Mobile Bearing Tray (MBT) and Metaphyseal Sleeves in Complex Primary Knee Surgery

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Total Knee Arthroplasty

The demand for Total Knee Arthroplasty (TKA) is projected to increase over the next two decades. As this occurs, the number of complex primary and revision knee cases will also increase, presenting a number of challenges. One such challenge is the need to obtain solid fixation of implants into host bone. In most primary situations a primary femoral component, tibial tray and non-constrained insert will provide adequate stability for the patient. However there is a subset of primary knee patients that require additional fixation options. Conditions like previous trauma, avascular necrosis, cyst formation (as seen in rheumatoid arthritis), severe deformity, neuromuscular diseases (such as post-polio) and instability may result in excess bone loss and the need for additional fixation or support. In addition, the number of patients presenting with morbid obesity has become a steadily increasing problem. Recent data from the Mayo Clinic highlighted the importance for surgeons to consider additional tibial fixation options for patients with a BMI over 35, even if excess bone loss is not present.2,3

Metaphyseal Sleeves in Complex Primary TKA

To address these pathologies in the primary knee setting, several techniques have been utilized including bone graft4-7, cement and screws8, block augments9-10 and tantalum metal cones11-16. An alternative option for addressing bone loss is the use of a porous coated metaphyseal sleeve. Metaphyseal sleeves have been successfully used for the past 40 years, starting with the S-ROM® NOILES™ Hinge Knee prosthesis. Metaphyseal sleeves engage into the metaphysis of the distal femur or proximal tibia via a stepped design. These steps compressively load the bone according to “Wolff’s Law” and feature a porous coating to promote biological fixation (Figure 1).

Since their inception with the S-ROM NOILES Hinge Knee, metaphyseal sleeves have demonstrated good long-term outcomes.17 Further knee implant developments have permitted the use of metaphyseal sleeves with a semi-constrained revision system. Initial studies looking at the outcomes of this use have been encouraging.18-21 More recently, metaphyseal sleeves have been utilized in complex primary cases where excess bone loss has occurred. While this trend has been predominately in Western markets, the challenges presented in many Asian markets make a strong case for the adoption of this technique for the appropriate complex primary knee arthroplasty.

In Asia, more patients present with primary arthritis of the knee and associated complex deformity than in the Western countries. This may be due to a combination of factors which include late presentation, compromised bone stock, variable anatomy and compensatory bone overgrowth. In Asia, surgeons have historically employed different strategies and techniques to treat these challenging patients. Some of these include bone graft, metal wedges with and without offset stems (Figure 2 and Figure 3), and extra articular osteotomy (Figure 4 and Figure 5).
Three anatomical zones exist within both the femur and tibia which can be used to support revision implants. These consist of the joint surface or epiphysis, the metaphysis and the diaphysis (Figure 6).

With the recent introduction of metaphyseal sleeves into most Asian markets, surgeons are now provided a viable alternative for complex primary cases in place of the techniques and options described above including deformity in Zones 1 and 2. As opposed to the traditional options, metaphyseal sleeves are able to fill defects in Zone 2 and provide fixation in this zone.

In cases where the deformity lies in Zone 3 (diaphysis), surgeons may still be required to use an osteotomy to correct the deformity, either on its own or combined with total knee arthroplasty.

These metaphyseal sleeve attributes are well demonstrated by the following case:

**Case study**

A 44-year-old man sustained a traumatic dislocation of his knee when he was 20 years of age. He developed significant osteoarthritis of the knee requiring a complex primary knee replacement (Figure 6), including a metaphyseal sleeve on the tibia. The intra-operative picture shows the sleeve preparation for the tibia and a standard posterior stabilized (PS) femoral (Figure 7a). The stepped porous coating gives biological fixation and leads to compressive metaphyseal loading (Figure 2 and Figure 7a), and bone remodeling. Figure 7b shows an intra-operative picture with the final femoral and tibial components and a trial mobile bearing insert in place. Figure 7c is a four year post-operative radiograph showing good integration of the sleeve. This radiograph points out another advantage of metaphyseal sleeves - with Zone 2 being adjacent to Zone 1, the use of an offset stem in this situation is not required (Figure 7c and Figure 8).
MBT Revision System

The metaphyseal sleeves are designed to be used in conjunction with the MBT Revision System. Metaphyseal sleeves provide a comprehensive option to help surgeons manage a variety of bone defects. On its own, the MBT Revision Tray is 67 mm in length, longer than most Fixed Bearing (FB) revision trays with their shortest stem.

The MBT Revision System also has the added advantage of using mobile bearing articulation. Mobile bearing articulation offers increased contact area, increased conformity, reduction of wear and reduced torque (Figure 10 and Figure 11) compared to fixed bearing articulation. The increased torsional forces associated with fixed bearing designs, especially in highly constrained designs, may increase the load transmitted to the bone-implant interface resulting in premature implant loosening (Figure 11).

The MBT Revision System can also facilitate patella tracking due to the self-aligning nature of the femoral component. Patella tracking is further benefited by the ability to freely rotate the tibial tray. Unlike FB designs, it is not critical to align the MBT Revision Tray with the medial third of the tibial tubercle. This provides the surgeon more flexibility in achieving optimal bone-implant coverage without sacrificing kinematics.
Conclusion
The MBT Revision System with metaphyseal sleeves has been shown to be effective in both complex primary and revision knee applications. With growing numbers of complex and revision cases around the globe (especially in Asia) surgeons will need solutions that deliver both fixation and flexibility. By making complex surgery less challenging, health care providers will be able to turn their attention to other critical aspects of patient treatment and care.

References