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Halonen, Lauri M.

2022

Halonen , L M , Stenroos , A , Vasara , H & Kosola , J 2022 , ' Intramedullary Fixation of Trochanteric Fractures Can Be Safely Performed by Senior Residents Without Immediate Consultant Supervision ' , Journal of Surgical Education , vol. 79 , no. 1 , pp. 260-265 . https://doi.org/10.1016/j.jsurg

http://hdl.handle.net/10138/355279
https://doi.org/10.1016/j.jsurg.2021.06.026

Intramedullary fixation of trochanteric fractures can be safely performed by senior residents without immediate consultant supervision

Lauri M Halonen[1], Antti Stenroos[2], Henri Vasara[2], Jussi Kosola[3]

[1] South Karelia Central Hospital, Department of Orthopedics and Traumatology, and University of Helsinki

[2]Helsinki University Hospital, Department of Orthopedics and Traumatology, and University of Helsinki

[3]Kanta-Häme Central Hospital, Department of Orthopedics and Traumatology

Correspondence:

Lauri Halonen

Department of Orthopedics and Traumatology, South Karelia Central Hospital

Valto Käkelän katu 3, 53130 Lappeenranta, Finland

Email: lauri.halonen@eksote.fi

Conflicts of interest: none. This research received no funding from Helsinki University and no grants from any funding agencies in the commercial or not-for-profit sectors.

Abstract

Objective: To assess the safety of senior residents performing trochanteric hip fracture surgery without immediate consultant supervision

Design: A retrospective chart review of trochanteric hip fractures (AO-OTA 31-A) operated in a single center between years 2011 and 2016 (inclusive). Operations were divided into three groups: Group 1 - surgeon was a senior resident without any immediate supervision; Group 2 - surgeon was a consultant and Group 3 - surgeon was a senior resident supervised by a consultant. The follow-up period was a minimum of 2 years or until death. All re-operations and surgical related mortality were assessed.

Setting: Helsinki University Hospital, Finland. A tertiary level trauma center.

Participants: 987 consecutive trochanteric fractures on 966 patients treated by operative fixation of an intertrochanteric fracture with an intramedullary nail between 2011and 2016 (inclusive).

Results: The total number of reoperations was smaller in Group 1 where the surgeon was a senior resident without any immediate supervision compared to Group 2 where the surgeon was a consultant (5.5 % vs 8.8 %, $p < 0.05$). There were no significant differences in mortality or length of surgery. The total rate of mechanical complications was 2.0 %, with no significant differences between groups. The observed blade cut-out rate was low: 1.3 %, suggesting a good overall quality of surgery.

Conclusions: Senior residents can safely perform intramedullary nailing of trochanteric fractures without immediate supervision.

Keywords – hip fracture, trochanteric fracture, surgical education, safe surgery

Introduction

The evolving pattern of orthopedic training is an area that remains frequently discussed between institutions responsible for orthopedic education throughout the world (1). Surgical training differs from other medical specialties, due to the significant amount of technical skill required that cannot be learned from books or lectures. The training should be taken under the guidance and supervision of consultant surgeons who are responsible for supervising the personal and professional development of residents towards gradually increasing their skills and independent decision-making.

In recent years there has been increased attention directed at surgical training, the assessment of proficiency and whether surgeons have the necessary skills when achieving their diploma qualification. There is now a growing trend towards competency-based systems in medical postgraduate education. (2, 3)

Final examinations, mandatory logbooks and minimum requirements for surgical procedures, have been identified to assure that surgeons have acquired sufficient skills before being awarded their specialist degree. (4) In many countries and regions, the consultant resource is scarce, which makes residents both students and part of the work force at the same time. (5) The treatment of hip fractures is a significant part of daily work in trauma centres throughout the world and, in our experience, it is a workload that burdens most consultant orthopaedic surgeons. The mortality for hip fractures is now known to increase drastically if there is more than 48 hours delay to surgery. (6) Therefore, hip fracture surgery is often performed outside office hours, when there are less staff available making residents' surgical contribution even more substantial.

Intramedullary fixation of trochanteric fractures is an essential part of orthopedic residents core curriculum. (7) The aim of this study was to assess the safety and feasibility of senior residents performing a typical urgent orthopedic trauma operation without immediate supervision: an intramedullary nailing of a trochanteric fracture (AO-OTA 31A1, 31A2, 31A3).

Patients and Methods

The research was conducted as a retrospective review of 987 consecutive trochanteric fractures on 966 patients between 2011 and 2016 (inclusive) treated in a single tertiary level trauma center. The study hospital is a university hospital responsible for teaching senior residents.

The patients were followed-up from the hospital's database for a minimum of two years postoperatively or until death. Operations were divided to 3 groups: Group 1 - surgeon was a senior resident without any immediate supervision; Group 2 - surgeon was a consultant and Group 3 - surgeon was a senior resident supervised by a consultant. Senior residents at our institute have at least 3 years of surgical experience and have typically performed 500 – 1000 operations.

The operations were performed according to the AO principles. (8) The operations were performed on a traction table with anatomical fracture reduction and appropriate osteosynthesis confirmed with intraoperative fluoroscopy. Open reduction (n=327) was performed if closed reduction was considered inappropriate. A proximal femoral nail anti-rotation device (PFNA, DePuy Synthes, Raynham, Massachusetts, USA) was used as fixation device for all fractures.

The primary outcome measure was the total amount of re-operations required following the primary operation. Secondary outcome measures were re-operations within 7 days from the operation, infections, blade cut-out, blade lateralisation, mortality and length of surgery.

Surgical site infections were specified by the criteria for fracture related infections (FRI) defined by Metskemakers et al. (9) Early (within 30 days) and late mortality (within 2 years) were determined from the Finnish population register. The length of surgery was defined as the time from when the first x-ray pictures were obtained during the closed reduction of the fracture to the closure of the operative wounds.

The patient characteristics are presented as means and medians (+/-SD) for continuous data and as the number of patients and associated percentages for categorical parameters. Comparisons between independent groups were performed using Chi square for categorical variables and using Mann-Whitney for quantitative parameters. P values of <0.05 were considered significant. Statistical program SPSS 25 (IBM Corp. released 2017. Armonk, NY: IBM Corp.) was used for analyzes.

Results

In total, 694 (70 %) of the operations were performed by residents independently (Group 1), 216 (22 %) by consultants (Group 2) and 77 (8 %) by residents under the supervision of a consultant (Group 3). The median number of operations per surgeon was 10 for residents and 5 for consultants during the research period. The basic characteristics of the patients did not differ between groups. (Table 1)

There were statistically significantly less revision surgeries for patients in Group 1 (operated on by residents) compared to patients in Group 2 (operated on by a consultant) (5.5 % vs 8.8 %, $p<0,05$). There was a statistically significant difference in implant survival, showing better implant survival on patients in Group 1 (operated on by residents) -see Figure 1.

There were no significant differences in the numbers of patients requiring early revision surgeries (within 7 days from the initial surgery). Four (0,6%) fractures in Group 1 (operated on by residents alone) needed revision surgery due to a technical error: a blade outside the intramedullary nail (n=1), a distal locking screw outside the nail (n=1), malreduction (n=1) and an unobserved intraoperative fracture at the tip of the nail (n=1).

Other reasons for an early reoperation were haemorrhage (n=2) and an early infection (n=1). The median length of surgery was 67 minutes for residents, 72 minutes for consultants and 69 minutes for operations performed by resident and consultant together. No statistically significant differences were noted.

The rate of deep surgical site infections was 1.7 % and the surgeons' experience did not have a statistically significant role in the rate of infections. The rates of mechanical complications were low, and there were no significant differences between the groups. The rate of blade cut-out was 1.2% for residents and 1.4 % for consultants. The total rate of mechanical complications observed was 2.0 % for the whole study group.

Risk factors for blade cut-out were further analysed for the patients with blade cut-out: In Group 2 (the consultant group), tip-apex distance varied between 14 and 28 mm (median 18 mm) and reduction was considered adequate in all 3 cases in which cut-out occurred. In Group 1 (the resident group) reduction was poor in 5 of the 8 cut-outs and tip-apex distance varied between 12 and 47 mm (median 25 mm). Tip-apex distance for patients with blade cut-out did not have a statistically significant difference between the groups.

There were no significant differences in mortality between the groups. 2-year mortality was 35.7% for Group 1 (patients operated by residents alone), 32.9 % for Group 2 (patients operated by consultants) and 39.0% for Group 3 (patients operated by a resident with a consultant).

Discussion

Our study hypothesis was that the outcomes of intramedullary nailing of trochanteric hip fractures performed by senior orthopedic residents would be similar for orthopedic consultants. The results of this study indicate that operations performed by senior residents are not inferior compared to those performed by consultants.

Furthermore, less complications for Group 1 (patients operated by senior residents unattended) were noted. Though, one must take into consideration that most likely the more challenging fractures were likely to be operated on by consultants as might be expected in a graduated training program.

The rate of revisions surgeries and blade cut-out was similar to previous reports (10-12), suggesting a good overall quality of surgical practice. Blade cut-out is often associated with unsatisfactory surgical technique, as poor reduction and positioning of the blade are known to increase the risk for cut-out (13). Therefore, the rate of blade cut-out is a good indicator of quality of trochanteric fracture surgery. Despite the non-significant increase in blade tip-apex distance and the amount of non-satisfactory fracture reductions for the residents (Group 1) compared to the consultants (Group 2) in blade cut-out cases, there was no increase in total blade cut-outs within patients operated by residents (Group 1). This study demonstrates that the occurrence of complications after intramedullary nailing of proximal femoral fracture was not increased if performed by a senior resident alone compared to a consultant surgeon.

There are a number of studies that have compared outcomes of procedures carried out in teaching hospitals by residents and attending surgeons. Most findings indicate that there are

some surgical procedures which residents can perform safely (14-16). Previous studies have shown that total hip arthroplasties for osteoarthritis and displaced femoral neck fractures operated on by residents do not have an increased risk for complications, though some longer operative times in the resident group have been reported (17-19). In our data the length of surgery did not differ between the groups, which may be explained by consultants operating on more challenging fractures.

Intramedullary fixation of trochanteric fractures is an important part of the orthopedic training curriculum. One way of assessing the quality of education is to see how senior residents manage independent work and decision-making. Residents are at first assisted by consultants at our institution, to ensure that they have adequate technical skills before being allowed to operate alone. Patient details and radiographs are reviewed together with a consultant before residents operate on fractures independently. Most cases are reviewed beforehand at a handover meeting. During the period of this study there was no systematic protocol for feedback after the surgery. This is being addressed with education of the consultants and allocation of time for feedback also after surgery.

At our institution, the complicated cases are discussed with the operating resident and with other residents to allow collective learning and to avoid making identical mistakes again. There were two major technical mistakes in the study group, one where the blade and the other where locking screw was inserted outside the nail. These complications were addressed at the institute level by educating both the resident and the consultant surgeons and the OR (Operating Room) technicians in the importance of standardized, high quality fluoroscopy pictures at the end of the operation. We found no association of the operation that had a

technical failure with poorer overall performance by the residents who performed the aforesaid surgeries.

Our study setting differs from most earlier studies concerning orthopedic training, because we did not assess resident involvement but rather independent operating without immediate supervision (17-21). Despite the relatively small numbers of operations performed alone by individual residents, their performance was not inferior to that of consultants. This suggests that the quality of teaching is acceptable at our institution. Orthopedic resident training is an essential assignment of teaching hospitals and serves the important purpose of producing future orthopedic surgeons. The importance of the resident role in patient care and management cannot be understated. We want to emphasize the importance of cadaveric training and surgical technique courses in orthopedic training. Though, independent decision-making is an important part of surgical training and the growing process towards the role of a consultant. (22) The results obtained by a resident or consultant should be similar, in order to ensure safety and efficacy of each surgical intervention.

Important limitations of the study are that, due its retrospective nature, we have not assessed hip function or patient reported outcome-measures. Our findings represent the results of a single medical center and most other centers outside Nordic countries use a different educational model in training their residents. The difficulty of fractures was not classified, as proper tools for carrying this out are lacking.

The reliability of the AO classification in recognizing the subgroups of proximal femoral fractures is poor to moderate (23). Other factors such as soft tissue damage, amount of fracture displacement and severity of osteoporosis can influence the difficulty of the

procedure but are hard to measure. As a result of the low complication rates, a nation-wide multicenter study would be required to be adequately powered to demonstrate equal outcomes. Considering the relatively minimal observed difference, we consider that there is no clinically relevant difference in major complications between resident and consultant performance of this operation.

In conclusion, we suggest that properly trained senior residents can safely operate on trochanteric hip fractures without immediate supervision. The rate of re-operations, mortality or length of surgery were not increased in the operations performed by senior residents compared to consultants.

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Table 1. Patient characteristics. The values are means if not otherwise specified. Percentages are compared to the group in question.

	Resident (n = 694)	**Consultant (n = 216)**	**Resident + Consultant (n = 77)**	**p-value**	**Total (n = 987)**
Age, median (range)	84 (29-100)	83 (30-104)	85 (29-99)	0.559	84 (29-104)
- <50 years of age (%)	18 (2.6 %)	5 (2.3 %)	5 (6.5 %)	0.129	28 (2.8 %)
Female sex, n (%)	477 (68.7 %)	142 (65.7 %)	57 (74.0 %)	0.394	676 (68.5 %)
ASA[1] (range)	3.22 (1-5)	3.29 (1-5)	3.16 (1-5)	0.245	3.23 (1-5)
CCI[2] (range)	4.83 (0-12)	4.86 (0-12)	4.62 (0-11)	0.602	4.82 (0-12)
Delay to surgery, days	2.22	2.12	2.16	0.334	2.19
Length of stay, days	7.20	6.94	7.94	0.055	7.20

1. American Society of Anesthesiologists classification
2. Charlson Comorbidity Index

Table 2. Complications of surgery (Percentages compared to the group in question). * p < 0.05 for the difference between groups. Resident group used as a control group for odds ratios.

	Resident	**Consultant**	**OR 95% CI**	**Resident and Consultant**		**Total**	**p**
	(n = 694)	(n = 216)		(n = 77)		(n = 987)	
Revision surgery							
< 7 days	5 (0.7 %)	1 (0.5 %)		1 (1.3 %)	7 (0.7 %)		
Total	**38 (5.5 %)**	**19 (8.8 %)**	**1.6 (0.9-2.9)**	**9 (11.7%)**	**2.2 (1-4.9)**	**66 (6.7 %)**	**0.04**
Mechanical complication							
Cut-off	8 (1.2 %)	3 (1.4 %)	1.0 (0.4-1.9)	2 (2.6 %)	1.2 (0.3-4.5)	13 (1.3 %)	0.3
Migration	5 (0.7 %)	2 (0.9 %)	1.2 (0.2-6)	0 (0 %)		7 (0.7 %)	0.9
Total	**13 (1.8 %)**	**5 (2 %)**	**1.2 (0.2-4)**	**2 (2.5 %)**	**1.3 (0.5-6)**	**20 (2 %)**	**0.86**
Infection							
Superficial	7 (1.0 %)	4 (1.9 %)	1.8 (0.9-2.2)	0 (0 %)		11 (1.1 %)	0.01
Deep	8 (1.2 %)	5 (2.3 %)	2	4 (5.2 %)	4.7	17 (1.7 %)	0.02
Total	15 (2 %)	9 (4 %)	2 (0.6-6.2)	4 (5 %)	4.6 (1.3-15)	28 (2.8 %)	0.01
Peri-implant fracture or implant failure	10 (1.4 %)	8 (3.7 %)	2.6	1 (1.3 %)	0.9	19 (1.9 %)	0.09

Figure 1. 2-year implant survival plot. The plot represents the proportion of the group which have not gone a reoperation. Log rank test was used to assess the p-value between the groups.