Equivalent mortality after operation with sliding hip screw or intramedullary nail for trochanteric AO/OTA A1 and A2 fractures reported in the Norwegian Hip Fracture Register 2008 to 2020

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Aims
This study aimed to compare mortality in trochanteric AO/OTA A1 and A2 fractures treated with an intramedullary nail (IMN) or sliding hip screw (SHS). The primary endpoint was 30-day mortality, with secondary endpoints at 0 to 1, 2 to 7, 8 to 30, 90, and 365 days.

Methods
We analyzed data from 26,393 patients with trochanteric AO/OTA A1 and A2 fractures treated with IMNs (n = 9,095) or SHSs (n = 17,298) in the Norwegian Hip Fracture Register (January 2008 to December 2020). Exclusions were made for patients aged < 60 years, pathological fractures, pre-2008 operations, contralateral hip fractures, fractures other than trochanteric A1/A2, and treatments other than IMNs or SHSs. Kaplan-Meier and Cox regression analyses adjusted for type of fracture, age, sex, cognitive impairment, American Society of Anesthesiologists (ASA) grade, and time period were conducted, along with calculations for number needed to harm (NNH).

Results
In unadjusted analyses, there was no significant difference between IMN and SHS patient survival at 30 days (91.8% vs 91.1%; p = 0.083) or 90 days (85.4% vs 84.5%; p = 0.065), but higher one-year survival for IMNs (74.5% vs 73.3%; p = 0.031) compared with SHSs. After adjustments, no significant difference in 30-day mortality was found (hazard rate ratio (HRR) 0.94 (95% confidence interval (CI) 0.86 to 1.02(; p = 0.146). IMNs exhibited higher mortality at 0 to 1 days (HRR 1.63 (95% CI 1.13 to 2.34); p = 0.009) compared with SHSs, with a NNH of 556, but lower mortality at 8 to 30 days (HRR 0.89 (95% CI 0.80 to 1.00); p = 0.043). No differences were observed in mortality at 2 to 7 days (HRR 0.94 (95% CI 0.79 to 1.11); p = 0.434), 90 days (HRR 0.95 (95% CI 0.89 to 1.02); p = 0.177), or 365 days (HRR 0.97 (95% CI 0.92 to 1.02); p = 0.192).

Conclusion
This study found no difference in 30-day mortality between IMNs and SHSs. However, IMNs were associated with a higher mortality at 0 to 1 days and a marginally lower mortality at 8 to 30 days compared with SHSs. The observed differences in mortality were small and should probably not guide choice of treatment.

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Introduction
The two most used implants for extracapsular hip fractures are extramedullary sliding hip screws (SHSs) and intramedullary nails (IMNs).[1] While most guidelines recommend the use of IMNs for unstable trochanteric fractures (AO/OTA 31A3)[2] and subtrochanteric fractures,[3–5] there is growing evidence that SHSs and IMNs provide similar

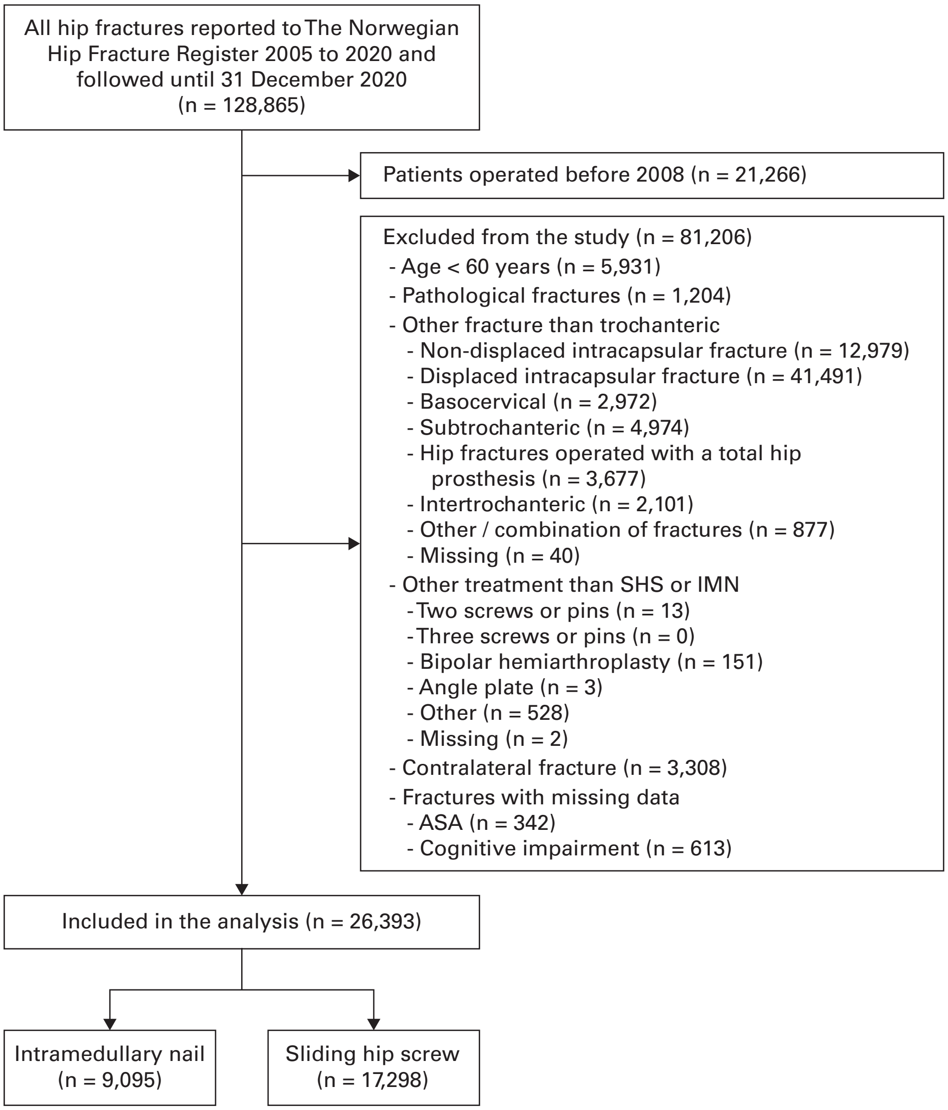

Fig. 1

Flowchart of patients. ASA, American Society of Anesthesiologists; IMN, intramedullary nail; SHS, sliding hip screw.

outcomes for stable trochanteric fractures (AO/OTA 31A1 and 31A2).[6,7] There is, however, an increasing trend internationally to use IMNs also for A1 and A2 fractures.[1,3,4,8]

The type of surgery may affect mortality. Studies on mortality following treatment of trochanteric fractures present conflicting results. One recently published register-based study reported lower one-year mortality after IMN compared with SHS.[7] However, two large randomized clinical trials have reported no difference in mortality at one year postoperatively.[6,9] On the other hand, higher 30-day mortality associated with IMN compared to SHS has been reported in two earlier large observational studies.[10,11]

Cemented compared with uncemented hemiarthroplasty for femoral neck fracture has been associated with increased mortality within the first 48 hours postoperatively,[12] probably due to increased intramedullary pressure and bone cement implantation syndrome.[13] Similarly, an IMN procedure involving instrumentation of the femoral canal has been shown to increase intramedullary pressure, embolic showers, and fat intravasation.[14] Accordingly, treatment with an IMN might increase early mortality compared to an extramedullary SHS. The evidence on early mortality following an IMN is sparse.[9,10]

In Norway, all hip fractures have been reported to the Norwegian Hip Fracture Register (NHFR) from 2005.[15] We used data from the NHFR from January 2008 to December 2020 to investigate whether there is a difference in mortality between SHSs and IMNs used for trochanteric A1 and A2 fractures, with a special focus on the early postoperative mortality. Our primary aim was to compare 30-day mortality between IMN and SHS. Secondary aims were to investigate changes in mortality over time by comparing the mortality rates between IMN and SHS at 0 to 1, 2 to 7, 8 to 30, 90, and 365 days postoperatively.

Table I. Baseline characteristics of trochanteric fractures operated with sliding hip screw and intramedullary nail reported to The Norwegian Hip Fracture Register, January 2008 to December 2020.

Variable	SHS	IMN	All fractures	p-value*
Total, n (%)	17,298 (65.5)	9,095 (34.5)	26,393 (100)	
Age group, n (%)				0.256
60 to 74 yrs	3,011 (17.4)	1,566 (17.2)	4,577 (17.3)	
75 to 79 yrs	2,129 (12.3)	1,180 (13.0)	3,309 (12.5)	
80 to 84 yrs	3,504 (20.3)	1,846 (20.3)	5,350 (20.3)	
85 to 89 yrs	4,608 (26.6)	2,329 (25.6)	6,937 (26.3)	
≥ 90 yrs	4,046 (23.4)	2,174 (23.9)	6,220 (23.6)	
Sex, n (%)				0.836
Male	5,000 (28.9)	2,640 (29.0)	7,640 (28.1)	
Female	12,298 (71.1)	6,455 (71.0)	18,753 (71.1)	
ASA grade, n (%)				0.003
I	464 (2.7)	187 (2.1)	651 (2.5)	
II	6,548 (32.7)	2,930 (32.2)	8,578 (32.5)	
III	9,870 (57.1)	5,327 (58.6)	15,197 (57.6)	
IV to V	1,316 (7.6)	651 (7.2)	1,967 (7.5)	
Cognitive impairment, n (%)				0.936
No	11,209 (64.8)	5,893 (64.8)	17,102 (64.8)	
Yes	4,458 (25.8)	2,333 (25.7)	6,791 (25.7)	
Uncertain	1,631 (9.4)	869 (9.6)	2,500 (9.5)	
Fracture type, n (%)				< 0.001
AO/OTA A1	9,162 (53.0)	3,690 (40.6)	12,852 (48.7)	
AO/OTA A2	8,136 (47.0)	5,405 (59.4)	13,541 (51.3)	
Waiting time for surgery, n (%)				0.002
0 to 24 hrs	10,177 (58.8)	5,544 (61.0)	15,721 (59.6)	
24 to 48 hrs	4,956 (28.7)	2,532 (27.8)	7,488 (28.4)	
> 48 hrs	1,881 (10.9)	881 (9.7)	2,762 (10.5)	
Missing data	284 (1.6)	138 (1.5)	422 (1.6)	
Nail type, n (%)†				N/A
Short		7,208 (79.0)		
Long		1,887 (21.0)		
Type of anaesthesia, n (%)				< 0.001
General	1,461 (8.4)	1,161 (12.8)	2,622 (9.9)	
Spinal	15,212 (87.9)	7,609 (83.7)	22,821 (86.5)	
Other	432 (2.5)	234 (2.6)	666 (2.5)	
Missing data	193 (1.1)	91 (1.0)	284 (1.1)	
Time, n (%)				< 0.001
January 2008 to December 2012	8,083 (46.7)	2,660 (29.2)	10,743 (40.7)	
January 2013 to December 2016	5,641 (32.6)	2,585 (28.4)	8,226 (31.2)	
January 2017 to December 2020	3,574 (20.7)	3,850 (42.3)	7,424 (28.1)	

*Chi-squared test.
†As indicated by the surgeon on the reporting form.
ASA, American Society of Anesthesiologists; IMN, intramedullary nail; N/A, not applicable; SHS, sliding hip screw.

Methods

The NHFR has been described in detail previously.[15] It has collected data from hip fracture operations in Norway since January 2005. The surgeon is responsible for filing information regarding the patient (including age, sex, American Society of Anesthesiologists (ASA) grade,[16] and cognitive function), the fracture type, and the treatment (including type of surgery and time of surgery). Trochanteric fractures are categorized according to the AO/OTA classification system as AO/OTA 31A1 (simple two-part), 31A2 (multifragmentary), and 31A3 (intertrochanteric/reverse oblique).[2]

The Norwegian Patient Registry (NPR) has been used to evaluate the completeness of reporting to the NHFR, which has been found to be 86%.[1] The NHFR was linked to the National Population Register, and information on death and emigration was available for all patients. Between January 2005 and December 2020, there were 128,865 fractures reported to the NHFR and the patients were followed until 31 December 2020. We excluded 81,206 fractures for the following reasons: fractures in patients aged under 60 years, fractures with missing data on the operation forms, any contralateral hip fracture, and pathological fractures (Figure 1). Further, we excluded fractures other than trochanteric A1 and A2 fractures, and fractures not treated with SHS or IMN. Finally, all fractures operated before 2008 were excluded, since the classification of trochanteric fractures in the NHFR was changed in 2007. After exclusion,

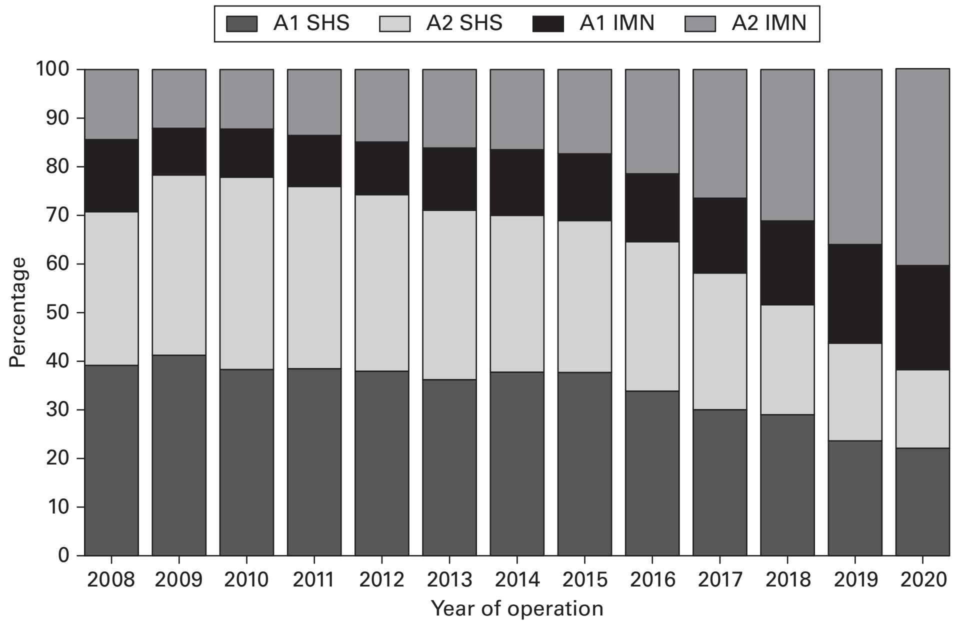

Fig. 2

Graph showing time trends for type of trochanteric fracture and treatment over the years (January 2008 to December 2020) reported to The Norwegian Hip Fracture Register. The data are presented as percentages according to type of fracture and treatment in each specific year. AO/OTA classification: A1, simple two-part; A2, multifragmentary. IMN, intramedullary nail; SHS, sliding hip screw.

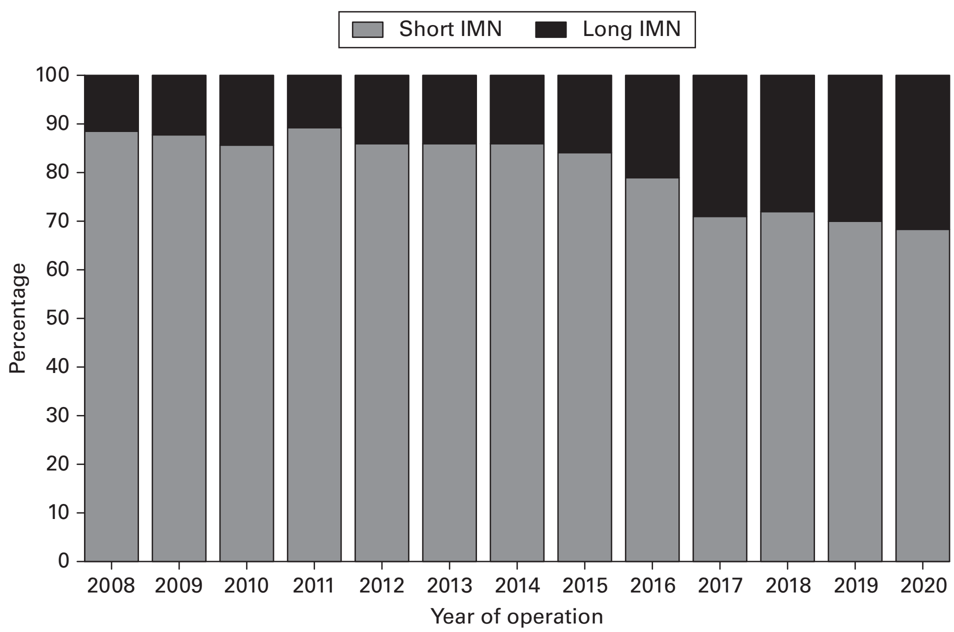

Fig. 3

Graph showing time trends for short and long intramedullary nail (IMN) used in trochanteric fractures over the years (January 2008 to December 2020) reported to the Norwegian Hip Fracture Register. The data are presented as percentages according to treatment with short or long IMN.

26,393 fractures, of which 9,095 were treated with IMN and 17,298 with SHS, were included in the analyses (Figure 1).

Patients. Of the 26,393 fractures, 9,095 (34.5%) were treated with IMN and 17,298 (65.5%) were treated with SHS. There were 18,753 female patients (71%). Almost 50% (n = 13,157) of the patients were aged 85 years and above. Severe comorbidity was present in 17,167 of the patients (57%). Chronic cognitive impairment was noted in 6,791 patients (26%), and the majority (n = 15,721) were operated within 24 hours (60%). There were minor differences in baseline characteristics between the two

Table II. Survival probabilities of patients with trochanteric fractures treated with sliding hip screw and intramedullary nail.

Variable	SHS (n = 17,298)		IMN (n = 9,095)		p-value*
	Number at risk	KM (95% CI)	Number at risk	KM (95% CI)	
30 days	15,729	91.1 (90.7 to 91.5)	8,332	91.8 (91.1 to 92.4)	0.083
90 days	14,617	84.5 (83.9 to 85.1)	7,775	85.4 (84.6 to 86.2)	0.065
365 days	12,726	73.3 (72.7 to 73.9)	6,859	74.5 (73.5 to 75.5)	0.031

*Log-rank test.
CI, confidence interval; IMN, intramedullary nail; KM, Kaplan-Meier; SHS, sliding hip screw.

Table III. Mortality after trochanteric fractures treated with sliding hip screw and intramedullary nail.

Days after operation	n	Deceased	HRR (95% CI)	p-value*
0 to 1 days				
SHS	17,298	73	Reference	
IMN	9,095	55	1.63 (1.13 to 2.34)	0.009
2 to 7 days				
SHS	17,225	464	Reference	
IMN	9,040	224	0.94 (0.79 to 1.11)	0.434
8 to 30 days				
SHS	16,761	1,032	Reference	
IMN	8,816	484	0.89 (0.80 to 1.00)	0.043
30 days				
SHS	17,298	1,569	Reference	
IMN	9,095	763	0.94 (0.86 to 1.02)	0.146
90 days				
SHS	17,298	2,681	Reference	
IMN	9,095	1,320	0.95 (0.89 to 1.02)	0.177
365 days				
SHS	17,298	4,572	Reference	
IMN	9,095	2,236	0.97 (0.92 to 1.02)	0.192

*Cox regression analyses adjusted for age group, sex, type of fracture, American Society of Anesthesiologists grade, cognitive status, and time period.
CI, confidence interval; HRR, hazard rate ratio; IMN, intramedullary nail; SHS, sliding hip screw.

compared methods of treatment, and there were more unstable fractures in the IMN group (Table I).

Statistical analysis. Pearson's chi-squared test was used for comparison of categorical variables in independent groups. We used Kaplan-Meier method to calculate patient survival at different endpoints, and p-values were calculated with the log-rank test. Differences between SHS and IMN were given as hazard rate ratios (HRRs) using an unadjusted and adjusted Cox regression model. By using the strategy of analyzing the timescale piecewise, the change in effect over time (i.e. non-proportionality) was accounted for. Adjustments were made for age group, sex, ASA grade, cognitive status, type of fracture, and time, since these factors have been identified as confounding variables in a previous study.[17] The Cox model was used to construct adjusted survival curves. Stratified analyses for ASA grade, age groups, type of fracture, and year of fracture were conducted. SHS was used as the reference in all analyses.

Number needed to harm (NNH) was calculated according to the method described by Andrade.[18]

In addition to the adjusted Cox regression, we investigated if there was a difference between the two groups using an instrumental variable (IV) analysis. IV analysis followed the method described by Mackenzie et al[19] for IVs in a Cox regression model using the statistical package R (R Foundation for Statistical Computing, Austria). In the instrument variable analyses, it is assumed that confounding adjustment is performed through the instrument.As instrument, we applied the year of operation within hospital. The IV analysis assumes the hospital is related to mortality only through their choice of treatment, IMN or SHS, for each year, and that the hospital is independent of unobserved covariates. Under these conditions, the estimated HRR can be interpreted as a causal HRR of SHS or IMN on mortality.

All results are presented with 95% confidence intervals (CIs). The significance level was set to 5% ($\alpha = 0.05$).The statistical analyses were performed using SPSS Statistics v. 29 (IBM, USA) and the R 2022.12.0 statistical package (R Foundation for Statistical Computing). The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines were followed.[20]

Results

Time trends. In the period of January 2008 to December 2012, 29% (2,660 out of 10,763) of the fractures were treated with IMN. From January 2013 to December 2016, 28% acquired IMN (2,585 out of 8,226). Lastly, from January 2017 to December 2020, 42% received IMN (3,850 out of 7,424) (Figure 2).

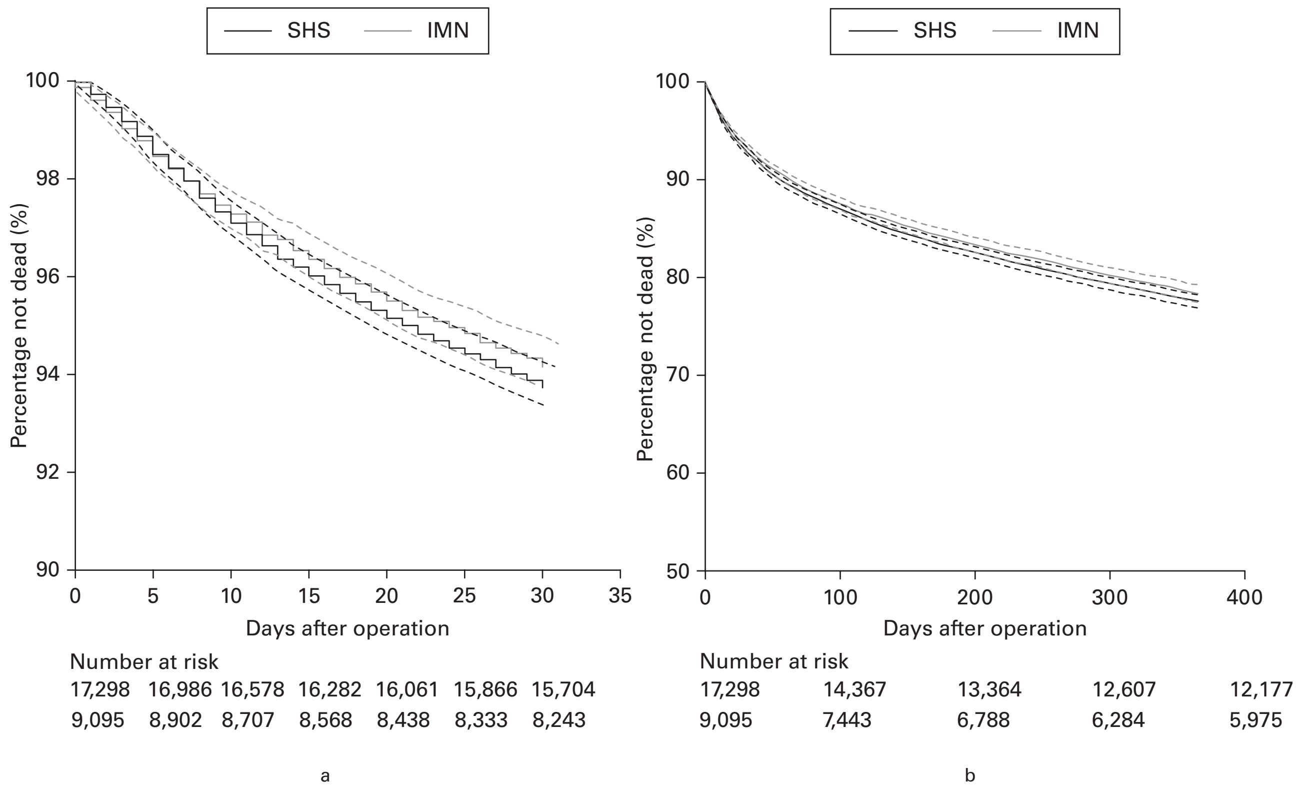

Fig. 4

a) and b) Cox adjusted survival function at 30 and 365 days. Cox regression analysis comparing treatment with sliding hip screw (SHS) and intramedullary nail (IMN) after trochanteric fracture with death as endpoint. Follow-up time was a) 30 days and b) 365 days. Adjustments were made for age group, sex, type of fracture, American Society of Anesthesiologists grade, cognitive status, and period of operation.

Short IMNs (total 7,208 out of 9,095) were most frequently used (89% of all nails) in the beginning, but by the end of the study the proportion of long IMNs had increased to 31% (total 1,887 out of 9,095) (Figure 3).

Mortality. At 30 days, the unadjusted patient survival was 91.1% for SHS and 91.8% for IMN, p = 0.083 (log-rank test). At 90 days, it was 84.5% for SHS and 85.4% for IMN, p = 0.065 (log-rank test). At 365 days, the patient survival was 73.3% for SHS and 74.5% for IMN, p = 0.031 (log-rank test) (Table II).

When adjusting for age group, sex, type of fracture, ASA grade, cognitive status, and time period, IMN had statistically significant higher mortality at 0 to 1 days compared with SHS (HRR 1.63 (95% CI 1.13 to 2.34); p = 0.009, adjusted Cox regression model). At 8 to 30 days, treatment with IMN was associated with a lower mortality than SHS (HRR 0.89 (95% CI 0.80 to 1.00); p = 0.043, adjusted Cox regression model) (Table III, Figure 4a). There was no statistically significant difference between IMN and SHS at 2 to 7, 30, 90, or 365 days (Table III, Figure 4b).

The increased mortality found for IMN at 0 to 1 days was only statistically significant for the period January 2008 to December 2012 (HRR 2.04 (95% CI 1.17 to 3.56); p = 0.012, adjusted Cox regression model) (Table IV). In the period January 2017 to December 2020, the only statistically significant difference was at 365 days, where patients treated with IMN had lower mortality compared with SHS (HRR 0.89 (95% CI 0.81 to 0.98); p = 0.022, adjusted Cox regression model).

In the subanalyses for different ASA grades, treatment with IMN was associated with higher mortality than SHS at 0 to 1 days postoperatively in ASA III patients (HRR 2.41 (95% CI 1.51 to 3.84); p < 0.001). Otherwise, no statistically significant differences were found (Table V).

Subanalyses on different fracture types showed that IMN was associated with higher mortality at 0 to 1 days (HRR 1.72 (95% CI 1.04 to 2.84); p = 0.036, adjusted Cox regression model) and lower mortality at 365 days (HRR 0.92 (95% CI 0.85 to 0.99)) compared to SHS for A1 fractures. For the A2 fractures, there were no statistically significant differences between the two operation methods (Table VI). The IV analysis confirmed the adjusted Cox analysis (Table VII).

NNH. NNH, i.e. the number of patients treated with IMN to cause one extra fatality at 0 to 1 days compared to treatment with SHS, was 556. This indicates that approximately 16 patients in this cohort could possibly have died during day 0 to 1 because of the IMN procedure alone compared with SHS (9,150 patients with IMN/556 NNH). However, the HRR at 8 to 30 days was 0.89 and in favour of IMN, meaning that the increased early mortality in the IMN group was more than outweighed after the immediate postoperative period.

Table IV. Mortality after trochanteric fractures treated with sliding hip screw and intramedullary nail, stratified for different time periods (January 2008 to December 2020).

Days after operation	2008 to 2012		2013 to 2016		2017 to 2020	
	HRR (95% CI)*	p-value†	HRR (95% CI)*	p-value†	HRR (95% CI)*	p-value†
0 to 1	2.04 (1.17 to 3.56)	0.012	1.48 (0.79 to 2.73)	0.214	1.24 (0.60 to 2.54)	0.553
2 to 7	0.87 (0.65 to 1.16)	0.345	1.08 (0.81 to 1.44)	0.608	0.90 (0.67 to 1.19)	0.458
8 to 30	0.90 (0.75 to 1.10)	0.228	0.82 (0.66 to 1.00)	0.050	0.94 (0.78 to 1.14)	0.525
30	0.94 (0.81 to 1.10)	0.433	0.92 (0.79 to 1.08)	0.326	0.94 (0.80 to 1.09)	0.430
90 days	0.98 (0.87 to 1.10)	0.701	0.92 (0.81 to 1.04)	0.164	0.96 (0.85 to 1.08)	0.515
365 days	1.04 (0.96 to 1.13)	0.352	0.94 (0.86 to 1.03)	0.208	0.89 (0.81 to 0.98)	0.022

*Sliding hip screw versus intramedullary nail. Sliding hip screw is the reference.
†Cox regression analysis adjusted for age group, sex, type of fracture, American Society of Anesthesiologists grade, and cognitive status.
CI, confidence interval; HRR, hazard rate ratio.

Table V. Mortality after trochanteric fractures treated with sliding hip screw and intramedullary nail, stratified for American Society of Anesthesiologists grade.

Days after operation	ASA I		ASA II		ASA III		ASA IV to V	
	HRR (95% CI)*	p-value†	HRR (95% CI)*	p-value†	HRR (95% CI)*	p-value†	HRR (95% CI)*	p-value†
0 to 1	N/A‡		N/A‡		2.41 (1.51 to 3.84)	< 0.001	0.96 (0.51 to 1.82)	0.904
2 to 7	N/A‡		0.96 (0.58 to 1.59)	0.856	0.88 (0.71 to 1.09)	0.227	1.06 (0.78 to 1.44)	0.717
8 to 30	N/A‡		0.91 (0.68 to 1.23)	0.543	0.87 (0.76 to 1.00)	0.050	0.95 (0.74 to 1.23)	0.692
30	N/A‡		0.91 (0.70 to 1.17)	0.459	0.92 (0.83 to 1.03)	0.163	0.99 (0.82 to 1.19)	0.891
90	1.66 (0.53 to 5.21)	0.382	0.83 (0.69 to 0.99)	0.041	0.98 (0.90 to 1.06)	0.647	0.94 (0.80 to 1.10)	0.434
365	1.29 (0.55 to 3.02)	0.554	0.95 (0.84 to 1.08)	0.418	0.98 (0.92 to 1.04)	0.501	0.92 (0.80 to 1.04)	0.189

*Sliding hip screw versus intramedullary nail. Sliding hip screw is the reference.
†Cox regression analysis adjusted for age group, sex, type of fracture, cognitive status, and time period.
‡No deaths observed in either intramedullary nail or sliding hip screw, and thus no estimate.
ASA, American Society of Anesthesiologists; CI, confidence interval; HRR, hazard rate ratio; N/A, not applicable.

Discussion

Our national register-based study of trochanteric fractures found no difference in 30-day mortality between IMN and SHS. However, treatment with IMN was associated with a 63% increased mortality at day 0 to 1 and an 11% lower mortality between eight and 30 days compared to SHS. Subanalyses revealed that the increased mortality at day 0 to 1 for IMN was only statistically significant in the first period (January 2008 to December 2012), for patients with AO/OTA A1 fractures, and for patients with ASA grade III.

The adjusted Cox regression and the IV analysis both found that IMN treatment led to lower or similar mortality compared with SHS, except at 0 to 1 days. Statistically significant differences were observed in the IV analysis at 8 to 30, 30, 90, and 365 days, while the Cox analysis only showed significance at 0 to 1 and 8 to 30 days. The IV analysis, although approximate and limited to a particular causal model, performs well in simulations and outperforms the standard Cox model when the model is valid.[19] However, it can be exaggerated or more biased when the instrument's association with the exposure is weak.[21] Given that the IV models lack other confounders besides hospital and year of operation, and given that the variables included in the IV models do not fully explain the confounding, we place greater emphasis on the fully adjusted Cox model.[19,21]

Studies have compared mortality after operation with IMN and SHS for extracapsular fractures but, as far as we know, none have investigated the immediate postoperative mortality at the day of surgery and the first postoperative day. A study from the Swedish Fracture Register reported an increased 30-day mortality for patients with trochanteric fracture treated with IMN compared with those treated with SHS.[10] The Swedish study included, however, only AO/OTA A1 and A2 fractures treated in the period January 2012 to December 2019. Our study population was larger and included fractures from 2008 to 2020, and did not find any difference in 30-day mortality.

A study based on the Danish Fracture Database comparing 9,547 patients treated with IMN and SHS from January 2012 to December 2018 found that the crude mortality was higher for patients treated with IMN within 30 and 90 days.[22] However, in their adjusted analysis, they did not find any differences between IMN and SHS.

Furthermore, Whitehouse et al[11] reported lower 30-day mortality for patients with trochanteric fractures treated with SHS compared with IMN between January 2011 and December 2014. In their study population, 86.7% (n = 66,440/76,589) were treated with SHS and 13.3% (n = 10,149/76,589) were treated with IMN. A group with this small percentage of IMNs might not be representative. We report mortality at different follow-up periods and demonstrate that the increased mortality for treatment with IMN compared with SHS was only present at 0 to 1 days postoperatively. Grønhaug et al[7] reported lower one-year mortality with IMN compared with SHS for stable and unstable fractures in a study from the NHFR covering January 2013 to December 2019. In our study (2008 to 2020), we also found lower one-year mortality with IMN in the January 2017 to December 2020 period, consistent with the findings of Grønhaug et al.[7]

The increased early mortality after intramedullary reamed nailing may be due to increased intramedullary pressure,

Table VI. Mortality after trochanteric fractures treated with sliding hip screw and intramedullary nail, stratified for fracture type.

Days after operation	AO/OTA A1*		AO/OTA A2*	
	HRR (95% CI)†	p-value‡	HRR (95% CI)†	p-value‡
0 to 1	1.72 (1.04 to 2.84)	0.036	1.49 (0.88 to 2.51)	0.136
2 to 7	0.95 (0.74 to 1.22)	0.702	0.93 (0.74 to 1.16)	0.501
8 to 30	0.85 (0.72 to 1.01)	0.070	0.91 (0.79 to 1.06)	0.240
30	0.92 (0.81 to 1.06)	0.248	0.94 (0.84 to 1.06)	0.327
90	0.95 (0.86 to 1.05)	0.325	0.96 (0.87 to 1.05)	0.331
365	0.92 (0.85 to 0.99)	0.027	1.01 (0.94 to 1.08)	0.821

*AO/OTA classification: A1, simple two-part; A2, multifragmentary.
†Sliding hip screw versus intramedullary nail. Sliding hip screw is the reference.
‡Cox regression analyses adjusted for age group, sex, American Society of Anesthesiologists grade, cognitive status, and time period.
CI, confidence interval; HRR, hazard rate ratio.

Table VII. Instrument variable analyses on hospital and year of operation. The comparison of mortality after trochanteric fractures treated with sliding hip screw and intramedullary nail.

Days after operation	HRR (95% CI)*	p-value†
0 to 1		
SHS	Reference	
IMN	1.24 (0.87 to 1.82)	0.288
2 to 7		
SHS	Reference	
IMN	0.93 (0.76 to 1.13)	0.469
8 to 30		
SHS	Reference	
IMN	0.87 (0.76 to 0.99)	0.038
30		
SHS	Reference	
IMN	0.88 (0.80 to 0.98)	0.022
90		
SHS	Reference	
IMN	0.89 (0.82 to 0.97)	0.007
365		
SHS	Reference	
IMN	0.93 (0.87 to 0.99)	0.014

*SHS versus IMN nail. SHS is the reference.
†Instrument variable: hospital and year of operation.
CI, confidence interval; HRR, hazard rate ratio; IMN, intramedullary nail; SHS, sliding hip screw.

potentially causing intramedullary contents to enter the circulation. This pressure variation in the femur, ranging from 20 to 1,950 mmHg, can far exceed intramedullary diastolic blood pressure (25 to 50 mmHg), possibly leading to fat embolism and pulmonary embolism.[3,14] Fat embolization is common in major orthopaedic procedures, but not all patients are clinically affected.[23] In patients with multiple trauma, systemic effects of nailing may be exacerbated, known as the 'multiple hit syndrome'.[24] Our results indicate that mortality is highest in patients with substantial comorbidities (ASA III), suggesting that the systemic effects of IMN insertion may be too severe for some patients.

The national guidelines for England and Wales recommend treating AO/OTA A1 and A2 fractures with a SHS.[3] However, Baldock et al[25] found that 25.8% of their UK study population of 18,156 A1 and A2 fractures were treated with a short or long IMN. They revealed variance from 0% to 97% in the use of treatment between hospitals. Despite growing evidence that SHS and IMN may provide similar outcomes for A1 and A2 fractures,[6,7] there is an internationally increasing trend to use IMN also for A1 and A2 fractures.[1,3,4,8] Based on the results from the current study, mortality should probably not influence the choice of treatment. However, surgeons should be aware of a marginally increased immediate postoperative mortality after IMN. One explanation for this increased mortality can be instrumentation of the femoral canal, which has been shown to increase intramedullary pressure, embolic showers, and fat intravasation.[14]

Further, anaemia is a major independent risk factor for adverse perioperative outcomes, and this includes an association with increased mortality.[26] Some studies have reported a higher blood loss when inserting IMNs compared to SHSs.[27,28] Furthermore, patients who received blood transfusion and were treated with IMN received more units of blood compared to those treated with SHS.[28]

The strength of our study is the high number of procedures representing the national results. The results are based upon 100% completeness of the mortality data. Fixation for trochanteric fractures in Norway is decided based on type of fracture and hospital routines. Normally, patient factors such as age, sex, ASA grade, and cognitive status do not guide the choice of treatment. This reduces the risk of selection bias and we have used IV analysis to adjust for the propensity for hospitals to choose IMN or SHS.

Study limitations include potential biases (selection, information, chance, and confounding).[29] We adjusted for confounding factors such as age group, sex, fracture type, ASA grade, cognitive impairment, and time period. The NHFR lacks cause-of-death data, and there may be under-reporting of intraoperative mortality, which will count as death at day 0, but reporting is likely similar between IMN and SHS patients. Our findings may not generalize to all implant brands. Register-based studies cannot establish causality; they aim to describe associations. Additionally, classification errors in fractures are possible, as the NHFR relies on the surgeon's judgement. Nevertheless, the observed mortality differences were small and should not strongly influence treatment choice.

The lack of randomization of the type of fracture pattern to be evenly applied to SHS and IMN fixation is a major limitation of this study. AO/OTA A1 fractures are more likely to be treated with SHSs, and more likely to do well from a healing perspective. In addition, grouping short IMNs with long IMNs may confound the IMN results; however, we did a subanalysis where we stratified these in two groups.

This national register-based study found no difference in 30-day mortality between IMN and SHS for trochanteric A1 and A2 fractures. However, treatment with IMN was associated with a higher mortality at 0 to 1 days and a marginally lower mortality at 8 to 30 days, but no difference at one year compared to SHS. The differences found in mortality were, however, small and should probably not guide choice of treatment.

Take home message

- This study found no difference in 30-day mortality between intramedullary nail (IMN) and sliding hip screw (SHS).
- However, IMN was associated with a higher mortality at 0 to 1 days and a marginally lower mortality at 8 to 30 days compared to SHS.
- The observed differences in mortality were small and should probably not guide choice of treatment.

Social media

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