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Original Research Article

Comparison of clinical and functional outcomes in patients operated with standard offset stem versus high offset stem in total hip replacement: a retrospective study

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ABSTRACT

Background: Femoral offset restoration in total hip replacement is crucial for normal anatomy and reduced joint forces, with potential implications for implant longevity and complications. This study compares standard and high offset stem total hip replacement outcomes for better restoration of native offset, also to improve understanding of clinical and functional outcomes particularly regarding implant selection in total hip replacements.
Methods: The study will include 40 patients who underwent THR, divided into standard offset and high offset stem groups. Preoperative data, including history and clinical examination, was collected. Post-operative recovery, satisfaction, and pain levels will be assessed through serial follow-ups at 6, 12, and 18 weeks, along with clinical improvement measured by Harris hip score. Analysis at 18 weeks will evaluate the outcomes of standard vs. high offset stem surgeries.
Results: Group A exhibited significantly higher proportions of patients with a Harris hip score >90 (excellent) compared to Group B (70% vs. 25%) and significantly lower proportions with scores indicating poor, fair, and good outcomes (<70: 0% vs. 10%, 70-79: 5% vs. 15%, 80-89: 25% vs. 50%, respectively; p=0.02).
Conclusions: This study confirms that increasing femoral offset with high-offset stems improves functional outcomes and biomechanics in total hip arthroplasty, emphasizing the need for patient-specific anatomical consideration.

Keywords: High offset stem, Standard offset, Total hip replacement, biomechanics of hip, Harris hip score

INTRODUCTION

In Human body, the hip joints bear the great responsibility of transmitting the ground reaction force against the body weight and simultaneously preserving the mobility.[1] Total hip replacement (THR) is the Most commonly performed Reconstructive procedure that replaces the femoral head, neck and acetabular articular surface.[2] THA is a highly successful procedure that has made numerous patients return to excellent function without pain and provides a stable, pain-free mobile joint. THA demands accurate surgical technique to reproduce a biomechanically sound joint.[3,4] Total hip replacement for hip osteoarthritis is one of the most successful and cost-effective operations in modern medicine. THR is now performed in increasingly younger patients but this trend places growing demands on implant longevity. The most common mode of implant failure is aseptic loosening primarily from osteolysis secondary to wear debris.[5,6] Femoral offset is the distance from the center of rotation of the femoral head to a line bisecting the long axis of the femur. The femoral offset is defined as the horizontal distance between the neutral axis

of the femur and the center of the femoral head.[7] It is an indicator of the abductor lever arm length, which, in principle, should be restored correctly in THR surgery to recreate normal anatomy and biomechanics. This radiographic measurement should be accurately performed and varies according to the hip rotation. Offset (range, 41 to 44 mm) increases with the size of the femur showing a good correlation coefficient.[8]

Increasing the offset (high offset) will increase the moment arm of the abductors which, in turn, reduces the abductor muscle force required during normal gait. Secondarily, this reduces the trans articular hip forces which should reduce articular surface wear and tear. An increased offset femoral component may also lead to increased bending moments and torsional forces in the proximal femur and potentially leads to premature failure of the femoral component by aseptic loosening.[9-12] Commonly total hip prostheses have had a relatively high neck-shaft angle and therefore a tendency to reduce the femoral offset. A decreased offset of the reconstructed hip compared to the preoperative state can result from using a femoral component that has less offset than the anatomy of the patient, from using a more valgus femoral stem or from using a short-necked femoral component. In addition, acetabular malposition and excessive deepening and resultant medialization can similarly reduce functional hip offset. Either way, a reduced functional hip offset decreases the abductor lever arm, increases joint reaction forces and increases the energy requirement for normal gait. This may manifest itself as an abductor lurch, limited range of motion and decreased stability.[13,14] We planned this study to evaluate the clinical and functional outcomes of standard offset stem versus high offset stem in total hip replacement. Our study will help in adding knowledge about the post-op complications of patients of total hip replacement and will give insight into the clinical & functional outcome of patients in these two groups and aid in selecting the tailored implant for the surgery.

Objectives

Objective was to assess the clinical outcome in terms of restoration of mobility and deformity and to check functional outcome in terms of patient's rehabilitation and satisfaction. Added objective was to evaluate the post-operative complications of standard offset stem versus high offsetstem in total hip replacement patients.

METHODS

Study design, duration and location

It is a retrospective comparative study which included 40 patients with high grade Avascular necrosis of hip managed with primary total hip replacement conducted from February 2023 to February 2024 at Topiwala National Medical College and BYL Nair Charitable Hospital, Mumbai, Maharashtra, India.

Inclusion criteria

Patients age 18 years and above of both genders who were operated with total hip replacement surgery for High grade avascular necrosis of hip with standard offset and high offset stem in last 12 months

Exclusion criteria

Patient with any neurovascular deficit in ipsilateral limb, ipsilateral limb pathology, not willing to participate, Patients with any neurocognitive impairment such as cerebrovascular disease, and mental retardation were not included in the study.

Procedure

This study was conducted during the period of February 2023 to February 2024. A minimum of 40 patients who were operated for total hip replacement will be included in the study. Patients will be categorized in two groups of 20 each of standard offset and high offset stem total hip replacement surgeries. Preoperative data, including patient's history and clinical examination will be recorded. Post-operative recovery, satisfaction and pain level will be recorded in serial follow ups along with clinical improvement based on physical examination and functional assessment in terms of restoration of mobility and deformity correction will be assessed based on Harris hip score. Patients routine post-operative follow ups made at 6 weeks, 12 weeks and 18 weeks will be noted and the data at the end of 18 weeks will be analyzed for the study.

Statistical analysis

The collected data was coded and entered in Microsoft Excel sheet. The data was analyzed using SPSS (Statistical Package for social sciences) version 20.0 software. The results were presented in tabular and graphical format. For Qualitative data various rates, ratios and percentage (%) was calculated. For Quantitative data Mean, SD, Median etc. was calculated.

RESULTS

Patients were categorized in two groups of 20 each of standard offset (Group B) and high offset (Group A) stem total hip replacement surgeries and results are as followed by independent t test, Chi square test. Distribution of age (years) was comparable between group A and B. (51-60 years 25% vs. 35% respectively, 61-70 years 45% vs. 40% respectively, 71-80 years 30% vs. 25% respectively) (p value=0.785). Mean±SD of age (years) in group A was 66.2±6.78 and in group B was 63.6±8 with no significant difference between them. (p=0.274) (Figure 1). Comparison of gender between group A and B was done by Chi square test. Distribution of gender was comparable between group A and B (female 35% vs. 65% respectively, male 65% vs. 35% respectively) (p=0.058) (Figure 2). Comparison of wound between group A and B: wound was

healed in all patients of group A and group B (Figure 3) and did not show any other post-operative complications in both groups.

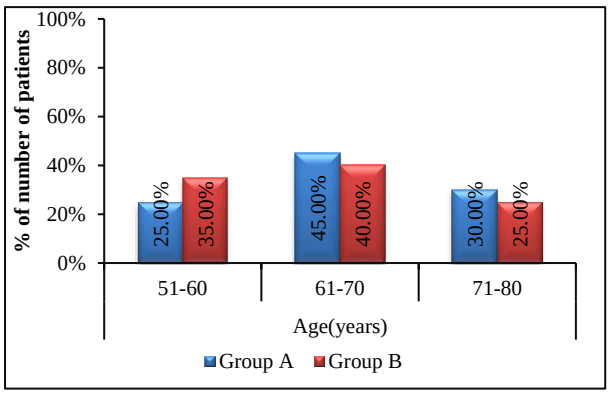

Figure 1: Comparison of age (years) between group A and B.

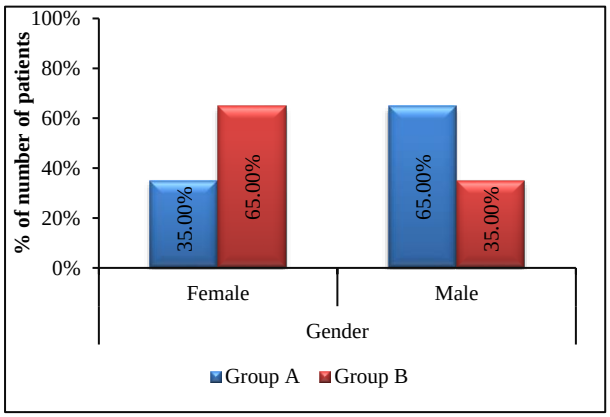

Figure 2: Comparison of gender between group A and B.

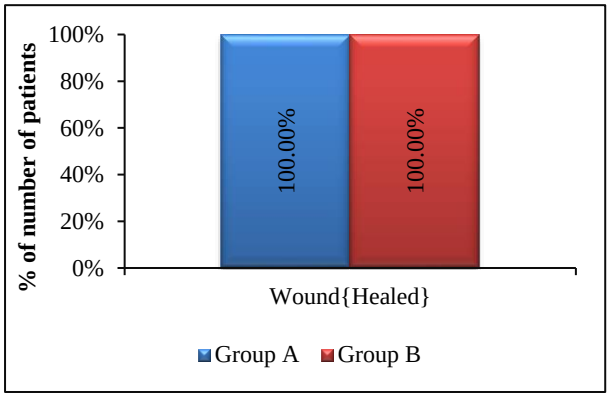

Figure 3: Comparison of wound between group A and B.

Comparison of total Harris hip score between group A and B was done by independent t test, * Fisher's exact test. Proportion of patients with total Harris hip score: >90 (excellent) was significantly higher in group A as compared to group B. >90 (Excellent): 70% vs. 25% respectively).

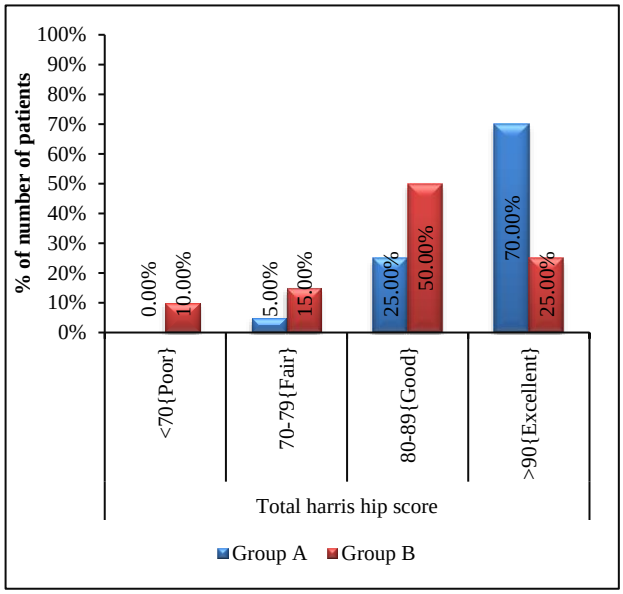

Figure 4: Comparison of total Harris hip score between group A and B.

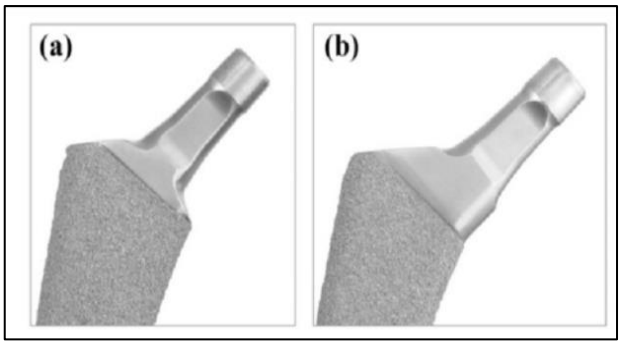

Figure 5: (a) Standard offset femoral stem, (b) High offset femoral stem.

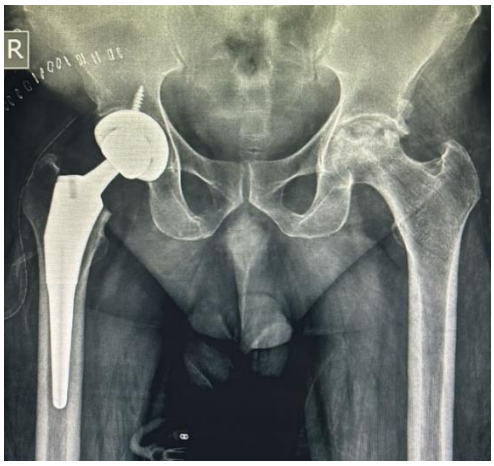

Figure 6: Left sided total hip replacement with higher offset femoral stem.

Proportion of patients with total Harris hip score: <70 (poor), 70-79 (fair), 80-89 (good) was significantly lower in group A as compared to group B. <70 (Poor): 0% vs. 10% respectively, 70-79 (Fair): 5% vs. 15% respectively, 80-89 (Good): 25% vs. 50% respectively) (p value=0.02). Mean±SD of total Harris hip score in group A was 92.5±6.01 which was significantly higher as compared to group B (84.1±9.08) (p value=0.001) (Figure 4).

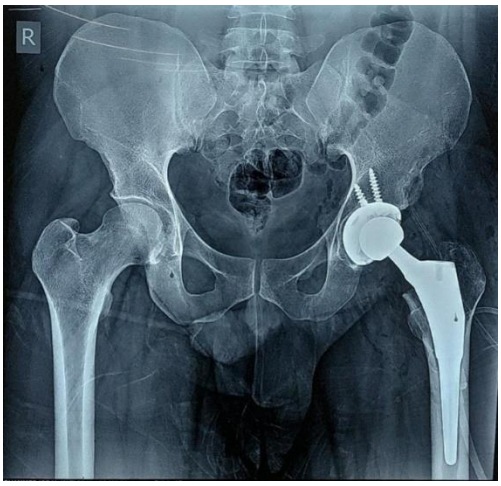

Figure 7: Right sided total hip replacement with standard offset femoral stem.

DISCUSSION

We conducted a study to compare the clinical and functional outcomes in patients operated with total hip replacement using two offsets of the femoral components standard offset and high offset stem (Figure 5). Results concluded that patients operated with higher offset stem had better rehabilitation and functional improvements compared to latter based on Harris hip scores (Figure 6, 7). A total hip replacement is a surgical procedure, which will alleviate the pain and debilitation caused by osteoarthritis, fractures, dislocations, congenital deformities, and other hip related problems. Where the diseased cartilage and bone of the hip joint is surgically replaced with artificial materials.[16] Although total hip arthroplasty is a highly successful treatment option for end-stage osteoarthritis with a positive responder rate of over 90%, the surgeon is faced with high patients' expectations regarding the functional capacity of the artificial hip joint. Beside a correct intraoperative orientation of both cup and stem, restoration of biomechanics such as offset is crucial for optimal function and long-term outcome after THA. Failure of correct offset restoration is associated with impingement, reduced hip abductor strength, altered gait kinematics and even higher wear of the artificial hip joint.[17] To address the interindividual variability of the femoral anatomy, most modern implant systems offer at least two different offset geometries of the femoral stem: a standard offset design and a high offset design. Prior to surgery the biomechanical restoration of offset is usually templated on radiographs illustrating the preferred stem design for the respective patient. However, intraoperative alterations in relation to the preoperative plan or reduced joint stability harbor the potential to complicate the right choice of femoral offset design during THA.[18] Charnley et al was among the first to emphasize the importance of restoring normal hip biomechanics as a goal of total hip replacement. One of the cornerstones of his philosophy was restoring or increasing the abductor moment arm. He considered offset restoration to be a factor under control of the surgeon at the time of total hip replacement surgery and accomplished this by using components of appropriate offset, making the neck cut at the appropriate level and lateralizing the greater trochanter. Now that trochanteric osteotomy is no longer a standard approach, the major tool at the disposal of the surgeon for increasing the abductor moment arm is restoring or increasing the femoral offset.[19] Dolhain et al compared hip replacement outcomes in Mallory-Head (standard offset) and Synergy (high offset) groups. Synergy group (90.8%) achieved superior femoral offset restoration compared to Mallory-Head (40.8%), indicating Synergy's reliability in hip joint center reconstruction. They attributed this to Synergy's design, including a 131° neck-shaft angle and dual offset option, emphasizing its advantage over Mallory-Head's valgus 135° neck-shaft angle.[20]

A biomechanical study, evaluating the impact of cup medialization via finite element modeling and CT analysis, suggested that increasing femoral offset could benefit patients with lower femoral anteversion by enhancing hip muscle moments.[21] However, acetabular component medialization must be balanced against potential bone loss and proprioceptive concerns regarding non-anatomic center of rotation. Increased joint reaction forces may affect long-term total hip arthroplasty survival, necessitating further long-term investigations.[22] Excessive femoral offset elevation may lead to heightened lateral trochanter friction, potentially explaining findings by Lieds et al.[23]

Peng et al found that the high offset Tri-Lock BPS demonstrated excellent clinical and radiographic outcomes at a minimum follow-up of 3 years. The mean Harris Hip Scores showed a significant improvement from pre-operative to the latest follow-up.[24.] Incavo et al found that a high-offset option aids the surgeon in proper leg length management. Harris hip score averaged 91, with no differences seen between the 132° and the 127° stem designs. Leg length measurements were considered equal side-to-side differences of 7 mm or less in 87% of cases: 82% of standard- and 92% of high-offset cases ($p<0.05$).[25] Panichkul et al found that the Harris Hip Score were significantly improved ($p<0.001$) from the preoperative period to latest follow-up on use of dual-offset implant. The Synergy stem design has achieved excellent clinical outcomes, predictable osteointegration, and outstanding survivorship of 99.5% at a minimum of 15 years follow-up, representing the standard for femoral stems($p<0.05$).[26] Malhotra et al conducted a study to review the outcome of total hip arthroplasty using a short femoral stem in 33 hips. The mean follow-up period was 6.5 (range, 5-8) years. The

mean Harris Hip Score improved from 40 (range, 37-54) to 90 (range, 88-97) at the final follow-up.[27] A retrospective review of 81 sequential primary total hip arthroplasties using a cementless, high-offset femoral stem was performed in another study by Incavo et al Follow-up was 24 to 60 months. The mean postoperative Harris Hip Score was 95.[28.] Roth et al found that subjective assessment of quality of life was evaluated using the Harris hip score (HHS) which had no significant differences in HHS on comparing standard offset and high offset implants.[29] Ensuring the biomechanical functionality of the hip joint is crucial in total hip arthroplasty, emphasizing the significance of pre-operative planning and surgical technique in offset restoration. Given its importance, numerous techniques have been detailed in literature to aid surgeons in achieving optimal offset to ensure better rehabilitation and increase the shelf life of the prosthesis.

Limitations

This study has certain limitations, notably a smaller sample size and its retrospective design, which limits control over all variables. To mitigate this, we confined the study to a single center and included consecutive stems for analysis. While the study reports patient-reported outcome scores, it does not encompass radiographic outcomes or stem survivorship. However, the study effectively addresses its objectives by demonstrating improved postoperative functional outcomes with higher offset stems, enhancing hip joint stability.

CONCLUSION

This study confirms the well-established biomechanical principle that augmenting femoral offset results in improved functional outcomes, supported by a hip-specific outcome measure. High-offset stems emerge as vital for reinstating biomechanics and enabling unimpeded range of motion in a considerable portion of total hip arthroplasty patients. Nevertheless, the consideration of patient-specific anatomy is crucial in THA to restore each individual's distinct biomechanical offset configuration. Striking a balance to avoid both excessive under- and over-restoration of offset is imperative in THA procedures.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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