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Infections after intramedullary fixation of trochanteric fractures are uncommon and implant removal is not usually needed.

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Conflicts of interest: none

Abstract

Background and purpose – Infections after intramedullary fixation of trochanteric femoral fractures are rare, but potentially life-threatening complications. There are limited data available to support decision making in these cases.

Patients and methods – A retrospective study of 995 consecutive operatively treated trochanteric fractures was made to find out different risk factors for infection and to describe the results of treatment.

Results – 28 patients developed a surgical site infection (2.8%) after intramedullary fixation of trochanteric fracture. 15 patients (1.5%) had a deep and 13 patients (1.3%) a superficial surgical site infection. Cigarette smoking ($p<0.05$) and prolonged operative time ($p<0.05$) were significant risk factors for an infection. 15 of 28 patients needed revision surgeries. Implant removal or exchange was needed only for 4 of 28 patients: 1 exchange of the blade, 1 removal of additional cable used to assist reduction and 2 removals of distal locking screws. None of the patients needed additional surgeries for problems with fracture healing. Mortality was not increased among patients with an infection.

Interpretation – Infection after intramedullary fixation of trochanteric fractures can be successfully treated without removal or exchange of the fixation material.

Keywords – hip fracture, trochanteric fracture, infection, fracture related infection

Introduction

A hip fracture is the most common operatively treated fracture among adults and daily work in trauma hospitals throughout the world. Approximately one third of hip fractures are trochanteric (1). It is estimated that the number of hip fractures will double between 2002 and 2050 (2).

Prosthetic joint infections are a well described complication after hemiarthroplasty performed for a hip fracture (3-6). The rate of prosthetic joint infections after hip fractures seem to be somewhat 2.2 - 6 % (5, 7, 8), and different treatment strategies have been developed to treat the infections (9, 10).

Previously reported non-modifiable risk factors for an infection after hip fracture surgery include obesity, glucocorticoid use and raised preoperative CRP-level, and as modifiable risk factors prolonged surgical delay, experience of the surgeon and longer operative time (11-13). Generally, the infection rates after intramedullary fixation of trochanteric fractures have been low (2-3%) and the risk factors are rather unknown (14-16).

A deep infection leads to longer stay in hospital and significantly higher mortality (14-16). It can also impair the patients' long-term mobility and they are less likely to return to their pre-injury residence (15).

There is still limited knowledge on the infection rates and infection predictive factors on intramedullary fixated trochanteric fractures. Furthermore, there are no clear guidelines on treatment protocols on fracture related infections on operative treated trochanteric fractures. Our hypothesis was that compared to what is known from many other fractures, surgical site infections after intramedullary fixation of trochanteric hip fractures could be treated without implant removal or exchange. Therefore, we conducted a retrospective review of 995 consecutive trochanteric hip fractures and analyzed specifically surgical site infections as an adverse event.

Patients and methods

All patients were identified from the hospital surgery database, by querying our operating theatre database for ICD-10 diagnoses coded as trochanteric fracture (S72.1) and with a procedure code for intramedullary fixation of proximal femoral fracture (NFJ54) by Nordic Classification of Surgical Procedures (NCSP). Complete chart review of all patients with a trochanteric fracture treated with an intramedullary nail fixation in Helsinki University Central hospital trauma unit, a level 1 trauma center, from 1.1.2011 to 31.12.2016 was done. In total, 995 consecutive trochanteric hip fractures on 973 patients were analyzed.

Medical and microbiological records were reviewed for recorded signs and symptoms of surgical site infections. We classified an infection as deep when the patients fulfilled the consensus group definition for Fracture related infection (17) and superficial if only superficial bacterial cultures were positive. Clinical state dictated the treatment: surgical site infections were initially treated conservatively, and a surgical debridement was done only if they responded poorly to the conservative treatment (Figure 1).

Potential patient and surgery-related risk factors for surgical site infection were identified by reviewing medical, operative, microbiological, and radiological records case by case. We collected the demographic data and possible comorbidities of the patients (ASA class, use of anticoagulants, other illnesses), delay to surgery (Table 1) and length of surgery (Table 2). Patients were followed from patient records for minimum of two years or until death. Readmissions and reoperations because of an infection were recorded and analyzed. Pathogens responsible for infection were recorded from laboratory database. Amount of revision surgeries were calculated, and patients were further divided to two groups whether the fixation material was removed or retained (Figure 1). Mortality was calculated based on information from the Finnish population information system.

The differences in demographic and preoperative characteristics between the groups were tested using the chi square test or student t-test when appropriate. P values of <0.05 were considered significant. Statistical program SPSS 25 (IBM Corp. released 2017. Armonk, NY: IBM Corp.) was used for analyzes.

Permission for the study was obtained from the research committee of the University of Helsinki and all acquired data was processed as required by European Union regulations. An ethics committee opinion was not sought, since study was a retrospective analysis of data without interaction with the patients.

Results

There were 28 surgical site infections in the 995 operated fractures (2.8%). There were 15 deep surgical site infections (1.5%) and 13 superficial surgical site infections (1.3%). Cigarette smoking was a statistically significant risk factor for an infection ($p < 0.05$, Table 1). Patients with infection had longer operations (median 97 min range 40-245 min) than patients without infection (71 min range 19-232 min, $p<0.05$) (Table 2).

Median time from initial operation to the diagnosis of an infection was 12,5 days (7-185 days). 25 of 28 patients presented with the infection within 4 weeks from the operation and only one infection presented after 2 months from the operation.

14 infections were monomicrobial and 14 were polymicrobial (Figure 2). Staphylococcus aureus (S. aureus) was found on cultures from 16 of the 28 patients (57%). There was 1 MRSA (methisillin-resistent S. aureus) infection, which resolved with 4 months antibiotic therapy without implant removal.

The most commonly used first line antibiotic was cefuroxime (17 of 28 patients). Antibiotic therapy was later addressed according to microbial cultures. Clindamycin was used for 8 patients, vancomycin for 5 patients, and cloxacillin for 3 patients. Other antibiotics used (1 for each) were piperacillin/tazobactam, ampicillin, meropenem, ciprofloxacin, fusidic acid, ceftriaxone and trimethoprim/sulfamethoxazole. 2 patients with superficial infections were treated with peroral cephalexin only. On 3 patients, permanent suppressive antibiotic therapy was used (cephalexin for 2 patients and amoxicillin for 1 patient). Median duration of nonpermanent antibiotic treatment was 31 (range 7-122) days.

18 % (5 of 28) patients had a positive blood bacterial culture (*S. aureus* n=2, *Streptococcus betahemolyticus group G* n=1, *Enterobacter cloacae* n=1, *Escherichia coli* n=1).

From 28 total infections, superficial infections (n=13) did not need surgical debridement (Figure 1). Implant removal or implant change was not done for any of the patients. For two patients with long nails the distal locking screw was removed as there was a sinus tract directly to the locking screw. Two patients had implant revisions which were not infection related: one patient had a too long blade changed for a shorter one, and another patient an additional cable used for fixation removed as it had become loose and could be seen in the wound in the debridement. None of the patients with a postoperative infection needed additional surgeries for delayed, mal-, or nonunion of trochanteric fracture. There was no increase in mortality among the patients with an infection (Figure 3).

Discussion

In our material, implant removal was not needed for any of the patients with a surgical site infection after intramedullary fixation of a trochanteric fracture. Most infections presented before the fracture had healed and therefore implant removal could cause significant morbidity in these mostly frail, elderly patients. In our study population, none of the patients with either deep or superficial surgical site infection needed additional surgeries for problems with fracture healing.

The overall surgical site infection rate in our study was low (2.8%) and deep infection rate (1.5%). A recent Norwegian cohort study of 1709 hip fracture patients including both hemiarthroplasties and sliding hip screws reported early incidence (< 30 days) of 2.2 % for deep infections (18). A Colombian retrospective study of 275 patients with trochanteric fractures reported deep surgical site infection incidence of 2.2 % (19), whereas as Harrison et. al (16) reported no deep infections on 602 patients and Edwards et. al (20) reported 3% infection rate on 129 patients. In our study the rate of surgical site infections is similar compared to previous studies.

Previously, more than 24 hours of surgical delay has been shown to increase the risk of infection after hip fracture surgery (11). In our study, surgical delay did not differ between patients with and without infection. There are contradictory reports of whether prolonged operative time increases infections after hip fracture surgery (12, 13, 16, 18, 20). We showed a statistically significant increase in infections with prolonged operative time. Length of surgery could be decreased by meticulous preoperative planning and earlier guidance from more experienced surgeon. Cigarette smoking was a statistically significant risk factor for an infection. Alcohol abuse and open reduction of fracture displayed non-significant trends towards increase in infection rate. Small total amount of infections makes it difficult to reliably point out patient characteristics increasing the risk for an infection.

Infections after intramedullary fixation of trochanteric hip fractures are uncommon complications compared to corresponding infections after hemiarthroplasty for femoral neck fractures (21, 22). Possible reasons for the significant difference in infections between hemiarthroplasty and intramedullary nails might be that intramedullary nail is inserted through small incision and the hardware is farther from the skin incision. Therefore, the hardware would less likely become affected in a superficial wound infection. The infections differ also regarding the treatment: compared to prosthetic joint infection after femoral neck fracture (5), infections after intramedullary fixation of trochanteric fractures can be principally treated successfully without implant removal or exchange.

Fracture-related infection consensus group's recommendation on general treatment principles (23) emphasize on fracture stability for both fracture healing and eradication of the infection. For many of trochanteric fractures there are no viable options for other fixation methods to achieve similar stability than cephalomedullary nails (24). Changing the nail also often compromises the vital fracture stability. Revision surgeries are only part of the successful treatment of these infections (23). Multidisciplinary team approach with early participation of infectious diseases specialist and proper microbiological samples are of paramount importance.

Previous Norwegian study (18) reported 3-fold increase in 30-day mortality and 2-fold increase in 1-year mortality on patients with an infection compared to patients without an infection after hip fracture surgery. Another recent study found increased mortality among these infected patients with OR 5.6 (19). In our study we found that an infection did not increase mortality when properly treated. This also supports treatment protocol with no implant removal.

There are several limitations to the study. Due to the retrospective nature of research, we cannot be certain that all infections were diagnosed, especially with patients who are deceased a short time after the operation. Prospective studies are warranted for the knowledge about patient reported outcome measures in this patient group. The low total amount of infections makes it difficult to observe significant differences in mortality or the risk factors for an infection.

Conclusion

Surgical site infections after intramedullary fixation of trochanteric fractures are rare. These infections seem to be associated to cigarette smoking and prolonged operative time. Mortality was not increased among patients with a surgical site infection compared to patients without an infection. Treatment without implant removal or exchange yields good results without need for additional operations for delayed, non- or malunion.

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Figure 1. Flow chart of surgical treatment and hardware removal.

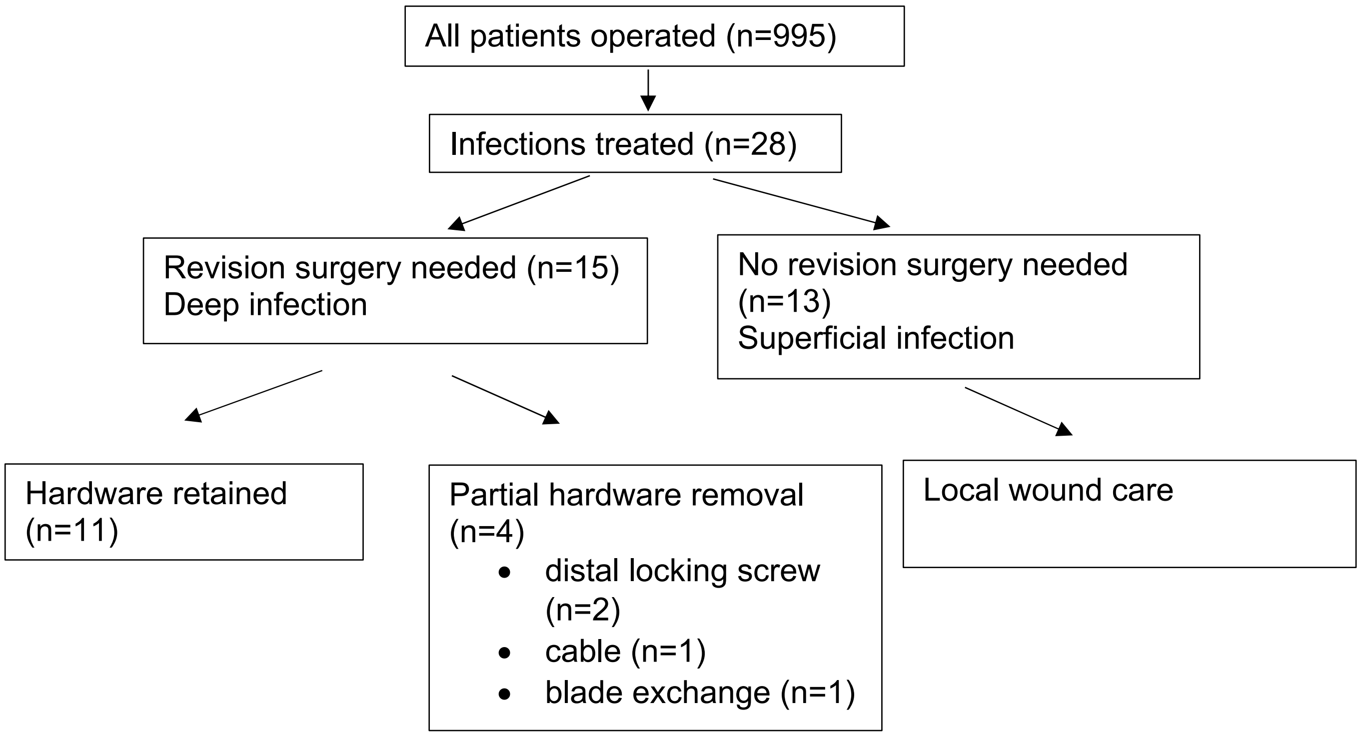

Figure 2. Pathogens from microbial cultures divided to monomicrobial and polymicrobial infections.

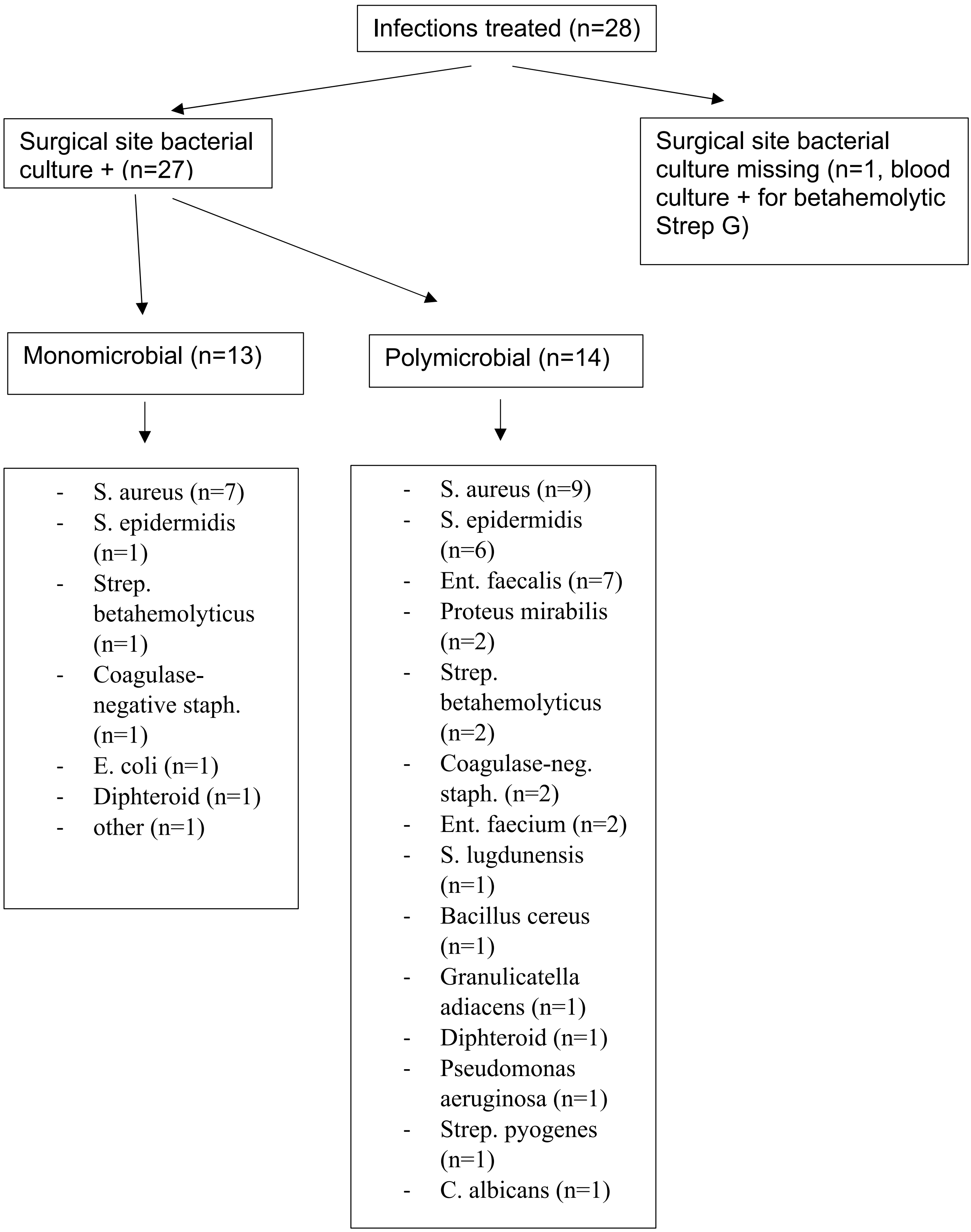

Figure 3. Cumulative survival of patients with and without infection after intramedullary fixation of trochanteric fracture.

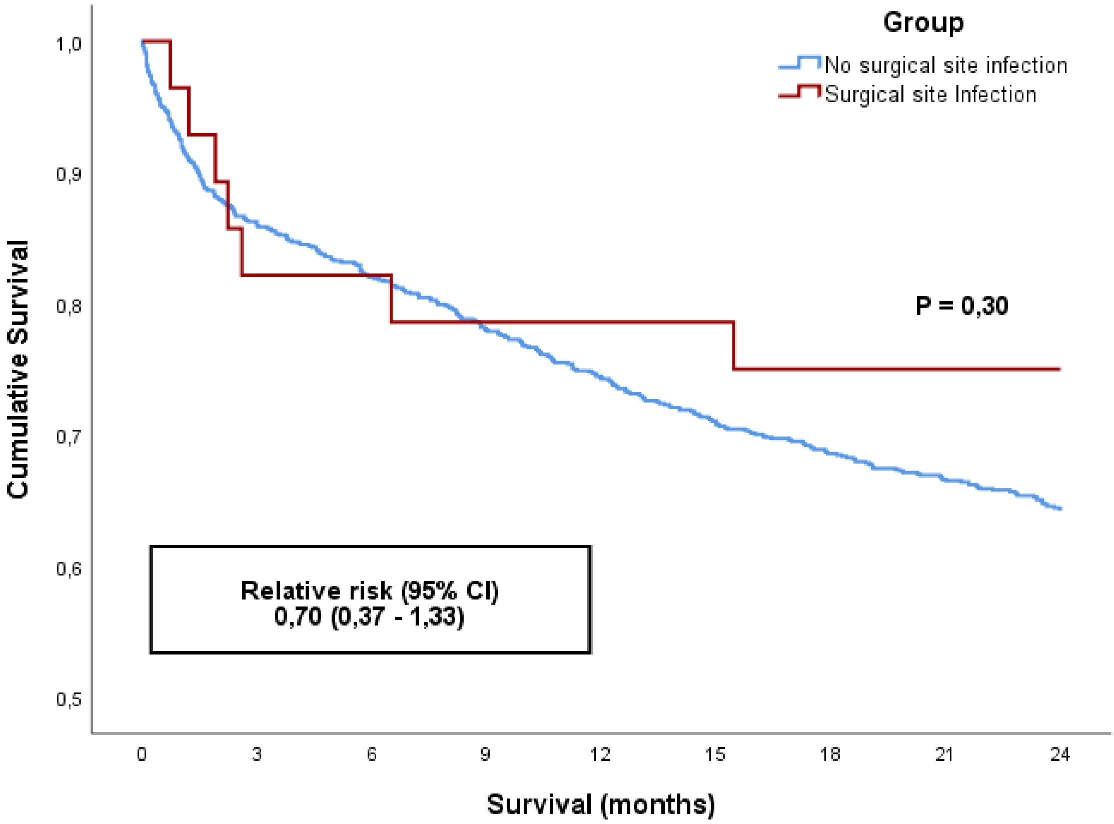

Table 1. Patient basic characteristics. Numbers are quantity (%) unless otherwise specified.

Characteristic	Surgical site infection (n=28)		No surgical site infection (n=967)		p-value	Total (n=995)	
Age, mean (range)	79.1	(53-99)	80.6	(29-104)	0.522	80.5	(29-104)
Female sex	21	(75.0%)	659	(68.1%)	0.443	680	(68.3%)
ASA[1] score, mean (range)	3.26	(2-4)	3.22	(1-5)	0.803	3.23	(1-5)
1	0	(0 %)	9	(0.9%)	0.609	9	(0.9%)
2	2	(7.1%)	60	(6.2%)	0.840	62	(6.2%)
3	13	(46.4%)	496	(51.3%)	0.612	509	(51.2%)
4	8	(28.6%)	256	(26.5%)	0.804	264	(26.5%)
5	0	(0.0%)	5	(0.5%)	0.703	5	(0.5%)
Not available	5	(17.9%)	141	(14.6%)	0.630	146	(14.7%)
CCI[2] score, mean (range)	4,82	(2-10)	4,81	(0-12)	0.936	4,81	(0-12)
Congestive heart failure	4	(14.3%)	112	(11.6%)	0.661	116	(11.7%)
Myocardial infarct	2	(7.1%)	44	(4.6%)	0.520	46	(4.6%)
Peripheral vascular disease	1	(3.6%)	39	(4.0%)	0.903	40	(4.0%)
Stroke or TIA	5	(17.9%)	119	(12.3%)	0.381	124	(12.5%)
Hemiparesis	1	(3.6%)	24	(2.5%)	0.717	25	(2.5%)
Dementia	5	(17.9%)	291	(30.1%)	0.163	296	(29.7%)
Diabetes	4	(14.3%)	164	(17.0%)	0.710	168	(16.9%)
Not complicated	3	(10.7%)	145	(15.0%)	0.531	148	(14.9%)
Complicated	1	(3.6%)	19	(2.0%)	0.551	20	(2.0%)
Liver failure	0	(0.0%)	25	(2.6%)	0.389	25	(2.5%)
Mild	0	(0.0%)	17	(1.8%)	0.480	17	(1.7%)
Moderate or severe	0	(0.0%)	8	(0.8%)	0.629	8	(0.8%)
Connective tissue disease	0	(0.0%)	22	(2.3%)	0.420	22	(2.2%)
Peptic ulcer disease	1	(3.6%)	16	(1.7%)	0.441	17	(1.7%)
COPD	4	(14.3%)	66	(6.8%)	0.128	70	(7.0%)
Tumor	2	(7.1%)	128	(13.2%)	0.346	130	(13.1%)
Localized	1	(3.6%)	115	(11.9%)	0.177	116	(11.7%)
Metastasized	1	(3.6%)	13	(1.3%)	0.324	14	(1.4%)
Kidney Failure	2	(7.1%)	23	(2.4%)	0.113	25	(2.5%)
Lymphoma	0	(0.0%)	8	(0.8%)	0.629	8	(0.8%)
Leukemia	0	(0.0%)	5	(0.5%)	0.703	5	(0.5%)
AIDS	0	(0.0%)	0	(0.0%)	N/A	0	(0.0%)
Osteoporosis	6	(21.4%)	117	(12.1%)	0.140	123	(12.4%)
Alcohol abuse[3]	3	(10.7%)	71	(7.3%)	0.503	74	(7.4%)
Tobacco smoking[4]	6	(21.4%)	94	(9.7%)	0.042	100	(10.1%)
Previous hip fracture	0	(0.0%)	63	(6.5%)	0.163	63	(6.3%)
Anticoagulation	6	(21.4%)	178	(18.4%)	0.685	184	(18.5%)
Days from ER to surgery[5], mean (range)	2,14	(1-3)	2,19	(1-13)	0.829	2,19	(1-13)
Length of stay[6], mean (range)	8.00	(3-28)	7.20	(2-34)	0.157	7.23	(2-34)
Exitus during follow-up							
30 days	1	(3.6%)	73	(7.5%)	0.430	74	(7.4%)
90 days	5	(17.9%)	132	(13.8%)	0.536	137	(13.8%)
6 months	5	(17.9%)	173	(18.0%)	0.986	178	(17.9%)
12 months	6	(21.4%)	248	(25.7%)	0.606	254	(25.5%)
24 months	7	(25.0%)	345	(35.8%)	0.240	352	(35.4%)

1. **American Society of Anesthesiologists; physical status classification system.**
2. **Charlson Comorbidity Index; Predicts 10-year survival considering comorbidities.**
3. **Medical records describing excessive alcohol consumption, ICD diagnosis for F10.1-10.9, intoxicated during the ER visit (blood alcohol l >0.5‰) or an end organ damage due excessive alcohol consumption.**
4. **Tobacco smoking at the time of the hip fracture. Previous history not recorded.**
5. **Number of complete days between the ER visit and surgery.**
6. **Number of complete days between the ER visit and the day of departure from our hospital ward.**

Table 2: Rate of infections by length of surgery. Median length of surgery was 71 min. Infections increased significantly when length of surgery exceeded 120 minutes ($p<0.001$).

Length of surgery (minutes)	Patients (n)	Infections (n)	Infections (%)
0-30	20	0	
30-60	304	5	1 %
60-90	373	9	2 %
90-120	156	2	1 %
120-150	89	5	6 %
150 -	53	7	18 %
Total	995	28	3 %