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Completeness of Tibia Fracture Reoperation Registration in the Swedish Fracture Register at Sahlgrenska University Hospital during 2011-2015

Degree Project in Medicine

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Abstract

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Background: Since the start in 2011 tibial fractures have been registered in the Swedish Fracture Register (SFR). Since then, several improvements have been made and the routines to secure high completeness of the register are still being developed. Some previous validation studies have been performed but none of those has focused on reoperation registrations during several years. A study of the results after tibial fractures based on the data in the SFR is planned, why the present validation is needed.

Aim: To validate the completeness of reoperation registration after tibial fractures during 2011-2015 in the SFR.

Methods: Each patient in the SFR was controlled in the operation planning programme using their personal identity number and if any unregistered procedure was found the medical records were controlled for further information. All missed procedures were compiled into an SPSS-file and were retroactively registered into the SFR. Subsequently a new extract from the SFR was made which was used in the analyses together with the SPSS-file with the compiled missed procedures.

Results: The completeness of reoperation registrations were 63.0%. The overall completeness of treatments in the register was 90.0%. Of the missed reoperation registrations, 44.7% were extraction of internal osteosynthesis material. Consultants in orthopaedic surgery with focus on fracture care had the highest completeness of registrations.

Conclusions: A high overall completeness in the SFR and a higher completeness of reoperation registration than previously shown is presented in this study. Retroactive registrations have completed the register of reoperations. Further studies will give more knowledge of the results of tibial fracture treatments, which will hopefully lead to improved quality of tibial fracture treatment.

Keywords: *orthopaedics, fracture register, tibia, completeness, reoperation*

List of Abbreviations

AO/OTA	Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association
DFD	Danish Fracture Database
ICD-10	International Statistical Classification of Diseases and Related Health Problems - Tenth Revision
KVÅ	Klassifikation av vårdåtgärder (Classification of Care Actions)
NAR	Norwegian Arthroplasty Register
NOMESCO	Nordic Medico-Statistical Committee
NPR	National Patient Register
SFR	Swedish Fracture Register
SU	Sahlgrenska University Hospital

Background

Epidemiology and classification of tibial fractures

People of all ages sustain tibial fractures. A minor fall in an osteoporotic patient or a traumatic car crash could both lead to tibial fractures. In a study from 1995, Court-Brown and McBirnie (1) performed an epidemiological analysis of tibial shaft fractures and found that more complex fractures were more often open whereas the most common type of fracture are closed, simple fractures (77.8%). The study also showed that high energy trauma such as sport, assault and road-traffic accidents were more commonly the reasons for tibial fractures in younger patients. In the study non-surgically treated fractures was included which gave more accurate epidemiological data than previous studies.

A study of the epidemiology based on the same cohort as the current study has been performed by Wennergren et al. (unpublished manuscript, April 2018) showing similar results to the study by Court-Brown et al. In the study based on the SFR, women were found to suffer more proximal fractures while men suffer more fractures on the shaft and the distal parts of the tibia. The mean age for tibial fractures in men were 43.8 years and were more often caused by high energy trauma. The women had a mean age of 56.1 years and the incidence increased by age and were most often caused by simple falls. Tibial shaft fractures were more often open compared to fractures in the other two segments of tibia. Partial intraarticular proximal fractures (AO/OTA 41B) were the most common tibial fracture group (32%) of all tibial fractures. The distal tibial fractures were the least common type of tibial fractures.

The epidemiology of tibial fractures has been studied many times. Two previous studies of tibial shaft fractures in Sweden have been published, one describing the epidemiology during 1950s and 1980s (2) and the other describing the epidemiology during the 1990s and 2000 (3).

The results of these studies correspond to those in the recent study by Wennergren et al. regrading highest incidence of tibial fractures in young men and an increasing incidence by age in women.

When studying the epidemiology of tibial fractures, classifying of the fractures is necessary. There are several systems of classification for tibial fractures according to location, morphology and soft tissue injury. The AO/OTA classification system (Figure 1) (4, 5) however is the most often used classification system (6). The Gustilo-Anderson classification (7, 8) is the most commonly used classification for open fractures. These two classification systems are also used in the SFR (9, 10). An ideal classification system should meet several criteria, such as being widely recognized, extensively employed, comprehensive, user friendly and valid but no current classification system meets all these criteria. However, the AO/OTA classification system is the most commonly used (9).



Figure 1
AO/OTA classification of tibial fractures in the Swedish Fracture Register

Treatment of tibial fractures

Tibial fractures can either be treated non-surgically, with external fixation or by internal fixation with intramedullary nailing or plate fixation (11). The treatment of tibial fractures are somewhat standardised based on the shape of the fracture and the soft tissue injury (11). Nowadays there

are no great controversies in the treatment of tibia fractures but some choices are still based on traditions and personal experience (12). Fractures treated non-surgically are usually stabilized with a cast or a brace (13). These fractures are examined radiologically until proper healing is ensured (14). The stability of the fracture is important in the choice of treatment. The more unstable the fracture, more often surgical fixation is needed. If the fracture is open and thus contaminated it can be treated at least temporary with external fixation (11, 14). External fixation is often performed as a primary procedure in more severe fractures or as a damage control in multiple trauma situations, followed by an internal fixation when the patient is stable enough to be operated on (11). Although external fixation can be the definitive treatment in some fractures (14, 15). Internal fixation is generally accomplished by intramedullary nailing or plate fixation but fixation by wires or screws alone might be used (11). Tibial plafond fractures (distal intra-articular fractures) are usually treated by plate fixation or external fixation while tibial shaft fractures are treated non-surgically or by intramedullary nailing and tibial plateau fractures (proximal fractures) are most commonly treated non-surgically or by plate and screw fixation (14).

Present literature of results after tibial fracture treatment

Several studies regarding different treatments and results of tibial fractures have been published. Most of the studies focuses on either one or two specific treatments and usually only includes fractures in one segment of the tibia. Fairly standardised treatments for the different type of tibial fractures are used (14). Most studies retrieved during the literature search were prospective cohort-studies. Only two studies focusing on reoperations after tibial fractures were found (16, 17). One of the studies was a meta-analysis of the results after open tibial fractures in 14 studies focusing on the choice of treatment (16). The other study focused on development of non-union and reoperations after tibial shaft fractures based on fracture characteristics rather

than choice of treatment (17). The present literature shows that currently used treatments for tibial fractures generally creates results considered as good. (16-20)

The Swedish Fracture Register (SFR)

SFR was initiated in Gothenburg 2011 with the purpose to evaluate the quality of fracture care. SFR makes it possible to evaluate the treatment results based on prospectively collected register data. The register is linked to the Swedish Population Register. Therefore only people with a Swedish personal identity number can be entered. (21)

Registrations are made by the orthopaedic surgeon via a web form. The surgeon registers the injury occasion and classifies each fracture according to AO/OTA classification and specifies whether it is an open or closed fracture. Open fractures are classified according to the Gustilo-Anderson classification. The treatment is then registered and classified as non-surgical, primary surgery, planned secondary surgery or reoperation. In case of a reoperation, the reason for the reoperation is registered. A notation is made if the procedure in question has been performed at another department or subsequent treatment are planned to take place at another department. The experience of the surgeon and whether the previous treatment of the fracture has been performed at a different department is also registered. (22)

In 2015 approximately two thirds of the orthopaedic departments in Sweden were contributing to the SFR (23). By that time, Sahlgrenska University Hospital (SU) had registered tibial fractures for five years and during that period the register was further developed (23). To evaluate the SFR the current study of the completeness for reoperation registrations is required.

Validation of the Swedish Fracture Register

The SFR can contribute to a deepened knowledge of fracture treatment and its results. To use the information in the SFR, the data in the register must be validated to secure that the

information in the register is correct and reflects reality. National Quality Registries have published a handbook on how to validate registers and calculate completeness in registers (24) and the methods in the present study have been based on the information from that handbook.

Several validation studies have been made focusing on different aspects of the register (9, 10, 25, 26). These studies have focused on primary fracture registrations and fracture classification in the SFR and reoperation registration during the first year of the SFR. To ensure high completeness of the register a weekly search of medical records regarding ICD-codes representing fractures has been implemented at SU. There is also a search function in the register to identify incomplete registrations (9). A few years ago, SU started to include KVÅ-codes (Classification of Care Actions) in the weekly search with the aim to find more of the reoperations where osteosynthesis material is removed. Yet there is no implemented routine to validate the completeness of reoperation registrations and no major studies have been conducted regarding this.

In 2015 a study of the completeness of registrations of tibial fractures in the SFR for fractures at SU in 2011 was performed (n=239) (25). That study showed that 60.3% of the reoperations and 57.9% of the surgeries with removal of osteosynthesis material were not registered. Retroactive registrations were made during this study. The study by Kapetanovic also included the completeness of reoperation registrations after humerus fractures during 2011 (n=657) and this was 54.2% and 51.9% of the extractions of osteosynthesis material were not registered.

A study of the results after tibial fractures focusing on the frequency of reoperations as a quality measurement of orthopaedic treatment is planned to be performed. Before such a study can be done an assessment of the completeness of reoperation registrations in the SFR has to be performed.

Aim

The aim of this study was to analyse the completeness of registrations of reoperations after tibial fractures in the Swedish Fracture Register during 2011-2015. The study also aims to retroactively register missed registrations in order to make the register as complete as possible.

Methods

The data collection is based on an extract from the SFR containing all proximal, shaft and distal tibial fractures in adults (16 years and above) (ICD-10 82.1, 82.2 and 82.3) from January 1, 2011 to December 31, 2015, treated or consulted at SU. The extract was made in 2017. The data was compiled in an SPSS-file which was then used to record the missing registrations in the SFR.

Validation of the completeness for reoperation registrations in the SFR was performed between November 2017 and February 2018, using the surgery planning data programme Operätt. A search in Operätt was performed using the personal identity number of each patient. The search was made in “Ortopedi div” covering five surgical departments at SU. They were “Dagkir MS”, “COP MS”, “Kir+Ort ÖS”, “Ortop SS” and “D Silvia-BUS”. These were the most commonly used surgical facilities.

If a procedure was registered in Operätt but not in SFR the operation report was controlled in the medical records (Melior) to get further information about the procedure, focusing on what kind of procedure had been performed and why. After gathering all information, all missed procedures were registered retroactively, and a note was made in the dataset for the statistical analysis.

The SPSS-file was later used to analyse the frequency of retroactively registered procedures to calculate the proportion of missed registrations and thereby the completeness of the register. The file was also used to further analyse the kind of missed registrations and affecting factors.

A new data set from the SFR was derived from SFR in March 2018 containing all procedures that had been registered since the first extraction. This was done to make sure that all procedures were included in the data analysis and that none of the properly registered procedures were missed. The new dataset was then combined with the first set containing the notes of the retroactively registered procedures in order to get information about which procedures in the new set that had been retroactively registered. The new set was then divided into two: one focusing on each procedure (n=2160) and one focusing on each fracture (n=1371) to enable all further analyses. Data analysis was thereafter performed using IBM SPSS Statistics 25.

Ethical considerations

This study is based on data in the SFR and data in the medical records and the surgery planning programme. Patients may withdraw their consent to the register and get all their personal data excluded from the register at any time.

The patients do not benefit directly from this research, nor do they suffer. This study may however contribute to new and deepened knowledge about tibial fractures and results thereafter, which may lead to improvements of the treatment in the future. The validation study is a part of a larger study on tibial fractures. That study was approved by the Central Ethical Review Board, Gothenburg (Dnr: 594-16).

Results

Completeness of reoperation registrations

There were 1371 tibia fractures in total in the study. 1216 had no missing reoperations which represents an overall completeness of 88.7% (Table 1). During the study, 217 procedures on 155 fractures were found to be missing

Table 1

Number of missed registrations of procedures per fracture

Number of missed registrations	Frequency	Percent
0	1216	88.7
1	115	8.4
2	31	2.3
3	5	0.4
5	1	0.1
6	2	0.1
8	1	0.1
Total	1371	100.0

and thereafter retroactively registered in the SFR. There was also one additional that was registered retroactively. Most of the fractures with missing registrations had one (n=115, 74.2%) or two (n=31, 20.0%) missed procedures. The highest number of missed registrations were 8 procedures following one fracture.

The 1371 tibia fractures were surgically treated by 2160 procedures. Of the 2160 procedures, 1396 were classified as primary procedures by the surgeon making the registration. Only 12 of these were missed registrations, resulting in a completeness of 99.1% for primary procedures (Table 2). The 12 missing primary procedures were surgical treatment following an initial non-surgical treatment or primary procedures performed at another departments. A change in structure of SFR has made a registration of a planned procedure or a reoperation not possible if there is no primary procedure registered first.

There were 302 procedures classified as planned secondary surgery and 34 of these were missed registrations. This gives a completeness of 88.7% regarding planned secondary surgery. The

remaining 462 treatments were classified as reoperations. 171 of the reoperations were missing, giving a completeness of 63.0% for registered reoperations in the register.

Table 2
Completeness according to treatment type

	Missed registrations	All	Completeness
Primary procedure	12	1396	99.1%
Planned secondary surgery	34	302	88.7%
Reoperation	171	462	63.0%
Total	217	2160	90.0%

Circumstances resulting in missed registrations

In total there were 217 procedures that were not registered in the SFR (Table 3). Almost half of these procedures were extraction of internal fixation material, 44.7% (n=97). The rest of the missed procedures were extraction of external fixation (14.3%), arthroscopic interventions (8.3%), knee replacements (6.0%), wound revision (5.5%), internal fixation (5.1%), external fixation (4.1%) and other procedures (11.9%). Other procedures include skin grafts, fasciotomy, arthrodesis, osteotomy, excision of bone fragments, open synovectomy and extraction of knee prosthesis. The procedures with the lowest completeness were primarily arthroscopic procedures (18.2%), knee replacements (18.8%), skin grafts and surgical flap procedures (36.4%).

Table 3
Type of procedure in missed registrations, non-surgical treatment excluded.

Treatment	Missed	Percent of all missed	All	Completeness
Internal fixation	11	5.1%	905	98.8%
Extraction internal fixation	97	44.7%	264	63.3%
External fixation	9	4.1%	185	95.1%
Extraction external fixation	31	14.3%	148	79.1%
Other	12	5.5%	65	81.5%
Wound revision	12	5.5%	34	64.7%
Arthroscopic procedure	18	8.3%	22	18.2%
Fasciotomy	7	3.2%	20	65.0%
Knee replacement	13	6.0%	16	18.8%
Skin graft/ Surgical flap	7	3.2%	11	36.4%
Total	217		1670	87.0%

Analysis of the completeness of reoperation registrations according to the reason of the procedure shows that reoperation due to patient discomfort or infection were the types of reoperations with the lowest completeness (Table 4). More than half of the reoperations (52.6%) were performed due to patient discomfort or other reasons.

Table 4
Completeness of reoperations according to the reason of procedure.

	Missed	All	Completeness
Reoperation due to non-union	17	57	70.2%
Reoperation due to malunion	20	58	65.5%
Reoperation due to infection	29	66	56.1%
Reoperation due to other reason	18	125	85.6%
Reoperation due to implant failure etc.	8	38	78.9%
Reoperation due to patient discomfort	79	118	33.1%
Total	171	462	63,0%

In most of the fractures with missed reoperation registrations the treatment was internal fixation (Table 5). Internal fixation by plate fixation (n=453) or intramedullary nailing (n=320) is the most common treatments for tibial fractures, alongside non-surgical treatment (n=464). Fractures treated by other surgical procedures or amputation are the ones with the lowest completeness, although there are few cases in those groups.

Table 5

Distribution of fractures with any missed registration according to main fracture treatment, non-surgical treatment excluded.

Main treatment	Any missed registration	All fractures	Completeness
Plate fixation	63	453	86.1%
Intra medullary nail	67	320	79.1%
Other surgical fracture treatment	9	85	89.4%
External fixation	6	30	80.0%
Amputation	2	5	60.0%
Other surgical procedure	2	4	50.0%
Arthroplasty	0	1	100.0%
Missing	0	9	100.0%
Total	149	907	

16.0% of the procedures in the register were missing information about the experience-level of the surgeon. Most of the procedures (53.8%) were performed by specialists in orthopaedics (Consultant orthopaedic surgeons) with more than fifty percent of their time spent doing fracture surgery during a regular work week (trauma surgeons) (Table 6a). Most of the procedures with missed registrations were performed by residents in orthopaedic surgery (14.6%). Other includes interns, unknown, missing or residents assisted by a specialist.

Table 6a
Distribution of procedures and missed procedures according to level of experience of the main surgeon.

All procedures	Missed	All procedures	Percent of all procedures	Completeness
Resident (ST)	37	253	11.7%	85.4%
Specialist in orthopaedics	44	324	15.0%	86.4%
Specialist in orthopaedics with >50% fracture surgery	124	1161	53.8%	89.3%
Other	12	422	19.5%	97.2%
Total	217	2160		90.0%

Table 6b
Distribution of primary procedures according to experience of the main surgeon

Primary procedure	Missed	All	Percent of all	Completeness
Resident (ST)	1	168	12.0%	99.4%
Specialist	2	221	15.8%	99.1%
>50% fracture surgery	5	605	43.3%	99.2%
Other	4	402	28.8%	99.0%
Total	12	1396		99.1%

Table 6c
Distribution of planned secondary surgeries according to experience of the main surgeon

Planned secondary	Missed	All	Percent of all	Completeness
Resident (ST)	4	15	5.0%	73.3%
Specialist	0	13	4.3%	100.0%
>50% fracture surgery	30	272	90.1%	89.0%
Other	0	2	0.7%	100.0%
Total	34	302		88.7%

Table 6d
Distribution of reoperations according to experience of the main surgeon

Reoperation	Missed	All	Percent of all	Completeness
Resident (ST)	32	70	15.2%	54.3%
Specialist	42	90	19.5%	53.3%
>50% fracture surgery	89	284	61.5%	68.7%
Other	8	18	3.9%	55.6%
Total	171	462		63.0%

The primary procedures and reoperations were performed by surgeons of all level of experience. However, 90.1% of the planned secondary surgeries were performed by trauma surgeons. The surgeons of that category were also those who have the highest completeness

in registrations of procedures (89.3%) (Table 6a-d).

The completeness of reoperation registrations (63.0%) was considerably lower than overall completeness (90.0%). This low completeness was seen throughout all groups of surgeons, still the most experienced trauma surgeons have the highest completeness (68.7%).

An analysis of completeness of registrations of procedures in fractures according to the ICD-codes showed a completeness in closed fractures (S82.10, S82.20 and S82.30) of 90.1%

compared with 73.9% in open fractures (S82.11, S82.21 and S82.31). The completeness of registrations of procedures in shaft fractures (both open and closed) was considerably lower (82.5%) than proximal and distal fractures which both had a completeness of over 90% (Tables 7a-b). Analyses also showed that 20.7% of the procedures performed in closed fractures were classified as reoperations while 25.6% of the procedures performed in open fractures were classified as reoperations. In the closed fractures most of the reoperations were performed due to patient discomfort (28.1%), other reasons (25.8%) and malunion (13.3%) while the reoperations in open fractures were most often due to other reasons (33.3%), non-union (24.4%) and infection (19.2%). On an average, 1.48 procedures were performed in each closed fracture and 2.56 procedures per open fracture.

Table 7a

Distribution of closed fractures according to segment.

Closed fractures	Fractures with any missed registration of procedures	All closed fractures	Completeness
Proximal	56	695	91.9%
Shaft	49	343	85.7%
Distal	19	214	91.1%
Total	124	1252	90.1%

Table 7b

Distribution of open fractures according to segment

Open fractures	Fractures with any missed registration of procedures	All open fractures	Completeness
Proximal	2	17	88.2%
Shaft	24	74	67.6%
Distal	5	28	82.1%
Total	31	119	73.9%

The completeness of registrations of procedures in fractures according to age at the time of the injury shows a tendency to increase with age. There were more fractures with at least one missed procedure in young patients than for old (Table 8). However, there were also more procedures being performed in young patients whereas older patients more often were treated non-surgical.

Table 8
Distribution of fractures according to age.

Injury Age	Missed	All fractures	Completeness
16-20	17	94	81.9%
21-30	36	199	81.9%
31-40	22	160	86.3%
41-50	21	207	89.9%
51-60	21	237	91.1%
61-70	23	221	89.6%
71-80	10	126	92.1%
81-90	4	96	95.8%
>90	1	31	96.8%
Total	155	1371	88.7%

Analysis of completeness of reoperation registration according to cause of injury and gender was also performed. These analyses showed no evidence that mechanism of injury or gender should affect the degree of completeness for reoperation registrations.

Analyses according to the month of treatment showed some monthly variance.

No analyses of the statistical significance of the varying completeness were performed (Figure 2).

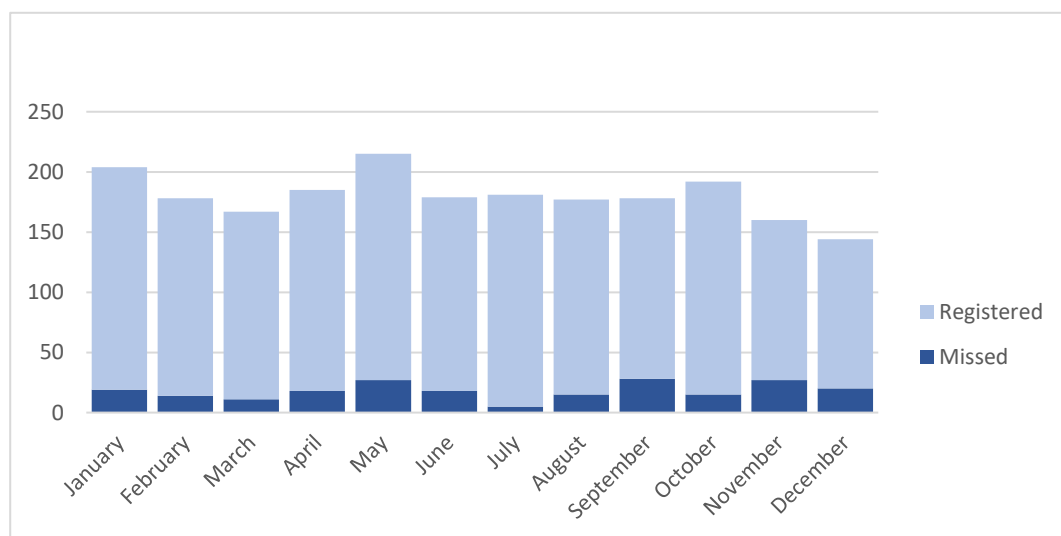


Figure 2
Distribution of proportion of missed procedures according to the month the procedure was performed.

From 2012 there has been a trend towards increasing completeness for reoperation registrations (Table 9). The high figure for 2011 is due to the previous study by Kapetanovic (25) where missed registrations were entered into SFR after the study was completed.

Table 9
Distribution of reoperations according to year of fracture.

	Missed registrations	Total number of reoperations	Completeness
2011	11	86	87,2%
2012	33	57	42,1%
2013	66	117	43,6%
2014	28	89	68,5%
2015	33	113	70,8%
Total	171	462	63,0%

Discussion

The principal finding of the present study was that completeness of reoperation registrations was 63.0% for tibia fractures at SU in 2011-2015. For planned secondary surgeries the completeness was 88.7% and for primary procedures 99.1%. The overall completeness was 90.0%. Of the missed registrations, 44.7% were extraction of internal fixation material. The procedures with the highest proportion of missed registrations were arthroscopic procedures, knee replacements and skin grafts. Open tibial shaft fractures had the lowest completeness and the most experienced surgeons had the highest completeness of registrations in the register.

There are different ways of validating register data, depending on what is considered gold standard. In this study, the surgery planning programme and medical records were considered gold standard, quite like the validation study of the Danish Fracture Database (27) and the Dutch National Intensive Care Evaluation (NICE) register (28). In some of the other validation studies, a questionnaire has been used. During validation of the Swedish Hip Arthroplasty Register, a comparison with the discharge register was used together with a questionnaire (29). In the validation of the Swedish Knee Arthroplasty Register, answers from a questionnaire were compared to the Patient Administrative System which is a national register of data regarding hospital admissions (30). In the validation of the Norwegian Arthroplasty Register (NAR), a

national patient register (NPR) was considered the gold standard. This register receives data from the electronic administrative systems in Norway. The data collection is based upon a coding system used in Norway (NOMESCO) and if a procedure is coded incorrectly in the medical records it will result in a missed registration in the NPR. This may explain the completeness of over 100% since a procedure then could be registered in the NAR but due to the wrong coding not be included in the NPR (31, 32). There is no consensus of what the general gold standard in validation of registers should be and therefore the completeness might differ from the true value and the completeness can in some studies be over 100%.

Most of the arthroplasty registers focus on completeness of primary procedures and revisions, thereby excluding reoperations (reoperations include all surgical procedures due to any complication while revisions include surgical procedures with replacement of implants). This makes comparisons between those registers and the current study hard. The Swedish Hip Arthroplasty Register has a completeness of 95% regarding both primary procedures and revisions (29) while other Scandinavian Arthroplasty Registers have a completeness of 80-101% regarding revisions (30, 32, 33).

The Danish Fracture Database (DFD) has a total completeness of 83%, 77% for planned secondary surgery and 58% for reoperations (27). Compared to that study, the SFR has a higher completeness regarding all kind of registrations. The validation of the DFD was made with data on fractures registered during the first year of the register, 2013. During that time, routines regarding registrations in the register were developed and therefore it is possible that the completeness in the register is higher if a new study was conducted covering data from a longer period. In the study of the completeness of reoperation registrations in the SFR during the first year of the register (2011), the completeness of reoperation registrations was only 39.7% compared to 63.0% in the current study (25). In the study by Kapetanovic the missed registrations were retroactively registered, which probably explain why the completeness of

reoperation registrations in 2011 was 87.2%. The reason for the completeness not being 100% is probably due to late reoperations performed after 2015 and the development of the SFR. The increase in completeness for fractures registered after 2014 indicates an increased tendency of making registrations of reoperations in the register.

As expected, most of the missed registrations of reoperations were extraction of internal osteosynthesis material. However, the registration completeness of these procedures have increased since 2011 from 42.1% to 63.3% (25). Extraction of internal osteosynthesis material was the second most common surgical procedure in tibial fractures. The procedures with the lowest completeness were arthroscopic procedures, fasciotomies, knee replacements and skin grafts. These procedures are usually performed by surgeons who are not involved in the primary fracture treatment on a regular basis and therefore probably not so used to make the registrations in the SFR. This can also be seen in the analyses of completeness according to the level of experience of the main surgeon, where residents and specialists in orthopaedic surgery had lower completeness than the specialists with more than fifty percent fracture surgery (trauma surgeons). The trauma surgeons probably have a higher awareness of the SFR since they do mostly fracture surgery. The procedures with the lowest completeness are procedures performed by specialists in orthopaedic surgery who are not trauma surgeons. The reason for the procedure determines if the procedure should be registered in the SFR.

The higher completeness in closed fractures (90.1%) compared to open fractures (73.9%) could be explained by the fact that the reoperation frequency was lower in closed fractures (20.7%) than open fractures (25.6%). Reoperations are usually not performed directly following the primary procedure, thereby not included in the first registration. Thus, the reoperation registrations demand an extra effort and awareness. There were also more procedures performed per fracture in open fractures resulting in a higher risk of missing registrations of procedures. The reasons for the reoperations differed between open and closed fractures. A

higher frequency of patient discomfort and malunion was seen as reason in closed fractures and non-union and infections in open fractures. The increased risk for infections in open fractures has been observed in previous studies (34). The fractures of the tibial shaft had a lower completeness of registrations of procedures (82.5%) compared to fractures on other parts of the tibia which had a completeness of registrations of procedures in fractures of over 90%. This might be explained by a higher degree of patient discomfort after surgery in that region, primary anterior knee pain (35). As shown in the current study, the reoperations due to patient discomfort showed the lowest completeness (33.1%) and this could also be explained by the time-lag from the primary procedure or perhaps the variety of procedures performed due to this indication which are normally quick procedures such as removing a locking screw or performing an arthroscopic synovectomy.

A question that was raised in the beginning of the study was if the month in which the procedure was performed would affect the completeness and if the months of vacations and holidays would have lower completeness. The results of the study however, show no difference in completeness according to month. This could partly be explained due to the routines of secondary registrations and the fact that the analysis was performed regardless of year, which evens out some differences from year to year.

Strengths and limitations

This study includes a large number of fractures. All types of tibial fractures and all treatment types are included. Each fracture has been reviewed manually to find missing registrations of reoperations. The study is based on data in the operation planning programme, medical records and the SFR, reducing the risk of overlooking any missed registrations.

The study is designed to validate the completeness of reoperation registrations in the SFR. Therefore, conclusions based on this study cannot be drawn regarding any other procedures

than reoperations for tibia fractures. The overall completeness of 90.0% is considered good and 99.1% completeness regarding primary procedures in the current study is better than previously reported in most orthopaedic registers but as mentioned above this was not the main focus of the study. The current study was not designed to examine primary registrations. No conclusions can be made based on the small variations in completeness according to main treatment or age at the time of the fracture found in this study since no further analyses were made.

Missed registrations of non-surgical treatments cannot be found with the design of the study. Therefore, the non-surgical procedures were excluded during the analysis. Wound revisions and fasciotomies might be overestimated in the study since the recommendation in the SFR is to register only the first procedure in a series of e.g. wound revisions is performed.

Only tibial fractures treated at SU during 2011-2015 was investigated and therefore the conclusion is not applicable for the whole SFR. Other types of fractures treated at SU might not have the same completeness in reoperation registrations since they have not been registered as long. Tibial fractures were the first fractures to be registered in the SFR (9). The current study uses the operation planning system as gold standard and therefore if reoperations are made outside SU, e.g. at private hospitals, such procedures would not be included in the study. However, the vast majority of reoperations are expected to be performed at SU and therefore the results of the study should be fairly close to the true completeness figures.

Recommendations

Further studies are required to validate reoperations in other departments and other fractures in the SFR. A study of the completeness of reoperation registrations after 2016 should be performed to evaluate the effect of including KVÅ-codes into the weekly searches. To validate non-surgical treatment, a different kind of study should be performed.

Conclusions

The present study shows a high overall completeness of tibia fracture registrations in the Swedish Fracture Register at Sahlgrenska University Hospital during the studied time period. A higher degree of completeness for reoperation registration than previously reported was shown. Retroactive registrations have completed the register which will enable further studies of the results after tibial fractures.

The aim of this study was to enable further studies of the results after tibial fractures. This is now possible because registrations of reoperations after tibial fracture at Sahlgrenska University Hospital can be considered complete.

Populärvetenskaplig sammanfattning

Validering av reoperationer av underbensfrakturer i Svenska Frakturregistret 2011–2015

Svenska Frakturregistret (SFR) startades 2011 för att öka kunskapen om benbrott och dess behandlingar och följder. I början registrerades endast benbrott (frakturer) på underbenet och överarmsbenet men med tiden har fler typer av frakturer börjat registreras. För att ett register ska kunna användas som grund för forskningsstudier behöver man säkerställa att informationen i registret är tillförlitlig samt speglar verkligheten. Därför utförs valideringsstudier. Denna valideringsstudie har fokuserat på i hur stor utsträckning reoperationer efter underbensfrakturer som skett under 2011–2015 och som behandlats på Sahlgrenska Universitetssjukhuset (SU) i Göteborg har registrerats. Reoperationer är en indikation på att något inte gått som planerat vid behandlingen av en fraktur och att detta lett till ett ytterligare ingrepp. Reoperationer kan bero på flera olika orsaker, som exempelvis infektioner eller patientupplevda besvär. Reoperationer används ofta som ett mått på kvaliteten av behandlingen i studier och därför är det viktigt att dessa data är korrekta. Data från denna studie planeras att användas för att utvärdera behandlingen av underbensfrakturer vid SU och ge ytterligare kunskap om resultat efter underbensfrakturer för att kunna utveckla behandlingen i framtiden.

För att ta reda på hur stor andel av registreringar av reoperationerna efter underbensfrakturer som har missats användes operationsplaneringsprogrammet Operätt. Med hjälp av personnumren på patienterna registrerade i SFR kontrollerades om de genomgått någon ytterligare operation på SU som ej registrerats i SFR. Om någon oregistrerad operation upptäcktes kontrollerades patientens journal för att få ytterligare information kring ingreppet och sedan efterregistrerades ingreppet i SFR.

Under arbetet har 1371 frakturer kontrollerats och 217 missade registreringar har hittats. Vissa av dessa ingrepp har dock varit andra typer av ingrepp än reoperationer. 63% av alla

reoperationer var registrerade i SFR från början. Det var främst ingrepp där man tog ut fixationsmaterial som man opererat in för att stabilisera frakturen som hade missats att registreras. Det kunde även konstateras att de mest erfarna läkarna var de som utförde de flesta operationerna och att det även var de som var bäst på att registrera ingrepp. De flesta reoperationerna som missades att registreras var på grund av patientupplevda besvär eller infektion.

Den nya kunskapen om hur bra läkare vid SU är på att registrera ingrepp i SFR skall användas för att motivera läkarna till att göra registreringar, särskilt i de situationer där det tenderar att missas. Detta för att öka tillförlitligheten i studier baserade på registret i framtiden. Eftersom efterregistreringar utfördes under arbetet kan registret över reoperationer av frakturer som uppkommit mellan 2011–2015 och behandlats på SU anses så komplett som möjligt för tillfället vilket ger goda förutsättningar för kommande studier av resultat efter underbensfrakturer.

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