

AETOS^o Meta Stem: Stable, Bone-Preserving Metaphyseal Fixation Across Bone Qualities

The incidence of shoulder arthroplasty is rising, growing by **6–15% annually**.¹ Cementless humeral stems are favored due to bone preservation and ease of revision, yet their press-fit nature can **alter load distribution and contribute to stress shielding**.^{2,3} The AETOS Meta Stem has been designed to **distribute load more proximally**, potentially reducing the risk of stress shielding, whilst **supporting bone preservation and enhancing rotational stability**, in both healthy and protic bone.

Targeted Engagement of AETOS Meta Stem Loads Bone Where It Matters Most^{4*}

Testing matrix

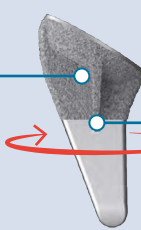
Stem Consideration	Goal	Results	
		AETOS Meta Stem (size 2) [†]	Comparator 2 (metaphyseal referencing) [‡]
Filling Ratio	Minimize overall & distally	24%	35%
Bone Loading (Strain Energy)	Proximal large volume of bone	3,178 mm ³	1,924 mm ³
Osteoporotic Bone Loading	Increase load distribution	5,450 mm ³	4,715 mm ³
Rotational Stiffness	Maximize with minimal mass	10 Nm/deg	7 Nm/deg
Varus Loading	Minimize distal %	3%	21%

AETOS Meta Stem Supports Bone Preservation and Reduces Risk of Stress Shielding

- AETOS Meta Stem supports bone preservation through proximal metaphyseal engagement, designed to **minimize distal stress transfer and reduce the risk of stress shielding**.²

Side view

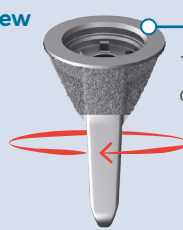
Plasma spray porous titanium coating



Cruciate fins

Front view

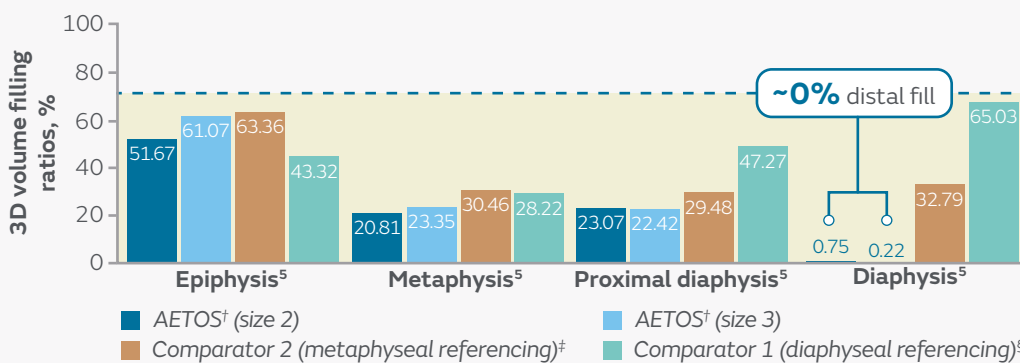
Tapered inlay design



The inlay design and cruciate fins of the AETOS Meta Stem **prioritizes the loading of the metaphyseal bone**.³

- In a virtual implantation model, analysis of 3D canal filling ratio reported 32% of the implant residing in the epiphysis with **0% extending into the diaphysis**.²
- Moreover, in FEA testing, the AETOS Meta Stem demonstrated **lower diaphyseal canal fill ratios** compared to cylindrical designs, supporting bone preservation by **minimizing distal stress transfer while maintaining proximal engagement**.^{2,4*}

Filling ratio

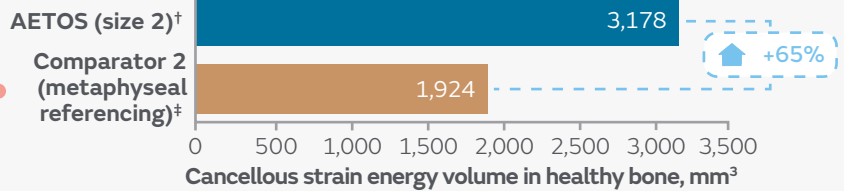


The AETOS Meta Stem has been shown to have a **canal filling ratio of less than 0.7^{4*}** – the threshold reported as being at risk of stress-shielding.⁶

- AETOS Meta Stem also allowed proximal fill scalability by going from Size 2 to Size 3 increasing epiphyseal fill ratio approximately 10%.⁴

Bone loading (strain energy)

In FEA testing, the AETOS^o Meta Stem design distributed resultant strain energy over a larger volume of metaphyseal cancellous, healthy bone than the comparator stem.³



Additionally, the AETOS Meta Stem demonstrated a more uniform load distribution in the metaphyseal bone³ and **reduced distal cancellous bone loading**, consistent with its low diaphyseal fill ratios, designed to reduce unnecessary distal stress.⁴

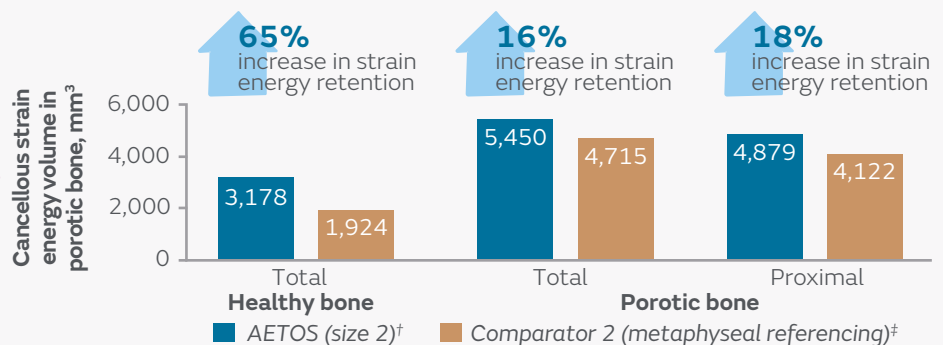
- With AETOS Meta Stem, <8% of total force transferred distally vs >30% with comparator, reflecting **deliberate proximal load transfer by design**.⁴

Osteoporotic bone loading

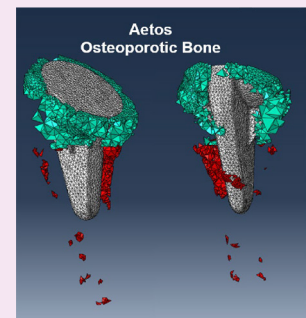
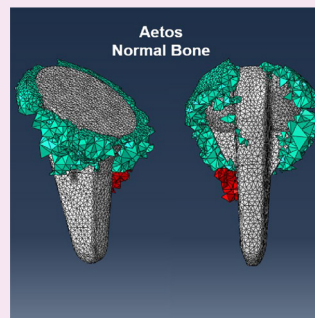
AETOS Meta Stem Demonstrates Consistent Performance Across Bone Qualities

- The AETOS Meta Stem's design offers **potential advantages in patients with osteoporosis**, who typically face higher implant-related risks, especially with cementless implants.^{7,8}
- In osteoporotic bone models, AETOS Meta Stem **maintained proximal load and rotational stability** due to fins and angular stem design, supporting potential advantage over other designs in higher-risk bone.⁴

AETOS Meta Stem demonstrated **greater strain energy retention in proximal bone**, designed to support long-term bone integrity.⁴



- Across point loading scenarios of healthy and porotic bone, AETOS Meta Stem distributed stresses more evenly in the proximal humerus while **minimizing distal stress concentrations**, aligning with balanced load distribution.⁴
- With AETOS Meta Stem, **<8% of total force transferred distally vs >30% with comparator**, reflecting deliberate proximal load transfer by design.⁴



Cancellous strain energy volume.

Green = cancellous bone in proximal region. **Red** = cancellous bone in the distal region.

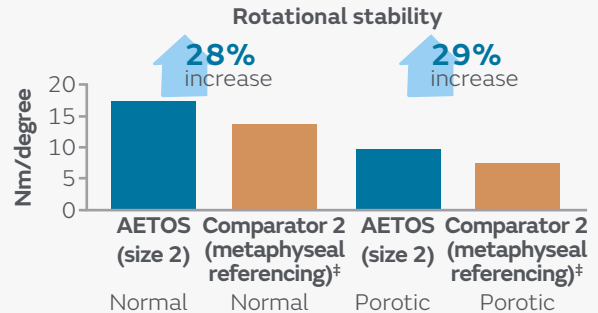
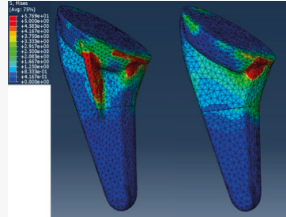
Rotational stiffness

AETOS^o Meta Stem Provides Enhanced Rotational Stability for Reliable Fixation

- In FEA testing, anterior-posterior fins of AETOS Meta Stem increased stability by 29% compared to the comparator, potentially improving stiffness in low-density bone.⁴

Sagittal fins of AETOS Meta Stem increased torsional stiffness by 45%, providing rotational stability without reliance on distal canal fin, compared with AETOS Meta Stem analyzed without fins.⁴

Effect of fin geometry on Von Mises stress distribution in Meta Stem implants

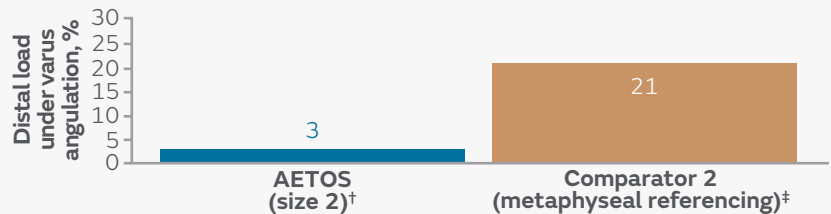


Varus loading

AETOS Meta Stem Effectively Distributes Varus Loading to Preserve Bone Integrity

- In varus angulation AETOS Meta Stem preserved 22% more load proximally in the metaphyseal region vs the comparator (92 vs 70%), which predominantly relies on distal canal contact for stiffness.⁴

In line with this, varus rotation of the comparator resulted in substantially greater forces distributed to the distal cancellous bone, relative to the AETOS Meta Stem.⁴



Conclusions

Through its unique design, the AETOS Meta Stem achieves targeted proximal metaphyseal engagement that loads bone where it matters most;^{4*} delivering superior rotational stability and physiological stress distribution, compared with comparator 2, while minimizing distal canal fill.

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 Smith+Nephew representative or distributor if you have questions about the availability of Smith+Nephew products in your area. For detailed product information, including indications for use, contraindications, precautions and warnings, please consult the product's applicable Instructions for Use (IFU) prior to use.

*As demonstrated in finite element modelling. [†]AETOS Meta Stem. [‡]Metaphyseal referencing is a humeral preparation technique in which the resected metaphyseal surface of the proximal humerus serves as the primary anatomical landmark for implant sizing, alignment, and orientation. [§]Diaphyseal referencing refers to a humeral stem preparation technique in which the diaphyseal canal is used as the primary anatomical reference for alignment, fixation, and implant stability.

Abbreviations: 3D = three-dimensional; FEA = finite element analysis; IFU = Instructions for Use; vs = versus.

References: **1.** Rupani N, Combesure C, Silman A, et al. International trends in shoulder replacement: a meta-analysis from 11 public joint registers. *Acta Orthop* 2024;95:348–357. **2.** Smith+Nephew. Analysis of risk of stress-shielding: 3D Canal filling ratio, 2025. CSD.REC.25.002v1. **3.** Smith+Nephew. Analysis of risk of stress-shielding: Finite Element Analysis, 2025. CSD.REC.25.001v1. **4.** Smith+Nephew. Analysis of Risk of Stress-Shielding in Osteoporotic Bone, 2025. CSD.REC.25.004v1. **5.** Urvoy M, Blakeney W, Raiss P, et al. *JSES Int* 2022;6(6):917–922. **6.** Kramer M, Olach M, Zdravkovic V, et al. *Arch Orthop Trauma Surg* 2024;144(2):663–672. **7.** Casp AJ, Montgomery SR, Jr., Cancienne JM, et al. Osteoporosis and Implant-Related Complications After Anatomic and Reverse Total Shoulder Arthroplasty. *J Am Acad Orthop Surg* 2020;28:121–127. **8.** Lawand JJ, Lopez R, Boufadel P, et al. Enhanced risk of 90-day medical and 2-year implant-related complications in total shoulder arthroplasty patients with osteoporosis. *J Shoulder Elbow Surg* 2025;34:e355–e360.