Evaluation of Implantation of Primary Cementless Total Hip Arthroplasty Using Anatomical Femoral Stem in Elderly Arthritic Patients

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Abstract
Introduction: Osteoarthritis is the most widespread chronic joint disease in the world, and total hip arthroplasty is one of the most successful surgical procedures. The success of this operation is its ability to relieve pain while preserving both the mobility and stability of the joint. The implant shapes determine cortical contact and stability, so the purpose of this study was to evaluate the results of cementless anatomical femoral stem in total hip arthroplasty in elder patients suffering from osteoarthritis.
Materials and methods: a prospective study of 43 cases in Beni-Suef university hospital and in Al-Helal hospital in Cairo who underwent hip arthroplasty using an atomical femoral stem (EXCEPTION from ZIMMER BIOMET). There were 43 patients including 22 females (51.2%) and 21 males (48.2%). Patients' ages ranged from 65 years to 74 years with a mean age of 67.8 ± 2.8 years and 14 months mean time follow- up. **Results:** There were 92.99% of the patients who reported excellent or good satisfaction at the most recent follow-up. At the last evaluation, The Harris Hip Score significantly increased (P-value< 0.01). From preoperative evaluation: increasing from 35(±7) to 91(±6) points. Radiographically using Gruens criteria, all protheses are stable, firmly fixed, showing good osteointegration without critical radiolucency (>2mm). **Conclusion:** Cementless anatomical stems are suitable for elderly patients with the following criteria: Active patients, good bone quality, and acceptance of complication and postoperative rehabilitation.
Keywords: Osteoarthritis hip; hip prosthesis; anatomical femoral stem; Exception stem.

INTRODUCTION
Osteoarthritis (OA) is the most widespread chronic joint disease in the world, defined as a common form of arthritis during middle or old age characterized by deterioration of the cartilage in the joints resulting in bones rubbing together and causing stiffness, discomfort, and restricted movement. It is one of the most well-known causes of agony and handicap in old patients and the general reports on the predominance of OA analyzed show a rising number of patients with this disease [1]. Failed conservative therapy is considered as the first choice to achieve total hip replacement (THR), which are effective and cost-effective procedures[1]. THA is one of the best positive surgical procedures frequently performed operations internationally and has been known as the "operation of the century" [2]. Cementless prostheses depend on the biological fixation of bone to the prosthetic's surface. Initial fixation is achieved by inserting a prosthesis marginally bigger than the prepared bone bed, producing compression hoop stresses, and obtaining the so-called "press-fit"[3]. Several femoral stem geometries are currently used and the implant shapes determine cortical contact and stability. [3]. The philosophy of an anatomical stem was introduced into the market in 1980 fully intent on getting the best press-fit in the metaphyseal proximal femur utilizing a plan that follows the regular geometry of the proximal femur[4]. The wide variety of femoral endosteal anatomy is explained by the fact that the femoral cavity does not have a consistent shape. [5]. Anatomical stem prostheses are curved matching the proximal femoral endosteal geometry. They are wider proximally, both laterally and posteriorly. In the lateral plane, they

bow posteriorly in the metaphysis and anteriorly in the diaphysis. These stems have anteversion of the neck and are produced for the right or left femora. Distally, they are cylindrical. Stability is produced by metaphyseal filling and distal curve. [6].

Patients and methods

In the period between January 2020 and March 2022, a prospective study was conducted involving 43 cases in Beni Suef University Hospital and in Al-Helal Hospital in Cairo who underwent primary hip arthroplasty using an atomical femoral stem. There were 43 patients including 22 females (51.2%) and 21 males (48.8%). Patients' age ranged from 65 years to 74 years **(table 1)** with a median age of 67 years with meantime follow-up 14 months.

Table (1): Baseline Demographic Characteristics of included patients (n=43)

	Mean ± SD	Median (IQR)	Minimum	Maximum
Age (Year)	67.8 ± 2.8	67 (5)	63	74
Weight (Kg)	84.6 ± 7.4	86 (9)	70	102
Height (cm)	167.4 ± 5.8	168 (6)	156	177
BMI (Kg/m^2)	30.3 ± 2.9	31.2 (3.5)	24.5	37.1

BMI: Body Mass Index, IQR: Interquartile Range, SD: Standard Deviation

Inclusion criteria: Relatively active patients more than 65 years suffering from osteoarthritic hip. **Exclusion criteria:** Patients with active infection. Or Fresh and non-united fracture acetabulum. Most surgeries (42 patients out of 43 patients) (97.6%) were performed using the modified Harding approach while only one patient was performed using the posterior approach (2.4%)

Methods: Preoperative data were collected at the time of admission from the patient, postoperatively the patients were called for outpatient visits for clinical and radiological evaluation. Consenting was essential to have the maximum cooperation of the patient as well as to decrease the patient's anxiety

Assessment: The patients were assessed clinically by Harris hip core and radiologically by Gruens criteria.

Surgical procedure of all cases in this study were performed through a modified Harding approach. It offers both excellent exposure and good orientation except one case with the posterior approach.

Preparation for implantation and application of THA system (A) Exposure of acetabulum (B) Acetabular preparation (C): Acetabular component implantation

(D): Preparation of the host bones for implantation and application of a cementless stem to achieve the appropriate starting point, all residual soft tissues were removed from the posterior lateral femoral neck by a bone nibbler **(Fig 1**). Box osteotome inserted posterolateral parallel to the posterior femoral cortex **(Fig 2)** followed by introduction of the reamer which is pushed laterally to avoid varus mispositioning of the implant.

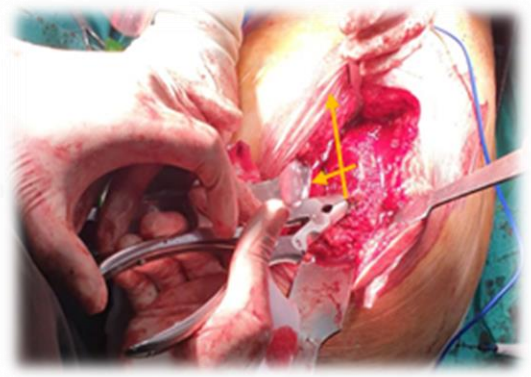

Figure 1: Soft tissues were removed from the posterior lateral femoral neck

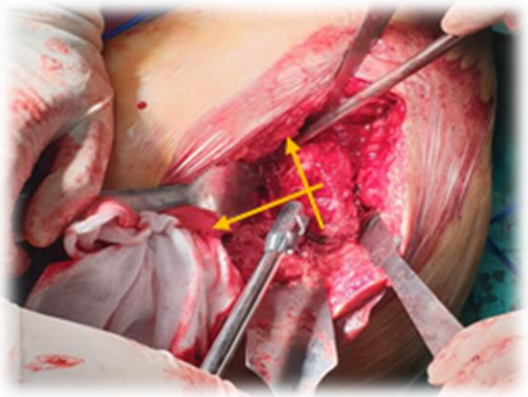

Figure 2*:* The box punch allows preparation of the femoral canal.

(E) Femoral component implantation and reduction.

POSTOPERATIVE STAGE: The leg was held with the operated hip abducted and internally rotated for all patients... This was done through a fiber template which adjusts the limb in internal rotation 15 degrees **(Fig *3*)**

Figure 3: Fiber template adjusts the limp in internal rotation *15* degrees.

Data managed categorical data are presented as numbers and proportions, and comparisons were done using chi-square and the Fisher exact test when appropriate. Continuous variables are presented in terms of mean and standard deviation and compared using an unpaired t-test for normally distributed data. Normality testing was conducted using Shapiro-walk test. For non-normally distributed continuous data, median, minimum,

maximum and interquartile range were used for data presentation while Mann-Whitney U test were used for statics comparison.

Repeated measured categorical data were tested using Friedman's ANOVA test, pair wise post hoc tests were performed using Wilcoxon sign rank test, and P-values are adjusted for multiplicity using Bonferroni correction. Spearman correlation were used to study the association between two categorical variables, the results were expressed in coefficient of correlation (rho), and P-value < 0.05 were considered a statistically significant correlation. All statistical tests were 2 sided, tests with a value of $P < 0.05$ were considered statistically significant. All statistical analyses were done with Statistical Package for Social Sciences (SPSS), version 26.

Ethical considerations: Institutional Review Board (IRB) of the Faculty of Medicine, Beni Suef University approved the study protocol. An informed consent was obtained from all participants of this study and they were told about the aim of the study, and were informed that the data would be used for scientific purposes only. An informed consent was obtained from all participants of this study and they were told about the aim of the study, and were informed that the data would be used for scientific purposes only. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

STATISTICAL ANALYSIS

Data collected throughout history, basic clinical examination, laboratory investigations, and outcome measures coded, entered, and analyzed using Microsoft Excel software. All statistical tests were 2 sided, tests with a value of P < 0.05 were considered statistically significant. All statistical analyses were done with Statistical Package for Social Sciences (SPSS), version 26.

RESULTS

The age of the studied patients ranged from 65 to 74 years old with a median age 67 years old. The average time for follow-up was 14 months, ranging from (6 to 18) months. The right hip was affected in 25 cases and the left in 18 cases which was operated by lateral approach (Harding). Intraoperative complications which included proximal femur cracks in 3 hips (6.9%), Circulage wiring was used for stabilization of these fractures and these fractures, healed completely (Fig 4) and did not affect the stem stability. Postoperative complications were superficial wound infection in 1 hip (2.3%), treated conservatively with parenteral antibiotics and repeated dressing, and deep venous thrombosis in 1 hip (2.3%)

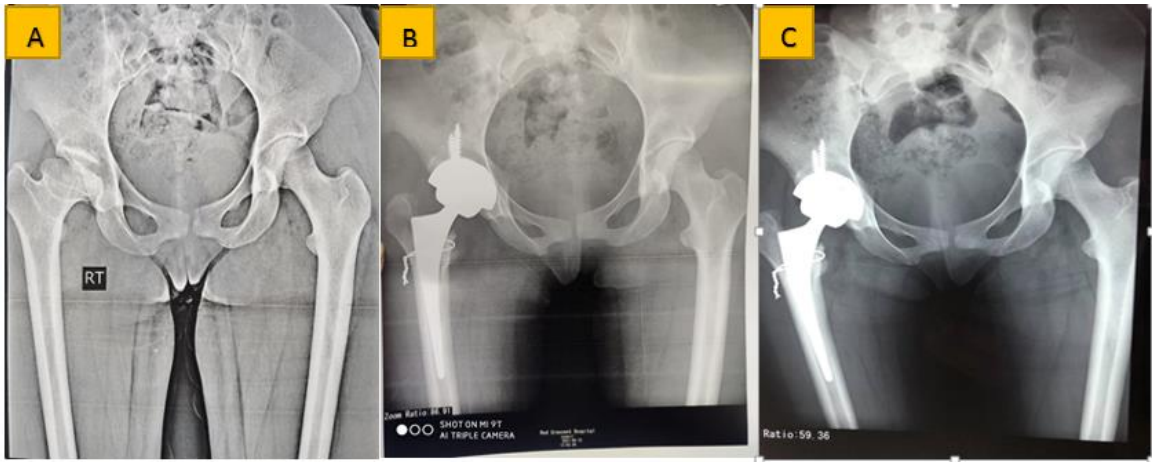

Figure 4: A Plain X ray pelvis AP showing Rt hip osteoarthritis (preoperative) (b) postoperative x-ray AP view showing RT hip arthroplasty with intraoperative calcar cracks managed with cerculage wiring (c)12 months postoperative x-ray last HHS was 93.

At the final evaluation, one case had a history of cerebrovascular stroke managed with an abductor hip brace for 6 weeks post-operatively. (5) Cases were suffered from thigh pain, there were statistically significant in relation to stem size (P <0.01).
(Table 1) showed the analytical results of (pain, limp, support, distance walked, Stairs, Put on shoes & socks, Sit cross legged, Range of motion, Use of public transportation, and Absence of deformity) showed significant improvement in pain (p <0.01) from median(10) points preoperatively to median (40) points postoperatively , significant improvement in limping (p <0.01) from median (5) points preoperatively to median (11) points postoperatively, significant improvement in support(p <0.01) from median (2) points preoperatively to median (11) points postoperatively, significant improvement in distance walked (p <0.01) from median (2) preoperatively to median (11) points postoperatively, significant improvement in Stairs (p <0.01) from median (1) points preoperatively to median (4) points postoperatively, significant improvement in Put on shoes & socks (p <0.01) from median (0) point preoperatively to median (2) points postoperatively , significant improvement in Sitting (p <0.01) from median (3) point preoperatively to median (5) points postoperatively, significant improvement in Range of motion (p <0.01) from median (4) points preoperatively to median (4) points postoperatively, significant improvement in absence of the deformity (P < 0.01) from median (2) point preoperatively to median (4) points postoperatively and significant improvement in Use of public transportation (p <0.01) from median (0) point preoperatively to median (1) points postoperatively . There were statistically improvements in all HHS domains in the studied patients before and after operation.

Table (1): Harris Hip Score Parameters Median & Interquartile Range Comparison

HHS Parameter	Pre-operative Median (IQR) Score	After 6 Weeks Median (IQR) Score	After 12 Weeks Median (IQR) Score	After 6 Month Median (IQR) Score	After 12 Month Median (IQR) Score	After 14 Month Median (IQR) Score	Test Statistic	P-Value
Pain	10 (10)	30 (0)	40 (10)	40 (0)	40 (0)	40 (4)	189.7	< 0.01
Limping	5 (3)	5 (0)	8 (3)	8 (0)	11 (3)	11 (3)	170.6	< 0.01

Support	2 (3)	5 (2)	7 (2)	7 (0)	11 (0)	11 (0)	192.2	< 0.01
Distance walked	2 (3)	2 (3)	5 (3)	8 (0)	8 (3)	11 (3)	191.7	< 0.01
Stairs	1 (1)	0 (0)	2 (2)	2 (0)	4 (2)	4 (2)	168.8	< 0.01
Shoes	0 (2)	0 (0)	2 (2)	2 (0)	2 (0)	2 (2)	137.0	< 0.01
Sitting	3 (0)	3 (0)	3 (0)	5 (2)	5 (0)	5 (0)	166.5	< 0.01
No deformity	4 (4)	4 (0)	4 (0)	4 (0)	4 (0)	4 (0)	100.0	< 0.01
Range	2 (1)	3 (0)	4 (1)	4 (0)	4 (1)	4 (1)	169.7	< 0.01
Public Transport	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)	1 (1)	124.1	< 0.01
HHS: Harris Hip Score, IQR: Interquartile Range								

The analytical results of the total points of the Harris hip score and showed significant improvement in total hip score points (P < 0.01) from average, median 35(7) points (23-47) preoperatively to average median 91(6) points (66- 97) postoperatively **(table 2) (Fig 5)**
At the last follow-up, 72.09% of patients (31 procedures) reported an excellent score (>90 points), 9 hips (20.9%) reported a good score (80-89) while the remaining 6.95% which are fair and poor scores (range 66-90 points, 3 procedures) is represented by patients with concomitant articular or other problems that can affect clinical evaluation and results.

Table (2): Harris Hip Scores Descriptive Statistics of Included patients (n=43)

	Median (IQR)	**Minimum Score**	**Maximum Score**
Preoperative HHS	35 (7)	23	47
After 6 weeks	52 (3)	34	69
After 12 weeks	71 (9)	48	78
After 6 Month	81 (3)	64	88
After 12 Month	90 (5)	66	96
After 14 Month	91 (6)	66	97

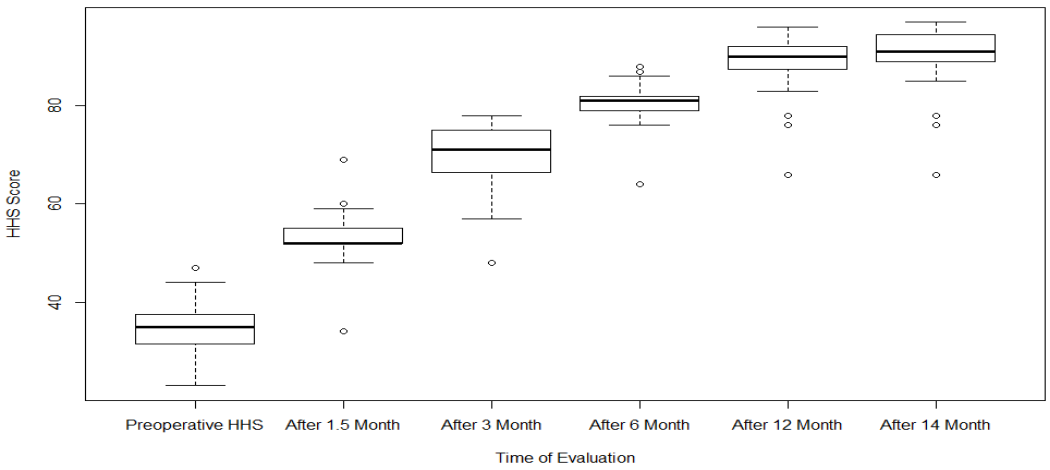

Figure 5: HHS score evaluation using BOX plot.

DISCUSSION

Total hip arthroplasty in old patients have to relieve pain, improve function, that lasts for the rest of the patient's life. Considerations regarding hip implant selection.in the elderly include bone quality, morphologic features of bone, implant fixation, design of the joint articulation, and implant cost.[8]

In the current study, we evaluated the results of an anatomical stem (Exception Zimmer-Biomet) designed based on the anatomy of the proximal medullary canal of normal femora We found excellent clinical results with an overall study time rate at 14 months after THA. Good fixation has been achieved with the Exception stem at the proximal part of the femur, and excellent results were confirmed.

A few kinds of anatomical stems have been created and are utilized around the world. Nonetheless, data in regard to the clinical aftereffects of these stems stay restricted, specifically, very little is realized about the anatomical stems intended for old patients with osteoarthritis. [9]

In the current study, we depend mainly on clinical assessment (Harris hip score) due to the short period duration of follow-up and the radiological assessment needs a long period duration of follow-up to detect changes in the vertical or horizontal center of rotation, in the inclination angle of the acetabular component, or the appearance of significant lucencies.

From the results obtained, it was demonstrated that there is marked improvement in relieving pain, decreasing the severity of limping, increasing the duration of walk, increasing the ability to walking without crutches, increasing the ability in using public transportation, using stairs and putting shoes alone and finally increasing the range of motion of the hip joint, and there is highly significant improvement in the total points of the Harris hip score($P<0.001$) from average 35 points preoperatively to average 91 points postoperatively. Few studies have presented clinical and radiographic outcomes of anatomical femoral stem prostheses with mid- to long-term follow-up. Favorable clinical and radiological results have been suggested in studies of HA-coated hip prostheses.

Bourne et al.[10], in a study of 101 total hip replacements with the PCA (porous-coated anatomic) prosthesis (Howmedica, Rutherford, New Jersey), reported an average Harris hip score of 96 points, but only patients who were free of pain were evaluated; when patients who had pain were included, the overall average score was 90 points. Heekin et al [11] reported an average score of 93 points after a minimum of five years of follow-up of ninety-one hips that had been treated with the PCA prosthesis.Kokubo et al [12] revealed that the HHS improved significantly at the last follow-up (93)points. At follow-up, 48 (61%) hips were assessed as excellent, 22 (28%) as good, five (6%) as fair, and four as (5%) poor.

The results of this study reported that all patients were routinely being subjected to full weight bearing within the first surgery except in cases with calcar crakes. Intraoperative calcar cracks occurred in three patients (6.9%) out of 43 cases with no statistically insignificant in relation to stem size. These cases were managed in the same surgery using cerclage wiring and the patients were restricted to non-weight-bearing activity postoperatively. It was noticed that this complication had occurred during the insertion of the original stem. Butler et al[13] enumerated intra Operative-calcar cracks in 3% (4 of 117) of hips and were managed with cerclage wiring and restricted to limited weight-bearing activity postoperatively. A. Kaneuji et al [14]In the entire cohort of 135 hips (106 patients), 5 (3.7%) experienced a nondisplaced metaphyseal fracture during implantation of the femoral component. All 5 femoral components subsequently showed stable ingrowth with the cerclage wire. Ozden et al [15] reported 2 (3%) intraoperative periprosthetic metaphyseal fractures occurred and managed with 2 cerclage wires to the secure primary stability of the

stem. Uemura et al [16]described that there were no fracture, which has been reported as a complication associated with anatomical stems.
A problem of THA in aged patients is the possibility of a decrease in initial fixation due to bone fragility caused by bone quality deterioration. Aged patients often have comorbidities and a high risk of developing postoperative complications. Therefore, perioperative management is important.
The expectation to learn and adapt in deciding the limit of various proximal femurs to endure the way of burden utilization of this stem is displayed in the development of higher use. Moreover, we found that when properly embedded, the anatomical designed stem permits patients to continue full weight bearing on the day after the medical procedure

CONCLUSION

Cementless anatomical stems are suitable for elderly patients and we suggest their use for patients who have the following criteria: Active patients, good bone quality, and acceptance of complications and post operative rehabilitation. We recommend that many technical issues must be strongly considered during the application of the stem: The entry point of the greater trochanter should be accurate posterolateral as well as graded meticulous rasping of the femur, which expose the area of the lesser trochanter, and its proximal extension., if minor cracks begin to develop at the level of the lesser trochanter stop rasping. Application of the same size as the last rasp to avoid calcar fractures during stem insertion, which managed by tight circulatory wiring (if they occur). Prophylactic usage of the abductor hip brace in patients with ligamentous laxity or instability. If there are no intraoperative or postoperative complications, full weight bearing is permitted in the first week; however, walking aids must be used for six weeks until soft tissue healing occurs. Physiotherapy must be started as soon as possible to prevent abductor weakness and Trendelenburg gait. Meticulous clinical and radiological evaluations are performed every 6 weeks, 3 months, and annually. Finally, elderly individuals undergoing THA must be active and have good bone quality. Acceptance of complications and recovery from surgery.

Study Limitations:

Short time follow- up period.

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