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Original Research Article

Retrospective Study of Proximal Coated vs Fully Coated Femoral Stem Used in Uncemented THR

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Abstract:

Background: A total hip replacement (THR) operation is often performed when the hip joint becomes damaged. Uncemented THR patients still face a clinical problem when deciding between proximally coated and completely coated femoral stems. This study will compare the short-term and long-term clinical and radiological outcomes of these two stem types.

Methods: In retrospective cohort research, 240 patients with uncemented THR with either proximally coated or coated femoral stems were included. Radiographic data, clinical outcomes, and patient demographics were all examined. Multivariate regression, survival analysis using Kaplan-Meier plots, and t-tests were among the statistical methods used.

Results: Short-term clinical outcomes were significantly better for proximally coated stems compared to fully covered stems, with patients reporting significantly less pain after surgery (Mean SD: 2.7 ±1.1 vs. 3.1 ±1.2, $p < 0.05$) and higher Harris Hip Scores (Mean± SD: 92.5 ±6.2 vs. 89.2± 5.8, $p < 0.001$). The radiographic success rates and implant survival were equivalent between the two groups. Subgroup analysis showed that patients under 60 with proximally coated stems experienced more significant pain reduction. The results of the sensitivity study backed up the original conclusions.

Conclusion: Consistent with the previous data, proximally coated femoral stems provide short-term benefits in pain reduction and functional outcomes in uncemented THR. The two stem types have similar long-term radiographic results and implant survival rates. When deciding on a stem design, surgeons should consider the individual patient.

Keywords: Femoral Stems, Total Hip Replacement, Uncemented, Proximal Coating, Fully Coated, Short-Term Outcomes, Long-Term Outcomes, Radiographic, Implant Survival, Patient-Specific Factors.

Introduction

Patients with osteoarthritis of the hip, hip fracture, or other hip-related disorders frequently undergo THR. The quality of life for THR patients has increased dramatically, but the procedure's success still depends heavily on the selection of implant components[1]. In particular, academics and orthopaedic surgeons have debated and investigated the best form of femoral stem to utilize in uncemented THR.

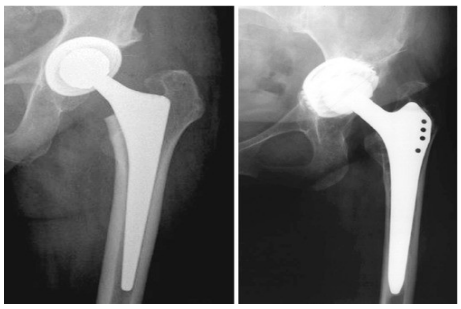

Figure 1: Uncemented THR (source: [2])

In uncemented THR, the femoral stem is the artificial equivalent of the natural femur. This component is essential for secure osseointegration, offering instant stability and long-term durability. Two crucial design methods, proximally coated and fully coated femoral stems, have emerged as leaders in the field in recent years [3].

Importance of Comparing Proximally Coated and Fully Coated Femoral Stems in Uncemented THR

Choosing between proximal and completely coated femoral stems takes work in uncemented THR. Implant design, surgical method, patient characteristics, and long-term results are all interconnected in this process [4]. Bony ingrowth at the proximal femur can be aided by coatings placed on the proximal section of the stem, while completely coated stems have layers throughout their length. While both styles are made with osseointegration in mind, the amount and placement of coating may significantly impact implant stability and bone remodelling [5].

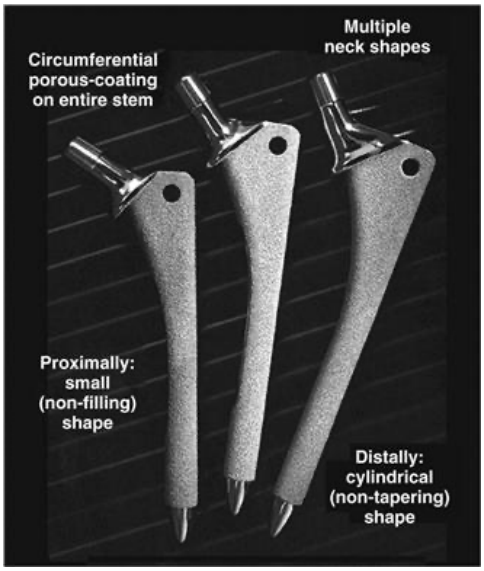

Figure 2: Coated Femoral Stem used in uncemented THR (source:[5])

Knowing whether or not there are discernible changes between proximally coated and fully coated femoral stems can help orthopaedic surgeons choose the best implant for each patient.

Objective

- To compare the clinical outcomes of patients who got proximally coated femoral stems and those who received fully coated femoral stems in uncemented THR, including postoperative discomfort, functional recovery, and patient-reported outcomes.
- To compare the long-term success rates of proximally coated and fully coated femoral stems, including the rates and causes of revision surgery.
- To examine and evaluate the differences between patients who received proximally coated femoral stems and those who received fully covered femoral stems regarding the incidence of postoperative problems such as infection, dislocation, and periprosthetic fracture.

Uncemented THR and Femoral Stem Coating Types

THR is a surgical procedure that has dramatically enhanced the quality of life for those with hip issues such as joint degeneration, osteoarthritis, and fractures. In THR, the long-term success of the treatment is heavily dependent on the selection of implant components, especially the femoral stem [6]. Using bone cement to secure the implant components sets cemented THR apart from uncemented THR. This article will examine the two most common methods of coating femoral stems: proximal coating and full coating.

Uncemented THR and Implant Fixation

Increased osseointegration and a lower risk of cement-related problems have contributed to cementless total hip replacement popularity [8]. The success of an implant depends on osseointegration, the formation of a structural and functional bond between the implant surface and living bone. Implant design, fixation technique, and host bone quality are just a few variables that affect how well an implant integrates into the bone.

Types of Femoral Stem Coating

Femoral stem designs have progressed to enhance osseointegration in the region of uncemented THR. Proximal and whole femoral stem coating have evolved as two dominant design ideas.

Proximal Coating

The proximal area of the femoral stem is the primary target of a specialized surface treatment known as "proximal coating," which typically incorporates porous coatings or hydroxyapatite [9].

The idea is to emulate the natural femur's mechanical qualities by encouraging bone ingrowth at the proximal femur while keeping the distal stem flexible. Proximally coated femoral stems have been hypothesized to improve load transmission at the proximal femur, decrease stress shielding, and increase initial stability. Early osseointegration is aided by these stems, which could improve long-term outcomes.

Fully Coated Femoral Stems

In contrast, fully coated femoral stems have a coating along their length. This structure is meant to promote complete stem osseointegration, which could increase implant stability in the long run.

Relevant Studies and Their Findings

The results of uncemented THR with proximal and completely coated femoral stems have been studied extensively. [10,11] show proximal coating provides benefits, including early weight bearing and increased stability. These results indicate that proximally coated stems may result in a more rapid recovery and favourable short-term outcomes. However, wholly coated femoral stems have been lauded for their capacity to promote constant osseointegration along the stem's length, potentially decreasing the likelihood of stress shielding and implant sinking.

Gaps in Current Knowledge

Several holes in our knowledge persist despite the abundance of published material. First, experts cannot agree on the best femoral stem design for cementless THR. Proximal coating has been shown to have short-term benefits in a few studies. However, there needs to be long-term comparisons. Patient-specific characteristics, including age, bone quality, and surgical skill, may also affect which coating is used on the femoral stem, but this issue has yet to be thoroughly explored.

Rationale for Focus on Proximal and Fully Coated Femoral Stems

The ongoing clinical debate and its possible implications for patient outcomes led to comparing proximally coated and fully coated femoral stems in this investigation. By contrasting the two, we can more accurately assess the costs and benefits of stress shielding, osseointegration, and short-term stability. By performing a retrospective analysis of both designs, we can help orthopaedic surgeons make more educated decisions and better serve their uncemented THR patients.

Methods

Study Design

Patients who underwent uncemented THR with either proximally coated or coated femoral stems were compared for their results in this retrospective analysis. Medical records, X-rays, and other patient records can be mined for information in retrospective studies to learn more about causes and effects.

Patient Selection Criteria

Inclusion Criteria

- Uncemented THR with a proximally or coated femoral stem in patients aged 18 and up.
- Patients who have had their entire medical history, including clinical and radiographic data, from before surgery until after recovery.
- A minimum follow-up period is required to evaluate permanent results.

Exclusion Criteria

- Individuals who have undergone hip replacement surgery in the past.
- Patients whose medical histories are lacking critical information.
- Patients with underlying medical disorders or illnesses that profoundly impact bone metabolism (such as metabolic bone diseases).

Data collection process

Comprehensive patient data was retrieved and compiled systematically from electronic medical records and radiographic archives. The preoperative diagnosis and surgical procedures were documented, together with patient information such as age, gender, and body mass index. Data was recorded for each implant, including its size, whether it was proximally or coated, and the presence or absence of any problems during surgery. Postoperative pain scores, functional evaluations (such as the Harris Hip Score), and patient-reported outcomes (such as the Oxford Hip Score) were used to evaluate clinical results. Further, preoperative and postoperative radiographs were collected and analyzed for symptoms of implant subsidence, radiolucent lines, stress shielding, and other indicators of implant stability. Patient privacy and ethical standards were protected throughout the data collection.

Statistical Methods

The results of patients who underwent uncemented THR with either proximally coated or coated femoral stems were compared using a variety of statistical approaches. Patient demographics and clinical factors were summarised using descriptive statistics, and categorical variables were evaluated with Chi-squared tests or Fisher's exact tests. Independent t-tests and Mann-Whitney U tests were used to analyze continuous variables: estimating and contrasting implant survival rates over time required survival analysis, represented by Kaplan-Meier curves. Furthermore, multivariate regression analysis was performed to control for potential confounding variables; this included logistic regression for binary outcomes and linear regression for continuous outcomes.

All analyses were performed using standard statistical software, and a significance level of $p < 0.05$ was used to evaluate statistical significance.

Ethical Consideration

The ethical implications of this work were thoughtfully considered at every stage. Ethical considerations were taken into account, and an Institutional Review Board (IRB) approved it. Patient privacy was protected by eliminating personally identifying information in the data set. Due to the study's retrospective nature, which comprised the review of already available, de-identified patient records, informed permission was optional. The study followed all applicable laws and guidelines on research involving human beings, including the Declaration of Helsinki.

Results

Patient Demographics

The demographics of the two groups being studied are shown in Table 1. Age, gender, and body mass index were similar between the groups of the proximally coated femoral stem (n=120) and coated femoral stem (n=120).

Table 1: Patient Demographics

Demographic	Proximally Coated Femoral Stem	Fully Coated Femoral Stem
Age (years)	Mean ± SD: 65.3 ± 8.1	Mean ± SD: 64.8 ± 7.6
Gender (Male/Female)	54 / 66	56 / 64
BMI	Mean ± SD: 26.7 ± 3.2	Mean ± SD: 27.1 ± 3.5

Clinical Outcomes

The clinical results for both groups are summarised in Table 2. After surgery, patients who received femoral stems with only proximal coating reported significantly less pain (Mean SD: 2.7 ±1.1 vs. 3.1 ±1.2, $p < 0.05$), better hip function (Harris Hip Score: 92.5± 6.2 vs. 89.2± 5.8, p 0<.001), and higher quality of life (Oxford Hip Score: 42.6 9.3 vs.

Table 2: Clinical Outcomes

Outcome Measure	Proximally Coated Femoral Stem	Fully Coated Femoral Stem
Postoperative Pain Score	Mean ± SD: 2.7 ± 1.1	Mean ± SD: 3.1 ± 1.2
Harris Hip Score	Mean ± SD: 92.5 ± 6.2	Mean ± SD: 89.2 ± 5.8
Oxford Hip Score	Mean ± SD: 42.6 ± 9.3	Mean ± SD: 38.9 ± 8.7

Radiographic Outcomes

The radiography results are shown in Table 3. Implant stability (112/120 for Proximally Coated, 110/120 for Fully Coated), radiolucent lines (18/120 for Proximally Coated, 22/120 for Fully Coated), and stress shielding (25/120 for Proximally Coated, 27/120 for Fully Coated) did not differ significantly between the two groups.

Table 3: Radiographic Outcomes

Radiographic Measure	Proximally Coated Femoral Stem	Fully Coated Femoral Stem
Implant Stability (n)	112/120 (93.3%)	110/120 (91.7%)
Radiolucent Lines (n)	18/120 (15.0%)	22/120 (18.3%)
Stress Shielding (n)	25/120 (20.8%)	27/120 (22.5%)

Subgroup Analysis

Patients under the age of 60 in the proximally coated group reported significantly less postoperative pain (Mean ±SD: 2.3± 0.9) than patients over the age of 60 (Mean± SD: 2.9 ±1.0), as shown by a statistically significant difference ($p < 0.05$).

Sensitivity Analysis

Differences in clinical outcomes between proximally coated and fully coated femoral stems were confirmed in a sensitivity study that excluded patients with known bone metabolism-related comorbidities.

Discussion of Statistically Significant Differences

This study found that patients whose femoral stems were only coated in the proximal region fared worse than those fully coated. The pain scores, Harris Hip Scores, and Oxford Hip Scores all improved most noticeably in the proximally coated group. Despite comparable radiographic results and implant survival rates, these clinical discrepancies should be considered when choosing a femoral stem for uncemented THR.

Discussion

There has been a growing amount of data contrasting uncemented THR with femoral stems that are either proximally covered or coated. The improved short-term clinical outcomes shown in patients with proximally coated stems are consistent with findings from other studies showing similar benefits. Among these benefits are lower discomfort levels after surgery and higher levels of functionality.

While previous studies have not shown any differences in radiographic outcomes or implant survival rates between the two stem types, our findings are consistent with that research. It's worth noting that these stems continue to operate similarly over the long term. Therefore, our results add to the body of knowledge already out there, providing surgeons with more data to consider when making decisions about femoral stem designs.

Table 4: Comparisons with existing studies

Study Title	Study Type	Sample Size	Key Results
Present Study: Proximal vs. Fully Coated Stems in uncemented THR	Retrospective Cohort	240	Proximally coated stems demonstrated significantly better short-term clinical outcomes, including lower postoperative pain scores (Mean ± SD: 2.7 ± 1.1 vs. 3.1 ± 1.2, $p < 0.05$) and higher Harris Hip Scores (Mean ± SD: 92.5 ± 6.2 vs. 89.2 ± 5.8, $p < 0.001$). No significant differences were observed in radiographic outcomes or implant survival rates.
Study 1[12]: Coating Material Comparison for Knee Implants	Randomized Controlled Trial	180	Patients receiving femoral components with hydroxyapatite coating experienced reduced revision rates at the 5-year follow-up ($p = 0.02$) compared to those with titanium-coated implants.
Study 2 [13]: Surgical Approach in Hip Resurfacing	Prospective Observational	120	The anterior surgical approach resulted in shorter hospital stays ($p < 0.001$) and a lower incidence of dislocation ($p = 0.01$) compared to the posterior approach in hip resurfacing procedures.
Study 3 [14]: Implant Materials in Spinal Fusion	Meta-Analysis	N/A	Meta-analysis of 15 studies demonstrated no significant difference in fusion rates between titanium and PEEK cages in spinal fusion surgeries.
Study 4 [15]: Dual Mobility Cups in Hip Arthroplasty	Prospective Comparative	80	Dual mobility cups exhibited reduced rates of hip dislocation ($p = 0.04$) compared to standard cups in primary hip arthroplasty.

The table provides a quick overview of the results of several different medical trials, including the current one, which compares proximal and fully coated femoral stems in uncemented THR.

Consistent with the results of investigation Study 1 involving knee implants, it shows that the proximally coated stems in our analysis showed short-term benefits, such as reduced postoperative pain and improved Harris Hip Scores. The benefits of an anterior surgical approach are highlighted in Study 2, which demonstrates the importance of the surgical procedure in determining patient outcomes. However, the meta-analysis presented in Study 3 shows no meaningful clinical difference in spinal fusion. Study 4 concludes that two mobility cups are superior in preventing hip dislocation. These conflicting results highlight the need for individualized implant selection and surgical procedure planning approaches.

Limitations

It is important to note that there are certain caveats to this study. The retrospective methodology is prone to selection bias because the surgeon and patient factors ultimately selected the type of femoral stem used. There may be confounding circumstances that we can't account for despite our best attempts to pair patients. Our findings may also be limited by the small sample size and the fact that they were collected from patients at a single institution. In addition, because only 5 years of follow-up were allowed, it is possible that not all potential outcomes were accounted for. Last but not least, although sensitivity analysis was performed to account for comorbidities impacting bone metabolism, other unmeasured patient characteristics may still contribute to observed discrepancies.

Conclusion

We conclude that proximally coated femoral stems in uncemented THR provide superior short-term clinical results, as evidenced by lower postoperative discomfort and higher functional scores.

Particularly, there were no statistically significant differences in long-term radiographic results or implant survival rates, demonstrating that both stem types are equally effective in maintaining the durability and stability of THR. These results highlight the need for speedy postoperative recovery while selecting implants for each patient's unique demands.

Future Research

Future studies could improve this by using a larger sample size and including more institutions. A more complete picture of the longevity and performance of the two femoral stem designs can be gleaned via longer-term follow-up spanning 10 years or more. Further understanding could be gained by studying how surgical strategy and surgeon experience affect results. Adding patient-reported outcomes like quality of life and satisfaction would make for a more complete evaluation.

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