

Ode to the All Polyethelene Tibia

TRAVIS SCUDDAY M.D.

Hoag Orthopedics.

Research • Education • Community Outreach

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Disclosures

- Ownership

- Hoag Orthopedic Institute
- Main Street Surgery Center
- Sylke

- Consulting

- Corin
- Exactech

- Education

- Loma Linda Residency
- Hoag Fellowship

- Partner at Orthopedic Specialty Institute

Background

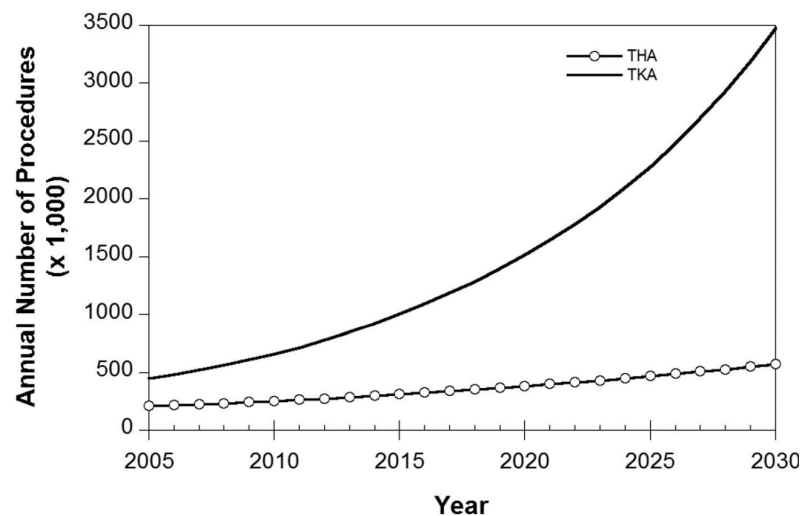
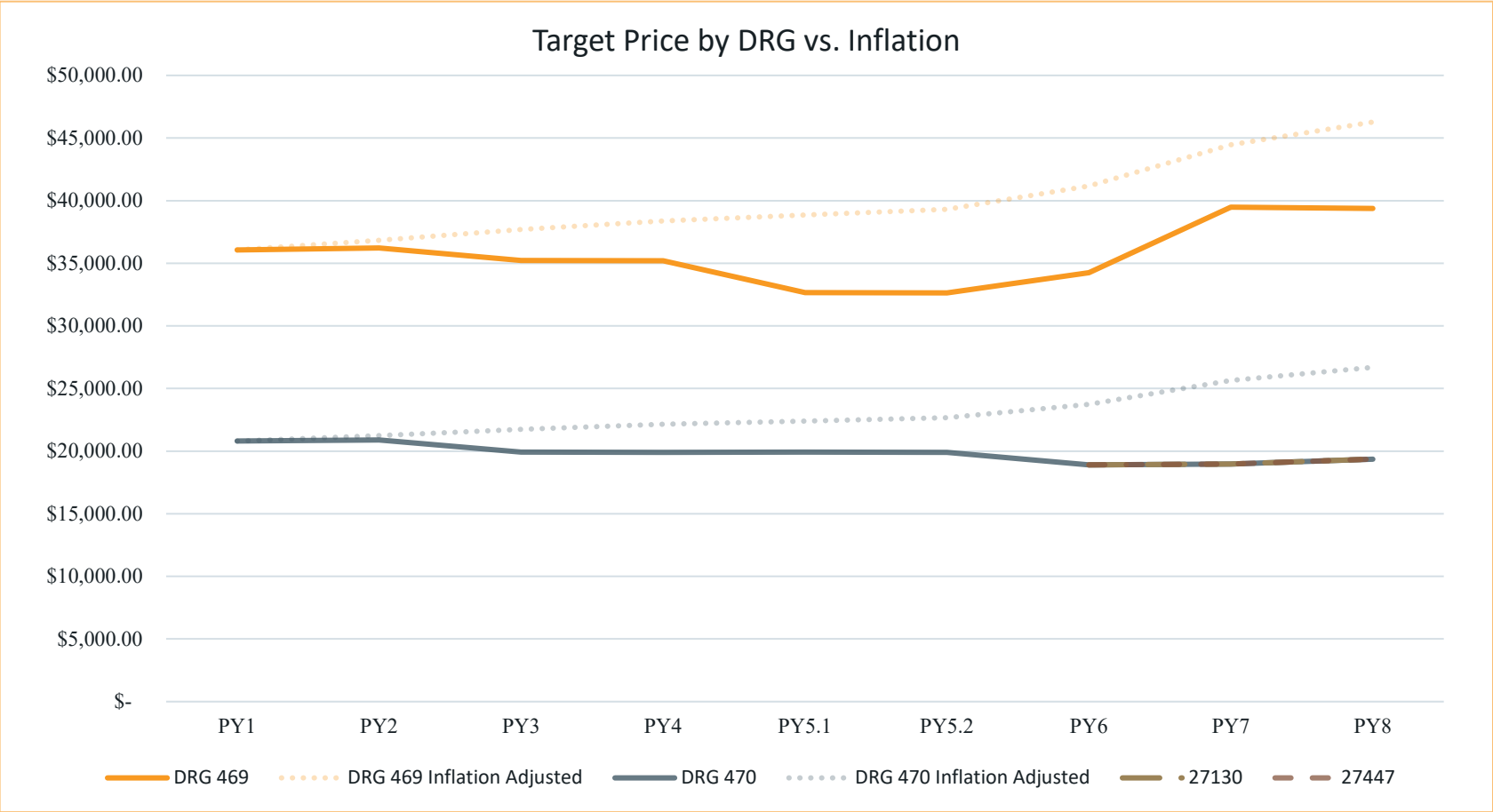
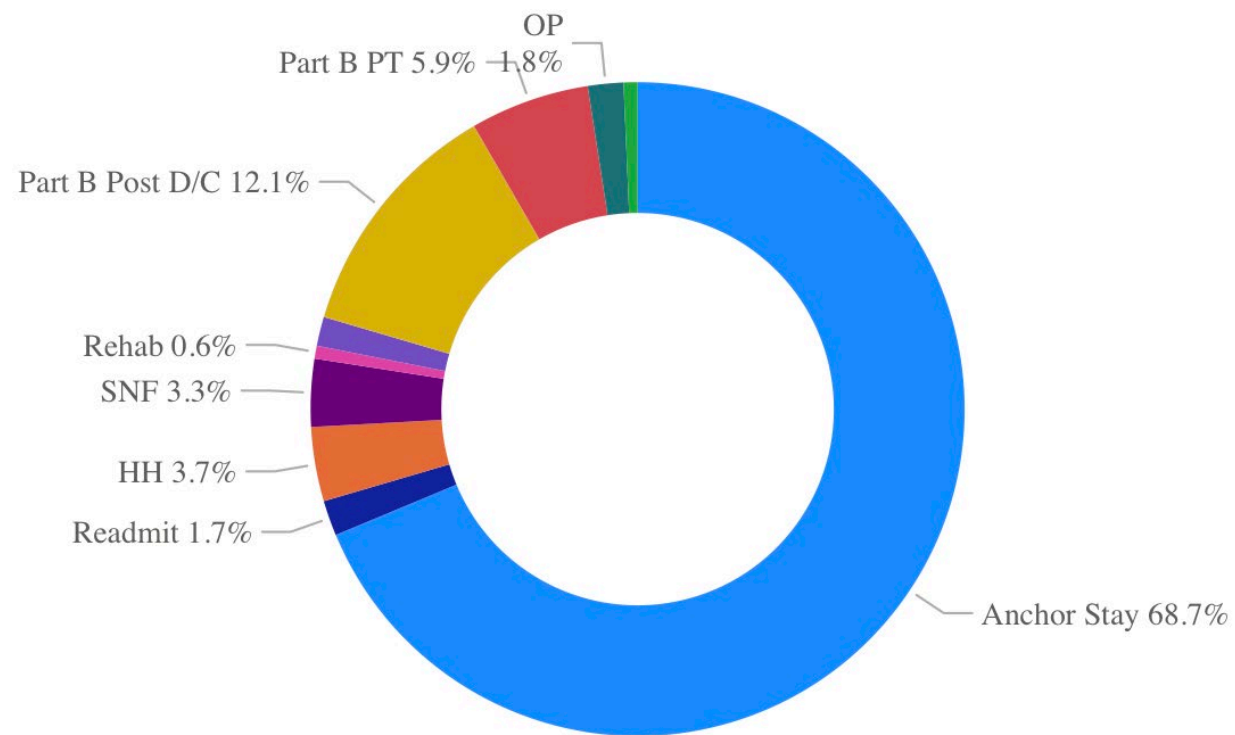


Fig. 1
The projected number of primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) procedures in the United States from 2005 to 2030.

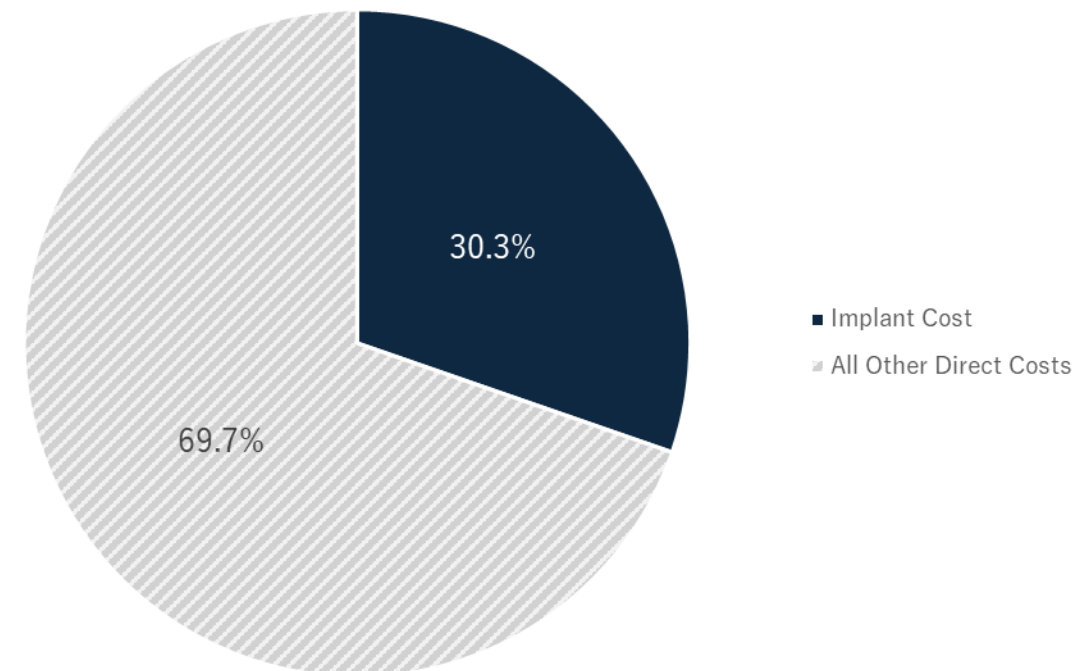
$$\text{V (VALUE)} = \frac{\text{Q (QUALITY)} + \text{S (SERVICE)}}{\text{\$ (COST)}}$$

- Bundled Payments
 - CJR
 - TEAMS



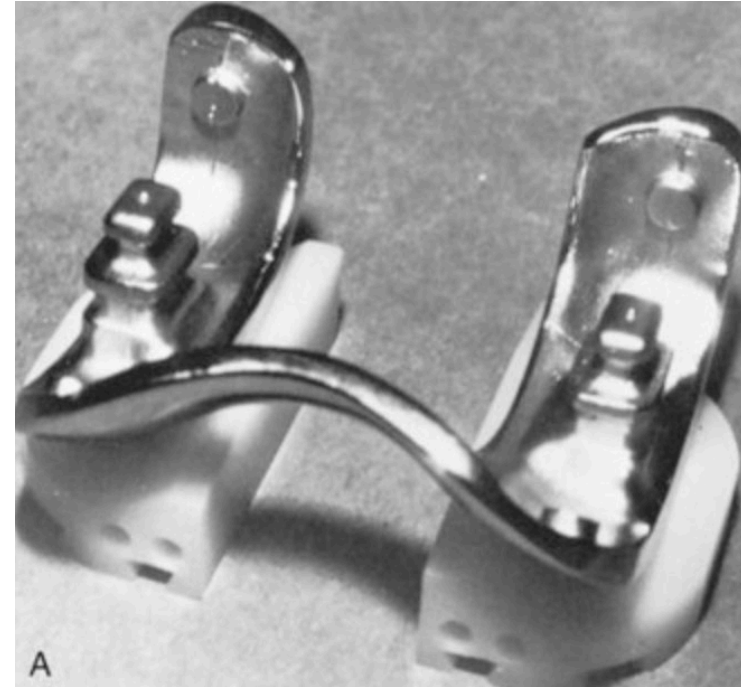


Implant Cost over Direct Costs of Anchor Stay
CJR Hip/Knee Patients, CY2019 - 2025Q2



History

- 1963
 - High density poly developed
- 1970s
 - First TKAs start as all poly tibia
 - Total Condylar, Insall-Burnstein
- 1980s
 - Transition to metal backed
- 2020s
 - <1% off TKA are all poly





History

- 1982 Bartel and Lewis JBJS
 - Metal decreased and spread cancellous stress
 - Metal protected cement
- Early Migration
- Loosening
- Cold Flow
 - Deformation

Performance of the Tibial Component in Total Knee Replacement

CONVENTIONAL AND REVISION DESIGNS*

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The Conventional Prosthesis-Bone Model

The conventional tibial components studied were variations of the total condylar design (Fig. 2). They included a plastic (ultra-high molecular weight polyethylene) component with no fixation peg, a plastic component with a plastic peg, and a plastic component with a cobalt-chromium alloy metal tray and metal peg (Table I). The finite-element model for these designs, as illustrated in Figure 3.

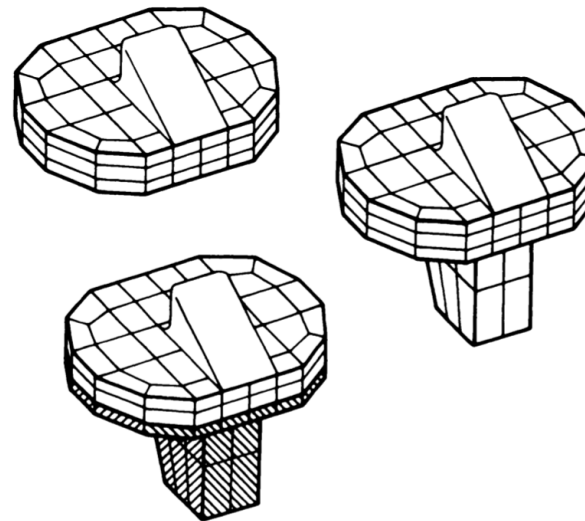


FIG. 2

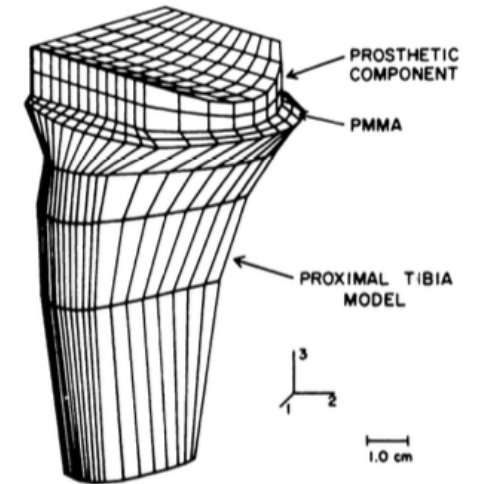


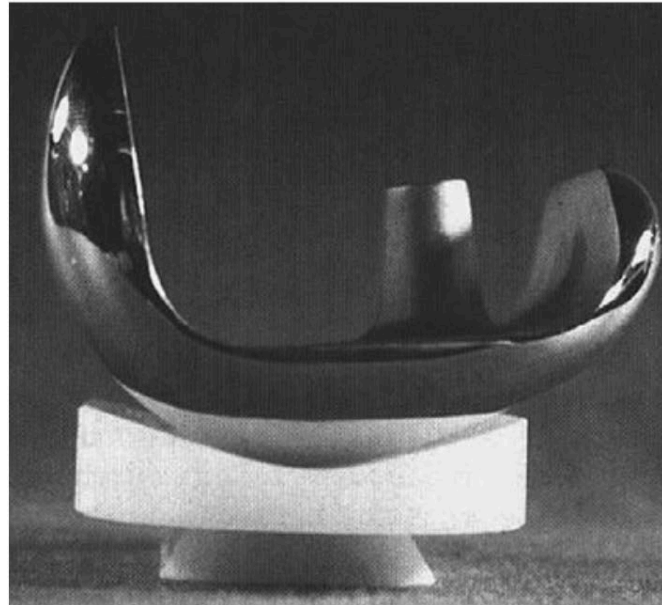
FIG. 1

Three-dimensional finite-element model of the proximal end of the tibia with a prosthesis.

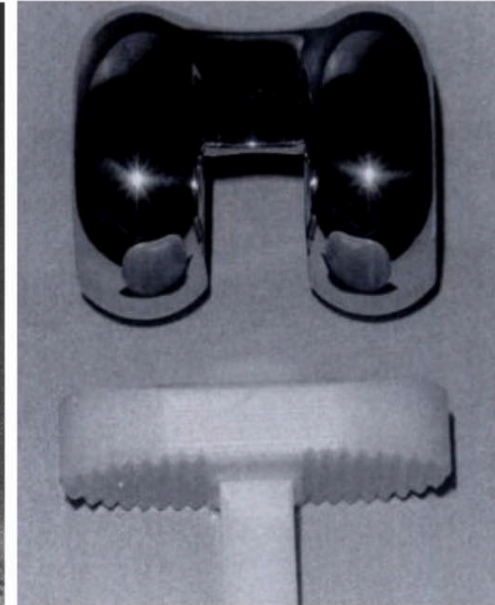
Metal Transition

- Modularity
- Intra-op flexibility
- Inventory
- Porous coatings
- Industry?

Freeman-Swanson



Total Condylar Knee



Insall-Burstein



Metal Backed Tray

- Cons

- Stiffness
- Poly thickness
- Backside wear
- Micromotion
- Locking Mechanism Failure
- Cost



- Pros

- Stiffness
- Modularity
- Cementless
- Liner revision?
- Inventory

Historical Outcomes

Table 1

Prospective, Randomized Radiostereometric Studies: Comparison of All-polyethylene Versus Metal-backed Tibial Components

Study	No. of Implants	Follow-up (yr)	Implant	Results
Adalberth et al ¹⁶	APT, 17 MBT, 17	2	AGC cemented (Biomet, Warsaw, IN)	APT equal or superior to MBT
Adalberth et al ¹⁷	APT, 20 MBT, 18	2	Freeman-Samuelson cemented (Biomet)	More migration of MBT between 1 and 2 yr
Gioe and Bowman ¹⁸	APT, 111 MBT, 102	3-5	PFC completely cemented (DePuy, Warsaw, IN)	No difference
Hyldahl et al ¹⁹	APT, 20 MBT, 20	2	AGC completely cemented	No difference
Hyldahl et al ²⁰	APT, 20 MBT, 20	2	AGC proximally cemented only	Increased motion with MBT
Norgren et al ²¹	APT, 12 MBT, 11	2	Profix cemented (Smith & Nephew, Memphis, TN)	More migration of MBT between 1 and 2 yr

AGC = Anatomic Graduated Component, APT = all-polyethylene tibia, MBT = metal-backed tibia, PFC = Press Fit Condylar



Historical Outcomes

Table 3

Clinical and Functional Outcomes: Comparison of All-polyethylene Versus Metal-backed Tibial Component Designs

Study	Clinical and Functional Outcome
Apel et al ⁵⁰	NSSD: knee, pain, function, ROM, flexion contracture SSD: muscle strength, instability in favor of MBT (authors attribute this to increasing surgical experience)
Adalberth et al ¹⁶	NSSD: knee, function, ROM, flexion contracture
Gioe and Bowman ¹⁸	NSSD: knee, function, ROM, flexion contracture
Adalberth et al ¹⁷	NSSD: knee, function, ROM, flexion contracture
Rodriguez et al ³⁶	NSSD: knee, function
Udomkiat et al ⁵¹	NSSD: knee, function, flexion contracture, SF-36
Najibi et al ⁵²	NSSD: knee, function, ROM, visual analog, HSS score
Pagnano et al ⁴⁸	NSSD: pain, stair climbing, function
Gioe et al ⁴⁷	NSSD: knee, ROM, SF-36 SSD: function in favor of APT
Gioe et al ⁴⁹	NSSD: knee, function, SF-36, WOMAC

APT = all-polyethylene tibia, HSS = Hospital for Special Surgery, MBT = metal-backed tibia, NSSD = no statistically significant difference, ROM = range of motion, SF-36 = Medical Outcomes Study 36-item Short-Form Health Survey, SSD = statistically significant difference, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index

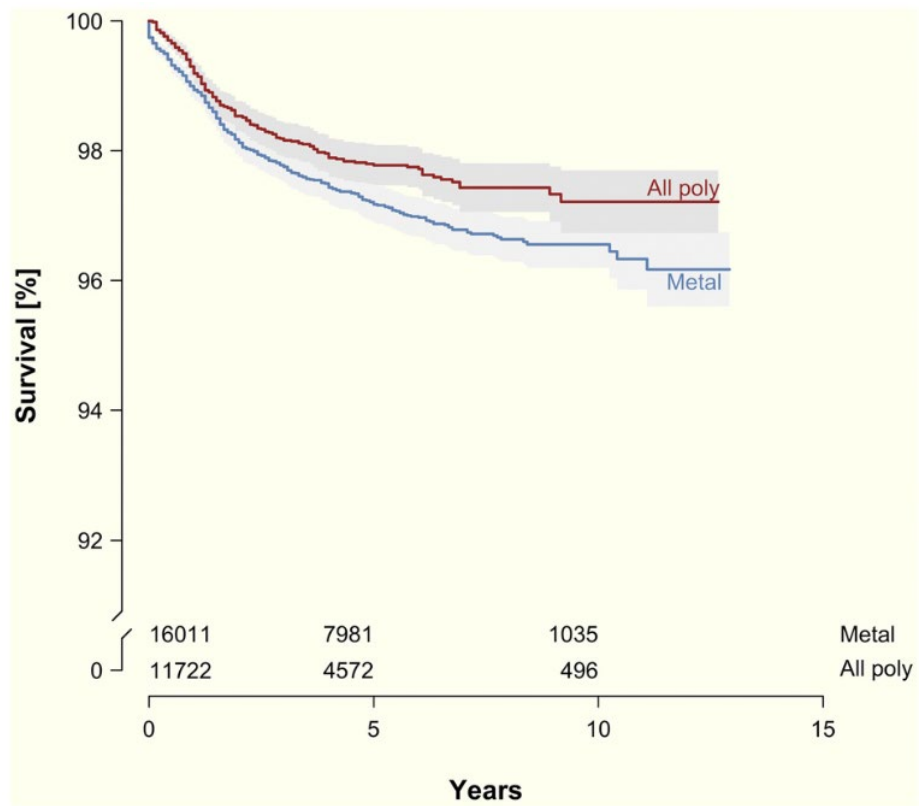
Table 2

All-polyethylene Tibial Component: Survivorship Analysis

Study	Study Design	No. of Knees	Implant Type	Follow-up (yr)	End Point	Survivorship (%)
Ranawat and Boachie-Adjei ³³	Prospective	APT, 112 MBT, none	Total condylar, cemented (Zimmer, Warsaw, IN)	11	Revision for septic or aseptic loosening and/or component position shift	88.7
Scuderi et al ³²	Retrospective	APT, 224 APT PS, 289 MBT PS, 917	Total condylar	7	Revision for any reason	APT, 92.6 APT PS, 97.3 MBT PS, 98.8
Rand ³⁴	Retrospective	APT, 22 MBT, 56	Total condylar	10	Revision, poor knee score, or complete radiolucent line	APT, 90 MBT, 85
Font-Rodriguez et al ³⁵	Retrospective	APT, 215 APT PS, 265 MBT PS, 2,036	Total condylar and Insall-Burstein II (Zimmer)	APT, 21 APT PS, 16 MBT PS, 14	Revision for any reason	APT, 90.8 to 85.3 APT PS, 94.1 to 90.3 MBT PS, 98.1 to 93.1 (best case–worst case)
Rodriguez et al ³⁶	Retrospective	APT, 130 MBT, 113	PFC, cemented (DePuy, Warsaw, IN)	7	Revision for any reason	APT, 96 to 88 MBT, 75 to 76 (best case–worst case)
Faris et al ³⁷	Retrospective	APT, 536 MBT, none	AGC (Biomet, Warsaw, IN)	10	Revision due to aseptic loosening or collapse and/or aseptic loosening	68.1
Rand et al ³⁸	Retrospective	APT, 464 MBT NM, 2,892 MBT M, 8,250	Various, cemented and uncemented	10	Revision for any reason	APT, 97 MBT NM, 92 MBT M, 90
Gioe et al ³⁹	Prospective	APT, 443 MBT, 4,977	DePuy, Wright Medical (Arlington, TN), Stryker Howmedica Osteonics (Mahwah, NJ)	13.2	Revision for any reason	APT, 99.0 MBT, 95.1
Dalury et al ⁴⁰	Prospective	APT, 120 MBT, none	PFC Sigma (DePuy)	7	Revision for any reason	APT, 99.4

AGC = Anatomic Graduated Component, APT = all-polyethylene tibia, M = modular, MBT = metal-backed tibia, NM = nonmodular, PFC = Press Fit Condylar, PS = posterior-stabilized

It does not last as long



All-Polyethylene Versus Metal-Backed Tibial Components—An Analysis of 27,733 Cruciate-Retaining Total Knee Replacements from the Swedish Knee Arthroplasty Register

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Investigation performed at the Department of Orthopedics, Institute of Surgical Sciences, Uppsala University Hospital, Uppsala, and the Swedish Knee Arthroplasty Register, Department of Orthopedics and Clinical Sciences, Lund University Hospital, Lund, Sweden

It does not last as long

Lower Associated Risk of Revision With All-Polyethylene Tibial Components in Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry

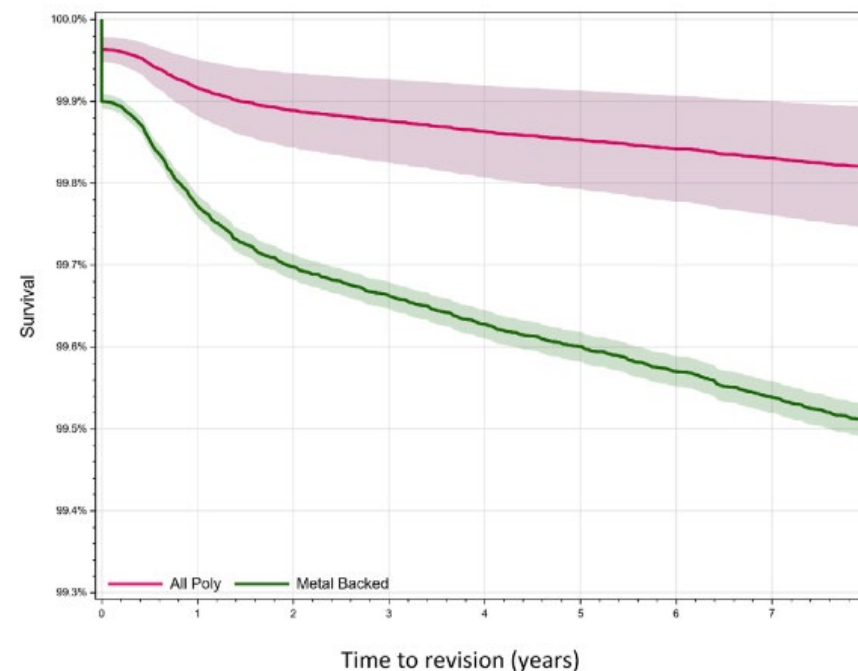
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It is not a Ferrari

The Medium-Term Survival Analysis of an All-Polyethylene Tibia in a Single-Series Cohort of Over 1000 Knees

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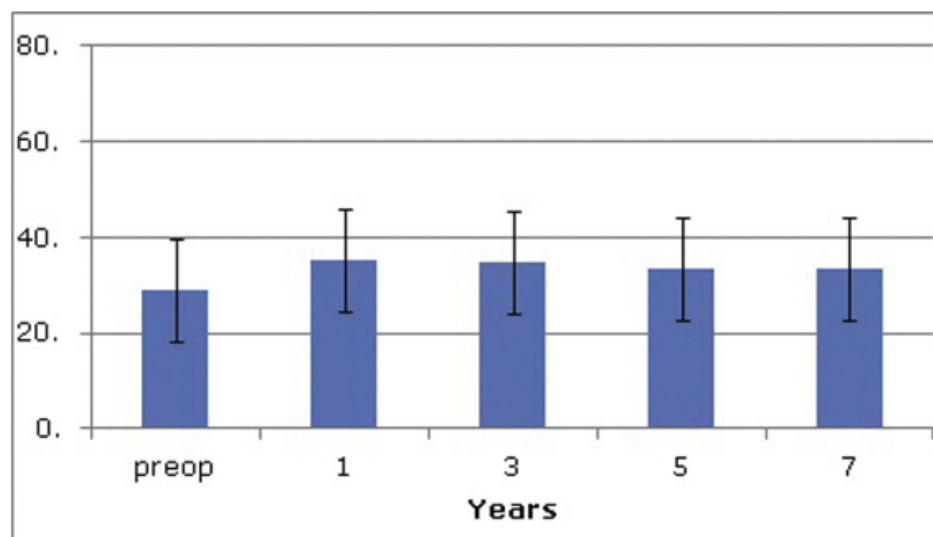


Fig. 3. SF-12 physical scores for preop and postop years ($P < .05$ for all postop years). SF-12, Short Form 12; preop, preoperative; postop, postoperative.

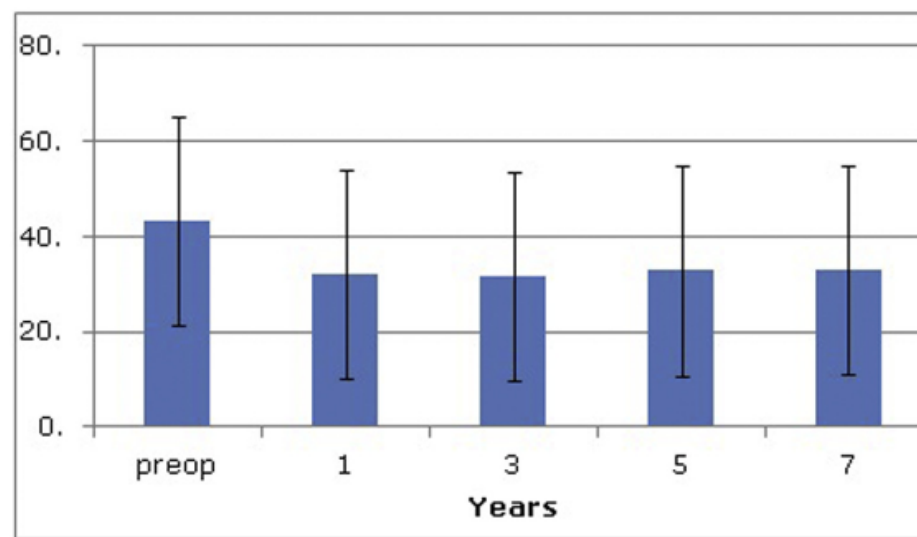


Fig. 5. WOMAC scores for preop and postop years ($P < .05$ for all postop years). WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

It is not a Ferrari

All-polyethylene versus metal-backed tibial components in total knee arthroplasty: a meta-analysis of randomized controlled trials

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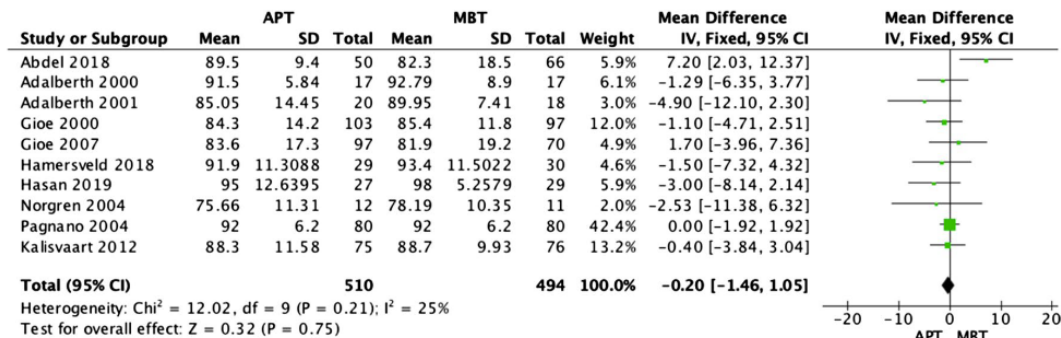


Fig. 4 Forest plot of clinical knee society score at the final follow-up between all-polyethylene (APT) and metal-backed (MBT) tibias, CI: confidence interval

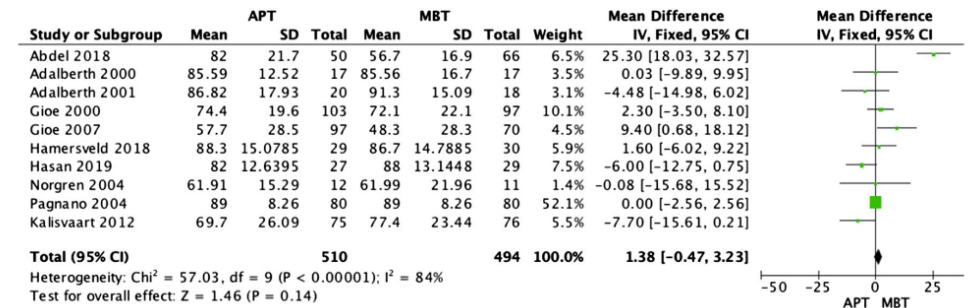


Fig. 3 Forest plot of functional knee society score at the final follow-up between all-polyethylene (APT) and metal-backed (MBT) tibias, CI: confidence interval

They only work in skinny patients

Metal or Modularity: Why Do Metal-Backed Tibias Have Inferior Outcomes to All-Polyethylene Tibial Components in Patients With Osteoarthritis

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BMI 35 to <40 kg/m ²						
MBM vs AP	11.19 (2.48-197.57)	.0002	1.60 (0.93-2.98)	.08	1.44 (0.56-4.86)	.47
MMB vs AP	12.38 (1.58-250.40)	.01	1.09 (0.25-3.39)	.89	—	—
MBM vs MMB	1.35 (0.42-8.22)	.65	0.91 (0.29-3.99)	.89	—	—
PS vs CR	0.80 (0.50-1.25)	.33	0.94 (0.66-1.33)	.73	0.85 (0.42-1.76)	.66
BMI ≥40 kg/m ²						
MBM vs AP	3.19 (1.00-19.49)	.04	1.15 (0.62-2.36)	.66	2.19 (0.66-13.52)	.22
MMB vs AP	7.15 (1.39-51.71)	.01	1.90 (0.59-5.38)	.25	—	—
MBM vs MMB	0.44 (0.18-1.47)	.16	0.60 (0.27-1.71)	.30	—	—
PS vs CR	0.75 (0.44-1.33)	.32	0.70 (0.47-1.08)	.11	0.36 (0.18-0.75)	.006

I may need to change poly in the future

- Poly exchange is rare
 - <5% of revisions
- Poly exchanges do poorly
 - Symmetric instability only
 - 2 times as high revision rate
- Planning for a poor outcome
 - Constrain everyone
 - CR femurs

A Comparison of Isolated Tibial Insert Exchanges for Global Instability to Full Revisions for Flexion Instability in Revision Total Knee Arthroplasty

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I can not perform a DAIR

- Never been studied
- Prevention?
 - Decreased infection risk?

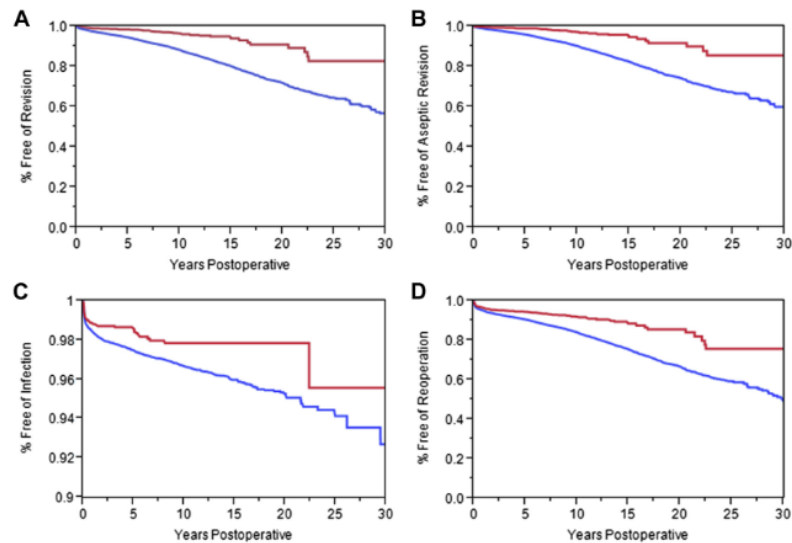


Fig. 1. Survivorship curves with endpoints of percent free of revision (A), aseptic revision (B), infection (C), and reoperation (D).

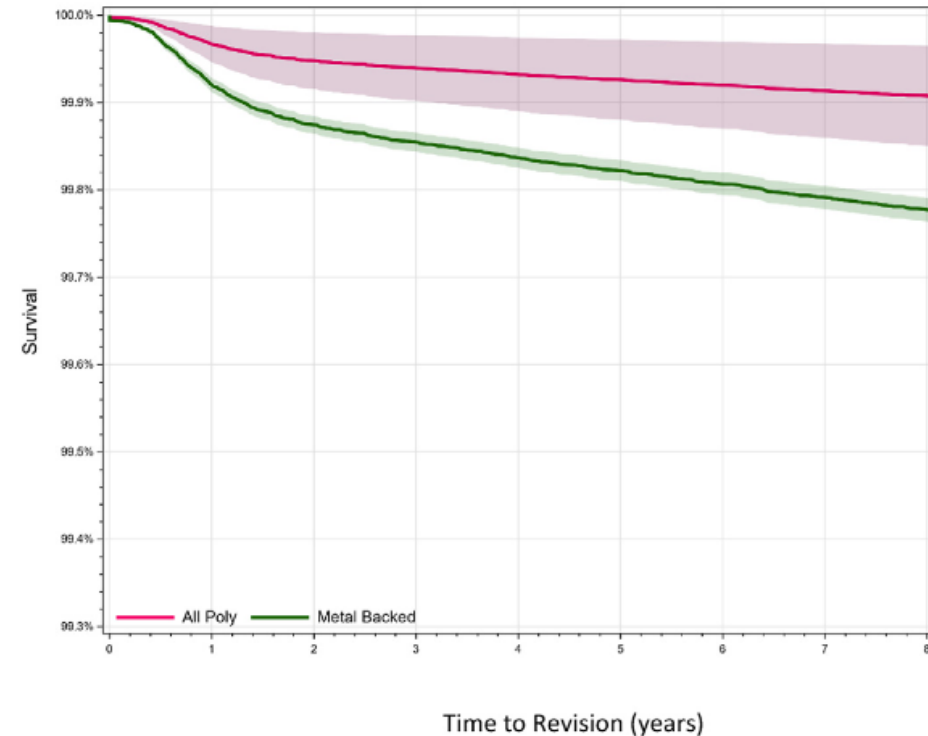


Fig. 3. Event-free survival curve for revision for infection comparing all-polyethylene to modular metal-backed tibial component primary total knee arthroplasty 2012 to 2019 time to revision (years).

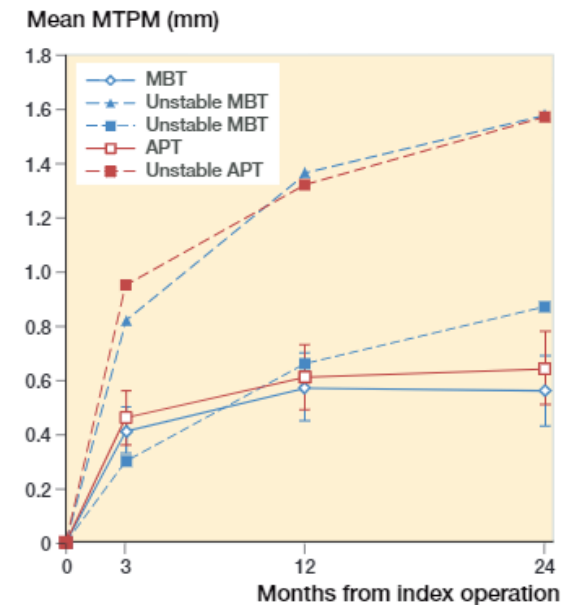
The bone is too soft

All-polyethylene versus metal-backed posterior stabilized total knee arthroplasty: similar 2-year results of a randomized radiostereometric analysis study

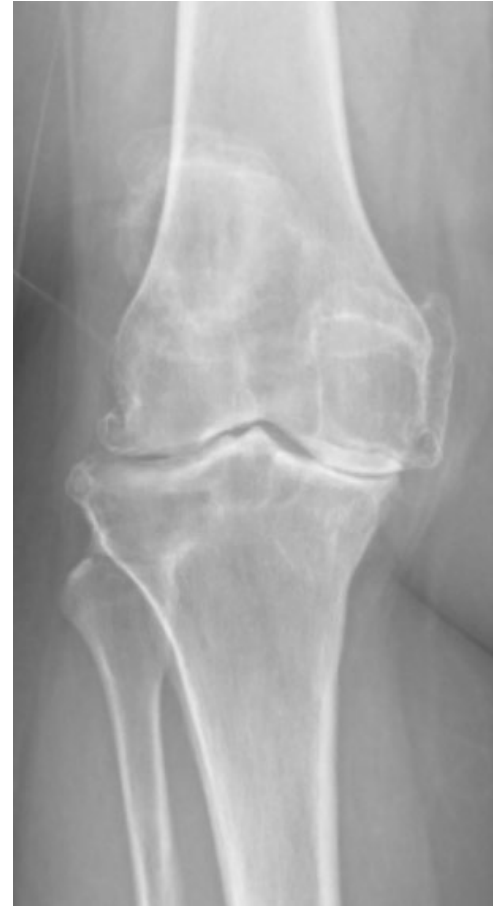
Shaho HASAN¹, Perla J MARANG-VAN DE MHEEN², Bart L KAPTEIN¹, Rob G H H NELISSEN¹, and Sören TOKSVIG-LARSEN³

Table 2. Mean (95% CI) MTPM in mm of the metal-backed tibial implant group (MBT) and the all-polyethylene tibial implant group (APT) at 3, 12, and 24 months follow-up

Time (months)	MBT	APT
3	0.41 (0.33–0.50)	0.46 (0.36–0.57)
12	0.57 (0.44–0.70)	0.61 (0.49–0.73)
24	0.56 (0.42–0.69)	0.64 (0.50–0.77)



It only works in straightforward cases









All Poly Conclusions

- Excellent survivorship
 - Lower infection?
- Equal function
- Cost effective
- Current Practice
 - AP tibia patients >70yo
 - No previous hardware

