Target Restoration of Hip Mechanics in THA

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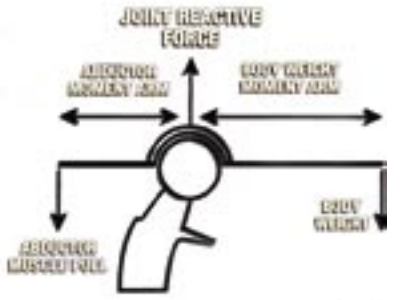
Introduction

THA continues to improve but complications still occur. Dislocation continues to be a significant problem.[1,2] The causes for dislocation can be multi-factorial, and include: mal-positioned components, soft tissue laxity, component design, head size, component orientation, surgical approach and impingement of component-on-component or on fixed obstructions such as osteophytes.[3,4,5,6] Weakness of the abductor muscles due to improper reconstruction can also be a contributing factor.[7,8] In countering these factors, stability is often achieved at the expense of limb lengthening.

Component-on-component impingement.



Over lengthening or shortening of the joint center can result in limp, back pain, increased risk of dislocation, revision and legal problems.

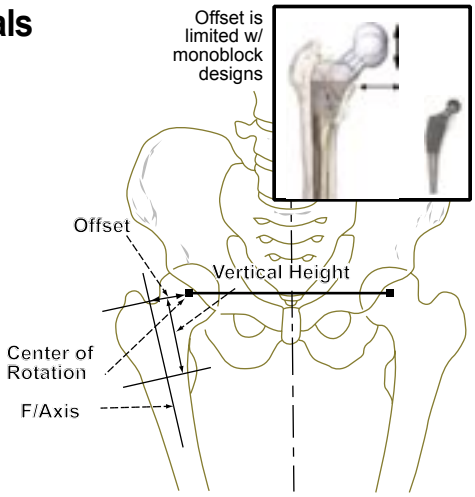
We see a number of trends that indicate hip joint instability remains a significant concern in THA outcomes: Big Heads, increased use of constrained sockets and development of expensive surgical navigation technology.

Immediate Goals

Eliminate Pain
- New hip

Restore Function
- Reproduce hip mechanics

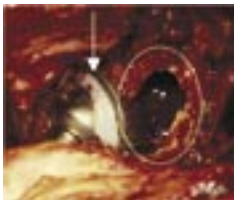
1. Femoral Offset
2. Neck Length
3. Version Angle



Two Remaining Significant Problems in THA

#1 Dislocation

#2 Wear Debris/Lysis



Methods

To study the influence of implant geometry on tissue balancing and joint stability, the authors selected a stem system that permits the independent selection of lateral offset, version and leg length. This study presents the short term results of this experience.

957 THA's were performed using the Apex Modular™ Stem, beginning in May 2001. 842 were primary and 115 were revision cases. All were performed using the posterior approach. Acetabular implants from a variety of manufacturers were employed. All cases were fully cementless. Data on stem, neck and head selection were available for 800 of these cases. Head centers were plotted in bubble chart format.

Instability - What should be done? Trail reduction demonstrates joint instability with slight increased leg length.

Modular Heads allow length adjustment, unfortunately increase head length increases leg length.

Big Heads! Theoretically, a bigger head is more stable... At the extremes of motion when the neck impinges In this case, intrinsic stability is unchanged (Head center stays the same).

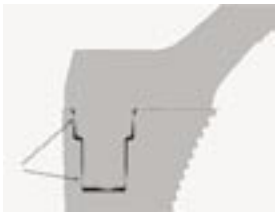
Biomechanical Solution Modular Neck! Add offset for joint stability reduce length for proper gait.

Design

Apex Modular™ Stem

- Modular necks for optimized lateral offset, leg length, and anteversion
- Key-hole proximal geometry with steps for good fill and initial stability
- Circumferential plasma sprayed CP titanium coating
- Distal slot(s) for reduced end stem stiffness
- No skirted heads
- Modular design allows for large selection of necks, to achieve proper combination of lateral offset, leg length, and anteversion
- Dual Press™ connection* is simple, robust, and stable
- Indexing permits neutral, and ±13º anteversion

Dual Press™



The Dual Press modular junction employs two areas of cylindrical press-fit*.

To create a mechanical lock, the proximal and distal diameters of the peg are slightly larger than the corresponding holes in the stem, creating two bands of interference, or "press-fit".

Dual Press™ vs Taper

Taper connection necessitates leaving a gap

- Apex's Dual Press™ connection allows neck to fully seat*
- Stem provides medial support, which increases strength and allows higher lateral offsets

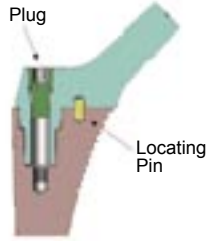
Tapered Design

Dual Press Design

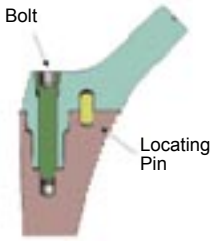
Improvements Made

Pin strength:

Old- 95 ft-lbs New- 210 ft-lbs



Previous design. Locating pin is .125". Plug seals hole but does not engage stem.

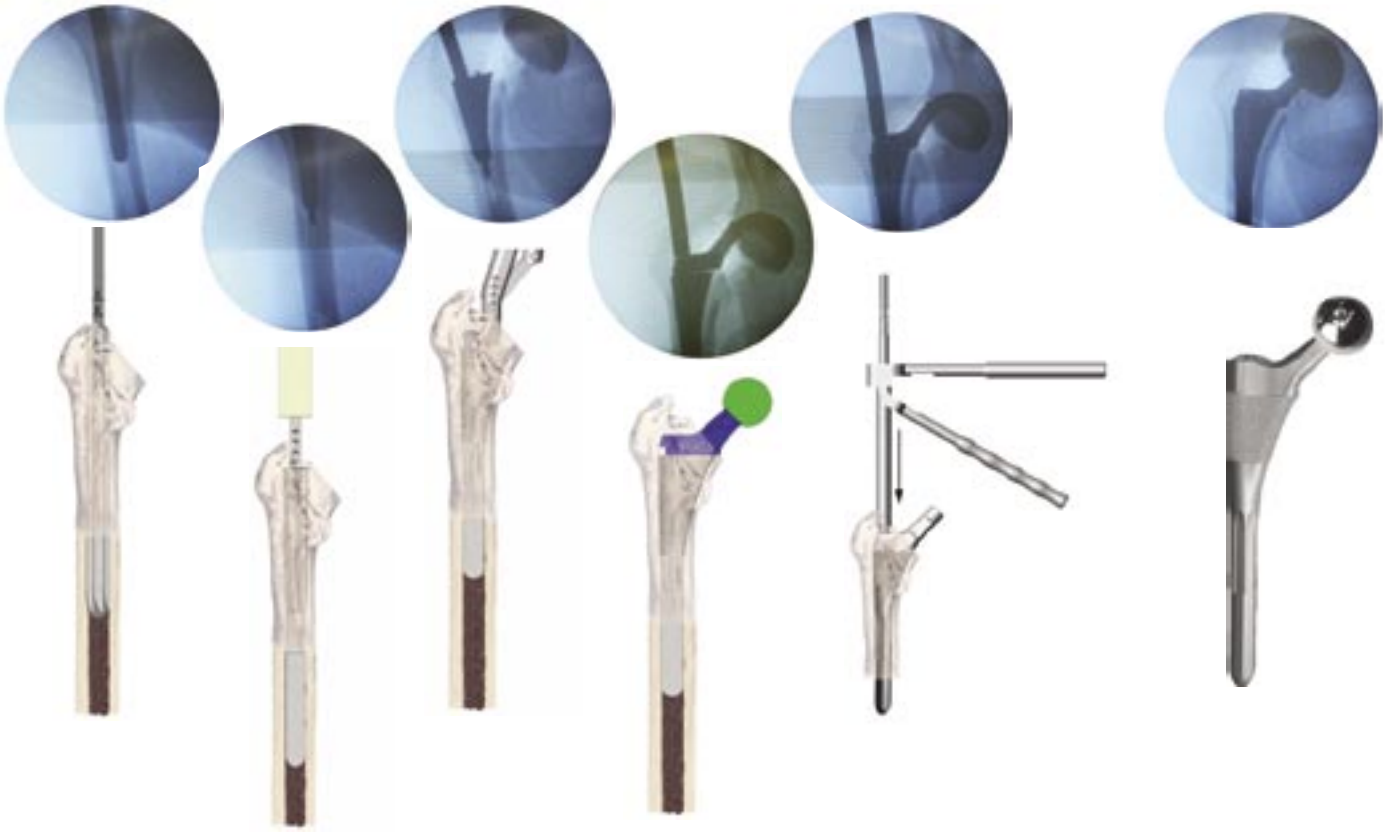


Current design. Locating pin is .188". Bolt seals hole and engages stem.

Previous design. Anteversion ± 16° in all necks

Current design. Anteverted necks are a separate code, ± 13°

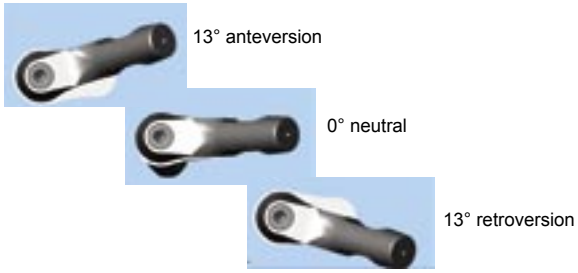
Surgical Technique



Typical 15 - 40° more ROM with neck anteverted.

Neutral neck position.

13° anteversion.

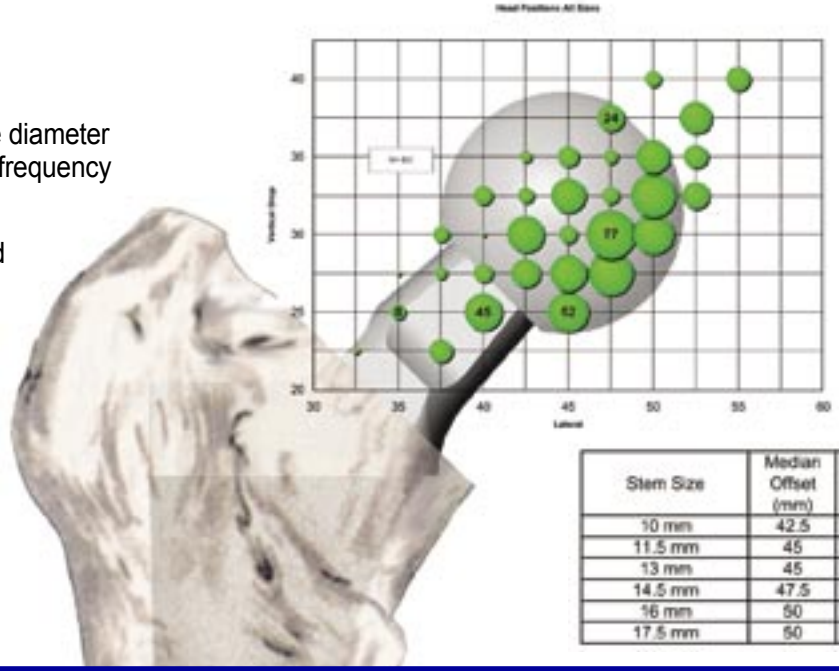


Anteverted neck used 18 times in the first 200 cases.

Results

The center of the bubble is head location; the diameter is an indication of frequency. Representative frequency values are given for several locations.

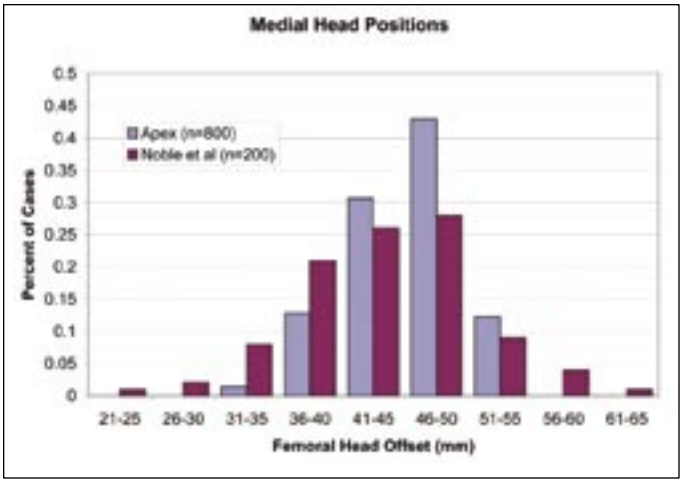
The head center location data clearly showed that a wide variety of offsets and lengths are required to properly balance the soft tissues. Further, when the data were sorted by distal stem diameter, it was clear that there is little correlation between head center location and stem size. Further, a significant number of small (10 mm or 11.5 mm) stems required large (>45 mm) offsets.[Table 1]



Stem Size	Median Offset (mm)	Median Vert Drop (mm)
10 mm	42.5	30
11.5 mm	45	30
13 mm	45	30
14.5 mm	47.5	30
16 mm	50	32.5
17.5 mm	50	32.5

Results (continued)

Lateral offset data are available in the literature for cadaver femora. We plotted our data on the same scale for comparison. The similarity of the lateral offset distribution confirms the appropriateness of the surgeons' head center selections.



1 Noble, Philip C., M.S., Alexander, Jerry W. B.S. et al, "The Anatomic Basis of Femoral Component Design", Clinical Orthopedics and Related Research, Number 235, October, 1988.

- 3 stem's locating pins failed (0.3%)*

- 2 dislocations (0.2%)**

- 0 significant length inequalities (+/- 5mm)
- 14 intra-operative fractures***

- 0 significant thigh pain

- 10% version indexed

13° anteversion

*All three required revision of stems. One replaced with same device, one replaced with cementless monoblock and one replaced at different center.
**One of the dislocations was treated conservatively after closed reduction and went on to an unremarkable course. The second had received a neck in the anteverted position and dislocated anteriorly. The surgeon chose to reoperate, remove the modular neck component and reinsert it in the neutral position, after which the patient rehabilitated normally.
***Intra-op fractures were encountered during first twelve months during instrumentation development (all wired without compromise to recovery).

Discussion

Restoration of normal joint biomechanics on a consistent basis was possible using the Apex Modular™ Stem because of the intra-operative versatility that stem system offers in regards to head center location when compared to monoblock stems. It combines the fit and fill features of today's contemporary cementless stems with updated modular components that provide for independent offset, version and leg length adjustments. This unique modular design allows for a large selection of proximal bodies to enable targeted implant selection for the restoration of proper soft tissue tension and joint biomechanics. Continued long-term follow up will provide additional information to aid in validation of this design concept.

Summary

- Modular neck design aids in fine tuning joint mechanics
- Works with all surgical approaches
- Allows for femoral stem insertion first (aids in reducing blood loss)
- Allows for ease and access in case of revisions
- Reduces chances of mechanical impingement of implants with mini-incision surgical approaches

Anterior-mini incision

Neck placement

Dual Press™ modular stem inplanted

Conclusion

The head location data suggest that hip joint reconstruction benefits from the availability of many head centers for every stem size. This may be accomplished with a large inventory of sizes or with a modular device. Review of 957 hips implanted for both primary and revision cementless application leads the authors to conclude that this "Dual Press™" proximal modular stem design is safe, effective and provides for a more accurate approach for reconstructing the biomechanics of the hip.

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