Original Article
MVP Journal of Medical Sciences, *Vol 7(1), 104-112, January-June 2020*
ISSN (Print) : 2348–263X
ISSN (Online) : 2348-2648
DOI: 10.18311/mvpjms/2020/v7i1/16548

Study of Survivorship and Functional Outcome of Total Hip Arthroplasty in Avascular Necrosis of Femur Head

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Abstract

Osteonecrosis of the femoral head is not a specific diagnostic entity, but rather the final common pathway of a series of derangements that produce a decrease in blood flow, leading to cellular death within the femoral head. It can present with a number of clinical manifestations. The most common complaint is a deep, intermittent, throbbing pain in the groin region which has an insidious onset. In the early stages, prophylactic measures are used to prevent further progression of the disease. When the patient is diagnosed in later stages, the collapse and distortion of the femoral head can be seen, for which a reconstructive procedure is the treatment of choice. The goals of total hip arthroplasty are to relieve pain, to provide motion with stability and to correct deformity so that they are able to return to their normal daily activities. Total hip arthroplasty can be the first treatment of choice. especially in the advanced stages of hip osteonecrosis, or can be reserved as a salvaging procedure when other more conservative treatments fail. Total Hip Arthroplasty is a good modality of treatment for patients with very poor pre-surgical functional scores combined with an excellent long term survival of the cement-less implants.

Keywords: Harris Hip Score, Osteonecrosis, Survival Analysis, Total Hip Arthroplasty

1. Introduction

Osteonecrosis of the femoral head is not a specific diagnostic entity, but rather the final common pathway of a series of derangements that produce a decrease in blood flow, leading to cellular death within the femoral head.[1] Osteonecrosis of the head of the femur is a devastating hip pathology, not so much for its consequences on the hip joint, but mainly because the disease typically occurs in young patients with severe underlying diseases.[2]

A-Vascular Necrosis (AVN) of the femoral head mainly affects patients in the third to fifth decades of life. The mean age at presentation is 38 years.[1] In most of the cases, the diagnosis is made at advanced stages of the disorder, and hence treating it with conservative methods becomes difficult.[3] Clinically, Osteonecrosis of the femoral head can present with a number of clinical manifestations. The most common complaint is a deep, intermittent, throbbing pain in the groin region which is insidious in onset.[4]

No single method has been demonstrated that can prevent the progression of avascular necrosis of head of femur. The natural history of this devastating disease is one

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of sclerosis and subchondral fractures leading to collapse and the development of a painful disabling arthrosis. Multiple treatment modalities are currently available for treating avascular necrosis of the head of femur. The treatment depends upon the stage of the disease. In the early stages, prophylactic measures are used to prevent further progression of the disease. When the patient is diagnosed in later stages, as seen by the collapse and distortion of the femoral head, a reconstructive procedure is the treatment of choice.[4]

The goals of total hip arthroplasty are to relieve the pain, to provide motion with stability and to correct deformity so that they can return to their normal daily activities[5]. Although a plethora of treatment modalities have been proposed for hip avascular necrosis in this challenging patient population, none has yet presented with a repeatable and sustainable results.[2]

In advanced stages of the diseased joint, methods of preservation are not feasible. However, the risk of aseptic loosening of total hip replacement has been reported to be substantially higher in patients with avascular necrosis of femur head.[6]

Total hip arthroplasty can be the first choice of treatment, especially in the advanced stages of hip osteonecrosis, or can be reserved as a salvaging procedure when other more conservative treatments have failed.[7]

The aim of the present study was to assess the functional outcomes of total hip Arthroplasty and implant survival in the study population.

2. Aims and Objectives

1. To study the survivorship of the un-cemented total hip replacements in patients with avascular necrosis of femoral head, and
2. To study the functional outcome of un-cemented total hip replacements in patients with avascular necrosis of femoral head.

3. Materials and Methodology

This is a retrospective-prospective study conducted by the Department of Orthopedics of a tertiary healthcare Centre with an attached medical college. A total of 25 patients in the age group of 30 - 75 years were randomly identified who suffered from Grade 3 or Grade 4 avascular necrosis of femur head based on the grading by Ficat and Artlet. All patients were operated upon, one year ago for hip arthroplasty by the same team of surgeons. Patients having paraparesis or local or systemic infection or those not willing were excluded from the study. The patients were contacted and after their written informed consent they were enrolled in the study. Preoperative and other relevant details were taken and evaluation was done at the beginning of the study (12 months post operatively), followed by at 18 months and 24 months respectively. Functional scoring was done by Harris Hip Score and survivorship by Kaplan Meier method.

3.1 All Patients were Assessed for

1. Demographic details,
2. Harris hip score[8], and
3. Survivorship analysis with Kaplan Meier method[9],

I. Ficat And Arlet Classification[5]

Grade I

a. Normal Radiograph, and
b. Diagnosis following MRI, Bone scan or histology.

Grade II

a. Radiographic changes of repair (osteoporosis/sclerosis/cysts),
b. No osteochondral fracture, and
c. Head Spherical.

Grade III

a. Wedge shaped density increased,
b. Mottled osteoporosis,
c. Subchondral lucent line, Crescent sign,
d. Head no longer spherical "our of round", and
e. Usually affects antero-lateral area of femoral head.

Grade IV

a. Marked Changes with secondary degenerative changes in the joint, and
b. Collapse of subchondral bone and severe deformity of head.

II. Harris Hip Score (Figure 1)

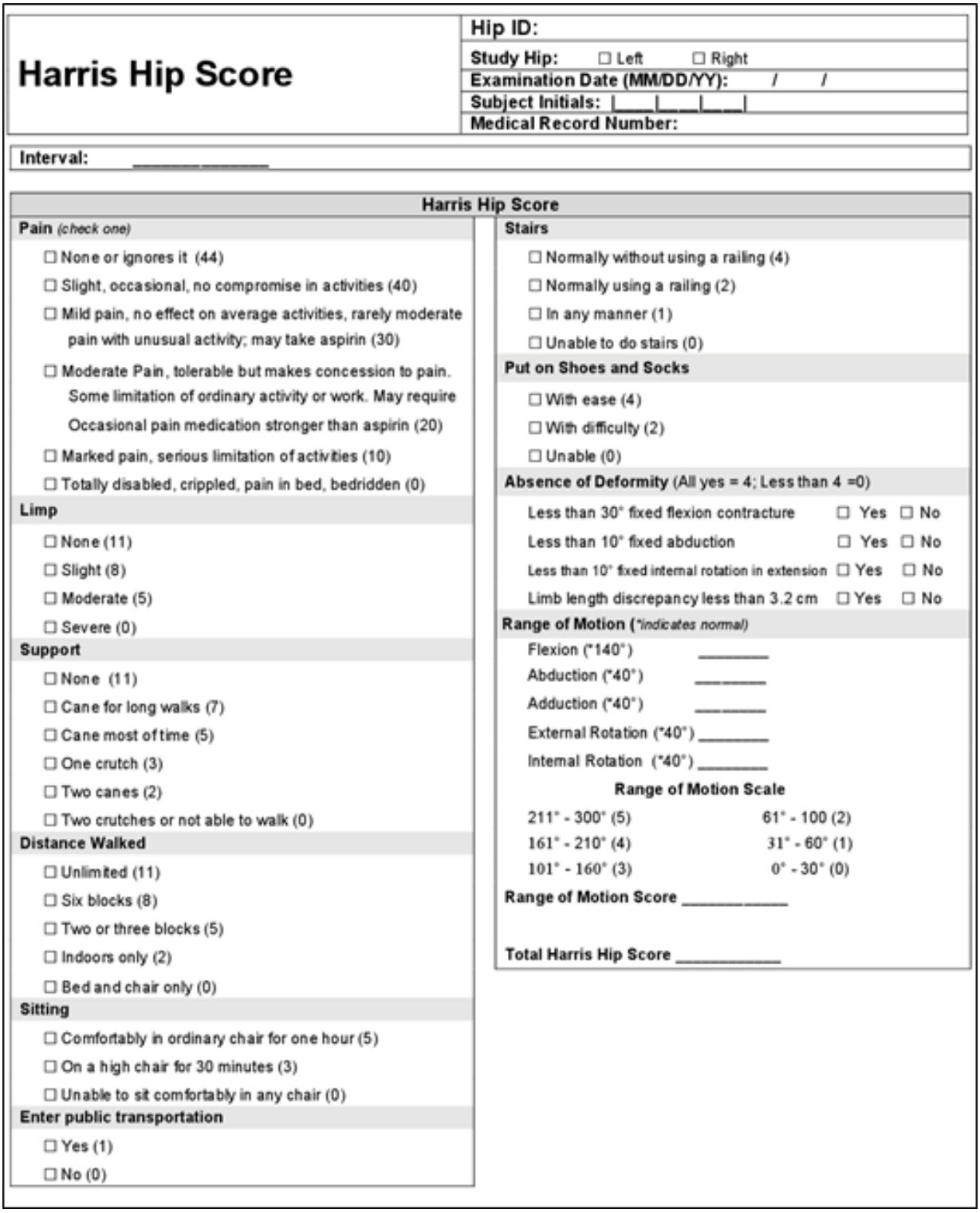
1. Kaplan Meier analysis

Let $S(t)$ be the probability that a member from a given population will have a lifetime exceeding time, t. For a sample of size N from this population, let the observed times until death of the N sample members be:

$t_1 \leq t_2 \leq t_3 \leq \ldots\ldots \leq t_N$

Corresponding to each t_i is n_i, the number "at risk" just prior to time t_i, and d_i, the number of deaths at time t_i.

The Kaplan–Meier estimator is the nonparametric maximum likelihood estimate of $S(t)$, where the



Harris Hip Score

Hip ID:
Study Hip: ☐ Left ☐ Right
Examination Date (MM/DD/YY): / /
Subject Initials: |___|___|___|
Medical Record Number:

Interval: _____

Harris Hip Score

Pain *(check one)*
- ☐ None or ignores it (44)
- ☐ Slight, occasional, no compromise in activities (40)
- ☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
- ☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
- ☐ Marked pain, serious limitation of activities (10)
- ☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp
- ☐ None (11)
- ☐ Slight (8)
- ☐ Moderate (5)
- ☐ Severe (0)

Support
- ☐ None (11)
- ☐ Cane for long walks (7)
- ☐ Cane most of time (5)
- ☐ One crutch (3)
- ☐ Two canes (2)
- ☐ Two crutches or not able to walk (0)

Distance Walked
- ☐ Unlimited (11)
- ☐ Six blocks (8)
- ☐ Two or three blocks (5)
- ☐ Indoors only (2)
- ☐ Bed and chair only (0)

Sitting
- ☐ Comfortably in ordinary chair for one hour (5)
- ☐ On a high chair for 30 minutes (3)
- ☐ Unable to sit comfortably in any chair (0)

Enter public transportation
- ☐ Yes (1)
- ☐ No (0)

Stairs
- ☐ Normally without using a railing (4)
- ☐ Normally using a railing (2)
- ☐ In any manner (1)
- ☐ Unable to do stairs (0)

Put on Shoes and Socks
- ☐ With ease (4)
- ☐ With difficulty (2)
- ☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)
- Less than 30° fixed flexion contracture ☐ Yes ☐ No
- Less than 10° fixed abduction ☐ Yes ☐ No
- Less than 10° fixed internal rotation in extension ☐ Yes ☐ No
- Limb length discrepancy less than 3.2 cm ☐ Yes ☐ No

Range of Motion (**indicates normal*)
- Flexion (*140°) _____
- Abduction (*40°) _____
- Adduction (*40°) _____
- External Rotation (*40°) _____
- Internal Rotation (*40°) _____

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score _____

Total Harris Hip Score _____

Figure 1. Harris hip score.

maximum is taken over the set of all piecewise constant survival curves with breakpoints at the event times t_i. It is a product of the form:

$$\hat{S}(t) = \prod_{t_i<t} \frac{n_i - d_i}{n_i}.$$

2. Statistical Analysis

Statistical Analysis was done using the SPSS Software Package for Windows Version 19.0

3.2 Results

Our study sample consisted of 25 patients selected randomly, who were diagnosed with avascular necrosis of the head of femur and operated one year prior to the beginning of the study.

a. Demographic factors of the study population

Table 1 shows the demographic details of the study population.

The study group consisted of 25 patients between the age group of 30 to 75 years with a mean age of 66.3 years. There were 15 (60%) males and 10(40%) females who participated in this study.

b. Preoperative assessment of study population

Table 2 shows the preoperative assessment of the study population.

Patients with Grade 3 and Grade 4 on Ficat and Arlet staging were included in the study. Out of the 25 patients, 14(56%) had grade 3 and 11(44%) had grade 4 of the Ficat-Arlet staging for avascular necrosis of the head of femur.

Functional scores of the patients were assessed preoperatively by Harris hip score. Out of the 25 patients,

Table 1. Demographic details of the study population

Variables		Number of pts.	Percentage
Age	<60 yrs	2	8
	61 to 70 yrs	16	64
	>70 yrs	7	28
Sex	Males	15	60
	Females	10	40

Table 2. Preoperative assessment of the study population

Variables		Number of patients	Percentage
Ficat Arlet stage	Grade 3	14	56
	Grade 4	11	44
Harris Hip score	<70	24	96
	71 to 79	1	4

Table 3. Serial assessment of functional outcome with Harris Hip Score

Grading of Harris hip score	Time of postsurgical assessment		
	12 months	18 months	24 months
Fair	1(4%)	2(8%)	2(8%)
Good	13(52%)	12(48%)	9(36%)
Excellent	11(44%)	11(44%)	14(56%)
Total	**25(100%)**	**25(100%)**	**25(100%)**

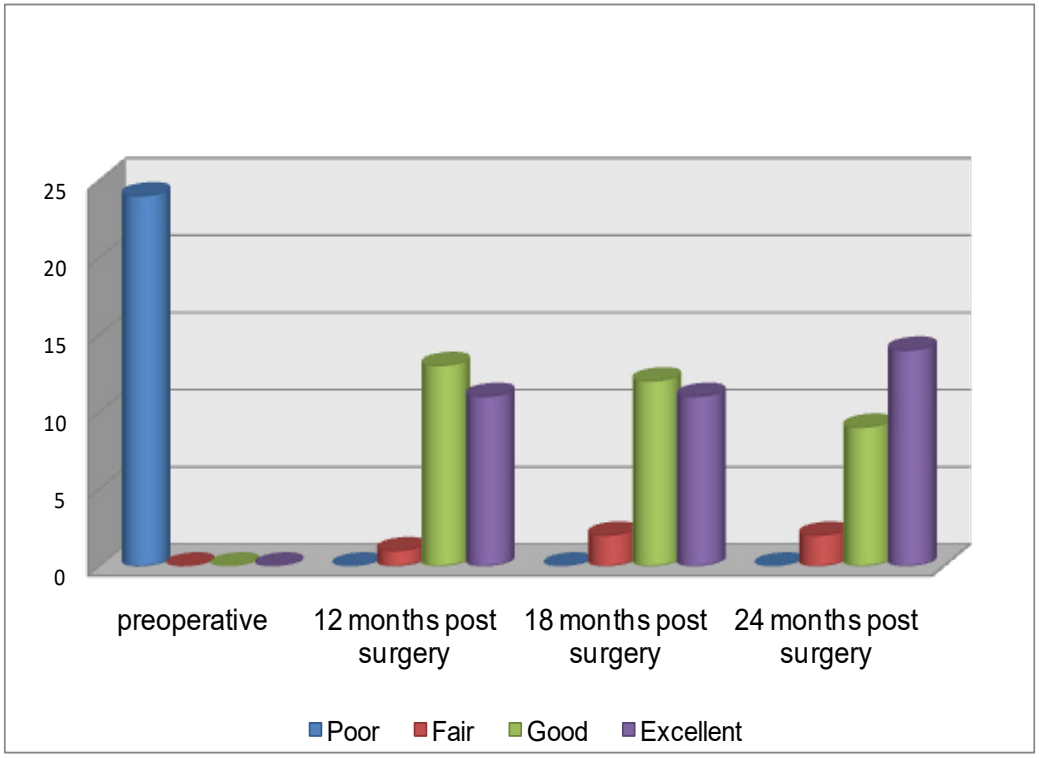


Figure 2. Serial assessment of functional outcome of the study population.

24(96%) had a score of <70 which indicated poor functional score and 1(4%) patient had a fair score of 74.

c. Scores of study population on postoperative assessment

Table 3 shows the interpretation of serial assessment of the study population with Harris hip score. At the end of 24 months 23(92%) patients had well to excellent functional outcome scores (Figure 2).

d. Survival Analysis of the study population

The survival analysis of the study was done with help of Kaplan Meier Analysis. Out of the study population of 25, three (12%) patients underwent revision of prosthesis,

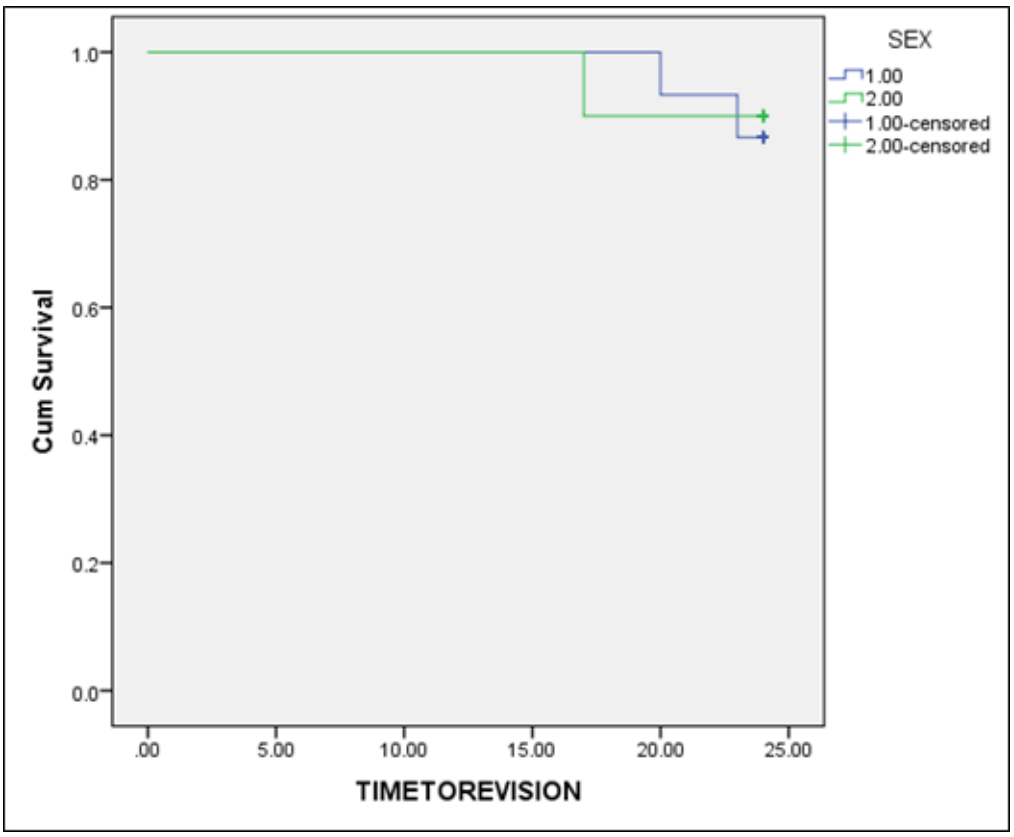


Figure 3. Survival functions.

due to various reasons. The revision of prosthesis took place within the study period. Out of the three, 2 were males and 1 was female patient. An Implant survival analysis was done with Kaplan Meier where the:

a. Event of interest was taken as 'revision of prosthesis'.
b. Serial time was taken as the time in months at which the event occurred.
c. Group was divided according to gender into males and females.
d. All the patients joined the study from the beginning and continued till the end of the study. Hence as per the assumptions of Kaplan Meier estimate, it was assumed that all the patients were operated one year prior to the commencement of the study. At the end of the study period, revision of prosthesis (event) had occurred in 3(12%) cases of the population. 23 (88%) cases were censored. Thus the implant survival at 24 months was 88%. There were no deaths or drop-outs of patients during the study period.
e. The Kaplan Meier survival (Figure 3).
f. X axis describes the cumulative survival of the implant.
g. Y axis describes the time to revision of implant (in Months).
h. The mean survival time for the implant in males was 23.66 months and the mean survival time for the implant in females was 23.30 months. The log rank test was done to test the equality of survival distributions for the different genders. No significant difference was found in the survival of the implant between males and females (p= 0.844).

4. Discussion

The present study consist of 25 patients selected randomly who had undergone unilateral total hip arthroplasty one year prior to the beginning of our study. The study population consisted of 15 men and 10 women in the age group of 30 to 75 years with a mean age of 66.3 years. In a review conducted by Buirs, et al. (2016)[10], a strong

evidence was found between the age at which surgery was done and the post-operative functional outcome.

Patients with Ficat and Arlet staging three and four prior to surgery were chosen. The patients were followed up retrospectively as well as prospectively from 2014 to 2016. The patients were reassessed 12-, 18- an 24-months post surgery. The demographic details like the patient's age, place of residence and occupation were noted. They were assessed for the survival of the implant, functional outcome and radiologically to identify complications. A similar study was conducted by Kakaria, et al. (2005)[11], on patients undergoing total hip arthroplasty for 2 years.

Pre-operatively, patients having Ficat and Arlet stage III and IV of avascular necrosis of femur with degenerative arthritis were chosen for surgery. Patients who subjectively complained of pain or difficulty while walking and who had poor Harris Hip Score were chosen. The mean pre-operative Harris hip score of the study population was 54.56 (SD). The preoperative Harris hip scores were also poor (<70) in studies conducted by Yaratpalli, et al. (2014)[12] and Siwach, et al. (2007)[13].

5. Survival Analysis of the Implant

Kaplan–Meier survival analysis was used to determine the survival after the primary total hip replacement. In the current orthopedic literature, the Kaplan-Meier estimator is an accepted standard in estimating the probability of revision surgery in cohort studies of any type of joint replacement. In our study, three (12%) patients underwent Revision surgery until the end of 24 months. The survivorship of the implant was seen in 88% of the patients at the end of 2 yrs. In a landmark paper by Dobbs, et al. (1980)[14], the survivorship of metal on plastic implant at eight years, post-surgery was 88%.

In the present study, it was found that 12% of the study population underwent revision of prosthesis at the end of 3 years post the primary total hip replacement. As mentioned earlier Kaplan-Meier estimator is an accepted standard in estimating the probability of revision surgery in cohort studies of any type of joint replacement. However, in the presence of competing risks, the Kaplan-Meier estimator overestimates the probability of revision surgery. In the Kaplan-Meier approach failures from the competing causes are treated as censored observations. Individuals who will never be revised because they have died, are censored and thus treated as if they still could be revised, thus overestimating the probability of revision[15].

In our study, the mean survival of the implant in men was 23.66 months and that in women was 23.30 months. But there was no significant difference in the survival rates of the implant according to the gender of the patient. Inacio et al., (2013)[16], evaluated the effects of gender on the short-term risk of revision in 35,140 THAs with a median follow-up of 3 years (57.5% women and 42.5% men. They showed that, at 5-year follow-up, the implant survival rate was 97.7% for men and 97.1% for women with women having a 29% higher risk of implant failure than men after THA. However, Kostamo et al., (2009)[17], evaluated the revision rate among 4114 THAs involving 1537 men and 1924 women at a minimum 2-year follow-up. They found that the rates were similar between men and women (9.3% *vs*. 8.3%; *P*=.16).

Clauss. et al., (2014)[18], also found a mean survival of the implant at 98.4% in cementless total hip arthroplasty.

According to the Finnish Arthroplasty register the 10 year survival rate was 72% in patients younger than 55 years and 90% in patients older than 70 years.[19]

In a study conducted by Mäkelä, *et al*., patients who were fifty-five years of age or older, who underwent cementless total hip replacements had comparable survival of implant as compared with those with cemented replacements. In patients who were fifty-five to seventy-four years old, straight porous-coated cementless stems had better long-term survival than the cemented stems which was similar to those used in our study.

6. Functional Outcome

In our study, 96% of the study population had a score of <70 which indicated poor functional outcome on the Harris Hip Score. The mean preoperative score was 54.56± 7.92 and the mean post surgery score at 24 months was 88.72± 5.16. Thus there was a significant improvement in the functional outcome by 34.16 and 92% patients reported well to excellent functional outcomes on Harris Hip Score.

A similar study was conducted by Jafar, et al., (2015)[20], to study the functional outcome of total hip arthroplasty in terms of pain relief, functional capacity, range of motion, and absence of deformity using Harris hip score. Their preoperative Harris hip scores were 23.77±9.50 and post-surgery scores were 87.90± 10.42 indicating good results.

Thus concluding that Total hip replacement is an effective treatment modality to improve functional outcomes in arthritic hip secondary to diseases affecting the hip[20,21].

In our study, functional outcome scores, P value is >0.05 in all the serial assessments done post-surgery, hence there is no significant correlation found in our study between gender of the patient and functional outcome. In a study conducted by Kennedy, *et al.*[22], gender was a significant predictor of physical performance measure scores 1 week after arthroplsty, there after men and women had similar rates of improvement.

Similar functional improvements were found between men and women until 5 years post-surgery following total hip arthroplasty by Cherian, *et al*[23].

In our study, no significant correlation was found between the age of the patients and the Harris hip score assessed post operatively at 12 months,18 months, and 24 months.

The younger and older groups of patients experience a similar degree of pain relief post total hip arthroplasty. The age of the patient appears to be more important for the improvement in physical function than for the improvement in pain[24].

As concluded by Smith, *et al.*[25], when making the decision about the timing of hip arthroplasty surgery, it is important to consider the age and preoperative function of the patient as these are strong predictive factors in achieving early excellent results at 3 years.

7. Limitations

The sample size of the present study was small and the findings need to be explored further with a larger sample size.

The patients need to be assessed over a longer duration for a comprehensive overview of complications occurring in the patients with Total Hip Arthroplasty.

The study was conducted in a tertiary hospital and is representative of the flow of patients at this hospital. A community based study would help in generalizing the outcome to the target population.

8. Recommendations

Total Hip Arthroplasty is a good modality of treatment for patients with very poor pre-surgical functional scores and the long term survival of the cement-less implants is excellent.

9. Conclusion

Almost all the patients undergoing total hip arthroplasty had poor pre-operative Harris Hip Score indicating poor physical functionality. After total hip arthroplasty at the end of 24 months, most of the patients had excellent functional outcomes as indicated by the Harris Hip Score. At the end of 24 months, survivorship of the implant was excellent among the study population. Gender did not have any implication on the survivorship of the implant.

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How to cite this article: Sarkar M, Wagh N, Pangavane S. Study of Survivorship and Functional Outcome of Total Hip Arthroplasty in Avascular Necrosis of Femur Head. MVP J. Med. Sci. 2020; 7(1):104-112.