Triathlon® Tritanium

Design rationale

Triathlon Tritanium | Design rationale

Encouraging outcomes for challenging **patient demographics**

Patient demographics for TKA have become younger and heavier,[1,2] and these patients have demonstrated higher risk of revision in TKAs.[3,4,5] When biologic fixation is achieved, cementless TKA has the potential for a more durable bone-implant interface that can better withstand the added mechanical stress in obese patients.[6] In a retrospective study with 193 patients with a minimum of five-year follow-up, morbidly obese (BMI ≥40) patients receiving cementless primary Triathlon TKA with a PS design demonstrated improved survivorship compared to those who received a cemented Triathlon TKA.[5] Furthermore, the American Joint Replacement Registry reported male patients younger than 65 years adjusted for age receiving a cementless TKA showed a better survivorship than those who received cemented TKA; however, the difference is small (<1%) and does not account for other potential confounders.[7]

Potential savings in time and cost

As the volume of TKA procedures continues to increase, the costs associated with this surgical procedure continue to be an important topic. Cementless TKA allows the potential to reduce operating room time[8,9] and save expenses without the use of bone cement and cement accessories.[10] A healthcare economic study in the U.S. concluded that the actual overall cost of cementless TKA could be offset by shortened operating room time and the lack of need for cement and cementing accessories.[10]

Strong clinical evidence

Cementless TKA is growing in popularity.[7] The 2020 National Joint Registry Report in the U.K. supports the long-term outcome of cementless femoral components,[11] and the AAOS evidence-based clinical practice guideline found strong evidence suggesting similar functional outcomes between cemented and cementless tibial baseplates.[12] Triathlon Tritanium cementless TKA demonstrated excellent clinical outcomes in multiple studies with five-year follow-up[13,14,15] and achieved similar functional outcomes and pain reduction when compared to cemented Triathlon TKA in multiple short- to midterm studies.[8,16]

Survivorship

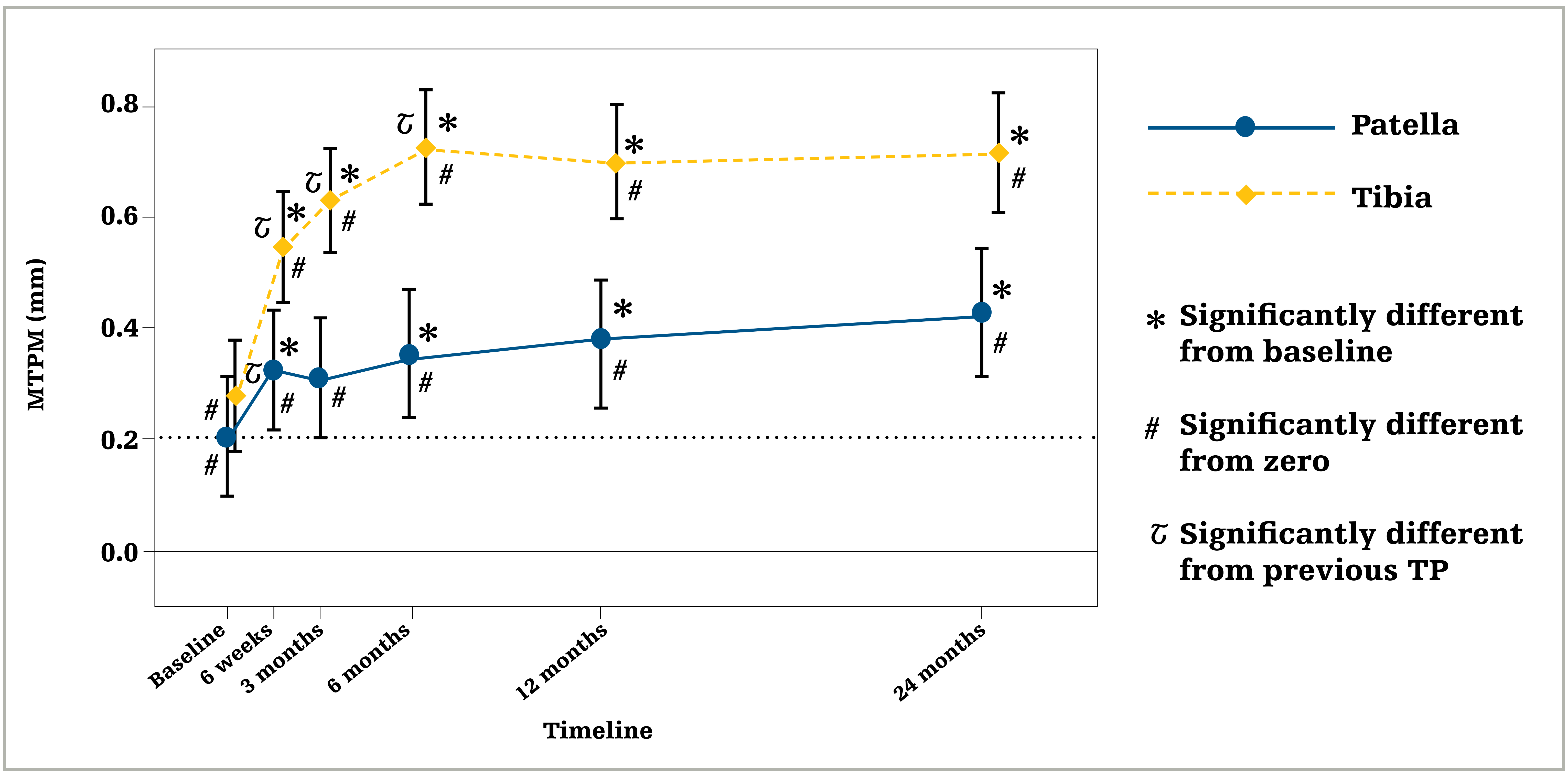
Triathlon Tritanium TKA survivorship	Source
98.4% aseptic survivorship in 296 Triathlon Tritanium TKAs and 99.2% survivorship for Triathlon Tritanium Baseplate at minimum five-year follow-up.[1]	Restrepo et al. Orthopaedic Proceedings. 2020
99.5% implant survivorship in 228 Triathlon Tritanium Baseplates at five-year follow-up.[2]	Tarazi et al. Journal of Knee Surgery. 2020
100% aseptic survivorship in 28 Triathlon Tritanium Baseplates with CR PA beaded femur at five-year follow-up.[3]	Silverstein et al. Orthopaedic Research Society 2020 Annual Meeting.
98% all-cause survivorship in 261 Triathlon Tritanium Metal-Backed Patellas at 4.5-year follow-up.[4]	Harwin et al. Journal of Knee Surgery. 2020
99.5% all-cause survivorship in 1024 Triathlon PS cementless TKAs at four-year follow-up.[5] Both Tritanium and PA beaded versions of the tibial baseplate and metal-backed patella were included.[5]	Harwin et al. Journal of Arthroplasty. 2017
99% all-cause survivorship in 708 Triathlon Tritanium TKAs at two- to four-year follow-up.[6] Tritanium Baseplate, Tritanium Metal-Backed Patella and PS PA beaded femurs were used.[6]	Bhowmik-Stoker et al. 2018 World Arthroplasty Congress.
100% all-cause survivorship in 72 Triathlon Tritanium TKAs at mean three-year follow-up.[7] Tritanium Baseplate, Tritanium Metal-Backed Patella and CR PA beaded femurs were used.[7]	Cohen et al. Orthopedics. 2018
No revision due to aseptic or septic loosening of Triathlon Tritanium Baseplate at two-year follow-up.[8]	Masini et al. American Academy of Orthopaedic Surgeons (AAOS) 2019 Annual Meeting poster. #2263

PA beaded femur survivorship with long-term follow-up	Source
Triathlon PA beaded femur showed all-cause survivorship of 96.8% for CR and 94.9% for PS at 10-year follow-up.[9]	Australian Joint Registry. 2020
Triathlon PS PA beaded femur 98% all-cause survivorship at eight-year follow-up.[10]	Harwin et al. The Journal of Arthroplasty. 2018

Radiostereometric analysis (RSA)

RSA of 27 Triathlon Tritanium TKAs at two-year follow-up suggested that the Triathlon Tritanium Baseplate and Metal-Back Patella achieve fixation through highly porous metal.[11] This pattern is consistent with other longer-term RSA studies showing that stabilization of uncemented tibial components can be achieved after high initial migration.[11,12,13]

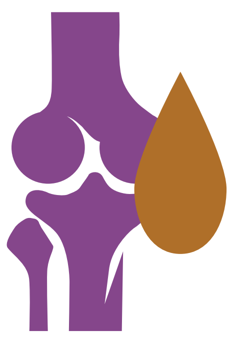
Plot of implant migration over time, measured by maximum total point motion[11]



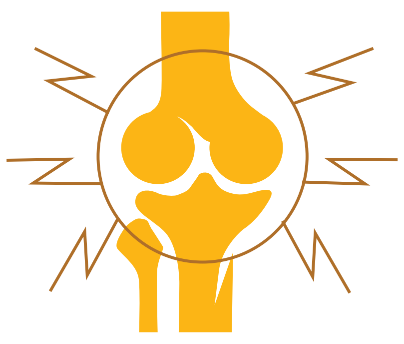
Outcomes compared to **cemented Triathlon**

Nam et al. The Journal of Bone and Joint Surgery[14]

A prospective, randomized controlled study of 76 Triathlon Tritanium TKAs vs. 65 Triathlon cemented TKAs demonstrated no differences in clinical results with no aseptic loosening in either cohort at mean two-year follow-up. Both cohorts received cruciate-retaining femoral components.



Similar blood loss



Similar pain reduction

Similar early PROM

Shorter OR time

Intraoperative outcome	Cemented	Cementless	p-value
Mean operative time (min)	93.7	82.1	**0.001**
Change in hemoglobin (g/dL)	-2.5	−2.6	0.5
All patients were permitted to fully weight bear, start range of motion as tolerated and ambulate on the day of surgery.			
Four- to six-week postoperative	**Cemented**	**Cementless**	**p-value**
% of patients who reported "no pain"	31	34	0.7
Mean visual analog scale	3.5	3.2	0.3
Mean change in OKS	0.9	2.1	0.4
Mean change in KSS	−1.3	1.8	0.3
Two-year postoperative	**Cemented**	**Cementless**	**p-value**
Aseptic loosening	0	0	
Change in OKS	17.3	19.7	0.2
Change in KSS	33.5	39.2	0.2

Miller et al. Journal of Arthroplasty[15]

A matched comparison of 200 Triathlon Tritanium TKAs vs. 200 Triathlon cemented TKAs showed similar functional and survivorship outcomes between the two cohorts at mean 2.4-year follow-up. Both groups received the same postoperative physical therapy protocol, which consisted of immediate weight bearing with passive and active motion exercises.

Intraoperative outcome	Cemented	Cementless	p-value
Total no. of revisions	8	7	.069
Aseptic loosening	5	1	0.2
Change in KSS function score	26.0	35.6	.0014
Change in KSS knee score	52.4	53.8	.385

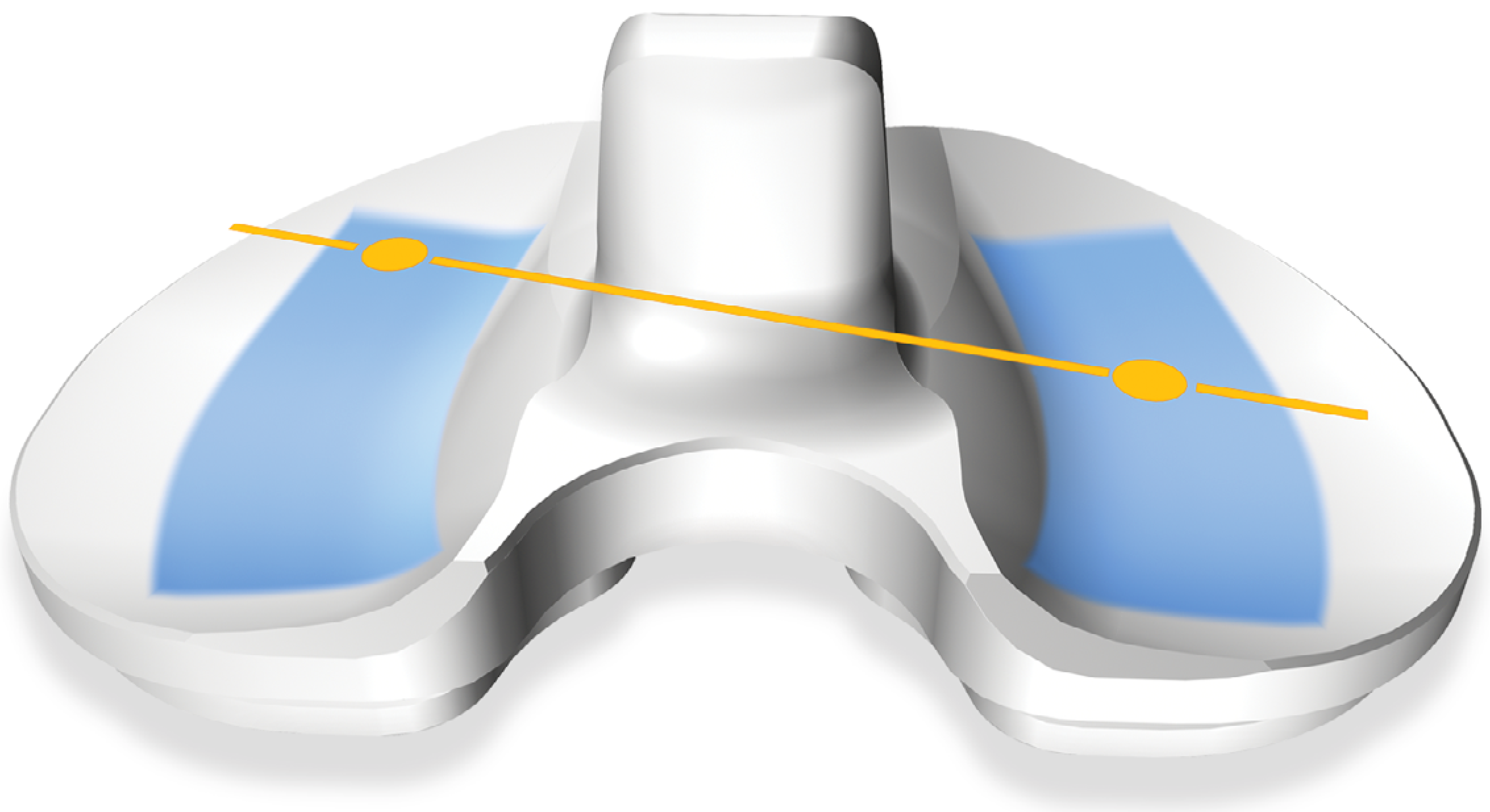
Patient selection data

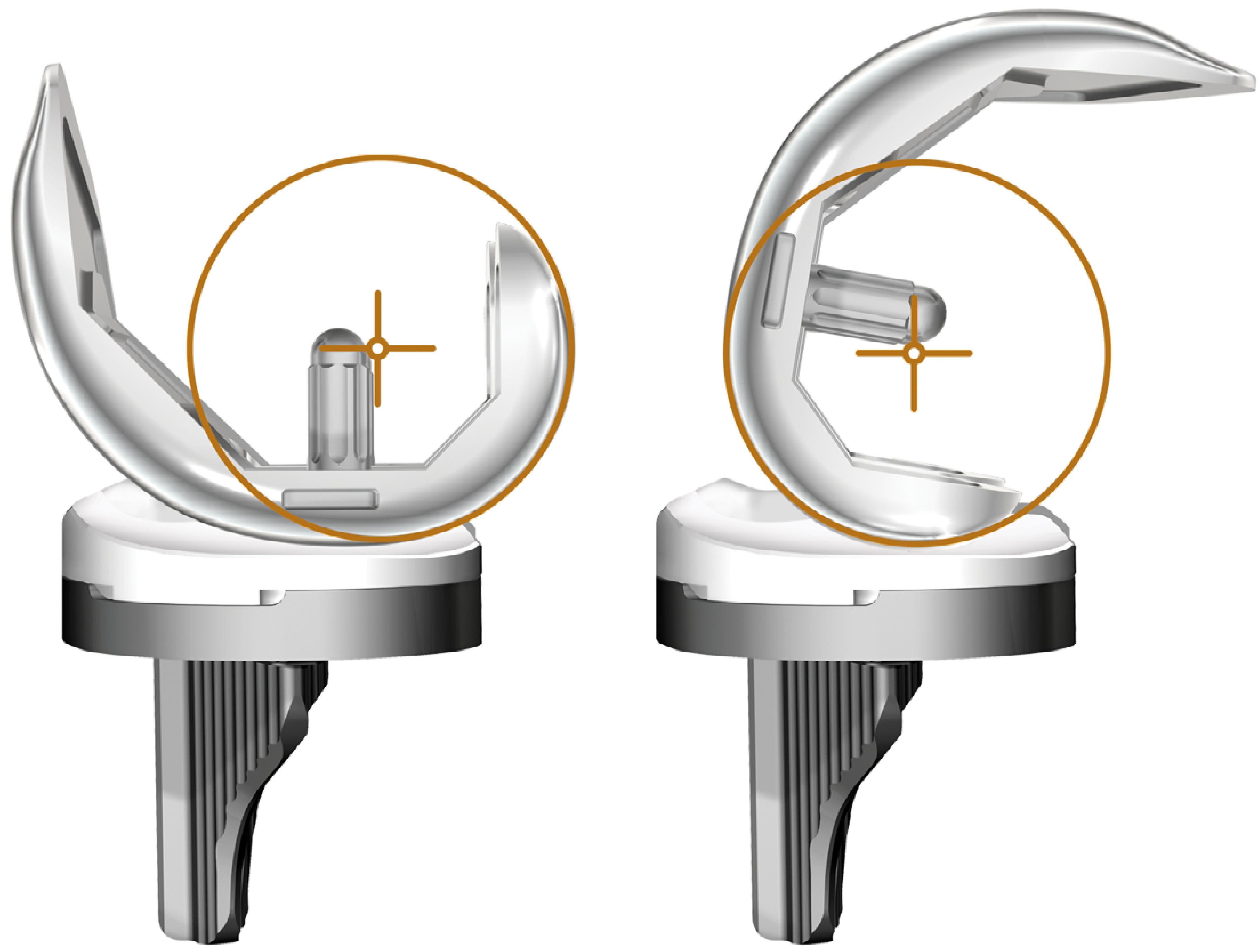
Survivorship	Source
Male patients < 65 years of age Male patients younger than 65 years adjusted for age receiving a cementless TKA showed better survivorship than those who received cemented TKA; however, the difference is small (<1%) and does not account for other potential confounders.[16]	American Joint Replacement Registry. 2020 Annual Report.
Patients <50 years of age Excellent survivorship and functional and radiographic outcomes at mean follow-up of four years with no component failure were observed in a study of 29 patients (31 knees).[17]	Mont et al. The Annals of Translational Medicine. 2017
Patients >75 years of age Excellent aseptic and overall midterm survivorship and improvements in functional outcomes with 99.3% aseptic implant survivorship at mean follow-up of four years were observed in a study of 134 patients.[18]	Newman et al. The Journal of Knee Surgery. 2017
Patients with BMI >40 In a retrospective study with 193 patients, survivorship in the cementless group remained at the steady state of 99.1% at eight years, whereas survivorship in the cemented group gradually decreased over time to 83.5% at 12 years.[19]	Sinicrope et al. The Journal of Arthroplasty. 2019
Patients with rheumatoid arthritis Excellent survivorship outcomes were reported in a study of 126 TKAs in 122 patients with rheumatoid arthritis, with 99.2% survivorship at mean follow-up of four years.[20]	Patel et al. Orthopedics. 2018

Triathlon design

Stable primary fixation of the implant is a prerequisite for biologic fixation.[1] The less constrained the design, the less potential for stresses generated at the articulating surface to be transferred to the bone-implant interface.[2] Triathlon is designed to minimize dynamic stress transfer to the tibial fixation interface by providing minimal resistance to internal and external motion and by locating the bearing sulcus directly over the tibial keel to help reduce sagittal rocking during ambulation.[3]

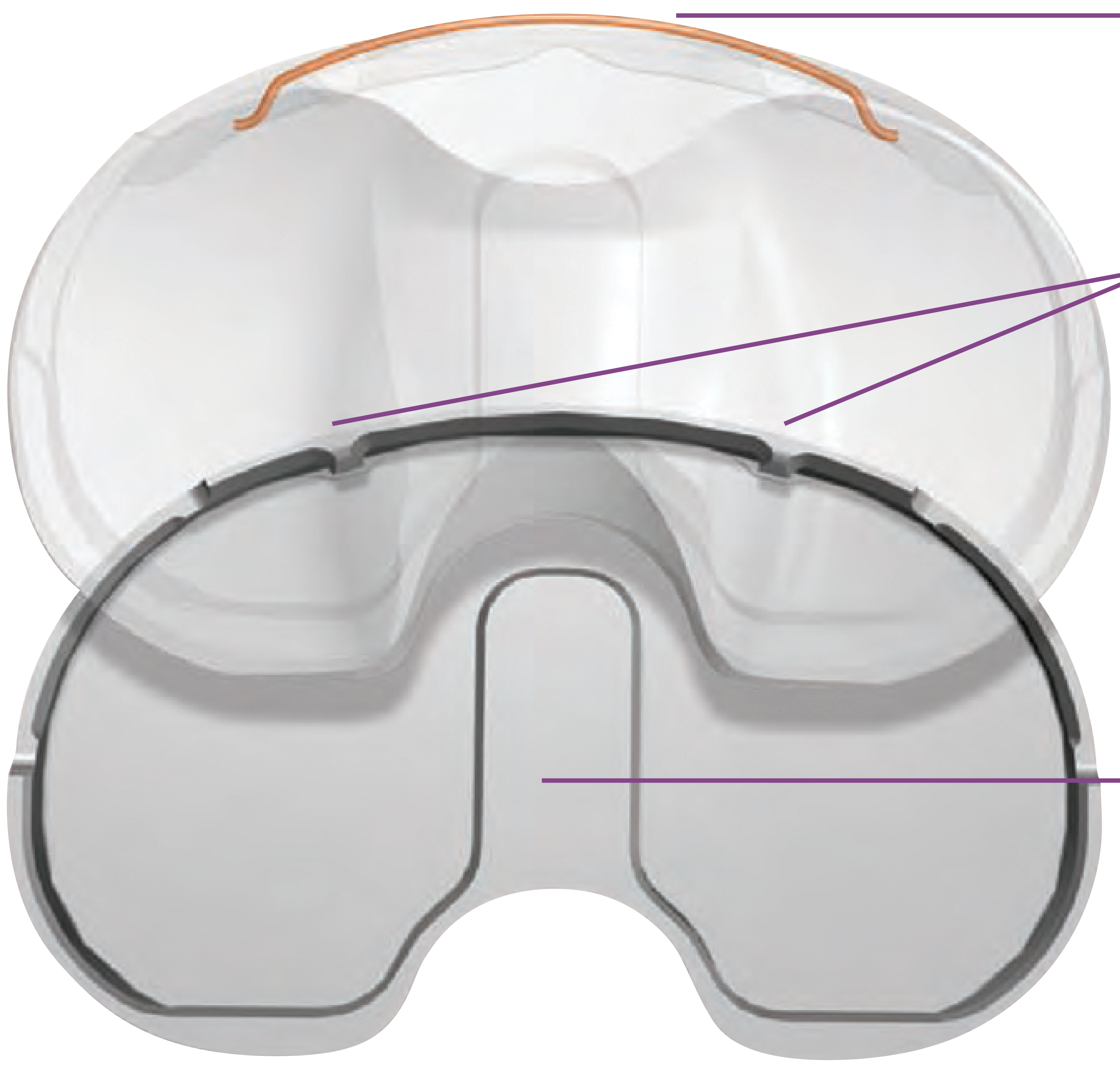
+/- 20° of internal/external freedom





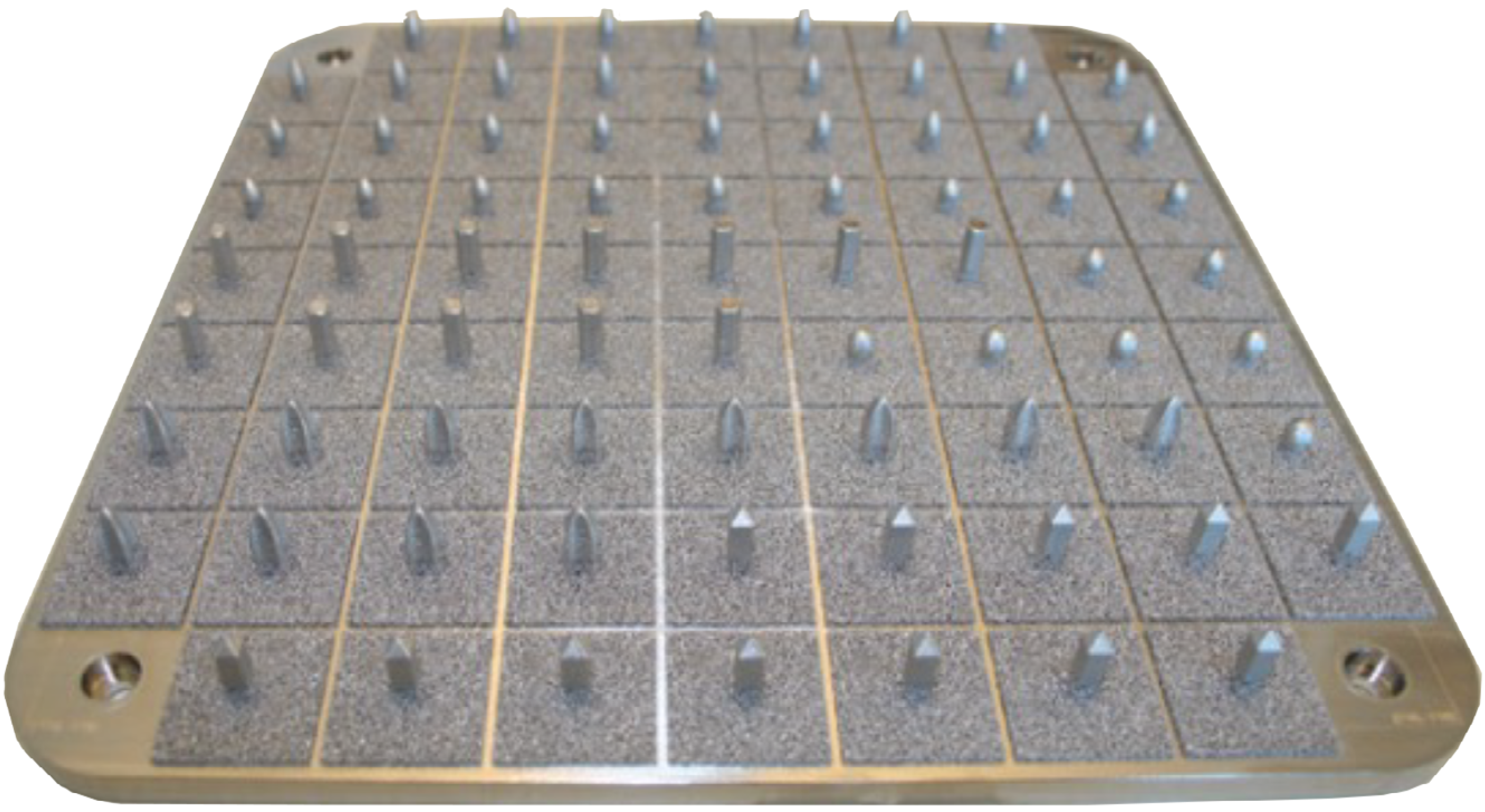
Single radius design allows the bearing sulcus to sit directly over the tibial keel

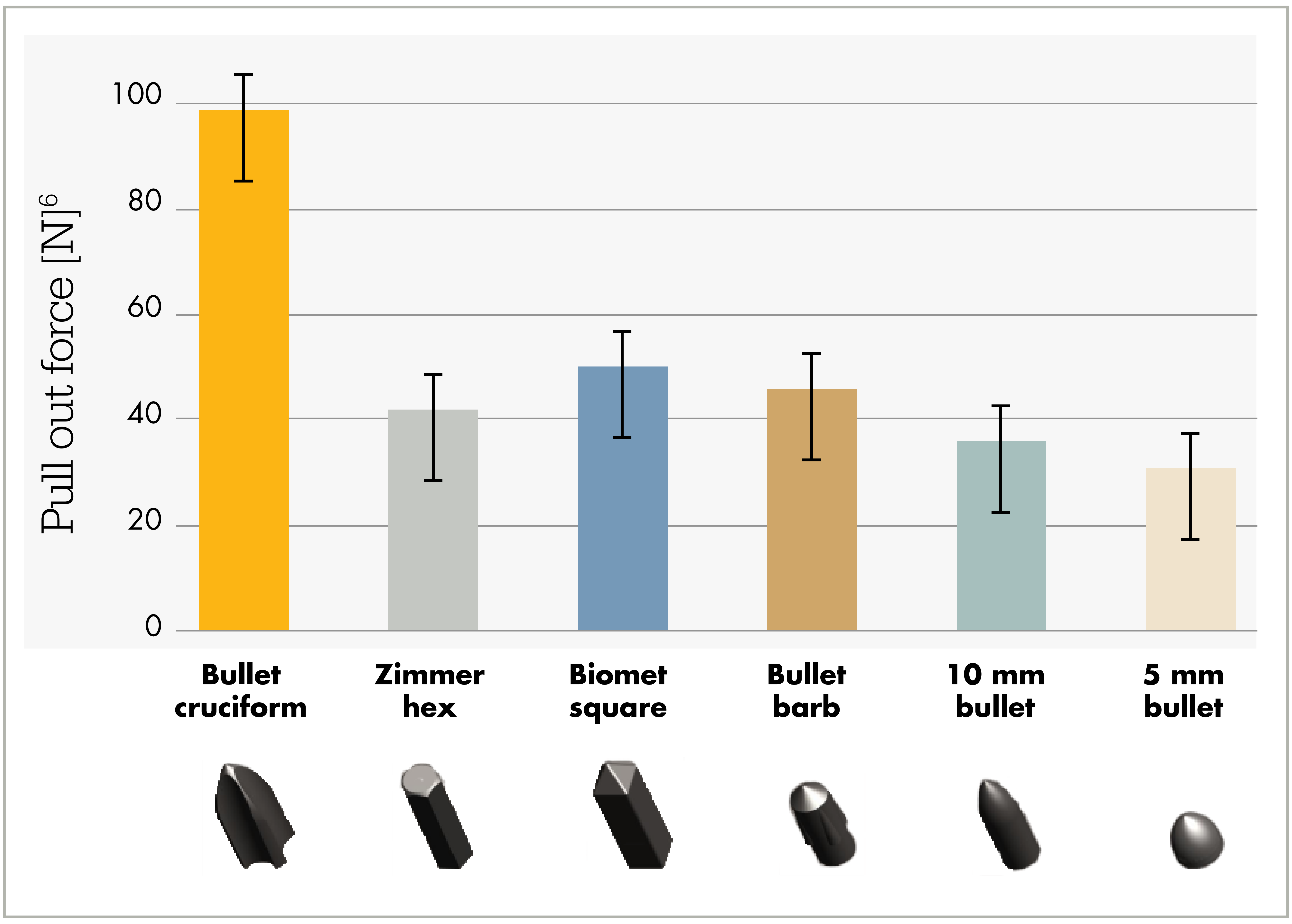
Additionally, Triathlon's locking mechanism is designed to help minimize micromotion.[4]



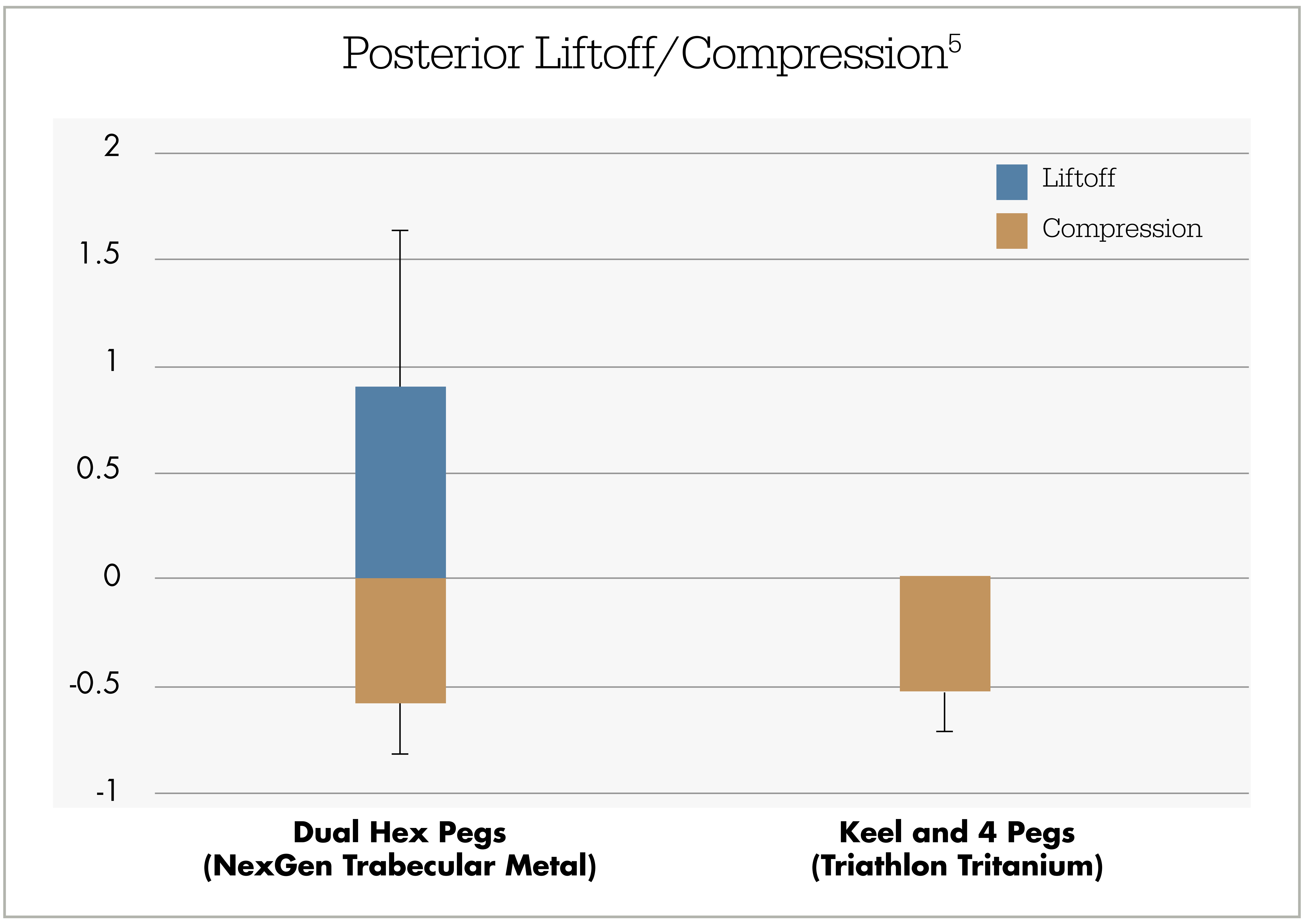
Peg design

Given the importance of stable primary fixation,[1] the underside of the Triathlon Tritanium Baseplate was designed to reduce micromotion and liftoff.[5] Additive manufacturing technology provided our engineers the ability to think of a design, 3D print it and then test it. Many designs were tested, but none provided greater stability than the Triathlon peg design.[6]





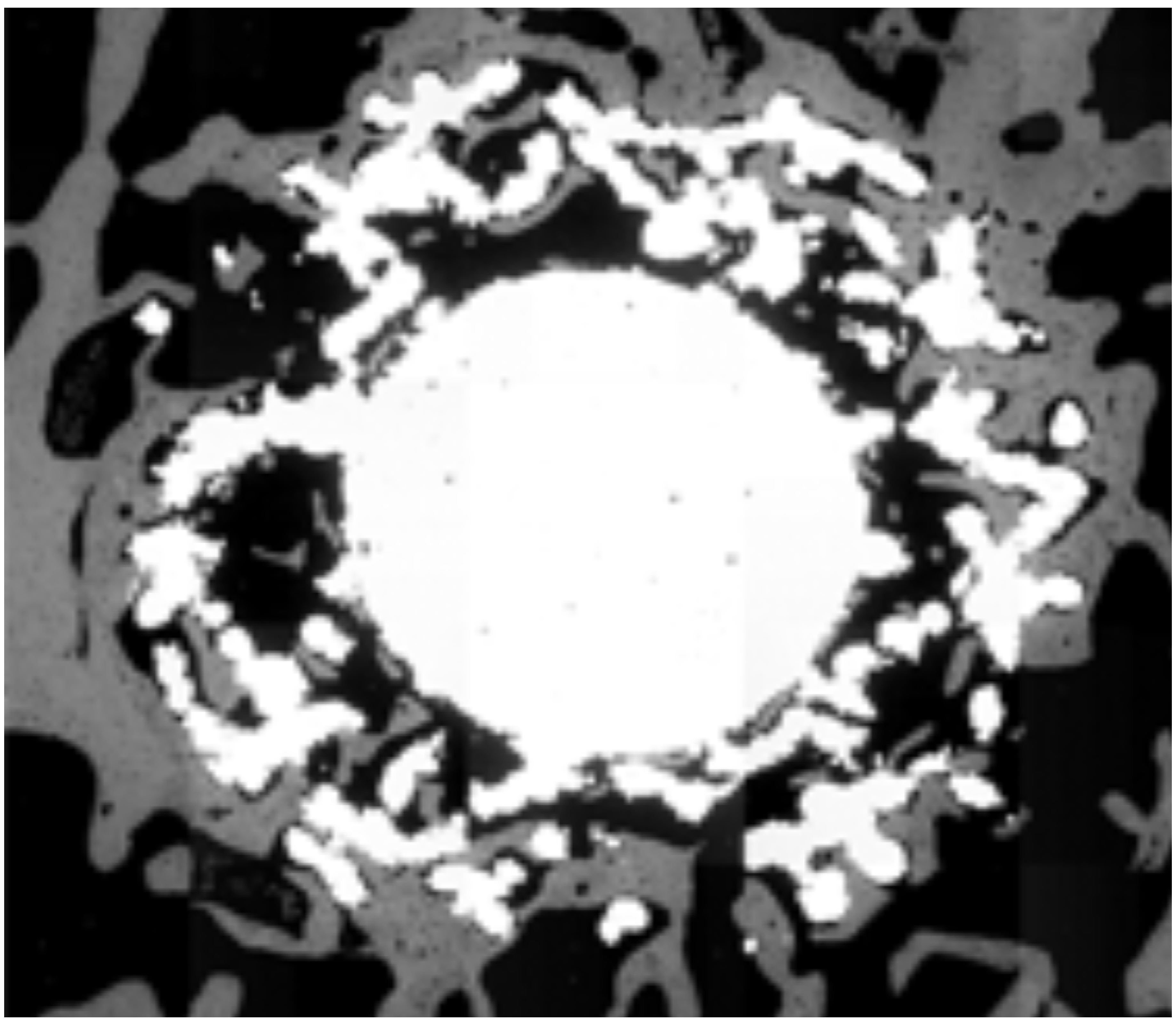
Coupled with the Triathlon tibial keel design, the underside design of the Triathlon Tritanium Baseplate showed reduced liftoff compared to the dual hex pegs design of NexGen in a benchtop study.[5]



Tritanium

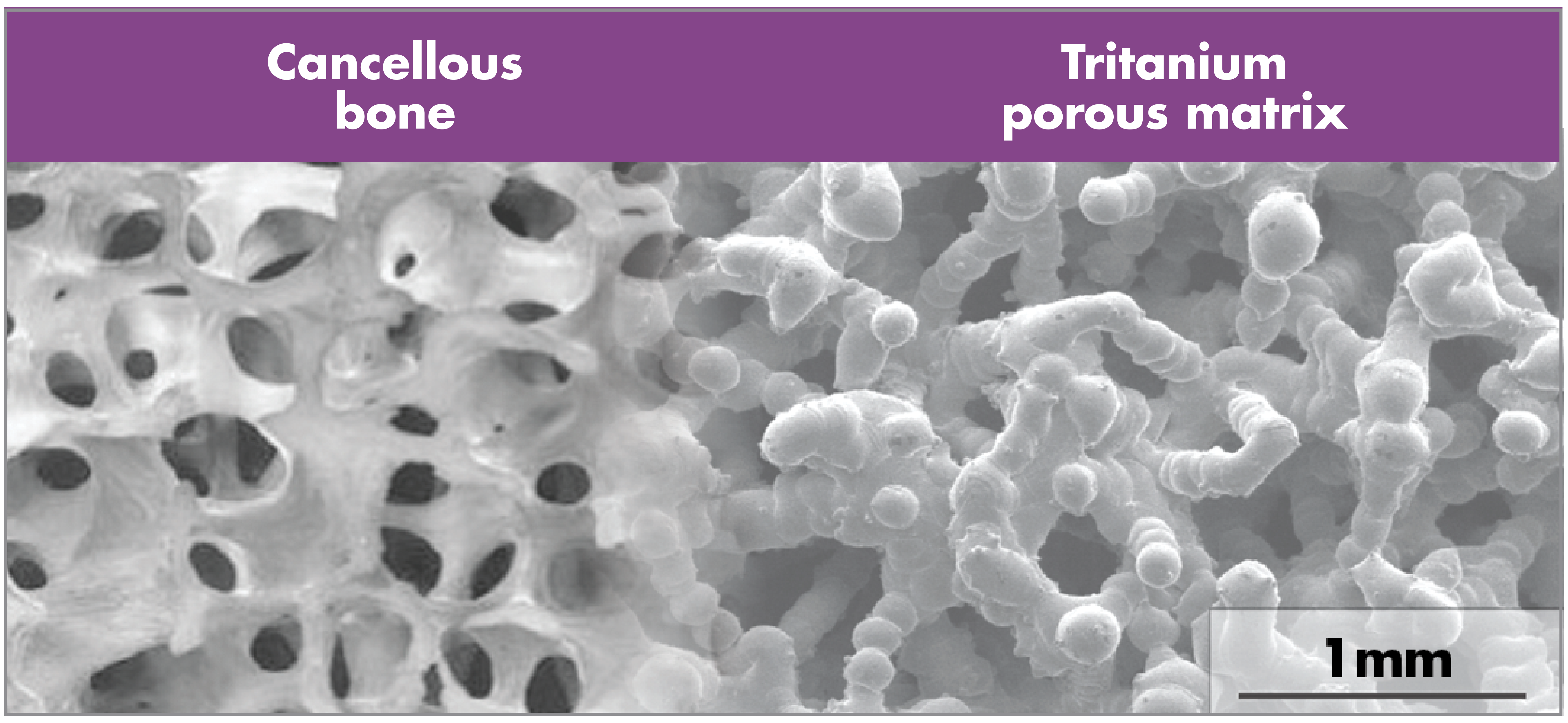
Tritanium is a highly porous metal biologic fixation technology. The porous structure of the Triathlon Tritanium Baseplate and Metal-Backed Patella is made of commercially pure titanium.

Histological image of Tritanium plug implanted in a rabbit after 10 weeks[1]*



*Animal studies are not necessarily indicative of clinical performance. Correlation to human clinical outcomes has not been demonstrated or established.

The Tritanium porous matrix closely resembles that of cancellous bone.



Material properties[2-4]	Tritanium Baseplate	Tritanium Metal-Backed Patella
Mean pore diameter (μm)	527	497
Coefficient of friction	1.02	.80
Mean porosity	68%	65%

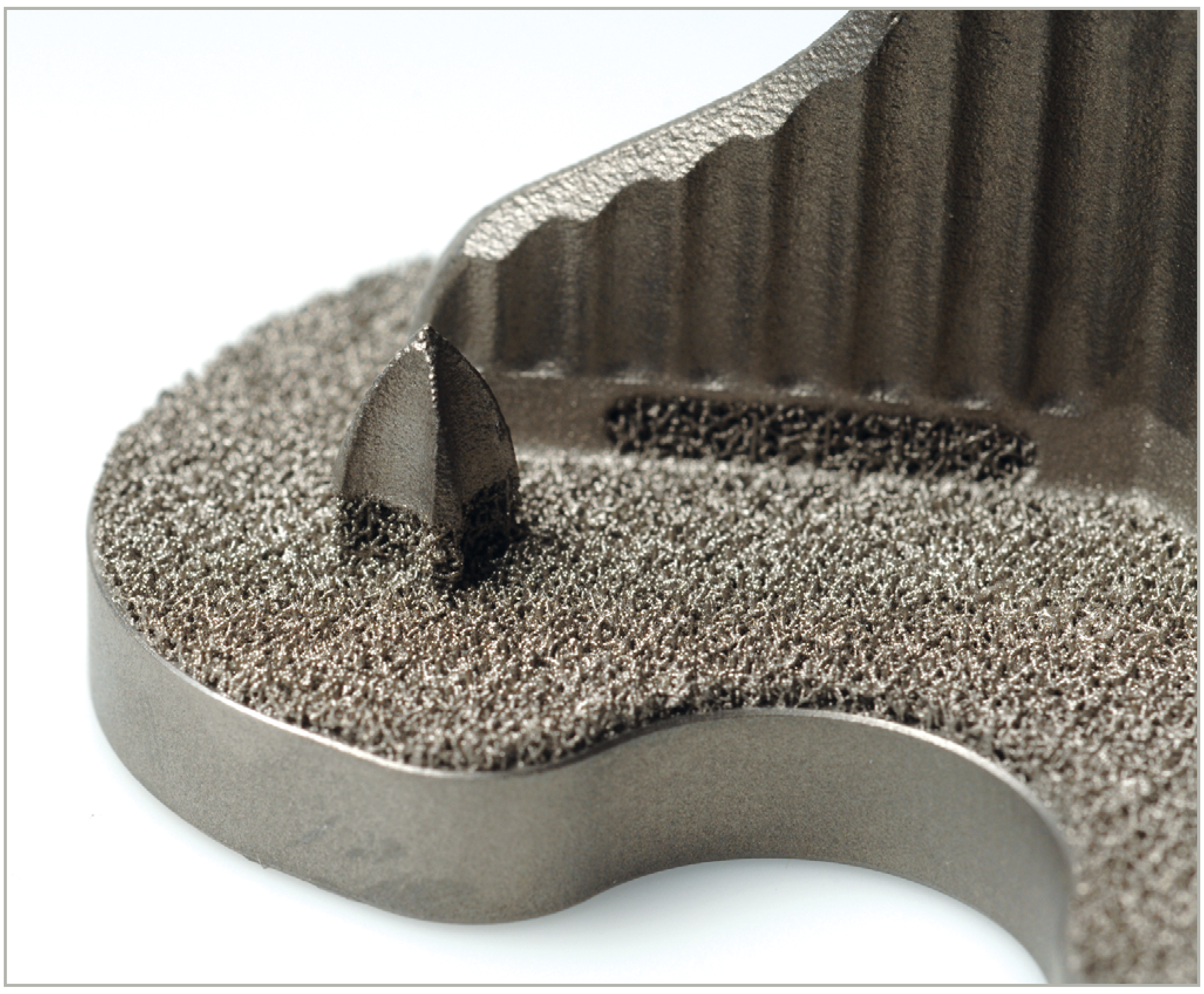
The Triathlon Tritanium Baseplate and Metal-Backed Patella are also indicated for cemented applications, providing surgeons intraoperative flexibility to decide on the fixation method with the actual component once bone quality is assessed.

Additive manufacturing

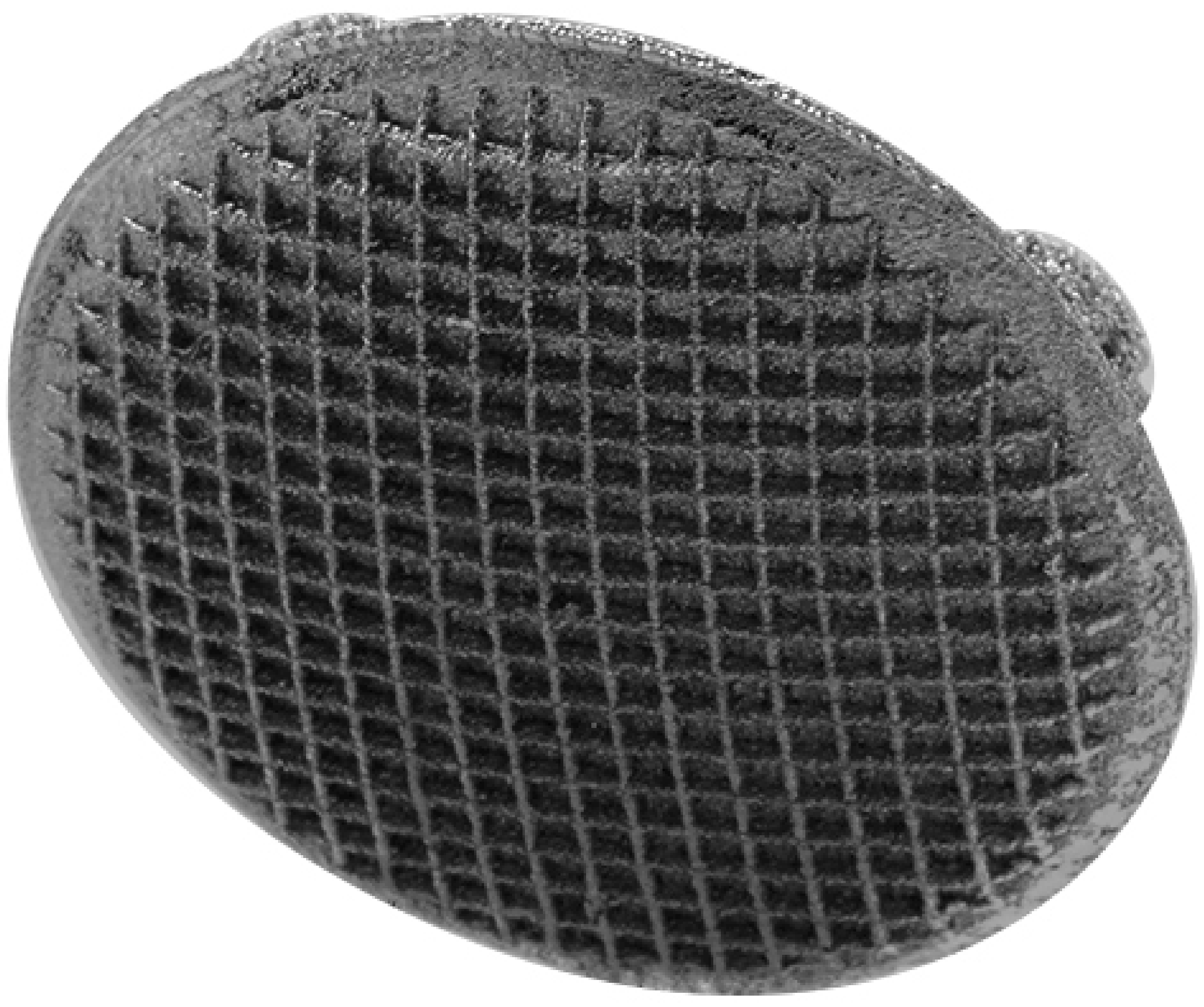
Triathlon Tritanium Baseplate and Metal-Backed Patella components are additive manufactured using a focused laser beam to sinter numerous layers of titanium powder to grow the implant structure layer by layer.

Triathlon Tritanium Tibial Baseplate

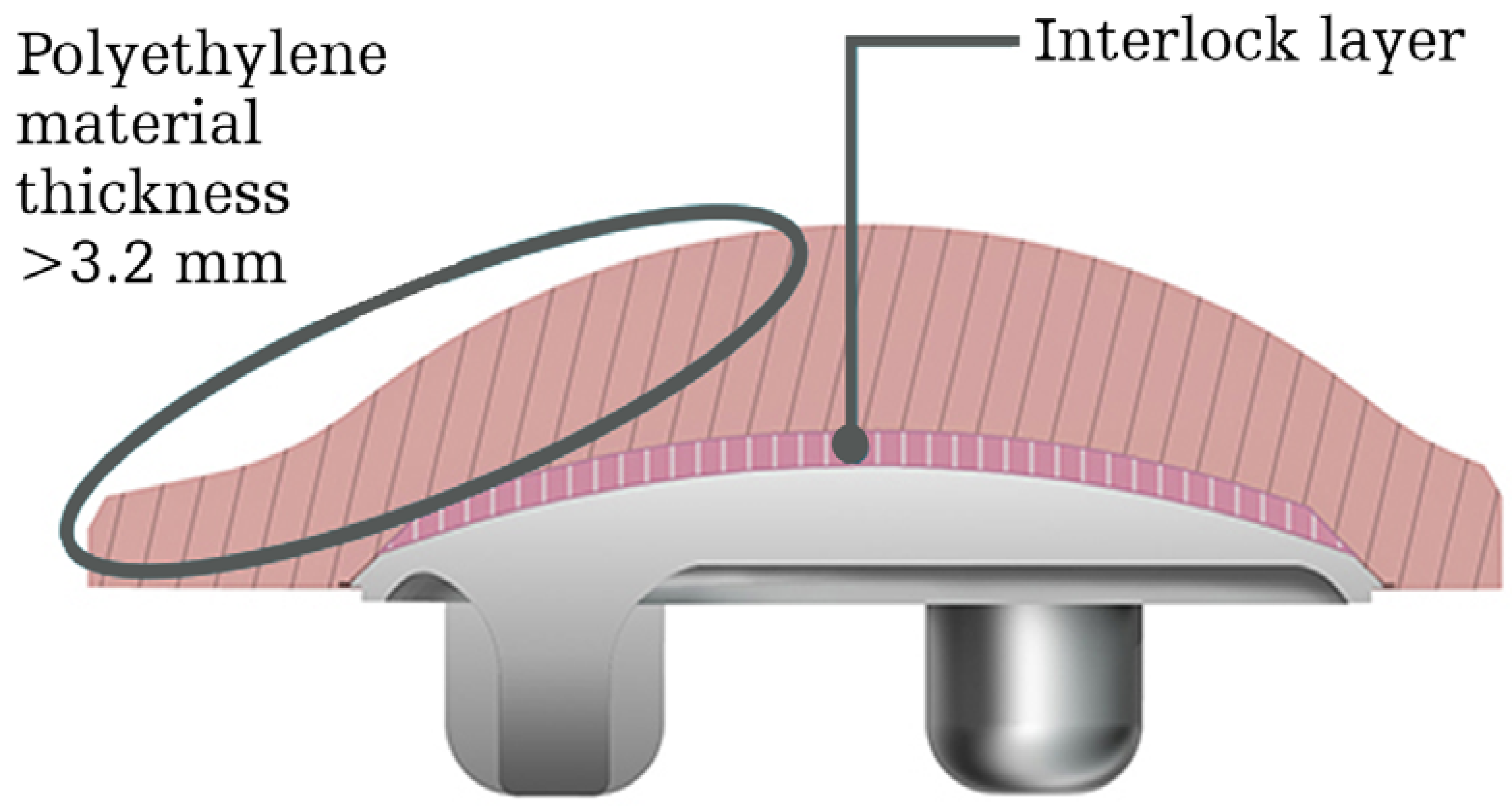
With additive manufacturing technology, we can manufacture implants that were previously difficult – or even impossible – to manufacture using conventional techniques, making it possible to selectively position porous structures in desired zones of the Triathlon Tibial Baseplate. Avoiding porous metal in the distal areas may reduce the risk of stress shielding. Additionally, avoiding distal biologic fixation is also a consideration in the event of a revision.



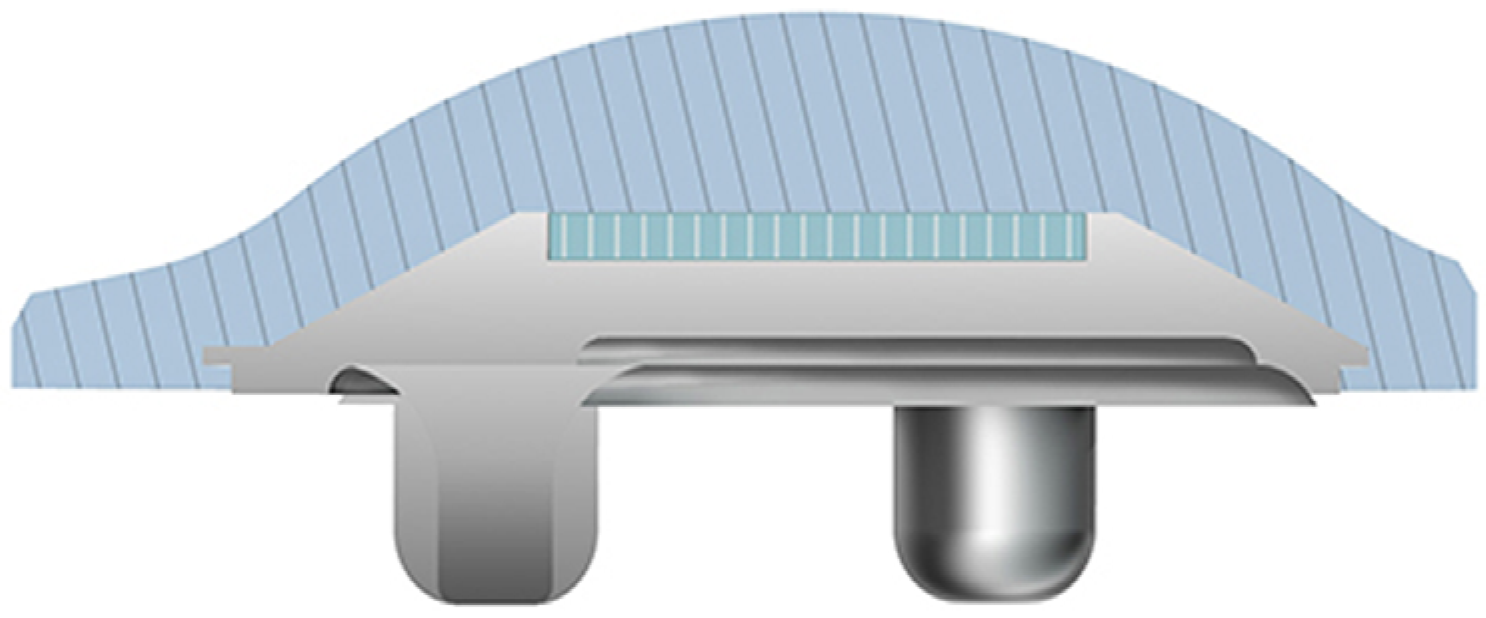
Triathlon Tritanium Metal-Backed Patella



The Triathlon Tritanium Metal-Backed Patella addresses the past clinical issue of dissociation of the metal-polyethylene interface[5] by enhancing the bond between the two components.[6] The architecture on the back side of the Triathlon Tritanium Metal-Backed Patella, combined with a direct compression molding process, is designed to minimize the potential for dissociation.[6] Additive manufacturing makes it possible to build a solid barrier layer between the porous surfaces, which allows for a smaller metal backing and greater polyethylene thickness.



Triathlon Tritanium

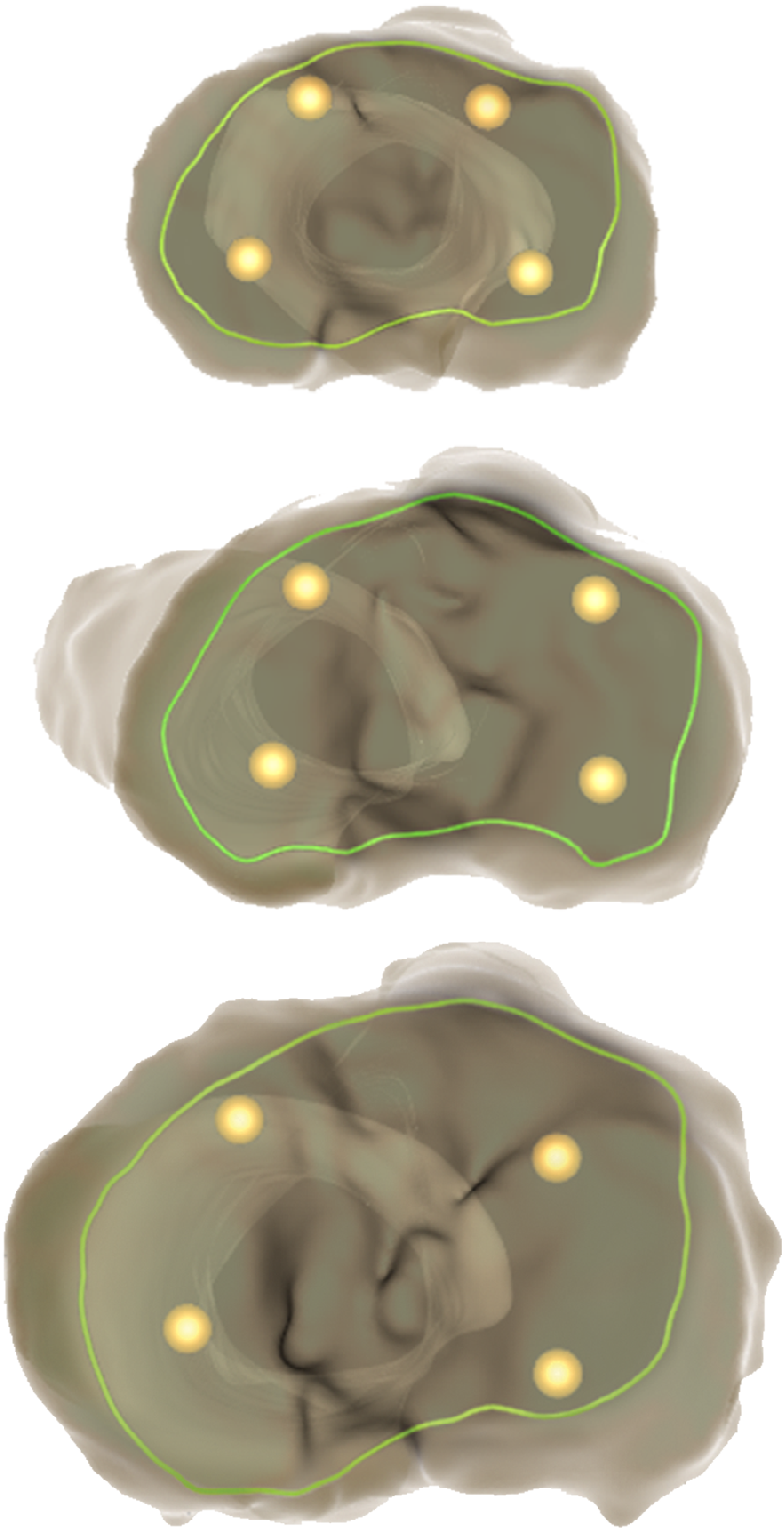


Triathlon Peri-Apatite (PA)

SOMA

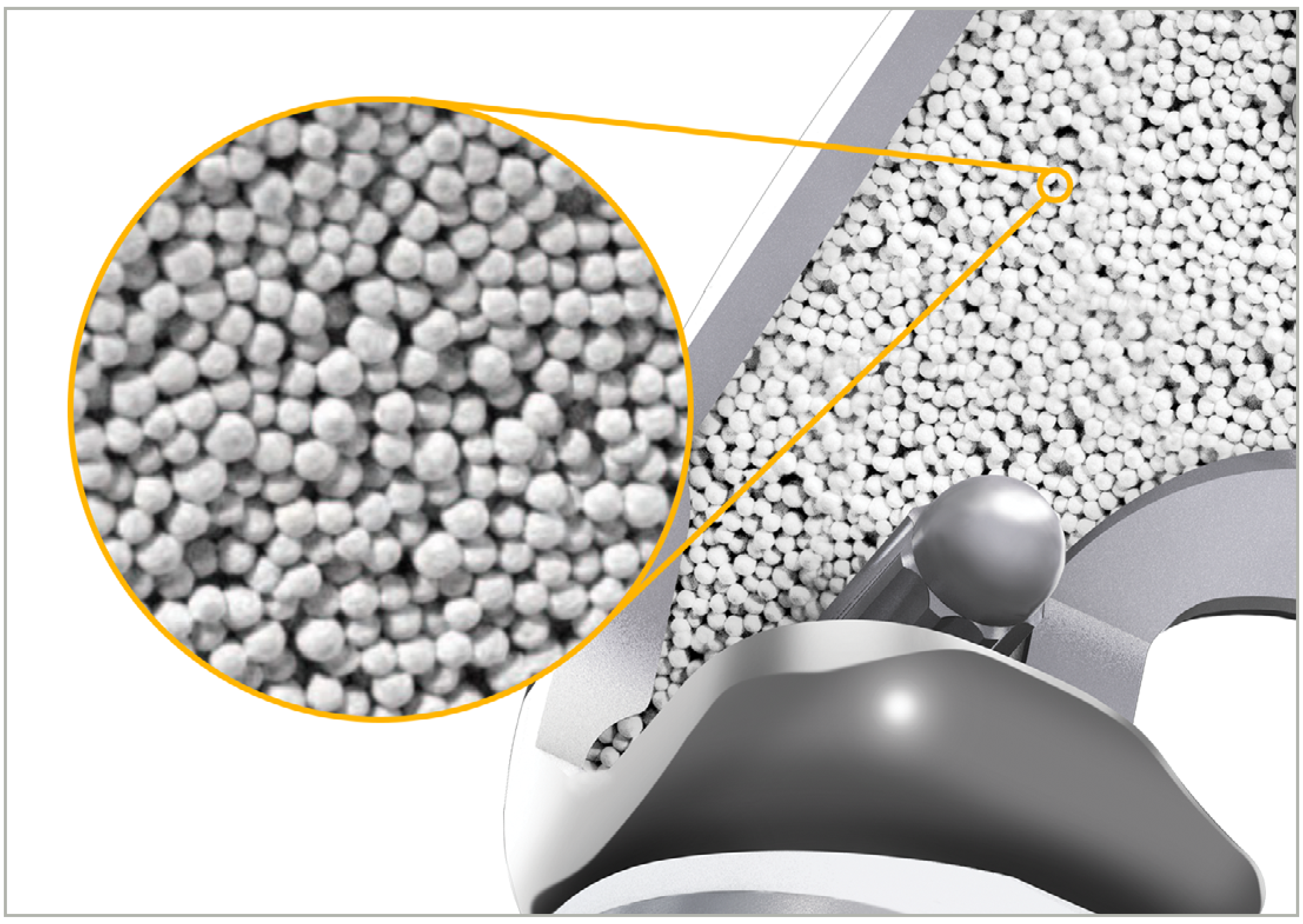
Stryker Orthopaedic Modeling and Analytics (SOMA) is a global database of bone morphology – including size, shape, density, stiffness, and inner and outer cortical diameters – drawn from diverse populations. SOMA was used to optimize the depth and placement of the Tritanium pegs. The Triathlon Tritanium Baseplate's size-specific peg design allows for purchase into denser regions of bone without perforating the cortex.[7]

Placement of pegs for baseplate sizes 1, 4, and 8.[7] The green line represents the cortex and the spheres represent the distal-most point on the pegs.



Peri-Apatite (PA)

Peri-Apatite (PA) was developed to coat hydroxyapatite (HA) onto porous-coated fixation surfaces. Triathlon cementless femoral components are manufactured with PA-beaded technology. As opposed to plasma-sprayed HA coatings, the PA coating wraps itself around the circumference of the porous surface, which is designed to increase the HA surface available for fixation.[8]



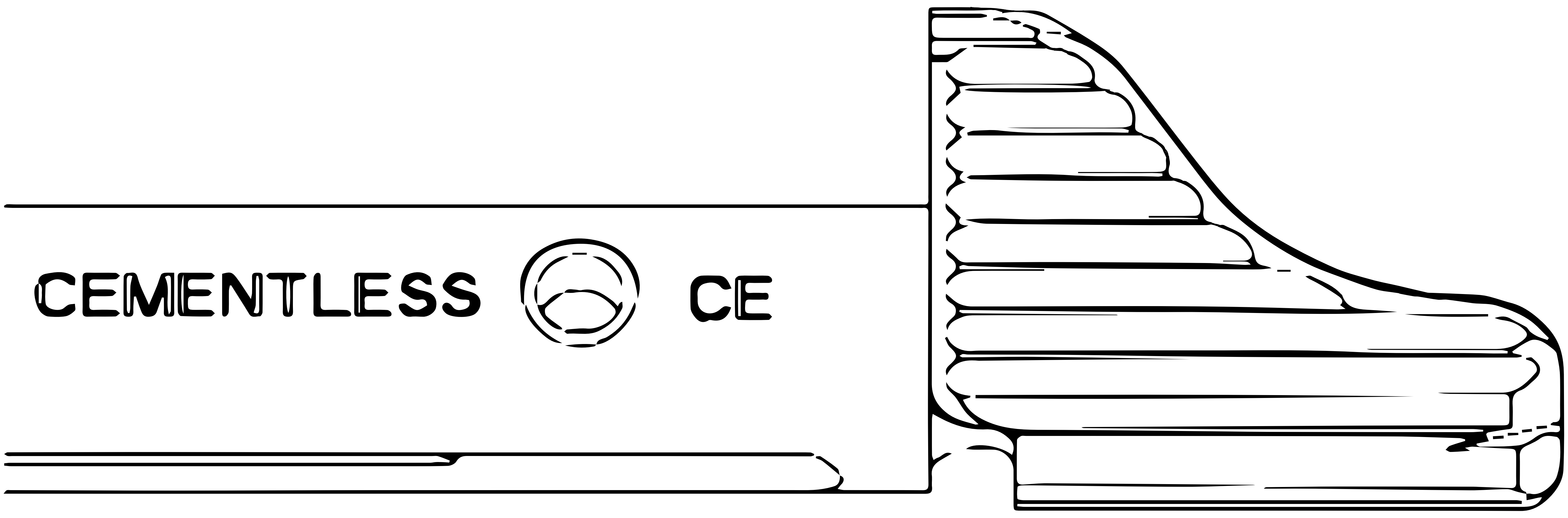
Flexibility with fixation techniques

Triathlon Tritanium Baseplate and Metal-Backed Patella are indicated for both cemented and cementless applications, providing surgeons intraoperative flexibility to decide the fixation method with the actual component after assessing bone quality.

Triathlon Tritanium Baseplate

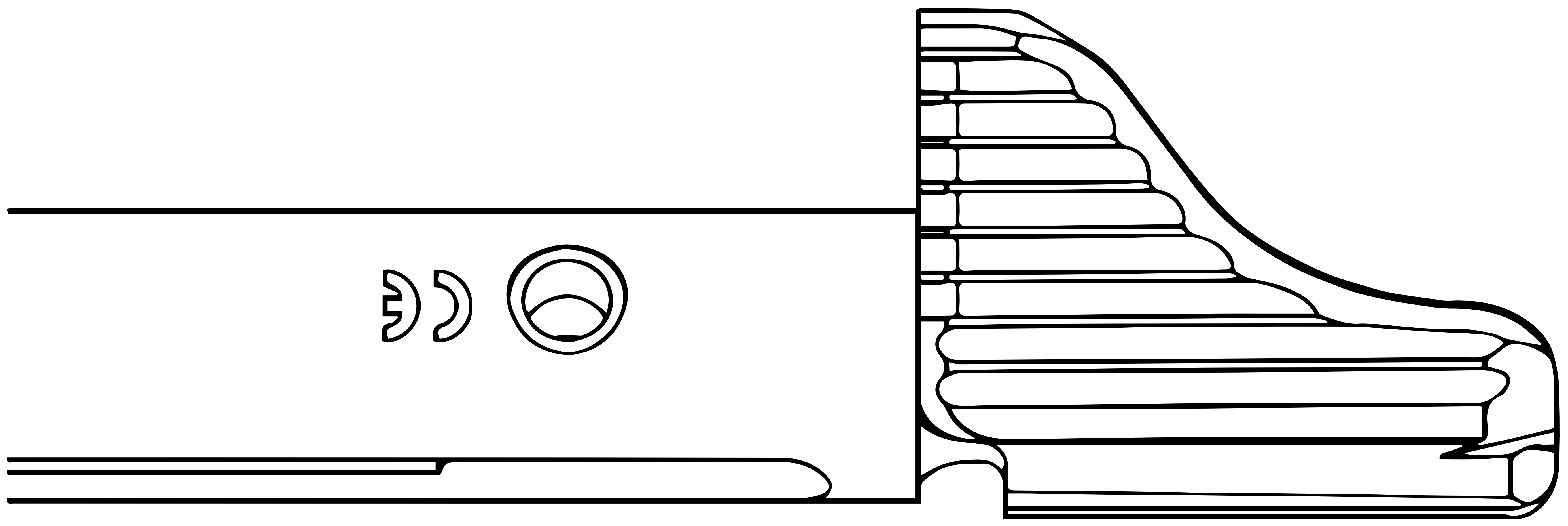
The Triathlon Tritanium Baseplate can be implanted with minimal additional preparation compared to a cemented Triathlon implant. The only additional step is to prepare the tibia for the pegs, which are designed to aid in initial stability.[1] The four peg prep holes on the Tibial Peg Drill Template correspond to the pegs on the implant.

- Use Cementless Keel Punch



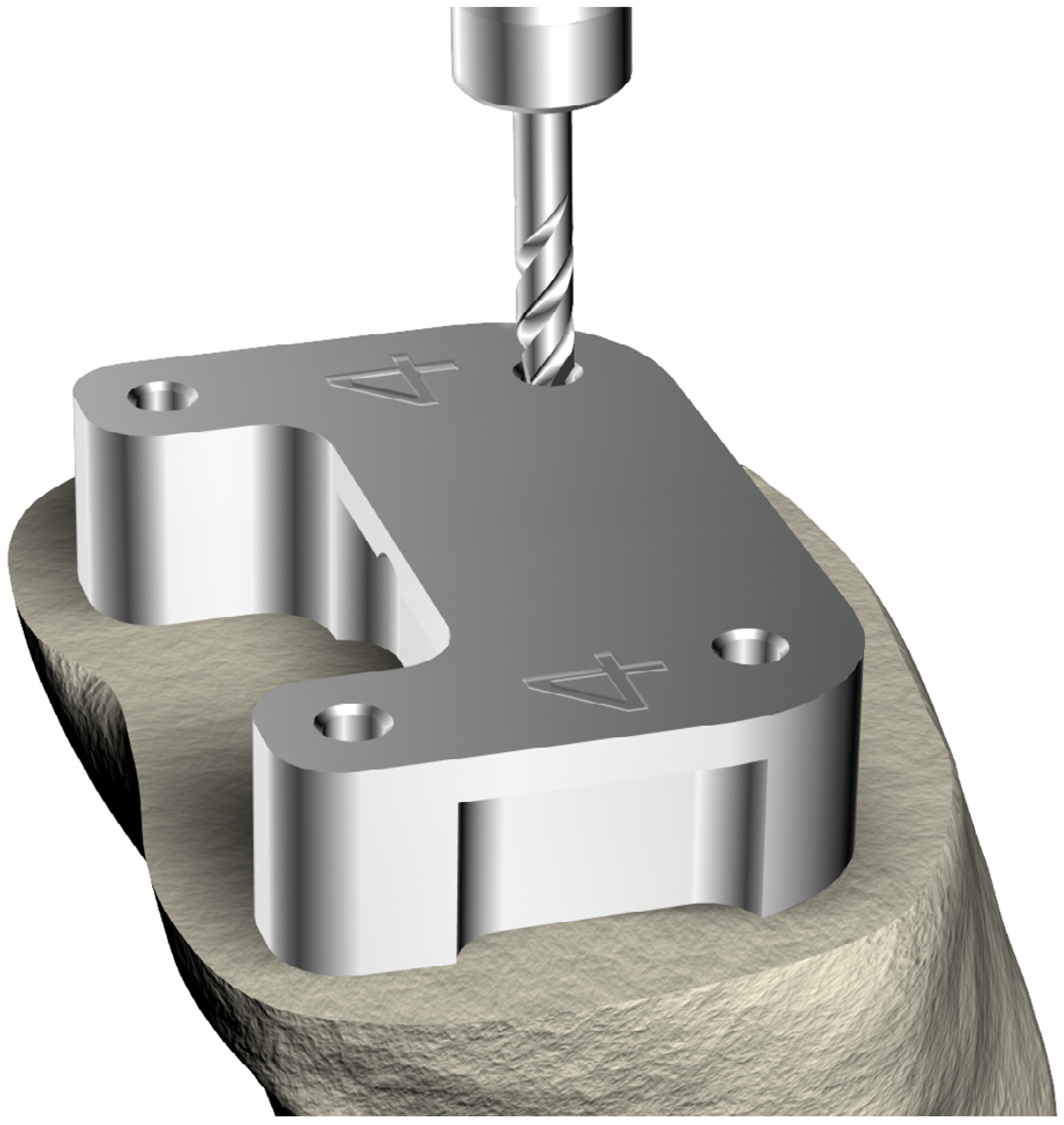
Cementless Keel Punch	
6541-**6**-013	Size 1-3
6541-**6**-046	Size 4-6
6541-**6**-078	Size 7-8

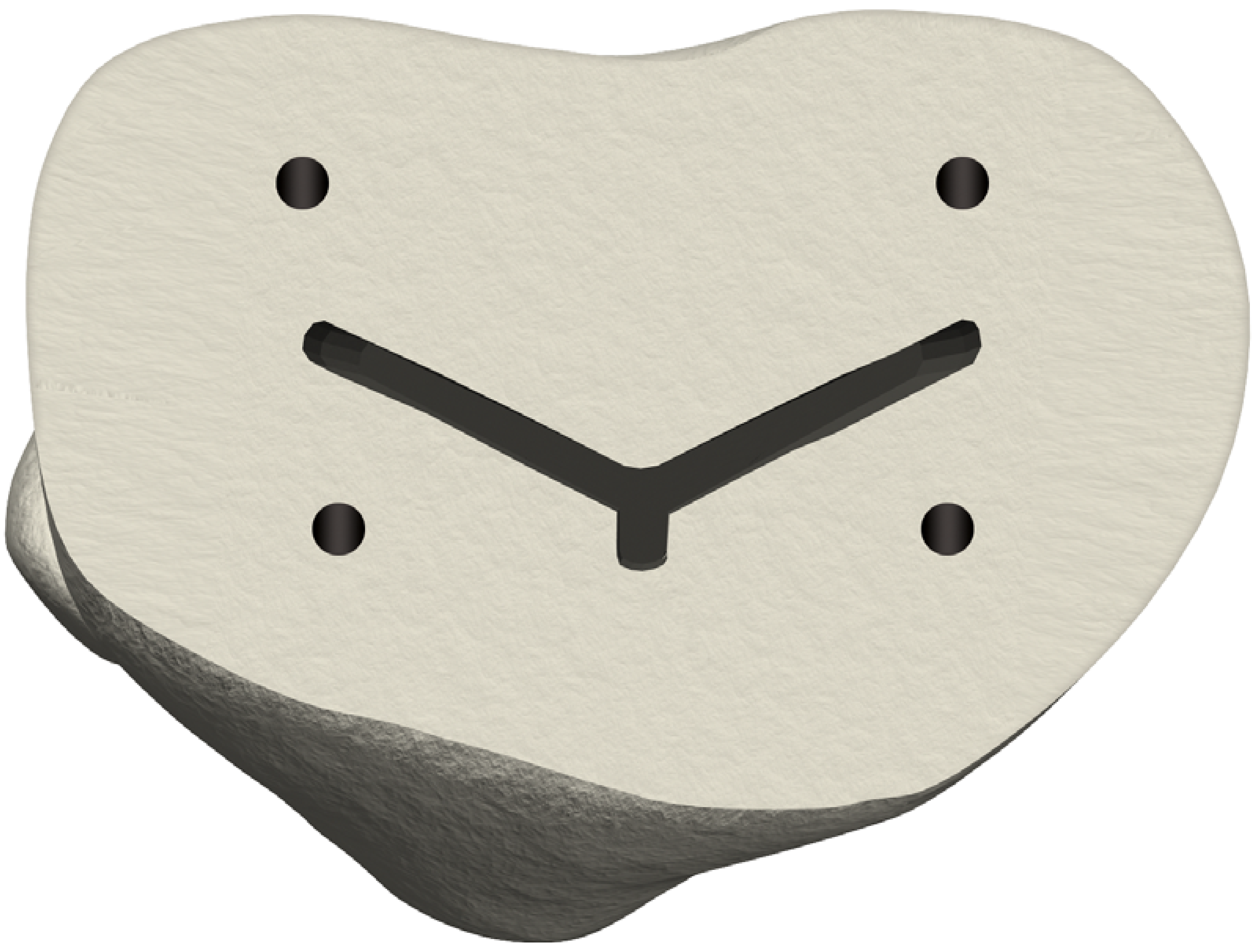
- Use Cemented Keel Punch



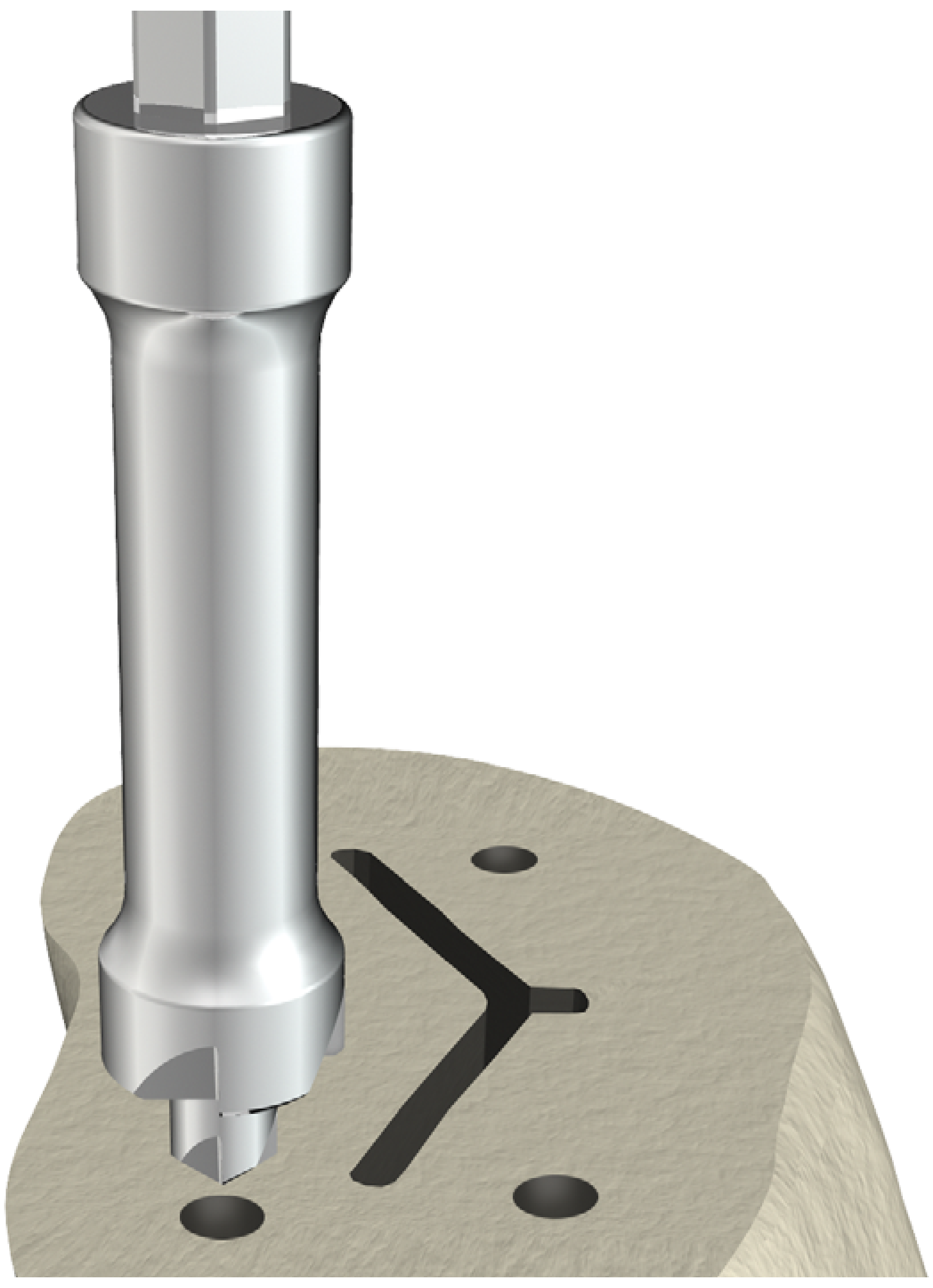
Cemented Keel Punch	
6541-**2**-013	Size 1-3
6541-**2**-046	Size 4-6
6541-**2**-078	Size 7-8

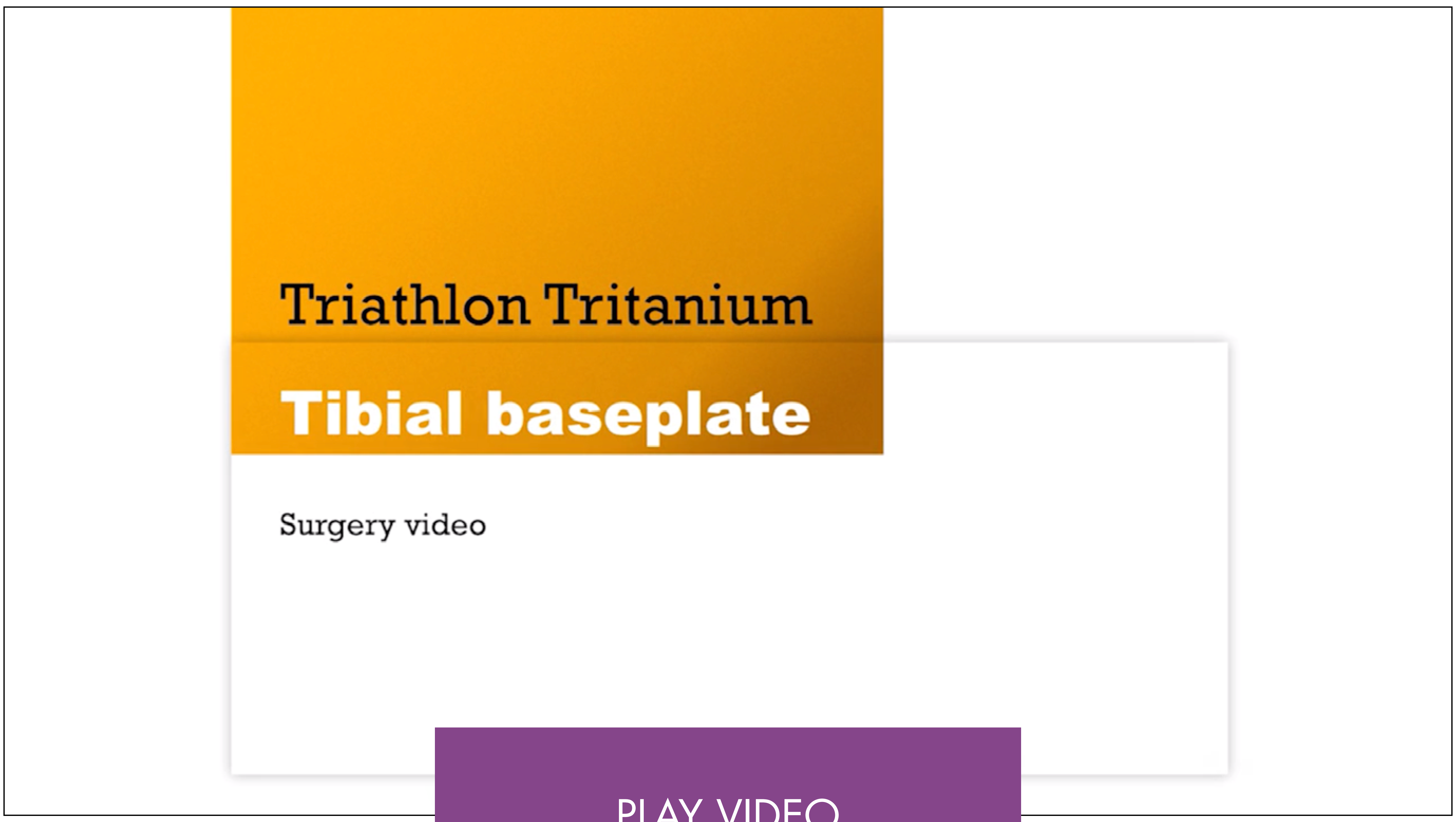
- Place size-specific tibial drill template on the prepared keel slot
- Prepare peg holes with 1/8 Tibial Peg Drill (6541-2-625)





- The optional 7/32 Peg Drill (6541-2-626) may be used to increase the size of the peg holes in dense, sclerotic bone



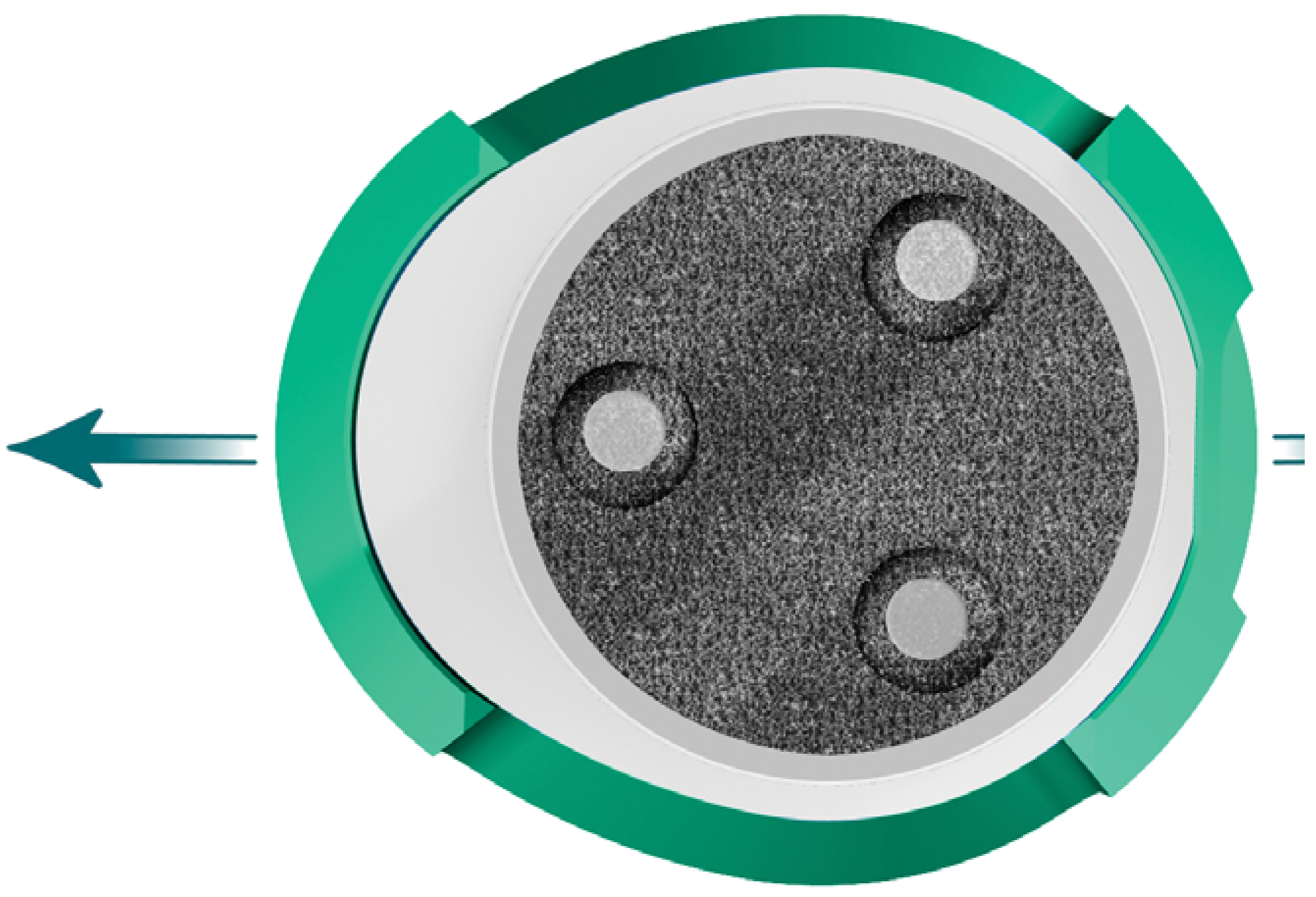


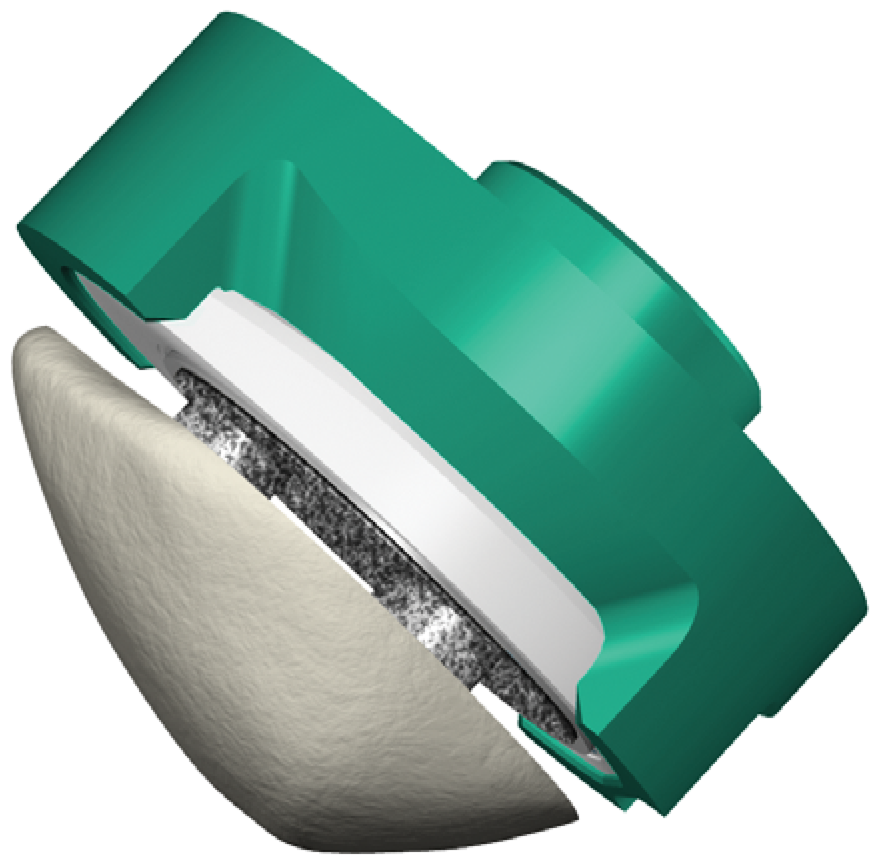
PLAY VIDEO

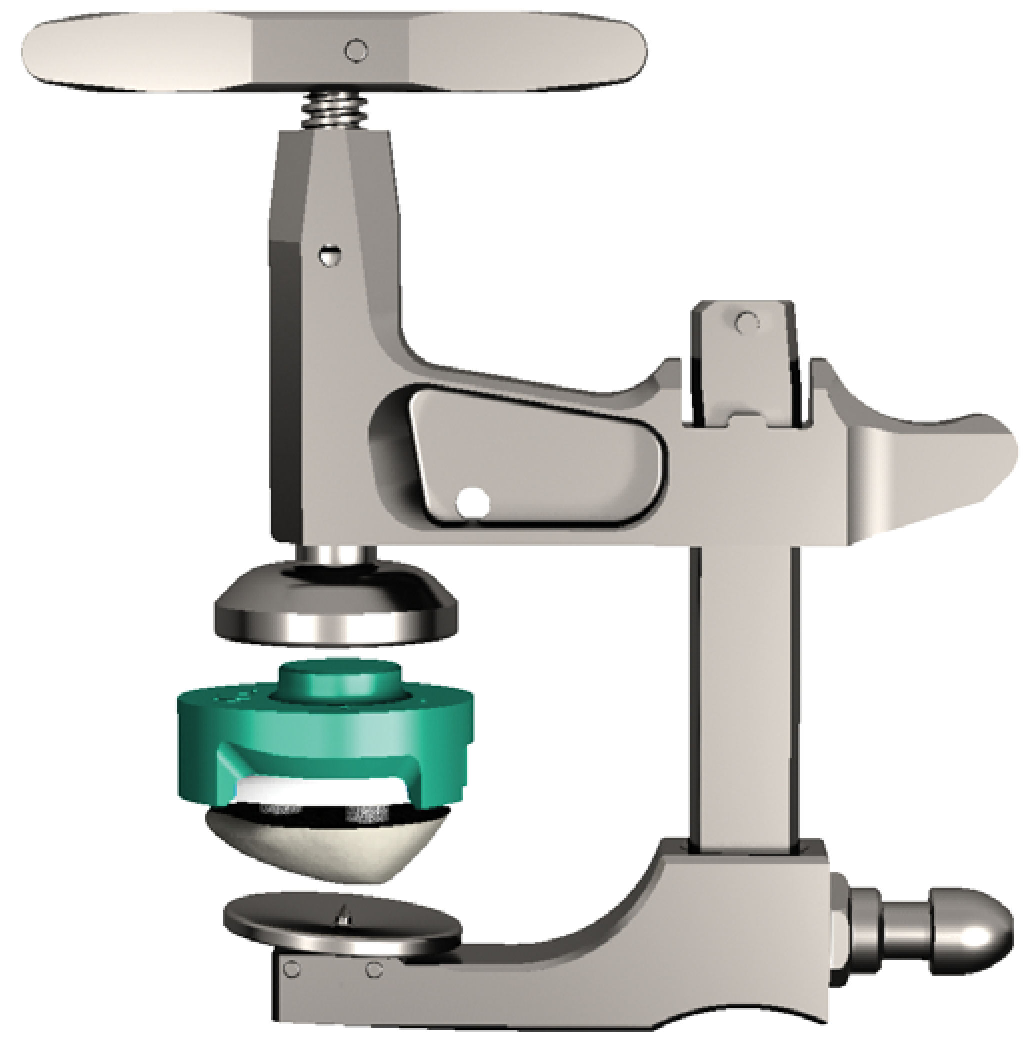
Triathlon Tritanium Metal-Backed Patella

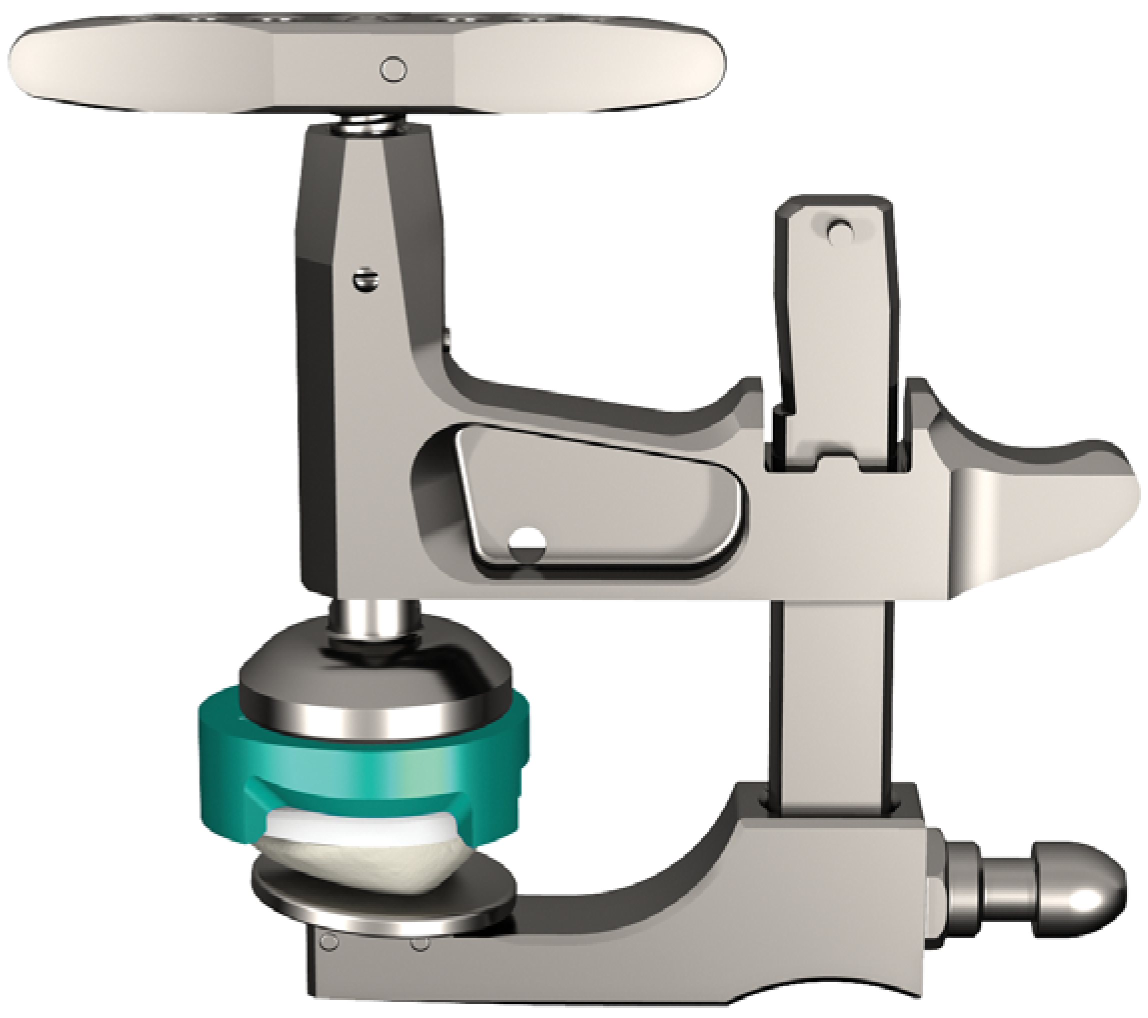
Drill selection guide

- For Triathlon Tritanium Metal-Backed Patella: Use the standard Metal-Backed Patella Drill (6541-3-522); 5.7mm (0.225in) drill diameter = 0.4mm (0.016in) pressfit.
- If the bone is sclerotic in any of the peg locations, the surgeon may elect to use the Tritanium Dense Bone Patella Drill (6541-3-526), which will create slightly less pressfit; 6.0mm (0.235in) drill diameter = 0.15mm (0.006in) pressfit.
- If the surgeon chooses to cement the Triathlon Tritanium Metal-Backed Patella or prefers to use a cemented All Poly-Patella, then the All-Poly Patella Drill (6541-3-524) must be used.
- Drill three fixation holes with the appropriate drill.





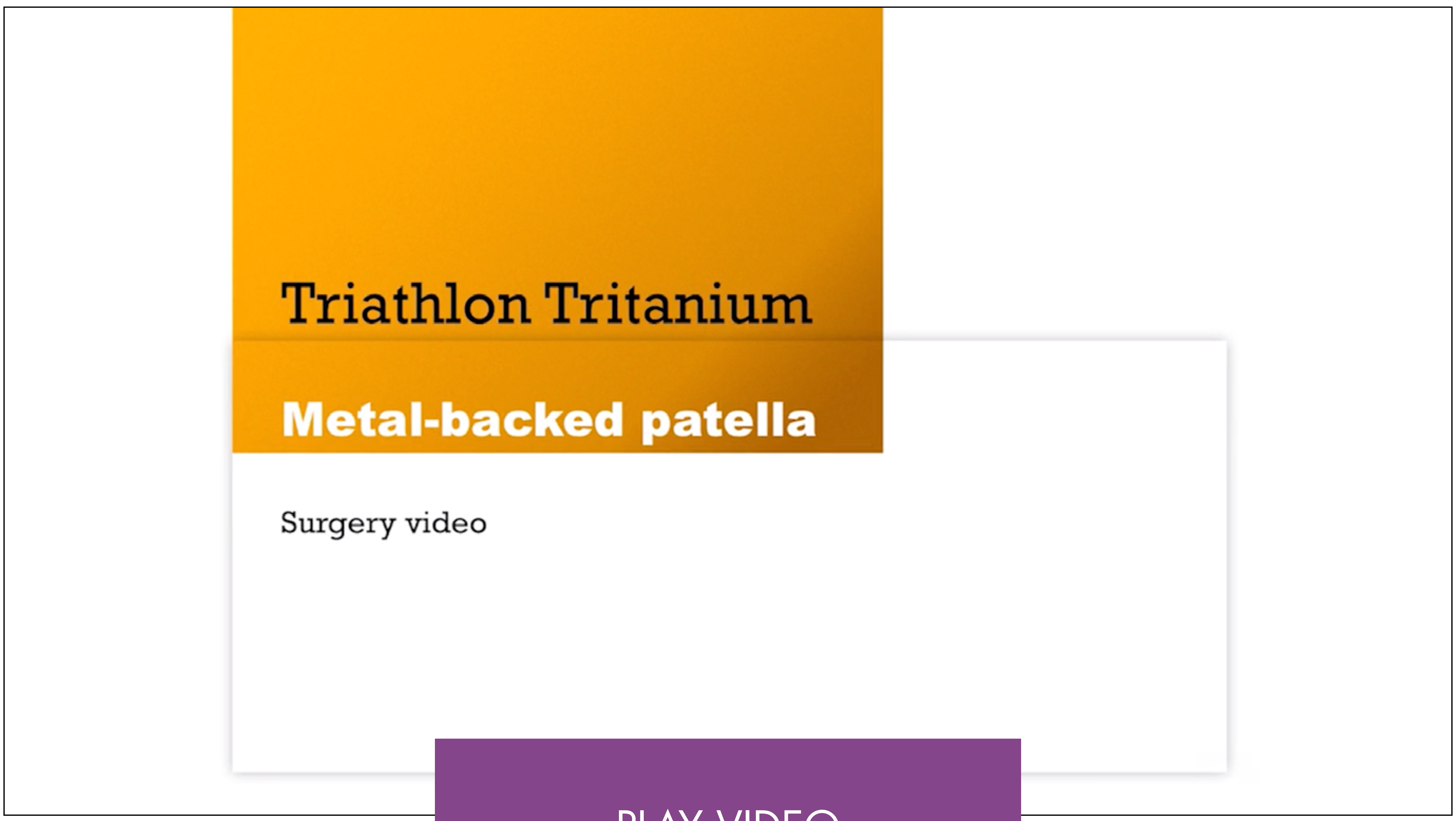




Additional instruments for Triathlon Tritanium Tibial Baseplate and Metal-Backed Patella

Part #	Description	Size	Tray location
6541-6-013	Triathlon Cementless Keel Punch	1-3	Triathlon Cementless Case
6541-6-046	Triathlon Cementless Keel Punch	4-6	
6541-6-078	Triathlon Cementless Keel Punch	7-8	
6541-8-003	Triathlon Cementless Case		
6541-2-64X	Triathlon Tibial Peg Drill Template	X=1-8	Triathlon Tritanium Prep Tray
6541-2-625	Tritanium Tibial Peg Drill	1/8 inch	
6541-2-626	Tritanium Dense Bone Peg Drill Tibial	7/32 inch	
6541-3-530	Tritanium Patella Inserter		
6541-3-319	Symmetric Patella Capture	S31	
6541-3-339	Symmetric Patella Capture	S33	
6541-3-360	Symmetric Patella Capture	S36	
6541-3-391	Symmetric Patella Capture	S39	
6541-3-299	Asymmetric Patella Capture	A29	
6541-3-320	Asymmetric Patella Capture	A32	
6541-3-350	Asymmetric Patella Capture	A35	
6541-3-391	Asymmetric Patella Capture	A38	
6541-3-401	Asymmetric Patella Capture	A40	
6541-3-526	Tritanium Dense Bone Patella Drill		
6541-8-100	Triathlon Tritanium Prep Tray		
1020-9000	Single Tray Case		
6541-3-522	Metal-Backed Patella Drill w/Stop*		Patellar Preparation – Lower Tray

*6541-3-522 Metal-Backed Patella Drill is used to prepare both the Triathlon Metal-Backed Patella Beaded w/Peri-Apatite and the Tritanium Metal-Backed Patella

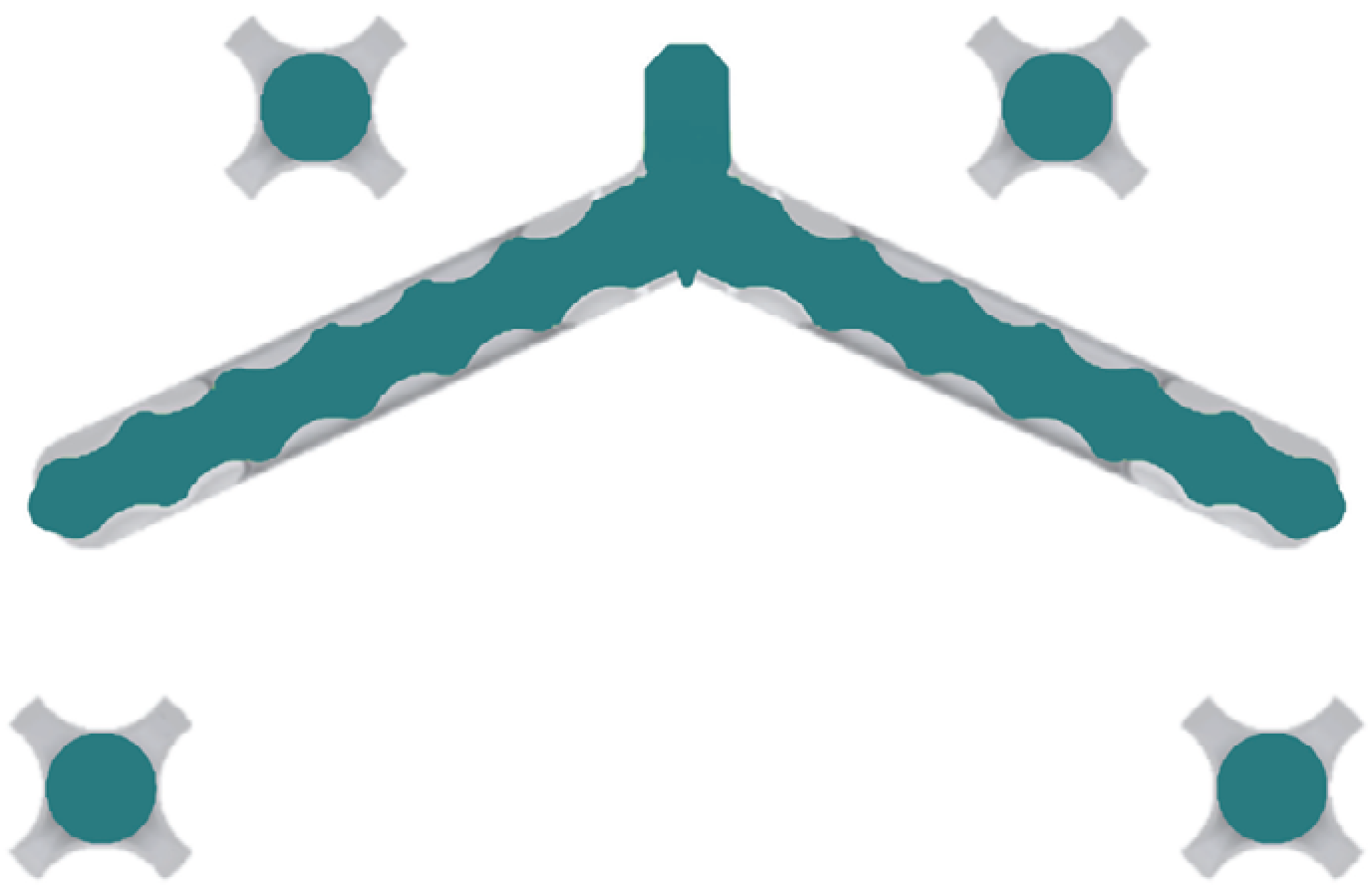


PLAY VIDEO

Triathlon Tritanium Baseplate dimensions

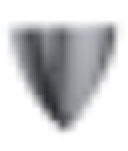
Size	M/L width	A/P width	Keel depth
1	61	40	28
2	64	42	28
3	67	44	28
4	70	46	34
5	74	49	34
6	77	52	34
7	80	56	39
8	85	60	39

Note: All dimensions are in millimeters



Prepared bone

Pressfit



Pegs are cruciform in shape and the pressfit is not circumferential. The pressfit is on the flutes

Tritanium Baseplate								
Peg diameter	7							
Tritanium foam thickness	1.14							
Keel pressfit on each side	When prepared with Cementless Keel Punch (6541-2-013 for size 1-3, 6541-2-046 for size 4-6, or 6541-6-078 for size 7-8): AP: 0.36							
Peg pressfit	When prepared with 1/8" Peg Drill: 3.7 When prepared with the 7/32" Dense Peg Drill: 1.4							
Peg length	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6	Size 7	Size 8
	7	8	9	9	10	11	11	12

Note: All dimensions are measured in millimeters

Tritanium Metal-Backed Patella					
Asymmetric patella					
Size	A29 × 9	A32 × 10	A35 × 10	A38 × 11	A40 × 11
Superior/inferior width	29	32	35	38	40
M/L width	33	36	39	42	44
Thickness	9	10	10	11	11
Peg diameter	6.1				
Symmetric patella					
Size	S31 × 9	S33 × 9	S36 × 10	S39 × 11	
Patella diameter	31	33	36	39	
Thickness	9	9	10	11	

Tritanium patella peg diameter is 0.03 mm larger than the pegs of PA Beaded Metal-Backed Patella

Patella sizes with the same colors have the same peg locations						
All-poly Asymmetric	A29 × 9	A32 × 10	A35 × 10	A38 × 11	A40 × 11	
All-poly Symmetric	S27 × 8	S29 × 8	S31 × 9	S33 × 9	S36 × 10	S39 × 11
Tritanium Asymmetric	A29 × 9	A32 × 10	A35 x 10	A38 × 11	A40 × 11	
Tritanium Symmetric			S31 × 9	S33 × 9	S36 × 10	S39 × 11

Peg pressfit for Metal-Backed Patella	
When prepared with 5.7 mm Standard Metal-Back Patella Drill (6541-3-522)	0.4
When prepared with 6 mm Dense Bone Patella Drill (6541-3-526)	0.15

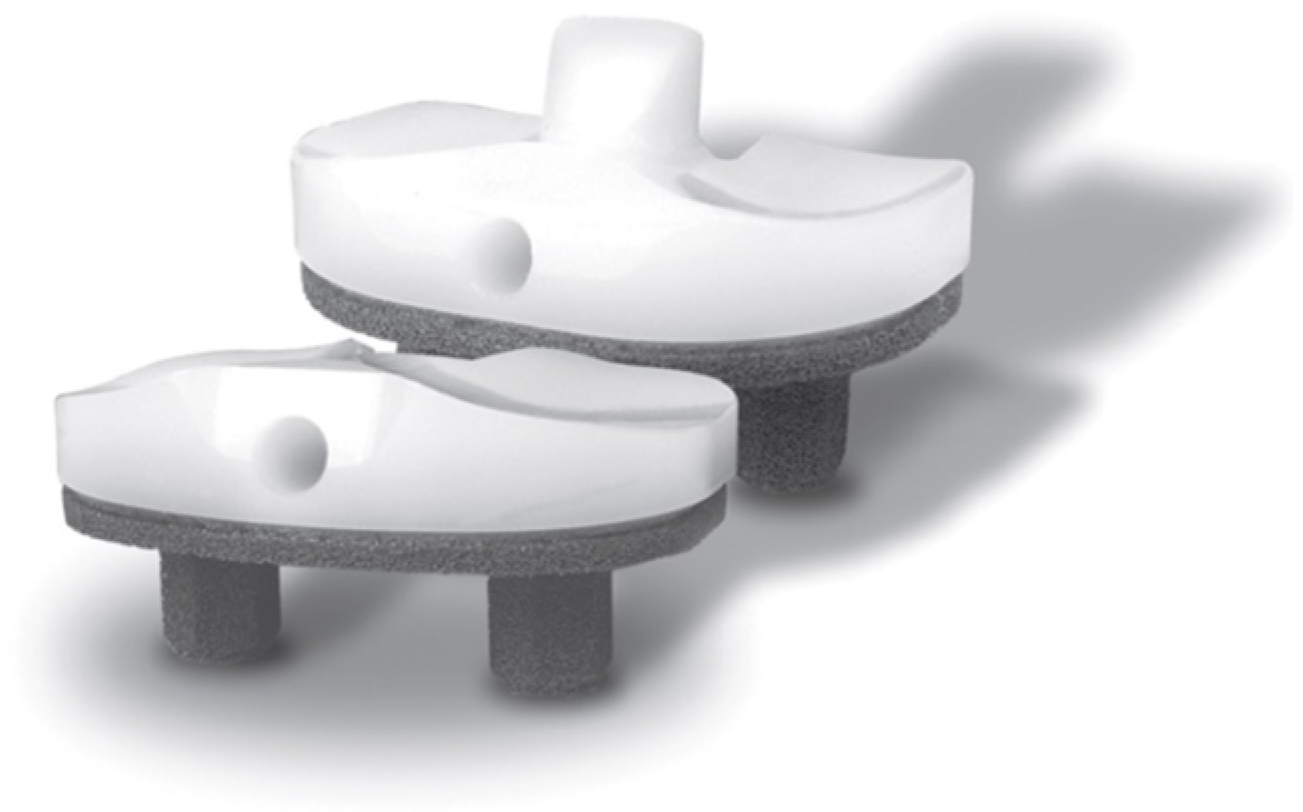
Note: All dimensions are measured in millimeters.

Zimmer Biomet Persona[1]

Trabecular Metal

Trabecular Metal is Zimmer Biomet's cementless technology. Note the underside geometry and peg designs of Zimmer Biomet's Trabecular Metal baseplates have changed over the years.[1,2,3]

NexGen Trabecular Metal Monoblock Tibia
2 hex pegs, symmetric design[2]



NexGen Trabecular Metal Tibial Tray[3]
3 hex pegs, symmetric design

Persona Trabecular Metal Tibial Tray[1]
2 hex pegs, asymmetric design

Stress shielding

Bone tissue is sensitive to the mechanical loads or stresses applied to it, and changes in applied loads can trigger bone remodeling. If bone is not stressed, it can remodel to become less dense and weaker. Decreases in bone density may increase the risk of migration and loosening of the prosthesis.[4] If biologic fixation occurs in a baseplate distally before it occurs proximally, the loads can be absorbed by the baseplate proximally and "shield" the proximal tibia from stress. This can lead to a decrease in bone density.

The cementless tibial pegs manufactured with Trabecular Metal technology feature pegs that are fully coated proximally and distally. In a study of 101 TKAs (93 patients) with NexGen Trabecular Metal baseplate, eight failures with stress shielding were observed at a mean of 18 months.[5]

NexGen Trabecular Metal monoblock baseplate

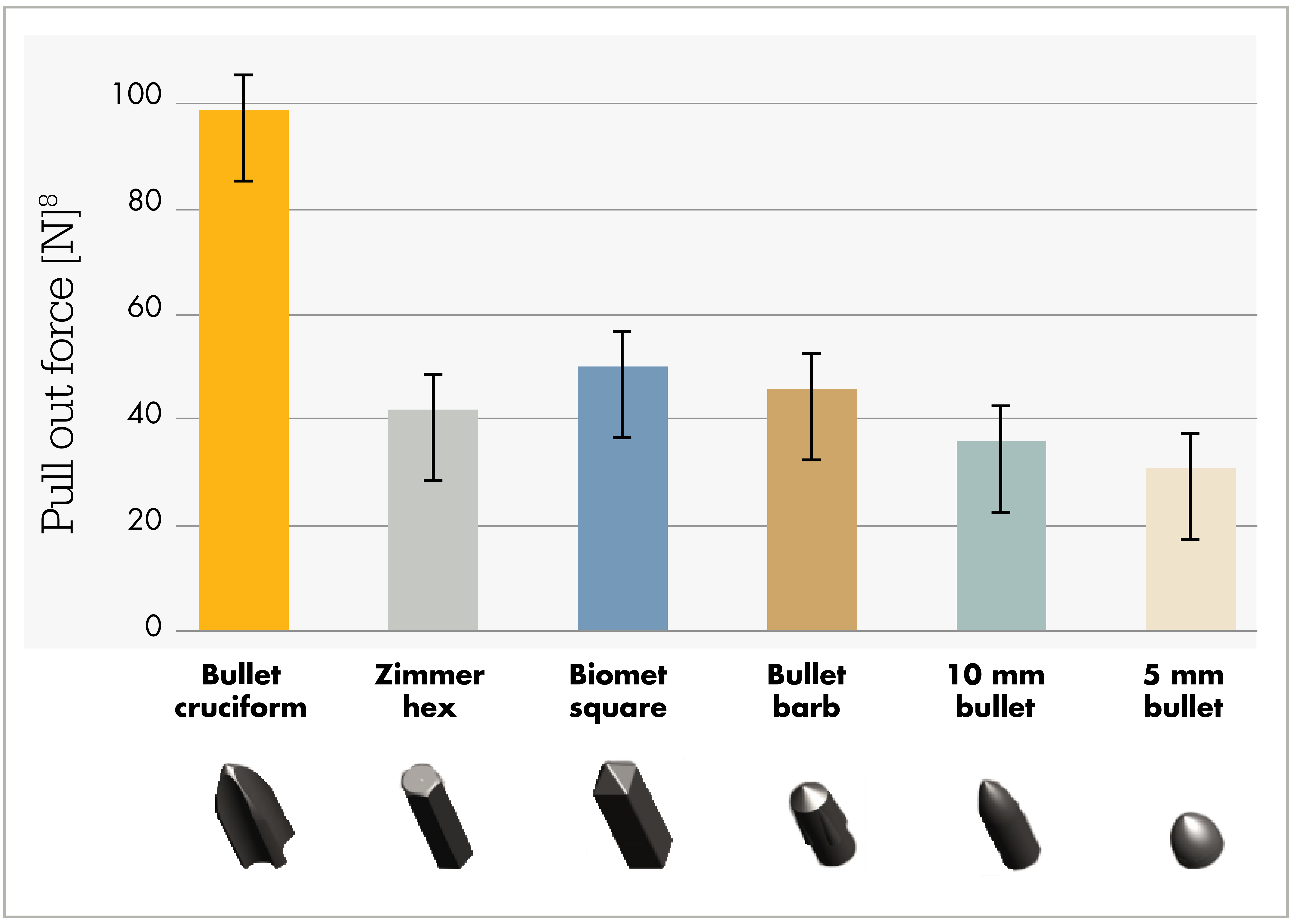
The additively manufactured Triathlon Tritanium Baseplate is designed to address the clinical challenges of stress shielding. The porous structures of the Triathlon Tritanium Baseplate are strategically positioned on the proximal pegs and keel to avoid porous metal in the distal areas, which may reduce the risks of stress shielding. Additionally, avoiding biologic fixation around distal pegs is a consideration in case of revision.

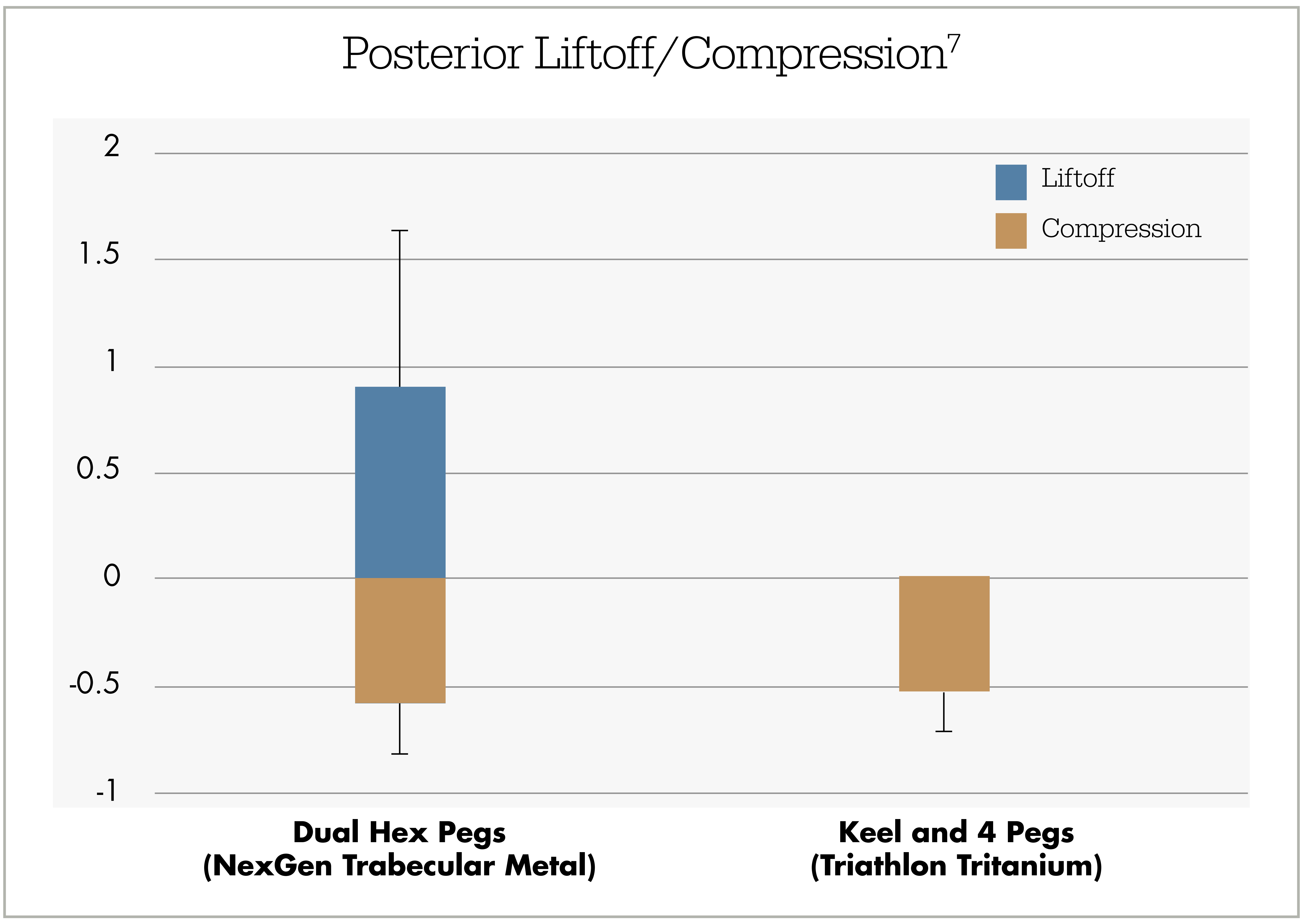
Persona Trabecular Metal baseplate

Triathlon Tritanium Baseplate

Peg and keel designs

Given the importance of stable primary fixation,[6] underside features of the Triathlon Tritanium Baseplate were designed to reduce micromotion and liftoff.[7,8] A benchtop test analyzed the effect of peg geometry on fixation and showed increased pull-out force required for our bullet cruciform peg compared to Zimmer Biomet's hex peg.[8] Coupled with our tibial keel design, Triathlon Tritanium Baseplate had less liftoff than Zimmer Biomet's dual pegs design.[7]





DePuy Attune

Rotating Platform (RP) & Fixed Bearing (FB) Cementless Knee[1,2,3]

Attune's cementless TKA system can be implanted with either Rotating Platform (RP) or fixed bearing (FB) tibial baseplates.[1,2,3] The cementless femoral components and RP tibial baseplate both feature POROCOAT porous-coating technology, which is composed of commercially pure titanium sintered metal beads.[1,2] The FB cementless tibial baseplate is manufactured from 3D printed titanium alloy (Ti-6Al-4V).[3]

Stress shielding

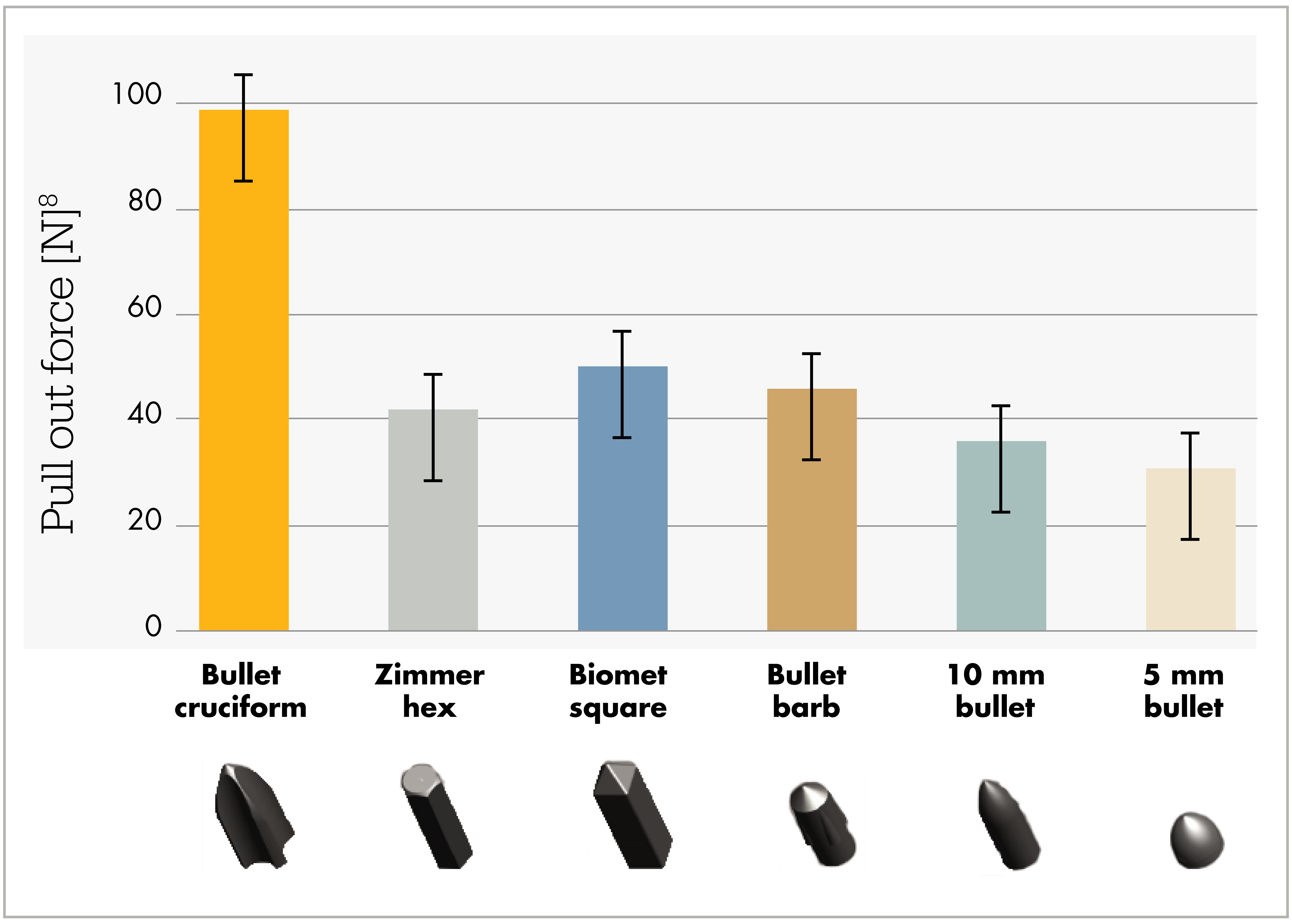
Bone tissue is sensitive to the mechanical loads or stresses applied to it, and changes in applied loads can trigger bone remodeling. If bone is not stressed, it can remodel to become less dense and weaker. Decreases in bone density may increase the risk of migration and loosening of the prosthesis.[4] If biologic fixation occurs in a baseplate distally before it occurs proximally, the loads can be absorbed by the baseplate proximally and "shield" the proximal tibia from stress. This can lead to decrease in bone density.

The tibial pegs on Attune RP and FB cementless baseplates are fully coated with titanium sintered beads proximally and distally.[1,2] In a study of 101 TKAs (93 patients) with NexGen Trabecular Metal baseplate, eight failures with stress shielding were observed at a mean of 18 months.[5]

The additively manufactured Triathlon Tritanium Baseplate is designed to address the clinical challenges of stress shielding. The porous structures of the Tritanium Baseplate are strategically positioned on the proximal pegs and keel to avoid porous metal in the distal areas, which may reduce the risks of stress shielding. Additionally, avoiding biologic fixation around the distal pegs is a consideration in case of revision.

Peg designs

Given the importance of stable primary fixation,[6] the underside feature of the Tritanium Baseplate was designed to reduce micromotion and liftoff.[7,8] Attune's cementless tibia has four short rounded pegs.[1] A benchtop test analyzed the effect of peg geometry on fixation and showed increased pull-out force required for our bullet cruciform peg compared to a 10 mm bullet design.[8]



WHY CEMENTLESS TKA

1. Memtsoudis et al. Trends in demographics, comorbidity profiles, in-hospital complications and mortality associated with primary knee arthroplasty. J Arthroplasty. 2009;24(4):518-527
2. Pabinger et al. Utilization rates of knee-arthroplasty in OECD countries. Osteoarthritis and Cartilage 2015; 23: 1664e1673
3. Johnson et al. Patient Demographics as a Predictor of the Ten year Survival Rate in Primary Total Knee Replacement. The Journal of Bone and Joint Surgery 2003 85.1 pp. 5256
4. Schreurs et al. Total Joint Arthroplasty in Younger Patients: Heading for Trouble? The Lancet (2017), volume 389, Issue 10077, P1374-1375.
5. Abdel et al. Increased aseptic tibial failures in patients with a BMI 35 and well-aligned total knee arthroplasties. J Arthroplasty 2015;30:2181e4.
6. Sinicrope et al. Increased survivorship of cementless versus cemented TKA in the morbidly obese. a minimum 5-year follow-up. J Arthroplasty. 2019;34(2):309-314
7. American Joint Replacement Registry (AJRR): 2020 Annual Report. Rosemont, IL: American Academy of Orthopaedic Surgeons (AAOS), 2020
8. Nam et al. Perioperative and Early Postoperative Comparison of a Modern Cemented and Cementless Total Knee Arthroplasty of the Same Design. The Journal of Arthroplasty 32 (2017) 2151-2155
9. Cohen et al. Early clinical outcomes of a new cementless total knee arthroplasty design. Orthopedics. 2018;41(6):e765-e771.
10. Yayac et al. The use of cementless components does not significantly increase procedural costs in total knee arthroplasty. J Arthroplasty. 2020;35(2): 407-412.
11. National Joint Registry for England, Wales and Northern Ireland and Isle of Man. 16th Annual Report. 2020.
12. American Academy of Orthopaedic Surgeons (AAOS). Surgical management of osteoarthritis of the knee. Evidence-based clinical practice guideline. 2015; https://www.aaos.org/globalassets/quality-and-practice-resources/surgical-management-knee/smoak-cpg_4.22.2016.pdf
13. Tarazi et al. Cementless Tritanium Baseplate total knee arthroplasty: survivorship and outcomes at 5-year minimum follow-up. J Knee Surg. Accepted manuscript. Published online June 19, 2020.
14. Silverstein et al. 5 year follow up data for cementless total knee arthroplasty patients. Poster presented at: Orthopaedic Research Society (ORS) 2020 Annual Meeting; February 8-11, 2020; Phoenix, AZ.
15. Restrepo et al. Minimum five-year follow-up of a novel 3D-printed tibial baseplate for cementless total knee arthroplasty. Orthopaedic Proceedings. Vol. 102-B, No. SUPP_9.
16. Miller et al. Results of cemented vs cementless primary total knee arthroplasty using the same implant design. J Arthroplasty. 2018;33(4):1089-1093.

CLINICAL EVIDENCE

1. Tarazi et al. Cementless Tritanium Baseplate total knee arthroplasty: survivorship and outcomes at 5-year minimum follow-up. J Knee Surg. Accepted manuscript. Published online June 19, 2020.
2. Restrepo et al. Minimum five-year follow-up of a novel 3D-printed tibial baseplate for cementless total knee arthroplasty. Orthopaedic Proceedings. Vol. 102-B, No. SUPP_91.
3. Silverstein et al. 5 year follow up data for cementless total knee arthroplasty patients. Poster presented at: Orthopaedic Research Society (ORS) 2020 Annual Meeting; February 8-11, 2020; Phoenix, AZ.
4. Harwin et al. Outcomes of cementless-backed patellar components. J Knee Surg. Accepted manuscript. Published online May 29, 2020.
5. Harwin et al. Outcomes of newer generation cementless total knee arthroplasty: beaded periapatite-coated vs highly porous titanium-coated implants. J Arthroplasty. 2017;32(7):2156-2160.

6. Bhowmik-Stoker et al. Clinical performance of a novel 3D printed cementless titanium tibial baseplate, 2-4 year follow-up. Presented at: 2nd World Arthroplasty Congress; April 19-21, 2018. Rome, Italy.
7. Cohen et al. Early clinical outcomes of a new cementless total knee arthroplasty design. Orthopedics. 2018;41(6):e765-e771.
8. Masini et al. Cementless total knee arthroplasty resulting in no revisions due to tibial component loosening and improved outcomes. Presented at: American Academy of Orthopaedic Surgeons (AAOS) Annual Meeting. March 24-28, 2018. Orlando, FL.
9. Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). Hip, Knee & Shoulder Arthroplasty: 2019 Annual Report. Adelaide: AOA, 2019.
10. Harwin et al. Cementless posteriorly stabilized total knee arthroplasty: seven-year minimum follow-up report. J Arthroplasty. 2018;33(5):1399-1403. doi:10.1016/j.arth.2017.11.020
11. Sporer et al. Evaluation of a 3D-printed total knee arthroplasty using radiostereometric analysis: assessment of highly porous biological fixation of the tibial baseplate and metal-backed patellar component. Bone Joint J. 2019;101-B(7_Supple_C): 40-47. doi:10.1302/0301-620X.101B7.BJJ-2018-1466.R1
12. Nilsson et al. Evaluation of micromotion in cemented vs uncemented knee arthroplasty in osteoarthritis and rheumatoid arthritis. Randomized study using Roentgen stereophotogrammetric analysis. J Arthroplasty. 1991;6(3):265-278.
13. Pijls et al.. RSA migration of total knee replacements. Acta Orthop. 2018;89(3):320-328. doi: 10.1080/17453674.2018.1443635
14. Nam et al. Perioperative and Early Postoperative Comparison of a Modern Cemented and Cementless Total Knee Arthroplasty of the Same Design. The Journal of Arthroplasty 32 (2017) 2151-2155
15. Miller et al. Results of cemented vs cementless primary total knee arthroplasty using the same implant design. J Arthroplasty. 2018;33(4):1089-1093.
16. American Joint Replacement Registry (AJRR): 2020 Annual Report. Rosemont, IL: American Academy of Orthopaedic Surgeons (AAOS), 2020
17. Mont et al. Outcomes of a newer-generation cementless total knee arthroplasty design in patients less than 50 years of age. Ann Transl Med. 2017;5(Suppl 3):S24. doi:10.21037/atm.2017.08.20
18. Newman et al. Cementless total knee arthroplasty in patients older than 75 years. J Knee Surg. 2017;30(9):930-935. doi:10.1055/s-0037-1599253
19. Sinicrope et al. Increased survivorship of cementless versus cemented TKA in the morbidly obese. a minimum 5-year follow-up. J Arthroplasty. 2019;34(2):309-314
20. Patel et al. Outcomes of cementless total knee arthroplasty in patients with rheumatoid arthritis. Orthopedics. 2018;41(2):103-106. doi:10.3928/01477447-20180123-05

DESIGN

1. Nilsson et al. Evaluation of micromotion in cemented vs uncemented knee arthroplasty in osteoarthritis and rheumatoid arthritis. Randomized study using Roentgen stereophotogrammetric analysis. J Arthroplasty. 1991;6(3):265-278.
2. Bhimji et al. Rotational constraint of posterior-stabilized total knee prostheses. J Knee Surg. 2008;21(4):315-319. doi:10.1055/s-0030-1247838
3. Harwin et al. Excellent fixation achieved with cementless posteriorly stabilized total knee arthroplasty. J Arthroplasty.2013;28(1):7-13. doi:10.1016/j.arth.2012.06.006
4. Bhimji et al. Tibial insert micromotion of various total knee arthroplasty devices. J Knee Surg. 2010;23(3):153-162. doi:10.1055/s-0030-1268696
5. Bhimji et al. Micromotion of cementless tibial baseplates: keels with adjuvant pegs offer more stability than pegs alone. J Arthroplasty. 2014;29(7):1503-1506. doi:10.1016/j.arth.2014.02.016
6. Stryker technical report: Report number RD-13-107. Effect of geometry on peg fixation strength. 2013.

TECHNOLOGY

1. Poggie et al. Novel porous titanium implants demonstrate bone ingrowth in a rabbit model. Presented at: Orthopaedic Research Society (ORS) Annual Meeting; January 26-29, 2013; San Antonio, TX.
2. Stryker technical report: Report number RD-12-117. Metal foam coefficient of friction - Triathlon Tritanium Baseplate and patella. 2013.
3. Stryker technical report: Report number RD-12-068. Porous-coated Triathlon Tibial Baseplate – a characterization of the physical properties. 2011.
4. Stryker technical report: Report number RD-12-047. Porous-coated Triathlon™ X3 Patella–a characterization of the physical properties. 2012.
5. Bayley et al. Failure of the metal-backed patellar component after total knee replacement. J Bone Joint Surg Am. 1988;70(5):668-674.
6. Stryker technical report: Report number RD-12-044. Tritanium patella statictensile bond strength of poly/metal interface. 2013.
7. Stryker tolerance analysis: Project number 92911. Triumph Tritanium Knee. D02521-1; 2013.
8. Serekian P. Hydroxyapatite: from plasma spray to electrochemical deposition. In: Epinette J-A, Manley MT, eds. Fifteen Years of Clinical Experience with Hydroxyapatite Coatings in Joint Arthroplasty. Springer-Verlag Paris; 2004:29-33.

PROCEDURAL HIGHLIGHTS

1. Bhimji st al. Micromotion of cementless tibial baseplates: keels with adjuvant pegs offer more stability than pegs alone. J Arthroplasty. 2014;29(7):1503-1506. doi:10.1016/j.arth.2014.02.016

COMPETITION – ZIMMER BIOMET PERSONA

1. Persona®. The Personalized Knee Trabecular Metal™ Tibia surgical technique. Zimmer Biomet. https://www.zimmerbiomet.com/content/dam/zimmer-biomet/medical-professionals/000-surgical-techniques/knee/97-5026-027-00%20Rev%205%20PERSONA%20Trabecular%20Metal%20Tibia%20SurgTech-digitalFINAL.pdf
2. Zimmer® NexGen® Trabecular Metal™ Monoblock tibial components surgical technique addendum. Zimmer Biomet. https://www.zimmerbiomet.com/content/dam/zimmer-biomet/medical-professionals/000-surgical-techniques/knee/zimmer-nexgen-trabecular-metal-monoblock-tibial-components-surgical-technique.pdf
3. NexGen® Trabecular Metal™ Tibial Tray surgical technique. Zimmer Biomet. https://www.zimmerbiomet.com/content/dam/zimmer-biomet-OUS-Surg-techniques/knee/97-5954-002-00%20Rev%203%20NexGen%20TM%20Modular%20Tibia%20SurgTech-FINAL%20DIGITAL.pdf
4. Small et al. Changes in tibial bone density measured from standard radiographs in cemented and uncemented total knee replacements after ten years' follow-up. Bone Joint J. 2013;95-B(7):911-916. doi:10.1302/0301-620X.95B7.30537
5. Meneghini RM, de Beaubien BC. Early failure of cementless porous tantalum monoblock tibial components. J Arthroplasty. 2013;28(9):1505-1508. doi:10.1016/j.arth.2013.03.005
6. Nilsson KG, Kärrholm J, Ekelund L, Magnusson P. Evaluation of micromotion in cemented vs uncemented knee arthroplasty in osteoarthritis and rheumatoid arthritis. Randomized study using Roentgen stereophotogrammetric analysis. J Arthroplasty. 1991;6(3):265-278.
7. Bhimji S, Meneghini RM. Micromotion of cementless tibial baseplates: keels with adjuvant pegs offer more stability than pegs alone. J Arthroplasty. 2014;29(7):1503-1506. doi:10.1016/j.arth.2014.02.016
8. Stryker technical report: Report number RD-13-107. Effect of geometry on peg fixation strength. 2013.

COMPETITION – DEPUY ATTUNE CEMENTLESS TKA ROTATING PLATFORM (RP)

1. DePuy Synthes. The Attune® Cementless Knee System. www.jnjmedicaldevices.com/en-US/product/attunecementless-knee-system

2. DePuy Synthes. Proven coating fixation technologies. https://www.corailpinnacle.net/pinnacle/fixation
3. 510(k) K202194
4. Small et al. Changes in tibial bone density measured from standard radiographs in cemented and uncemented total knee replacements after ten years' follow-up. Bone Joint J. 2013;95-B(7):911-916. doi:10.1302/0301-620X.95B7.30537
5. Meneghini et al. Early failure of cementless porous tantalum monoblock tibial components. J Arthroplasty. 2013;28(9):1505-1508. doi:10.1016/j.arth.2013.03.005
6. Nilsson et al. Evaluation of micromotion in cemented vs uncemented knee arthroplasty in osteoarthritis and rheumatoid arthritis. Randomized study using Roentgen stereophotogrammetric analysis. J Arthroplasty. 1991;6(3):265-278. doi:10.1016/s0883-5403(06)80174-9
7. Bhimji et al. Micromotion of cementless tibial baseplates: keels with adjuvant pegs offer more stability than pegs alone. J Arthroplasty. 2014;29(7):1503-1506. doi:10.1016/j.arth.2014.02.016
8. Stryker technical report: Report number RD-13-107. Effect of geometry on peg fixation strength. 2013.

A surgeon must always rely on his or her own professional clinical judgment when deciding whether to use a particular product when treating a particular patient. Stryker does not dispense medical advice and recommends that surgeons be trained in the use of any particular product before using it in surgery.

The information presented is intended to demonstrate the breadth of Stryker's product offerings. A surgeon must always refer to the package insert, product label and/or instructions for use before using any of Stryker's products. Products may not be available in all markets because product availability is subject to the regulatory and/or medical practices in individual markets. Please contact your sales representative if you have questions about the availability of products in your area.

TRITAN-APP-5_Rev-2_28474