TaperSet™ Cementless Hip Arthroplasty System

Introduction

Cementless total hip arthroplasty (THA) is an effective treatment method for severe hip arthritis. One of the most important factors in driving a successful cementless THA is achieving osteointegration between implant and bone. Although multiple factors may impact osteointegration, implant design and geometry, surface treatment methods, and location of modularity have been reported to be critical to achieving clinical and radiographic outcomes in cementless THA [1-5]. Cementless femoral stems are designed with appropriate femoral vertical height, medial offset, neck-shaft angle, and version to achieve the hip center of rotation close to the native hip center. Furthermore, depending on the shape and geometry of the cementless stem, the contact area and site between the implant and femoral cortical bone might differ, resulting in differences in primary stability and biologic fixation. All cementless stem designs aim to achieve optimum restoration of hip biomechanics and biological fixation.

The collarless, proximally coated single wedge stem design has been reported to achieve optimum clinicoradiological outcomes in the short- and long-term for cementless THA [1–5]. The shoulder of the proximal stem is inclined to make a slope to encourage bone preservation and lower the risk of fracture while stems are inserted. The neck is designed to minimize collision between liners and acetabular cups by making it slightly thinner. Similarly, to reduce stem elasticity, long grooves on both the anterior and posterior sides of distal parts of stems, parallel to the vertical axis, have been incorporated in the stem design.

TaperSet™ design features

The TaperSet Total Hip System was designed to provide surgeons a proven hip system with offset versatility based upon the experience and success of the Mueller flat tapered stems of the past 30 years. The TaperSet Total Hip System incorporates the following design features:

- Dual taper wedge geometry provides stability in both the mediolateral and anteroposterior planes.
- 135° neck angle allows for restoration of joint mechanics.
- Neck geometry allowing for a maximum range of motion.
- 12 Standard and 12 High-Offset options to restore biomechanics without lengthening the leg.
- Proximal circumferential porous plasma spray coating provides for biological fixation at the implant-bone interface.
- Ti-6Al-4V alloy has proven biocompatibility without excessive stiffness.
- Instrumentation designed for accuracy and simplicity.
- 12/14 Neck Taper – Compatible with Consensus® Femoral Heads.
- The Reduced Distal Profile (RDP) TaperSet Stem, offers an improved distal sizing option in narrow "Type A" femurs and optimal fit in proximal-distal mis-match sizing.

The TaperSet cementless femoral implant (Fig 1.1) is an uncemented titanium alloy hip stem. The TaperSet stem with its Reduced Distal Profile stem (RDP) design helps address the proximal-distal femoral canal geometry mismatch and improve the proximal fit of the implant in the metaphysis.

Fig 1.1 TaperSet Stem

Early radiological results of the TaperSet Hip arthroplasty system

A prospective, multicentric study performed at a tertiary hospital in a dedicated hip arthroplasty unit between March 2022 and March 2023 presented the early radiological results of the TaperSet hip arthroplasty system [6]. The inclusion criterion was all patients with hip arthritis who underwent the TaperSet THA surgery during the study period. The exclusion criteria were all patients with incomplete clinical and radiological records and patients who were not available for routine follow-up. All patients underwent the TaperSet uncemented THA surgery under spinal or general anaesthesia using the posterolateral approach in the lateral decubitus position.

Outcome variables

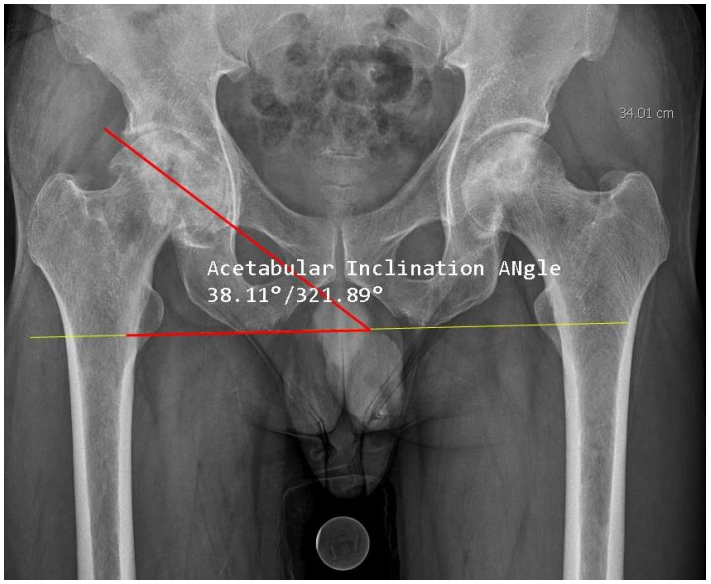
Perioperative data was collected from all patients, including age, gender, BMI, co-morbidities, ASA grade, tourniquet time, and length of hospital stay. Pre- and postoperative clinical outcome was measured using the Harris Hip score in all patients. Pre- and postoperative pelvis and both hips and hip lateral radiographs were assessed for acetabular inclination, femoral vertical, horizontal, and global offset, and hip center of rotation.

Results

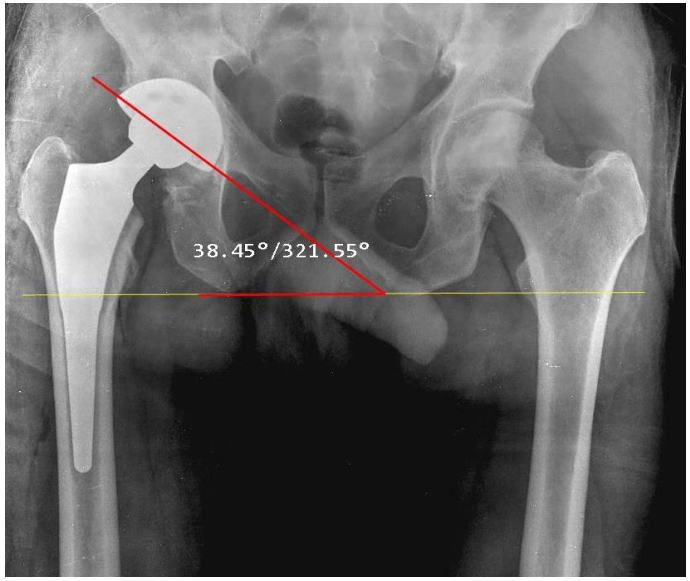
Data from a total of 114 THAs (in 106 patients) was analyzed for this study. There were 80 males and 26 females with a mean age of 50±10.5 (range, 29-79 years). The primary diagnosis was inflammatory arthritis in 81 hips, AVN in 24 hips, and non-union of fracture neck femur in 1 hip. The mean preoperative acetabular inclination of 39° changed to 41.5° postoperatively (Fig 1.2), the mean preoperative femoral vertical offset of 40mm changed to 46mm postoperatively (Fig. 1.3), the mean preoperative femoral horizontal offset of 35.5mm changed to 34mm postoperatively

(Fig 1.4), and the mean preoperative global femoral offset of 117mm changed to 113mm postoperatively (Fig 1.5). The mean preoperative vertical COR of 17.2 changed to 18.7 postoperatively and the mean preoperative horizontal COR of 25.1 changed to 24.5 postoperatively (Fig 1.6).

Fig 1.2 Acetabular Inclination

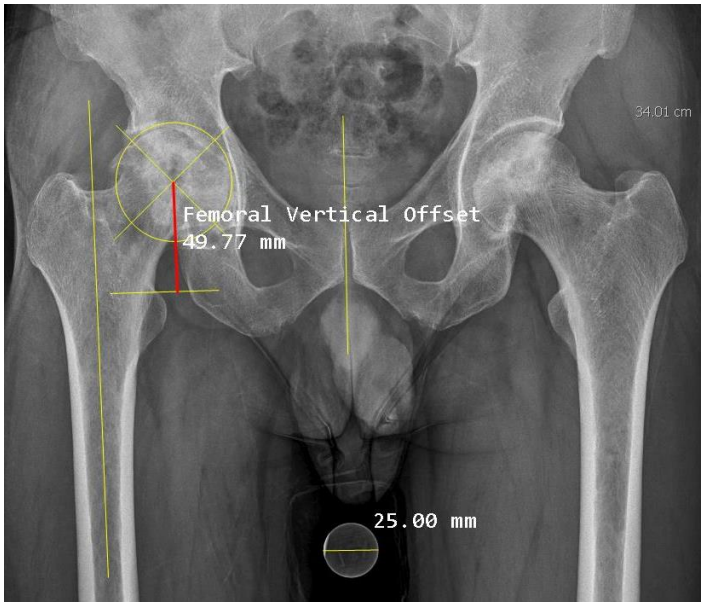


PreOp- 39deg

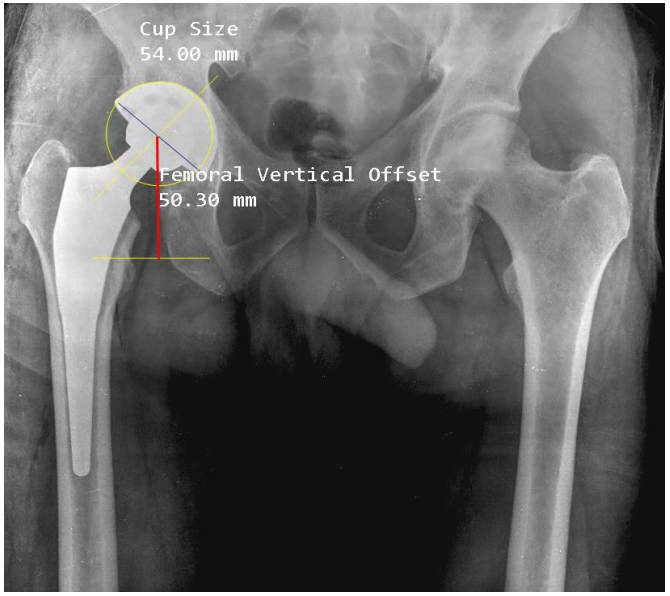


PostOp- 41.5deg

Fig 1.3 Femoral Vertical Offset

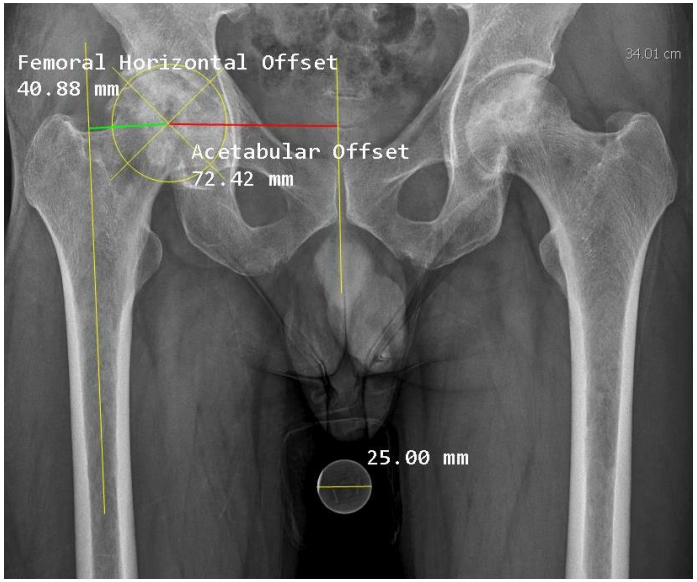


PreOp - 40mm

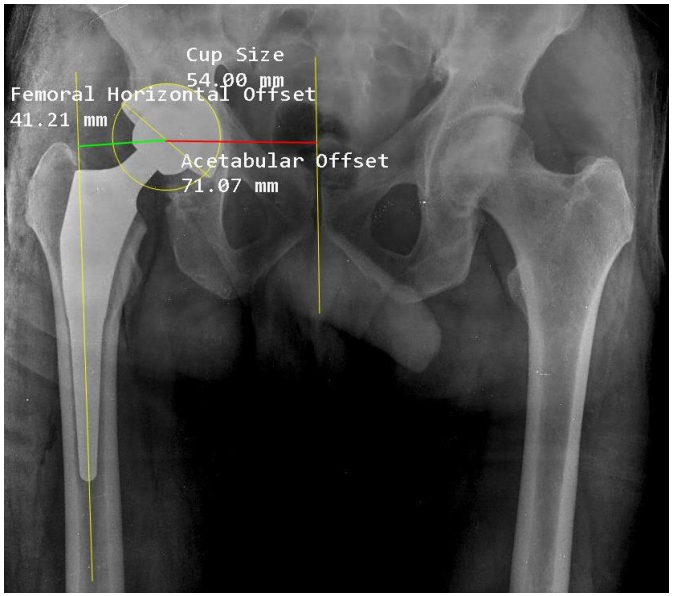


PostOp - 46mm

Fig.1.4 Femoral Horizontal offset

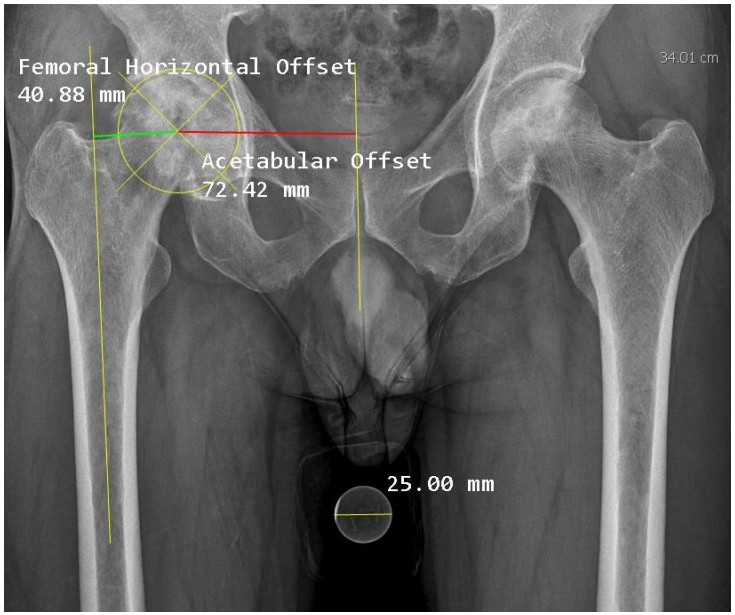


PreOp - 35.5 mm

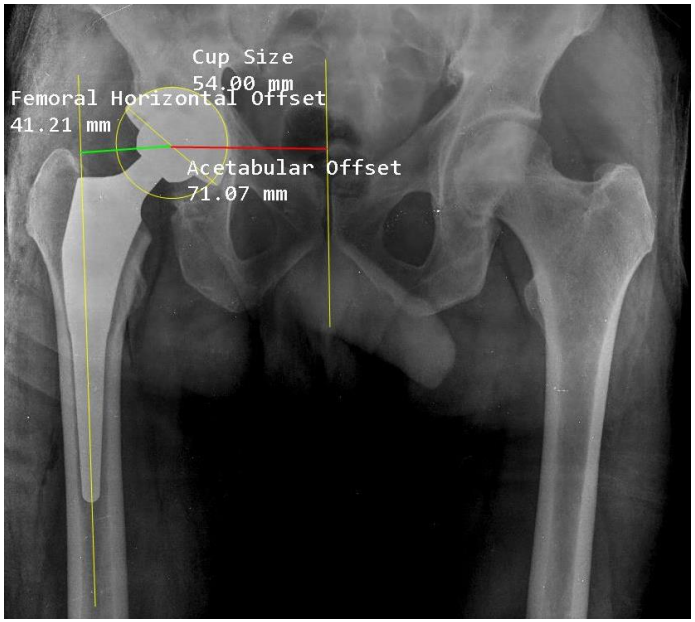


PostOp - 34 mm

Fig.1.5 Global Femoral offset

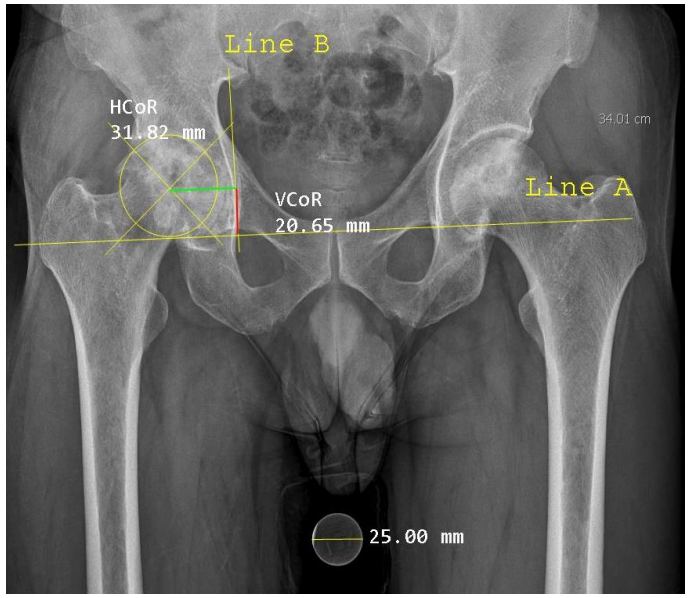


PreOp - 117 mm

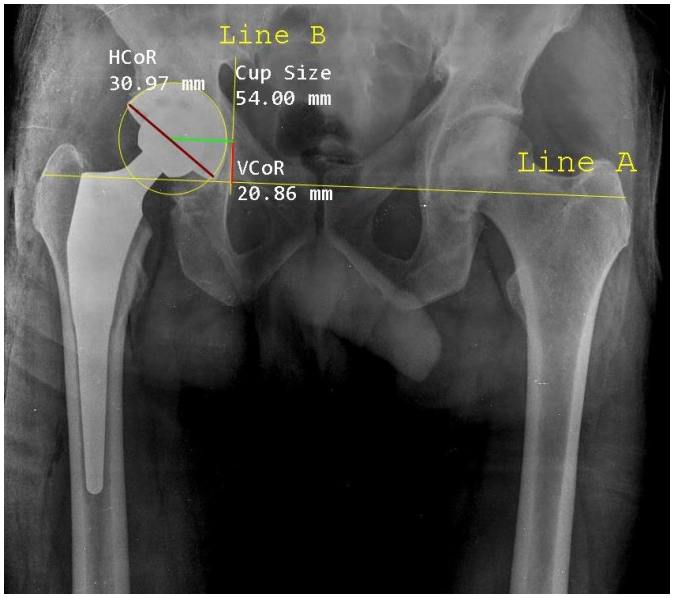


PostOp - 113 mm

Fig.1.6 Vertical and Horizontal Centre of Rotation



Horizontal COR– 25.1
Vertical COR – 17.2



Horizontal COR– 24.5
Vertical COR– 18.7

Conclusion

The TaperSet cementless stem design helps restore global femoral offset and COR within 5mm of preoperative values. The TaperSet THA design with meticulous surgical technique helps restore optimum hip anatomical measures as measured on postoperative x-rays.

Comparison with other cementless stem designs

The early results of the TaperSet cementless stem were similar to recently published studies on other uncemented THA stem designs.

Study	Year/ Country	n	Cementless stem design	Mean FVO difference	Mean FHO difference	Mean FGO difference	Mean VCOR difference	Mean HCOR difference
Bjarnason & Reikeras [7]	2015 Norway	73	Corail hydroxyapatite coated straight and rectangular press fit stem (DePuy, France)	2.2mm	NR	NR	NR	NR
Belzunce et al [8]	2020 UK	30	Quadra-H System femoral stem (Medacta International SA, Switzerland).	0.2mm	2.3mm	NR	6.6mm	NR
Luger et al [9]	Austria 2021	106	Fitmore® curved short stem (ZimmerBiomet, USA)	NR	7.3mm	NR	NR	NR
Maurer-Ertl et al. [10]	2022 Austria	99	ANA.NOVA Alpha Schaft Proxy® cementless short stem with metaphyseal fixation (ImplanTec GmbH, Austria)	NR	1.6mm	NR	NR	NR
Maurer-Ertl et al. [10]	2022 Austria	62	Optimys® cementless short stem (Mathys, Switzerland)	NR	4.1mm	NR	NR	NR
Maurer-Ertl et al. [10]	2022 Austria	90	Corail® Hip System (DePuy International Ltd., UK)	NR	4.9mm	NR	NR	NR
Tjønneland et al. [11]	2024 Denmark	127	Primoris hip implant (ZimmerBiomet, USA)	NR	-0.8mm	NR	3.5mm	-2.6mm
Akçaalan et al. [12]	2024 Turkey	95	Optymis short femoral stem (Mathys, Switzerland)	NR	19.4 %	NR	NR	NR

Akçaalan et al. [12]	2024 Turkey	90	Accolade II conventional stem ((Stryker, USA)	NR	6.7%	NR	NR	NR
Shah et al. [6]	2024 India	114	TaperSet Total Hip System	9.3mm	-1.5mm	-4mm	1.5mm	-0.6mm

n - number of hips; FVO - femoral vertical offset; FHO - femoral horizontal offset; FGO - femoral global offset; VCOR – vertical centre of rotation; HCOR - horizontal centre of rotation; NA – not reported

References

1. Radaelli M, Buchalter DB, Mont MA, Schwarzkopf R, Hepinstall MS. A New Classification System for Cementless Femoral Stems in Total Hip Arthroplasty. J Arthroplasty. 2023;38(3):502-510. doi: 10.1016/j.arth.2022.09.014.
2. Kim JT, Yoo JJ. Implant Design in Cementless Hip Arthroplasty. Hip Pelvis. 2016;28(2):65-75. doi: 10.5371/hp.2016.28.2.65.
3. Lemme NJ, McDonald CL, Hamilton WG, Crisco JJ, Cohen EM. Uncemented Collared Femoral Stems in Total Hip Arthroplasty. Orthopedics. 2022;45(3):e122-e126. doi: 10.3928/01477447-20220128-02.
4. Hoskins W, Rainbird S, Peng Y, Graves SE, Bingham R. The Effect of Surgical Approach and Femoral Prosthesis Type on Revision Rates Following Total Hip Arthroplasty: An Analysis of the Most Commonly Utilized Cementless Stems. J Bone Joint Surg Am. 2022;104(1):24-32. doi: 10.2106/JBJS.21.00487.
5. Janssen L, Wijnands KAP, Janssen D, Janssen MWHE, Morrenhof JW. Do Stem Design and Surgical Approach Influence Early Aseptic Loosening in Cementless THA? Clin Orthop Relat Res. 2018;476(6):1212-1220. doi: 10.1007/s11999.0000000000000208.
6. Shah VI, Pachore JA, Sheth A, Kshatriya A, Gujjar P. Early radiological results of the Taperset Hip arthroplasty system: a prospective study. Indian Society of Hip and Knee Surgeons (ISHKS) Conference 2024 Podium Presentation. 7th April 2024.
7. Bjarnason JA, Reikeras O. Changes of center of rotation and femoral offset in total hip arthroplasty. Ann Transl Med. 2015;3(22):355. doi: 10.3978/j.issn.2305-5839.2015.12.37.
8. Belzunce MA, Henckel J, Di Laura A, Hart A. Uncemented femoral stem orientation and position in total hip arthroplasty: A CT study. J Orthop Res. 2020;38(7):1486-1496. doi: 10.1002/jor.24627.
9. Luger, M., Feldler, S., Klasan, A, Gotterbarm T, Schopper C. The morphology of the proximal femur in cementless short-stem total hip arthroplasty: No negative effect on offset reconstruction, leg length difference and implant positioning. J Orthop Surg Res. 2021;16:730. doi: 10.1186/s13018-021-02876-7.

10. Maurer-Ertl W, Friesenbichler J, Pfann M, Maier M, Reinbacher P, Leithner A, Smolle MA. Restoration of hip geometry after total hip arthroplasty: retrospective comparison of two short stems and one straight stem. BMC Musculoskelet Disord. 2022;23(1):1035. doi: 10.1186/s12891-022-05923-4.
11. Tjønneland A, Nielsen PT, Jakobsen T. Biomechanics of a collum-fixated short stem in total hip arthroplasty. J Orthop. 2024;52:61-66. doi: 10.1016/j.jor.2024.02.027.
12. Akçaalan S, Akbulut B, Çağlar C, Uğurlu M. Comparison of mid-term clinical and radiological results of short and conventional femoral stems in total hip arthroplasty. Sci Rep. 2024;14(1):18060. doi: 10.1038/s41598-024-68696-x.