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Adherence to guidelines regarding the treatment of trochanteric hip fractures at Sahlgrenska University Hospital, since the implementation of new guidelines in 2017.

Degree Project in Medicine

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Programme in Medicine

Gothenburg, Sweden 2019

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List of Abbreviations

AO – Arbeitsgemeinschaft für Osteosynthesefragen

ASA – American Society of Anaesthesiologists

DHS – Dynamic Hip Screw

IM – Intramedullary nail

LoS – Length of stay

OTA – Orthopaedic Trauma Association

SFR – Swedish Fracture Register

SU – Sahlgrenska University Hospital

Abstract

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Adherence to guidelines regarding the treatment of trochanteric hip fractures at Sahlgrenska University Hospital, since the implementation of new guidelines in 2017.

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Background - Hip fractures are a common fracture among the elderly and result in increased mortality, impaired function and decreased quality of life. Regarding the treatment of trochanteric hip fractures, the common opinion is that the Dynamic Hip Screw (DHS) is preferable when it comes to stable fractures while the intramedullary nail (IM) is more suitable for unstable fractures. At the Department of Orthopaedics at Sahlgrenska University Hospital (SU), new guidelines were introduced in March 2017 to implement the recommendations stated above as common opinion.

Aim – The primary aim of this study was to study the adherence to guidelines regarding the treatment of trochanteric hip fractures. Secondary aims were to describe the main surgeon's level of expertise and its effect on the choice of treatment method, and to compare the length of stay (LoS) for different treatment methods.

Methods – This was a register-based study using data from the Swedish Fracture Register to analyse trochanteric hip fractures treated at Sahlgrenska University hospital in 2015 and 2017-2019. 1571 patients were included in the study.

Results – There was a trend towards increased use of IM for all fracture types. The use of IM for treating stable fractures rose from 33% in 2017 to 73% in 2019. Consultants specialised in trauma had the highest adherence to the guidelines with 79%. The least adherence had orthopaedic residents with 69%. The mean LoS for the DHS group was 11.6 days and 11.9

days for the IM group (p=0.94).

Conclusions - This study concluded that IM is the most commonly used treatment method for stable trochanteric fractures at SU, even though guidelines recommend the use of DHS. The use of IM should be reduced until contradictory evidence is presented. Further studies analysing the reason for the low adherence is necessary.

Key words – Trochanteric, hip fracture, treatment, dynamic hip screw, intramedullary nail

1. **Background**

1.1 Hip fractures

Hip fractures are a common fracture among the elderly and result in increased mortality, impaired function and decreased quality of life (1, 2). One in ten patients does not regain the ability to walk after a hip fracture and the one-year mortality associated with hip fractures in Sweden is approximately 26% (3, 4). In 1990 around 1.26 million people in the world suffered from hip fractures annually and estimates were made that in 2050 this number will have risen to 6.3 million, with possibilities of much larger numbers (5, 6). Sweden has one of the highest incidence rates in the world, and about 16,000 hip fractures occur every year (7, 8). Hip fractures affect mainly older women and in Sweden 69.4% of the hip fracture patients are women. The mean age is 82.4 years (3).

1.2 Diagnostics

A hip fracture is often incurred after a fall at the same level in the patient's home and is associated with pain and inability to walk (3). Clinical signs may be a shortened and externally rotated leg and inability to bear weight on the injured side (9, 10). The statement from the patient or witnesses to the accident, the clinical signs, and plain radiograph is usually enough to verify a hip fracture. In some cases, for example, when the fracture is undisplaced, Magnetic Resonance Imaging (MRI) may be needed to confirm the diagnosis (9).

1.3 Fracture classification

Fractures of the hip are divided into three anatomical categories; femoral neck, trochanteric and subtrochanteric fractures. This classification is made based on plain radiograph. Femoral neck fractures are located within the hip capsule and are therefore also referred to as intracapsular. Trochanteric and subtrochanteric hip fractures are both extracapsular. Subtrochanteric fractures are located within the area below and 5 cm distal to the lesser

trochanter (9). The Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA) has created a classification system for fractures to enable more detailed descriptions (Fig. 2, 3 and 4)(11). Other classification systems exist but the AO/OTA system is the most commonly used to classify the extracapsular fractures, while for example the femoral neck fractures are usually classified using the Garden system (10, 12, 13). Fractures in the trochanteric region are classified as AO/OTA 31A, and then there is a sub-classification that describes the fracture pattern in detail. In the latest revision of the AO/OTA instructions, there have been some changes made regarding the classifications of trochanteric hip fractures (11, 12). Since the SFR, from which data used in this study is extracted, has not updated its classifications, the old classifications will be used in this report (12). In Sweden, 31A2 is the most common trochanteric hip fracture with 49% of the trochanteric fractures, followed by 31A1 (29%) and 31A3 (22%) (3). When analysing trochanteric fractures in studies, it is common to present 31A1 and 31A3 fractures without further classifications while 31A2 fractures are usually presented with sub-classifications. This is because of the stability aspect which is further described later in this paper (14).

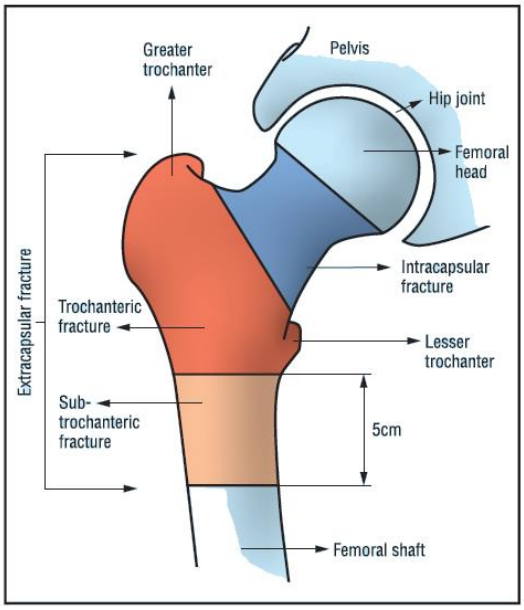

Fig. 1. The anatomical regions of the proximal part of femur.
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1.3.1 31A1 fractures

Fractures in the 31A1 group are characterised by a single fracture line going from the greater trochanter to the medial side above or below the lesser trochanter, resulting in two fracture fragments(14, 15). In group 31A1.1 there is a fracture line in the femur running along the intertrochanteric line which separates the femoral neck and the intertrochanteric region. In

31A1.2 the fracture line ends above the lesser trochanter, while in 31A1.3 it ends below (15).

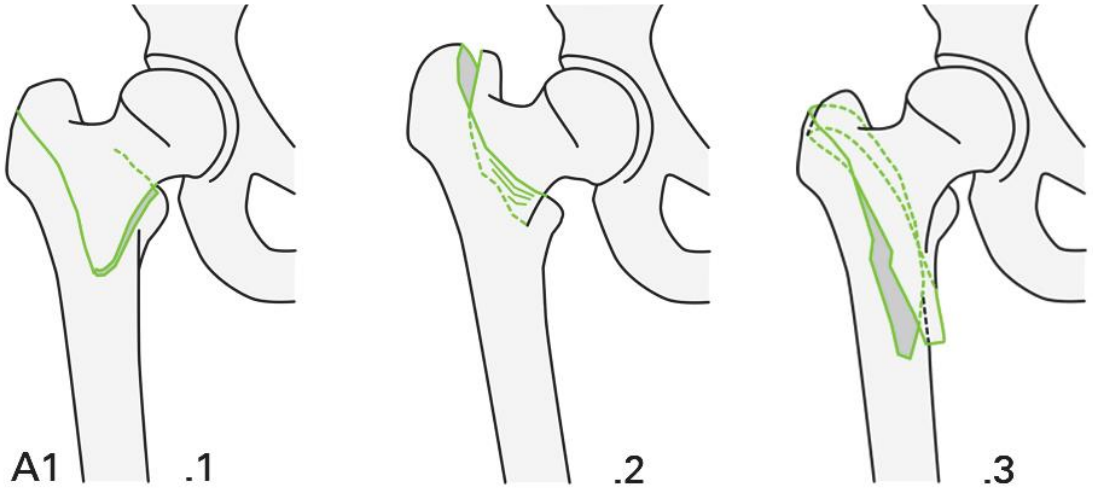

Fig. 2. Fracture group 31A1 according to the AO/OTA classification system. The definitions of the sub-groups are described in the text. Copyright the AO Foundation, Switzerland.

1.3.2 31A2 fractures

31A2 fractures are all multifragmentary with one or more fracture lines starting at the greater trochanter and then running into the medial side dividing it at two or more places. 31A2.1 is a fracture with only one intermediate fragment, usually the lesser trochanter. If there is more than one intermediate fragment it is classified as a 31A2.2 fracture and if a fracture line reaches further distal than 1 cm from the lesser trochanter it is a 31A2.3 fracture (15).

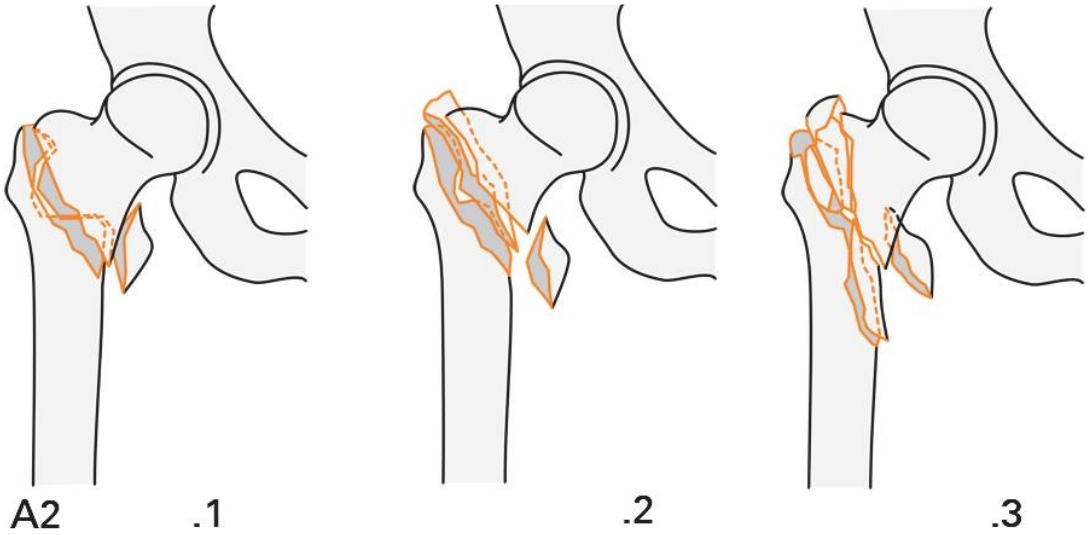

Fig. 3. Fracture group 31A2 according to the AO/OTA classification system. The definitions of the sub-groups are described in the text. Copyright the AO Foundation, Switzerland.

1.3.3 31A3 fractures

31A3 fractures consists of the subtrochanteric and oblique fractures (14). When the fracture line begins distal to the greater trochanter and runs up towards the lesser trochanter as a single line it is a simple reverse oblique fracture, 31A3.1. The simple transverse fracture, 31A3.2, has a single line straight across the femur. In the case of multiple fragments, the fracture is classified as a 31A3.3 (15).

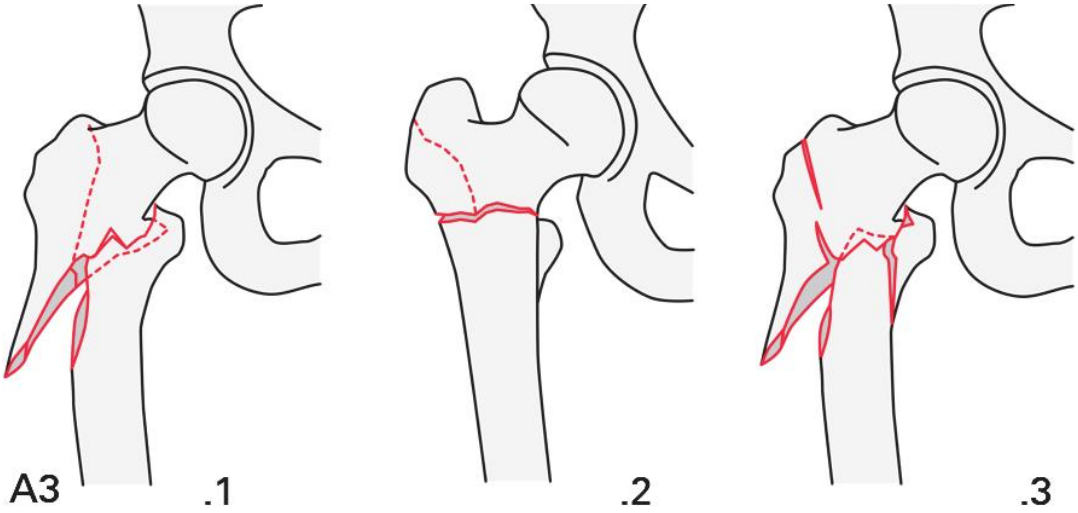

Fig. 4. Fracture group 31A3 according to the AO/OTA classification system. The definitions of the sub-groups are described in the text. Copyright the AO Foundation, Switzerland.

1.4 Fracture stability

When deciding the treatment of a hip fracture it is important to consider the fracture stability. Fracture groups 31A1 and 31A2.1 are often considered as stable while 31A2.2, 31A2.3 and 31A3 are considered as unstable (Fig. 5) (14). The stability of a hip fracture depends on the number of intermediate fragments and which parts of the bone that are engaged by the fracture (16). The fractures in group 31A1, having one fracture line is, thus, more stable than the 31A2.2 fractures which have two or more intermediate fragments (14). When analysing outcomes after treatment of the different fracture groups, 31A2.1 has shown higher similarity to 31A1 than to the other 31A2 groups (17). It seems as if the intermediate fragment in the

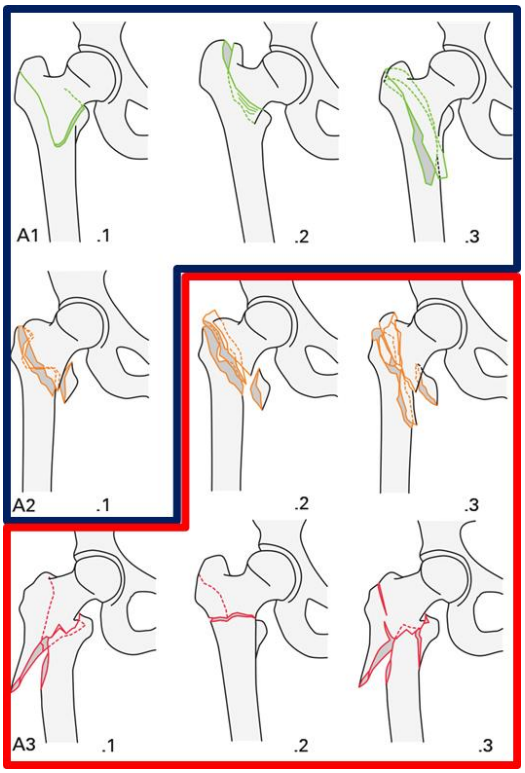

Fig. 5. Group 31A1 and 31A2.1 (blue) are often considered stable trochanteric fractures, while 31A2.2, 31A2.3 and 31A3 (red) are considered unstable. Copyright the AO Foundation, Switzerland.

31A2.1 fracture is too small to affect the stability. Group 31A2.1 is hence considered a stable fracture in the same manner as the two-part fractures in group 31A1 (14). Regarding the position of the fracture lines, an intertrochanteric hip fracture is commonly considered unstable when it is affecting the posteromedial or lateral cortex, for example as in the case of the reverse oblique fracture, 31A3.1, where the fracture line goes from the lateral distal to the medial proximal (14). The major reason why the posteromedial part of the intertrochanteric region plays such an important role for stability is the calcar femorale - a ridge of dense bone posteromedially in the proximal femur shaft (Fig. 6), redistributing the axial forces to the rest of the bone (18). Because of the increasing degree of instability with each subclass in the AO/OTA system, it is difficult to divide the fracture classes into stable and unstable. As mentioned above, the general agreement today is that the partition goes between 31A2.1 and A2.2 (14, 18).

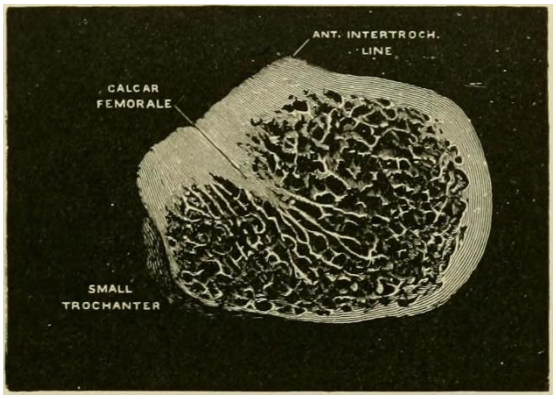

Fig. 6. Transverse section of the proximal part of femur, showing the dense bone ridge called calcar femorale. Copyright Quain, Jones. Quain's Elements of anatomy (1891).

1.5 Treatment methods

Dynamic hip screw (DHS) and intramedullary nail (IM) are the two most common surgeries for treating trochanteric hip fractures (19). Non-surgical treatment is

seldom used nowadays since it tends to lead to prolonged immobilisation, which is associated with higher mortality risk (9, 10). Further, the risk of acquiring decubitus ulcers and nosocomial infections, such as pneumonia, increases with the length of stay (LoS) (20). A single-center retrospective study performed in Singapore found that patients treated non-surgically had a four times higher mortality risk during the first year compared with patients treated surgical (21).

1.5.1 Dynamic Hip Screw

DHS consists of a barrel plate attached to the lateral part of the proximal femoral shaft using cortical screws, and a lag screw fixating the femoral head (Fig. 7) (19). The first DHS was patented in 1951 as an upgrade to the previously used nail-plate, which due to its rigid union of the plate and nail caused various complications (22, 23). The design of the DHS allows the fracture to compress in a controlled manner as the lag screw slides in the barrel when the fracture is loaded (19). The dynamic properties of the DHS divert the force of the bodyweight so that instead of shearing the fragments apart it compresses them. To utilize the full potential of the dynamics, early mobilization is advantageous (23). Further development of the DHS lead to the creation of the Medoff sliding plate, which allows compression in both the lag screw and along the axis of the femoral shaft (24, 25). A retrospective observational study performed at two Swedish hospitals found that the Medoff sliding plate lead to less frequent and severe complications than IM, when used on unstable trochanteric fractures (25).

Fig. 7. Dynamic hip screw (DHS)
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1.5.2 Intramedullary nail

The first IM for treatment of trochanteric fractures was designed in the early 1940s, but the

method did not gain popularity until the introduction of the Gamma nail in 1988 (22). Since then, multiple updates have been made to refine the product and other brands have emerged. The first-generation nail had a higher risk of adverse events than the DHS, but this risk has decreased with the newer models (19, 26, 27). The principle of IM is that instead of the barrel plate seen in the DHS, the stabilization comes from a nail inserted into the femur (Fig. 8) (15). The shorter distance from the femoral head to the implant compared with the DHS reduces the bending force in the lag screw (26). As with the DHS the lag screw telescopes through the nail. To prevent rotation the intramedullary nail is fixated with distal locking screws (15). Depending on the generation and brand of IM, the femoral head is fixated with either one or two lag screws or a blade (19).

Fig. 8. Intramedullary nail (IM) Patient treated at Sahlgrenska University Hospital.

1.5.3 Choosing a treatment method

Historically, DHS has been the primary method used for all trochanteric fracture types (4). This is gradually changing as the use of IM is increasing, especially for treating unstable hip fractures (28). The views on which method to use on which fractures varies, but a common opinion is that DHS is preferable when it comes to stable fractures while IM is more suitable for unstable fractures (14, 19, 29). However, different clinical studies show various results and there is no strong evidence supporting the preferences, leading to differing opinions (10, 26, 30).

For example, in 2017, Parker published the results of a randomised trial with 1000 trochanteric hip fracture patients, treated with either DHS or IM (30). The study included all

trochanteric fracture groups (31A1, 31A2 and 31A3) and found no significant differences in outcomes between the treatment groups except for the regain of mobility, which favoured the IM. Zhu et al. performed a meta-analysis, studying outcomes for patients with 31A2 fractures treated with either DHS or IM (26). Including six randomised control studies with a total of 909 patients they concluded that the patients treated with IM had less operative blood loss, leg shortening, LoS and wound infections. They did, however, not find any significant differences regarding fracture fixation complications, postoperative complications, and one-year mortality. In a prospective study including 140 patients with 31A1 or 31A2 fractures, Carulli et al. found that there was no significant difference regarding complications when comparing treatment with DHS with IM (31). At the same time, they found that IM were superior when it came to, for instance, surgical time, operative blood loss, LoS and regain of walking ability. While it seems, IM is minor superior to DHS, all these studies demonstrate the difficulties in agreeing on a gold standard regarding treatment of trochanteric hip fractures, as DHS has been the most used treatment method for a long period of time.

Studies examining the experience of the surgeon concerning the choice of implant have so far been inconclusive. A smaller study performed at an international AO course indicated that surgeons with less experience were more likely to choose IM (32). In contrast, a larger study in the United States concluded that even though the majority of surgeons, independent of years in practice, had been trained using DHS they favoured IM (33). When considering the price of the implants themselves, IM is more expensive than DHS (14).

Regarding the cost-effectiveness, an analysis has been made stating that DHS should be used for 31A1 fractures, IM for 31A3 fractures and in the case of 31A2 fractures DHS seems to be more favourable on average (34). The study did not analyse variables such as LoS, blood transfusions or postoperative function, which are all sources of large costs involved in treating

patients with hip fractures. Instead they found the rate of fixation failure to be the most important variable. When further assessing the cost of treating a hip fracture, an English study concluded that 84% of the total cost was due to the in hospital stay, and only 9% was due to the operative procedure (35). This indicates the importance of evaluating the LoS for different treatment methods.

1.6 Sweden and Sahlgrenska University Hospital (SU)

In Sweden, there is a trend of decreasing use of DHS in favour of IM although there are variations between clinics across the country (Fig. 9) (4, 8). New guidelines were implemented at SU in March 2017 stating which osteosynthesis method should be used for each fracture group. The guidelines were developed by two orthopaedic consultants at SU, using a consensus methodology, and addressed all health professionals at the orthopaedic department. The recommendations stated in the guidelines were that DHS should be used for treating stable fractures, i.e. 31A1 and 31A2.1, and IM for treating unstable fractures, i.e. 31A2.2, 31A2.3 and 31A3 (36). These recommendations were made referring to various recent publications among which a Norwegian study performed in 2013, concluding that patients with unstable trochanteric hip fractures treated with DHS had a higher re-operation rate (6.4% at one year) than patients treated with IM (3.8% at one year) (29). The study also showed that patients with unstable fractures treated with IM suffered less pain, were more satisfied and had better

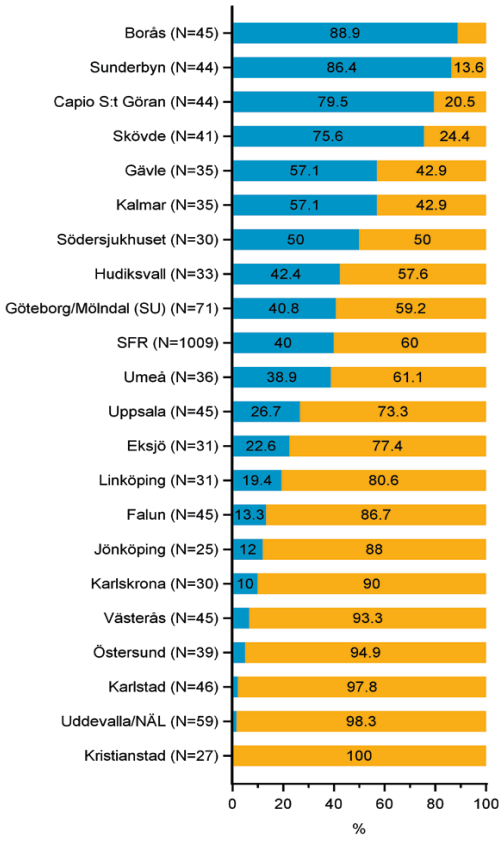

Fig. 9. The treatment methods for 31A1 fractures in Sweden registered in the SFR 2018. Intramedullary nail (Blue) and Dynamic Hip Screw (Yellow). Copyright the Swedish Fracture Register.

walking ability after surgery. Despite the guidelines, a report from 2018 shows that 41% of 31A1 fractures at SU were treated with the use of IM (Fig. 9) (8). This necessitated the need for a follow-up study to more closely monitor compliance to the guidelines.

1.7 The Swedish Fracture Register

Sweden has a national quality register for fractures, the Swedish Fracture Register (SFR). SFR began collecting data in 2011 after being developed between the years 2007 and 2010. Initially, only fractures of the tibia and humerus were registered but in the following years more fracture types were added and after five years more than 103,000 fractures had been registered (37). Today the number of registered fractures exceeds 400,000, and the SFR is now a unique national register collecting data on all fracture types treated both surgically and non-surgically (38, 39). In 2017, approximately 85% of orthopaedic clinics in Sweden participated in registering in the SFR and 70-95% of fractures were registered (8). Several studies have been made to validate the classification of fractures in the register, proving it to be moderate to substantial (38, 40-42). The SFR offers valuable opportunities to perform orthopaedic studies, such as this one.

2. Aim

The primary aim of this study was to analyse the adherence to guidelines for the treatment of trochanteric hip fractures following the implementation of new guidelines at SU in March 2017. Secondary aims were to describe the main surgeon's level of expertise as a possible factor affecting the choice of treatment method and to compare the length of stay (LoS) for different treatment methods.

3. Material and Methods

3.1 Study design

This was a register-based study, with retrospective analysis of prospectively collected data.

3.2 Study population and collecting variables

3.2.1 Study population

Data regarding patients with trochanteric hip fractures (ICD-10 S72.1 and S72.2) treated at SU between January the 1st 2017 and October the 9th 2019 were extracted from the SFR. As a reference, data on patients treated in 2015 was also extracted from the SFR. 2015 was chosen as reference because it was possible that the development of the guidelines might have affected the choices of treatment during 2016 when the guidelines were being developed. Only patients with a Swedish personal identity number can be registered in the SFR and, therefore, only patients residing in Sweden were included in the study (37). In cases where a patient occurred twice because of a hip fracture on the contralateral side, these fractures were treated as two independent cases.

3.2.2 Exclusions

The database extracted from the SFR contained 1693 patients. 38 patients that were registered as patients with *Fracture of proximal femur close to previous implant or hip prosthesis* were excluded. 11 patients where the fracture was registered as *Atypical* were excluded. 1 patient was incorrectly registered as *ICD-10 S72.1* when it was a S72.0 fracture, meaning that it was a cervical fracture and not a trochanteric. 82 patients had treatment registered as *Non-surgical* and their medical records were reviewed to verify the reason for this. Of these patients, 63 had fractures affecting only the greater (62 patients) or lesser (1 patient) trochanter, which according to guidelines were treated non-surgically. 13 patients had fractures close to an existing implant, which were treated non-surgically, resulting in a total of 51 patients being excluded because of peri-prosthetic fractures. 2 patients were previously amputated on the affected side at thigh level and needed no surgical treatment. 3 patients died before surgery and 1 patient was treated with IM. All patients treated non-surgically were excluded from the study. Some patients fulfilled more than one exclusion criteria. No exclusions were made based on age.

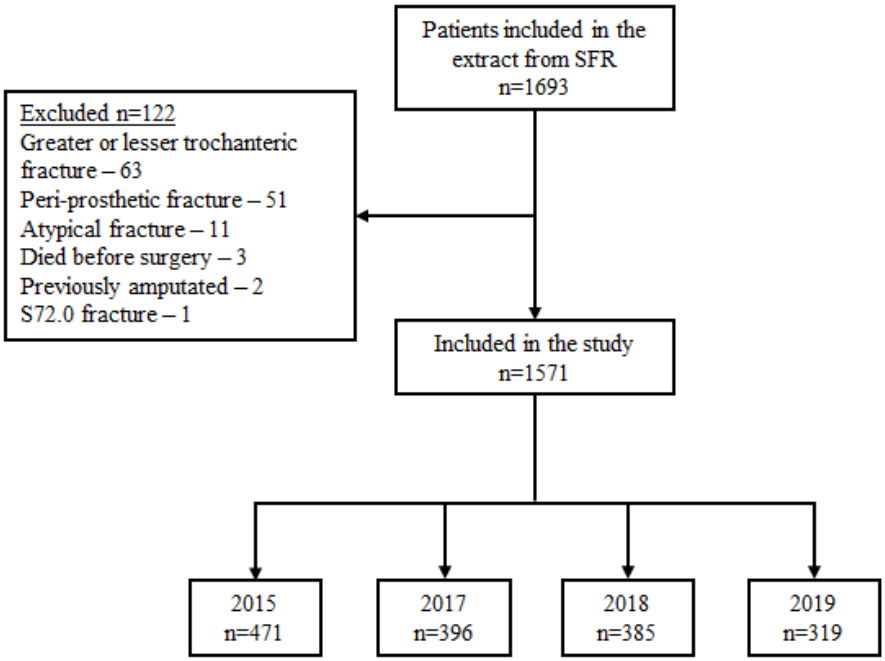

Fig. 10. Flowchart showing the number of patients in the extract from the Swedish Fracture Register (SFR), excluded patients and patients included in the study separated by year.

3.2.3 Review of medical records

In cases where no treatment or a treatment method not suitable for trochanteric fractures were registered in the SFR, the medical records of the patients were reviewed. The data in the extract was completed and the treating method was changed if incorrectly registered. Before June 2017 it was not possible to register sub-classifications to the AO/OTA 31A2 class and 358 patients lacked required fracture classifications because of this. One orthopaedic consultant reviewed plain radiographs of these patients and classified them.

3.2.4 Length of Stay (LoS) and American Society of Anaesthesiologists score (ASA)

Data on the LoS and the ASA score for the 1100 patients treated between 2017 and 2019 was obtained from a database at SU. This data was merged with the file from the SFR based on key variables; personal identity number, age when injured, sex, and injury year. Manual searches were made to make sure patients treated for hip fractures on both sides during the same year were correctly registered. Information could be obtained for 932 of the 1100 patients.

3.3 Analysing data

Analyses were made using IBM SPSS Statistics 25.0. A p-value below 0.05 was considered as significant.

3.3.1 Changes in the use of implants

Descriptive statistical analyses were performed to show annually and quarterly changes in the distribution of treatment methods relative to fracture classification. Patients treated with DHS, IM, prosthesis or Girdlestone were included. In the fourth quarter of 2019, only one patient was registered and was, hence, excluded from the analysis. To enable comparison between the different years, confidence intervals were calculated using the Wilson score method to describe the proportions of use of DHS and IM (43). In these calculations only patients treated with either DHS or IM were included.

3.3.2 Treatment method depending on the main surgeon

The SFR holds information regarding the main surgeon's level of expertise, or title. In this paper, level of expertise was used to categorise main surgeons. Cross-tables were made to describe the use of DHS and IM related to AO/OTA class depending on the surgeon's experience. Patients treated with either DHS or IM from the introduction of the guidelines in March 2017 were included. A total of 30 patients had main surgeon registered as *Unknown* or had no information registered and were, therefore, excluded from the analysis. Adherence to the guidelines depending on the surgeon's expertise was also described using a cross-table. Chi-square test was performed to compare adherence in the different groups.

3.3.3 Mean length of stay and ASA score

The Mann Whitney U test was used to compare the mean LoS and ASA score between the patients treated with DHS and IM. Patients treated in 2017-2019 were included as LoS and ASA was not obtained for patients treated in 2015.

4. Ethical considerations

The SFR has itself been approved by the Swedish Data Inspection Board and according to the Swedish Patient Data Act signed consent from patients is not required for national quality registers (37). Since this study was of a retrospective type, there were no medical risks imposed on the patients. According to Swedish legislation it is not needed to seek approval from an Ethical Review Board when a clinic wants to study data registered at the own clinic to improve local quality (37). Instead, the Head of Department of Orthopaedic at Sahlgrenska University Hospital approved this study and signed the form allowing access to medical records as a part of local quality improvement.

5. Results

Of the 1693 patients in the extract from the SFR, 1571 were included in the study (Fig. 10). 70% of these were women and the mean and range of age were 83 and 17-103 years respectively (Table 1). A number of 66 and 23 patients were under the age of 60 and 50 years when injured, respectively. The differences in age, gender and ASA score between the years were small or non-existing.

Fracture group 31A2.2 was the most common with 450 (29%) patients. The least common group was 31A2.3 (Table 1). The distribution of fracture groups was similar in all the years except for the 31A1 and 31A2.1 groups in 2015 which stood out compared to the other years. In 2015, fracture group 31A1 accounted for 29% of all the fractures while it in 2017-2019 accounted for between 20 and 25%. For fracture group 31A2.1, the numbers were 13% in 2015 and between 18 and 23% during 2017-2019.

Table 1.
Characteristics of the patients included in the study separated by injury year. Information regarding American Society of Anaesthesiologists score was obtained for the years 2017-2019 and was available for approximately 85% of the patients each year.

	2015	2017	2018	2019	Total
Number of patients, n (%)	471 (30%)	396 (25%)	385 (25%)	319 (20%)	1571
Mean age in years	82.2	82.7	83.0	83.0	82.7
Age SD ± in years	11.1	11.9	10.1	11.8	11.2
Age range	24-101	24-101	33-102	17-103	17-103
Women, n (%)	339 (72%)	271 (68%)	262 (68%)	220 (69%)	1092 (70%)
Mean ASA score (n)		2.7 (339)	2.6 (328)	2.7 (265)	2.7 (932)
ASA score I or II n (%)		120 (30%)	134 (35%)	95 (30%)	349 (32%)
Fracture type, n (% of that year)					
31A1	137 (29%)	99 (25%)	77 (20%)	66 (21%)	379 (24%)
31A2.1	61 (13%)	72 (18%)	90 (23%)	68 (21%)	272 (17%)
31A2.2	125 (27%)	102 (26%)	110 (29%)	90 (28%)	450 (29%)
31A2.3	45 (10%)	34 (9%)	35 (9%)	39 (12%)	150 (10%)
31A3	103 (22%)	89 (23%)	72 (19%)	56 (18%)	320 (20%)

ASA=American Society of Anaesthesiologists

When including all fracture types, there was a mean of 406 hip fractures treated with DHS, IM, prosthesis or Girdlestone annually. IM was, by far, the most common treatment method. There were little to no differences in characteristics between the patients treated with IM and DHS (Table 2.). The 12 patients treated with prosthesis had a higher mean age and ASA score. The range of age in this group was narrower than the ones for DHS and IM. No calculations were made to statistically compare the characteristics of the patients treated with the different methods. Only two patients were treated with Girdlestone, both cases occurring in 2015.

Table 2.
Characteristics of all the included patients, separated by treatment method (n=1571). Information regarding American Society of Anaesthesiologists score was obtained for 85% of the patients treated in 2017-2019 (n=932).

	DHS	IM	Prosthesis	Girdlestone
Number of patients	335	1222	12	2
Mean age in years [Range]	82.4 [31-101]	82.8 [17-103]	85.1 [66-100]	79 [57-101]
Median age in years	85.0	85.0	86,5	79.0
Women n (%)	213 (64%)	869 (71%)	8 (67%)	2 (100%)
Mean ASA score (n)	2.7 (186)	2.7 (741)	3.2 (5)	
ASA score 1 or 2 n (% of total n)	69 (30%)	280 (33%)	0 (0%)	

ASA=American Society of Anaesthesiologists, DHS=Dynamic Hip Screw, IM=Intramedullary nail

5.1 Changes in the use of implants

In 2015, 38% of 31A1 fractures were treated with the use of IM, 82% of 31A2.1, 90% of 31A2.2, 98% of 31A2.3, and 97% of 31A3 fractures (Fig. 11). The following years the use of IM decreased for 31A1 and 31A2.1 fractures in 2017 but increased in 2018 and 2019 (Fig. 12). During the period 2017-2019, a total of 24 (3.8%) patients with 31A2.2, 31A2.3 or 31A3 fractures were treated with a method other than IM. The most common method in these cases was DHS (22 patients) followed by prosthesis (2 patients).

Fig. 11. The treatment method depending on fracture type for patients treated in 2015 (n=471). Intramedullary nail (IM), Dynamic Hip Screw (DHS), Prosthesis and Girdlestone.

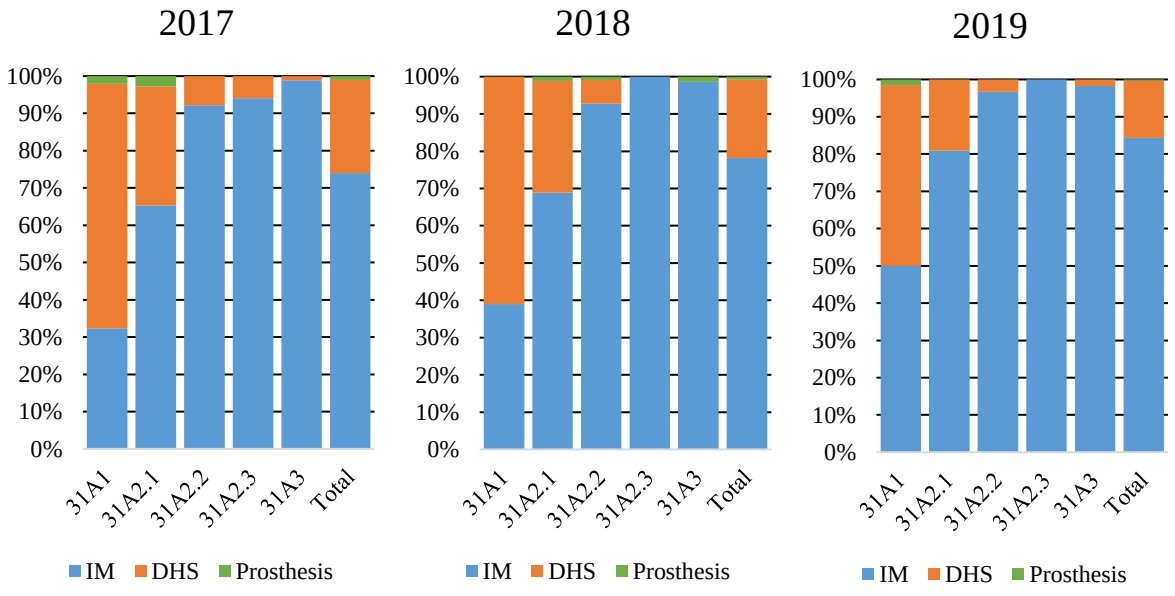

Fig. 12. Treatment method depending on fracture type for patients treated in 2017-2019. Intramedullary nail (IM), Dynamic Hip Screw (DHS) and Prosthesis. According to guidelines, 31A1 and 31A2.1 should be treated using DHS, while 31A2.2, 31A2.3 and 31A3 should be treated using IM.

The quarterly changes in the treatment of 31A1 and 31A2.1 fractures are shown in Fig. 13. The proportion of IM used for 31A1 fractures rose from 31% the first quarter of 2017 to 52% the third quarter of 2019, and from 38% to 92% for 31A2.1 fractures. After the introduction of the guidelines in the end of the first quarter of 2017 the use of IM for 31A1 fracture initially rose but subsequently began to decrease in the third quarter of 2017. Regarding 31A2.1 fractures there was a sharp increase the second and third quarter of 2017, followed by a minor decline.

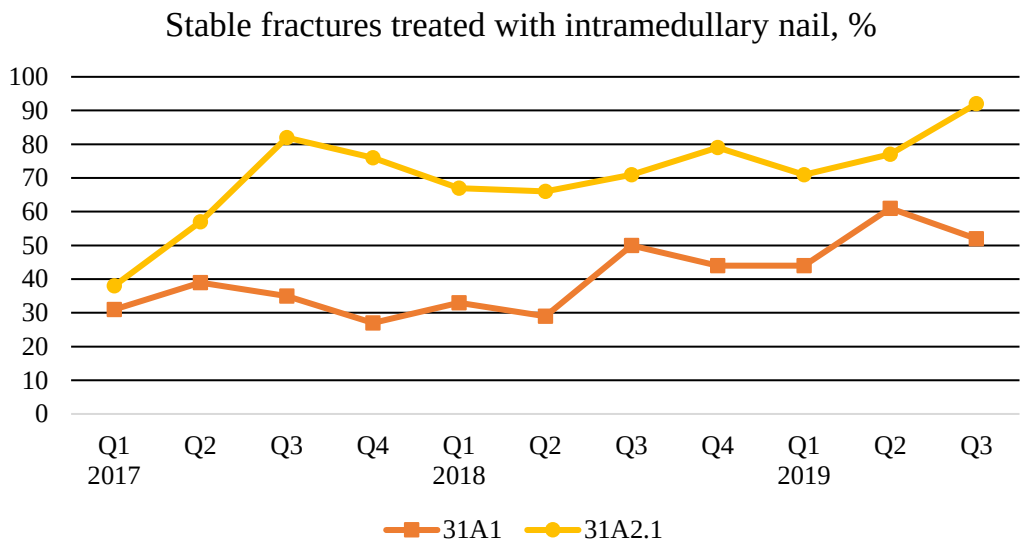

Fig. 13. Percentage of stable fractures treated using intramedullary nail during the period 2017-2019.

The results of statistical analyses made to calculate confidence intervals regarding the proportion of 31A1 and 31A2.1 patients treated with IM in 2017, 2018 and 2019 are demonstrated in Table 3. Even though there is a trend towards an increase in the percentage of cases treated with IM, the confidence intervals are overlapping, and a significant rise cannot be assumed.

Table 3.

Percentages of 31A1 and 31A2.1 fractures treated with intramedullary nail and confidence intervals calculated using the Wilson score method. Patients treated with intramedullary nail or Dynamic Hip Screw were included in the analysis.

	31A1				31A2.1			
	IM n	Total n	IM %	95% CI	IM n	Total n	IM%	95% CI
2017	32	97	33%	24-42%	47	70	67%	54-76%
2018	30	77	39%	28-49%	62	89	70%	58-77%
2019	33	65	51%	38-61%	55	68	81%	69-87%

CI=Confidence interval, IM=Intramedullary nail

5.2 Adherence to the guidelines depending on the main surgeon

Patients treated with either DHS or IM after the introduction of the guidelines had the main surgeon registered in the SFR for 980 of the 1010 patients. As shown in Table 4 the use of DHS and IM was relatively similar in the different surgeon groups. One group that stood out was 31A1 fractures treated by orthopaedic consultants specialised in trauma were the use of IM was lower than in the other groups. Most surgeries were performed by an orthopaedic resident (39%) followed by a consultant specialised in trauma (23%), orthopaedic consultant (18%) and resident assisted by consultant (17%).

Table 4.

Percentage of patients treated with Intramedullary nail depending on the main surgeon's level of expertise and fracture group, together with the total number of patients. Patients treated with Dynamic Hip Screw or intramedullary nail after the introduction of the guidelines were included.

	31A1 IM % (Total n)	31A2.1 IM % (Total n)	31A2.2 IM % (Total n)	31A2.3 IM % (Total n)	31A3 IM % (Total n)	Total
Orthopaedic resident	43% (81)	75% (102)	92% (113)	100% (40)	100% (55)	391
Orthopaedic consultant specialised in trauma	33% (57)	71% (35)	96% (48)	100% (24)	98% (63)	227
Orthopaedic consultant	49% (35)	73% (40)	95% (56)	96% (26)	100% (29)	186
Resident assisted by consultant	49% (35)	70% (30)	98% (57)	100% (12)	100% (37)	171
Orhopaedic consultant specialised in arthroplasty		100% (1)	100% (2)		100% (1)	4
Intern			100% (1)			1

IM=Intramedullary nail

Regarding the adherence to the guidelines independent of fracture type, orthopaedic consultants specialised in trauma had the highest adherence with 79% if the only surgery with an intern as main surgeon was excluded (Table 5). The least adherence was in the group with orthopaedic residents with 69%. When analysing the adherence depending on main surgeon using the Chi-square test, a significant difference was obtained (p=0.033). This when excluding the two smallest groups; *Consultant specialised in arthroplasty* and *Intern*.

Table 5.
Adherence to the guidelines depending on the main surgeon's level of expertise. Patients treated with Dynamic Hip Screw or intramedullary nail after the introduction of the guidelines were included.

	Adherence to guidelines		Total n
	Yes n (%)	No n (%)	
Orthopaedic resident	270 (69%)	121 (31%)	391
Orthopaedic consultant specialised in trauma	180 (79%)	47 (21%)	227
Orthopaedic consultant	136 (73%)	50 (27%)	186
Resident assisted by consultant	131 (77%)	40 (23%)	171
Orhopaedic consultant specialised in arthroplasty	3 (75%)	1 (25%)	4
Intern	1 (100%)	0 (0%)	1
Total	724 (74%)	259 (26%)	980

5.3 Length of stay depending on the treatment method

The mean LoS for the DHS group was 11.6 days, and for the IM group it was 11.9 days (Table 6). Information about LoS was obtained for 930 of the 1092 patients treated with IM or DHS in 2017-2019. There was no statistically significant difference when comparing the two treatment groups including all fracture types, neither for LoS (p=0.94) nor ASA score (p=0.55). IM had a larger range of LoS than DHS but both the mean and standard deviation were nearly the same. Because IM is mainly used for more difficult fractures, the analysis was reproduced including only patients treated for stable fractures. No statistically significant difference was found then either (Table 6).

Table 6.
Comparison of the length of stay and American Society of Anaesthesiologists score between patients treated with Intramedullary nail (IM) or Dynamic Hip Screw (DHS) during the period 2017-2019. Results when including only stable fractures presented separately. Information was missing for 14% of the patients in the IM group and for 18% in the DHS group.

All fracture types		IM	DHS	Mann Whitney U
Length of stay				p=0.94
	Patients n	743	187	
	Mean	11.9	11.6	
	SD±	7.4	6.0	
	Range	1-75	1-37	
ASA Score				p=0.55
	Patients n	741	186	
	ASA I or II %	38%	37%	
	ASA III or IV %	62%	63%	
31A1 and 31A2.1		IM	DHS	Mann Whitney U
Length of stay				p=0.52
	Patients n	226	169	
	Mean	11.5	11.5	
	SD±	7.5	5.9	
	Range	2-67	1-33	
ASA Score				p=0.88
	Patients n	226	168	
	ASA I or II %	38%	37%	
	ASA III or IV %	62%	63%	

ASA=American Society of Anaesthesiologists, DHS=Dynamic Hip Screw, IM=Intramedullary nail

6. Discussion

The most important finding of this study is that a vast majority of stable trochanteric fracture at SU were treated using IM in 2019, despite this going against the guidelines. The connection between the introduction of the guidelines and the decrease in the use of IM a couple of months later can neither be confirmed nor ruled out, but the trends was not long lasting. Even though the graphs seem to show a pronounced increase in the use of IM between 2017 and 2019, the comparison of the annual means could not confirm a significant increase for neither 31A1 nor 31A2.1 fractures. Since this was a study of the results of one hospital, the number of included patients was naturally limited to this hospital's admitted patients, which limited the analyses. However, the fact that orthopaedic surgeons at SU do not follow the guidelines

for approximately 60% of stable trochanteric fractures is a surprising and interesting finding. The annual report by RIKSHÖFT from 2017 shows that the use of IM is increasing in almost all regions in Sweden (4). The report from RIKSHÖFT did not separate the results by fracture types, and it is thus not possible to know whether the increase was mainly in the treatment of stable or unstable fractures. Gjertsen et al., reporting from the Norwegian hip fracture register, found that the use of IM in Norway had increased in all fracture groups between 2005-2006 to 2013-2014 (28). For 31A1 fractures the use of IM increased from 9.1% to 26%, and corresponding percentages for group 31A2 were 15% to 33%, and for group 31A3 27% to 61%. Findings in previous publications and this study supports the idea that the use of IM is overall increasing.

The study found merely minor differences in the choices of treatment method depending on the main surgeon's level of expertise. One could speculate that this is because surgeons with less experience consult an older colleague before choosing method, and the opinion of the most experienced surgeon could hence influence the whole department. Nevertheless, the findings that consultants specialised in trauma had the highest adherence to the guidelines while residents had the lowest could be seen as expected results. That residents assisted by consultants had almost the same adherence as consultants specialised in trauma indicates that it is the consultants that choose the method in these cases. Sciacca et al. conducted a study at an AO/OTA course with 52 participating surgeons and found that surgeons with less than 3 years of experience were more likely to choose IM for treating a 31A2 fracture than surgeons with more than 3 years of experience (32). Niu et al., asked 3'687 American orthopaedic surgeons about their preferred treatment method for trochanteric fractures (33). They found that even though a majority of the surgeons had trained using DHS they still favoured IM. This because the participating surgeons considered it to be easier to use, and to have better outcome and superior biomechanics than DHS. These opinions described in Niu's study

might be an explanation as to why the use of IM is increasing. Looking at the results in these studies one could speculate that the insufficient adherence to the new guidelines might be a result of surgeons being drawn to the newer and allegedly easier IM, despite lack of high-grade evidence supporting these ideas and clear guidelines opposing the aforementioned potential benefits of IM. It could also be speculated that residents, not having the same level of experience as consultants, choose a safer method (IM) if they feel uncertain over the stability of fracture.

There were no significant differences between the patients treated with DHS and IM in 2017-2019 when it came to LoS. These results remained after a subgroup analysis including only stable fractures. The mean LoS of twelve days was in line with the results of Pareja Sierra et al. who discussed the importance of allowing the patient to stay for some days at the hospital to recover (44). Regarding the comparison between DHS and IM, the findings in this study were in line with the results of a recent, randomised study with 1000 patients made by Parker et al. (30). They also found no differences when it came to neither LoS, nor complications, when comparing treatment with DHS to IM. On the other hand, Carulli et al. concluded in a prospective study, including 31A1 and 31A2 fractures, that IM had a shorter LoS than DHS (31). It seems that it is difficult to determine the LoS and that the generalisability between hospitals is weak. However, the fact that IM does not lead to shorter LoS at SU motivates the use of DHS instead of IM.

6.1 Strengths and limitations

This study is, naturally, limited by the limitations of the SFR. The register is dependent on the participating clinics' completeness and their accuracy in registrations. The SFR was created at SU and as expected the annual report from 2018 indicate that the completeness in the region around Gothenburg is one of the highest in Sweden (8, 37). When examining data extracted

from the SFR and comparing with medical records few errors were discovered. It was not possible to verify the variables on all 1693 patients and there could be more errors included. However, previous studies validating the SFR, indicates that the misregistrations are few and the information in the database should be considered reliable (38, 40-42).

There was an initial wish to compare implant survival and re-operation rate between the DHS and IM groups as this is an important outcome when discussing treatment methods. No study has, to my knowledge, analysed the re-operation completeness regarding hip fracture in the SFR. However, the completeness of re-operation registration has been analysed regarding tibial fractures in the SFR and was then found to be 63% (12). A rough estimate of the re-operation frequency in the material in this study was made by dividing the number of patients registered as re-operations (n=89) with the number of patients registered as primary treatments (n=1571). This was found to be approximately 6% but since no verification has been made and there was not enough time to go through all the patients to find and complete the registrations missing, neither implant survival nor re-operation rate were analysed in this study. It would be beneficial if, in the near future, re-operations after hip fracture surgeries were registered in the SFR to enable valuable analyses.

Another weakness was that one orthopaedic consultant classified all 31A2 fractures registered in 2015 and the beginning of 2017 because of lacking sub-classifications. The consultant is one of the supervisors of this report and could hence be biased. When examining plain radiographs of the fractures he had access to radiographs taken after treatment and could therefor be influenced by the chosen treatment method. The fracture groups in 2015 did not conform with the distribution of the other years but it was mainly fracture group 31A1 that accounted for a larger proportion in 2015 than during 2017-2019. However, no statistical calculations were made using the fractures registered in 2015, and there were only a few fractures registered in the first months of 2017 that needed retrospective sub-classification. If

excluding the first quarter in 2017 from Fig. 12, the numbers are still very interesting as it was the changes in 2018 and 2019 that were crucial. When calculating adherence, only patients treated after the implementation of the guidelines were include, and the results were hence not affected by the retrospective classifications.

The study aimed to study the fracture treatments at SU and since the SFR has been evaluated to have substantial completeness at the department this method should be reliable (8). Because SU has one of the largest orthopaedic departments in Sweden the cohort is relatively large. This is of course beneficial when trying to analyse outcomes. No power-analysis were carried out as this was mainly a descriptive study. As previous studies have indicated, large cohorts seem to be needed to find any differences in outcomes when studying hip fractures (30, 45). With this said, future studies might have to use data from more than one Swedish hospital, or include more years to be able to find any significant differences in, for example, re-operation rate or implant survival.

6.2 Further research

Moreover, a study examining the reason for the low adherence to the hip fracture guidelines would be beneficial. A study similar to this one is currently being conducted at SU, studying adherence to guidelines regarding tibial fractures. The preliminary results show a high adherence, suggesting that it is not guidelines themselves that are the problem. Instead this confirms that there is a widespread disagreement regarding the treatment of trochanteric hip fractures. It would, nevertheless, be interesting to carry out a survey, asking the reason for surgeons at SU choosing IM for treatment of stable fractures.

As mentioned above, retrospective registrations of re-operations would give valuable opportunities to perform studies with large cohorts to find differences in outcomes between

patients treated with DHS and IM. It seems the difference of the price of the two implants is decreasing, and since this has been one of the strongest arguments to choose DHS for treatment of stable fractures up to now, this would lead to an interesting change. Perhaps the surgeon's choice, and the opinion that IM is easier to use, will be the strongest argument in coming guidelines.

6.3 Conclusions

This study concluded that IM is the most commonly used treatment method for stable trochanteric fractures at SU, despite the guidelines recommending the use of DHS. A few larger studies have been conducted since the implementations of the guidelines, concluding a minor superiority of IM, also regarding stable fractures. This together with the results in this report, and the information that the implant now cost nearly the same, should motivate reflection whether the department should move on to using only IM for all trochanteric fractures. However, the use of IM should be reduced until strong contradictory evidence is presented. Nevertheless, further studies analysing the reason why guidelines are not being followed is necessary.

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Populärvetenskaplig sammanfattning på svenska

Följsamhet till riktlinjer gällande behandling av trokantära höftfrakturer på Sahlgrenska Universitetssjukhuset.

Höftfrakturer är en mycket vanlig fraktur som drabbar framförallt äldre kvinnor. Cirka 16 000 personer drabbas av en höftfraktur i Sverige varje år. Efter en höftfraktur har den drabbade blivit begränsad i sin dagliga funktion och löper även en högre risk för att dö. Det har konstaterats att för att minimera dessa negativa följder är det viktigt att operera alla som klarar av en operation. Utan operation blir patienten sängliggande och riskerar då att drabbas av vårdorsakade skador så som liggsår och infektioner. Vid val av operationsmetod behöver hänsyn tas till typen av fraktur. Höftfrakturer grupperas efter var på den övre delen av lårbenet skadan sitter. Därefter studeras riktning på frakturlinjerna och antalet benbitar. Detta görs för att kartlägga frakturens stabilitet, vilket enkelt kan förklaras som att ju färre bitar desto stabilare fraktur. De två vanligaste operationsmetoderna vid frakturer som sitter nedanför lårbenshalsen (pertrokantära frakturer) är en platta med glidskruv eller en märgspik. Det är idag vanligast att man behandlar de frakturer som bedömts som stabila med platta med glidskruv och de instabila med märgspik. Det råder dock delade meningar i frågan och båda metoderna går att använda på de båda frakturtyperna. I den här studien beskrevs valet av behandlingsmetod för olika typer av pertrokantära höftfrakturer på Sahlgrenska Universitetssjukhuset i Göteborg/Mölndal. Studien visar att fler och fler av de stabila frakturerna behandlas med märgspik trots att riktlinjerna rekommenderar platta med

glidskruv. Studien visade också att kirurgens erfarenhetsnivå till viss del påverkade valet av behandlingsmetod då ortopeder specialiserade på frakturer till större del följde riktlinjerna än läkare som var under utbildning till att bli ortopeder. Då märgspik i sig är dyrare än platta med glidskruv jämfördes även vårdtiden för de två metoderna då detta är en viktig del i kostnadsanalyser. Här hittades ingen skillnad mellan de två grupperna. Sammanfattningsvis visade studien att kirurger på Sahlgrenska Universitetssjukhuset använder märgspik mer och mer vid behandling av stabila höftfrakturer, att detta tycks vara delvis påverkat av läkarens erfarenhet och att val av behandlingsmetod inte tycks påverka vårdtiden.

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