Revision Primary Total Hip Replacement: Causes and Risk Factors

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Objective: *To determine 1) causes of failure of primary total hip replacement (THR) in Thai patients and 2) whether patient characteristics, underlying diagnosis, and type of primary THR were associated with the causes of revision THR.*
Material and Method: *The authors retrospectively reviewed all revision THRs in one referral hospital in Thailand between 2002 and 2012. All medical records and radiographic studies were used to identify the causes of primary THR failure. Randomly selected primary THRs performed in the same period were used to compare with revision THRs to determine the risk factors for revision.*
Results: *This study included 219 THRs. After 5 years (late failure) from index surgery, 138 primary THRs (63.0%) were revised. Late failures were aseptic loosening (75.4%) followed by periprosthetic fracture (8.0%), and polyethylene wear (5.8%). The major reasons for revision surgery within 5 years (early failure) were periprosthetic joint infection (29.6%), aseptic loosening (28.4%), and instability (22.2%). Age <45 at index surgery had the lowest risk for revision with a hazards ratio of 0.695 (95% CI 0.492-0.981). Hybrid fixation was found to be a risk factor for revision THR with a hazards ratio of 1.652 (95% CI 1.166-2.341).*
Conclusion: *Most THRs failed after 5 years. Periprosthetic joint infection was the most common cause of failure in the early period. Aseptic loosening was a major cause of failure in the late period and overall in both periods. Hybrid fixation is an independent risk factor for revision surgery after primary THR. Younger patients at the time of primary THR were associated with a reduced risk for failure.*

Keywords: *Failure, Infection, Loosening, Periprosthetic fracture, Thai, Total hip replaecment*

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Total hip replacement (THR) is one of the cost-effective procedures[1] that can relieve pain and improve functions of the patients. From a worldwide joint registry, although the results of primary THR are generally excellent, 6.45% and 12.9% of the patients require revision surgery in 5 and 10 years, respectively[2]. Because of an increase in the number of patients who are undergoing primary THR and the higher demands of their activity levels, the number of revision surgeries is presumed to increase substantially in the near future[3].

Revision THR is a difficult and complex procedure. It has a greater risk of complications compared to the primary procedure[4]. Determining the causes and risk factors of failure is important and mandatory for developing new strategies to improve the longevity of prostheses. Different reasons for revisions have been reported in different databases. Ulrich et al. found that aseptic loosening and instability were the leading causes of failure in late and early failures, respectively[5]. This result was also confirmed by the Clohisy et al and Delaunay et al studies[6,7]. However, most of the databases come from western countries.

Asian people have different characteristics and life styles especially in floor activities when compared to Caucasians. These differences may affect the longevity of THR. Satoh et al found that toileting postures of Japanese is a risk factor for revision THR[8] while some studies revealed that Asian ethnicity had a lower risk than Caucasians[9,10]. Gender, age, body mass index (BMI), primary diagnosis, and underlying disease have been proposed as risk factors for revision surgery in much of the literature[11-14].

Due to the lack of an Asian database, we therefore determined 1) causes of failure of primary THR in Thai patients and 2) whether patient

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characteristics and the underlying diagnosis of primary THR were associated with the causes of revision THR.

Material and Method

All patients who underwent revision THR (417 cases) in our institute between 2002 and 2012 were retrospectively reviewed. Excluded cases were repeat revision THR (57), revision of hemiarthroplasty (134), conversion of resection arthroplasty (2), and revision due to tumor reconstruction (5). The remaining 219 revision cases were recruited for analysis. To serve as a control group, 219 patients who underwent primary THR in our institute were randomly selected from the same period of revision surgery was done. The study was approved by our institutional review board.

In the present study, we classified the mode of primary THR into 7 categories including aseptic loosening, periprosthetic fracture, periprosthetic joint infection, polyethylene wear, instability, component malposition, and component failure. Sinus tract or positive culture were used as a definite diagnosis of periprosthetic joint infection. If synovial fluid culture was negative but clinical findings and laboratory studies showed elevation of synovial white blood cells, ESR and CRP, this group of patient were also classified as periprosthetic joint infection. Revision for fracture without previous signs of loosening was classified as perirprosthetic fracture. Polyethylene wear without component loosening was classified as polyethylene wear. The revision for recurrent dislocation without component loosening was categorized as instability. Nevertheless, if there was any evidence of component malposition, it was classified as component malposition. Component failure meant fracture or dissociation of the prosthesis. The mode of failure in each patient was determined using history, physical examination, radiographs, intraoperative findings, laboratory investigations, and tissue cultures. All data were assessed by two authors (IK and PC). In controversial cases, the senior author (CK) would evaluate and judge.

Patient demographic data were recorded including age, gender, BMI, primary diagnosis, Charlson Comorbidity Index (CCI), and type of fixation. Time to revision was calculated from the difference of age between primary and revision surgery. We stratified the time to revision into early and late using 5 years as a cut-point.

Statistical analysis

The data were analyzed using SPSS v.13.0 (SPSS Inc., Chicago, Illinois). Quantitative data were presented as mean and SD. The differences of data between the two study groups were analyzed using the unpaired Student's t-test and Chi-squared test. Cox regression analysis was used to calculate the odds ratio (OR) and 95% confidence interval (CI) after controlling the confounding variables. Age, gender, BMI, primary diagnosis, type of fixation and CCI were designated as the explanatory variables. Statistical significance was set at a *p*-value less than 0.05.

Results

There were 102 male and 117 female patients in the revision group. The majority of cases were cementless fixation (42.9%). Avascular necrosis of the femoral head was the most commmon primary diagnosis at index surgery accounting for 37% followed by primary osteoarthritis and femoral neck fracture. The mean age at the time of revision surgery was 54.7 years (Table 1). There were some missing BMI data. This was due to severe pain of patients who were unable to be weighed.

After 5 years, 138 primary THRs (63.0%) were revised from index surgery. The most common reason for revision was aseptic loosening (58%) followed by periprosthetic joint infection (14.2%) and instability (19.6%). We used 5 years as a cut-point between early and late failures. Within 5 years, 37% of primary THRs failed after index surgery. Periprosthetic joint infection was the most common cause of total hip failure within 5 years and aseptic loosening was the most common cause for late failures (Table 2).

From Cox regression analysis, age below 45 years at the time of primary surgery had the lowest risk for revision with a hazards ratio of 0.695 (95% CI 0.492-0.981). Hybrid fixation was found to be a risk factor for revision THR with a hazards ratio of 1.652 (95% CI 1.166-2.341) (Table 3).

Discussion

Longevity of a total hip replacement is the ultimate goal after surgery but we still find from the worldwide joint registry that revision surgery is required in 5 and 10 years in 6.45% and 12.9% of the patients, respectively[2]. Revision surgery is a demanding skill and is a high cost surgery but the outcomes are not as good as the primary surgery[15]. Identifying the causes and risks of failure may prevent adverse outcomes in the future. Few research papers in the literature have studied this topic.

Table 1. Demographic data

Categorical variables*	Number of patients (%)		*p*-value
	Revision (n = 219)	Control (n = 219)	
Gender			0.387
Female	117 (53.4)	126 (57.5)	
Male	102 (46.6)	93 (42.5)	
Side			0.535
Right	111 (50.7)	104 (47.5)	
Left	108 (49.3)	115 (52.5)	
Body mass index			0.494
<25	90 (59.6)	127 (63.2)	
≥25	61 (40.4)	74 (36.8)	
Type of THR fixation			<0.001
Cementless	94 (42.9)	162 (74.0)	
Cemented	76 (37.7)	8 (3.7)	
Hybrid	49 (22.4)	49 (22.4)	
Primary diagnosis			0.004
Avascular necrosis	81 (37.0)	120 (54.8)	
Non-avascular necrosis	117 (63.0)	99 (45.2)	
Primary osteoarthritis	37 (16.9)	29 (13.2)	
Fracture neck of femur	18 (8.2)	3 (1.4)	
Posttraumatic osteoarthritis	16 (7.3)	22 (10.0)	
Inflammatory arthritis	16 (7.3)	1 (0.5)	
Postseptic osteoarthritis	10 (4.6)	6 (2.7)	
Developmental dysplasia of the hip	7 (3.2)	21 (9.6)	
Other	13 (5.9)	16 (7.3)	
Unknown	21 (9.6)	1 (0.5)	
Charlson comorbidity index			0.747
0	181 (82.6)	177 (80.8)	
1-2	36 (16.4)	40 (18.3)	
3-4	2 (0.9)	2 (0.9)	
Continuous variables**	Mean (SD)		
Age at primary arthroplasty (years)	45.0 (15.0)	54.1 (15.0)	0.771
Age at revision arthroplasty (years)	54.7 (13.9)	-	-
Time to revision (months)	113.9 (91.2)	-	-
Follow-up time (months)	-	69.26 (33.63)	-

THR = total hip replacement
* Chi-squared test, ** Student's t-test

Table 2. Cause of revision total hip replacement

Cause of revision	Number of patients (%)		
	Early (<5 years)	Late (>5 years)	Overall
Periprosthetic joint infection	24 (29.6)	7 (5.1)	31 (14.2)
Aseptic loosening	23 (28.4)	104 (75.4)	127 (58.0)
Instability	18 (22.2)	3 (2.2)	21 (9.6)
Component malposition	8 (9.9)	0	8 (3.7)
Periprosthetic fracture	7 (8.6)	11 (8.0)	18 (8.1)
Components failure	1 (1.2)	5 (3.5)	6 (2.7)
Polyethylene wear	0	8 (5.8)	8 (3.7)

Table 3. Cox regression analysis for revision THR

Covariate	Group	Hazards ratio (95% CI)	*p*-value
Gender	Female	1	
	Male	1.020 (0.784-1.340)	0.859
Age at primary surgery	>55	1	
	45-55	0.681 (0.458-1.012)	0.057
	<45	0.695 (0.492-0.981)	0.038*
Body mass index	≥25	1	
	<25	0.920 (0.662-1.280)	0.621
Primary diagnosis	Avascular necrosis	1	
	Non-avascular necrosis	1.104 (0.828-1.473)	0.499
Type of THR fixation	Cementless	1	
	Cemented	0.994 (0.721-1.372)	0.973
	Hybrid	1.652 (1.166-2.341)	0.005*
Underlying disease	Yes	1.497 (0.785-2.588)	0.220
Charlson comorbidity index	0	1	
	1-2	0.880 (0.536-1.445)	0.614
	3-4	0.978 (0.136-7.018)	0.982

Table 4. Comparison with previous studies

Early failure study	1st cause (%)	2nd cause (%)	3rd cause (%)
Clohisy et al. 2004 (n = 37)	Aseptic loosening 51.0	Instability 18.0	Infection 11.0
Ulrich et al. 2008 (n = 119)	Instability 30.5	Aseptic loosening 27.1	Infection 19.6
Current study 2012 (n = 138)	Infection 29.6	Aseptic loosening 28.4	Instability 22.2
Late Failure			
Clohisy et al. 2004 (n = 37)	Aseptic loosening 61.0	Osteolysis 26.0	Periprosthetic fracture 8.0
Ulrich et al. 2008 (n = 119)	Aseptic loosening 80.7	Infection 9.2	Instability 4.2
Present study 2012 (n = 138)	Aseptic loosening 75.4	Periprosthetic fracture 8.0	Polyethylene wear 5.8

This is the first study that identified the causes and risks of failure after primary THR in Asian patients. Thirty-seven percent of the revisions were performed within 5 years after primary surgery which is nearly the same as the study of Melvin et al in 2013 which found 33% were early revisions[16]. For the causes of early failure, we found periprosthetic joint infection, aseptic loosening, and instability were the leading causes of failure. These results also confirmed the previous studies of Clohisy et al[17] and Ulrich et al[5]. These causes often resulted from an improper surgical techniques such as malposition of components and improper aseptic technique. Revision from periprosthetic joint infection resulted in poor outcome, high medical expense[18], and was also associated with repeat revision surgery[19]. Prevention and early diagnosis of this cause can reduce complications.

Aseptic loosening is the leading cause of failure of THR in both the overall and late (>5 years) periods. Most of the literature also found aseptic loosening is the most common cause of failure in THR[5,17,20,21]. Aseptic loosening is not an unexpected reason as the leading cause of failure. There are many predisposing factors that contribute to failure such as stem design, malposition of components, some cytokines, and genetic susceptilibty[22-25].

When the authors compare with previous reports from western countries, there are not many different causes of failure after THR. The only finding that was different in the present study was a higher percentage of periprosthetic joint infection in early failure than in western countries (Table 4).

Younger age at primary diagnosis was found to be associated with a protective factor for revision in our study which is in contrast to the majority of the previous studies[26,27]. But there were some studies which also found that younger age is not a risk factor for revision with certain prosthetic designs.

Hartofilakidis et al found that late failure of Charnley arthroplasty in younger patients (range, 24-55 years) is comparable to older patients in a 20-year outcome[28]. Nevertheless, advanced age was associated with postoperative complications[10,29]. Another reason that may contribute to this result was bias in the implant selection by the surgeon. In developing country, cost of implant and reimbursement system had an influence on implant selection. Surgeons tend to select the implant that has better theoretical longevity for younger patients than the older patients.

In the present study, hybrid fixation was associated with risk for revision THR. Cementless acetabular components and cemented femoral components had higher risk of revision due to aseptic loosening in Swedish Hip Artrhoplasty Register[30].

The CCI[31] was developed to predict 1-year mortality in non-trauma patients who were admitted to hospital and was used to predict risk in readmission after arthroplasty surgery[32]. The CCI is associated with postoperative complications, readmission rate, and mortality after orthopedic surgery[29,32]. There is only one study by Gordon et al that studied the relationship between the CCI with re-operation after primary THR and they found no relationship between them[33]. The present study also confirmed this result but the reader should be aware that the majority of patients in our study had a low CCI.

The authors recognized some limitations that should be mentioned. First, the data were reviewed retrospecitvely from a single institute so it may not reflect the risk factors for Thai patients after THR. Nevertheless, our institute is a high-volume referral center for artrhoplasty in Thailand. The authors did not collect the patient functional status, level of activity or socioeconomic factors for analysis which may be different from western populations. Second, we determined the cause at the time of revision which may not identify the true cause of failure such as polyethylene wear from standing a long time and osteolysis which usually ends up with aseptic loosening. Third, this study used the revision as the end point of failure. Some patients who had medical problems that prevented revision or refused surgery were not included in this study.

Conclusion

Most primary THRs failed after 5 years. Periprosthetic joint infection was the most common cause of failure in the early postoperative period. Aseptic loosening was a major cause of failure in the late period and overall in both periods. Hybrid fixation is an independent risk factor for revision surgery after primary THR. Younger patients at the time of primary THR were associated with a reduced risk for failure.

What is already known on this topic?

Different reasons and risk factors for revision total hip replacements have been reported in various published databases. However, most of the available databases report only on the situation in western countries.

What this study adds?

This is the first study to seek to identify causes of and risks factors associated with failure after primary total hip replacements in Thai patients.

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Potential conflicts of interest

None.

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สาเหตุและปัจจัยเสี่ยงของการล้มเหลวในการผ่าตัดเปลี่ยนข้อสะโพกเทียม

คณินทร์ เอี่ยมธนาภรณ์, กีรติ เจริญชลวานิช, จตุรงค์ พรรัตนมณีวงศ์

วัตถุประสงค์: *เพื่อศึกษาหาสาเหตุและปัจจัยเสี่ยงของการล้มเหลวในการผ่าตัดเปลี่ยนข้อสะโพกเทียมที่ต้องเข้ารับการผ่าตัดซ้ำ*
วัสดุและวิธีการ: *ทำการเก็บข้อมูลย้อนหลังจากเวชระเบียนและภาพถ่ายรังสีของผู้ป่วยที่เข้ารับการผ่าตัดแก้ไขข้อสะโพกเทียมที่โรงพยาบาลศิริราชตั้งแต่ พ.ศ. 2545 ถึง พ.ศ. 2555 รวมทั้งสุ่มเก็บข้อมูลผู้ป่วยที่เข้ารับการผ่าตัดเปลี่ยนข้อสะโพกเทียมที่ไม่ได้เข้ารับการผ่าตัดแก้ไขในช่วงเวลาเดียวกัน แล้วนำมาเปรียบเทียบเพื่อหาปัจจัยเสี่ยงของความล้มเหลวในการผ่าตัดเปลี่ยนข้อสะโพกเทียม*
ผลการศึกษา: *พบว่ามีผู้ป่วยที่เข้ารับการผ่าตัดแก้ไขข้อสะโพกเทียมจำนวน 219 ราย โดย 138 ราย (63.0%) เข้ารับการผ่าตัดภายหลังจากการผ่าตัดเปลี่ยนข้อสะโพกเทียมครั้งแรกมากกว่า 5 ปี สาเหตุส่วนใหญ่ของการล้มเหลวในระยะหลังคือ ข้อสะโพกเทียมหลวม (75.4%) กระดูกรอบข้อสะโพกเทียมหัก (8.0%) และการสึกหรอของพลาสติกรองเบ้าสะโพกเทียม (5.8%) ส่วนสาเหตุของการล้มเหลวในระยะแรกภายใน 5 ปี คือ การติดเชื้อของข้อสะโพกเทียม (29.6%) ข้อสะโพกเทียมหลวม (28.4%) และข้อสะโพกเทียมไม่มั่นคง (22.2%) เมื่อศึกษาเปรียบเทียบกับผู้ป่วยที่ไม่ได้เข้ารับการผ่าตัดแก้ไขข้อสะโพกเทียมพบว่า ถ้าผ่าตัดเปลี่ยนข้อสะโพกเทียมครั้งแรกเมื่ออายุน้อยกว่า 45 ปี จะลดความเสี่ยงต่อการผ่าตัดแก้ไขได้ 0.695 เท่า ขณะที่ถ้าใช้ข้อเทียมที่ยึดแบบไฮบริดจะมีความเสี่ยงต่อการผ่าตัดแก้ไขมากขึ้น 1.652 เท่า*
สรุป: *การผ่าตัดเปลี่ยนข้อสะโพกเทียมส่วนใหญ่จะล้มเหลวหลังจาก 5 ปี การติดเชื้อเป็นสาเหตุหลักของความล้มเหลวในระยะแรก ภาวะข้อสะโพกหลวมเป็นสาเหตุหลักในระยะแรก การยึดข้อเทียมแบบไฮบริดเป็นปัจจัยเสี่ยงที่สำคัญของการผ่าตัดแก้ไข ส่วนการผ่าตัดในผู้ป่วยอายุน้อยพบว่ามีความเสี่ยงที่ลดลง*
