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Comparative Study of the Short Term Results of Short Stem Cementless Total Hip Arthroplasty and Standard Stem Cementless Arthroplasty

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ABSTRACT

This study evaluates the short-term outcomes of short stem cementless total hip arthroplasty (THA) compared to standard stem THA in patients with arthritic hips. Conducted on 40 patients, the prospective analysis included 20 patients receiving a short AIDA stem and 20 with a standard stem, all undergoing minimally invasive surgery with ceramic-on-ceramic implants. Postoperative assessments utilized the Harris Hip Score (HHS) for clinical evaluation and radiological measures to analyze stem position, migration, subsidence, and osseointegration. Results indicated high satisfaction, with mean HHS scores of 96.2 for the short stem and 96.1 for the standard stem, and no occurrences of stem subsidence or positional changes during follow-up. The findings suggest that both implant types yield excellent early results, with the short stem demonstrating advantages in reducing thigh pain and preserving bone stock, highlighting its potential benefits in hip arthroplasty.

Key words: Arthroplasty, STEM, AIDA, THA, HHS.

INTRODUCTION

Short stem is bone conserving prosthesis violating less bone stock requires a resection level closely under the femoral head. By doing this, the femoral neck ring is preserved, which is needed for a firm anchorage of the implant. If those prerequisites are met, good primary stability of the SHA implant can be achieved providing more favorable conditions should revision be required. The absence of diaphyseal anchorage attempts proximal load transfer to reduce stress shielding and thigh pain

A total hip replacement is one of the most reliably successful procedures in orthopedics.(1,2). While symptomatic hip arthritis typically affects older patients, there is a growing subset of active patients in who are affected and were previously thought of as, “too young for a hip replacement.” Over the last several decades, advances in hip replacement surgery are allowing us to rethink that position.(3). As bone remains the most important substance for long-term implant fixation, bone preservation on both the femoral and the acetabular side remains the main criterion for selection of implant designs and surgical procedures. Surface replacement and shorter hip stems have been introduced as bone preserving implant concepts in several European countries.

Limitations of hip resurfacing include advanced age and postmenopausal status with osteoporosis, impaired renal function, and known metal hypersensitivity, deficiency of the femoral head or neck bone stock, severe hip dysplasia. Extensive collapse from avascular necrosis and related conditions precludes hip resurfacing, making THA a more reasonable option.(4)Short stem is bone conserving prosthesis violating less bone stock requires a resection level closely under the femoral head. If these prerequisites are met, good primary stability of the SHA implant can be achieved providing more favorable conditions should revision be required. The absence of diaphyseal anchorage attempts proximal load transfer to reduce stress shielding and thigh pain.(5)

Achieving good primary stability is critical for the success of any orthopedic implant. In the case of the short stem SHA (Short Hip Arthroplasty) implant, the design facilitates this stability by ensuring that the implant is well-seated within the preserved bone structure.

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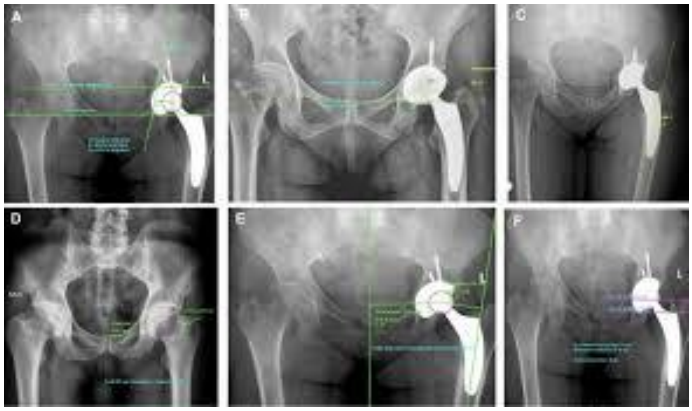

Figure-1. Reference lines used for acetabular migration measurement (https://doi.org/10.1038/s41598-024-68696-x)

PATENTS AND METHODS

This prospective study is conducted over 40 patients with arthritic hips. All the patients had undergone cementless ceramic on ceramic total hip arthroplasty. 20 patients of them were managed using standard stem and the other 20 patients had short AIDA stem. All the operations were done through the minimally invasive posterior approach. The follow up of the patients ranged from 12 months to 24 months with a mean of 13 months. 23 patients were males and 17 seventeen were females. The mean age was 38.25 years. The most common indication was 1ry osteoarthritis. Other indications included 2 ry osteoarthritis and avascular necrosis. Patients were examined both clinically and radiologically. Harris hip score was used for clinical evaluation.It contains four main issues: Pain, mobility, daily activities,range of motion.

Standard Anteroposterior and lateral radiograph of the operated hip were examined for the following criteria:

1. Acetabular component: position, radiolucency (Delee and Charnley)[6] and migration.
2. Shortstem:Position,migration,subsidence,radiolucency (Gruen zones)[7],osseointegration,heterotopic ossification and endostealcavitations.

Approach: MIS posterior Approach. Data were analyzed statistically by the mean, standard deviation, and Spearman's rank correlation coefficient.

.RESULTS

The postoperative Harris Hip score for both groups at the last follow up ranged from 88 to 100, with a mean of 96.2 for the short stem group and 96.1 for the standard stem group. The number of patients with satisfactory results was 40 (100%).

At the end of follow up 15 patients of the group managed by standard stem had no pain, 2 had slight pain and 3 had mild pain. 16 patients of the group managed by short stem had no pain, 2 had slight pain and 2 had mild pain2 patients of the standard stem group had slight limping and one of the short stem group had also slight limping.No patients need support to walk at the end of the follow-up.17 of the standard stem group can walk an unlimited distance, while 3 can walk only 1 km. 18 of the standard stem group can walk an unlimited distance, while 2 can walk only 1 km. 16 patients of the standard stem group could climb stairs normally. 4 used railing and no one was unable to climb stairs. 17 of the short stem group could climb stairs normally, 3 used the railing, and no one was unable to climb stairs. All the patients attained a range of motion score of 5. (Total range of motion ranged from 211 up to 300). No patients presented with any deformity. No patients had Trendelenberg gait and Trendelenburg test was negative**.**

The acetabular inclination was determined in relation to the inter-teardrop line. Acetabular inclination in all patients ranged from 36º-55º with a mean of 45.68º.here were no cases of cup dislodgement occurred, at last, follow up. There were no cases of stem migration and subsidence. There were no cases of heterotopic ossification reported in this study. At the end of the follow-up; there were no cases with lucent lines. No patients had periprosthetic fractures. We didn't encounter any dislocation, infection, DVT, neurovascular injuries or heterotopic ossification.

The early results of THR showed that all the results were satisfactory and the mean HHS was 96.2 for short stem group and 96.1 for the standard stem group. There was no significant difference between patients regarding their period of follow up.

DISCUSSION

For patients older than 65 years with severe arthritis of the hip, several implant designs for total hip arthroplasty have shown excellent long term results in terms of both function and value for money.[8]However, in younger and more active patients, these traditional implants have a high failure rate. Modern implant designs for total arthroplasty could improve on these results, but the search for new and more durable forms of arthroplasty continues.[9]Short stems with fixation limited to the proximal metaphysis have been introduced to improve loading transfer in the operated femur to reduce the incidence of thigh pain and preserve femoral bone stock for revision procedures.[10]However, a major concern in reducing diaphyseal fixation of the femoral stem is the concomitant reduction of implant stability and the increase of the interface micromotion which by encumbering osseointegration increases the risk of implant loosening and thigh pain.[11]Distally fixed stems, or stems that contact the diaphyseal cortex as part of three-point fixation, offload distally with proximal stress protection osteopenia.[11]In THA, this stress-shielding, with subsequent bone resorption, is a different entity than the wear-induced bone resorption known as osteolysis The loss of bone induced by stress-shielding is typically seen on radiographs as cortical thinning or a more diffuse

decrease in periprosthetic bone density. Osteolysis, on the other hand, appears as localized lesions with well-defined borders [12].

Analysis of the results

1) Incidence:

Age distribution: The mean age in the present study was 38.25 years old with a mean HHS:96.2. The mean age in other published series using cementless short stem was higher reaching up to 68 years as published by Cinotti[13](2013) with mean HHS:88 , 75 years old as published by Ronak et al[14] (2012) with mean HHS:88 and 45 years old with mean HHS:93.5 as published by Zeh[15](2011). It was noticed that the HHS decrease with studies above 60 years which may be explained by the decrease of bone quality with age, the associated comorbidities which may affect the results, and muscle strength which decreases by age.

Sex distribution: In the current study, 23 patients are males (57.5%) and 17 only are females (42.5%). The HHS in males was slightly better than in females. The mean of the final score in males was 96.63 while the mean result in females was 93.6. This is similar to Schmidutz[16](2012) study done on Sports Activity of patients after short-stem hip Arthroplasty in which males HHS was 95 while females were 92 despite an equal postoperative activity level. This is may be due to the difference in musculature between males and females. However, in many studies there is no major difference between male and female outcomes regarding their Harris hip score and hip function.

2) Etiology:

Avascular necrosis was the most common cause in our study(40%)..1ry osteoarthritis is the most common cause similar to many studies such as Dorr et al[17] (Forty-nine hips out of 56 had primary osteoarthritis), and Ronak et al.[14]

3) Pain:

Thigh pain is a common complaint following traditional non-cemented hip arthroplasty.

Three (15%) of the patients managed by standard stem had pain in the front of the thigh and two had associated lumbar disc pain radiating to the thigh. 2 patients managed by short stem had pain with hip flexion which may be due to iliopsoas tendon irritation and 2 patients have associated back pain.

This was less good than Toth[18](2010) study among the Proxima hip cases, Hube et al[19] who did not find any thigh pain following THA with the Mayo® stem.

While better than Cinotti[13](2012)study which reported 5 patients(8%)at 2 year follow up having thigh pain 3 of them were due to lumbar stenosis at L3-4.

It is well known in the literature that incidence of thigh pain is less in hip resurfacing than conventional hip arthroplasty[20]. And that the presence of a femoral stem inevitably causes some degree of thigh pain, which is more common with larger stems.[21]

We can explain the lower incidence of thigh pain with the short stem that it doesn't violate the femoral canal. Its load in the femur is more proximal and more biological which eliminates the incidence of thigh pain, also it may be due to the axial and torsional stability in the proximal femur and absence of contact between the distal stem and the femoral cortex.

By clinical examination:

a) Harris hip score:
The preoperative Harris Hip score for all patients ranged from 29 to 71, with a mean of 54.2.The postoperative Harris Hip score for both groups at the last follow up ranged from 88 to 100, with a mean of 96.2 for the short stem group and 96.1 for the standard stem group. This was better than: Study done by Zeh et al [15](2011) done on 21 patients treated by Mayo stem with mean HHS :93.5and Study done by Simank HG[22] (2010)done on 120 cases treated by Metha stem with mean follow up 2 years with mean HHS:93.4 While it was less good than Study done by Ettinger et al[23] (2011)on 65 patients treated by NANOS stems with mean follow up 5 years and mean HHS :97.5and study done by Wittenberg RH[24] (2013)on 250 short metha stems with mean follow up of 5 years and mean HHS was: 97 while similar to Gagala et al[25](2009) study done on 35 patients treated by Mayo stem with mean follow up 2 years and mean HHS was 96.

b) radiologically:

1. Stem position:
Among 40 hips 36 hips(90%) were in neutral position, one standard stem (5%) was in slight valgus position and 3 short stems (15%) were in slight valgus position..During the follow-up period, no signs of either clinical or radiological loosening were detected and no cases did revision till the end of the study. In Cinotti et al[13] study stem alignment was neutral in 40 hips (56%), varus in 27 (37%) and valgus in 5 (7%).19 of varus-valgus misalignment were found immediately postoperative and 13 were changed into varus and valgus within months.However, it didn't change in 6 months postoperative follow-up. Severe varus valgus misalignment was found in 6 patients with mean HHS of 86 while the 40 patients with neutral stem their mean HHS was 88.

In Banerjee et al[26] study which was done on many types of short stems 20.6% of cases has varus valgus misalignment .however, no clinical relevance was noted related to the malalignment. Among 48 hips in a study done by Toth[18] on Proxima stems nine stems were implanted in varus. Its explanation was as no intramedullary guidance is available for the Proxima™ stem due to its metaphyseal location, a varus position is more likely to occur, especially when a minimally invasive

approach is used, as visualization of the femoral axis is difficult. It is imperative to perform intraoperative axis measurements during sequential broaching.

It is known that excessive varus alignment of the femoral stem in total hip replacement (THR) creates a sub-optimal biomechanical environment which is associated with increased rates of revision surgery and component wear. Little is known regarding the effect of femoral stem alignment on patient functional outcome as published by Holleyman[27] (2012) who made a retrospective study on 90 hip replacement with various stems positions and found that alignment of the femoral stem on sagittal and coronal planes has a direct effect on survivorship of the prosthesis, but does not demonstrate any relationship between femoral stem alignment and functional outcome in patients undergoing primary THR.

2. Stem subsidence:

These values were obtained from anteroposterior radiographs taken at 1 week after surgery and were compared with those obtained from the anteroposterior radiographs taken at the final follow up to define the amount of subsidence.No patients had subsidence of the stem greater than 4 mm.This was similar to a study published by Kim et al[28](2012) on 144 hips, and to Cinotti[13] study published 2012 on 72 hips. However, stem subsidence greater than 5mm was found in studies published by Kim YH, Mouttet A and Bidar R.[13]. These authors believe that few cases of the short stem may need initial settling in the host bone to gain mechanical stability and subsequent metaphyseal osteointegration of the implant.

3. Radiolucency:

In the current study, all stems were radiographically stable with no reactive lines of greater than 2 mm or loosening identified. These results are similar to studies published by Toth[18] . While in Hagel [19]study(2008) on 270 hips treated by short Mayo stem only 5 cases have aseptic loosening in a follow-up period of 10 years. However, until now, early loosening and wear were considered as major concerns in total hip arthroplasty. With the development of special fixation techniques in combination with specific implant materials and coatings as well as optimization of various bearings, these problems have almost been resolved.

Complications

No patients had dislocations, infection, thromboembolic complications or Heterotopic ossification, no cases had periprosthetic fractures and no revision was done to any stem with a mean follow up period of 28 months.

This is less than Toth[18]who published that among the 50 Proxima™ stem implantations, the only intraoperative complication was a spiral femoral shaft fracture. The stem sank deeper into the femoral shaft than the identically sized broach, causing an infraction, which resulted in a complete spiral shaft fracture during the repositioning maneuver. Also less than Cinotti[13] study which includes three incomplete fractures at the calcar level and two others at the anterior femoral neck cortex.

The Mayo and lateral flare designs have a higher incidence of periprosthetic fractures compared with shortened proximally coated stems. This could be related to the relative ease of insertion of the shortened proximally coated stems compared with the other designs. Another reason for the higher intraoperative fracture incidence, particularly for the Mayo stem, may be the use of the proximal lateral femoral cortex as a guide during insertion. This critical step requires careful broaching to avoid cortical penetration of the lateral femoral cortex, especially when poor bone quality is encountered. This may explain the higher reported incidence of periprosthetic fractures with the Mayo stem in some series.[29]Periprosthetic fracture is a similar complication to Wittenberg RH[24](2013) study done on metha short stem. A stem which has a similar design to AIDA stem 2 hips only among 250 hips had femoral periprosthetic fractures intraoperatively. The surgical technique for insertion of some of these short stems appears to be challenging due to the system of curved awls and rasps in contrast to the straight instruments used for insertion of conventional stems. However, the curved instruments are beneficial for preparing the femoral canal in a minimally invasive fashion.

CONCLUSION

The current study showed excellent early results of ceramic on ceramic total hip arthroplasty using both standard stem or short AIDA stem. Decreased thigh pain and preservation of bone stock are the main advantages of short stem over the standard stem. AIDA stem is a good option for young adults and can be revised later with standard stem when needed but the standard stem, when loose, will be revised by a long stem which means more bone destruction.

Conflicts of Interest

Authors declare that there is no conflict of interests regarding the publication of this paper.

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