Measurement and evaluation of hip fracture care

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Trauma surgery by general surgeons: still an option for proximal femoral fractures?

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ON BEHALF OF THE STUDY GROUP ON CERTIFICATION OF TRAUMA PROXIMAL FEMORAL FRACTURES

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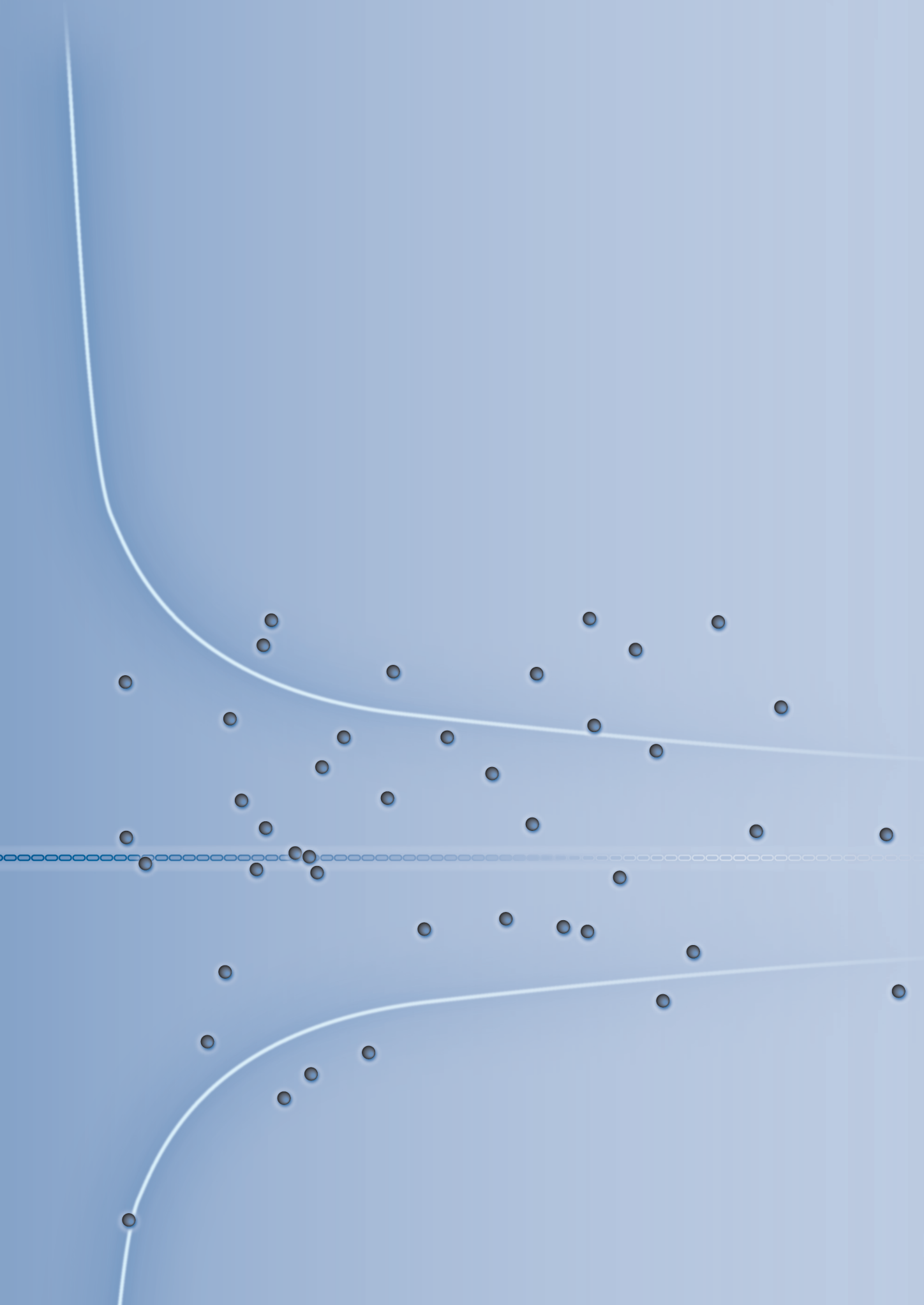


Abstract

Background

Surgery for proximal femoral fractures in the Netherlands is performed by trauma surgeons, general surgeons and orthopaedic surgeons. The aim of this study was to assess whether there is a difference in outcome for patients with proximal femoral fractures operated by trauma surgeons versus general surgeons. Secondly, the relation between hospital and surgeon volume and postoperative complications was explored.

Methods

Patients of 18 years and older were included if operated for a proximal femoral fracture by a trauma surgeon or a general surgeon in two academic, eight teaching and two non-teaching hospitals in the Netherlands from January 2010 until December 2013. The combined endpoint was defined as reoperation or surgical site infection. Multivariable analysis was used to adjust for patient and fracture characteristics and hospital and surgeon volume. Categories for hospital volume were > 170/year (high volume), 96 – 170/year (medium volume) and < 96/year (low volume).

Results

Of the 4,552 included patients 2,382 (52.3%) had surgery by a trauma surgeon. Postoperative complications occurred in 276 patients (11.6%) operated by a trauma surgeon and in 258 patients (11.9%) operated by a general surgeon ($p = 0.751$). When considering confounders in a multivariable analysis, surgery by trauma surgeons was associated with less postoperative complications (odds ratio 0.746, 95% confidence interval 0.580 – 0.958, $p = 0.022$). Surgery in high-volume hospitals was also associated with less complications (odds ratio 0.997, 95% confidence interval 0.995 – 0.999, $p = 0.012$). Surgeon volume was not associated with complications (odds ratio 1.008, 95% confidence interval 0.997 – 1.018, $p = 0.175$).

Conclusion

Surgery by trauma surgeons and high hospital volume are associated with less reoperations and surgical site infections for patients with proximal femoral fractures.

Introduction

Surgery for proximal femoral fractures has high postoperative complication percentages. For patients of 60 years and older complication percentages of 20% are reported [1]. In the Netherlands more than 15,000 patients with a proximal femoral fracture are admitted to hospital each year, accounting for 20% of all hospital admissions due to trauma [2]. Patients with proximal femoral fractures in the Netherlands are admitted either to the department of surgery or to the department of orthopaedic surgery, depending on local agreements.

Currently, surgery for proximal femoral fractures in the Netherlands is performed by trauma surgeons, general surgeons and orthopaedic surgeons. Certification of trauma surgeons in the Netherlands started in 2010, with the goal to further improve the quality of treatment of trauma patients. This certification is executed and registered by the Dutch Association of Surgeons (*Nederlandse Vereniging voor Heelkunde* – NVvH) and the Dutch Association for Trauma Surgery (*Nederlandse Vereniging voor Traumachirurgie* – NVT) [3]. Surgeons that qualify for this certificate spend at least 20% of their clinical activities on trauma care, or finished trauma differentiation after or within their surgical training. Besides specialization of the surgeon, surgeon and hospital volumes are also clinician-related parameters that could influence the complication rates after surgery for proximal femoral fractures [4-6].

The aim of this study was to investigate whether there is a difference in postoperative complications between patients with proximal femoral fractures operated by trauma surgeons compared to general surgeons. Secondly, the relation between hospital and surgeon volume and complication percentages was investigated in this patient group.

Methods

Study population

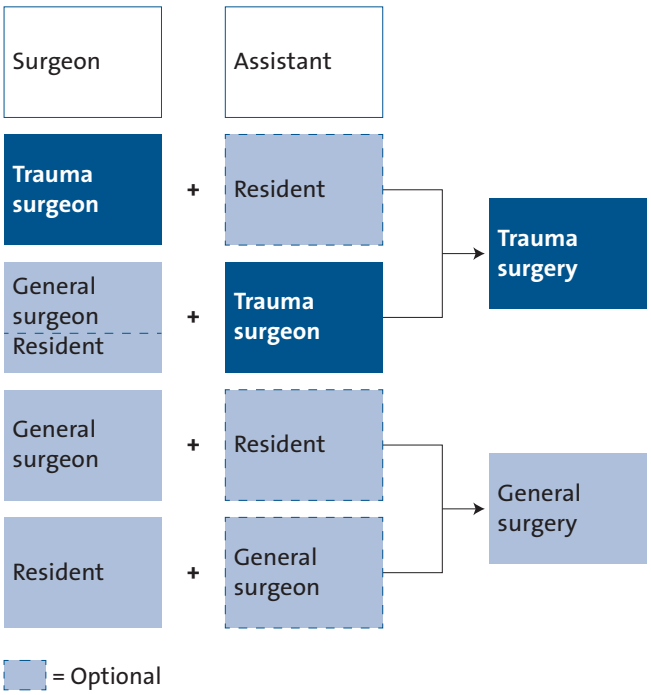
Inclusion criteria were age of 18 years or older and surgery for proximal femoral fracture in two academic, eight teaching and two non-teaching hospitals in the Netherlands from January 2010 until December 2013. Proximal femoral fracture was defined as a fracture of the femoral neck or pertrochanteric or subtrochanteric femur. Exclusion criteria were multitrauma (Injury Severity Score ≥ 16), fractures with malignancy and absence of the operative report. Patients operated by orthopaedic surgeons were excluded since this study focused on specialization within general surgery.

Definitions

Surgery was defined as having been performed by a trauma surgeon if a surgeon certified by the NVT was the first surgeon, or the first assistant when a resident was performing the surgery. Every surgeon not certified by the NVT was defined as a general surgeon. In case a

trauma surgeon acted as assisting surgeon next to a general surgeon, it was considered to be a form of supervision and the operation was filed as surgery by a trauma surgeon (Figure 1).

Figure 1. Definition of surgery by trauma surgeon (NVT-certified)



Complications were defined by a combined endpoint, consisting of reoperation within one year and deep or superficial surgical site infections. Removal of osteosynthesis material following complaints of pain, at the patient's request or because of a surgeon's preference, did not count as a reoperation. Surgical site infections were defined by the criteria of the US Center for Disease Control and Prevention [7]. Superficial wound infections were scored if only the skin or subcutaneous tissue of the surgical site was involved and these infections occurred within 30 days after surgery. Deep surgical site infections were scored if the fascial or muscle layers or joint of the surgical site were involved and these infections occurred within one year. The combined endpoint was formulated before the start of data collection.

Surgery during out-of-office hours was defined as surgery after 6 p.m. and before 7 p.m. during weekdays and surgery during the weekend.

Hospital volume was defined as the count of surgery for proximal femoral fractures at the surgery department per year averaged for the complete study period. Surgeon volume was defined as the count of operations performed by a surgeon during the respective calendar year. Surgeon volume for the most experienced surgeon in the operating team was used to define the surgeon volume for each operation.

Patient selection and data collection

Patients were selected from two regional trauma registries in the Netherlands. Patients with an Abbreviated Injury Scale (98 edition) for a fracture of the femoral neck or pertrochanteric or subtrochanteric femur and an admission date within the study period were screened for inclusion and exclusion criteria. Patient identifier variables were verified by the hospital information system. Study-specific variables and variables missing from the regional trauma registry were collected from the surgery and anesthesia reports, admission and discharge letters. The local institutional review board determined that the proposed study was not subject to the Dutch Medical Research Involving Human Subjects Act (*Wet maatschappelijke ondersteuning* – Wmo).

Statistical analysis

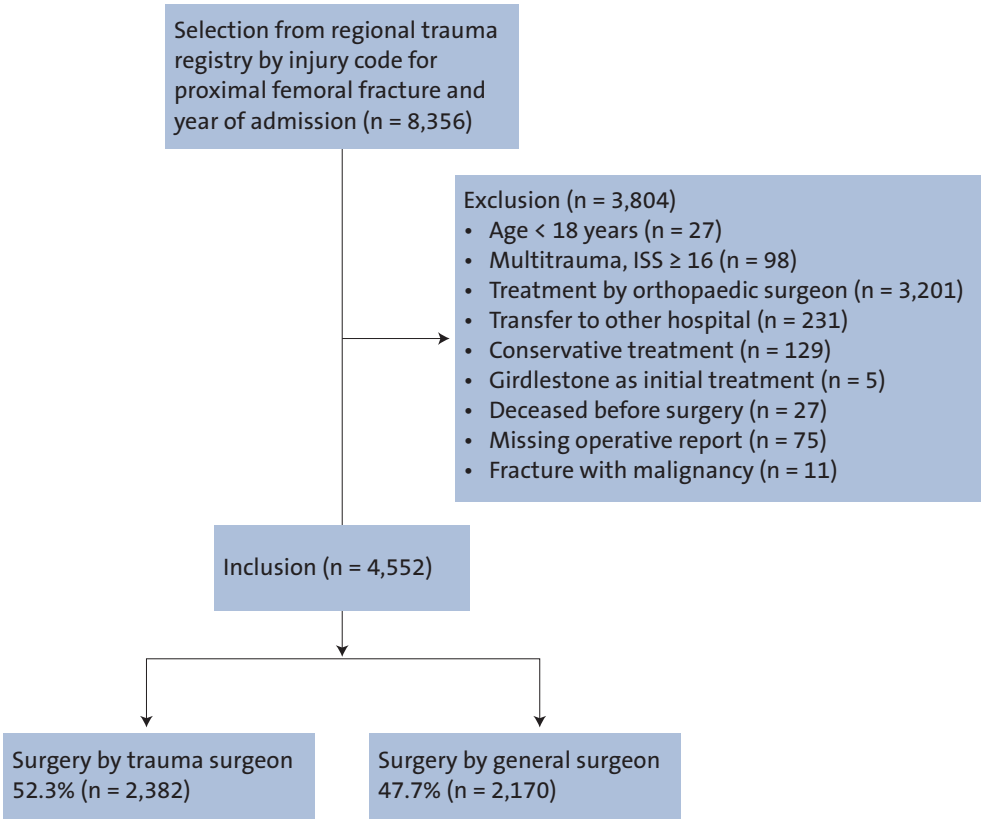
All data was analyzed using SPSS version 22 (SPSS Inc., Chicago, Illinois). Descriptive data is presented as percentages for categorical data, averages being shown with standard deviations for normally distributed continuous data and with median and interquartile ranges for non-normally distributed continuous data. Distribution of the data was assessed by the Shapiro-Wilk and Kolmogorov-Smirnov tests and frequency distribution histograms.

Data was compared by the Chi-square test for categorical data, the student's t-test for unpaired normally distributed continuous data and the Mann-Whitney U test for non-normally distributed continuous data. Differences were considered significant if p-value < 0.05. Multivariable analysis was performed to adjust for patient and fracture characteristics, and hospital and surgeon volumes. Hospital and surgeon volumes were divided into three categories with the aim to obtain equal patient counts. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated in comparison to the low-volume categories.

Results

From two regional trauma registries 8,356 patients with a proximal femoral fracture were selected, while 3,804 patients were excluded, of whom 84.1% for reason of surgery by an orthopaedic surgeon. Of the 4,552 included patients 2,382 (52.3%) had surgery performed by a trauma surgeon and 2,170 (47.7%) by a general surgeon (Figure 2).

Figure 2. Flowchart of patient selection



The two patient groups were not different in terms of age, sex, severe co-morbidity and timing of surgery (Table 1), but fracture location and type of surgery differed between the two patient groups (Figure 3). Trauma surgeons performed surgery for the femoral neck more often ($p < 0.001$) and inserted more hemiarthroplasties compared with general surgeons ($p < 0.001$). Osteosynthesis with cannulated screws was not different between the two patient groups ($p = 0.551$). General surgeons performed more surgery for pertrochanteric fractures ($p < 0.001$) and used more dynamic hip screws ($p < 0.001$) and intramedullary fixation ($p < 0.001$).

Table 1. Patient characteristics

	Trauma surgeon (n = 2,382)		General surgeon (n = 2,170)		*p*
Age – years (IQR)	82	(73-88)	83	(74-88)	0.071*
Male sex – n (%)	766	(32.2)	699	(32.2)	0.969^
ASA grade > 2 – n (%)+	621	(35.9)	550	(36.4)	0.744^
Fracture location – n (%)					
Femoral neck	1,349	(56.6)	1,040	(47.9)	< 0.001^
Pertrochanteric femur	926	(38.9)	1,052	(48.5)	< 0.001^
Subtrochanteric femur	107	(4.6)	78	(3.6)	0.126^
Type of surgery – n (%)					
Hemiarthroplasty	856	(35.9)	527	(24.3)	< 0.001^
Intramedullary fixation	934	(39.2)	981	(45.2)	< 0.001^
Dynamic hip screw	359	(15.1)	461	(21.2)	< 0.001^
Cannulated screws	233	(9.8)	201	(9.3)	0.551^
Timing of surgery – n (%)					
> 1 calendar day after admission	302	(12.7)	298	(13.7)	0.294^
Out-of-office hours: 18 – 7 hrs / weekends+	974	(46.9)	803	(47.9)	0.542^
Duration of surgery – minutes (IQR)+	56	(39-75)	58	(42-81)	< 0.001*
Duration of surgery ≥ 70 min – n (%)	603	(29.4)	579	(34.5)	0.001^

ASA American Society of Anesthesiologists physical status classification system

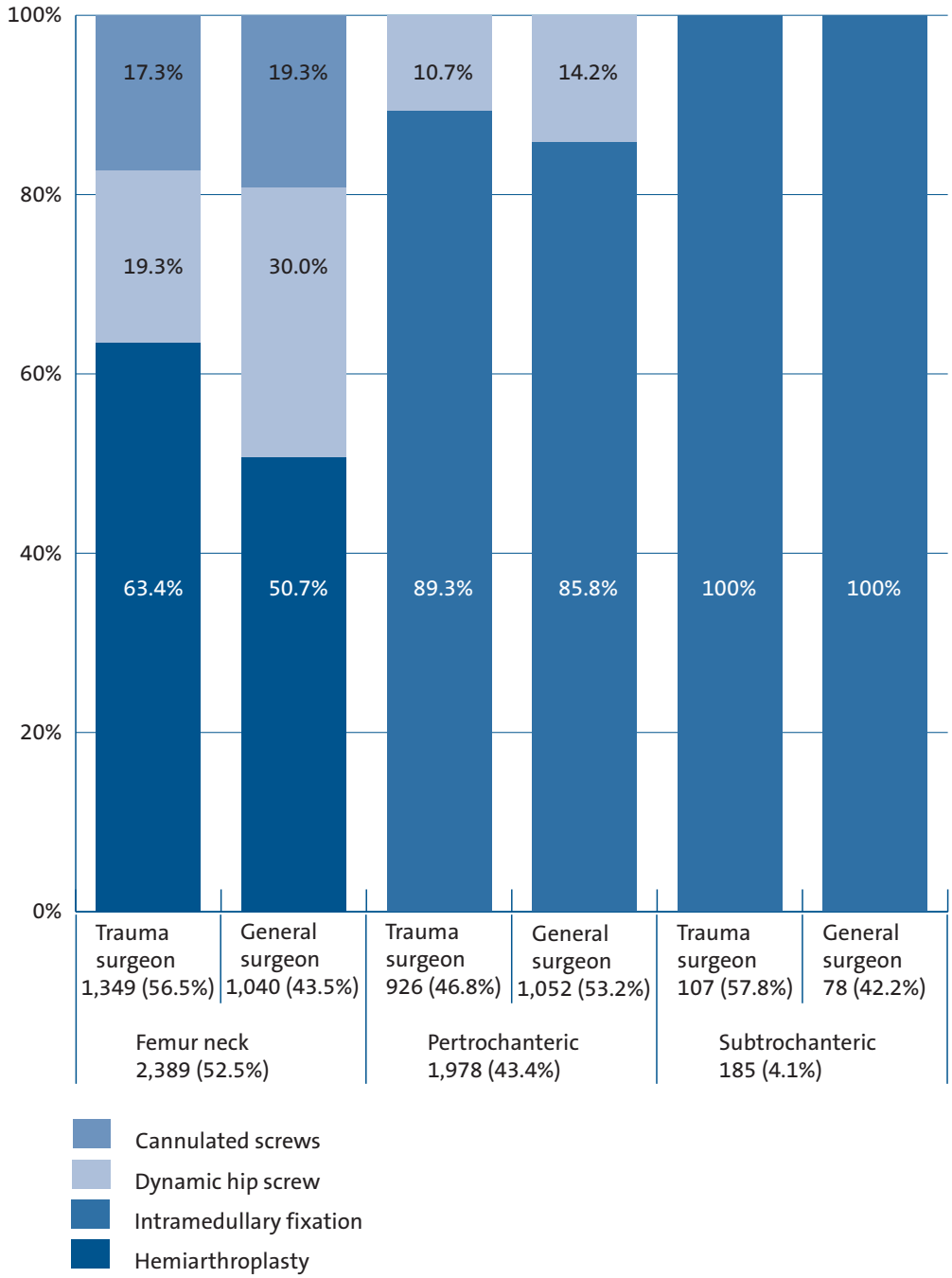
IQR Interquartile range

+ Missing values - n (%): ASA 1,313 (28.8); surgery out-of-office hours 802 (17.6); duration of surgery 823 (18.1)

* Mann-Whitney *U* test

^ Chi-square test

Figure 3. Type of surgery within fracture locations, n (%)



Surgery by trauma surgeons

In 11.6% of the patients treated by trauma surgeons a postoperative complication occurred. This did not differ significantly from the 11.9% of the patients operated by general surgeons ($p = 0.751$). Separate analyses for reoperations and surgical site infections did not show significant differences (Table 2). There was a trend of less inadequate repositions or

osteosynthesis after surgery by trauma surgeons compared to general surgeons (0.3% vs 0.7%; p = 0.062). Less avascular necrosis of the femur head was seen after surgery for femur neck fractures by trauma surgeons (1.5% vs 2.7%; p = 0.037). Reoperations for dislocations after hemiarthroplasty did not differ between trauma surgeons and general surgeons (0.6% vs 0.7% p = 0.661). Adjusted analysis for postoperative complications showed that surgery by trauma surgeons was associated with less postoperative complications (OR 0.746, 95% CI 0.580 – 0.958, p = 0.022; Table 3). Characteristics associated with more complications were female sex, surgery for femoral neck fractures, surgery during out-of-office hours and extended duration of surgery.

Table 2. Surgery-related complications

	Trauma surgeon (n = 2,382)		General surgeon (n = 2,170)		*p*
Reoperation and/or surgical site infections – n (%)	**276**	**(11.6)**	**258**	**(11.9)**	**0.751^**
Reoperation – n (%)	**214**	**(9.0)**	**204**	**(9.4)**	**0.627^**
Inadequate reposition or osteosynthesis – n	8		16		
Non-union or peri-prosthetic fracture – n	122		104		
Dislocation following hemiarthroplasty – n	14		15		
Avascular necrosis of the femur head – n	22		30		
Deep surgical site infection – n	48		39		
Surgical site infection – n (%)	**126**	**(5.4)**	**105**	**(4.9)**	**0.455^**
Deep – n	60		43		
Superficial – n	66		62		

^ Chi-square test

Table 3. Multivariable analysis for surgery by trauma surgeons

	Odds ratio	95% CI	*p*
Trauma surgeon (binary)	0.746	0.580-0.958	0.022
Age (continuous)	0.994	0.985-1.003	0.199
Male (binary)	0.755	0.584-0.977	0.032
ASA grade >2 (binary)	0.821	0.635-1.061	0.131
Fracture location (categorical)			
Femoral neck	2.300	1.776-2.980	< 0.001
Petrochanteric femur	Ref	--	--
Subtrochanteric femur	1.580	0.891-2.799	0.117
Timing of surgery (binary)			
> 1 calendar day after admission	1.031	0.732-1.453	0.862
Out-of-office hours: 18–7 hrs / weekends	1.371	1.088-1.727	0.008
Duration of surgery (continuous)	1.004	1.001-1.008	0.012
Hospital volume (continuous)	0.997	0.995-0.999	0.012
Surgeon volume* (continuous)	1.008	0.997-1.018	0.175

ASA American Society of Anesthesiologists physical status classification system

CI Confidence interval

* Calculated for the most experienced surgeon at the operating table

Hospital and surgeon volume

High hospital volume was associated with less postoperative complications in an adjusted analysis (OR 0.997, 95% CI 0.995 – 0.999, p = 0.012; Table 3). Patients operated in high-volume hospitals (> 170/year) had a postoperative complication percentage of 10.2% which significantly differed from 12.8% in low-volume hospitals (< 96/year) (OR 0.776, 95% CI 0.626 – 0.962, p = 0.021; Table 4). The complication percentage in medium-volume hospitals (96 – 170/year) was 12.5% and did not differ from the low-volume category (OR 0.971, 95% CI 0.777 – 1.215; p = 0.798; Table 4).

High surgeon volume was not associated with postoperative complications in an adjusted analysis (OR 1.008, 95% CI 0.997 – 1.018, p = 0.175). Patients operated by high-volume surgeons (> 25/year) experienced complications in 11.3% of the cases, which did not differ from 13.2% of the patients operated by low-volume surgeons (< 15/year) (OR 0.832, 95% CI 0.671 – 1.032, p = 0.095; Table 5). The complication percentage of patients operated by medium-volume surgeons (15 – 25/year) was 10.6% and did differ from the low-volume category (OR 0.774, 95% CI 0.620 – 0.966, p = 0.024; Table 5).

Table 4. Hospital volume

	Low volume	Medium volume	High volume
Hospital volume – average per year	< 96	96 - 170	> 170
Hospital count – n	8	2	2
Patient count – n (%)	1,587 (34.9)	1,243 (27.3)	1,722 (37.8)
Reoperation or SSI – n (%)	203 (12.8)	155 (12.5)	176 (10.2)
Odds ratio (95% CI)	Ref	0.971 (0.777-1.215)	0.776 (0.626-0.962)

CI Confidence interval

SSI Surgical site infection

Table 5 Surgeon volume

	Low volume	Medium volume	High volume
Surgeon volume – average per year	< 15	15 - 25	> 25
Patient count – n (%)*	1,578 (34.7)	1,457 (32.0)	1,517 (33.3)
Reoperation or SSI – n (%)	209 (13.2)	154 (10.6)	171 (11.3)
Odds ratio (95% CI)	Ref	0.774 (0.620-0.966)	0.832 (0.671-1.032)

CI Confidence interval

SSI Surgical site infection

* Calculated for the most experienced surgeon at the operating table

Discussion

This study demonstrates that patients with a proximal femoral fracture have lower rates of reoperation and surgical site infection if operated by a trauma surgeon compared with a general surgeon. This difference was not present with univariable analysis. However, within the patient and fracture characteristics there were several potential confounders to acknowledge, such as fracture location and type of surgery. With a multivariable analysis adjusted for these confounders, the risk of postoperative complications was reduced for patients operated by trauma surgeons. Furthermore, after comparing specific complications with an indication for a reoperation, one might conclude that specific fractures should not be treated by general surgeons. For example, the rate of avascular necrosis after osteosynthesis for femur neck fractures in this study was lower when surgery was performed by trauma surgeons.

Other studies on specialization for surgery for proximal femoral fractures investigated the trauma specialization within the department of orthopaedic surgery. A Canadian study from 1997 compared surgery performed by general surgeons who completed three to six months of orthopaedic training to surgery by orthopaedic surgeons. No differences were found for reoperations or surgical site infections. However, no adjusted analysis for confounders

was performed in this study[8]. A Spanish study from 2015 also reported no association for surgical site infections with surgery for proximal femoral fractures by orthopaedic surgeons specialized in hip surgery compared to general orthopaedic surgeons[9].

Besides surgery by trauma surgeons our study demonstrates another association of high hospital volume and lower complication rates. Hospital volume for proximal femoral fractures higher than 96 to 170 cases per year was associated with lower complication rates. An association with surgeon volume could not be shown. A potential explanation is that the multivariable analysis could not adequately adjust for selection of more vulnerable patients, with more challenging fractures being selected for surgery by a trauma surgeon. Adjusted analysis with more detailed measure for co-morbidity and type of fracture could have resulted in an association with postoperative complications and surgeon volume.

These results are partially in accordance with previous studies. An American study from 2005 investigated the association between hospital and surgeon volume with surgical site infections in patients with hemiarthroplasty, but did not find an association[4]. Another American study from 2009 reported a higher risk of surgical site infection in patients with surgery for femoral neck and pertrochanteric fractures in low-volume hospitals (< 57 cases/ year). An association between surgeon volume and surgical site infections or between surgeon and hospital volume and implant failure was investigated as well, but could not be demonstrated[6]. One Dutch study from 2015 reported less reoperations within 60 days in a high-volume teaching hospital (285 cases/year) compared with a low-volume academic hospital (41 cases/year) in patients with proximal femoral fractures[10].

Limitations

One limitation of this study is its retrospective design. Patients with fractures that are more challenging to reduce and fixate are more likely to be treated by a trauma surgeon. Therefore, in this study an adjusted analysis was performed with a multivariable analysis. Furthermore, because of the retrospective design postoperative complications might be underreported or treated in hospitals not involved in this study. However, reoperation should be well documented by the operative reports when performed in the same hospital. Underreporting of superficial surgical site infections should be assumed since these are often diagnosed at the outpatient clinic and are prone to being poorly registered in the patient files. However, there is no reason to assume underreporting of postoperative complications is unequal between both groups. This study focuses on specialization of trauma surgeons within the surgery department and does not investigate trauma differentiation within the orthopaedic department, neither the differences between general surgeons and orthopaedic surgeons. Though relevant, this was beyond the scope of the current study and should be the topic of future research.

The combined outcome measure consists of reoperations and surgical site infections, and represents the complications related to initial surgery and therefore reflects the performance of the surgeon. This combined outcome measure is suitable for investigating whether patients with proximal femoral fractures experience less postoperative complications. Another strength of this study is the robust data collection in twelve hospitals from two different trauma regions, which most likely correctly reflects the situation of surgery for patients with proximal femoral fractures in the Netherlands. Therefore, the results of this study are useful for decision-making regarding specialization within surgery departments and restructuring of the care of patients with proximal femoral fractures. Surgical training becomes more differentiated and surgery within departments becomes more specialized. This differentiation of training and specialization within surgery departments for specific patient groups seems to reduce postoperative complications. These results support the policy of the NVvH and the NVT to train and certify trauma surgeons.

Conclusion

Surgery by trauma surgeons and high hospital volume are associated with less reoperations and surgical site infections after surgery for proximal femoral fractures.

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