Sliding hip screw versus intramedullary nail for trochanteric hip fracture regarding death within 120 days and ability to return to independent living

a nationwide cohort study on 27,530 patients from the Swedish Hip Fracture Register

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Aims

The primary aim of this study was to compare surgical methods (sliding hip screw (SHS) vs intramedullary nailing (IMN)) for trochanteric hip fracture in relation to death within 120 days after surgery and return to independent living. The secondary aim was to assess whether the associations between surgical method and death or ability to return to independent living varied depending on fracture subtype or other patient characteristics.

Methods

A total of 27,530 individuals from the Swedish Hip Fracture Register RIKSHÖFT (SHR) aged ≥ 70 years, admitted to hospital between 1 January 2014 and 31 December 2019 with trochanteric hip fracture, were included. Within this cohort, 12,041 individuals lived independently at baseline, had follow-up information in the SHR, and were thus investigated for return to independent living. Death within 120 days after surgery was analyzed using Cox regression with SHS as reference and adjusted for age and fracture type. Return to independent living was analyzed using logistic regression adjusted for age and fracture type. Analyses were repeated after stratification by fracture type, age, and sex.

Results

Overall, 2,171 patients (18%) who were operated with SHS and 2,704 patients (18%) who were operated with IMN died within 120 days after surgery. Adjusted Cox regression revealed no difference in death within 120 days for the whole group (hazard ratio 0.97 (95% CI 0.91 to 1.03)), nor after stratification by fracture type. In total, 3,714 (66%) patients who were operated with SHS and 4,147 (64%) patients who were operated with IMN had returned to independent living at follow-up. There was no significant difference in return to independent living for the whole group (odds ratio 0.95 (95% CI 0.87 to 1.03)), nor after stratification by fracture type.

Conclusion

No overall difference was observed in death within 120 days or return to independent living following surgery for trochanteric hip fracture, depending on surgical method (SHS vs IMN) in this recent Swedish cohort, but there was a suggested benefit for SHS in subgroups of patients.

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Take home message

- This study indicates that neither sliding hip screw (SHS) nor intramedullary nailing for trochanteric hip fracture is superior regarding death within 120 days after surgery.
- There may be benefits to using SHS in certain patients with two-fragmented fractures.

Introduction

Hip fracture is a serious injury where the affected individuals are at risk of substantial negative impacts on their health, mobility, and independence. Optimal perioperative and surgical treatment can give the patients the best possible chance at continued life, with as intact a level of function as possible. Currently, trochanteric hip fractures are operated with either sliding hip screw (SHS) or, increasingly,[1,2] intramedullary nailing (IMN).

IMN is an established surgical method for sub-trochanteric and unstable trochanteric fractures,[3-5] and has also gained popularity for trochanteric fractures overall.[1,2,6] However, the use of IMN for stable fractures has no convincing evidence of its superiority.[7] Some studies even suggest harm associated with IMN use – a recent Swedish cohort study, which included patients with AO/Orthopaedic Trauma Association (AO-OTA)[8] classification 31-A1 (simple pertrochanteric fracture) and 31-A2 (multifragmentary pertrochanteric fracture), observed an increased risk of death at 30 days after surgery for patients operated with IMN.[9] However, the effect size was small, and very close to statistical non-significance (adjusted relative risk 1.1, 95% CI 1.0 to 1.2). Substantial regional differences in practice have been reported internationally,[10] as well as from Sweden. In Sweden, some orthopaedic clinics almost exclusively favour one method over the other, while most fall somewhere in between.[6,11] Consequently, orthopaedic trainees in some hospitals have limited exposure to either method, which can influence their future implant choices.[12]

Both IMN and SHS come with their own sets of surgical complication risks, mainly infection and nonunion for SHS and implant-related fractures for IMN,[7] although improved design of newer IMN models seems to have decreased the risk of fracture complications.[13] SHS entails a larger surgical dissection with increased risk of visible operative blood loss,[14] while IMN involves disruption of the intramedullary space and thus, theoretically, an increased risk of fat emboli.[15] These differences could ultimately lead to differences in function and/or mortality.

While survival differences are a central measure in studies comparing surgical methods, other aspects such as walking ability, pain, and to what extent the patients can maintain their activities of daily living have to be considered as well. One proxy measure of such aspects is whether the patient can remain living independently in their own home, which has been reported as a central desire among patients themselves.[16] It has, to our knowledge, not been previously investigated whether the choice of surgical method for trochanteric fracture is associated with return to independent living postoperatively. Change in practice despite absence of proven benefits warrants scientific evaluation, which is the motivation for this study.

Methods

Study design, setting, and data sources

This is a nationwide cohort study using prospectively collected data from the Swedish Hip Fracture Register RIKSHÖFT (SHR),[17] a national clinical quality register. SHR collects information on patients with hip fractures in Sweden, with data from the initial hospitalization and follow-up information collected approximately four months after surgery. SHR had a completeness of > 80% between 2008 and 2017, when compared with the Swedish National Patient Register (NPR).[18] Data from SHR were linked with NPR[19-21] and the Swedish Dwelling Register, an administrative register containing information on household size.[22] Data linkage was facilitated by the unique personal identity number assigned to every person living legally in Sweden for more than a year.[21]

Inclusion criteria were individuals with trochanteric hip fracture aged ≥ 70 years admitted to hospital between 1 January 2014 and 31 December 2019. Exclusion criteria were American Society of Anesthesiologists (ASA)[23,24] grade ≥ 5, pathological hip fracture, intervention other than SHS or IMN, missing data on surgery type, and non-surgical treatment. When an individual appeared more than once in the register in the study period, only the first event was included. The analyses of return to independent living were restricted to individuals who lived independently before the fracture with information on residence from the follow-up survey (Figure 1). The baseline characteristics for the included patients are shown in Table I.

Exposure variable

Surgical method was defined as SHS or IMN in the SHR. No distinction was made between different models of the surgical methods, or between long and short intramedullary nails.

Outcome variables

Date of death is recorded with near-perfect completeness in Swedish administrative registers and can thus be used as a reliable outcome in research. The Fragility Fracture Network (FFN) suggests using death within either 30 or 120 days for hip fracture audits.[25] We considered 30 days to be too narrow a time frame to investigate, while acknowledging that the more time has elapsed from surgery, the less likely it is that the surgical method affects mortality.

The second outcome, "return to independent living", was defined as the patient living in their own home at follow-up (defined as 60 to 180 days after surgery) if they had lived in their own home before the fracture. Those who had died within 180 days after surgery were considered not to have returned to independent living.

Potential confounders

Age and fracture type were selected a priori as confounders. Age was dichotomized into two groups, 70 to 84 years and > 85 years, for the stratified analyses. Two-fragmented fractures in SHR, and in this present study, correspond to fractures with AO-OTA classification 31-A1 (simple pertrochanteric).[8] Multifragmented fractures correspond to AO-OTA classification 31-A2 (multifragmentary pertrochanteric) and 31-A3 (intertrochanteric (reverse obliquity)). Fracture type was determined by the treating orthopaedic surgeon and reported to the

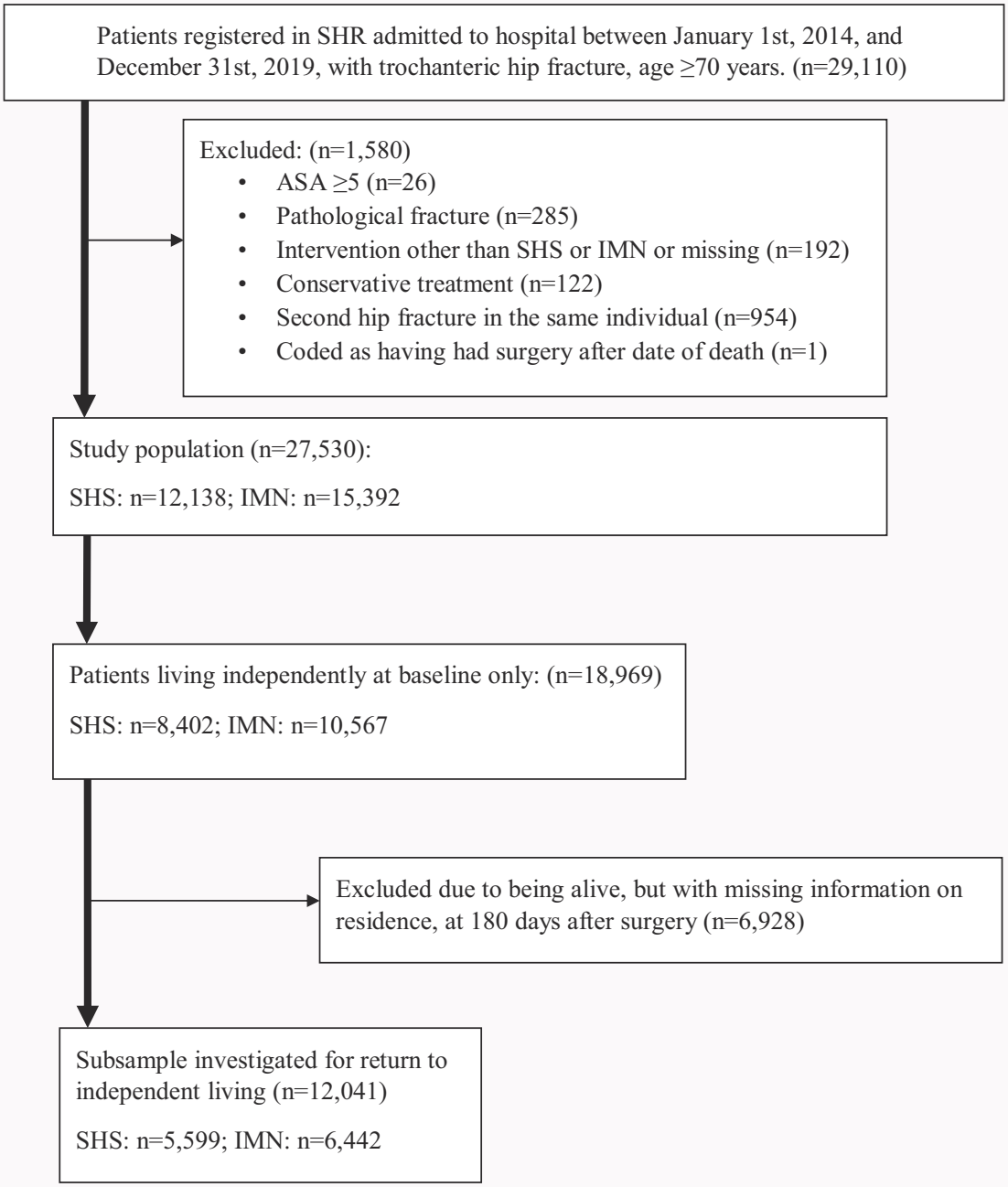

Fig. 1
Flowchart of the study population. ASA, American Society of Anesthesiologists; IMN, intramedullary nailing; SHR, Swedish Hip Fracture Register; SHS, sliding hip screw.

register. There is high agreement on fracture type when comparing SHR with NPR.[18]

Covariates

Pre-fracture walking ability was defined based on recorded use of walking aids and categorized into "high" (able to walk without aids, or with one cane or crutch), "medium" (able to walk with two canes or crutches, with a walking frame or a wheeled walker), and "unable to walk" (wheelchair user or bedridden). Dementia was defined as either being categorized as "known dementia" in SHR and/or having either of the ICD-10 diagnoses G30-31 or F00-03 registered in NPR in the last five years before the hip fracture up until 30 days after fracture. Cohabitation status in the year before the fracture was used for cohabitation status.

Statistical analysis

Descriptive baseline characteristics were presented for the whole population and for those operated with SHS and IMN separately. Medians and IQRs were used to describe continuous variables. Frequencies and percentages were used to describe categorical variables. Treatment groups were compared using chi-squared test or Mann-Whitney U test, and p-values < 0.05 were considered statistically significant. Cox proportional hazards models were used to analyze the association between surgical method and death within 120 days after surgery. Logistic regression was used to analyze

Table I. Descriptive statistics of the study population.

Characteristic	SHS	IMN	p-value
Patients, n (%)	12,138 (44)	15,392 (56)	
Female sex, n (%)	8,433 (69)	11,096 (72)	< 0.001§
Median age, yrs (IQR)	86 (80 to 90)	86 (80 to 90)	0.040¶
ASA grade, n (%)*			< 0.001§
I	349 (3)	441 (3)	
II	3,874 (32)	5,004 (33)	
III	6,983 (58)	8,376 (55)	
IV	888 (7)	1,300 (9)	
Known dementia, n (%)	2,969 (24)	4,171 (27)	< 0.001§
Trochanteric two-fragmented fracture, n (%)	7,950 (66)	4,792 (31)	< 0.001§
Median time to surgery, hrs (IQR)†	19 (12 to 25)	19 (12 to 25)	0.105¶
Baseline living situation, n (%)			< 0.001§
Admitted from own home	8,402 (69)	10,567 (69)	
Admitted from institutional care	3,068 (25)	4,119 (27)	
Admitted from other	668 (6)	796 (5)	
Co-habitating before fracture (from the dwelling register)‡	4,714 (39)	5,773 (38)	0.023§
Baseline walking ability, n (%)			0.391§
High walking ability before fracture	5,337 (44)	6,869 (45)	
Medium walking ability before fracture	6,395 (53)	8,041 (52)	
Unable to walk before fracture	406 (3)	482 (3)	
Deceased during index hospitalization	411 (3)	550 (4)	0.401§
Deceased within 30 days after surgery	1,053 (9)	1,385 (9)	0.349§
Deceased within 120 days after surgery	2,171 (18)	2,704 (18)	0.492§

*Missing ASA grade: n = 315 (1%)
†Missing time to surgery: n = 525 (2%)
‡Missing cohabitation status: n = 20 (0.001%)
§Chi-squared test.
¶Mann-Whitney U test.
ASA, American Society of Anesthesiologists; IMN, intramedullary nail; SHS, sliding hip screw.

the association between surgical method and return to independent living. All analyses were adjusted for age, which was squared to allow for a non-linear relationship between age and the respective outcome. The analyses were repeated with stratification by: fracture type, age group, and sex. Analyses not stratified by fracture type were adjusted for fracture type in a second step, and those stratified by factors other than fracture type were thereafter also repeated with stratification by fracture type. The analyses were conducted using Stata version 17 2021 (StataCorp, USA). The STROBE guidelines were followed.[26]

Sensitivity analysis

Sensitivity analyses were performed to assess whether additional subgroups of patients displayed associations between surgical method and the outcome that differed from, or could help explain, the main analyses. The Cox regression analyses (investigating death within 120 days after surgery) were repeated with the population divided into subgroups based on ASA grade, walking ability, and dementia. ASA grade was considered a proxy for comorbidities.

The logistic regression analyses (investigating return to independent living) were repeated for subgroups based on ASA grade, walking ability, dementia, and co-habitation status at baseline. All sensitivity analyses were further stratified by fracture type.

Results

The crude outcome data for the subsample of patients investigated for return to independent living are shown in Table II. Out of the 18,969 patients living independently at baseline, 12,041 (63%) had information on residence (or were deceased) at follow-up and were thus investigated for return to independent living. Characteristics of the 6,928 patients who were excluded from the analyses due to being alive but missing information on residence at follow-up are displayed in Supplementary Table i. Overall, the baseline characteristics (including age, sex, and distribution of ASA grade) of the patients excluded were similar to those included. Those excluded had a slightly lower percentage of two-fragmented fractures (44% vs 47%, $p < 0.001$), were more often operated with IMN (60% vs 54%, $p < 0.001$), and more often lived alone at baseline (61% vs 57%, $p < 0.001$) than those included in the analyses.

120-day mortality

By 120 days after surgery, 2,171 patients (18%) of those operated with SHS and 2,704 (18%) of those operated with IMN had died, which was not statistically significantly different ($p = 0.492$). The younger patients, aged 70 to 84 years, had lower mortality compared with those aged 85 years and above: 11% vs 23% ($p < 0.001$). Women had lower mortality than men: 16% vs 23% ($p < 0.001$) (Table I). Cox regression revealed no statistically significant difference in the hazard ratio (HR) of death within 120 days for patients operated with SHS versus IMN overall (HR 0.97 (95% CI 0.91 to 1.03)), nor after stratification by fracture type (Table III).

Stratifying the fracture type groups further into age groups failed to reveal any association between type of surgery and death (Supplementary Tables ii and iii). When stratifying by sex alone, there was no association between type of surgery and death within 120 days among either sex (Supplementary Table iv). When stratifying further by both sex and fracture type, there was a borderline significant association between IMN and lower hazard of death among women with two-fragmented fractures (HR 0.89 (95% CI 0.79 to 1)). There was no significant association between type of surgery and death for women with multifragmented fractures (HR 1.02 (95% CI 0.92 to 1.13)), men with two-fragmented fractures (HR 1.08 (95% CI 0.94 to 1.23)), or men with multifragmented fractures (HR 0.92 (95% CI 0.78 to 1.06)).

Table II. Descriptive statistics for patients living independently at baseline, with those alive at 180 days and those with no information on residence in range excluded.

Characteristic	SHS	IMN	p-value
Patients, n (%)	5,599 (47)	6,442 (54)	
Female sex, n (%)	3,810 (68)	4,590 (71)	< 0.001¶
Median age, yrs (IQR)	85 (79 to 90)	85 (80 to 90)	0.118**
ASA grade, n (%)*			< 0.001¶
I	196 (4)	248 (4)	
II	1,993 (36)	2,444 (38)	
III	3,036 (54)	3,224 (50)	
IV	364 (7)	489 (8)	
Known dementia, n (%)	503 (9)	701 (11)	0.001¶
Trochanteric two-fragmented fracture, n (%)	3,680 (66)	1,993 (31)	< 0.001¶
Median time to surgery, hrs (IQR)†	19 (12 to 25)	19 (12 to 25)	0.481**
Co-habitating before fracture (from the dwelling register), n (%)‡	2,400 (43)	2,720 (42)	0.482¶
Baseline walking ability, n (%)			0.295¶
High walking ability before fracture	2,989 (53)	3,410 (53)	
Medium walking ability before fracture	2,516 (45)	2,944 (46)	
Not able to walk before fracture	94 (2)	88 (1)	
Median time to follow-up, days (IQR)§	131 (123 to 142)	132 (123 to 146)	< 0.001**
Living situation at follow-up, n (%)			0.050¶
Living in own home	3,714 (66)	4,147 (64)	
Living in institutional care	546 (10)	717 (11)	
Other living situation	152 (3)	171 (3)	
Deceased at follow-up, n (%)	1,187 (21)	1,407 (22)	
Deceased during index hospitalization, n (%)	246 (4)	290 (5)	0.774¶
Deceased within 30 days after surgery, n (%)	463 (8)	569 (9)	0.271¶
Deceased within 120 days after surgery, n (%)	1,057 (19)	1,222 (19)	0.899¶

*Missing ASA grade: 47 (0%).
†Missing time to surgery: 47 (0%).
‡Missing cohabitation status: 1 (0%).
§Missing time to follow-up: 1,338 (11%).
¶Chi-squared test.
**Mann-Whitney U test.
ASA, American Society of Anesthesiologists.

Return to independent living

In total, 3,714 of the patients (66%) operated with SHS and 4,147 of the patients (64%) operated with IMN had returned to independent living at follow-up. The crude distributions of living situation at follow-up were borderline significantly different between the two treatment groups (p = 0.050) (Table II). A higher proportion of the younger patients (aged 70 to 84 years) had returned to independent living compared with the older (aged 85 years and above): 77% versus 54% (p < 0.001). A slightly higher proportion of women had returned to independent living compared with men: 67% versus 61% (p < 0.001).

Logistic regression revealed no difference in return to independent living depending on surgical method for the whole group (odds ratio (OR) 0.95 (95% CI 0.87 to 1.03)). After stratification by fracture type, those with two-fragmented fracture had a borderline significant association between IMN and lower odds of return to independent living. There was no association among those with multifragmented fracture (Table IV).

Stratification by age groups and fracture type revealed an association between IMN and lower odds of return to independent living among patients aged 70 to 84 years with two-fragmented fractures, but not among those with multifragmented fractures or those aged 85 years and over, regardless of fracture type (Supplementary Tables v and vi).

Stratifying by sex revealed no association among women, but IMN was associated with lower odds of return to independent living among men (Supplementary Table vii). When stratifying these groups by fracture type, the lack of association persisted among women. Among men, the association between IMN and lower odds of return to independent living remained for those with two-fragmented fracture only (OR 0.71 (95% CI 0.58 to 0.88) vs OR 0.98 (95% CI 0.79 to 1.23)) for men with multifragmented fractures.

Sensitivity analyses

No association between type of surgery and death within 120 days was found after stratification either by ASA grade, baseline walking ability, cohabitation status, or dementia, nor after further stratification by fracture type (data not shown).

There were significant associations between IMN and decreased return to independent living among patients with two-fragmented fractures in combination with the following characteristics: high baseline walking ability (OR 0.81 (95% CI 0.67 to 0.97)); ASA grade III (OR 0.82 (95% CI 0.7 to 0.96)); and no baseline dementia (OR 0.87 (95% CI 0.76 to 0.99)). There was a borderline significant association between IMN and lower return to independent living among those with two-fragmented fractures who had cohabitated at baseline (OR 0.83 (95% CI 0.68 to 1)). There was no significant association between type of surgery and return to independent living in any other combination of fracture type and patient characteristic (data not shown).

Discussion

This present study shows no apparent clinical or statistically significant differences between SHS and IMN overall. It does, however, suggest a disadvantage for IMN, specifically for return to independent living among subgroups of patients with two-fragmented fractures.

Our observations of no association between surgical method and death are in line with the most recent Cochrane review,[7] the INSITE randomized controlled trial,[27] and a 2020 USA propensity score-matched cohort study on over 17,000 patients.[28] Other studies using data from clinical quality registers in the UK[2] and in Sweden[9] have reported mortality

Table III. Age-adjusted hazard ratios and 95% CIs for death within 120 days after surgery estimated with Cox proportional hazards regression, stratified by fracture type.

		Two-fragmented fractures			Multifragmented fractures
Type of surgery	**Deaths, n (%)**	**(n = 12,742)**	**Type of surgery**	**Deaths, n (%)**	**(n = 14,788)**
SHS (n = 7,950)	1,418 (18)	Ref	SHS (n = 4,188)	753 (18)	Ref
IMN (n = 4,792)	805 (17)	0.94 (0.86 to 1.02)	IMN (n = 10,600)	1,899 (18)	0.99 (0.91 to 1.08)

IMN, intramedullary nailing; SHS, sliding hip screw.

Table IV. Age-adjusted odds ratios and 95% CIs for return to independent living estimated with logistic regression, stratified by fracture type.

Type of surgery	**Returned to independent living, n (%)**	**Two-fragmented fractures (n = 5,673)**	**Type of surgery**	**Returned to independent living, n (%)**	**Multifragmented fractures (n = 6,368)**
SHS (n = 3,680)	2,484 (68)	Ref	SHS (n = 1,919)	1,230 (64)	Ref
IMN (n = 1,993)	3,777 (67)	0.88 (0.78 to 1)	IMN (n = 4,449)	2,854 (64)	1.01 (0.9 to 1.13)

IMN, intramedullary nailing; SHS, sliding hip screw.

benefits for those operated with SHS, while one from the Norwegian Hip Fracture Register reported mortality benefit for those operated with IMN.[29] Although the studies mentioned have investigated death at different timepoints, complicating direct comparisons, an argument can be made that potential differences in death depending on surgical method are probably very limited at most timepoints.

This study demonstrates that IMN for two-fragmented trochanteric fracture was associated with decreased return to independent living at follow-up among men and among patients aged 70 to 74 years. Sensitivity analyses displayed a similar pattern among ASA grade 3 patients, those with high baseline walking ability, and those without dementia at baseline. These results may reflect the vulnerability of the population at risk for hip fracture – those who were already at the older end of the spectrum, and had lower baseline walking ability and/or dementia at baseline, but were still able to live independently, may already have had significant adaptations to their homes, making small differences in, for example, functional level or pain relating to surgical method less impactful.

In light of the increasing popularity of IMN, the potential benefits of using SHS over IMN, found in this study and others,[2,9,30] highlight the importance of making sure that SHS remains a technique being actively taught to and used by current and future orthopaedic surgeons.

This is a cohort study that covers a large majority of all patients with hip fracture in Sweden during the study period, ensuring inclusion of a very broad patient population. By linking SHR with administrative registers, we were able to conduct sensitivity analyses on subgroups of patients who have not always been considered in similar studies. Investigating return to independent living, an important aspect of quality of life among patients with hip fracture, is a major strength of this study. By including those who had died in the group considered not to have returned home, we accounted for the competing risk of death, which may otherwise have introduced bias to our results. The living situation of older people varies in different parts of the world, complicating direct comparisons over different countries. However, the internal validity is unaffected.

There were limitations to this study. As in all observational studies, there is a risk of residual confounding. Implant selection for trochanteric fracture in Sweden varies regionally; if there is regional variation in survival after hip fracture and chances of returning to independent living, geographical region could be a confounder that is not accounted for. Implant selection can also be influenced by other factors, such as fracture characteristics[12] and perceived patient benefit.[10] A systematic difference in unmeasured patient characteristics over the treatment groups could bias our results. However, there was no difference in baseline walking ability across the treatment groups, speaking against a selection based on functional status (Table I). Both fracture type and type of surgery are categorized relatively broadly in SHR, which meant that we were unable to compare fracture types beyond two-fragmented and multifragment. We were unable to distinguish between different types of implants, which introduces the risk that unfavourable outcomes could be partly due to a learning-curve effect for surgeons using a new device, and that the potential effects of individual subtypes of implants, in either direction, may have been obscured. We were also unable to consider factors such as the experience level of the personnel involved in caring for the patients.

To investigate return to independent living, those who did not live independently at baseline had to be excluded. This likely entails a selection of the more robust patients of the study population, and it is unknown whether the treatments studied have similar or different effects on the more vulnerable individuals. To overcome this problem, outcomes related to functional ability other than return to independent living should be studied. Furthermore, 6,928 patients – 37% of those who lived independently at baseline – were excluded due to missing follow-up information, which is substantial enough to introduce uncertainty. However, when comparing the baseline

characteristics of this group with the one that was analyzed, they appear similar.

Our analyses revealed no apparent differences between the two methods for either death or independent living overall, but point towards a small benefit of SHS for two-fragmented fractures for return to independent living, at least for younger patients and men.

Supplementary material

Descriptive data of patients excluded from the analyses of return to independent living, as well as results of stratified and sensitivity analyses.

References

1. **Chen F**, **Wang Z**, **Bhattacharyya T**. Convergence of outcomes for hip fracture fixation by nails and plates. *Clin Orthop Relat Res*. 2013;471(4):1349–1355.
2. **Whitehouse MR**, **Berstock JR**, **Kelly MB**, **et al**. Higher 30-day mortality associated with the use of intramedullary nails compared with sliding hip screws for the treatment of trochanteric hip fractures. *Bone Joint J*. 2019;101-B(1):83–91.
3. **Bhandari M**, **Swiontkowski M**. Management of acute hip fracture. *N Engl J Med*. 2017;377(21):2053–2062.
4. **No authors listed**. Management of hip fractures in older adults: evidence-based clinical practice guideline. American Academy of Orthopaedic Surgeons. 2021. https://www.aaos.org/globalassets/quality-and-practice-resources/hip-fractures-in-the-elderly/hipfxcpg.pdf (date last accessed 25 September 2024).
5. **No authors listed**. Hip fracture: management. National Institute for Health and Care Excellence (NICE). 2011. https://www.nice.org.uk/guidance/cg124 (date last accessed 25 September 2024).
6. **No authors listed**. Annual report 2020. RIKSHÖFT (Swedish National Registry for Hip Fractures). https://www.xn--rikshft-e1a.se/_files/ugd/3ac01b_2ce2105ebca7495c800465396dadaf89.pdf (date last accessed 25 September 2024).
7. **Lewis SR**, **Macey R**, **Gill JR**, **Parker MJ**, **Griffin XL**. Cephalomedullary nails versus extramedullary implants for extracapsular hip fractures in older adults. *Cochrane Database Syst Rev*. 2022;1(1):CD000093.
8. **Meinberg EG**, **Agel J**, **Roberts CS**, **Karam MD**, **Kellam JF**. Fracture and Dislocation Classification Compendium 2018. *J Orthop Trauma*. 2018;32 Suppl 1:S1–S170.
9. **Wolf O**, **Mukka S**, **Ekelund J**, **Rogmark C**, **Möller M**, **Hailer NP**. Increased mortality after intramedullary nailing of trochanteric fractures: a comparison of sliding hip screws with nails in 19,935 patients. *Acta Orthop*. 2022;93:146–150.
10. **Baldock TE**, **Dixon JR**, **Koubaesh C**, **Johansen A**, **Eardley WGP**. Variation of implant use in A1 and A2 trochanteric hip fractures: a study from the National Hip Fracture Database of England and Wales. *Bone Jt Open*. 2022;3(10):741–745.
11. **Hernefalk B**, **Rydberg EM**, **Ekelund J**, **et al**. Inter-departmental variation in surgical treatment of proximal femoral fractures: a nationwide observational cohort study. *PLoS One*. 2023;18(2):e0281592.
12. **Mellema JJ**, **Janssen S**, **Schouten T**, **et al**. Intramedullary nailing versus sliding hip screw for A1 and A2 trochanteric hip fractures. *Bone Joint J*. 2021;103-B(4):775–781.
13. **Pascarella R**, **Fantasia R**, **Maresca A**, **et al**. How evolution of the nailing system improves results and reduces orthopedic complications: more than 2000 cases of trochanteric fractures treated with the Gamma Nail System. *Musculoskelet Surg*. 2016;100(1):1–8.
14. **Zhu Q**, **Xu X**, **Yang X**, **et al**. Intramedullary nails versus sliding hip screws for AO/OTA 31-A2 trochanteric fractures in adults: a meta-analysis. *Int J Surg*. 2017;43:67–74.
15. **Vetrugno L**, **Bignami E**, **Deana C**, **et al**. Cerebral fat embolism after traumatic bone fractures: a structured literature review and analysis of published case reports. *Scand J Trauma Resusc Emerg Med*. 2021;29(1):47.
16. **Robinson SM**, **Ní Bhuachalla B**, **Ní Mhaille B**, **Cotter PE**, **O'Connor M**, **O'Keeffe ST**. Home, please: a conjoint analysis of patient preferences after A bad hip fracture. *Geriatr Gerontol Int*. 2015;15(10):1165–1170.
17. **No authors listed**. The Swedish National Hip Fracture Registry (RIKSHÖFT). 2022. https://www.rikshoft.se/english (date last accessed 17 September 2024).
18. **Meyer AC**, **Hedström M**, **Modig K**. The Swedish Hip Fracture Register and National Patient Register were valuable for research on hip fractures: comparison of two registers. *J Clin Epidemiol*. 2020;125:91–99.
19. **No authors listed**. National patient register [patientregistret]: national board for health and welfare [socialstyrelsen. Socialstyrelsen] NBfHaW. 2020. https://www.socialstyrelsen.se/en/statistics-and-data/registers/national-patient-register/ (date last accessed 25 September 2024).
20. **Ludvigsson JF**, **Andersson E**, **Ekbom A**, **et al**. External review and validation of the Swedish national inpatient register. *BMC Public Health*. 2011;11:450.
21. **Ludvigsson JF**, **Almqvist C**, **Bonamy A-KE**, **et al**. Registers of the Swedish total population and their use in medical research. *Eur J Epidemiol*. 2016;31(2):125–136.
22. **No authors listed**. https://metadata.scb.se/mikrodataregister.aspx (date last accessed 3 October 2024).
23. **Saklad M**. Grading of patients for surgical procedures. *Anesth*. 1941;2(3):281–284.
24. **No authors listed**. Statement on ASA Physical Status Classification System. American Society of Anesthesiologists. 2021. https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system (date last accessed 17 September 2024).
25. **Johansen A**, **Ojeda-Thies C**, **Poacher AT**, **et al**. Developing a minimum common dataset for hip fracture audit to help countries set up national audits that can support international comparisons. *Bone Joint J*. 2022;104-B(6):721–728.
26. **Vandenbroucke JP**, **von Elm E**, **Altman DG**, **et al**. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *Int J Surg*. 2014;12(12):1500–1524.
27. **Schemitsch EH**, **Nowak LL**, **Schulz AP**, **et al**. Intramedullary nailing vs sliding hip screw in trochanteric fracture management: the INSITE randomized clinical trial. *JAMA Netw Open*. 2023;6(6):e2317164.
28. **Warren JA**, **Sundaram K**, **Hampton R**, **et al**. Cephalomedullary nailing versus sliding hip screws for Intertrochanteric and basicervical hip fractures: a propensity-matched study of short-term outcomes in over 17,000 patients. *Eur J Orthop Surg Traumatol*. 2020;30(2):243–250.
29. **Grønhaug KML**, **Dybvik E**, **Matre K**, **Östman B**, **Gjertsen J-E**. Intramedullary nail versus sliding hip screw for stable and unstable trochanteric and subtrochanteric fractures: 17,341 patients from the Norwegian Hip Fracture Register. *Bone Joint J*. 2022;104-B(2):274–282.
30. **Berney M**, **Moore J**, **Walsh M**, **et al**. Is the increased use of intramedullary nailing over DHS for intertrochanteric hip fractures justified? - a review of the Irish hip fracture database 2016-2020. *Surgeon*. 2024;22(1):31–36.

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Data sharing

The data used for this study are considered sensitive personal information and cannot be accessed without an ethical permit. The datasets generated and analyzed in the current study are therefore not publicly available. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

Ethical review statement

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