ORIGINAL ARTICLE

Total hip arthroplasty revision etiologies: a cross-sectional study in Isfahan, Iran

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Background: Complications after primary total hip arthroplasty (THA) are the most common reason for revision. Due to the high prevalence of revision surgery, we investigated the frequency of postprimary THA complications and related risk factor revision surgery. **Materials and Methods:** This is a cohort study that was performed in 2011–2019 on all patients who underwent primary THA surgery re-admitted to the Kashani and Saadi Hospital affiliated to Isfahan University of Medical Science, Iran, due to some complications after THA. Demographic and basic data were collected from patient's medical documents. Harris hip score (HHS) was calculated for all patients 6 months after the last surgery. The obtained data were analyzed using SPSS software version 21. Appropriate statistical tests were conducted to compare the results between the study groups. **Results:** Among 1260 patients who underwent primary THA, 1006 of them entered the study after applying the exclusion criteria. Thirty nine patients were under revision, 53.8% had prosthesis infection, 56.4% had instability, 6% had aseptic loosening, and 30.8% had periprosthetic fracture. Odds ratio for the above complications were 45.5, 45, 6.4, and 15.5, respectively. HHS postoperatively was also significantly ($P < 0.001$) higher in patients without revision. No correlation between gender or surgeon experience and revision was detected; however wound discharge ($P < 0.001$), body mass index (BMI) ($P = 0.003$), and Infection during hospitalization ($P < 0.001$) affect revision rate significantly. All four postsurgery complications, i.e., instability, postoperative prothesis infections, periprosthetic fractures, and aseptic loosening, significantly increased the risk of revision ($P < 0.001$, for all). **Conclusion:** Instability, prosthetic infections, periprosthetic fractures, and aseptic loosening were the most common causes for increasing revision rates after THA, respectively. Higher BMI, persistent wound discharge, and nosocomial infections during the first hospitalization also increased the rate of revision after primary THA.

Key words: Aseptic loosening, instability, periprosthetic fracture, revision, septic loosening, total hip arthroplasty

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INTRODUCTION

Total hip arthroplasty (THA) is the most common reconstructive performed reconstructive hip procedure in adults, reducing their pain and improving their quality of life. It has been considered a treatment in both acute and chronic end-stage hip arthritis.[1] THA is usually performed in chronic hip osteoarthritis after the failure of conservative management and joint-preserving techniques.[2,3] Component failure may sometimes lead to revision arthroplasty despite the excellent outcomes associated with primary THA.[4] The results obtained from 1168 hip revision THAs revealed that aseptic loosening, infection, instability, metallosis, and fracture are the most common causes of primary THA failure, respectively.[5] Hip dislocation and mechanical loosening are considered the main indications for revision THAs in the United States. The historical prevalence of dislocation after THA is approximately 3%. Anatomic, surgical, and epidemiologic factors may increase this risk. Trochanteric nonunion, abductor muscle weakness, and increased preoperative range of motion are anatomic features that increase the risk of instability. Postoperative dislocation is more common when there has been previous surgery on the hip, especially with revision total hip replacement.[6] A study on a large

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number of patients who underwent revision THAs showed that the indication for 17.3% of all primary THAs was dislocation followed by mechanical loosening (16.8%).[4] A series of several studies that included 4656 revision THAs demonstrated that 421 out of all revision THAs in their survey were performed after dislocation of the hip joint following the primary THA (9.04%).[6] Infection and septic loosening are also considered among the most frequent complications of primary THA, resulting in component failure and subsequent revision surgery. In a study, 11.4% of revision THAs were indicated due to infection following the primary THA, which was the third cause after aseptic loosening (42.3%) and periprosthetic fracture (11.8%). Postoperative prosthesis infection is a difficult complication affecting THA. It is painful, disabling, costly, often requiring removal of both components, and is associated with reported survival rates of 88.7% and 67.2% at 1 and 5 years after diagnosis.[6] Male gender, avascular necrosis, arthroplasties with dual mobility cups, and anterolateral approach were all associated with an increased risk of infection.[7] In a large study in Norway, Dale *et al*. found an increase in postprimary THA infection in Nordic countries. Based on their findings, infection was associated with an increased risk for component failure and revision surgery.[8]

Here in the present study, we aimed to evaluate postprimary THA complications leading to component failure and revision surgery, including septic loosening, instability, aseptic loosening, and periprosthetic fracture. In addition, we evaluated the relationship between surgeon's experience and inhospital postoperative infection with long-term need to revision THAs. All these variables were evaluated together over a long time follow-up as a novel for the first time in the growth population in Isfahan.

MATERIALS AND METHODS

Study design

This cohort study was performed at Kashani and Saadi medical centers affiliated to Isfahan University of Medical Sciences in 2011–2019. The study was conducted on the patients who underwent primary THA. These patients were followed for an average of 6.8 years, and the etiology of component failure was investigated among those who underwent revision THA. The study protocol was approved by the Research and Ethics Committees of Isfahan University of Medical Sciences (REC number: IR.MUI.MED.REC.1398.542).

Inclusion and exclusion criteria

The inclusion criterion was all patients underwent primary THA within the study period. Our exclusion criteria were patients who had neurologic diseases (such as Parkinson. Due to rigidity, dislocation rate in these patients is more) affecting the outcome, neuropathic arthropathy, significant comorbidities including hemophilia, any procedures previously done on the ipsilateral hip like arthroscopy, incomplete and inaccessible file information, not having written informed consent to participate in the study, or death within the follow-up period and individuals who did not consent to participate in the study or/and to the surgery.

Data collection

All patients' demographic and baseline clinical characteristics, including age, gender, body mass index (BMI), and past medical history, were extracted from patients' medical records. The surgeon's experience and postoperative inhospital infections, including symptomatic pneumonia, urinary tract infections (UTIs), and periodontal infections, were also recorded from medical charts. Infection of the prosthesis, recurrent instability, periprosthetic fracture, and aseptic loosening as common possible risk factors for primary THA failure[6] were investigated in all patients during the follow-up period. Based on the annual number of performed THAs in our medical centers, surgeons were categorized into two groups:

1. Experienced surgeons with more than 30 THAs per year[9]
2. Inexperienced surgeons with <30 THAs per year.[9]

Furthermore, we considered surgeons with postgraduate degree or fellowship as experienced surgeons and general orthopedic surgeons as nonexperienced.

Chronic serous wound discharge was defined as continuous discharge for more than a month.[6] Laboratory evaluations including erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and D-dimer were checked for patients at the time of hospitalization and 2 weeks after completion of antibiotic therapy. Normal ESR, CRP, and D-dimer values (ESR <30 mm/h, CRP <10 mg/L, and D-dimer <850 ng/ml based our laboratory department reference values) along with the absence of any signs and symptoms of infection were considered as the appropriate response to the treatment.[10] Prosthesis infection was diagnosed by hip joint aspiration analysis if one of the three previously mentioned laboratory values are elevated and the aspiration was performed 2 weeks after discontinuation of antibiotic therapy. Aerobic and anaerobic cultures, and cell count with differential, are obtained from the aspirant. Leukocyte esterase test strip and alpha-defensin testing are additional synovial fluid markers that were done for infection.[6] Recurrent instability was defined as more than three instability and dislocation in recent month.[6] Anteroposterior radiography was our primary imaging modality for the diagnosis of instability and periprosthetic fracture. Harris hip score (HHS) was also calculated after

both primary and revision THAs and compared as a measure of clinical outcome of patients.

Statistical analysis

The obtained data were analyzed using the Statistical Package for the Social Sciences (SPSS) software (version 24.0; SPSS Inc., Chicago, IL, USA). Demographic and clinical characteristics of patients were reported as frequency (percentage) for qualitative variables and mean ± standard deviation (SD) for quantitative variables. Qualitative variables between the study groups were compared using the Chi-squared test and Fisher's exact test. Normality of distribution in quantitative variables was assessed using the Kolmogorov–Smirnov test. Normally and nonnormally distributed quantitative variables were compared between the study groups using the independent *t*-test and Mann–Whitney *U*-test, respectively. The association of after THA surgery complications with revision was investigated using logistic regression in crude and adjusted models. Odds ratio (OR) and 95% confidence interval (95%CI for OR) were reported. $P < 0.05$ was considered as the significance threshold in all analyses.

RESULTS

From 2011 to 2019, 1260 patients underwent primary THA in our medical centers. One thousand two hundred and sixty patients were entered our study and data obtained from 1006 patients were analyzed after applying the exclusion criteria. Thirty-nine patients underwent revision THA during the follow-up period due to septic loosening, instability, aseptic loosening, and periprosthetic fracture. Age ranged from 58 to 75 years with a mean of 66.22 and SD of 4.67. Five hundred twelve patients (50.9%) were female and 494 patients (49.1%) were male. The mean BMI was 22.29 + 3.47 ranging from 15 to 33. Six hundred forty-three surgeons (63.9%) were categorized as nonexperienced compared to 363 experienced surgeons (36.1%). Wound discharge was detected in 954 patients (94.8%) after primary THA [Table 1]. One hundred and forty-seven (14.61) primary THAs were cemented and 859 (85.39%) of them were noncemented.

According to data analyses, prosthesis infection, aseptic loosening, hip joint instability, and periprosthetic fracture, as the four main postprimary THA complications, were significantly more prevalent in patients who had undergone revision THA compared to the nonrevision group ($P < 0.001$, < 0.001, < 0.001, and < 0.001, respectively). The mean of HHS in nonrevision patients was significantly higher than those who had undergone revision THA ($P < 0.001$) [Table 1].

Moreover, the instability and periprosthetic fracture have been shown in the anteroposterior radiography as a first-line imaging study in these patients [Figure 1].

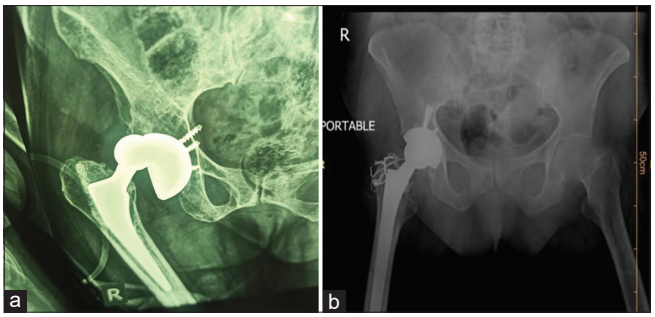

Figure 1: (a) Before THA revision, (b) After THA revision. THA: Total hip arthroplasty

Table 2 shows the results obtained from logistic regression analysis for the association of four major postprimary THA complications. Strong association was found between each post-primary THA complications and revision surgeries based on separate binary logistic regression tests (crude model). Moreover, multivariate logistic regression test showed significant association between the post-THA complications and revision surgery in these patients (adjusted OR). Finally, we adjusted the potential confounding effect of age, BMI, and wound discharge, the multivariable association of four postsurgery complications was strongly remained significant. Among four complications, based on estimated ORs, instability (OR: 57.790; 95% CI: 11.964–279.137) and prosthetic infection (OR: 44.339; 95% CI: 8.623–227.980) showed the highest association with THA revision [Table 2].

DISCUSSION

Based on our findings, HHS was significantly higher in patients without revision compared to the revision group. Therefore, it seems paramount to investigate the etiology of component failure in order to prevent subsequent revision surgery. Prevalence of hip joint dislocation and instability has been reported approximately 3% in the literature. In a study, Goldstein *et al*.[11] retrospectively evaluated the prevalence of dislocation after THA with the two different techniques. The prevalence of dislocation was reported at 2.8% after the capsulectomy and capsulotomy. In our study, recurrent dislocation after primary THA significantly resulted in component failure and revision THA. It appears that surgical techniques may lead to component failure due to dislocation of the hip joint.[12] In a large study on patients who had undergone primary THA in Sweden, Parker MJ *et al*. demonstrated that the posterior approach in the surgery is associated with a higher risk of dislocation.[13] As mentioned earlier, Goldstein's *et al*. study also showed a correlation between the surgical technique and hip joint dislocation.[11] In our study, various causes leading to dislocation were not investigated. It is recommended that studies be conducted in this field in the future. Certain neurological diseases have been identified as risk factors for hip dislocation after primary THA.[14] In our

Table 1: Basic demographic and clinical characteristics of study patients in two groups

Variable	Revision		*P*
	Yes Number of patients=39, *n* (%)	No Number of patients=967, *n* (%)	
Age, mean±SD	63.38±7.82	66.33±4.47	0.025*
Gender			
Male	23 (4.7)	471 (95.3)	0.253
Female	16 (3.1)	496 (96.9)	
BMI, mean±SD	24.74±4.99	22.20±3.36	0.003
Surgeon's experience			
Experienced	13 (33.3)	350 (36.2)	0.865
Nonexperienced	26 (66.7)	617 (63.8)	
Infection during hospitalization			
Yes	15 (38.5)	40 (4.1)	<0.001
No	24 (61.5)	927 (95.9)	
Wound discharge			
Yes	24 (61.5)	930 (96.2)	<0.001
No	15 (38.5)	37 (3.8)	
Prosthetic infection			
Yes	21 (53.8)	20 (2.1)	<0.001
No	18 (46.2)	947 (97.9)	
Aseptic loosening			
Yes	6 (15.4)	20 (2.1)	0.006
No	33 (84.6)	947 (97.9)	
Instability			
Yes	22 (56.4)	24 (2.5)	<0.001
No	17 (43.6)	943 (97.5)	
Periprostatic fracture			
Yes	12 (30.8)	15 (1.6)	<0.001
No	27 (69.2)	952 (98.4)	
Harris Hip score, mean±SD	5.74±49.75	4.42±49.83	<0.001

*<0.05 is significant. Continuous variables are described by the mean and standard deviation (mean±SD) and qualitative variables by frequency (percentage). *P* Values are reported according to the relevant tests (independent *t*-test for continuous variables and Chi-squared test or Fisher's exact test for qualitative variables). BMI=Body mass index; SD=Standard deviation

Table 2: The odds ratio and 95% confidence interval for odds ratio of the association of postsurgery complication with total hip arthroplasty revision resulted from the logistic regression model

Complication	Univariate OR (95% CI for OR)	Crude multivariable OR (95% CI for OR)	Adjusted multivariable OR (95% CI for OR)*
Prosthetic infection	55.242 (25.585-119.276)	79.231 (25.986-241.576)	44.339 (8.623-227.980)
Instability	50.848 (23.984-107.804)	55.896 (18.956-170.774)	57.790 (11.964-279.137)
Aseptic loosening	8.609 (3.244-22.849)	5.119 (1.239-21.146)	9.620 (1.581-58.527)
Periprostatic fracture	28.207 (12.056-65.997)	12.128 (3.405-43.193)	9.995 (1.477-67.639)

*Adjustment was made for potential confounders (age, BMI, wound discharge). OR=Odds ratio, BMI=Body mass index; CI=Confidence interval

study, we excluded all patients with a history of neurological diseases to prevent the effect of possible confounders on the results.

Early postoperative dislocation could also happen because of the patient's incompliance with rehabilitative programs. However, as we mentioned earlier, the surgical technique is the leading cause of recurrent dislocation and revision surgery. Our findings showed that higher BMI results in more component failure. It could be explained by the fact that component positioning is more challenging during the surgery in these patients.

Periprosthetic fracture has been shown as one of the devastating complications following primary THA resulting in adverse outcomes including: component failure, 30-day mortality and 1-year mortality.[1,3]

Mayo Clinic Total Joint Registry reported the prevalence of intraoperative femoral fractures in primary THA as approximately 1.7%. Twelve percent of them needed revision THA. Females, elderly patients, patients with rheumatoid arthritis or disuse osteoporosis, and those treated with uncemented stems were at higher risk of periprosthetic fractures.

Many studies have investigated the risk factors contributing to periprosthetic fracture following primary THA; however, the results are quite controversial. In a study on 14065 patients who had undergone primary THA, 305 postoperative periprosthetic fractures occurred during 6.3 years of follow-up.[14]

A few investigations have shown a significant difference between males and females regarding the prevalence of periprosthetic fracture.[15-17] Inconsistent with their findings, Miocinovic *et al*.[18] and Sarvilinna *et al*.[19] found no difference between genders.

One large registry study in the United Kingdom revealed an increased risk of periprosthetic fracture among female patients aged over 70 years.[20] In a small retrospective study of 16 periprosthetic fractures, Wu *et al*. proved that old age is associated with higher postoperative fractures.[21] Different studies have investigated the prevalence of periprosthetic fracture and its contributing risk factors. In the current study, periprosthetic fractures after primary THA significantly resulted in revision THA. Inconsistent with previous observations, no relationship between gender and the need for revision surgery was seen in our study. Age was marginally associated with component failure due to periprosthetic fracture. The missed or untreated osteoporosis patients could explain the discrepancy in the association between age, gender, and periprosthetic fracture in the literature.

Another debilitating complication affecting the primary THA outcome is septic loosening and surgical site infection (SSI).

Central line-associated bloodstream infections, catheter-associated UTIs, SSIs, and ventilator-associated pneumonia are also considered frequently prevalent nosocomial or health-care-associated infections that can increase hospitalization stay.[12] In a study on 142 primary THAs, 21 presented with postoperative infection, and the main reason for revision surgery was septic loosening. Hips with *in situ* implants for more than 5 years showed less possibility to become infected than those with *in situ* implants <5 years.[22] In the present study, there was a significant relationship between septic loosening and component failure. Other postoperative infections defined as the term "infection" in the present study were also indicated as risk factors for component failure following the primary THA. With its debilitating effects on postoperative patients' satisfaction, infection is an inevitable complication of every orthopedics procedure, especially arthroplasties that contain foreign device components. Limited access to disposable guns, incomplete sterility control, and lack of antibiotic-coated prostheses are the major risk factors of postoperative infection. Patients undergoing THAs must be consulted with an infectious disease specialist to prevent subsequent disastrous complications regarding postoperative infections.

Aseptic loosening has been reported in cemented and cementless components of several designs. It is recently recognized that metal, cement, and polyethylene particles can lead to periprosthetic osteolysis.[23] Osteolysis among metal-on-metal THAs (14.3%) was significantly more prevalent than ceramic-on-ceramic THAs (2.1%).[23,24] Similarly, in the current study, osteolysis resulted in a higher rate of revision THA as well. Using effective materials such as bone morphogenetic protein and more qualified protheses might decrease the risk of aseptic loosening and component failure. It must be noted that some degrees of osteolysis and loosening are inevitable, especially with aging. We found a marginally significant negative correlation between age and revision, as depicted in Table 1. An explanation could be the higher risk of performing major procedures on elderly patients with comorbidities. These patients also have more limited daily activities, which reduces the necessity of performing such a major surgery. Most of our patients had cemented prosthesis and few have noncemented, but we did not investigate the prevalence of THA failure and revision in these two categories.

Fender *et al*., analyzing 1198 primary THA, showed that the risk of component failure and revision surgery was four times greater when performed by surgeons with the experience of <30 hip replacements per year compared to surgeons with more than 60 hip replacements per year.[25] Inconsistent with their findings, we found no difference between experienced and nonexperienced surgeons regarding the incidence of component failure. The difference between the studies regarding the definition of experience may explain the discrepancy of findings.

HHS as a valid measure of THA outcomes has four domains: pain, function, absence of deformity, and range of motion. As discussed previously, HHS is lower in patients with revision surgery after primary THA than in patients without revision procedures. Injuring soft tissues surrounding the hip joint, especially the abductor's muscles, is one of the main reasons for decreased HHS score and hip function after revision surgery.

CONCLUSION

Taken together, our study demonstrated a correlation between component failure following primary THA and postoperative complications, including infection, instability, aseptic loosening, and periprosthetic fracture. Nosocomial infections, BMI, and wound discharge also affected the

revision rate. Further studies on the risk factors contributing to component failure would be beneficial in terms of THA outcomes.

Declarations

Ethics approval and consent to participate

This research has been performed in accordance with the Declaration of Helsinki and has been approved by the ethics committee of Isfahan University of Medical Sciences (Ethics code: IR. MUI. MED. REC.1398.542). Written informed consent was obtained from the patients.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to the nature of patients available from the corresponding author upon reasonable request.

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Conflicts of interest

There are no conflicts of interest

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