HOW THE HISTORY OF ZWEYMULLER HIPS LED TO THE DESIGN OF THE

PROFEMUR® Z

TOTAL HIP SYSTEM

In 1979, the German surgeon, Karl Zweymuller, MD revolutionized cementless hip arthroplasty with the introduction of his first generation of press-fit total hips. Zweymuller, a press-fit hip enthusiast, was reluctant to utilize bone cement in patients probably due to the inherent dangers of thermal necrosis, pulmonary emboli, and general toxicity.[7,8,9] Although a believer in the press-fit concept, Zweymuller found fault with the design concepts employed by the press-fit hips of that era. These hips featured macroporous coatings such as sintered beads, plasma spray, and woven metal to promote bone in-growth. Zweymuller found these bulky coatings unnecessary. Instead, he felt a microporous (grit-blasted) surface was sufficient. Furthermore, the surgical technique for these early hip prostheses involved coring-out the cancellous bone in the femur and implanting proximal and distal canal-filling stems. Zweymuller theorized these elliptical, space-filling hip stems removed too much bone, interrupted intramedullary blood flow, and exhibited poor torsional resistance.[1,3]

Every iteration of Zweymuller stem has achieved excellent clinical results. This is due to the "square peg in a round hole" design philosophy. When implanted, the dual tapered stem is wedged into the cylindrical metaphysis and proximal diaphysis until the corners of its rectangular cross-section find solid purchase in cortical bone | **FIGURE 1**. This provides immediate primary fixation.[3]

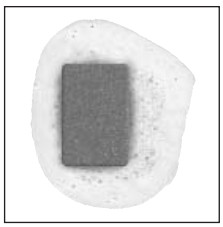

FIGURE 1

As it is impacted, the stem taper causes a slight, pre-stress which loads the bone evenly and prevents bone resorption.[1] Secondary fixation is provided by bone on-growth, which is promoted through the corundum-blasted titanium implant and superior stress transfer along the length of the stem. Broaches, equal in size to the implants, are utilized to conservatively prepare the femoral canal. This reduces the amount of bone that is displaced; preserving vascular cancellous bone which will surround the implant and facilitate bone on-growth. [3,4,5,6]

FIGURE 2A

Although clinical experience with the Zweymuller stem has been exemplary,[4,10,11] most of its use has taken place in Europe. In fact, many surgeons in the United States have been reluctant to utilize it due to its angular geometry. Common concerns of those unacquainted with the stems are fears of subsidence, femoral fracture, and difficulty in positioning. Although these concerns may be encountered within the orthopedic community, the outstanding clinical history of Zweymuller stems is creating greater market acceptance.

The first generation of Zweymuller stem, the Hochgezogan (HG), was manufactured by Sulzer (now Centerpulse) in 1979. Instead of the rounded geometry of a standard hip stem, the HG featured a rectangular cross-section with a dual-taper.[2] | **FIGURE 2A** Like many modern titanium hip stems, it was composed of an alloy containing 4% vanadium (Ti-6Al-4V). Proximally, the dual-taper geometry was interrupted by a recessed proximal narrowing (commonly called the "step") | **FIGURE 2B**. Nine holes were placed in this proximal area to allow sutured attachment of tissue. Instead of the usual macro-coatings, the entire surface of the HG was relatively smooth (1 μmRa). Although this stem was strikingly different in geometry from standard press-fit hips, studies have shown it was 95% successful after 10-years.[1]

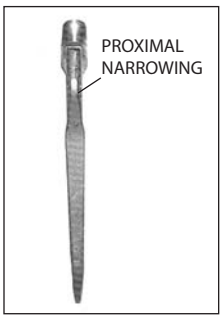

FIGURE 2B

WRIGHT.

Few clinical issues were reported with the stem; however osteolysis and poor bone on-growth were noted in the proximal region.[2] The osteolysis was attributed to the high wear rate of the Zweymuller all-poly acetabular cup which was routinely utilized with the stem.[3] The lack of proximal bone growth was attributed to the lack of stress transfer due to the proximal narrowing of the stem.[2]

In 1986, the second generation of Zweymuller stem was designed to rectify the issues of the HG and was called the Stepless (SL) **| FIGURE 3**. Although very similar in appearance to the HG, the SL did not feature the proximal narrowing or "step". It was originally sold under the trademark Allopro® and is now distributed by Centerpulse as the Alloclassic®. Although the stem was still composed of a titanium alloy, the vanadium was replaced with niobium (Ti-6Al-4N) because vanadium was thought to be toxic.[3] It appears these concerns were relatively unfounded due to the prevalence (and clinical success) of vanadium in current titanium orthopaedic implants. To achieve better bone on-growth, this titanium substrate was corundum-blasted to a micro-porous texture of 3-5 μmRa. Furthermore, the Zweymuller all-poly acetabular shell was replaced with a self-tapping, threaded titanium shell; which proved to have a better clinical reputation.[3] Studies have shown the superiority of the SL over the HG; with the SL demonstrating approximately 99% survivorship at 10-years.[4,11]

FIGURE 3

The third generation of Zweymuller stem was called the SL-Plus, and it is currently being distributed by Plus Orthopaedics (Rotkreuz, Switzerland) **| FIGURE 4**. Due to the outstanding clinical results achieved with the SL, the SL-Plus has undergone only slight design changes. It features the same 3-5 μmRa micro-porous coating, a dual-taper, and a rectangular cross-section. However, it does feature a broader trochanteric wing that provides 5% greater contact area to resist rotation[3] **| A IN FIGURE 4**.

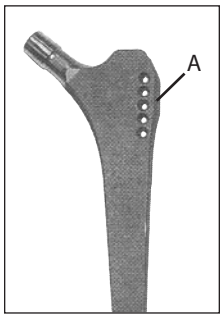

FIGURE 4

The PROFEMUR® Z Hip System was launched in 2001 by Wright Cremascoli Ortho (Italy), and is based on the outstanding design of the Zweymuller stems. This is evidenced by the geometry of the PROFEMUR® Z Hip, which is reminiscent of the SL-Plus **| FIGURE 5A**. It features a similar trochanteric wing, a dual-taper, and a rectangular cross-section **| FIGURE 5B**. Like the titanium alloy of the Zweymuller HG, the PROFEMUR® Z Hip contains vanadium instead of niobium. Furthermore, to allow better osteointegration, the PROFEMUR® Z Hip has a clinically proven surface roughness of 6 μmRa instead of the Zweymuller 3-5 μmRa. However, these changes are slight. The most major and identifiable change of the PROFEMUR® Z Hip System lies in its modular necks. Through the use of these necks, limb-length and offset may be adjusted independently for perfect hip balance every time. This offers surgeons more intraoperative flexibility than was ever afforded by any previous generation of Zweymuller hip.

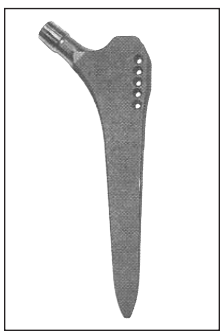

FIGURE 5A

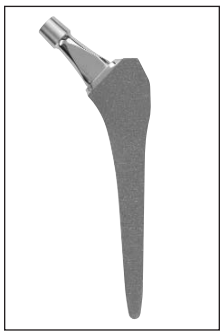

FIGURE 5B

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