

Young age and wedge stem design are risk factors for periprosthetic fracture after arthroplasty due to hip fracture

A case-control study

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Background It has been suggested that a hip fracture as a primary diagnosis for arthroplasty is a risk factor for periprosthetic fracture.

Patients and methods We compared 16 patients with late periprosthetic fracture of the femur to 48 controls. The primary diagnosis for all patients was hip fracture. The date of operation for hip fracture was used to select the control group of patients, all of whom were operated at the same time and in the same hospital district. No other selection criteria were used. Complications at the time of index operation, type of prosthesis, age, sex, BMI, patient's diseases, medication, and surgeon's experience were compared using conditional logistic regression.

Results We found that low age at the time of the hip fracture operation increased the risk of periprosthetic fracture (OR = 4.9, CI = 1.2–20). The polished wedge type of prosthesis was associated with a higher risk of periprosthetic fracture than were other designs (OR = 11, CI = 1.2–97).

Interpretation These findings of risk factors for periprosthetic fracture are new and should be confirmed by further studies using larger numbers of patients.

Periprosthetic fracture (PF) of the femur is a rare complication of hip arthroplasty. It has been proposed that a previous hip fracture may be a risk

factor, with both fractures usually being a consequence of falling (Beals and Tower 1996, Sarvilinna et al. 2003, 2004). Risk factors in hip fracture of the elderly may also apply to the periprosthetic fracture. There has only been one finding of correlation between the design of the prosthesis and periprosthetic fracture type (Löwenhielm et al. 1989). In a register-based study of 32 000 hip arthrosis patients, the design of the prosthesis was not found to be a risk factor (Sarvilinna et al. 2003).

In this case-control study, 16 patients with late PF after arthroplasty of hip fracture were compared to a control group of 48 patients who were treated with arthroplasty for hip fracture. We used a case-control method because PF is a rare complication. Our aim was to find risk factors for periprosthetic fracture in this patient group.

Patients and methods

Patients in the case group were selected from the Tampere University Hospital register. Data were collected from all four units of the Tampere University hospital district. During years 1992–1999, the patients in the case group had been operated by using a revision femoral prosthesis because of a periprosthetic fracture. All revision prostheses were long-stemmed, and 2 of them were cemented. The

Table 1. ASA classification and associated diseases at the time of index operation

	Case group n = 16	Control group n = 46
ASA = 1	1	0
ASA = 2	5	10
ASA = 3	9	28
ASA = 4	1	8
Dementia	3	4
Depression	3	4
Diabetes	2	8
Dizziness	4	5
Hemiparesis or TIA	1	7
Rheumatoid arthritis	2	2
Elevated blood pressure	6	24
Cardiac insufficiency	3	14
Lung disease	1	2
2 or more of the symptoms above	5	17
3 or more of the symptoms above	5	6

primary diagnosis at the first hip operation was hip fracture. No other selection criteria were used, leaving 16 patients with 16 fractures into the case group. The previous operation date was collected from the patient files. This operation (index operation) was primary in 11 patients and a reoperation in 5 patients. 4 of the reoperated patients were primarily treated by internal fixation and 1 by unipolar prosthesis. Median time from index operation to reoperation was 2.8 (Q_1 – Q_3 = 1–8) years. There were 12 women and 4 men, with a median age of 74 years (Q_1 – Q_3 = 69–78). 1 patient in the case group had a loose prosthesis and was waiting for a reoperation at the time of PF. The closing date of our study was December 1, 2002. The follow-up for possible periprosthetic fracture was from the index operation to the closing date, to re-operation or death.

The date of the index operation was used to find three controls for each case. Control patients were operated at the same hospital district and were the next hip fracture patients to be operated after the index operation. No other selection criteria were used, leaving 48 patients with 48 hip fractures and no periprosthetic fractures in the control group. 45 patients were operated due to hip fracture using hip arthroplasty. 3 patients had undergone revision because of failure after primary hip fracture: 2 because of pseudoarthrosis and 1 because of loosening of the Thompson prosthesis. There

Table 2. Type of prosthesis after the index operation

Prosthesis type	Case group n = 16	Control group n = 48
Austin-Moore	0	1
Bimetric bipolar	2	0
Biomet total	1	3
Euro	0	1
Exeter	6	6
Lubinus	1	3
Thompson	6	34

were 42 women and 6 men, with median age of 80 years (Q_1 – Q_3 = 74–86). The median time from the index operation to the closing date (12 patients), reoperation (3 patients), or death (33 patients) was 3.8 (Q_1 – Q_3 = 2–8) years.

Postoperative and late complications after the index operation were compared. This information was obtained from the case records, including scheduled follow-up. All complications that require hospital care or follow-up control are recorded in patient files at Pirkanmaa hospital district. Age (under or over 70, and under or over 80), sex, number of drugs (0, 1, 2 or more), any medication affecting the central nervous system (0, 1 or more), patient diseases mentioned in patient files at the time of the index operation (one by one), number of earlier fractures in other bones (0, 1 or more), ASA group (Table 1), prosthesis type and BMI (< 25 and > 25) at the time of the index operation were compared. The type of index operation (primary or reoperation) was compared between the groups. The study groups included 7 types of prosthesis (Table 2). Prostheses were divided into two groups: Exeter (Howmedica Inc., Rutherford, NJ, USA) and other types of prosthesis. The possible specific association between the polished and wedge design of the prosthesis and the incidence of PF was studied. Surgeons were divided into three groups, based on their experience at the time of the index operation: orthopedic trainees, general surgeons and orthopedic surgeons. Patient diseases mentioned in patient files at the time of the index operation were compared between the groups and in categorized groups (< 2 or \geq 2 diseases, and < 3 or \geq 3 diseases) (Table 1). A multivariate analysis was done including age (\leq 70, > 70, \leq 80, > 80 years), BMI (< 25, \geq 25) and sex.

A power analysis showed that the sample size was large enough to show statistically significant differences (> 80% probability) between the groups when the percentage difference in prevalence of the studied factor between the case ($n = 16$) and the control ($n = 48$) group was over 45% units (ko) ($p < 0.05$). Patients were matched using date of the index operation. Analysis was done using conditional logistic regression analysis. Odds ratios (OR) were calculated with 95% confidence intervals (CI) and a p -value below 0.05 was considered significant. Median and quartiles (Q_1 – Q_3) for time variables are presented. SPSS for Windows (version 10.1; SPSS Inc., Chicago, IL, USA) and the STATA program (version 7.0; Stata Corporation, TX, USA) were used.

Results

In the case group, the reason for the index operation was falling on plain ground for 15 patients, and a car accident for 1 patient. In the control group, the reason was falling on plain ground for 44 patients, slipping and falling for 3 patients, and a hit for 1 patient. 94% of the injuries in the case group and 100% of injuries in the control group were low-energy traumas. 2 of fractures in the case group and 16 of fractures in the control group occurred at home.

In the conditional logistic regression analysis, the ASA group, number of medications, number of medications affecting the central nervous system, BMI, weight, the experience of the surgeon, complications at the time of the index operation, the patient's diseases considered separately (heart failure, neurological diseases, lung diseases, rheumatoid arthritis, blood pressure, diabetes, depression, dementia) and sex had no statistically significant association with PF. There were no statistically significant differences in postoperative or late complication rate between the groups after the index operation. Reoperation as indication for index operation was a risk factor for PF (OR = 13.1, CI = 1.5–114).

BMI and age together were not found to have any influence on the incidence of PF in multivariate analysis. Age under 70 years (OR = 4.9, CI = 1.2–20) alone increased the risk of PF in the con-

ditional regression analysis. According to this type of analysis, polished and wedge-shaped (Exeter) prosthesis type increased the risk of PF as compared to all other types of prosthesis (OR = 11, CI = 1.2–97). One of these prostheses was operated after nonunion following internal fixation, whereas the rest were primary operations.

Discussion

The age-standardized incidence of hip fracture is growing in Finland. Increasing osteoporosis and increasing numbers of falls and fractures in certain birth cohorts probably have an etiologic role. (Lees et al. 1993, Kannus et al. 1999, 2002). Periprosthetic fracture of the hip is a rare complication of hip arthroplasty, and it has been discussed that a previous hip fracture may be one risk factor (Beals and Tower 1996, Sarvilinna et al. 2003). Some risk factors for hip fracture in the elderly may also increase the risk of periprosthetic fracture. McLaughlan et al. (1997) found that the average age of patients with Johansson type III fracture was greater than the average age of those with other injuries. These authors suspected that the type III injury is probably part of the natural incidence of femoral fracture rather than being a prosthesis-related problem (Johansson et al. 1981). In this study, all patients in both groups were operated mainly because of hip fracture and thus the influence of the primary diagnosis could not be studied.

Pre-existing stress risers such as cortical windows or perforations (Scott et al. 1975, Missakian et al. 1993) are risk factors for PF in the early postoperative period. Known risk factors for late postoperative PF are component loosening, osteolysis and proximal femoral bone loss (Christensen et al. 1989, Kelley 1994, Moran 1996, Radl et al. 2000). According to the literature, it seems that elderly women or patients who have loose femoral components most commonly have periprosthetic fractures (Betha et al. 1982, Tower and Beals 1999). We found 1 patient in the case group with loose femoral component before PF. The index operation was more often reoperation in the case group than in control group, and there was also one reoperation in the case group. This is not a new

finding, as the risk of PF has been estimated to be as much as two times higher in revision than in primary operations (Khan et al. 1977).

There is also a positive correlation between changes in medication and risk of falling, and use of hip protectors has been proven to prevent hip fractures (Ray et al. 1987, Parkkari 1997, Kannus et al. 2000, Gillespie et al. 2002). However, we found no evidence that medication affecting the central nervous system or any other medication increases the risk of PF. The fact that substantially more fractures in the control group took place at home could indicate a different activity level in the 2 groups, but we were unable to study daily activities or calculate Harris hip scores for these patients at the time of index operation, and thus this question remains unsolved.

Our aim was to study differences between hip prosthesis patients who had had PF and those who had not. The groups were large enough to allow statistical analysis using categorized variables, but not large enough to compare many small groups. As only one of the stems (Exeter) was polished and wedge-shaped, we wanted to compare it to all other prostheses and found that it increased the risk of PF. To our knowledge, this is a new finding. Other designs in our study have a shape which is meant to achieve a completely stable interface with the cement mantle or bone. Characteristically minor subsidence of the Exeter stem during the first post-operative year is not considered to be an imminent failure. It is possible that the wedge design of the stem predisposes to a trauma-related uncontrolled subsidence and subsequent fracture.

We found that age under 70 years at the time of hip fracture increased the risk of PF by 4.9 times, despite the fact that the median time from the index operation to the next operation, closing-time or death was longer in the control group. This was unexpected, since old age has been believed to be a risk factor for PF. Despite the fact that the patients in the case group were younger, there was a statistically significant difference – which further supports this observation.

Younger age, reoperation of hip fracture and polished wedge type of stem are possible risk factors for PF in hip fracture patients. We found no evidence that risk factors for hip fracture and PF might be the same. However, many other factors

such as osteoporosis and the daily activities of the patient were not included in this study, and thus further studies are required to explain our findings. Unfortunately, primary hemiarthroplasties after hip fracture are not included in Finnish Arthroplasty Register. This might otherwise have facilitated conduction of a large register-based study of PF as a complication after hip fracture operation.

No competing interests declared.

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