With the growing number of total knee arthroplasties being performed in the United States, revisions have inevitably become common practice. Presently over 50,000 revision surgeries are being performed each year in the United States.\(^1\)

With less bone stock, bony fixation is more complex and less reliable. In addition, collateral deficiency requires higher levels of constraint. Therefore, bone stock and constraint issues have led to challenges with long-term success. Traditionally augments and stems have been used to improve fixation to condylar and plateau bone. Cemented and non-cemented stems currently exist to support adjunctive fixation. Cemented stems can be metaphyseal, while non-cemented must be diaphyseal. These stems do not bypass the plateau fixation but can distribute the forces off-loading the plateau to an extent.

With early revision options, the main goal is to rebuild the bone stock in order to create a stable plateau and to permit a stable surface for the tibial baseplate to rest. If the baseplate does not sit directly on the tibial plateau, shear forces increase, which can lead to a cantilever effect and ultimate failure (Figure 1). In addition, fixed bearing knees must have proper rotation of the baseplate or patella tracking issues can occur. With an internally rotated tibial baseplate, the Q-angle increases, leading to the potential for patella subluxation or dislocation. These two factors created the need for the development of offset stem options for component fixation. Consequently, this promotes the best coverage for the tibial baseplate, decreasing shear forces and properly positioning the baseplate for patellar tracking when using a fixed bearing.

Greater constraint decreases the risk of implant instability, but leads to increased forces on the polyethylene post and metal tibial baseplate. This kinematic conflict has led to the introduction of mobile bearing revision options available through the Sigma\textsuperscript{®} TC3 and LCS\textsuperscript{®} VVC systems. By increasing implant constraint, and uncoupling the polyethylene from the baseplate, the potential risk for implant loosening is minimized.

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**Why Offset Stems are Obsolete with Mobile Bearing Revision Total Knee Arthroplasty**

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Figure 1: Eccentric compressive forces lead to a cantilever effect and early failure
In order to understand why \textit{fset} is not necessary with the combination of a rotating platform design and metaphyseal sleeves, the industrial engineering concept of spindle in cradle should be observed (Figure 2). The cradle is put into a device that is heated in order to cause expansion. Once heated, the spindle is dropped into the cradle, and rapidly cooled. This process causes the two materials to fuse together. Metaphorically speaking, the metaphyseal sleeve would be the cradle and the baseplate is analogous to the spindle. By fusing these together, fixation occurs at the metaphysis, bypassing the poor bone at the tibial plateau (Figure 3). Reliance upon a rigid cortical rim fit is not paramount.

This system of metaphyseal sleeve fixation is completely unique in the orthopaedic market place. Other systems such as porous cones or augments attempt to create a stable platform for the tibial baseplate to be cemented onto by filling cavity and segmental defects. The tibial baseplate is then cemented into the augment. Since cement is a static material, if cantilever forces occur, the baseplate will ultimately loosen. With a spindle in cradle concept, implant fixation remains distal, where good bone stock exists. Therefore, not only do these sleeves fill cavitary defects but, if a segmental defect exists, they are bypassed.

Although cantilever loosening is not a concern with biologically ingrown metaphyseal sleeves, overhang is a concern as a cause for retinacular pain. Therefore the question becomes: Is there a way to avoid overhang with a central keel? The answer is yes. One key advantage of rotating platform technology is its self-aligning properties. Since the polyethylene will self-align, the tibial baseplate may be downsized and rotated for best coverage of the tibial plateau. Rotating platform designs do not require exact placement of the tibial baseplate relative to the tibial tubercle, as do fixed bearing designs (Figure 4). In addition, with a fixed bearing design, peripheral cortical contact is paramount in order to decrease cantilever forces. Since fixation is achieved in the metaphysis, the potential for cantilevering, and ultimately implant failure, is minimized.

If a revision requires 25 mm or more of combined polyethylene and tibial baseplate build up, the M.B.T. Revision thick trays may be used. These have the advantage of using larger baseplates that taper to smaller sizes distally. For example, a size 4 built up tibial baseplate is a size 2 at the bone interface (Figure 5).
Case example: The use of offset stems are unnecessary when using metaphyseal sleeves with a rotating platform TC3.

This patient was a 67 year old female, four years status post revision total knee replacement (Figure 6). The patient complained of shin pain, especially with ambulation. Her infection work up was negative, however, her bone scan was consistent with loosening on the tibial side. Even though this offset stem allowed for proper peripheral cortical coverage of the tibial plateau, the prosthesis was still loose at only four years postoperatively.

Notice that the best bone is the metaphysis region is missing (Figure 6). There is also lysis around the stem and distal pedestal.

Postoperative AP X-ray: The revision surgery consisted of removal of all components and conversion to a rotating platform Sigma Revision TC3. Metaphyseal sleeves were used both in the tibia and femur for biologic fixation. Non-cemented diaphyseal stems were used for alignment and provisional stability while ingrowth occurred. Cement was used only at the plateau surface of the tibial and the condylar surface of the femur. Notice that the metaphyseal sleeve fixation allows the proper alignment and restoration of the joint line without requiring the use of an offset stem to achieve fixation (Figures 7 and 8).

No overhang occurred in this case, even though an offset stem was required with the previous fixed bearing system.

The X-ray in figure 8 reveals a large amount of proximal cement, greater than the classic 5 mm accepted. The entire proximal tibial plateau was essentially bypassed. Cement was used only for provisional fixation while biological tissue ingrowth occurred. Notice the spot weld seen on the medial aspect of the metaphyseal sleeve. By using a smaller tibial baseplate and rotating it, no overhang occurred.

In conclusion, the combination of rotating platform technology and metaphyseal sleeves is revolutionary in the field of revision total joint arthroplasty. For the first time poor bone stock can be bypassed. This is analogous to using an 8 or 10 inch distally fixed hip replacement when no proximal bone remains. By combining porous coated sleeves with mobile bearing technology, tibial base plates can be rotated for best fit and offset stems are no longer necessary.
References