

## Original Research Article

# Short-term clinical outcomes on a new dual-taper wedge femoral stem in total hip replacement

Daniel Colome<sup>1\*</sup>, Antonio Da Costa<sup>1</sup>, Jacob Calpey<sup>1</sup>, Nathan Gilmore<sup>1</sup>, Jonathan B. Courtney<sup>2</sup>

<sup>1</sup>Charles E. Schmidt College of Medicine, Florida Atlantic University, Boca Raton, FL, USA

<sup>2</sup>Department of Surgery, Charles E. Schmidt College of Medicine, Florida Atlantic University, Boca Raton, FL, USA

**Received:** 11 September 2024

**Revised:** 09 October 2024

**Accepted:** 21 November 2024

### \*Correspondence:

Dr. Daniel Colome,

E-mail: [dcolome2023@health.fau.edu](mailto:dcolome2023@health.fau.edu)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ABSTRACT

**Background:** Short femoral stems have become increasingly popular in total hip arthroplasty (THA), offering potential advantages such as bone preservation and improved load transfer. The Everglade stem (Signature orthopedics Australia), a novel dual-tapered design, aims to enhance initial stability while minimizing complications such as subsidence and fracture. This study evaluates the short-term clinical and radiological outcomes of the Everglade stem.

**Methods:** We conducted a retrospective review of 100 consecutive patients (41 men, 59 women; mean age 68 years) who underwent THA using the Everglade stem at the Delray beach surgical center, a physician-owned ambulatory surgical center (ASC), between December 2022 and January 2023. Pre-operative and post-operative hip disability and osteoarthritis outcome score (HOOS-Jr) data were collected. Radiological outcomes, including stem subsidence, periprosthetic fracture, and osteolysis, were assessed at the 6-week and 6-month follow-ups.

**Results:** The median follow-up was 161.5 days (IQR 43-187). The mean HOOS-Jr score improved from 57.07 pre-operatively to 86.03 at 6 weeks and 92.7 at the latest follow-up. No cases of stem subsidence, periprosthetic fracture, or osteolysis were observed at any follow-up. There were no stem revisions or postoperative infections.

**Conclusions:** The Everglade stem demonstrated promising short-term outcomes, with significant improvements in patient-reported functional scores and no radiological complications. Longer-term studies are needed to evaluate the stem's durability and long-term performance.

**Keywords:** THA, Dual-tapered stem, Everglade stem, HOOS-Jr score, Radiological outcomes, Stem subsidence

## INTRODUCTION

Total hip arthroplasty (THA) is one of the most successful orthopedic procedures, significantly improving patient quality of life by restoring function and alleviating pain in patients, while traditional stems have been at the cornerstone of THA for decades, the use of short stems has gained increasing popularity. Benefits of the short stem when compared to a traditional stem include larger preservation of bone stock for potential revision surgery as well as improved load transfer to the proximal femur.<sup>1-3</sup> Short stem implants also enable less invasive surgical procedures, reducing the likelihood of intraoperative

complications and offering the known benefits of minimally invasive techniques.<sup>4</sup> There is evidence to show that short stems have similar survivorship and comparable clinical outcomes to traditional stems.<sup>5,6</sup> However, short stems have been associated with a higher rate of revisions due to primary instability, including early dislocations and impingement-related events.<sup>5</sup> This may be due to short stems exhibiting greater micromotion compared to standard-length stems.<sup>6</sup>

When considering different designs of short stems, the two most common types emerge: single-tapered and dual-tapered short stems. A single-tapered short stem is one that

narrows in one direction, typically from proximally to distally. Single tapered stems provide a better wedge fit, that is associated with enhanced initial stability when compared to traditional short stems.<sup>7</sup> This is due to the taper design that allows the stem to conform more precisely to the femoral canal, promoting better load distribution. Dual-tapered short stems, on the other hand, narrow in two planes-mediolaterally and anteroposteriorly. This design increases circumferential contact between the prosthesis and cortical bone, particularly in the anterior-posterior dimension of the femoral metaphysis. There is some evidence that use of a dual-taper leads to lower postoperative periprosthetic fracture rate when compared to a single-tapered stem.<sup>8</sup> However, while there has been some exploration of single-tapered and dual-tapered short stems, the available literature is limited, leaving a significant gap in understanding their respective clinical outcomes.

The potential advantages of dual taper implants compared to single taper stems were highlighted in some radiographic studies, where the modularity allowed for better replication of femoral morphologies, even in cases with atypical anatomies.<sup>9,10</sup> Despite this, large database studies revealed that these theoretical benefits did not result in improved survival rates; instead, modularity was associated with higher revision rates due to implant failures.<sup>11,12</sup> Consequently, these studies recommended against the routine use of exchangeable necks in THAs for primary osteoarthritis, as the increased revision rates outweighed the limited practical benefits, even when using compatible titanium alloy modular systems.<sup>11,12</sup> It is recognized, however, that the performance of dual taper implants is heavily influenced by the design of each femoral component.<sup>12</sup>

Giardina et al analyzed long-term registry data and found that while dual-tapered stems provided comparable clinical outcomes to traditional stems, they were associated with a slightly higher revision rate due to implant failures in certain patient populations<sup>5</sup>. This study emphasized the importance of understanding the biomechanical interaction between the stem design and patient-specific factors such as bone quality and anatomy (Giardina et al).

Dietrich et al explored the outcomes of using dual-tapered stems in patients undergoing direct anterior minimally invasive THA.<sup>4</sup> They observed that dual-tapered stems allowed for a less invasive approach without compromising implant stability or increasing the risk of complications, making them an attractive option for patients who prioritize a quicker recovery and reduced surgical trauma. However, they emphasized that the success of these stems depends heavily on proper patient selection and precise surgical technique.<sup>4</sup>

Despite these positive findings, some studies have raised concerns regarding the use of dual-tapered stems. For example, Bieger et al highlighted that while dual-tapered

stems might offer better initial fit, they can be prone to subsidence in cases where bone quality is compromised, such as in elderly patients or those with osteoporosis.<sup>2</sup> Their study recommended cautious use of dual-tapered stems in such populations, where alternative designs might offer more predictable outcomes.<sup>2</sup>

The Everglade stem (Signature orthopedics Australia) represents a novel dual-tapered short stem that incorporates several design features aimed at addressing the limitations observed with other short stems. Notably, it offers three offset options that do not alter leg length, a narrowly tapered distal geometry with a polished anodized finish to minimize stem hang-up, and an anteroposterior flare designed to fill voids in the femoral canal. These features are intended to enhance stability and reduce complications such as subsidence, fracture, and the revision.

There is a noticeable gap in the literature comparing different dual-tapered stems with each other, particularly in terms of their respective advantages, limitations, and long-term performance. This study specifically addresses this gap by evaluating the early clinical and radiological outcomes of the Everglade stem, thereby contributing to the ongoing discourse on optimal stem design in THA. We conducted a retrospective analysis to evaluate the patient-reported outcomes, periprosthetic fracture rate, subsidence rate, as well as the revision rate in this new stem.

## METHODS

This study is a retrospective review of 100 consecutive patients who underwent direct anterior hip replacement with the Signature Everglade stem at the Delray beach surgical center, a physician-owned ASC, between December 2022 and January 2023. No patients were excluded from the study. All patients attended a pre-operative visit during which their questions regarding the surgery were addressed, and a pre-operative HOOS-Jr score was obtained. Pre-operative AP pelvis and frog-leg lateral hip X-rays were taken for all patients prior to surgery."

The surgeries were all performed at the same ambulatory surgery center. All patients received general anesthetic and a local peri-articular block for pain control. The surgeries were performed on a standard operating room table. A direct anterior approach was used in all cases with a longitudinal incision over the tensor fascia muscle belly. A signature world acetabular cup was implanted followed by the world acetabular liner. Femoral preparation and trialing followed.

Fluoroscopic imaging was used in all cases to confirm appropriate sizing of trial components and to compare leg-lengths and offset to the contralateral leg. After trialing the appropriate sizes, the trials were removed, and the actual implants were impacted into place and final fluoroscopic images were obtained. Following the surgery, the patients

were made weight-bearing as tolerating and went home after recovering in the recovery room. Patients were sent home with walkers and were encouraged to get up and take walks every hour. A physical therapist came to the patient's home twice a week for the first two weeks. Patients were instructed to use the walker until they were comfortable walking without it.

Patients had their first follow up visit with the practice's athletic trainer who evaluated the wound, patient's gait, range of motion, as well as addressed any concerns. If there were any problems, the patient would then see the operative surgeon that week. The next visit was at the six-week mark from surgery, where the patient would see the surgeon and X-rays and a HOOS-Jr score would be obtained. The next visit would be at the six-month mark where X-rays were obtained as well as the 6-month HOOS-Jr score.

A retrospective chart review recorded age, sex, laterality, BMI, pre-op HOOS-JR, 6-week HOOS-JR, 6 month HOOS-JR scores, incidence of radiolucent lines, and incidence of stem revisions. Descriptive statistics, including means and standard deviations for continuous variables (e.g., HOOS-Jr scores), were manually calculated. No inferential statistical analysis was performed, as the goal of the study was to describe short-term clinical outcomes rather than compare groups or test hypotheses.

Ethical approval for this study was obtained from solutions IRB, and the study was conducted in accordance with the ethical standards of the declaration of Helsinki and its later amendments. Given the retrospective nature of the study

and the use of de-identified data, informed consent was waived.

## RESULTS

A total of 100 patients (41 men and 59 women) with a mean age of 68 years (interquartile range 62-76) underwent THA using the Everglade stem (Signature orthopedics, Australia). The median follow-up period was 161.5 days (interquartile range 43-187 days). The mean pre-operative HOOS-Jr score was 57.07 (standard deviation (SD) 12.3). At the 6-week post-operative visit, the mean HOOS-Jr score significantly improved to 86.03 (SD=10.2), demonstrating a mean increase of 28.96 points. By the latest follow-up, the mean HOOS-Jr score further improved to 92.7 (SD=9.8), reflecting a mean increase of 35.63 points from the pre-operative baseline.

Radiological assessment at the 6-week follow-up revealed no incidences of stem subsidence, periprosthetic fractures, or radiolucent lines. Additionally, there were no cases of osteolysis observed on any of the follow-up radiographs. Throughout the follow-up period, there were no reported cases of stem revision. Additionally, no postoperative infections were documented.

**Table 1: Demographic characteristics of patients included in the study.**

Characteristics	Value
<b>Number of patients</b>	100
<b>Age (Mean±SD) (in years)</b>	68.59±8.83
<b>Sex (M/F)</b>	41M, 59F
<b>BMI (Mean±SD)</b>	26.99±5.55

**Table 2: Summary of outcomes following total hip arthroplasty using the Everglades stem.**

Patients (Total)	Mean age	Mean pre-op HOOS-Jr score	6-week post-op HOOS-Jr score	Latest follow-up HOOS-Jr score	Mean increase in HOOS-Jr score (6 weeks)	Mean increase in HOOS-Jr score (Latest follow-up)
<b>100 (41 men, 59 women)</b>	68 years (IQR 62-76)	57.07 (SD 12.3)	86.03 (SD 10.2)	92.7 (SD 9.8)	28.96 points	35.63 points

## DISCUSSION

This study was performed to examine the short-term outcomes of the Everglade stem (Signature orthopedics, Australia), a new dual-tapered femoral stem.

A total of 100 patients with a mean patient age of 68 years were retrospectively studied and received 100 stems. The HOOS-Jr score improved from a mean 57.07 pre-operatively to a mean 86.03 at the 6-week visit and to 92.7 at the latest follow-up. At the 6-week X-ray assessment, we observed no incidence of stem subsidence, periprosthetic fracture, or radiolucencies. There were no cases of osteolysis and no stems were revised.

Our findings of a 35.63-point improvement in HOOS-Jr scores by the latest follow-up are consistent with similar studies on short-stem prostheses, such as the 5-year study by Darwich et al which reported comparable improvements using a collared cementless femoral short-stem prosthesis.<sup>13</sup> For context, a study of triple-tapered hydroxyapatite-coated femoral short stems showed an improvement of 40.6 points at 3 months post-op, 48.4 points at 12 months post-op, and 48.1 points at 5 years post-op.<sup>13</sup> Another study of the Optimys short stem in hip arthroplasty, which is a cementless short femoral stem, saw a HOOS-Jr improvement of 37.93 points at 2 years post-op.<sup>14</sup> Although direct comparisons are challenging due to differing follow-up periods and starting scores,

these results suggest that the Everglade stem performs comparably well in the short term and that the Everglade stem is associated with decreased patient reports of hip pain and/or difficulty performing activities of daily living. Similarly, De Waard et al observed a 37.93-point improvement at 2 years post-operation in patients receiving the Optimys short stem, a cementless short femoral stem, indicating that short stems like the Everglade show comparable early results.<sup>14</sup>

Additionally in our radiological assessment at 6-week follow up, there were no incidences of stem subsidence, periprosthetic fractures, or radiolucent lines, this aligns with the findings from Ikemura et al where they also found a significant reduction in early subsidence when using tapered wedge stems in Dorr type C femurs.<sup>7</sup>

This stem has several theoretical benefits over other contemporary dual-taper stems. First, this stem has three offset options that do not affect the overall leg-length. Second, the distal geometry is narrowly tapered with a polished anodized finish to minimize stem hanging, especially in Dorr A femurs. Finally, the antero-posterior flare in the stem body helps fill any voids in the femoral canal that are often visible when using a blade style stem. This enhanced contact is believed to contribute to lower rates of postoperative complications such as periprosthetic fractures, loosening, and the need for revision surgery.<sup>15</sup> Additionally, Ma et al demonstrated that dual-wedge stems like the Everglade stem are associated with lower rates of periprosthetic fractures compared to flat-wedge designs, further supporting the favorable outcomes observed in our study.<sup>15</sup>

There are several notable limitations in our study. First, there was no control group, which limits the ability to make definitive comparative claims. Second, the retrospective nature of the study introduces potential biases and confounders that could affect the outcomes. Third, the follow-up period is relatively short, and longer-term outcomes are necessary to fully understand the efficacy and durability of the Everglade stem.

This study is the first to assess the clinical and radiological outcomes of the Everglade stem, and it shows acceptable short-term results in hip arthroplasty.

## CONCLUSION

This study is the first to evaluate the short-term clinical and radiological outcomes of the Everglade stem, a novel dual-tapered femoral stem used in THA. Our findings demonstrate that the Everglade stem offers significant improvements in patient-reported outcomes, as evidenced by the marked increase in HOOS-Jr scores post-operatively. Additionally, no instances of stem subsidence, periprosthetic fractures, or radiolucent lines were observed, and no stems required revision within the follow-up period. These results suggest that the Everglade stem provides a reliable option for hip arthroplasty with

minimal complications in the short term. This study advances the understanding of dual-tapered stem performance, indicating that the Everglade stem may offer promising clinical benefits, particularly in reducing complications such as subsidence, while maintaining optimal functional outcomes. Future studies with longer follow-up periods are necessary to determine the long-term durability and efficacy of this implant.

## ACKNOWLEDGEMENTS

Authors would like to thank Cassandra Cortese, ATC for her support in data collection. Alos, to orthopaedic surgery associates for providing the necessary facilities and resources for this study.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Pepke W, Nadorf J, Ewerbeck V, Marcus RS, Stefan K, Tobias G, et al. Primary stability of the Fitmore® stem: biomechanical comparison. *Int Orthop*. 2014;38(3):483-8.
2. Bieger R, Ignatius A, Decking R, Claes L, Reichel H, Dürselen L. Primary stability and strain distribution of cementless hip stems as a function of implant design. *Clin Biomech*. 2012;27(2):158-64.
3. Gustke K. Short stems for total hip arthroplasty: Initial experience with the Fitmore™ stem. *J Bone Joint Surg Br*. 2012;94-B(11A):47-51.
4. Dietrich M, Kabelitz M, Dora C, Zingg PO. Perioperative Fractures in Cementless Total Hip Arthroplasty Using the Direct Anterior Minimally Invasive Approach: Reduced Risk with Short Stems. *J Arthroplasty*. 2018;33(2):548-54.
5. Giardina F, Castagnini F, Stea S, Bordini B, Montalti M, Toni A. Short Stems Versus Conventional Stems in Cementless Total Hip Arthroplasty: A Long-Term Registry Study. *J Arthroplasty*. 2018;33(6):1794-9.
6. Hirao M, Miyatake K, Koga D, Ryohei T, Gaku K, Atsushi O, et al. Comparison of 5-year postoperative results between standard-length stems and short stems in one-stage bilateral total hip arthroplasty: a randomized controlled trial. *Eur J Orthop Surg Traumatol*. 2021;31(4):743-53.
7. Ikemura S, Motomura G, Hamai S, Masanori F, Shinya K, Taishi S, et al. Tapered wedge stems decrease early postoperative subsidence following cementless total hip arthroplasty in Dorr type C femurs compared to fit-and-fill stems. *J Orthop Surg*. 2022;17(1):223.
8. Castagnini F, Bordini B, Cosentino M, Tassinari E, Guizzardi G, Traina F. Comparison of single taper and dual taper versions of the same stem design in total hip arthroplasty for primary osteoarthritis. *J Orthop Traumatol*. 2023;24(1):5.

9. Massin P, Geais L, Astoin E, Simondi M, Lavaste F. The anatomic basis for the concept of lateralized femoral stems. *J Arthroplasty*. 2000;15(1):93-101.
10. Duwelius PJ, Burkhart B, Carnahan C, Grant B, Laura MK, Yingxing W, et al. Modular versus Nonmodular Neck Femoral Implants in Primary Total Hip Arthroplasty: Which is Better? *Clin Orthop*. 2014;472(4):1240-5.
11. Colas S, Allalou A, Poichotte A, Piriou P, Dray-Spira R, Zureik M. Exchangeable Femoral Neck (Dual-Modular) THA Prostheses Have Poorer Survivorship Than Other Designs: A Nationwide Cohort of 324,108 Patients. *Clin Orthop*. 2017;475(8):2046-59.
12. Kop AM, Keogh C, Swarts E. Proximal Component Modularity in THA-At What Cost? An Implant Retrieval Study. *Clin Orthop*. 2012;470(7):1885-94.
13. Darwich A, Pankert K, Ottersbach A, Betsch M, Gravius S, Bdeir M. 5-Year Clinical and Radiographic Results of the Direct Anterior Approach for Total Hip Arthroplasty Using a Collared Cementless Femoral Short-Stem Prosthesis. *J Clin Med*. 2022;11(2):346.
14. De Waard S, Sierevelt IN, Jonker R, Daniel H, Harm MV, Gino MMJK, et al. The migration pattern and initial stability of the Optimys short stem in total hip arthroplasty: a prospective 2-year follow-up study of 33 patients with RSA. *HIP Int*. 2021;31(4):507-15.
15. Ma HH, Chou TFA, Tsai SW, Chen CF, Wu PK, Chen WM. Uncemented femoral stem design might have an impact on postoperative periprosthetic femur fracture pattern. A Comparison between flat-wedge and dual-wedge stems. *Injury*. 2021;52(11):3461-70.

**Cite this article as:** Colome D, Da Costa A, Calpey J, Gilmore N, Courtney JB. Short-term clinical outcomes on a new dual-taper wedge femoral stem in total hip replacement. *Int J Res Orthop* 2025;11:25-9.