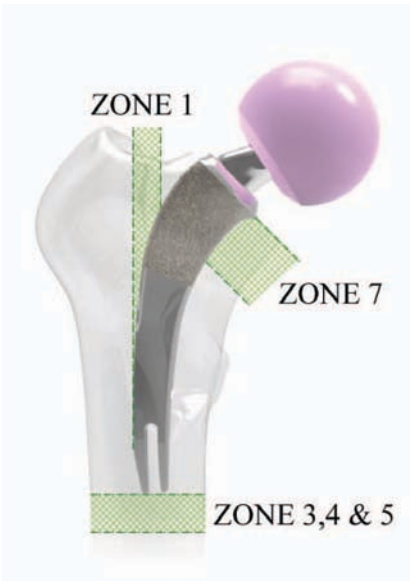

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THE SCIENCE BEHIND A SHORT CURVED STEM TOTAL HIP REPLACEMENT

Timothy McTighe, Dr. H.S. (hc)
Executive Director, JISRF

Acknowledgement: Declan Brazil, PhD
Adrian van der Rijt, MD; John Keggi, MD, Louis Keppler,MD;
Robert Kennon, MD, Terry Clyburn, MD; Edward McPherson, MD
and TSI™ Study Group Members

JISRF is a 501 c3 Non-Profit Foundation (1971)

JISRF is dependent on outside funding to support many of its activities.

Since 1971 JISRF has received funding from +30 commercial affiliations.

JISRF has stock investments in a number of commercial affiliations.

Executive Director: McTighe has vested interest in CDD, LLC; J&J; Signature Orthopaedics, Ltd; Omnilife; and has royalty interest in CDD, LLC

Note: JISRF Board Members and Advisors have multiple commercial relationships.

Intent

To make JISRF available as a resource to all within the orthopaedic community.

www.jisrf.org

Past 10 years

Influx of Short Stems

Difficult to compare results

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"Lack of Classification System"

The Joint Implant Surgery and Research Foundation (JISRF) has developed and advocated a stem classification system by primary stabilization contact regions to help identify, differentiate, and catalog stems for total hip replacements.

Zones

1. Head Stabilized
- A. Hip Resurfacing
- B. Mid-Head Stem

2. Neck Stabilized
- A. Short Curved Stems
- B. Short Lateral Engaging Stem
- C. Neck Plugs or Neck Only

3. Metaphyseal Stabilized
- A. Taper Stems
- B. Bulky/Fit and Fill Stems

4. Conventional Metaphyseal/Diaphyseal Stabilized

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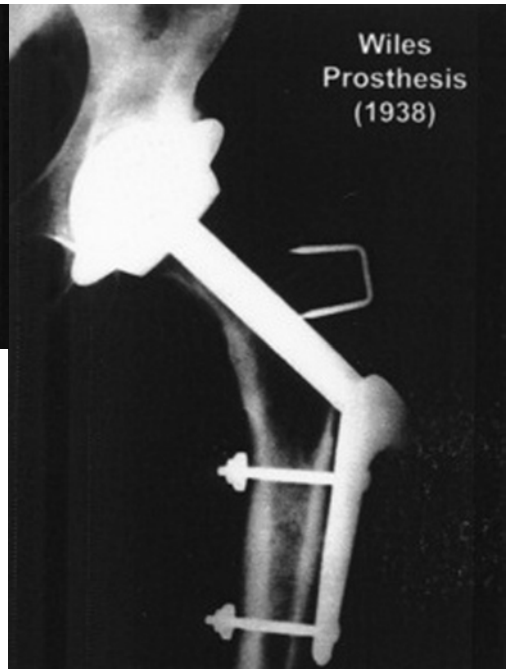
JISRF Stem Classification System

MODERN-DAY CONSERVATIVE IMPLANT DESIGNS FOR THA STARTED IN EUROPE WITH THE INTRODUCTION OF THE THRUST PLATE IN 1978. SIMILAR TO THE PHILIP WILES HIP REPLACEMENT FROM 1938.?



Wiles performed
A total of (6) replacements.
1 explanted stem (1960s) is in the archives of the BOA on loan to the Hunterian Museum at the Royal College of Surgeons

Thrust Plate 1978
Arnold H. Huggler &
Hilaire A. C. Jacob

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Historical Review of THA Conservative Cementless Implants

João de Azevedo Lage (born December 3rd, 1920 and died In July 25th, 2001)

Lafayette de Azevedo Lage, MD
(Son)
Second generation
orthopaedic surgeon

"Lage Prosthesis"
1956 as Endo to Bi-Polor to THA
His son Lafayette stopped using the device in May 2001

Many Stems are still functioning today!

Pipino first presented the femoral neck-conserving **Biodynamic™** hip prosthesis for cementless fixation in 1979.

c.c. material with sintered beads

(Howmedica/Stryker Orthopaedics)

In 1982, B. F. Morrey **Mayo Clinic Stem** designed a short (60 mm), double-tapered titanium alloy short femoral stem with a modular head.

Titanium alloy with proximal fiber mesh pads.

(Zimmer)

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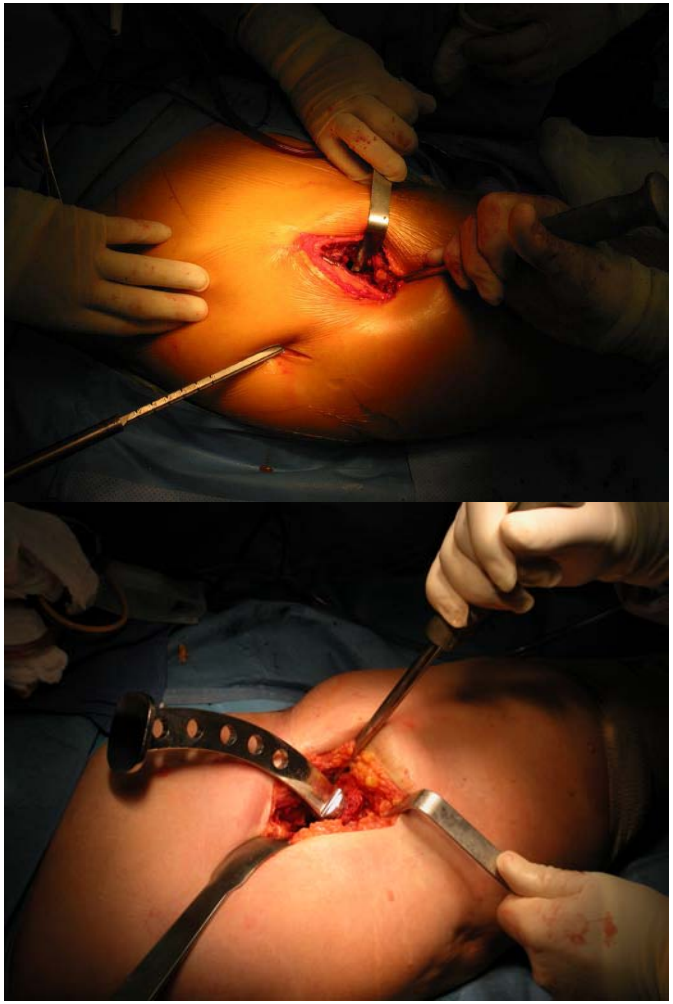
Two Significant Designers that impacted and influenced designs of short stem.

Pipino (1979) & Morrey (1982)



K. Keggi Experience
40 + years

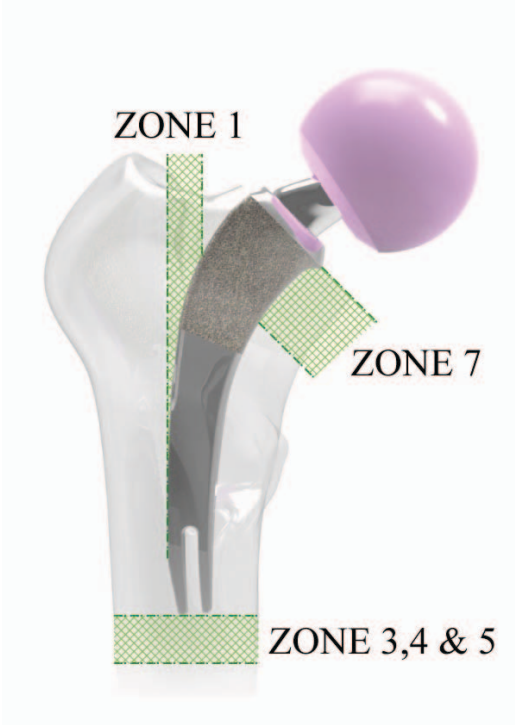
Dual incision for 30+ years
Helpful with heavy patients for femoral canal preparation and insertion of modular stems.
K.Keggi

All short stems designs including neck preserving can be done with a single anterior incision. J. Keggi (2010)

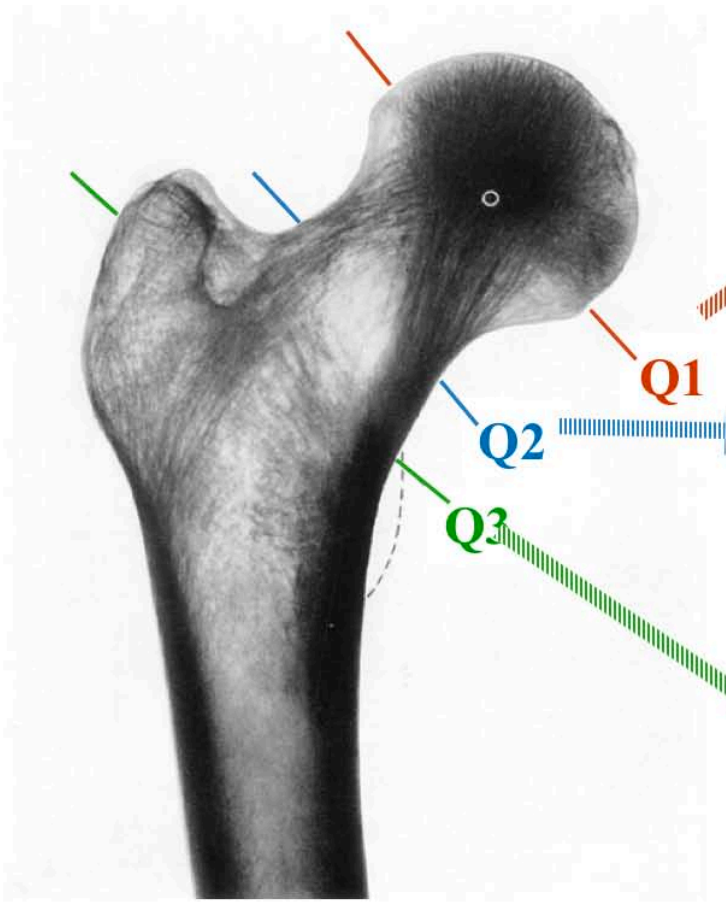
The growing interest in the Anterior Approach has also influenced the development of short stem designs.

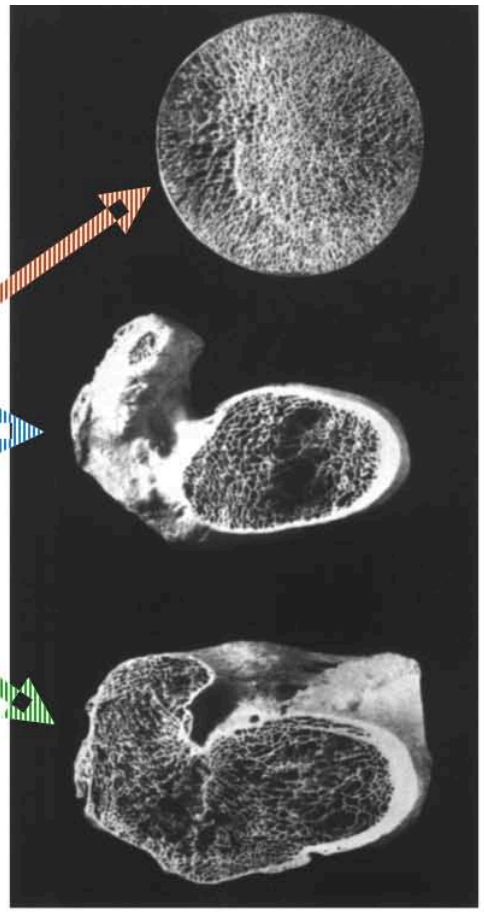
•Preservation of Tissue (Hard & Soft)
•Less Blood Loss
•Reduced Thigh Pain (end of stem)
•Easier Stem Preparation and Insertion
•Reduced OR Time
•Reduced Hospital Time (Now being done as outpatients in selective centers.)
• Reduced Instrumentation (1 pan)
•Reduced Stem Inventory (sizing 6-7 stems)
•Reduced Rehabilitation
•Easier Explanation if Necessary
•Easier Revision (conversion to Primary Stem length)
•Overall Reduction in Health Care cost

1. **OR time reduced ($3,000 per hr.)**
2. **Less inventory (neck preserving)**
3. **Less instruments (trays cost on average $250-$300 per tray to recycle)**



Potential Advantages of Short Stems





We can do better

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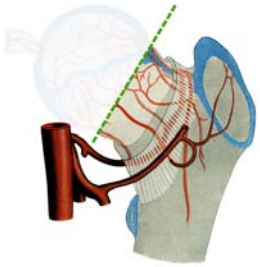
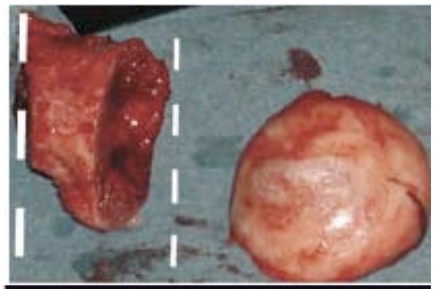
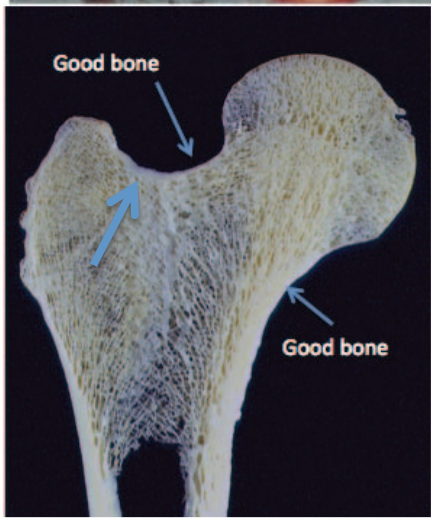
Architectural changes in the proximal

femur after THA continues to be a problem.

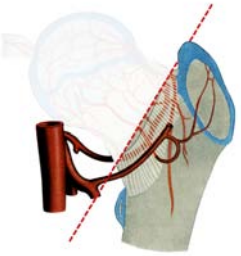


Saves bone





Why get rid of it?



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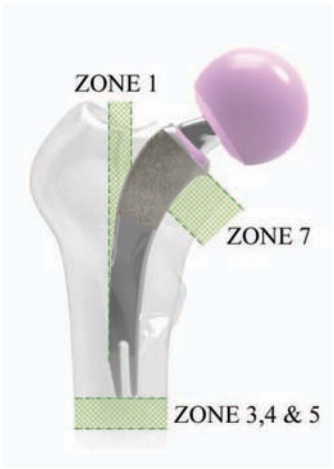
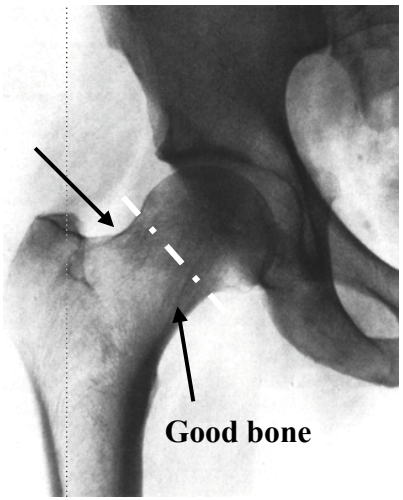
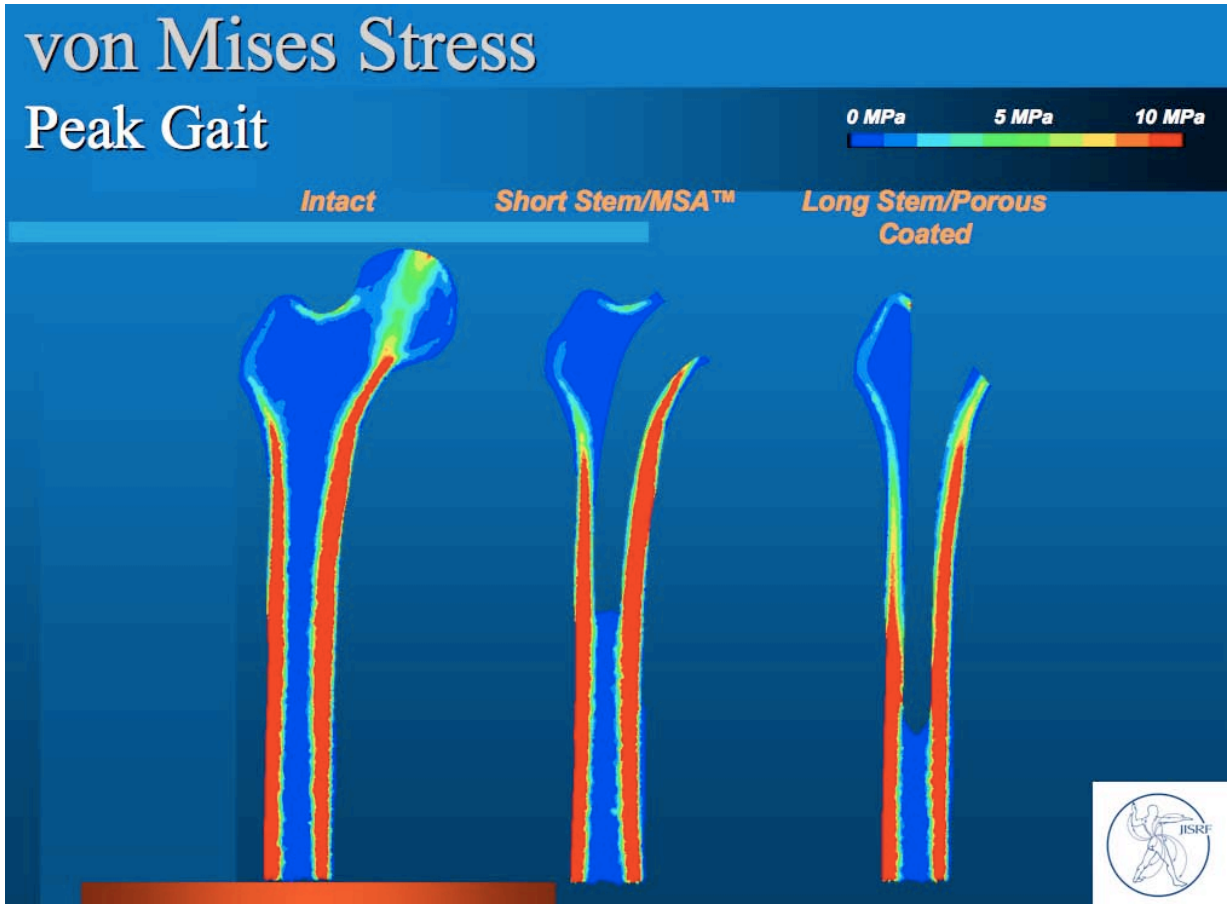
NECK SPARING STEM VS. CONVENTIONAL STEM





- Provides better blood flow vs. hip resurfacing (Pipino)
- Provides better axial and torsional stability vs. conventional THA (Freeman & Whiteside)
- Provides for more tissue sparring approaches (Pipino)
- Potential for less blood loss (Pipino)
- Potential for quicker rehab (Pipino)

Neck Retention



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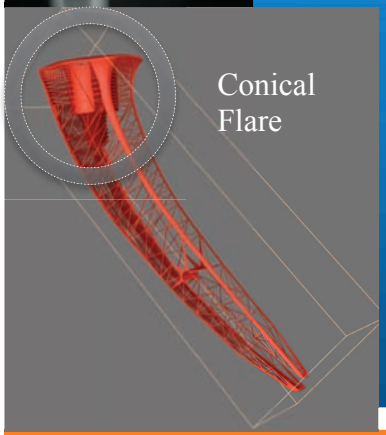
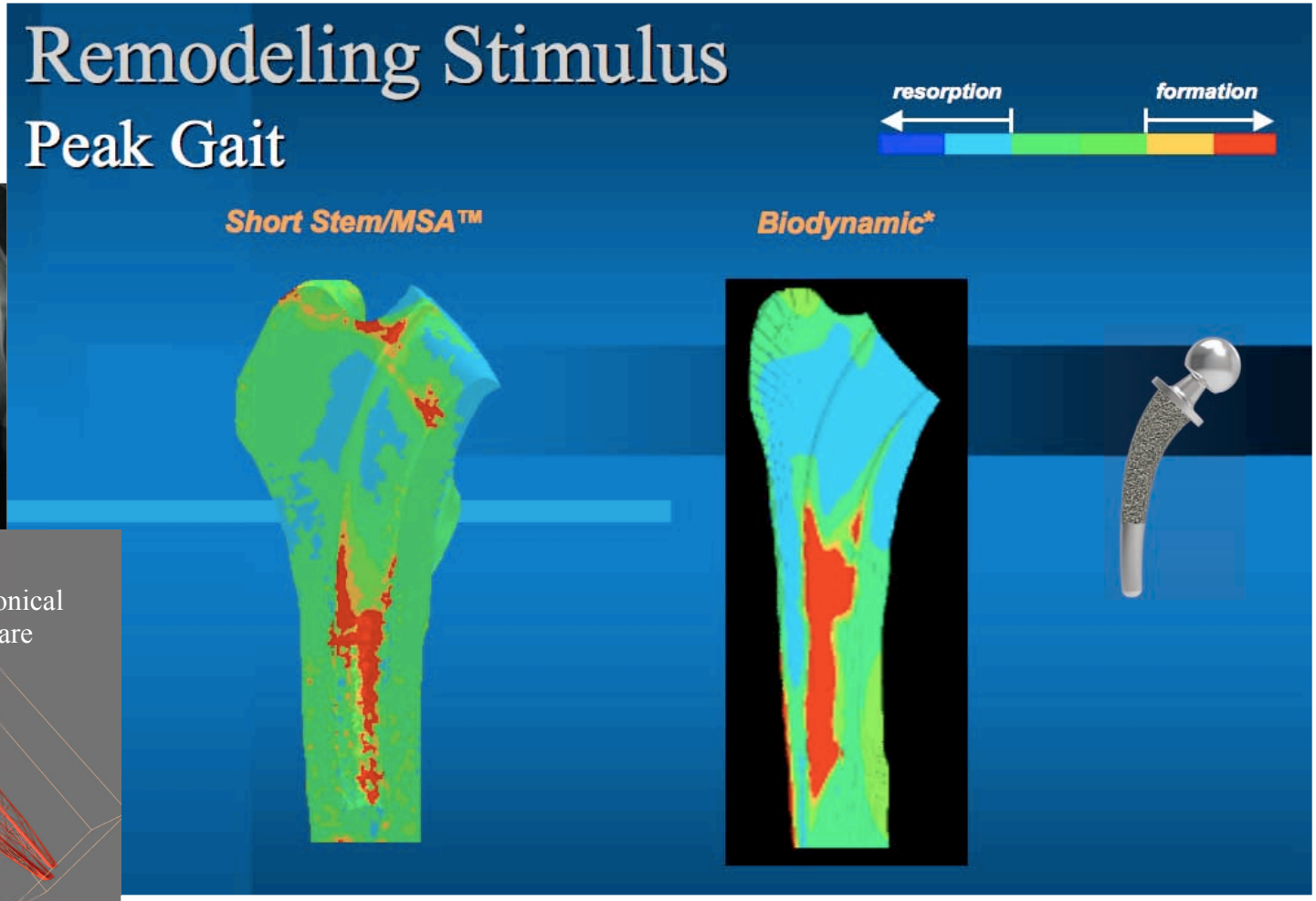
FEA modeling has demonstrated better potential for bone remodeling for the Short Curved Neck Sparing compared to previous porous coated stems

(AML style). McTighe, Brazil, Turnbull, Harrison, et al., AAOS 2008

Remodeling Stimulus
Peak Gait





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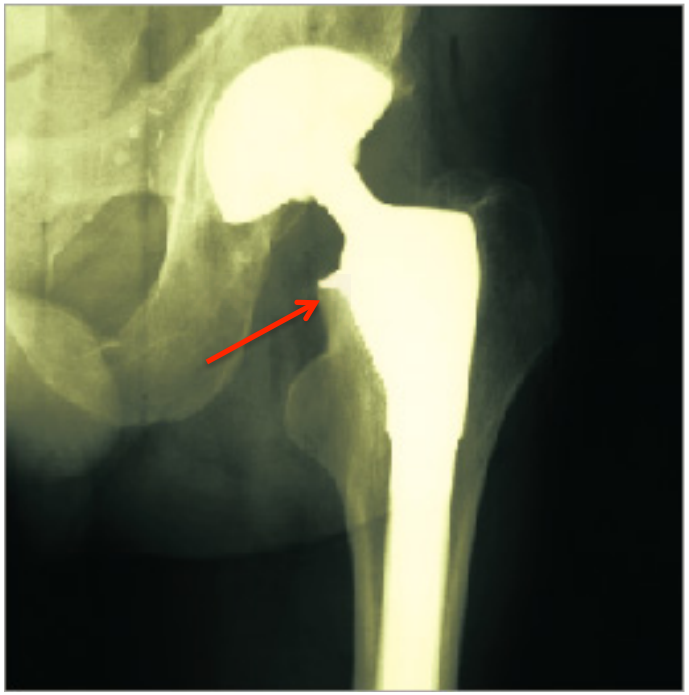
FEA modeling for short curved neck preserving stem with a proximal novel conical "Flare" has demonstrated better potential for bone remodeling compared to previous short stem "Biodynamic™"

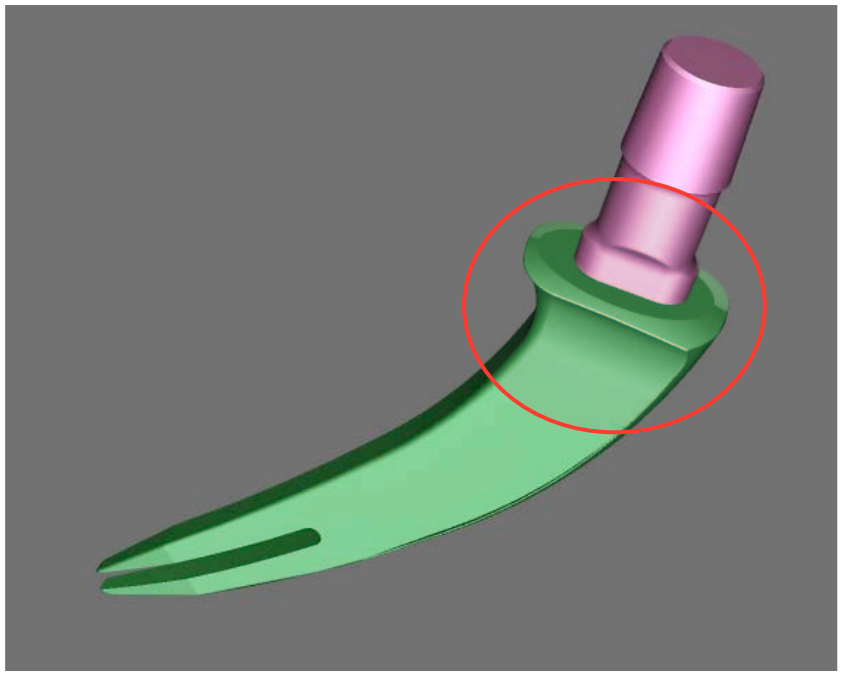
- McTighe, Brazil, Turnbull, Harrison, et al., AAOS 2008

Conical Flair Designs work to offload hoop tension into compressive loads.

Intrinsic™ Stem / Primaloc™



Conical Flare on MSA™/ ARC™ / TSI™



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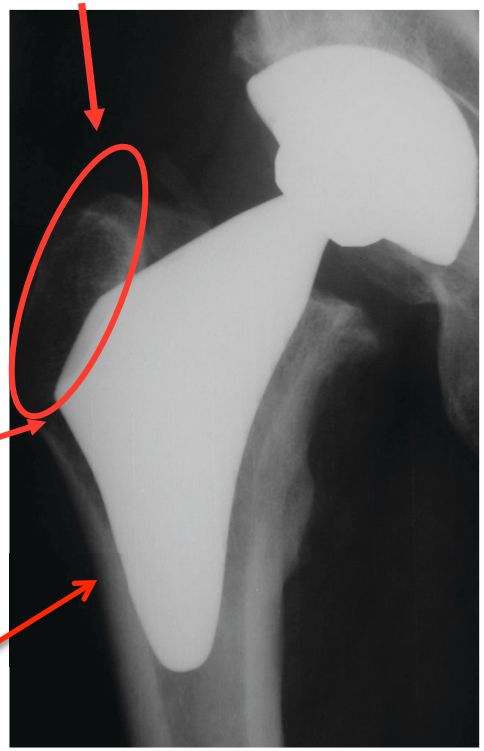
1994 DESIGN CONICAL COLLAR STRAIGHT STEM MCTIGHE ET AL. PATENT ISSUED 1998 # 5,725,594

Alternative Load Transmission

Removes Bone

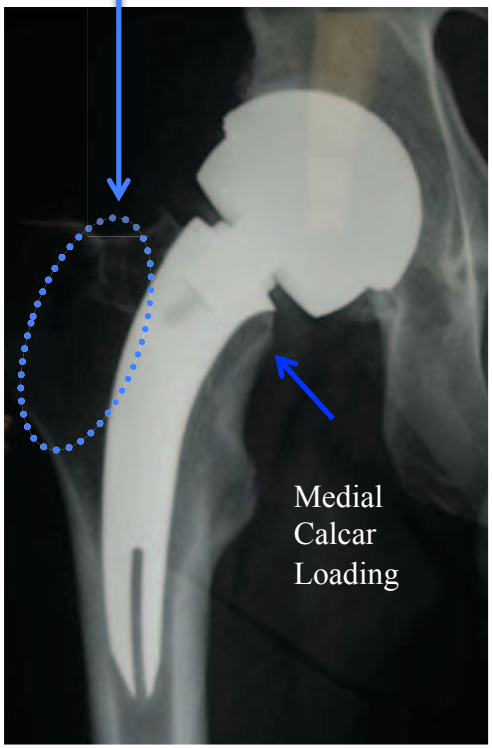


Risk of Fx.

Lateral Load Bearing

Natural Load Sharing

Saves Bone



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Note all short stems are equal in design philosophy or function.

"Why Resect the Neck," 1986 JBJS

Cementless

Cemented

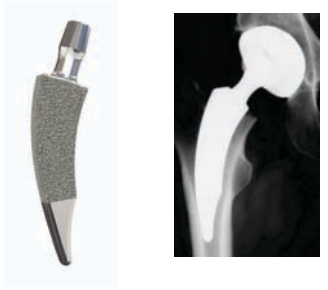
Conventional stem length in both a cementless and cemented style.

Significant advantages in biomechanical benefits: Reduction of both torsional and axial moments. Freeman

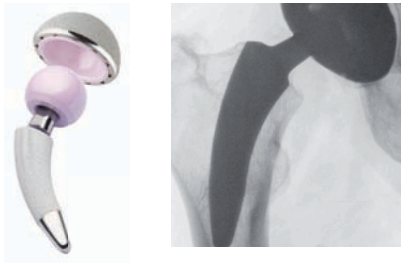
C.F.P.™ by Link$_{1996}$

Longest follow up of short curved neck preserving stems in the literature.

Historical
Lage Hip Brazil
1956-2001

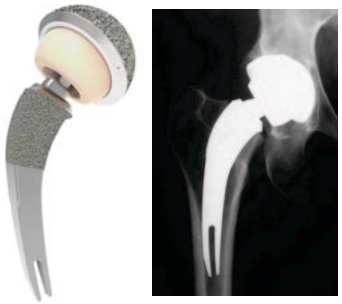


Nanos™ Neck Preserving Stem
By Smith & Nephew, International



Corin Mini Hip™
International $_{\mathbf{2008}}$ & U.S. $_{\mathbf{2010}}$

MSA™ by Global, Au $_{2007}$



ARC™ by Omni, U.S. $_{2010}$

TSI™ by Signature Orthopaedics, Ltd.
2104

Promise Neck Preserving Stem
Permedica Manufacturing (Italy)

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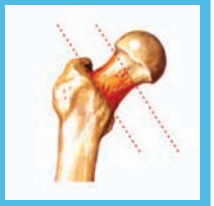
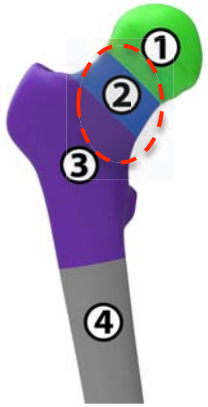
Short Curved Neck-Stabilized Stems (JISRF Classification 2a.)



This is the only neck-preserving lateral flare short stem on the market. Most lateral flare stems are metaphyseal stabilized styles.

High neck resection makes stem insertion difficult due to the bulky style of the stem.

Relies on metaphyseal fit and fill for stability.



Several modified neck-sparing designs have recently been introduced that are only inserted into the femoral neck region. These have been referred to as “neck plugs or neck replacement” and are limited to international clinical experience. They appear to be a hybrid design between the short curved neck-sparing stem and the mid-head device by McMinn (BMHR).

CUT Femoral Neck
Mixed results by different investigators
Sterns 5yr = 98%
Ender 5 yr. = 89%
Ishaque 8 yr = 49.6%

Primoris™ Trials underway

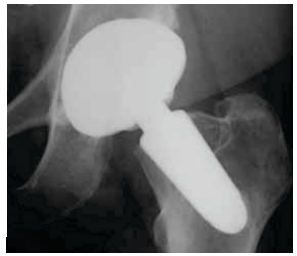
Spiron Neck Screw

Häring 1 yr

Haring 56 patients at 5 yrs. = 97%
Luger 28 hips at 3 yrs = 1 aseptic loosening

TSI™ Neck Replacement
In Development

Silent Hip



BOA presentation 2009 141 hips
97% at 3 yrs
Waller 15 hips all had ASR Bearings
6 ASR MoM cup revisions

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Neck Plugs or Neck Replacement Implants (JISRF Classification 2c)

First Reported Revision for High Metal Ions "Pseudo Tumor"

Patient D.C Pre revision AP Radiograph

42y Male
July 2009 (elsewhere): MSA stem with metal-metal bearing
June 2012: Revised to SROM stem & Pinnacle cup (CoC)

Pre-revision Diagnosis

Pain lateral buttock

- Uncomfortable in daily activities in particular during sitting
- limp & quadriceps wasting
- Synovitis on MRI

Blood results (elevated Co and Chr):

Co 115 nmol/L
Cr 46 nmol/L

A.Prof William L. Walter

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Three (3) reported cases of high metal ions resulting in pain (pseudo tumors) requiring revision surgery. All three cases had Metal on Metal Bearings.

1 case MSA™ and 2 Cases ARC™

78 CASES / 1 REVISION =1.2%

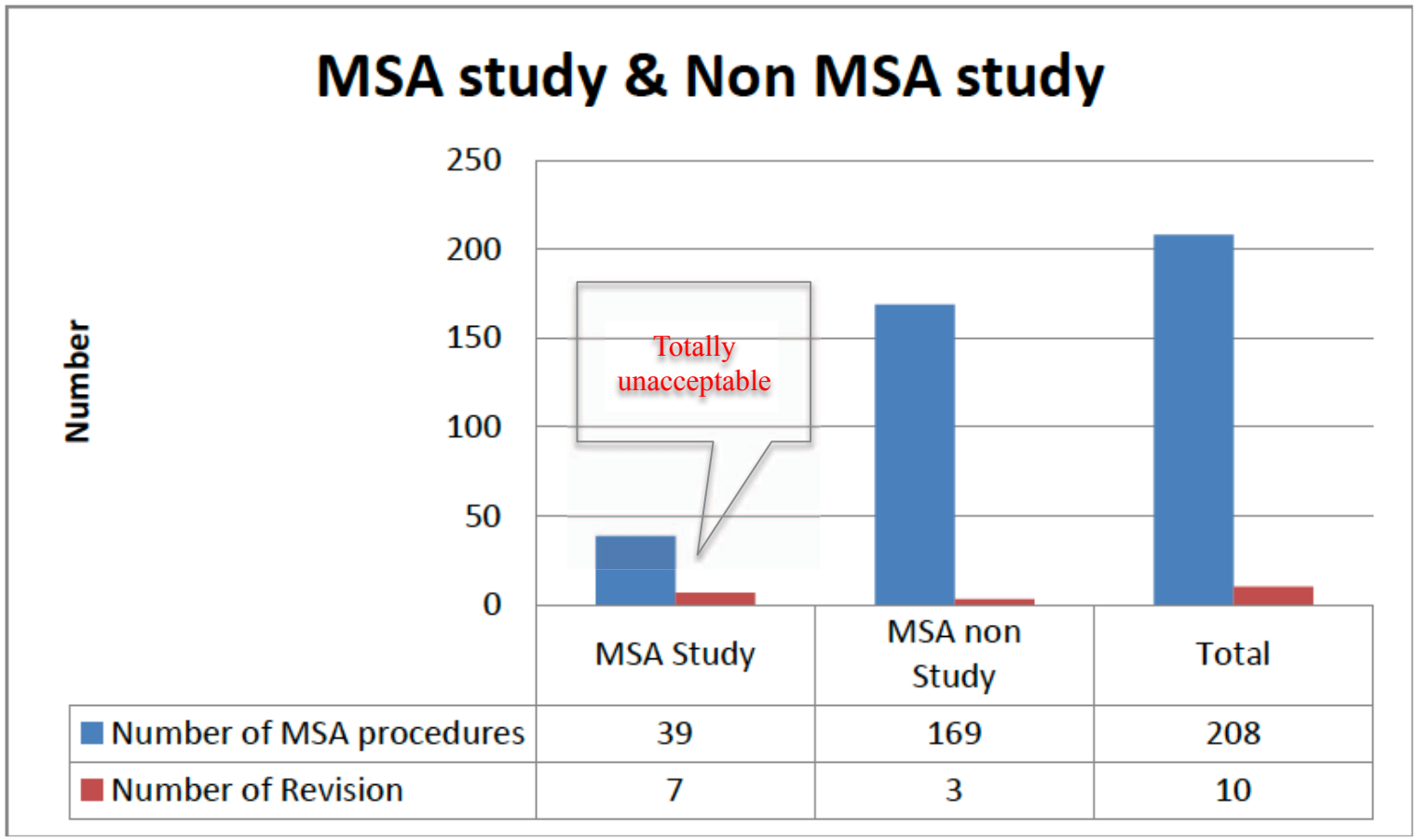
Design - Curved, short,
neck loading femoral stem.

Proximal

- Trapezoidal, taper cross-section
- Proximal titanium/HA porous coating zone in femoral neck
- Torsional stability further enhanced by lateral □ □back
- Proximal conical flare transfers compressive loads to medial calcar

Proximal (Cremascoli taper)

1. **Modular neck + head**
   - Distal polished implant



Revision Rate	**17.9%**	**1.7%**	**4.8%**

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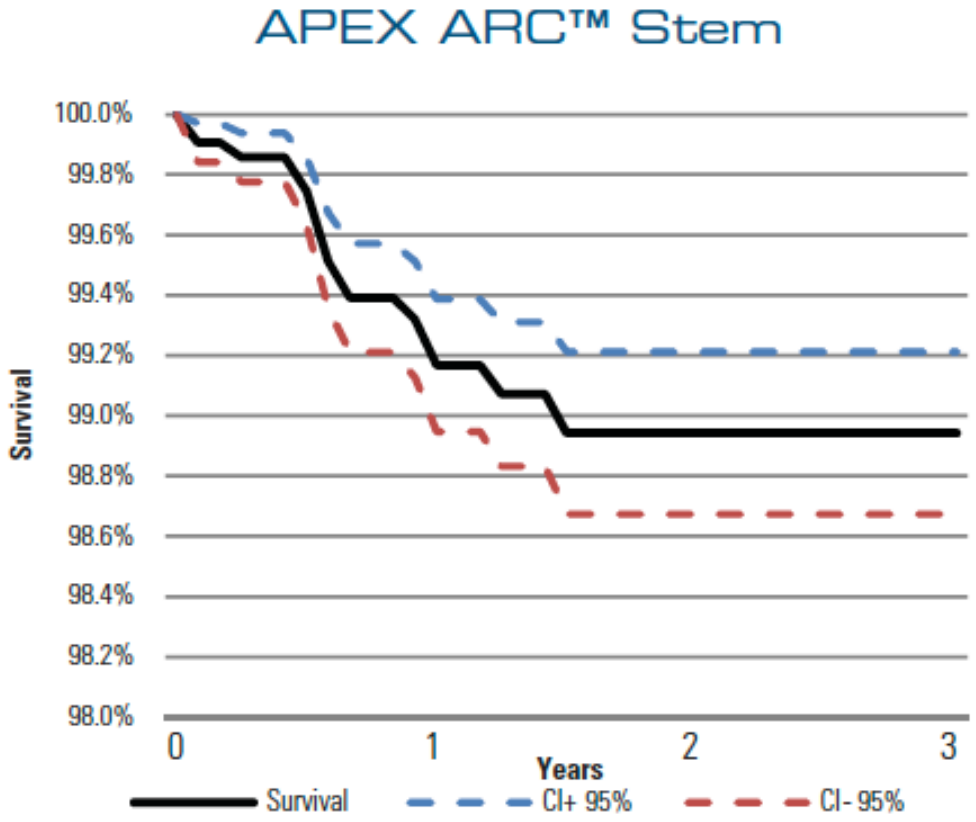
The revision rate within the study was 17.9%, compared with 1.7% outside the study (and thus 4.8% overall). P. Hannaford



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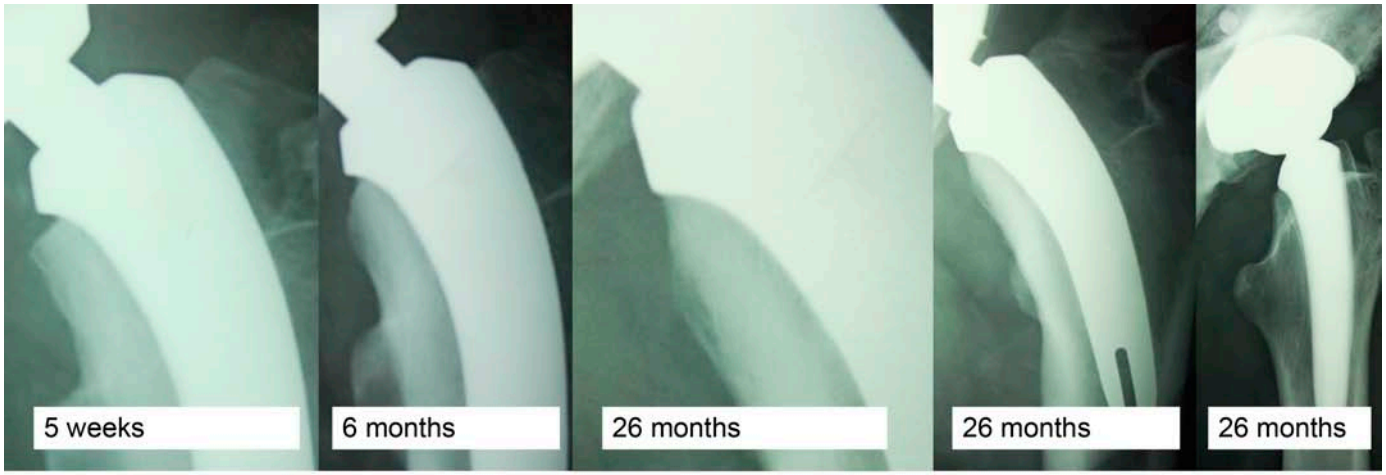
The survival estimate is above 98.6% This report does not account for non-reporting or competing events that preclude revision such as death. Omnilife science™

The design philosophy of neck retaining implants concerns achieving osseo integration in a very small area of femoral neck, maintaining physiological load, bone stock and function. The preservation and incorporation within the femoral neck should reduce the axial and importantly the torsional load on the implant so there are theoretical and, in my opinion (in practice) real improvements in the mechanical environment of the implant. Adrian van der Rijt, MD (February 3, 2014)



Male 174cm BMI 24
62 year old 79kg

Dense new bone growing up to conical flare

- **78 Australia MSA™ Stems by: Adrian van der Rijt**

1 revision (for aseptic loosening) = 1.2% Revision Rate

- **169 Australia MSA™ Stems total non-study = (3 Revision) = 1.7% Revision Rate**
- **39 Australian Study had 7 Revision =17.9%**
- **208 Combined total = 4.8% Revision Rate**

- **576 USA ARC™ stems by:**

J. Keggi, MD; L. Keppler, MD; R. Kennon, MD; T. Clyburn, MD; E. McPhersom

576 ARC™ stems = 10 revisions

(2 aseptic loosening, 2 infections, 2 chronic dislocations, 1 cup resulting removal of neck/replaced with new neck, 2 aseptic loosening, 1 neck disassociation,) = 1.7% Revision Rate TSI Study Group

- **2,825 USA ARC™ stems since April 2010. 98.6% survival = 1.4% Revision** Omnilife science
  - **Overall World Wide Survival with removal of AU study = 1.5% Revision Rate**

- **Worldwide Survival Rates with AU Study Removed = 98.5%**

Short stems can facilitate surgical technique for THA. Specifically, when one is using DAA, the neck-sparing curved design significantly facilitates cases of stem insertion. The curved stem can be introduced anteriorly rather than leaning toward the greater trochanter. Less trochanteric levering reduces the risk of proximal femur fractures. Furthermore, with larger-sized patients, proximal extension of the incision is avoided. When utilizing a posterior hip approach, surgeons must note that a true neck-sparing implant provides a distinct advantage for soft tissue closure. Specifically, the capsular envelope is not extensively removed. This allows for a more robust closure of the posterior hip capsule, which may translate to improved posterior hip stability. Furthermore, since a majority of the femoral neck is preserved, the short external complex is successfully closed in a consistent fashion. This adds an additional soft tissue layer that is protective.

Short stems have a definite role in modern total hip arthroplasty, as greater emphasis is being placed on soft-tissue and bone-sparing techniques and as refinements continue in the understanding of proximal femoral fixation and the biomechanics of head/neck and neck/stem modularity.

Summary

Our combined experience with the MSA™ and ARC™ Neck Stabilized stems has been rewarding.

For a first generation new design concept with new developmental instrumentation has provided a safe, effective and reliable construct for our younger more active patients.

Improved bone remodeling has been impressive.

Retaining the femoral neck has significant mechanical advantages and we have not seen the problems associated with other model neck stem designs.

Note: There is a short learning curve but very definitive.

We are encouraged and continue to use and evaluate these devices.

Conclusion

Short Curved Neck Stabilized Stems