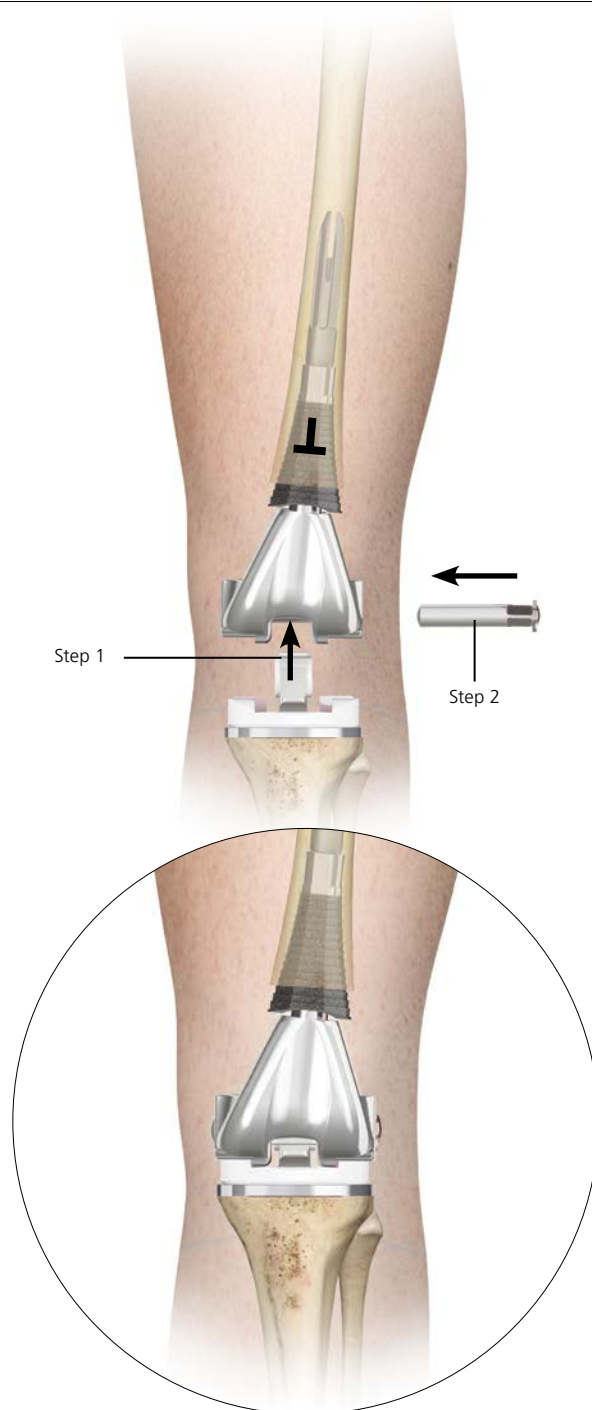


Figure 3.23

Closure

If knee flexion beyond 90 degrees causes luxation of the hinged insert bearing out of the base of the tibial component, this could be due to grossly inadequate soft tissue integrity. In that situation, the patient must have a knee brace post-operatively to limit flexion to 90 degrees.

In such cases, consider closing the wound with the knee in full extension. One of the most important aspects of this procedure is the soft tissue reconstruction, which is done based on individual patient needs. Soft tissue closure should completely cover the prosthesis.

In oncologic applications when soft tissues are resected to achieve a wide bone tumor margin, the amount of remaining soft tissue coverage is reduced. In this case, remaining musculature mobilization may be necessary to achieve proper soft tissue coverage around the prosthesis.

Perform wound closure in multiple layers to potentially reduce hematoma formation. Perform meticulous wound closure to potentially reduce wound complications that may preclude immediate physical therapy or other adjuvant oncologic treatments, such as radiation therapy or chemotherapy (Figure 3.24).

Occasionally, if there is significant soft tissue fibrosis (e.g. from prior surgery, trauma, irradiation, etc.), then extremity shortening may be necessary to reduce soft tissue tension and allow wound closure without undue tension. Typically the wound is closed over large bore drains to potentially reduce hematoma collection.



Figure 3.24

Proximal Tibia Replacement

Pre-operative Planning

Use the LPS System to perform the proximal tibia reconstruction due to significant bone loss. The following technique reviews the intended design and use of the instruments and implants for this procedure and provides a general framework. Utilize techniques that best meet the needs of each case, since each is unique and has specific challenges. Consider the following recommendations for a successful outcome:

- Perform pre-operative planning and radiographic analysis for every case. Use the LPS System Templates (Cat. No. 2987-99-000) for pre-operative planning to assess the following: approximate resection level; jointline; the proximal tibial replacement position and segmental components (if needed) to restore leg length; and the diameter and length of the tibial stem extension that could be used to provide adequate fixation and stability in the remaining host tibial diaphyseal bone.
- Evaluate the femur to confirm establishment of the knee joint line and assess any abnormalities or deficiencies that may exist.



Exposure and Intra-operative Planning

Use a surgical approach that best achieves the exposure needed for extensive bone removal in the proximal tibia and distal femur. It is important to check leg length measurement and alignment prior to any bone resection. During surgery, take care to avoid stretch injury to the neurovascular structures. If performing the reconstruction for primary bone sarcoma, review the pre-operative imaging studies, such as plain radiographs, CT scans and MRI of the tibia to determine a safe resection level.

The minimum proximal tibial resection level is 105 mm with a 12 mm LPS Universal Tibial Hinge Insert Bearing. This minimum resection level includes the 73 mm proximal tibial replacement component length plus the 12 mm hinged insert-bearing plus the 20 mm stem component collar height. If additional replacement length is needed, the 25 mm segmental component is the shortest segment available making the 130 mm the next level of resection (Figures 4.1 – 4.3). Segmental components are then available in 5 mm increments alone or in combination with other segmental components to adjust leg length.

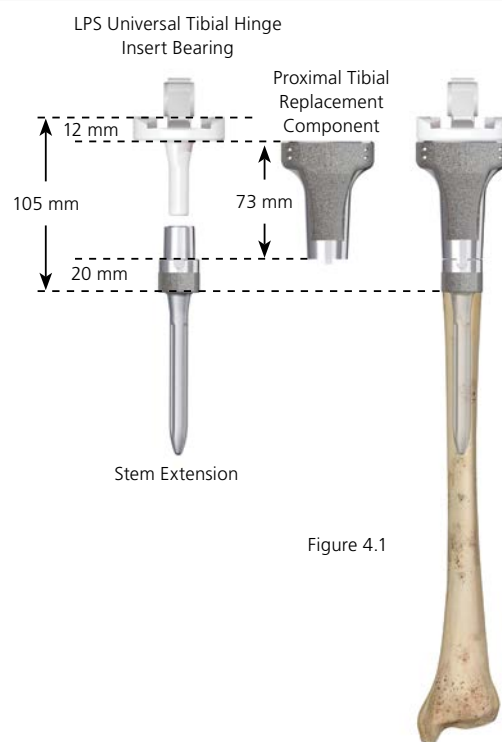


Figure 4.1

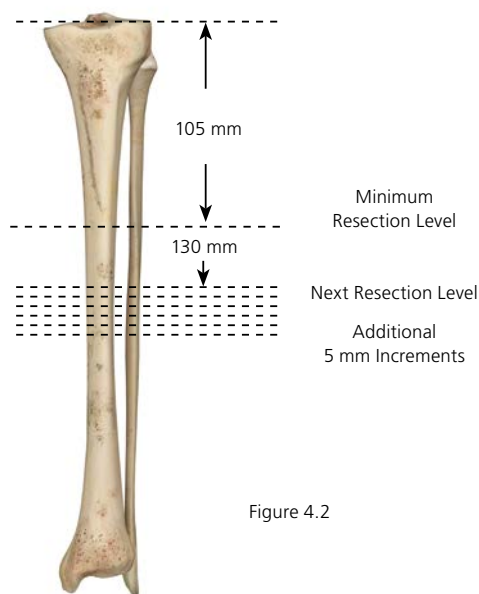


Figure 4.2

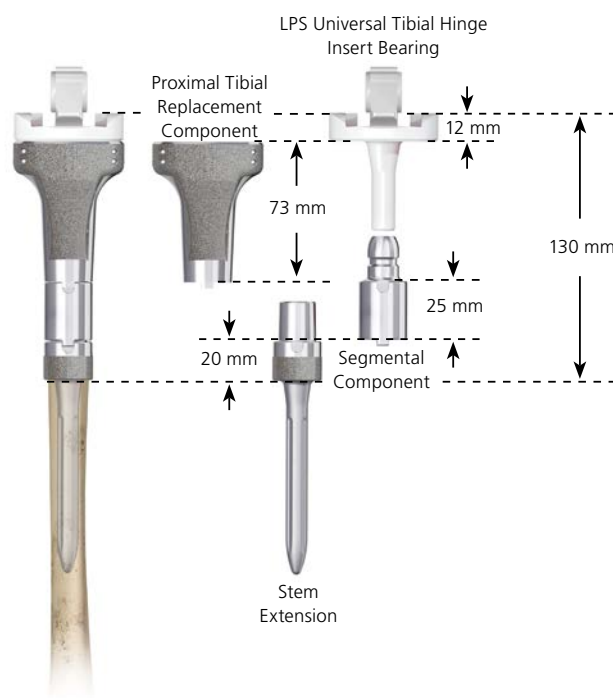


Figure 4.3

After achieving proximal tibia and distal femur exposure, mark the proposed tibial resection level with the leg fully extended in a reproducible position. Avoid knee flexion for consistency of estimating results. Mark a horizontal line on the tibia 1 cm below the proposed resection level as a reference for use in leg length estimate and make a perpendicular vertical mark on the anterior crest of the tibia.

Mark another horizontal line on the femur, above the level of the femoral component and in line with the trochlear groove. Make these marks with electro cautery, osteotome, marking pen or methylene blue (Figure 4.4). Record this estimate prior to any resection and use for future reference in the procedure.

Tibial Resection

When a proximal tibial tumor resection is required, excise the tumor and affected soft tissue prior to any femoral bone resection. The tibia is then resected to healthy, diaphyseal bone.

Femoral Preparation

When using a hinged component, follow the technique for implanting the S-ROM Hinged Femoral Component and prepare the distal femur for the S-ROM Hinged Femoral Component (Surgical Technique Cat. No. DSUS/JRC/0414/0052(1) Rev. 3). It is mandatory to use the Universal Femoral sleeve and stems with the S-ROM Hinged Femoral Component.

The proximal tibial replacement is also compatible with the distal femoral component. If this component is used, refer to the surgical technique starting on page 26 of this guide. For the remainder of the proximal tibia technique, the use of an S-ROM Hinged Femur will be shown.

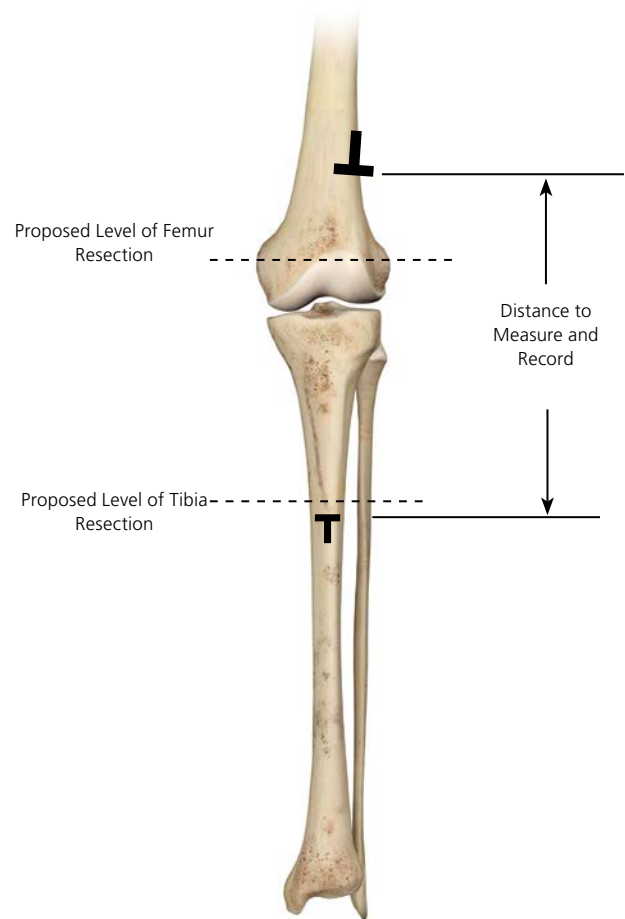


Figure 4.4

Tibial Medullary Canal Preparation

Following the distal femoral preparation, ream the remaining tibial canal for the stem extension. Straight stems are recommended for use in the tibia. Straight AML System Reamers are recommended for the straight stem extension.

If using a cemented stem, choose the final stem that is smaller than the last reamer used to allow for a circumferential cement mantle around the stem. For example, if a 15 mm IM reamer was last used, an 11 mm stem would have a 2 mm cement mantle per side. If a 13 mm stem was used, there would be a 1 mm cement mantle per side.

Do not ream the tibial canal to the cortical bone for a cemented application. Leave some cancellous bone for cement interdigitation.

When using a porous-coated stem, under ream by 0.5 mm for a stem press-fit application. If the remaining bone is fragile, consider line-to-line reaming.

The LPS System Stem Extensions are available in 100 and 125 mm straight lengths in cemented and porous-coated options for tibial use. The table to the right reviews the stem options that are available.

Finish Preparation Using the Calcar Planer/Bevel Reamer

Once reaming is completed, prepare the tibial resection osteotomy surface to help assure proper stem extension fit. The calcar planer/bevel reamer is designed to produce an even cut surface and is designed to cut an angled relief (bevel) in the bone to match the stem extension flare under the collar. This helps to assure complete tibial stem extension seating on the prepared diaphyseal bone surface.

Stem Extensions

Cemented Stems (Straight)
10 mm diameter x 100 mm length
11 mm diameter x 100 mm length
12 mm diameter x 100 mm length
12 mm diameter x 125 mm length
13 mm diameter x 125 mm length
14 mm diameter x 125 mm length
15 mm diameter x 125 mm length
16 mm diameter x 125 mm length
17 mm diameter x 125 mm length
Porous Stems (Straight)
11.5 mm diameter x 100 mm length
12.5 mm diameter x 100 mm length
13.5 mm diameter x 100 mm length
13.5 mm diameter x 125 mm length
14.5 mm diameter x 125 mm length
15.5 mm diameter x 125 mm length
16.5 mm diameter x 125 mm length
17.5 mm diameter x 125 mm length
18.5 mm diameter x 125 mm length

Note: Reference the LPS System Pocket Reference Guide, (Cat. No. 0612-35-050 Rev. 5), for complete ordering information.

Use the calcar planer/bevel reamer with pilot that is at least 1 mm smaller than the last IM reamer used (Figure 4.5) and insert it into the femoral canal. Sequential use of the bevel reamer with the pilots will prepare the bevel in the remaining bone with more efficiency and precision. Attach the assembled planer and bevel reamer with a pilot to a power drill reamer using the appropriate adapter. The calcar planer/bevel reamer should be under power prior to planing the resection cut. This will reduce any resected bone chipping caused by the calcar planer cutting blades. The following are recommendations for using the calcar planer/bevel reamer with cemented or porous stems:

For a porous stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the intended stem extension size. (For example, if a 15.5 mm stem is the chosen implant, the final bevel reamer with a pilot will also be 15.5 mm).

For a cemented stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the final IM reamer size used. (For example, if the last IM reamer used was 15 mm, the 15 mm bevel reamer pilot will be the final bevel reamer used, irrespective of the stem size chosen, to allow for an adequate cement mantle).

Note: The shaft of the bevel reamer is undersized by 0.5 mm per side from the stated size.

Resurface the patella using a domed patella replacement, such as the S-ROM Dome Patella when using the S-ROM Hinged Femoral Component or the SIGMA Knee Dome Patella when using the LPS Distal Femoral Component.

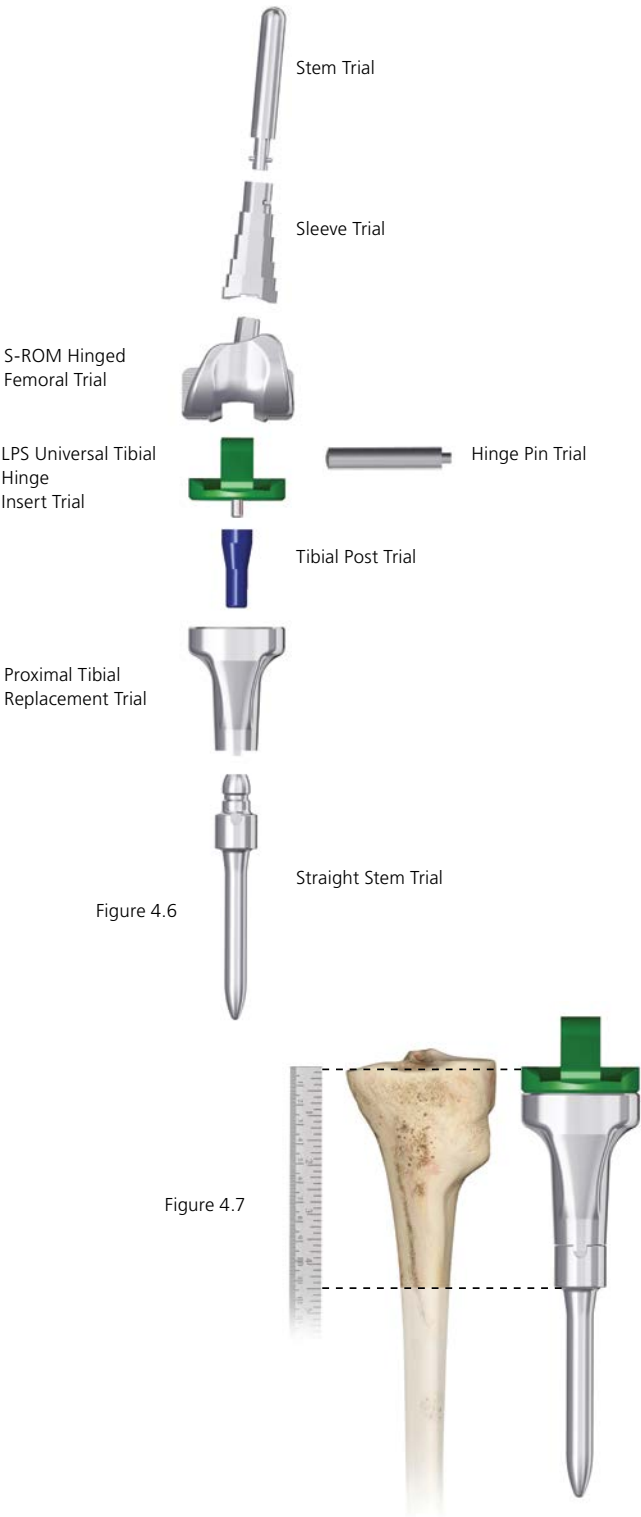


Figure 4.5

Trial Reduction

Following the tibial preparation for the stem extension, perform a trial reduction. Estimate the gap from the distal tibial resection to the level of the contemplated joint line. Check leg length restoration using the marks made previously on the femur and tibia. Utilizing this estimate, assemble the tibial replacement components and distal stem trials that would fill the gap of missing bone (Figure 4.6). If the proximal tibia is available in one piece, an alternate method is to measure the resected bone.

Assemble the trial components, and from the joint line to the resection line, evaluate the match of the trial to the resected bone (Figure 4.7).



The LPS Trial Components are designed to snap together and match the implant component dimensions. Utilize the properly sized stem trial to provide enough stability to prevent “spinning” when performing a trial reduction.

The stem trial size should closely match the size of the last reamer and it can be 1–2 mm smaller than the last IM reamer used depending on the fit. Insert all trial constructs by hand and do not impact them into the canal. Insert the trial construct into the remaining proximal tibia and mate with the trial S-ROM Femoral Hinged Trial Construct to assess fit, leg length, joint line, joint stability, soft tissue tension and range of motion (Figure 4.8).

Varying the hinged insert-bearing trials and/or segmental trials, if used, can help fine tune leg length adjustments.

Use the trial construct to assess proper component rotational orientation. Once proper orientation is established, use the anti-rotation slot (tab) on the trial to mark the tibia (Figure 4.8). This mark serves as an alignment guide when inserting the implant.

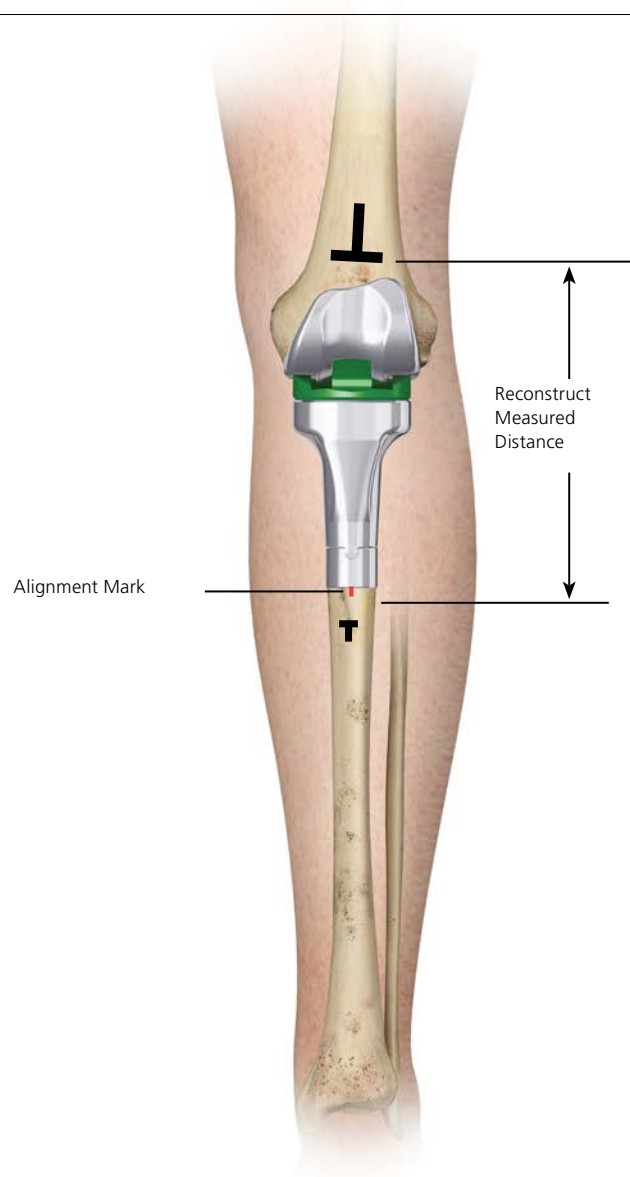


Figure 4.8

Implant Assembly

Once the trial segments yield a satisfactory result with the trial reduction, assemble the appropriate implant components. The implant components use a Morse-taper design for locking. Assemble them by hand with the tibial component plateau placed on top of a clean, sterile cloth or positioned on the S-ROM Tibial Assembly Stand with the stem pointing towards the ceiling.

Assemble the implant components and place the impaction cap over the stem extension. Then use a mallet to securely seat the tapers together (Figure 4.9). There should be approximately a 1 mm gap between the component bodies.

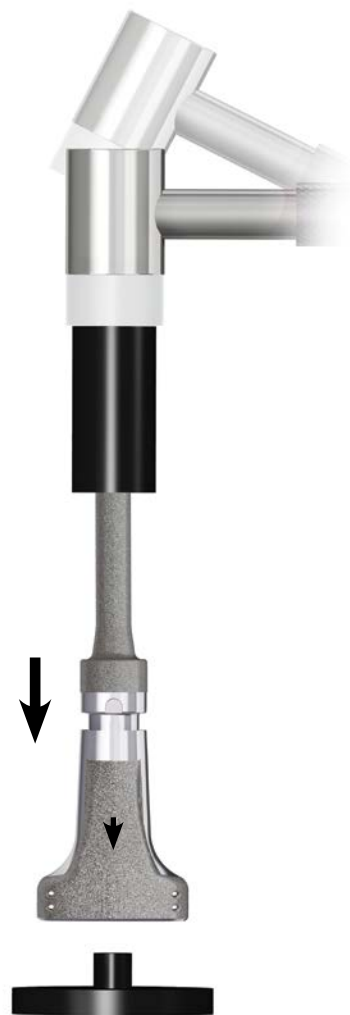


Figure 4.9

Implant Insertion

If using SMARTSET MV Bone Cement to secure the distal femoral stem extension to host bone, follow the manufacturer's recommended procedures to mix, deliver and pressurize the bone cement.

Use the S-ROM Tibial Impactor to insert the implant construct. Orientate the implant's anti-rotation slot with the alignment mark previously placed on the tibia.

If using the porous stem, impact the construct in place using a mallet to strike the inserter and align the anti-rotation tab with mark on the tibia for proper alignment (Figure 4.10).

Placement of a "prophylactic" cerclage wire around the proximal end of the remaining diaphysis may potentially decrease the risk of an intra-operative fracture during press-fit insertion of a porous stem extension, particularly with fragile bone.

Insert a cemented stem construct and align as noted above. Remove the excess bone cement from around the implant collar.



Figure 4.10

The stem extension shoulder should be flush to the tibia's cut surface when using either the cemented or porous stem extension (Figure 4.11). Give meticulous attention to the stem's position. Failure to align the stem in proper rotation may result in patellar instability.

Perform a final trial reduction. Make leg length adjustments and check joint stability by using the LPS Universal Tibial Hinge Insert Bearing Trials prior to choosing the final implant.

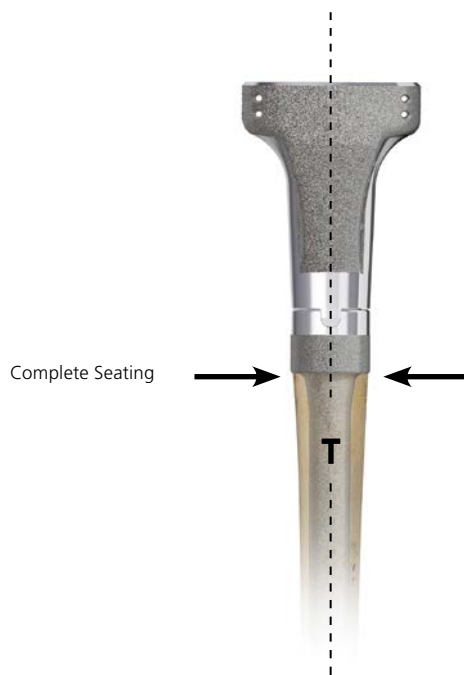


Figure 4.11

Use the hinge pin to mate the S-ROM Hinged Component to the LPS Universal Tibial Hinge Insert Bearing through the hinged tibial insert bearing. Pass the hinge pin through the S-ROM Hinged Femoral Component and the LPS Universal Tibial Hinge Insert Bearing Bushings (Figure 4.12).

It is important to note that the LPS Universal Tibial Hinge Insert Bearing chosen must match the S-ROM Hinged Femoral Component. For example, if a small S-ROM Hinged Femoral Component size is used, then the corresponding LPS Universal Tibial Hinge Insert Bearing must be a small size component.

This insert to femoral component compatibility exists with the LPS Distal Femoral Component as well. For example, if an X-small LPS Distal Femoral Component size is used, then the corresponding LPS Universal Tibial Hinge Insert Bearing must be an X-small size component.

One method to secure the hinge pin uses manual pressure to push the hinge pin through until it “clicks” and locks into place. Another method uses a small rongeur or pliers to squeeze the hinge pin while pushing the pin until it is completely seated in the square cut- out in the S-ROM Hinged Femoral Component. After the pin is seated, pressure is released from the small rongeur or pliers.

Once the pin is securely locked, push the hinge pin from the opposite side of insertion and confirm that it is captured and locked.

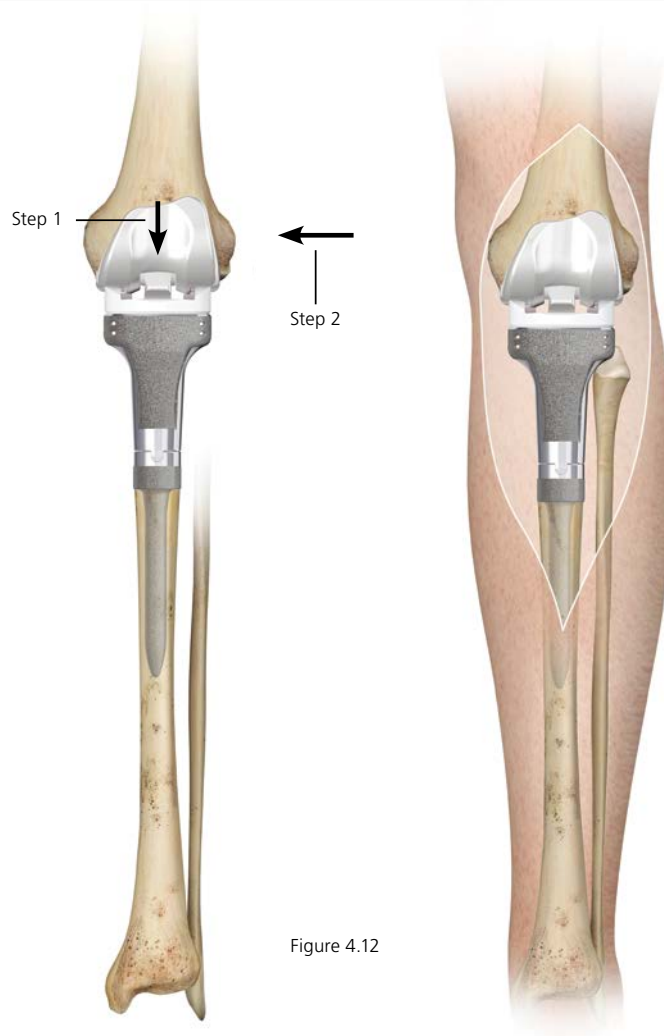


Figure 4.12

Closure

One of the most important aspects of this procedure is the soft tissue reconstruction. Attach the patellar tendon to the implant with heavy sutures or MERSILENE Suture. In order to further secure the patellar tendon, raise the medial or lateral or bilateral gastrocnemius flaps and suture them to the patellar tendon and the surrounding soft tissues. The gastrocnemius flap(s) also fills the defect left by the biopsy tract excision and covers the implant. Use a split thickness skin graft over the exposed muscle flap at the biopsy track excision site.

If, due to grossly inadequate soft tissue integrity, flexion beyond 90 degrees causes luxation of the hinged insert bearing out of the base of the tibial component, the patient must have a knee brace post-operatively to limit flexion to 90 degrees. In such cases consider closing the wound with the knee in full extension.

Perform wound closure in multiple layers to potentially reduce hematoma formation. Perform meticulous wound closure to potentially reduce the wound complications that may preclude immediate physical therapy or other adjuvant oncologic treatments, such as radiation therapy and chemotherapy (Figure 4.13).

Typically close the wound over large bore drains to potentially reduce hematoma collection.



Figure 4.13

Mid-Shaft Femur Replacement

Pre-operative Planning

Intercalary resection and reconstruction is a less common procedure; however, the LPS System allows for such reconstructions when necessary. The indications for the implant's use include soft tissue sarcomas that have invaded bone, midshaft locations for primary bone sarcomas, selected mid-shaft femoral metastatic lesions and selected non-union of the femur's mid-shaft.

Contraindications include active sepsis and situations where insufficient remaining bone is present to support the reconstruction.

The possible advantages of using the LPS System for intercalary reconstruction includes the ability for immediate weight bearing and no reliance upon host bone for allograft healing for long-term durability. This healing may be compromised because of post-operative adjuvant treatment such as radiation therapy or chemotherapy.



The system is modular and is comprised of two medullary stems in the proximal and distal femur and a one-piece intercalary segmental component. The modular stems Morse taper into both ends of the intercalary segmental component. If necessary, segmental components can be added between the stems that adjust for resection length differences to restore leg length. The following technique reviews the intended design and use of the instruments and implants for this procedure and provides a general framework. Use techniques that best meet the needs of each case, since each case is unique and with its own challenges. Consider the following recommendations:

- Perform pre-operative planning and radiographic analysis for every case. Use the LPS System Templates (Cat. No. 2987-99-000) for pre-operative planning to assess the approximate resection levels, use of a segmental component (if needed) to restore leg length and the diameter and length of the femoral extension stems that are used to provide adequate fixation and stability in the remaining host femoral diaphyseal bone.

Exposure and Intra-operative Planning

Use a surgical approach that best achieves the exposure needed for bone resection. It is important to check leg length estimates and alignment prior to any bone resection. Take care during surgery to avoid stretch injury to the neurovascular structures. Use the pre-operative imaging studies such as plain radiographs, CT scans and MRI to determine the resection levels. The minimum intercalary femoral resection amount is 95 mm. This minimum resection level includes the 55 mm intercalary segment component length, plus the two 20 mm stem collar heights (Figure 5.1). If additional replacement length is needed, the 25 mm segmental component is the shortest segment available, making the 120 mm the next level of resection (Figure 5.2). Segmental components are then available in 5 mm increments alone or in combination with other segmental components to adjust leg length.

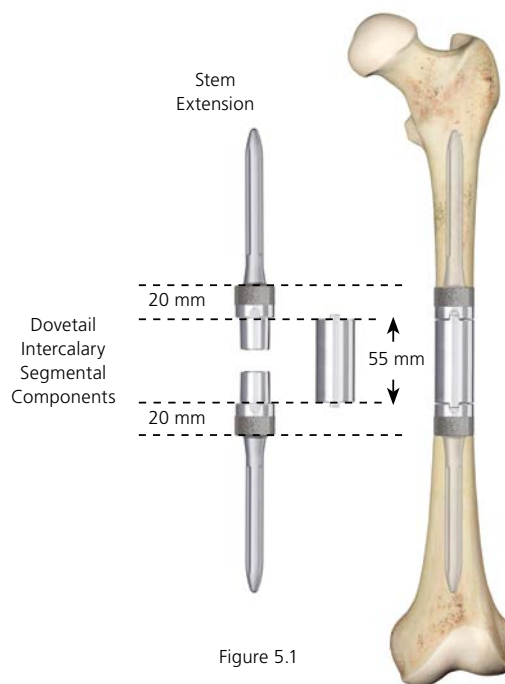


Figure 5.1

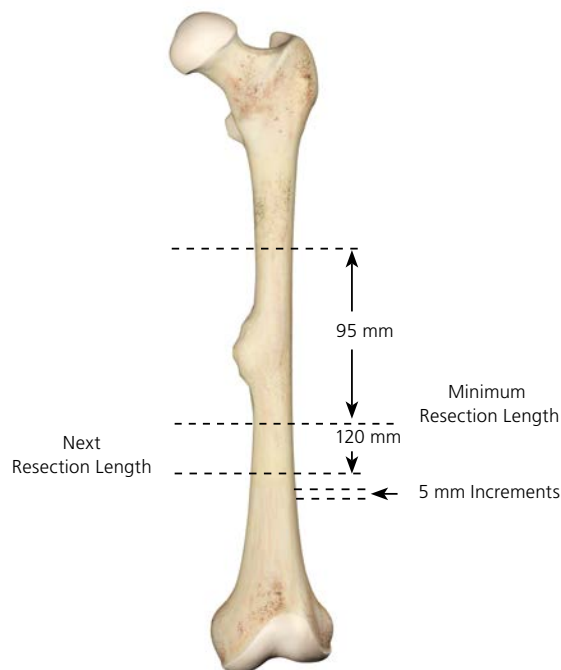


Figure 5.2

After exposing the femur, mark horizontal lines on the femur 1 cm above and below the anticipated resection levels to allow for an estimate to recreate leg length. Record this measurement prior to any resection and use it for future reference in the case (Figure 5.3).

In order to restore proper rotational orientation after reconstruction, make vertical lines perpendicular to the horizontal lines to indicate the femur's anterior surface. Make these using an osteotome, electro-cautery, marking pen or methylene blue.

Femoral Shaft Resections

Following tumor resection, create the proximal and distal osteotomies using an oscillating saw.

Once the bone and soft tissue resection has been performed, prepare the remaining host femur.

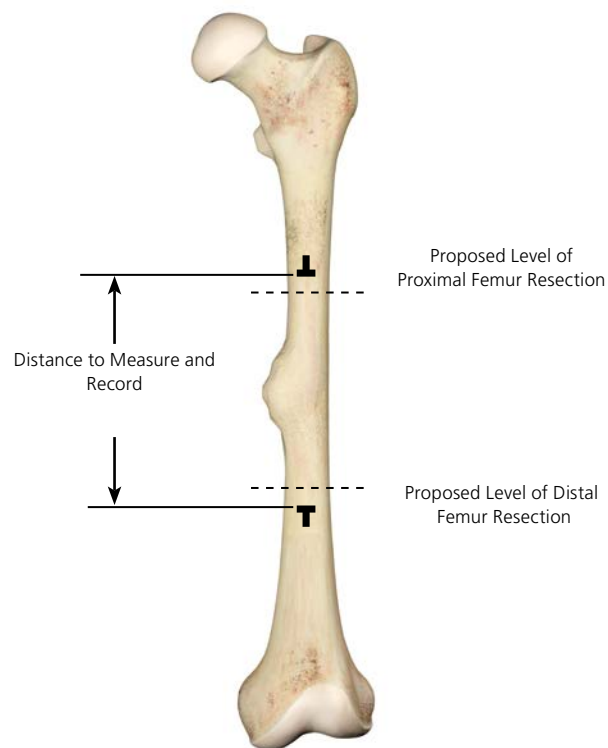


Figure 5.3

Femoral Medullary Canal Preparation

Ream the femoral canals for the stem extension (Figure 5.4). A straight AML System Reamer is recommended for the straight stem extension.

Cemented Stem Application Options

If using a cemented stem, choose a final stem that is smaller than the last reamer used to allow for a circumferential cement mantle around the stem. For example, if a 15 mm IM reamer was used last, an 11 mm stem would have a 2 mm cement mantle per side.

Do not ream the femoral canal to cortical bone for cemented application. Leave some cancellous bone for cement interdigitation.

Porous Stem Application Options

When using a porous-coated straight stem extension, under ream by 0.5 mm for press-fit application of the straight stems. If the remaining bone is fragile, consider line-to-line reaming.

Do not use a cementless application in patients with marked osteopenia or who are deemed to be at risk for an intra-operative fracture. Placement of a “prophylactic” cerclage wire around the proximal and distal ends respectively of the remaining diaphyses may potentially decrease the risk of intra-operative fracture during insertion of the press-fit stems or with fragile bone.

The LPS System Straight Stem Extensions are available in 100 and 125 mm lengths with a range of diameters in 1 mm increments (see the chart on page 67).

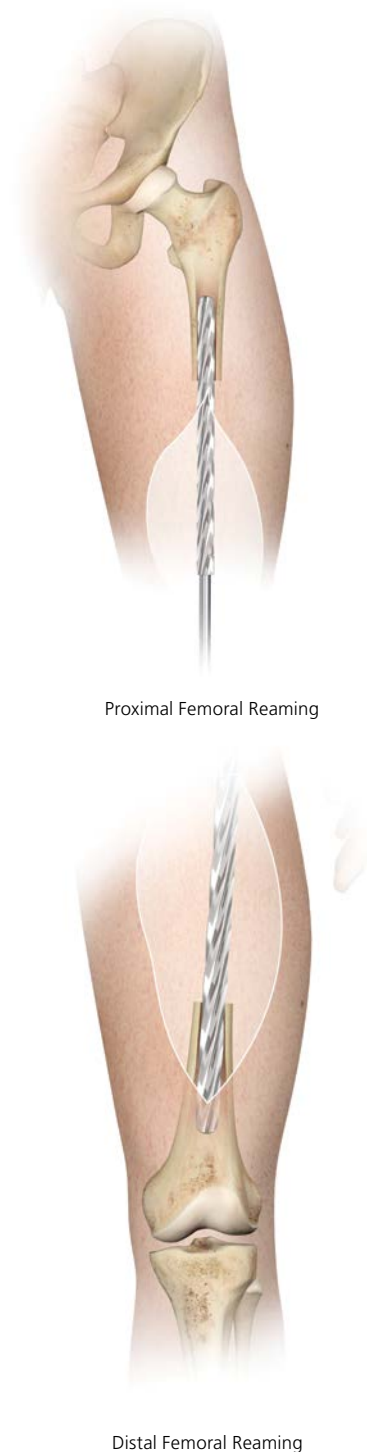


Figure 5.4

Finish Preparation Using the Calcar Planer/Bevel Reamer

Once reaming is completed, prepare the resection to help assure proper stem extension fit. The calcar planer/bevel reamer is designed to produce an even cut surface and an angled relief (bevel) in the bone to match the stem extension flare under the collar. This helps to assure complete stem extension seating on the prepared diaphyseal bone surface.

Choose a calcar planer and insert a bevel reamer with a pilot that is at least 1 mm smaller than the last IM reamer used and insert it into the femoral canal. Sequential use of the bevel reamer with the pilots will prepare the bevel in the remaining bone with more efficiency and precision.

Attach the assembled planer and bevel reamer with a pilot to a power drill reamer using the appropriate adapter. The calcar planer/bevel reamer should be (Figure 5.5) under power prior to planing the resection cut. This will potentially reduce any resected bone chipping caused by the calcar planer cutting blades. The following are recommendations using the calcar planer/bevel reamer with cemented or porous stems:

For a porous stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the intended stem extension size. (For example, if a 15.5 mm stem is the chosen implant, the final bevel reamer with a pilot will also be 15.5 mm).

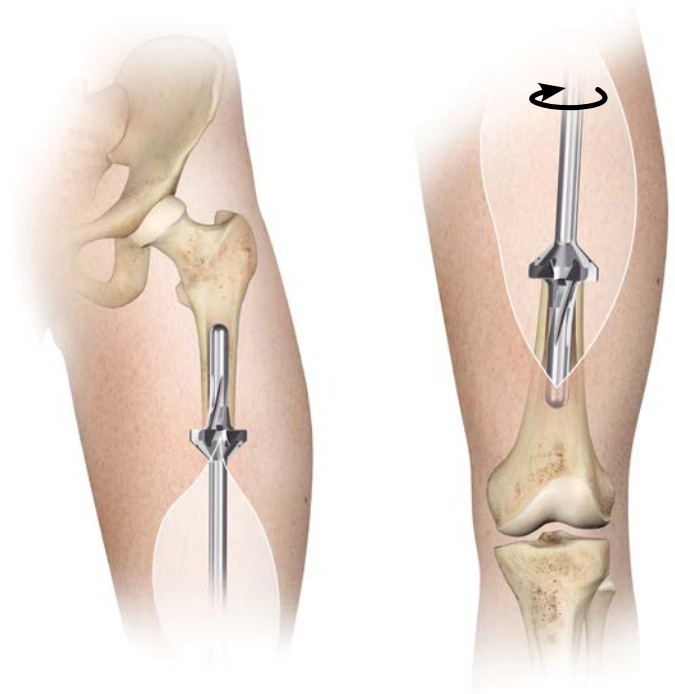


Figure 5.5

For a cemented stem extension:

- Begin reaming with a calcar planer/bevel reamer with a pilot that is at least 1 mm less than the final IM reamer used.
- Progressively increase the size of the bevel reamer until you reach a size that matches the final IM reamer size used. (For example, if the last IM reamer used was 15 mm, the 15 mm bevel reamer pilot will be the final bevel reamer used, irrespective of the stem size chosen, to allow for an adequate cement mantle).

Note: The shaft of the bevel reamer is undersized by 0.5 mm per side from the stated size.

Trial Reduction

Following the femur preparation for the stem extensions, perform a trial reduction. Utilizing the preosteotomy estimate, assemble the appropriate diameter trial stem extensions, intercalary segmental trial and segmental component, if needed, that would fill the missing bone gap. An alternate estimate method is to use the resected femur length to match total trial component length (Figure 5.6).

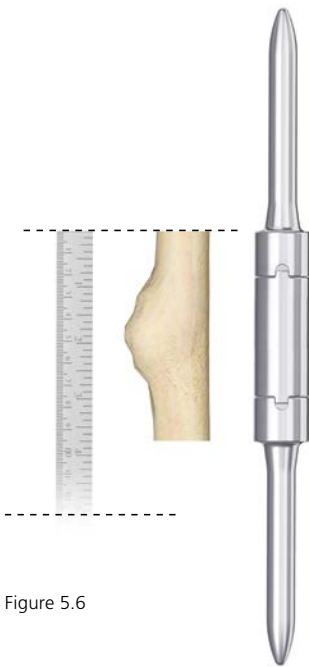


Figure 5.6

Stem Extensions

Cemented Stems (Straight)
10 mm diameter x 100 mm length
11 mm diameter x 100 mm length
12 mm diameter x 100 mm length
12 mm diameter x 125 mm length
13 mm diameter x 125 mm length
14 mm diameter x 125 mm length
15 mm diameter x 125 mm length
16 mm diameter x 125 mm length
17 mm diameter x 125 mm length

Porous Stems (Straight)
11.5 mm diameter x 100 mm length
12.5 mm diameter x 100 mm length
13.5 mm diameter x 100 mm length
13.5 mm diameter x 125 mm length
14.5 mm diameter x 125 mm length
15.5 mm diameter x 125 mm length
16.5 mm diameter x 125 mm length
17.5 mm diameter x 125 mm length
18.5 mm diameter x 125 mm length

Note: Reference the LPS System Pocket Reference Guide, (Cat. No. 0612-35-050 Rev. 5), for complete ordering information.

The trial stem should closely match the last IM reamer or it can be 1–2 mm smaller than the last IM reamer used. Utilize the properly sized stem trial to provide enough stability to prevent “spinning” when performing trial reduction. Insert all trial stems by hand and do not impact them into the canal. Place the intercalary segmental trial between the two stem trials, resting on the stem trial’s flat edge (Fig. 5.7). Use the trial set up to assess stem fit, limb length, soft tissue tension and trial orientation. Assembly and disassembly of the intercalary segmental trial with the stem trials is not recommended because of the risk of stretch injury to the neurovascular and soft tissue structures.

Alignment and limb restoration length are assessed. Once a satisfactory trial reduction is completed, mark the proximal distal femur in line with the anti-rotation slots (Figure 5.7). These marks are important to provide a reference for alignment when inserting the implanted stems in the femur.

With trials in place, if the soft tissues are excessively tight, it may indicate limb length is longer than desired. In such a case, consider additional resection and/or varying the segmental trial (if used) to address this situation. If the limb length is short and needs to be lengthened, consider use of a segmental trial.

Additional resection may be necessary if the segmental trial was not used previously and its use is greater than the amount of shortening. If any additional bone is resected, it is recommended that the femoral canal be reamed further distally and proximally followed by finishing preparation using the calcar planer/bevel reamer. Use the trial construct to mark proper rotational orientation of the components. To establish rotational alignment, center the anti-rotation slot (tab) on the femur’s anterior aspect and mark the femur proximally and distally. These marks will serve as alignment guides on either side of the femur when inserting the stems to align the limb so that it is in the correct rotation after being coupled together through the intercalary segmental component (Figure 5.7).

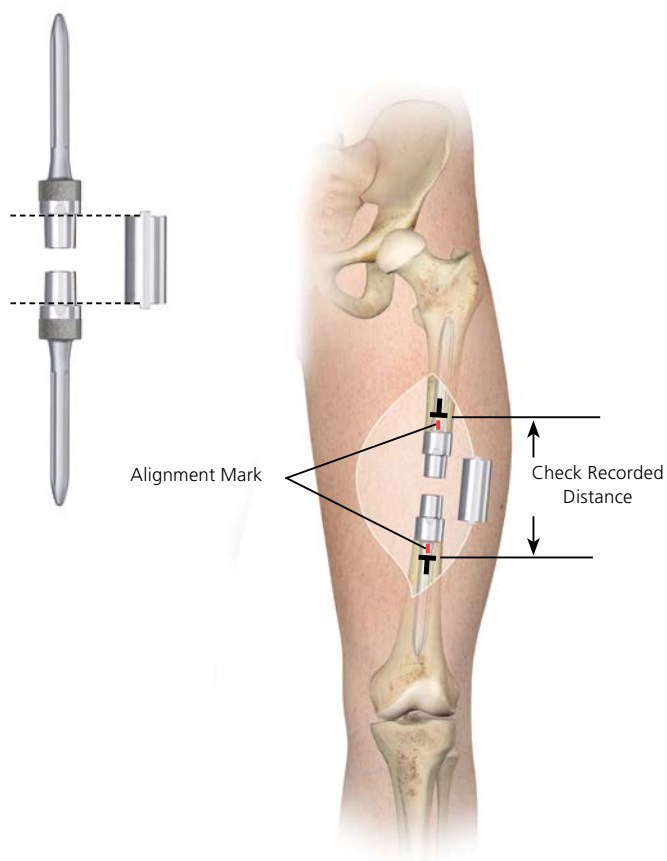


Figure 5.7

Implant Assembly and Insertion

Once the component trials yield a satisfactory result with the trial reduction, assemble the appropriate implant components.

Assemble the intercalary segment by hand to one stem only and place the intercalary segment with the stem on a sterile cloth on the back table with the stem pointing towards the ceiling. Place the impaction cap over the stem and use a mallet to impact the component tapers together to securely seat the components (Figure 5.8).

There should be approximately a 1 mm gap between the intercalary component and the LPS Stems.

If using SMARTSET MV Bone Cement to secure the femoral stems to the host bone, follow the manufacturer's recommended procedures to mix, deliver and pressurize the bone cement into the femoral canal openings.

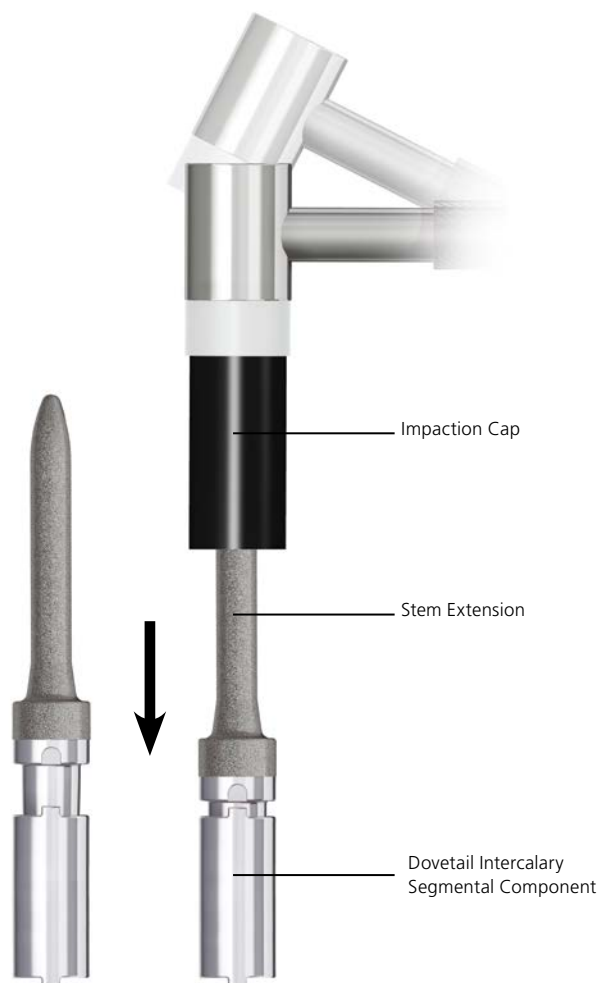


Figure 5.8

Insert the stem/implant into the distal end of the femur, aligning the anti-rotation slot of the stem with the mark previously made on the anterior surface of the femur. Clean any cement from around the stem collar and bone junction. Hold the stem until the bone cement hardens. Align the second stem with the Intercalary Segmental Component to the mark made previously, and insert it into the femur's proximal end and hold it until the bone cement hardens. Again, remove excess cement from the stem collar and bone junction.

Join the remaining taper junction by flexing the femur at the mid-shaft to introduce the distal stem's male taper into the proximal intercalary component's female taper (Figure 5.9).

It is important to clean and dry both tapers prior to assembly. Slowly extend the femur and position the tapers to slide into each other and engage (Figure 5.10). It is important that the component's tab and slot are properly aligned so the taper can fully engage. Seat the tapers by pushing on the patient's knee to help compress the tapers. Post-operatively, allowing the patient to stand and weight bear will allow additional force on the tapers.

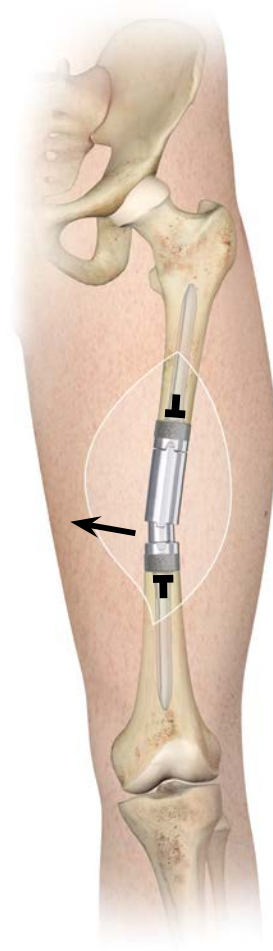


Figure 5.9



Figure 5.10

Closure

One of the most important aspects of this procedure is the soft tissue reconstruction. Soft tissue closure should completely cover the prosthesis. In oncologic applications, when soft tissues are resected to achieve a wide bone tumor margin, the amount of remaining soft tissue coverage is reduced. In this case, remaining musculature mobilization may be necessary to achieve proper soft tissue coverage around the prosthesis (Figure 5.11).

Perform wound closure in multiple layers to potentially reduce hematoma formation. Perform meticulous wound closure to reduce wound complications that may preclude immediate physical therapy or other adjuvant oncologic treatments, such as radiation therapy or chemotherapy.

On occasion, if there is significant soft-tissue fibrosis (e.g. from prior surgery, trauma, irradiation, etc.) then extremity shortening may be necessary to reduce soft tissue tension and allow wound closure without undue tension. Typically close the wound over large bore drains to reduce hematoma collection.



Figure 5.11

Appendix 1: Technique to Disassemble Implant Tapers

Although the LPS System Components are designed for secure implant taper locking, it is possible to disassemble the tapers if needed. The disassembly tool is designed to separate the tapers quickly and efficiently. Although it can be done in situ, it is easier to do this after dislocating the hip.

The disassembly tool's jaws are aligned with the implant's antirotation slots. It is critical to match the disassembly instrument's "half-moon" shape with the implant anti-rotation slot's "half-moon" shape. Once aligned, squeeze the disassembly tool's handle and push down quickly on the disassembly tool (Figure 6.1). The force generated in the anti-rotation slots will produce adequate force to disassemble the taper junction (Figure 6.2).



Figure 6.1

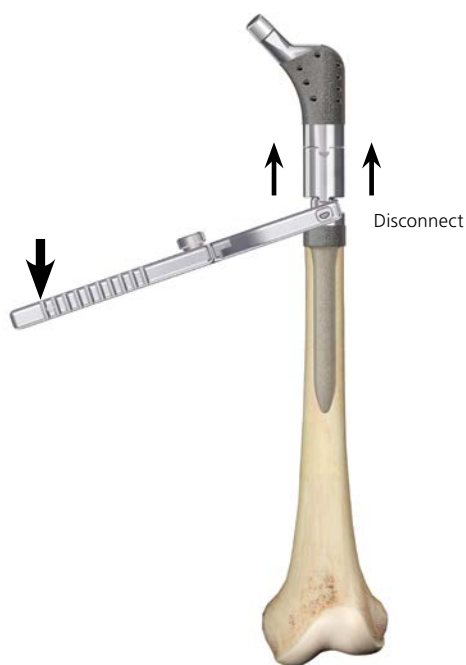


Figure 6.2

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