Trabecular Metal™ Technology

The Best Thing Next to Bone™

Trabecular Metal™ Material resembles trabecular bone in its cellular structure and weight-bearing characteristics. By approximating the mechanical and physical properties of bone, this highly porous, structural biomaterial enables rapid and extensive bone infiltration.[1,2,3]

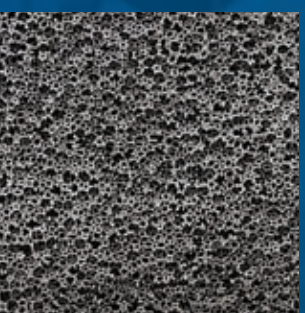
The Best Thing Next to Bone

Since 1997, over 100,000 cases have been performed worldwide with *Trabecular Metal* Implants. The clinical results in primary hip and knee reconstruction and spinal surgery have been truly remarkable.

7 Year Follow-up

Trabecular Metal Technology

- **Used clinically since 1997**
- **75-80% porous, permeability similar to bone** [1,2,4]
- **Enables osteoconduction and fixation** [1,2,3]
- **High strength and ductility** [1,2]
- **Elasticity similar to bone** [1,2]
- **Intrinsically high friction and stability** [5,6]



Trabecular Metal *Material*
Actual size

Porosity

Fully interconnected pores and 75%-80% porosity allow approximately two to three times greater bone ingrowth than with conventional porous coatings and double the interface shear strength.[1,2]

Bone Fixation Strength

Bone interface shear strength (MPa) of *Trabecular Metal* Material compared with sintered beads at four weeks.[1,2]

***Trabecular Metal* Material** ≥ **18** (MPa)

Sintered Beads **7-9** (MPa)

The Best Thing Next to Bone

Friction/Stability

Trabecular Metal Material produces significantly more friction than sintered coatings on cancellous bone, which increases initial implant stability.[5,6]

Stability Comparison

***Trabecular Metal* Material** **.88**
Friction on Cancellous Bone

Sintered Beads **.60**
Friction on Cancellous Bone

Flexibility

Trabecular Metal Material is made from elemental tantalum metal, and is strong, ductile and can withstand physiological loading. The 3-D structure of *Trabecular Metal* Material provides inherent flexibility similar to bone, thereby reducing the potential for stress shielding.[7,8]

Elastic Modulus

Trabecular Metal Material's elastic modulus is between that of cortical and cancellous bone, and similar to subchondral bone.[1,2]

Cobalt-Chromium **210** (GPa)
Titanium Alloy **110** (GPa)
Cortical Bone **15** (GPa)
***Trabecular Metal* Material** **3** (GPa)
Subchondral Bone **2** (GPa)
Trabecular Bone **.10** (GPa)

For the total knee surgeon who strives to optimize implant fixation, stability, and alignment, *Trabecular Metal* Technology offers an opportunity to achieve an excellent level of each. In primary TKA, this remarkable material addresses the issues associated with polyethylene wear debris and stress shielding.[8]

Primary
Total Knee Arthroplasty

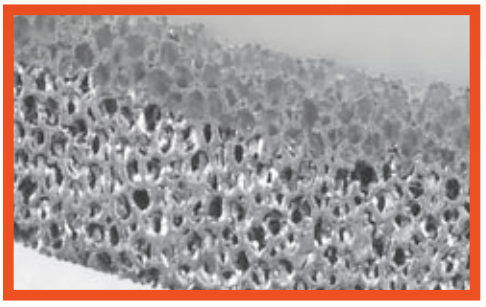
Trabecular Metal Monoblock Tibial Component

By combining *Trabecular Metal* Technology with the clinically proven geometries of the *NexGen*® Complete Knee Solution Tibial Articular Surfaces, the physical and mechanical properties of the monoblock design mimic those of bone.[8] High compressive strength and low stiffness help prevent stress shielding and lift-off. The monoblock design eliminates the possibility of backside wear caused by micromotion at modular interfaces. In addition, press-fit *Trabecular Metal* pegs provide excellent initial stability.[9]

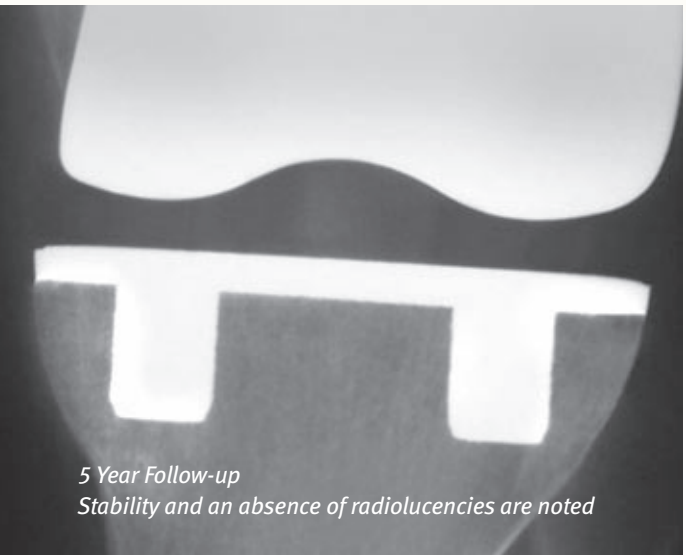
Trabecular Metal Primary Patellar Component

This true monoblock porous patellar design is distinctly different from the traditional metal-backed patellar designs. The structural properties of *Trabecular Metal* Material, combined with the compression molding process, eliminate the problems associated with disassociation of the polyethylene and the metal.

Direct Compression Molded Polyethylene



The compression molding process infuses the polyethylene directly into the pores of the Trabecular Metal *matrix to create a secure polyethylene to* Trabecular Metal *Material interface. A uniform penetration of approximately 1.5mm is achieved.*[10]



5 Year Follow-up
Stability and an absence of radiolucencies are noted

For the revision knee surgeon who is concerned about the availability of implants that address the specific challenges encountered with each patient, *Trabecular Metal* Material is available in a diverse range of revision and reconstruction components. Combined with surgeon skills and expertise, these implant options provide a full measure of RevisionAbility.

RevisionAbility

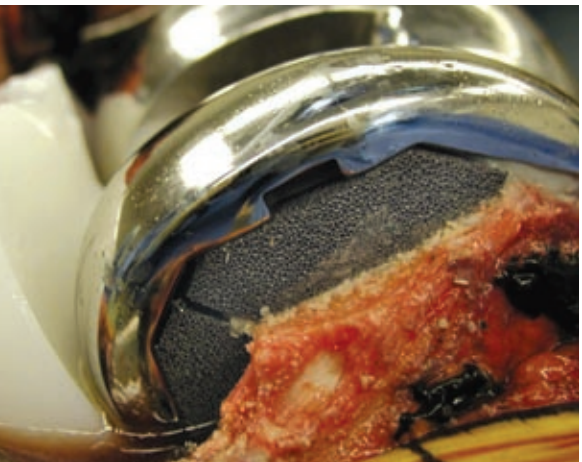
Total Knee Arthroplasty

Trabecular Metal Cones and Augments

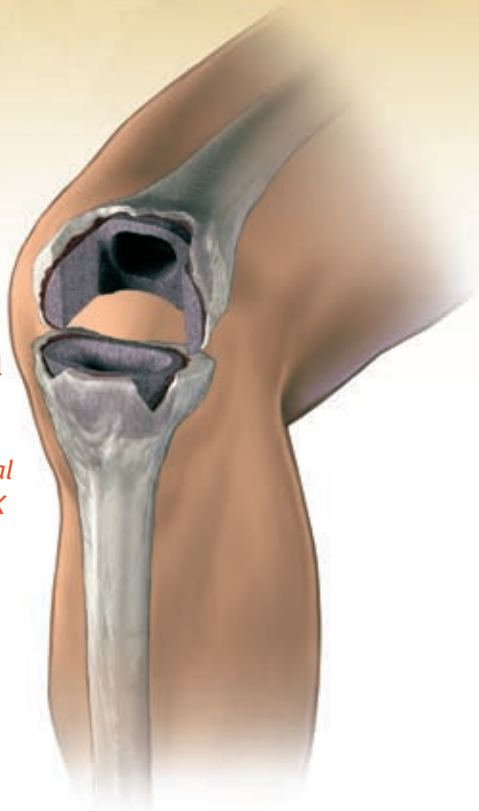
The *Trabecular Metal* Cones and Augments, when used with LCCK femoral and tibial components, offer a cementless implant alternative to bone graft when addressing bone loss. The augments provide structural support for the distal femur and proximal tibia. The femoral and tibial cones provide structural support and stability in cases of severe cavitary bone loss.

Trabecular Metal Augmentation Patella

The *Trabecular Metal* Augmentation Patella is the only prosthetic solution for the severely bone deficient patella. The all-polyethylene articular surface is cemented into the *Trabecular Metal* Patella's base. Initial fixation is facilitated by suturing the implant to the patellar tendon and cementing to the remnant bone.



Intraoperative photograph of Trabecular Metal *Femoral Augments.*



Trabecular Metal *Cones provide fixation and reliable structural integrity for LCCK and Rotating Hinge Knee* Articulating Components.*

*Cemented use only

For the surgeon seeking a conservative treatment that can help to reduce pain and slow the progress of the disease in stage I or stage II osteonecrosis of the femoral head, the *Trabecular Metal* Osteonecrosis Intervention Implant System may delay or prevent the need for THA in many patients.

Early Intervention Osteonecrosis Treatment

Osteonecrosis Intervention Implant System

The *Trabecular Metal* Osteonecrosis Intervention Implant System is designed to structurally support the necrotic segment of the femoral head. It is also designed to interrupt the interface between healthy and necrotic bone and provide a pathway for re-vascularization. The high coefficient of friction and ingrowth potential of *Trabecular Metal* Material facilitates early implant fixation and stability. The flexibility of the material allows for more normal physiological loading of the femoral head and neck and allows new bone formation. The implant may be used with or without bone graft.

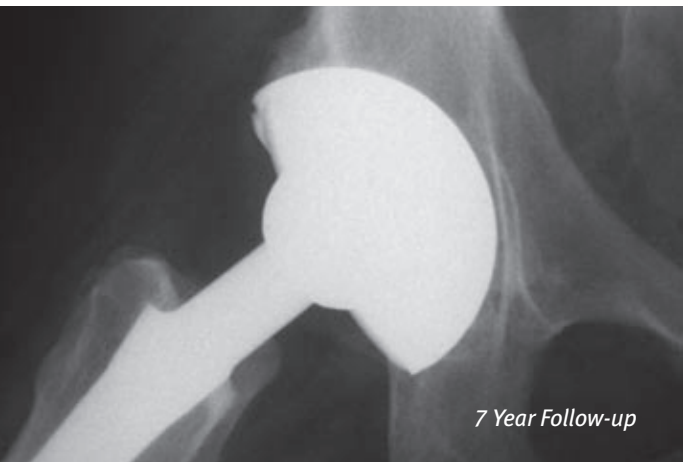
No radiologic advancement of disease state.

For the total hip surgeon who seeks to minimize polyethylene wear, loss of fixation, joint instability, and stress shielding, *Trabecular Metal* Technology allows for optimized implant designs that help meet patient demands for pain relief and restoration of function.

Primary Total Hip Arthroplasty

Trabecular Metal Modular and Monoblock Acetabular Cup Systems

Used in both modular and monoblock acetabular cup systems, *Trabecular Metal* Material combines a high strength-to-weight ratio with low stiffness to closely mimic the dynamics of cancellous bone.[1,2,7] The strut configuration provides a high coefficient of friction against bone to help ensure a secure initial scratch fit.[5] For the monoblock implants, the compression molded polyethylene is securely embedded into the *Trabecular Metal* Implant to eliminate backside wear.[10] *Trabecular Metal* Modular Cups allow the surgeon to integrate the advantages of *Trabecular Metal* Material with the versatility offered by the complete selection of *Longevity*® Highly Crosslinked Polyethylene Liners.

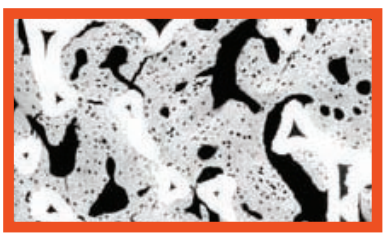


7 Year Follow-up

Trabecular Metal Primary Hip Stem

The *Trabecular Metal* Primary Hip Prosthesis brings the distinctive properties of *Trabecular Metal* Technology to a bone conserving and proximal loading stem design. This results in an optimal combination of initial stability, potential for biological fixation, and efficient proximal load transfer.[1,2,5,11]

Biological Ingrowth



The high porosity and interconnected matrix of Trabecular Metal *Material is proven to be osteoconductive, providing secure fixation to bone.*[12]

For the revision hip surgeon, *Trabecular Metal* Technology provides for enhanced initial fixation via friction and maximizes the potential for bone ingrowth, an attribute that is essential in meeting the challenges often encountered in revision hip arthroplasty.[13,14]

RevisionAbility

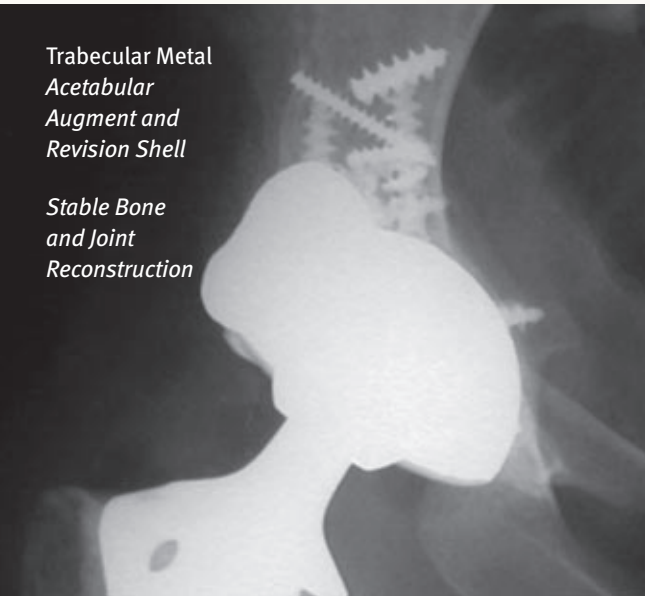
Total Hip Arthroplasty

Trabecular Metal Revision Acetabular Cup

Trabecular Metal Material provides structural support for bone ingrowth and remodeling in acetabular revision and reconstruction.[13,14] The bone-like properties of *Trabecular Metal* Material help facilitate joint reconstruction and restoration of normal weight bearing. The high coefficient of friction created by the strut configuration helps ensure a stable scratch fit for revising an acetabular component.[5,14]

Trabecular Metal Acetabular Augment and Restrictor

The *Trabecular Metal* Augments and Restrictors provide numerous options for reconstruction of the bone-deficient acetabulum. Augments offer a bone-conserving alternative to structural allograft, while restrictors provide coverage of medial wall defects. The porous, structural material helps create intimate bone/implant apposition, allowing biological fixation and incorporation of bone graft.[13,14]



Trabecular Metal *Acetabular Augment and Revision Shell*

Stable Bone and Joint Reconstruction

For the shoulder surgeon who prefers a porous fixation option with the potential for immediate stability and long-term fixation, the *Trabecular Metal* Humeral Stem and *Trabecular Metal* Reverse Shoulder System provide a scaffold for biological ingrowth combined with restoration of biomechanics.

Primary Shoulder Reconstruction

Trabecular Metal Humeral Stem

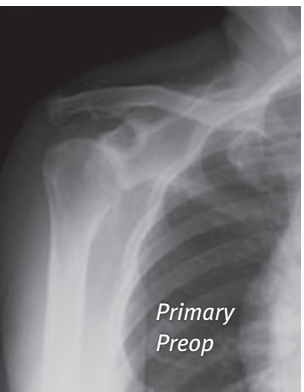
The Zimmer *Trabecular Metal* Humeral Stem design represents a progressive evolution in total shoulder arthroplasty. Designed to help replicate natural joint mobility, balance, and stability, the stem allows for press-fit or cemented fixation, and can be used for primary, revision, or fracture cases.

Trabecular Metal Reverse Shoulder System

The humeral stem of the *Trabecular Metal* Reverse Shoulder System is easily converted to a standard humeral component. It has a versatile, low-profile design that allows adjustments in the height of the humeral head. Suture holes are located around the face of the proximal stem, and a ridge surrounding the periphery allows sutures to be wrapped around the stem.

The Added Advantage of Trabecular Metal Technology

The addition of *Trabecular Metal* Material to these well established shoulder designs provides implant technology that better approximates the physical and mechanical properties of trabecular bone.[1,2] The high coefficient of friction helps provide immediate implant stability, while biological fixation of bone and/or soft tissue is permitted by the high, interconnected porosity that is characteristic of *Trabecular Metal* Material.[1,2,5,15]



For the shoulder surgeon who endeavors to preserve bone, achieve optimal proximal fixation, and gain a solid potential for bone and tissue healing in revision or fracture cases, the *Trabecular Metal* Humeral Stem and *Trabecular Metal* Reverse Shoulder System offer a wide range of joint reconstruction options.

Revision/Fracture
Shoulder Reconstruction

Trabecular Metal Humeral Stem

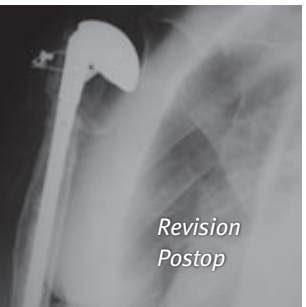
The Zimmer *Trabecular Metal* Humeral Stem can be used for revision and fracture cases, as well as primary cases. In particular, the larger sizes provide excellent fill of the humeral canal in revision situations. The friction created by the *Trabecular Metal* Material provides an immediate scratch fit, and the biological ingrowth properties facilitate long-term fixation.[1,2,5,15]

Trabecular Metal Reverse Shoulder System

The *Trabecular Metal* Reverse Shoulder System is designed for use in primary, revision, and fracture situations. For grossly deficient rotator cuff, a polyethylene articular surface is snapped onto the proximal face of the stem. The head is then attached to the Reverse Glenoid Component, which also contains *Trabecular Metal* Material. Biological fixation of the glenoid component is supplemented with variable angle locking screws. The stem can be converted from a reverse stem to a standard humeral component by attaching a taper adaptor and a modular head.


Revision Preop

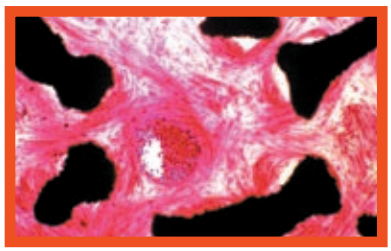

Fracture Preop


Revision Postop


Fracture Postop

Trabecular Metal *Humeral Stems include suture holes for enhanced tuberosity reattachment, allowing for tight cinching against the stem.*

Biological Ingrowth



The high-volume porosity and interconnected cellular structure of Trabecular Metal *Material supports rapid soft-tissue ingrowth.*[15]

For the spinal surgeon who wants to be confident in the initial stability, strength of spinal implants, and biological ingrowth potential, *Trabecular Metal* Spinal Devices offer a reliable approach.

Spinal Solutions

Trabecular Metal Device Options

Trabecular Metal Spinal Devices

Available in a variety of shapes to accommodate multiple geometric requirements, *Trabecular Metal* Spinal Devices are designed for bony defect support and thoracolumbar vertebral body replacement. With physical and mechanical properties very close to those of trabecular bone, this novel material is ideally suited for spinal procedures. Its load-sharing and biological fixation properties make it an excellent alternative to allograft and autograft bone and other synthetic materials.

Notes

Acknowledgements

1. **Hips Primary** — Follow-up radiograph of the *Trabecular Metal* Acetabular Cup provided by Thomas O'Keefe, MD, Ann Arbor, MI.

2. **Knee Primary** — Follow-up radiograph of the *Trabecular Metal* Monoblock Tibia courtesy of James Wood, MD, Baltimore, MD.

3. **Early Intervention** — Follow-up radiograph of the *Trabecular Metal* ONII courtesy of Michael Christie, MD, Nashville, TN.

4. **Hips Revision** — Follow-up radiograph of the *Trabecular Metal* Acetabular Augment and Revision Shell courtesy of David Lewallen, MD, Rochester, MN.

5. **Knee Revision** — Photograph of *Trabecular Metal* Femoral Augments Courtesy of S David Stulberg, MD, Northwestern University Fermi School of Medicine, Chicago, IL.

6. **Shoulder Primary** — Follow-up radiographs of the *Trabecular Metal* Humeral Stem courtesy of Evan Flatow, MD, New York, NY.

7. **Shoulder/Revision/Fracture** — Follow-up radiographs of the *Trabecular Metal* Humeral Stem courtesy of Louis Bigliani, MD, New York, NY. George M. McCluskey III, MD, Columbus, GA.

1. Bobyn JD, Stackpool GJ, Hacking SA, Tanzer M, Krygier JJ. Characteristics of bone in-growth and interface mechanics of a new porous tantalum biomaterial. *J Bone Joint Surg.* September 1999;81-B(5):907-914.

2. Bobyn JD, Hacking SA, Krygier JJ, Chan SP, Toh KK, Tanzer M. Characterization of a new porous tantalum biomaterial for reconstructive surgery. Scientific Exhibition: 66th Annual Meeting of the American Academy of Orthopaedic Surgeons; February 4-8, 1999; Anaheim, CA.

3. Bobyn JD, Toh KK, Hacking SA, Tanzer M, Krygier JJ. Tissue response to porous tantalum acetabular cups - a canine model. *J Arthroplasty.* 1999;14(3):347-354.

4. Shimko DA, Shimko VF, Sander EA, Dickson KF, Nauman EA. Effect of porosity on the fluid flow characteristics and mechanical properties of tantalum scaffolds. Published on-line February 2005 in Wiley Interscience (www.interscience.wiley.com).

5. Zhang Y, Ahn PB, Fitzpatrick DC, Heiner AD, Poggie RA, Brown TD. Interfacial frictional behavior: cancellous bone, cortical bone, and a novel porous tantalum biomaterial. *Journal of Musculoskeletal Research.* 1999;3(4):245-251.

6. Shirazi-Adl A, Dammak M, Paiement G. Experimental determination of friction characteristics at the trabecular bone/porous-coated metal interface in cementless implants, *J Biomed Mat Res.* 1993;27:167-175.

7. Pedersen DR, Brown TD, Poggie RA. Finite element analysis of peri-acetabular stress of cemented, metal-backed, and porous tantalum-backed acetabular components. Presented at: 45th Annual Meeting, Orthopaedic Research Society; February 1-4, 1999; Anaheim, CA.

8. Rawlinson JJ, Wright TM, Bartel DL. Finite element analysis of a porous tantalum monoblock tibia compared with a metal-backed tibial component. Presented at: 51st Annual Meeting, Orthopaedic Research Society; February, 2005; Washington D.C.

9. Florio CS, Poggie RA, Sidebotham C, Lewallen DG, Hanssen AD. Stability characteristics of a cementless monoblock porous tantalum tibial implant without ancillary fixation. Presented at: 50th Annual Meeting, Orthopaedic Research Society; March 7-10, 2004; San Francisco, CA.

10. Poggie RA, Cohen R, Averill RG. Characterization of porous tantalum metal, direct compression molded UHMWPE junction. Presented at: 44th Annual Meeting, Orthopaedic Research Society; March 16-19, 1998 New Orleans, LA.

11. O'Keefe T, Lewis R, Unger AS. Proxilock femoral stem – 2 to 5 year results. Poster exhibit at: 70th Annual Meeting of the American Academy of Orthopaedic Surgeons; February, 2003; New Orleans, Louisiana, USA.

12. Gruen T, Hanssen AD, Lewallen DG, Lewis R, et al. Radiographic evaluation of a monoblock acetabular component--a multi-center study with 2 to 5 years results. *J Arthroplasty*. April 2005;20(3):369-378.

13. Nehme A, Lewallen DG, Hanssen AD. Modular porous metal augments for treatment of severe acetabular bone loss during revision hip arthroplasty. *Clin Orthop.* December 2004;429:201-208.

14. Paprosky WG, O'Rourke M, Sporer SM. The treatment of acetabular bone defects with an associated pelvic discontinuity. *Clin Orthop.* December 2005;441:216-220.

15. Hacking SA, Bobyn JD, Toh K, Tanzer M, Krygier JJ. Fibrous tissue in-growth and attachment to porous tantalum. *J Biomed Mat Res.* December 2000;52(4):631-638.

Contact your Zimmer Representative or visit us at www.zimmer.com.

zimmer
Confidence in your hands®

97-7255-062-00 7.5ML Printed in USA