Stemless Revision TKA Utilizing Metaphyseal Press-fit Sleeves

Kirk Kindsfater, MD. | Orthopaedic Center of the Rockies - Fort Collins, Colorado

Revision total knee arthroplasty can be a complex and difficult procedure.[1-4] There are many decision points that a surgeon must navigate during the procedure to produce an acceptable outcome. Consideration must be given to obtaining reliable fixation of the prosthetic components, managing bony defects, and providing an appropriately aligned and stable construct.

Difficulties in Utilizing Stems

Obtaining stability in revision TKA can often be difficult especially if there are defects in the bone that would normally be supportive of the prosthesis. Utilizing stems in either a press-fit or cemented fashion is a common method of trying to obtain appropriate stability of the prosthetic components.[5-8] Traditionally stems have been used to provide varus/valgus stability and may be able to provide axial and rotational stability as well, although this is somewhat dependent on the design of the stem.[9] However, utilizing stems can make the procedure more difficult and add a layer of complexity to the case. In the case of deformed or bowed intramedullary canals the stem may cause malalignment of the prosthetic component if there is impingement of the stem against the cortex of the tibial or femoral metaphysis/diaphysis. This inadvertent engagement of the cortical bone may "kick" the prosthesis into unwanted varus or valgus malalignment.

Deformed intramedullary canals can also dictate an unfavorable position of the resurfacing portion of the revision component on the distal femur or more commonly on the proximal tibial surface. Often on the tibial side of the joint one must offset the tibial tray in order to allow passage of a stem distally into the IM canal. This may lead to overhang of the tibial tray or necessitate the use of an offset stem so that overhang can be avoided. In addition, intra-operative x-ray or fluoroscopic images are also often required in these instances to verify correct positioning of the stem in the canal. Intra-operative radiography may also be necessary to assure either an appropriate press-fit and/or to confirm that there has been no perforation or violation of the canal by the stem or the preparatory process required to place the stem (i.e., flexible or solid reaming of the canal). This entire process of preparing the canal for a stem, placing the stem and then verifying its position with x-ray adds significant time and complexity to the case, not to mention each additional step in this process adds the potential for an intra-operative error or complication.

Additional factors to consider when utilizing stems include the fact that it can be difficult to obtain a true press-fit with many of the currently available cylindrical shaped stems – especially in the patulous distal femur. If a tight press-fit is obtained, then end of stem pain can also be a significant factor – most commonly seen on the tibial side of the construct.[10,11] To avoid these difficulties and complications, some surgeons have resorted to using cemented stems for their revisions.[11-13] Although relatively reliable in the short term, the longevity of these cemented constructs is unknown in the younger and more active population that are now undergoing revision TKA. Cementing into a sclerotic bed created by the previous arthroplasty may not provide long term fixation in the younger or more active patient. If the need for revision of one of these cemented constructs arises at a later date, revision can be very difficult since a significant portion of the intramedullary canal may be filled with cement that requires removal.

Metaphyseal Filling Sleeves

All of these complicating factors and technical difficulties associated with the use of femoral and tibial stems in revision TKA could potentially be avoided if adequate stability of the construct could be obtained without using stems.

Metaphyseal filling sleeves have now been available for use with the Mobile Bearing Revision base and modular femoral implants for eight years (*DePuy Synthes Joint Reconstruction*, a division of DOI 2014). These sleeves are available in fully porous coated (femoral), partially porous coated (femoral and tibial), and cemented options (femoral and tibial) (Figure 1). There are many advantages associated with the use of these sleeves in revision TKA.

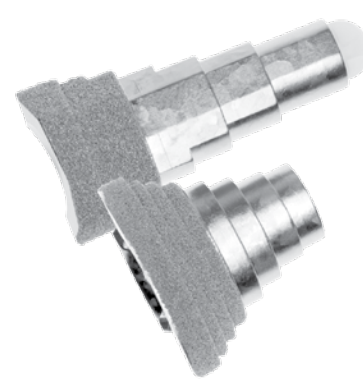

Figure 1: Femoral and tibial metaphyseal sleeves

Metaphyseal Filling Sleeves (continued)

Metaphyseal sleeves in the tibia have an oblong geometrical shape proximally which transitions to a more cylindrical shape distally. The femoral sleeves have more of a constant trapezoidal shape. The sleeves taper in size as one moves from the proximal tibia or distal femur towards the metaphysis of the bone. This geometrical shape and tapering of the sleeves allows for extremely secure fixation in the metaphysis of the tibia or femur. This is very much akin to the stability a tapered femoral stem achieves in the proximal femur when performing THA. Therefore, not only do these metaphyseal sleeves provide for varus/valgus stability, but they also provide for axial and rotational stability (Figure 2). This stability is often great enough that supplemental fixation with stems is not necessary, thereby simplifying the entire revision operation.

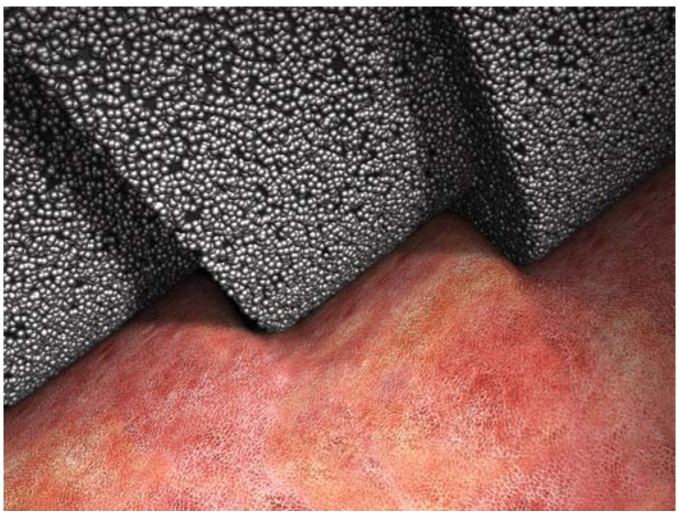

Figure 2 - Stepped geometry of metaphyseal sleeves

Advantages of Metaphyseal Sleeves Without Stems

In addition to enhanced stability, metaphyseal sleeves when utilized without stems provide many other advantages when compared to traditional stems. The sleeves are very easy to place – utilizing a simple broaching technique similar to what most surgeons are familiar with in total hip arthroplasty. The placement of the sleeves is typically independent of any deformity or bowing of the tibial or femoral intramedullary canals. Because of this, the sleeves can be placed so that the sleeve/tibial tray construct will have optimal coverage of the proximal tibia without overhang. The same analogy can be drawn on the femoral side of the joint, although this is not typically of as much concern as on the tibial side of the construct. Since there is no need for preparation of the intramedullary canal, there is much less risk of diaphyseal/metaphyseal perforation. Additionally, because there is no stem being placed in the canal, the need for intra-operative imaging is reduced along with the surgical time of the case.

The stability of the sleeves allows for use in most contained defects and some uncontained defects of the proximal tibia or distal femur (Figure 3). Also, because the sleeves are available in porous coated versions (partially coated on the tibia, partially and fully coated on the femur) they can be used in a press-fit fashion, avoiding the need for cement in the metaphysis or diaphysis of the tibia/femur. This may be particularly advantageous for the younger/more active patient undergoing revision TKA who may benefit from biologic fixation of their implants. Finally, since the sleeves have some rotational freedom in how they are placed on the tibial/femoral components, the sleeves can be rotated to take advantage of the best available bone. This is particularly important on the tibial side of the joint as the sleeve can be placed in the best available bone and tibial component can be rotated to gain the best coverage of the proximal tibia. This "rotational freedom" compliments the attributes of the rotating platform articulation of the mobile bearing revision tray.

Figure 3 - Contained and uncontained defects in revision cases

Surgical Technique

The author utilizes a tibia first surgical technique on all revision TKA's. The rationale is that the tibial cut should be one of the easiest cuts to make in the correct alignment and the remainder of the surgery, including the axial alignment of the joint and the rotational alignment of the femoral component, are based off the tibial cut.

Once the old components are removed from the knee, the tibial cut is addressed first. A clean up cut is performed utilizing either an extramedullary or IM guide. The purpose of this cut is to give the surgeon a flat, planar surface on the proximal tibia. If all bone defects are not taken out with this minimal 3 – 4 mm resection, they can be ignored initially and will be dealt with later in the case. Any remaining cement debris should also be removed from the tibial surface and tibial canal at this time. Starting with the smallest broach for the sleeves, the proximal tibia is broached with the intent of having the surface of the broach co-planar with the cut tibial surface. In the author's experience, this is relatively easy to do. Placing a stem trial on the broach to help guide the construct down the IM canal is avoided as this negates many of the advantages of utilizing the sleeves in a stemless fashion. In most cases, the defect in the proximal tibia is large enough to begin using the smallest broach. If the defect in the proximal tibia is not large enough to accommodate the smallest broach, then a conical reamer is used to open up the plateau and metaphyseal area for the broach. Progressively larger broaches are utilized until the broach is axially and most importantly rotationally stable when fully seated in the proximal tibial metaphysis. The surgeon should be able to torque the seated broach vigorously without any evidence of rotation. If there is rotational motion, then the next larger broach should be utilized until rotational stability is obtained. Once the final broach is seated, any deviation in the plane of the top of the broach and the tibial plateau can be touched up by either utilizing the top of the broach as a guide and cutting off of it or utilizing a cutting guide that connects to the top of the broach. It is important for the surgeon to keep in mind that during the preparation for and implantation of the metaphyseal sleeve that there is a risk of malalignment if he/she prepares the envelope for the metaphyseal sleeve in such a fashion that when seated the sleeve is not coplanar with the proximal tibial cut. Once this clean-up cut is made, the broach is removed and the trial construct is assembled and impacted onto the proximal tibia.

Spacer blocks should then be utilized in both extension and flexion to determine the respective gaps. This will provide the surgeon with the appropriate information to ensure that the flexion and extension gaps are balanced.[14,15]

The femur is then addressed. A distal clean up cut is made by utilizing the intramedullary femoral guide set to the appropriate valgus angle (either 5 or 7 degrees). Broaching of the distal femur is then undertaken as described for the tibia. As on the tibial side of the joint, a conical reamer can be used to open up the metaphysis or entry point to the canal. One difference in broaching on the femoral side vs the tibial side is that the author does utilize a small diameter stem on the broach to help guide the femoral broach up the femoral canal. The patulous nature of the distal femur can allow for malalignment of the broach/sleeve if done freehand. Once the femoral broach has been seated to the appropriate depth (to accommodate for the appropriate extension gap) the anterior/posterior cuts can be made. These are based off of the extremely stable femoral broach construct, which allows for very accurate anterior/posterior placement of the femoral component. The box and chamfer cuts are then completed, and the trial femoral components are then assembled and implanted.

Once the trialing process is complete, the trial components are removed. Care should be taken to not disturb the relative positions of the trial sleeves on the trial components. This positioning will be used to assemble the real components with the sleeves in the correct rotation with respect to the tibial and femoral components as noted on the trials. The tibial and femoral sleeves are positioned correctly and then impacted onto their tapers. The assembled components are then implanted. Cement is used only on the tibial plateau and on the resurfacing portion of the femur. Cement is avoided in the metaphyseal areas of the implants as the goal is to obtain biologic fixation from the porous coated surfaces of the sleeves.

One additional technical point on the tibial side of the joint should be considered. If there is a defect in the tibia requiring an augment, only the smallest tibial sleeve (29 mm) is compatible with augment and the proximal tibia should be prepared accordingly. If adequate press-fit cannot be obtained with the small tibial sleeve, then adjunctive fixation with a stem can be utilized or the sleeve can be cemented.

Author's Clinical Experience

The author has performed twenty-eight TKA revisions utilizing metaphyseal sleeves without stems. The average length of follow-up has been 11.7 months. There have been no failures to date. One press-fit tibial sleeve with 27 month follow-up has a radio-sclerotic line around the sleeve, but without evidence of subsidence and the patient is asymptomatic. The remaining sleeves at this time show no evidence of radiographic loosening. None of the sleeves have required revision for any reason.

Figure 4 shows the follow-up radiograph at 20 months of a revision TKA performed for aseptic loosening. Both femoral and tibial constructs utilize ingrowth press-fit sleeves. The bone prosthetic interface of the sleeves show no evidence of loosening or micromotion and the construct appears well fixed on both the femoral and tibial sides of the joint.

Discussion

Although follow up is short on this single surgeon series of revision TKA's, the early results are encouraging as far as fixation and clinical performance are concerned. Revision TKA utilizing this technique can make the surgery easier, less complicated, and more efficient from a time standpoint. The pitfalls of utilizing diaphyseal engaging stems or cemented stems can be avoided in many revision cases.

Not all revision TKA's will be amenable to this technique, however, if adequate stability can be obtained with sleeves alone, consideration can be given to utilizing metaphyseal sleeves without adjunctive stem fixation.

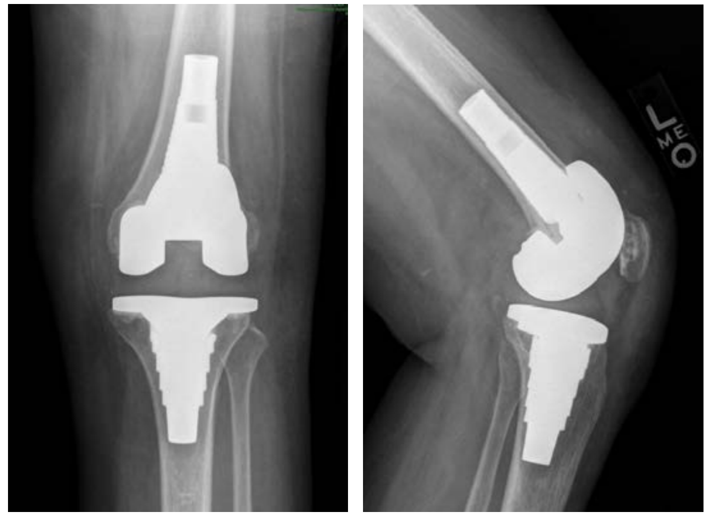

Figure 4 - A/P and Lateral of revision TKA utilizing press-fit metaphyseal sleeves.

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0612-92-509 (Rev. 1) 04/13