

Cemented Hemiarthroplasties Are Associated with a Higher Mortality Rate after Femoral Neck Fractures in Elderly Patients

Cementované hemiartroplastiky u zlomenin krčku femuru starších pacientů jsou spojeny s vyšší úmrtností

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ABSTRACT

PURPOSE OF THE STUDY

The postoperative outcomes of total hip replacement and hemiarthroplasty after femoral neck fractures in elderly patients were analysed to determine general and local complications as well as morbidity and mortality rates in order to detect risk profiles and assess the best individual treatment option.

MATERIALS AND METHODS

One hundred sixty-one femoral neck fractures among patients aged ≥ 65 years treated with cemented hemiarthroplasty (HA) or uncemented total hip arthroplasty (THA) between January 2005 and October 2013 were evaluated. In the presence of articular pathologies as well as a fracture type Garden III or IV, the indication for joint replacement was given. Criteria for performing hemiarthroplasty were previously limited mobility. Freely and fully mobilised patients and patients with manifested osteoarthritis received a cementless THA. A comparison of the observed complications was made, differentiating between general and surgery-specific hip-related complications. Furthermore, the mortality rates were analysed in relation to the respective surgical treatment.

RESULTS

Seventy cemented HA and ninety-one uncemented THA were performed. There was a high complication rate of approximately 19% in both surgical intervention groups. The patients were more likely to develop general complications (HA 12.8%; THA 10.8%) even though cardiopulmonary complications occurred more frequently in the cemented HA group. Four patients died after cemented hemiarthroplasty due to thromboembolic events (5.7% mortality rate), whereas no deaths occurred after total hip replacement. Surgery-specific complications rates were 7.8% in THA and 5.7% in HA patients.

CONCLUSIONS

THA in elderly patients with femoral neck fractures is associated with a higher complication rate, mostly of general medical entity. After cemented HA, our study reveals a high mortality rate due to thromboembolic events. For patients with multimorbidity in particular, these findings therefore suggest that uncemented THA should be considered to prevent lethal complications.

Key words: femoral neck fracture; total hip arthroplasty; hemiarthroplasty; complications.

INTRODUCTION

The medial femoral neck fracture represents one of the world's most common types of fracture and, as a result of the demographic development of the western industrialised nations, its incidence is constantly increasing (27). Thus, more than 6 million femoral neck fractures per year are expected worldwide in the year 2050 (2). As a result of the higher multimorbidity of the mostly elderly patients, the 2-year mortality rate after surgically treated fractures close to the hip is between 9 and 43%

(3, 13, 14). It is therefore very important to determine the best patient-specific therapy with the lowest complication rate. Surgery is the method of choice today (1, 11, 13, 24, 27). Beside the surgeon's preference and the basic trauma surgery or orthopaedic orientation of the respective hospital, the decision regarding the treatment strategy is primarily influenced by radiological (fracture age, degree of osteoarthritis, fracture classification) and patient-related criteria (patient age, prior degree of

mobility, comorbidities) (10, 13, 22). In patients with pre-existent osteoarthritis or irreducible and unstable fracture types, joint replacement by means of femoral hemiarthroplasty (HA) or total hip arthroplasty (THA) is the method of choice (11, 14, 16, 19, 22, 23, 25, 27). With regard to patient characteristics and risk profiles, however, the best individual treatment option remains a matter of considerable debate (3, 13, 14, 17, 19, 22). Therefore, the objective of this study was to evaluate total hip replacement and hemiarthroplasty in terms of complication rates as well as mortality and morbidity rates. In accordance with these investigations, general risks and risk groups are to be identified, in order to generate therapy recommendations with a best possible patient-orientated treatment strategy for this complex patient population.

MATERIAL AND METHODS

After receiving approval from the ethics committee, a retrospective data collection was conducted on the basis of the hospital's internal information system and the specific ICD codes. Thus, all patients who had undergone treatment in our department for a femoral neck fracture in the period between 01.01.2005 and 31.10.2013 were selected. Patients were then included in the study if they were at least 65 years old and had undergone THA or HA. With regard to the minimum age, we followed the inclusion criteria of the American Academy of Orthopedic Surgeons for drafting of the current evidence-based AAOS Clinical Practice Guideline for the treatment of fractures close to the hip in elderly people (24, 29). In patients taking oral anticoagulation, preoperative conditioning was initially indicated by switching to therapeutic anticoagulation with low molecular weight heparins. In the presence of additional articular pathologies (osteoarthritis, avascular necrosis of the femoral head, AVN) as well as a fracture type Garden III or IV, the indication for artificial joint replacement was given. Criteria for performing hemiarthroplasty were previously limited mobility under preoperative assistance of a rolling walker or walking aids. For this purpose, a cemented prosthetic stem (Versys-Heritage, Zimmer, Warsaw, Indiana, USA) with a dual head (metal shell with 28 mm metal head, Aesculap, Tutlingen, Germany) corresponding to the diameter of the femoral head was used. Cementing was done with 80 mg Palacos cement (Heraeus, Wehrheim, Germany) after extensive lavage of the medullary space and use of a medullary plug (Ethisorb, Ethicon, Somerville, USA). Freely and fully mobilised patients and patients with manifest osteoarthritis generally received a cementless THA (straight stem, SL-Plus standard stem, Smith&Nephew, Warsaw, Indiana, USA; press-fit cup, Allofit®, Zimmer, Warsaw, Indiana, USA; 32 mm PE inlay (highly cross-linked PE), 32 mm ceramic head (Biolox® forte, Ceramtec, Plochingen, Germany). After all interventions, mobilisation on the first postoperative day under pain-adapted full weight bearing was aimed for. As far as allowed by coordination, this was done on forearm crutches or with the aid of a rolling walker or

walking frame. The interventions were performed by different surgeons. A specialist physician with several years experience in the respective surgical technique was always present. The surgical methods were evaluated taking the following aspects into account: period of time between diagnosis and surgical treatment, duration of the operation, period spent in the intensive care unit (ICU), total period of hospitalisation, total packed red blood cells (PRBCs) transfused and the haemoglobin value on the first postoperative day (POD).

In addition, a comparison of the complications observed was made, differentiating between general and surgery-specific hip-related complications. With regard to the classification of complications, we refer to a study by Blomfeldt et al. on the evaluation of the surgical outcome in an elderly patient population after dislocated femoral neck fractures (3). The general complications were further differentiated according to the predominantly affected organ system into pulmonary (pneumonia, pulmonary artery embolism (PAE), respiratory failure, pulmonary oedema), cardiac (myocardial infarction, angina pectoris symptoms, hypotensive circulatory disorders, cardiac arrhythmias), nephrological (acute kidney injury), gastrointestinal (ulcer bleeding) or neurological entities (stroke). Pneumonia or pulmonary oedema were diagnosed on the basis of clinical (body temperature, auscultation) and laboratory aspects (blood gas analysis (BGA), ANP, BNP) as well as radiologically by means of posterior-anterior (PA) standing chest x-ray images, if this was not possible by anterior-posterior (AP) supine chest x-ray images. Respiratory failure was defined as an arterial reduction of oxygen partial pressure to below a limit value of 65 mmHg under ambient air conditions. The diagnosis of PAE was rendered by contrast medium enhanced CT imaging. A myocardial infarction was defined as an elevation of troponin T with (ST-segment elevation myocardial infarction, STEMI) or without (non ST-segment elevation myocardial infarction, NSTEMI) morphological changes in the ECG, whereas the diagnosis of unstable angina pectoris symptoms was rendered exclusively on the basis of clinical symptoms without physical activity. Cardiac arrhythmias were diagnosed electrocardiographically under the premise that a preoperative ECG finding was normal. A hypotensive circulatory disorder was defined as a systolic blood pressure < 80 mmHg for > 5 min under prior exclusion of other causal factors (volume deficit, bleeding). Acute kidney injury was present at a creatinine value > 2 mg/dl in the case of preoperative retention parameters in the normal range and oliguric (< 400 ml total urine per day) or non-oliguric elimination. Gastrointestinal bleeding was diagnosed by means of oesophago-gastroduodenoscopy. If stroke-like events were suspected, a CT was performed.

Periprosthetic fractures, dislocations, nerve lesions and infections were rated as surgery-specific complications. The need for revision surgery was also rated as a complication. Periprosthetic fractures and dislocations were diagnosed clinically as well as radiologically on the basis of pelvic x-ray and axial images. Nerve lesions were diagnosed clinically and verified by means of

electrophysiological examinations. An infection was present if there was a positive test for pathogens after hip puncture or a wound healing disorder with putrid retention.

In addition, the mortality rates observed over the course were analysed in relation to the respective surgical treatment. In order to detect risk groups, patient-related parameters were also evaluated in relation to the investigated outcome and complication rates. For this purpose, the patient population was examined for the documented American Society of Anesthesiologists (ASA) scores, the calculated body mass indices (BMI) as well as for the presence of manifest dementia (Mini Mental State Examination, MMSE < 20 points) and the surgical outcomes and complications were set in relation to these parameters. Statistical analysis was performed with a defined significance level of $p < 0.05$ using the software program SPSS (Version 21, IBM, Armonk, NY, USA).

RESULTS

A total of 161 patients were included in the study. Of these, 70 (43.5%) underwent hemiarthroplasty and 91 (56.5%) total hip arthroplasty.

Hemiarthroplasty

The mean age of the HA patients was found to be significantly greater than in the THA group and was 81.7 ± 7.4 years. With regard to the duration of surgery, at an average of 94 ± 29 min, statistically longer cut to suture times were observed for these procedures. Furthermore, the HA patients were found to spend a significantly longer period in intensive care ($4.7 \text{ d} \pm 3.8 \text{ d}$), but a significantly shorter period in hospital. A quantitative and statistical overview of the respective patient-specific data is presented in Table 1. After implantation of the femoral prosthesis, a total complication rate of 18.5% was observed. Predominantly general complications occurred (12.8%), which were attributable to pulmonary entities in 6 cases alone. A pulmonary embolism (PAE) was diagnosed in 3 patients during surgery and over the postoperative course. In addition, 2 cases of pneumonia, one of respiratory failure and 3 cardiac events (myocardial infarction, hypotensive circulatory disorder, paroxysmal atrial fibrillation; Table 2) were observed. Surgery-specific problems were found in 5.7% of the cases. Here, different complications occurred in 4 cases (periprosthetic fracture, dislocation, nerve lesion, infection), but none of them required revision. Four patients of the HA group died during their hospital stay, due to secondary pulmonary and cardiac complications, which yields a mortality rate of 5.7%. An overview of the complication, revision and mortality rates is presented in Table 2.

Total hip arthroplasty

The THA patients were on average 76.4 ± 7.5 years old and showed the significantly longest periods spent in hospital ($14.4 \pm 8.3 \text{ d}$). Furthermore, quantitatively the most packed red blood cells were transfused after total hip arthroplasty. A blood transfusion was necessary

Table 1. Patient specific overview

		HA (n=70)	THA (n=91)	p value
Age (a)	Mean	81.7 ± 7.4	76.4 ± 7.5	(< 0.001)
	Median	83	76	
	Range	68 to 97	66 to 97	
Time until surgery (d)	Mean	1.5 ± 2.3	1.6 ± 1.2	(0.134)
	Range	0 to 13	0 to 7	
Duration of surgery (min)	Mean	94 ± 29	86 ± 37	(0.009)
	Median	90	75	
	Range	35 to 205	37 to 285	
ICU stay (d)	Mean	4.7 ± 3.8	2.5 ± 3.4	(0.04)
	Median	3	3	
	Range	1 to 12	1 to 13	
	Proportion	21.4%	13%	
Hospital stay (d)	Mean	11.5 ± 5.6	14.4 ± 8.3	(0.007)
	Median	11	12	
	Range	1 to 42	8 to 56	
Transfusion of PRBCs (n)	Mean	0.8 ± 1.4	1.0 ± 1.3	(0.188)
	Range	1 to 5	1 to 6	
	Frequency	32%	42%	
Hb 1st POD (g/dl)	Mean	10.1 ± 1.3	9.7 ± 1.5	(0.134)
	Range	6.9 to 13	6.2 to 15.6	

Table 1 displays a quantitative and statistical overview of the respective patient-specific data, providing information on patient demographics, treatment times, stays, Hb value and transfusion of PRBCs. P values allow significance determination between the patient groups.

Table 2. Complications, revision and mortality rates

Complications	HA (n=70)	THA (n=91)
Proportion of total (%)	18.6 (n=13)	18.7 (n=17)
Proportion of general (%)	12.8 (n=9)	10.8 (n=10)
Pulmonary (n)	6	3
Pulmonary oedema (n)	–	2
Pulmonary artery embolism (n)	3	–
Respiratory failure (n)	1	1
Pneumonia (n)	2	–
Cardiac (n)	3	3
Myocardial infarction (n)	1	–
Hypotensive circulatory disorder (n)	1	–
Atrial fibrillation (n)	1	2
Unstable angina pectoris (n)	–	1
Neurological (n)	–	1
Stroke (n)	–	1
Gastrointestinal (n)	–	1
Ulcer bleeding (n)	–	1
Nephrological (n)	–	2
Acute kidney injury (n)	–	2
Proportion of surgery-specific (%)	5.7 (n=4)	7.8 (n=7)
Periprosthetic fracture (n)	1	4
Dislocation (n)	1	2
Nerve lesion (n)	1	–
Delayed wound healing (n)	1	–
Infection (n)	–	1
Revision rate (%)	0	4.3 (n=4)
Mortality rate (%)	5.7 (n=4)	0

Table 2 provides detailed information on quantitative and percentual composition of general and surgery specific complications, defined in sub-divisions, as well as information on revision and mortality rates.

in 38 THA operations (42%). A quantitative and statistical overview of the respective patient-specific data is presented in Table 1. The total complication rate of the THA patients was 18.6%. General complications were predominantly observed, at 10.8%. In contrast to the HA group, however, there was no organ-specific focus. Pulmonary, cardiac, neurological, gastrointestinal and nephrological entities were observed with an equivalent incidence (Table 2). Surgery-specific complications occurred in 7 patients (7.8%). Four periprosthetic fractures (3 trochanter fractures, 1 stem fracture), 2 dislocations and 1 infection were observed, which required revision over the further course in 4 cases (1 stem fracture, 1 trochanter fracture, 1 infection, 1 dislocation). This yielded a revision rate of 4.3% in the THA group. The mortality rate in the observation period was 0%. An overview of the complication, revision and mortality rates is presented in Table 2.

With regard to the preoperatively collected ASA scores, no significant difference was found between the three comparative groups ($p = 0.8$; Table 3). The majority of patients were classified to the ASA scores 2 and 3. The highest rate of dementia was observed in the group of HA patients (27%), at a significance level of $p < 0.01$ (Table 3).

Table 3. ASA scores and dementia

	HA	THA	p value
ASA score (n)			
1	10 (14.2%)	7 (7.6%)	0.58
2	29 (41.4%)	42 (46.2%)	
3	29 (41.4%)	40 (44%)	
4	2 (3%)	2 (2.2%)	
Dementia (n)	19 (27%)	10 (11%)	0.008

In Table 3 recorded ASA scores are listed and the proportional distribution was analysed for HA as well as THA patients. Further, the table provides information on the quantitative and percentual number of detected dementia cases in both patient cohorts. P values allow an assessment of significance levels.

DISCUSSION

The optimum treatment for femoral neck fractures in elderly people is the subject of considerable debate (1–3, 10, 13, 16, 21–23, 29). In the present study, a retrospective analysis of 161 patients with medial femoral neck fractures and subsequent joint replacement surgery (HA or THA) was conducted. The general and local complications as well as morbidity and mortality rates were to be evaluated.

In both treatment options, a high complication rate of around 18% (proportion of total) was determined. The patients showed a higher rate of internal medical problems. These were observed most frequently in the group of cemented hemiarthroplasties, in which among other things four thromboembolic events (3 PAE, 1 myocardial infarction) occurred over the postoperative course, with a lethal outcome. In a study conducted by Christie

et al., the intraoperative embolic complications experienced by 20 patients after cemented or cementless HA implantation were investigated by means of transoesophageal echocardiography (5). A much higher rate of thromboembolic events in the sense of pulmonary or cardiac embolisms was observed in the group of cemented endoprostheses (5). In a further investigation conducted by Hossain and Andrew, who evaluated a population of 1402 patients with surgically treated proximal femoral fractures, a total of 15 (1%) deaths occurred within a period of 48 hours after the start of surgery (12). The highest mortality rate was also observed in the cemented HA group, at 2.5% (8 of 314 patients), whereas no deaths were registered after the uncemented HA operations (0 of 168 patients, $p < 0.001$). An autopsy performed on 3 of the deceased 8 patients of Hossain and Andrew identified PAE as the cause of death in 2 cases. The average age of the HA patients (cemented and uncemented), at 82 years (range, 73–94 years), was comparable with the respective patient population of our study, as were the documented ASA scores (12). On the basis of our data, a total mortality rate of 2.5% was determined. All deaths were also observed in the cemented HA population (4 of 70 patients; 5.7%). Preoperatively, all of them had been rated as type 3 or 4 according to the ASA classification. Thus, there appears to be a connection between comorbidities, cementing and the occurrence of lethal thromboembolisms in the HA patient collective. Precisely against this background, the option of a cementless HA implantation should be considered for reduction of these complications, naturally taking into account adequate bone quality. In a study conducted by Ozturkmen et al., the results of 48 uncemented HA patients with an average age of 88 years were investigated over a follow-up period of 4.2 years after proximal femoral fractures. No deaths occurred over the entire period of the patients' stay in hospital. The only revision had to be performed due to stem migration. On the basis of good functional and clinical outcomes, the authors concluded that cementless HA implantation represents a good method for the surgical treatment of proximal femoral fractures, particularly in patients with existing cardiovascular comorbidities (20). Voskuil et al. investigated femoral neck fractures addressed with total or hemiarthroplasty in more than 82,000 patients and concluded that the duration of their hospital stay and the mortality rates were exclusively associated with the existing preoperative comorbidities and not with the surgical procedure. Although a 40% higher risk of complications was determined in the hemiarthroplasty population, this was attributed to a selection bias as a result of the greater number of comorbidities diagnosed. The results were not differentiated according to cemented or cementless hemiarthroplasty (29). Surgery-specific complications after primary total hip arthroplasty are described as being between 2.1% and 9% in the literature (6, 7, 26). In our study, they were seen in 7.8% of the cases in non-elective patients with femoral neck fractures. Here, 3% involved a fracture of the greater trochanter. Osseous lesions of the greater trochanter are observed

in total hip arthroplasty in 0.5% to 11% of all primary implantations, depending on the surgical approach chosen (15, 28). In a study conducted by Laffosse et al., the anterolateral approach was investigated in comparison with the posterior approach in primary arthroplasty. A fracture of the greater trochanter occurred in 4 of 35 patients (11%) with the anterolateral approach, in contrast to which no osseous lesions were observed in 43 procedures with a posterior approach. Berend et al. also reported significantly higher fracture rates after the anterolateral (32 of 476; 6.3%) compared with the posterior (26 of 1959; 1.3%) approach in over 2500 primary implantations. In contrast to this, the results of Tsai et al. showed only 5 trochanter fractures (0.5%) in over 1000 primary THA implantations via a modified anterolateral approach. Whereas the disadvantages of the anterolateral approach appear to be potential fractures of the greater trochanter, the posterior approach is associated with an increased risk of dislocation. In this study, low dislocation rates were found (HA 1.5%, THA 2.2%). In comparative literature research concerning the choice of the posterior approach, dislocation rates of 7% to 14% are described in primary total hip arthroplasty after medial femoral neck fractures (8, 9, 18). On the basis of the evaluation of more than 1400 THA operations after femoral neck fractures, the data of the Lithuanian Arthroplasty Register demonstrate a 2.3-fold higher risk of revision due to dislocation when the posterior approach is used, compared with the anterolateral technique (4). In a clinical practice guideline published by the AAOS, 25 recommendations concerning the treatment strategy for hip fractures in the elderly were described, based on 169 scientific articles. As an evidence-based finding, the posterior approach was associated with increased dislocation rates in dislocated femoral neck fractures after joint replacement surgery and thus a recommendation for the use of alternative approaches was given for this patient population (24).

SooHoo et al. investigated the 3-month complication rate of over 45,000 patients who had undergone THA or HA after medial femoral neck fractures (26). Surgery-specific complications (dislocation, infection) were observed in 2.1% of the THA population, compared with 2.2% of all HA patients. Compared with our data, a lower rate of surgery-specific events is shown by both therapy groups of SooHoo et al. However, the authors reported markedly higher mortality rates (12.9% for HA; 10.1% for THA), compared with the present study. Thus, the total complication rate (17.4% for HA, 14.4% for THA) in SooHoo et al. was found to be comparable with the data of our study, with comparable patient demographics (average age 78 years for THA, 81 years for HA). The authors did not observe any significant differences between the observed number of revision operations and the surgical method performed (26).

A few limitations must be mentioned for the present study. It is a retrospective analysis, without a fixed follow-up period. In addition, complications were recorded only if they occurred during the patients' stay in hospital or were diagnosed upon the patients' renewed presentation

at the outpatient department. Patients who were treated at external hospitals could not be included in the evaluation statistics. An evaluation of quality of life and patient satisfaction was not implemented. A further critical point to be mentioned is that the average age differed between the respective investigational groups. The interventions were performed by different, but always experienced surgeons who were well versed in the respective surgical procedure.

CONCLUSIONS

The complications of arthroplasty tend to be of a general internal medical nature. The highest risk of mortality is for elderly patients with existing comorbidity and a cemented arthroplastic treatment. Therefore, with regard to stem anchorage, the indication for a cementless approach should be examined on the basis of the cement-associated increased thromboembolic mortality rate.

Compliance with ethical standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Conflict of interest

All authors declare no professional or financial affiliations that pose a potential conflict of interest or bias to this study.

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