Orthopaedic injuries in trauma patients, A nationwide register study including 37266 patients

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Abstract

Purpose

Trauma causes over 4 million annual deaths globally and accounts for over 10 % of the global burden of disease. Trauma patients often sustain multiple injuries in multiple organ systems. This study aims to investigate the incidence of orthopaedic injuries in adult trauma patients.

Methods

The study was a register-based study using data from the national Swedish trauma register – SweTrau. The inclusion criteria for the register are all patients with a trauma that activated the trauma team at the admitting hospital, or patients admitted without trauma team activation but with NISS (New Injury Severity Score) >15. By categorizing Abbreviated Injury Scale (AIS) codes into different orthopaedic injury types, we provided a detailed description of what types of orthopaedic injuries that occurred in trauma patients.

Results

A total of 37266 patients were included in the study. A total of 15246 (40%) patients had sustained any orthopaedic injury, and 7733 (51%) patients had more than one orthopaedic injury. Spine injuries were the most common type of injury affecting 19% (n= 7083) of all trauma patients, followed by injuries of the upper extremities (n=6273, 17%) and lower extremities (n=5943, 16%). Fractures were the domination type of orthopaedic injury (n=30755, 87%). Traffic injury was the most common injury mechanism with almost half (n= 18112, 49%) of the patients being admitted after some sort of traffic related incident

Conclusion

Orthopaedic injuries are common in trauma and occur in 40% of trauma patients. Slightly more than half of the patients with orthopaedic injury had ≥ 2 orthopaedic injuries.

Background

Trauma causes over 4 million annual deaths globally and accounts for over 10% of the global burden of disease[1]. Despite the mortality and morbidity caused by trauma, the epidemiology and patterns of injuries in trauma patients is not a prioritised area within the scientific world[2]. Orthopaedic injuries are known to be frequent among trauma patients [3] but it is a subject in need of more descriptive studies as little is known about the frequencies of different injury types. Beerekamp et al concluded in 2017 that “current epidemiologic data on extremity fractures and their treatment are scarce, outdated or aiming at a small spectrum of fractures”[4]. Since then, a few high-quality register studies on prevalence of orthopaedic injuries in trauma have been published but they tend to focus on a specific injury type[5–7]. There are also a few large nationwide studies based on discharge data with a focus on fracture epidemiology[8–10]. However, because they generally do not differentiate between injuries caused by

high-energy trauma and the frailty fractures typical for elderly individuals, results from these studies are not representative for a trauma population. Consequently, orthopaedic injury prevalence among trauma patients is still a scientific area with room for improvement.

The aim of this study was to investigate the prevalence of orthopaedic injuries including the anatomical location and types of injuries in adult trauma patients. The hypothesis was that a substantial part of trauma patients had orthopaedic injuries. The study was based on data from a national Swedish trauma register.

Methods

Study design

The study was a register-based descriptive study using data from SweTrau, the national Swedish trauma register. It was based on data from the years 2015–2019.

Study population and the SweTrau register

Sweden has a state founded national healthcare system where all healthcare is subsidized. In the more densely populated areas trauma care is centralized to university hospitals, while in the less densely populated areas trauma cases are usually referred to the closest hospital regardless of hospital type and trauma experience.

SweTrau is a national register for trauma in Sweden that was started in 2013. Currently (2021), 46 out of the 50 hospitals with 24/7 emergency care in Sweden report data to the SweTrau register. The register has emphasis on major trauma. The inclusion criteria for the register are all patients with a trauma that activated the trauma team at the admitting hospital, or patients admitted without trauma team activation but with NISS (New Injury Severity Score) > 15. Exclusion criteria are patients moved to the hospital > 7 days after the trauma, patients where the only injury is a chronic subdural hematoma and cases where the trauma team was activated without an actual traumatic event. In this study, we also excluded patients who did not have any traumatic injuries registered and those aged < 18 years.

The registry reports data in accordance with “*The Utstein Trauma Template for Uniform Reporting of Data following Major Trauma*”[11]. Data in the register is reported by trained personnel at each reporting hospital. For validation of data SweTrau has logical controls on the in-data so that values outside the expected values are questioned. Missing values are accepted but in the case of missing data, a reminder is sent to the reporting hospital to provide an additional opportunity to find the missing value in the patient chart. The registry publishes an estimate of the completeness of the register in yearly reports (www.swetrau.se). The estimate is calculated by dividing the number of patients with intensive care needs in the SweTrau register with the number of care sessions of patients with a traumatic admission diagnosis in the Swedish intensive care registry (www.icuregswe.org). The validity of the register has been investigated by a recent study regarding penetrating injuries. By crosschecking the prevalence and

epidemiology of victims of violent penetrating injuries reported by the SweTrau register and The Swedish National Council for Crime Prevention (BRÅ). The authors of the study found the numbers reported by SweTrau to corresponded well with reports from BRÅ[12].

Categorisation of orthopaedic injuries

The AIS (Abbreviated Injury Scale) system is a numerical system for indexing traumatic injuries depending on severity on a scale of 1–6. The system also provides information about anatomical location and type of injury[13]. Besides giving information about each injury, the AIS codes were also used to calculate NISS (New Injury Severity Score) which is the sum of the squares of the three most severe AIS codes regardless of body region[14]. For each trauma case, the SweTrau register reports up to 50 AIS codes related to the trauma. AIS codes were used in this study to identify orthopaedic injuries, and for categorising orthopaedic injuries into groups such as fractures, dislocations, and amputations. As each injury is coded separately, combined injuries can result in several independent injury codes. In the AIS system, pelvic injuries are labelled as a lower extremity injury.

Statistical analysis

Numerical data were presented as mean $\pm$ standard deviation (SD) and range or median with interquartile range (IQR). Categorical data was presented as frequency and percent distribution. Processing of data and calculations were performed in Microsoft Excel (Microsoft 365 MSO v. 2010).

Ethical approval

The study was approved by the Swedish authority for ethical approvals with reference number: 2020-04655.

Results

Patient and injury characteristics

A total of 51335 cases were found in the register. After exclusion of 7696 cases that did not have any traumatic diagnosis (AIS codes) registered from the trauma and 6373 patients aged <18, a total of 37266 patients were included in the study. The mean ($\pm$ SD, range) age for the whole cohort was 47.3 ($\pm$ 20.8, 18–116) years and 25025 (67%) of the patients were males. The mean age for females was 49.9 ($\pm$ 21.4, 18–116) years and 46.1 ($\pm$ 19.8, 18–115) years for males.

Traffic injury was the most common injury mechanism with almost half (n= 18112, 49%) of the patients being admitted after some sort of traffic-related incident. Data regarding injury mechanism was unknown or absent in a total of 203 cases.

On arrival, 1232 (3.3%) of the patients had GCS (Glasgow Coma Scale) <9, and 778 (2.1%) of the patients were in circulatory shock (systolic blood pressure <90 mmHg). 6602 (18%) of the patients had ISS >15

and 9572 (26%) had NISS >15. Data was absent regarding GCS in 3981 cases and regarding systolic blood pressure in 2379 cases. Regarding ISS and NISS, no cases had missing values whereas the numbers are generated from the AIS codes, and the absence of any traumatic injury code was an exclusion criterium for this study.

Detailed patient characteristics are presented in Table 1 and data on injury mechanisms in Table 2.

Overview of orthopaedic injuries

The total number of orthopaedic injuries in the cohort was 35258. In the whole cohort of 37266 patients, a total of 15246 (40%) patients had sustained at least one orthopaedic injury. Of those with an orthopaedic injury, approximately half (n=7733, 51%) had more than one orthopaedic injury (Table 3). Of all orthopaedic injuries, a fracture was the most common orthopaedic injury (n=30755, 87%).

A spine injury was the most common orthopaedic injury type (n=14852), affecting 19% (n=7083) of all trauma patients. Lower extremity injuries was the second most frequent orthopaedic injury type (n=11009), affecting 16% (n= 5943) of all patients, followed by upper extremity injuries (n=9397), affecting 17% (n=6273) of all patients (Tables 4, 5 and 6).

Spine injuries

The mean ($\pm$ SD, range) age of patients with spine injuries was 51.3 ($\pm$ 20.7, 18-115) years and 4848 (68%) of the patients were males. Injuries to the thoracic spine (fracture, dislocation, or disc injury) was the most common spinal injury type with a total of 4889 injuries in the cohort, affecting 2585 patients. A total of 4796 lumbar spine injuries (fracture, dislocation, or disc injury) in 2755 patients, and 3376 cervical spine injuries in 2158 patients were found. Patients with spine injuries had on average just over two (2.1) injuries (Table 4).

Upper extremity injuries

The mean ($\pm$ SD, range) age of patients with upper extremity injuries was 48.8 ($\pm$ 19.6, 18-102) years and 4522 (72%) of the patients were males. Forearm and wrist fractures (n=2591), affecting 1849 patients were the most common injury types in the upper extremity, followed by clavicle fractures (n=1661, in 1624 patients) and fractures of the hand (n=1362, in 1018 patients) (Table 5).

Lower extremity injuries

The mean ($\pm$ SD, range) age for patients with lower extremity injuries was 48.5 ($\pm$ 21.3, 18-115) years and 4079 (69%) of the patients were males. Pelvic fractures (n=1994), foot fractures (n=1727) and tibia

fractures (n=1475) were the most common injuries of the lower extremity. As patients with foot fractures often had multiple injuries (mean 2.1 injuries/patient) the number of patients affected by one or more foot fracture was 808. Pelvic fractures and tibia fractures were the injuries that affected the highest number of patients (pelvic n= 1800, and tibia n=1310). Femur fractures were divided into proximal (including hip fractures), shaft and distal, but when counted as one group they affected 1556 patients (Table 6).

Discussion

Injury panorama

Comparisons between the injury panorama of our cohort and previous studies are hard to make as previous literature are typically limited to either a specific group of patients[15-17], a specific trauma mechanism[18-20], or a specific injury type[5-7, 21-23]. We found only a few studies that presented incidences of orthopaedic injuries in unsorted trauma patient populations. Dziubinski et al[24] studied poly-trauma patients in Poland and found that 78% of the patients had one or more bone fractures. In our cohort, 40% had sustained some sort of orthopaedic injury. The study by Dziubinski was however based on only 81 patients. In addition, they had a 22% in-hospital mortality rate indicating that their patients were more severely injured than those in our cohort.

Regarding anatomical locations, spine injuries was the most common injury type in our cohort (n= 14852) followed by lower extremity (n= 11009) and upper extremity (n= 9397). The number of patients with at least one injury in the respective anatomical location was more evenly distributed; still spine injuries was the most common injury type (7083 patients) followed by upper extremity (6273 patients) and lower extremity (5943 patients). Dimaggio et al[8] conducted a large descriptive study of traumatic injury discharges from US hospitals. That study did not provide detailed information on the anatomical locations of injuries, but they found that the incidence of severe injuries located in the extremities was only 7.9% as compared to 3.0% in the spine. However, as 30 % of the injuries were labelled as unclassifiable regarding anatomical location, comparisons between their study and ours are hard to make. Our finding that slightly more than half of the patients had more than one orthopaedic injury is interesting. This was in concordance with a previous study by Banerjee et al[23] that reported data regarding trauma patients with extremity injuries and ISS>15 from the German trauma register. They found that patients with relevant extremity injuries on average sustained 2.1 fractures per case. Banerjee et al also found that the most common extremity injuries were fractures of forearm/wrist, femur, tibia and clavicle. These injuries were also among the most common extremity injuries in our material.

Specific injury types

Spine injuries were the most common orthopaedic injury type in our cohort constituting 42% of orthopaedic injuries. Among spinal injuries, the distribution between cervical, thoracic, and lumbar injuries

was quite even, with thoracic and lumbar spine injuries being slightly more common than cervical injuries. These findings were concordant with a study investigating traumatic spinal fractures in northern Finland, however reporting slightly more cervical and less thoracic injuries, respectively[25].

Forearm or wrist fracture was the dominating injury type among upper extremity injuries in our cohort representing 28% of upper extremity injuries. Because these fractures also exhibit the highest incidence in the general population[4], this finding was not surprising.

Pelvic fracture was the most common lower extremity injury (18 % of lower extremity injuries). As pelvic fractures are known to cause severe disability[26] and as it is an injury with increasing incidence in later years[27] further research on management of pelvic fractures should be a prioritised area.

Injury mechanisms

Traffic-related accidents was the most common injury mechanism (49%) in the whole cohort. This might seem somewhat surprising as Sweden has a high traffic safety, with only 2.2 traffic deaths per 100 000 citizens and year compared to the average in the European union of 5.9 per 100 000/year[28]. Despite the improvements in in traffic safety regarding traffic related deaths further improvements with emphasis on non-lethal traffic injuries should be encouraged.

The anatomical distribution of injuries did not vary much with regards to different injury mechanism, but we found that upper extremity injuries were overrepresented in motorcycle and bicycle accidents. An interesting finding regarding penetrating trauma was that stab/knife injuries more often affected the upper extremity, whereas gunshot injuries predominantly affected the lower extremities. These findings are concordance with previous literature. Persal et al[29] found that the ratio of gunshots to the lower versus upper extremity was 1.8: 1. In knife assaults, Uchino et al[30] found the same ratio to be 1: 4. The reason for this difference is not fully known but one can speculate that the victims of knife assaults often have time to make an attempt to fend off their attacker resulting in hand and forearm injuries.

The most common injury type caused by high energy falls was spine injuries, with 34% of patients with spine injury having sustained their injury in a high energy fall. As high falls are previously shown to be the most common injury mechanism to cause spine injuries[31] this result did not come as a surprise.

Less than 10% of patients had sustained their injury in a low energy fall, indicating that the national criteria for activation of a trauma teams are generally followed.

Strengths and limitations

One major strength of this study was the large, unselected patient cohort from a national register. Another strength was the available detailed dataset for each trauma case due to the use of the Utstein Trauma Template reporting system used by the SweTrau register. Another strength was that the study represented

all trauma cases that activated the trauma team at the admitting hospital and thus gives a good representation of what injuries that can be expected at the trauma room. However, the choice to include all trauma cases and not just the ones with ISS >15 is important to consider when comparing our results with other and future similar studies. One obvious limitation in this study was that, although being a large cohort, it contained only Swedish patients. As the panorama of traumatic injuries differs greatly in different parts of the world our results are not necessarily representative for all other countries. However, knowledge about what types of injuries that will be the result of trauma is of great importance and further studies from other parts of the world would help to improve our knowledge of traumatic injuries. An additional limitation was that the study lacks outcome data. As the outcome data reported by the The Utstein Trauma Template is limited to hospital length of stay, Glasgow outcome score and mortality we chose not to include it in this study. It would however be interesting to see if these different injury types influenced the long- and short-time functional outcome for different patient groups and this is a subject for future studies. Another limitation was the studied time-period of 5 years. A longer period would allow for a longitudinal analysis of shifting trends in injury mechanisms and injury panorama. Finally, as with all large register studies, there were some missing data in the dataset.

Conclusion

In this cohort, 40% of patients had at least one orthopaedic injury, where a spine injury was the most common injury type. Fractures constituted the dominating orthopaedic injury type with 87% of all injuries. We also found that slightly more than half (51%) of the patients with orthopaedic injuries had ≥ 2 orthopaedic injuries.

Declarations

Ethics approval (include appropriate approvals or waivers):

The study was approved by the Swedish authority for ethical approvals with reference number: 2020-04655.

Consent to participate

(include appropriate statements): Not applicable as this was a national register study.

Consent for publication

(include appropriate statement): The authors of study do consent publication in BMC Musculoskeletal Disorders

Availability of data and material:

Available on request

Code availability (software application or custom code):

Available on request

Conflicts of interest/Competing interests:

No conflicts of interest.

Funding:

No external funding was received.

Author Contributions

JH,HB and AE all contributed to design of the study, processing of the data and writing of the manuscript. All authors have read and approved the manuscript.

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Tables

Table 1

Patient characteristics.

Variable	
Age (yrs), mean (SD, range),	47.3 (20.8, 18-115)
Males, n (%)	25025 (67.2)
ASA 3-4 pre-injury, n (%)	5221 (14.0)
ISS, median (IQR)	5 (1-11)
ISS>15, n (%)	6602 (17.7)
NISS, median (IQR)	6 (2-17)
NISS>15, n (%)	9572 (25.6)
GCS, median (IQR)	15 (15-15)
GCS< 9, n (%)	1232 (3.3)
Systolic BP, mean (SD)	138,3 (26.3)
Systolic BP<90, n (%)	778 (2.1)

ASA: American society of Anesthesiologists, ISS: Injury Severity Score; NISS, New Injury Severity Score, GCS: Glasgow Coma Scale, BP: Blood Pressure.

Table 2

Prevalence of injuries in different body regions depending on injury mechanism.

Injury mechanism, n (%)	Patients with Spine injury	Patients with Upper extremity injury	Patients with Lower extremity injury
Motor vehicle accident	2014 (28.4)	1197 (19.1)	1213(20.4)
Motorcycle accident	646 (9.1)	1082 (17.2)	747 (12.6)
Bicycle accident	456 (6.4)	694 (11.1)	294 (4.5)
Traffic pedestrian	203 (2.8)	259 (4.1)	402 (6.7)
Traffic other	111(1.5)	107 (1.7)	92 (1.6)
Gunshot	54 (0.8)	153 (2.4)	372 (6.3)
Stabbed by knife or similar	39 (0.6)	420 (6.7)	280 (4.7)
Struck or hit by blunt object	334 (4.7)	241 (3.8)	289 (4.9)
Low energy fall	632 (8.9)	389 (6.2)	578 (9.7)
High energy fall	2383 (33.6)	1580 (25.2)	1437 (24.2)
Blast injury	9 (0.1)	18 (0.3)	9 (0.2)
Other	178 (2.5)	120 (1.9)	211 (3.6)
Unknown	24 (0.3)	13 (0.2)	9 (0.2)
Total	7083(100.0)	6273(100.0)	5933 (100.0)

Table 3

Number of orthopedic injuries in each patient

Number of orthopedic injuries in each patient	Number of patients n (%)
1	7513 (49.2)
2	3508 (23.0)
3	1596 (10.5)
4	959 (2.6)
5	555 (1.5)
6	366 (1.0)
7	216 (0.6)
8	161(0.4)
9	110 (0.3)
≥10	262 (0.7)
Total	15246(100.)

Table 4

Total number of spine injuries and number of patients with each injury in the cohort, presented by injury type

	Number of injuries in cohort	Percentage of total orthopedic injuries	Number of patients in cohort with injury	Percentage of patients in cohort with injury
Cervical spine unspecified injury	42	0.1%	38	0.1%
Cervical cord injury	477	1.4%	453	1.2%
Cervical fracture, dislocation, or disc injury	3376	9.6%	2158	5.8%
Thoracic unspecified injury	12	0.0%	11	0.0%
Thoracic cord injury	652	1.8%	591	1.6%
Thoracic fracture, dislocation, or disc injury	4889	13.9%	2585	6.9%
Lumbar unspecified injury	86	0.2%	84	0.2%
Lumbar cord injury	522	1.5%	496	1.3%
Lumbar fracture, dislocation, or disc injury	4796	13.6%	2755	7.4%
TOTAL SPINE INJURY	14852	42.1%	7083	19.0%

Table 5

Total number of upper extremity injuries and number of patients with each injury in the cohort, presented by injury type.

Type of injury	Number of injuries in cohort	Percentage of total orthopedic injuries	Number of patients in cohort with injury	Percentage of patients in cohort with injury
Upper extremity injury, unspecified	3	0.0%	3	0.0%
Traumatic amputation of arm above wrist	22	0.1%	21	0.1%
Traumatic amputation of hand or part of hand	37	0.1%	28	0.1%
Compartment syndrome upper extremity	10	0.0%	9	0.0%
Crush injury upper extremity	3	0.0%	3	0.0%
Penetrating injury upper extremity	524	1.5%	342	0.9%
Muscle, tendon or ligament injury upper extremity	448	1.3%	367	1.0%
Acromioclavicular joint dislocation	109	0.3%	109	0.3%
Sternoclavicular joint dislocation	11	0.0%	11	0.0%
Glenohumeral dislocation	177	0.5%	171	0.5%
Elbow joint dislocation	88	0.2%	85	0.2%
Wrist or hand joint dislocation	174	0.5%	150	0.4%
Clavicle fracture	1661	4.7%	1624	4.4%
Scapula fracture	1082	3.1%	1040	2.8%
Humerus fracture	1095	3.1%	1010	2.7%
Forearm or wrist fracture	2591	7.3%	1849	5.0%
Hand fracture	1362	3.9%	1018	2.7%

**TOTAL UPPER
EXTREMITY**

9397

26.7%

6273

16.8%

Table 6

Total number of lower extremity injuries and number of patients with each injury in the cohort, presented by injury type.

Type of injury	Number of injuries in cohort	Percentage of total orthopedic injuries	Number of patients in cohort with injury	Percentage of patients in cohort with injury
Unspecified injury lower extremity	1	0.0%	1	0.0%
Traumatic amputation lower extremity	40	0.1%	39	0.1%
Compartment syndrome lower extremity	39	0.1%	38	0.1%
Crush injury lower extremity	24	0.1%	20	0.1%
Penetrating injury lower extremity	867	2.5%	512	1.4%
Hip joint dislocation	133	0.4%	133	0.4%
Knee joint dislocation	23	0.1%	22	0.1%
Ankle dislocation	47	0.1%	46	0.1%
Muscle, tendon or ligament injury lower extremity	493	1.4%	353	0.9%
Unspecified fracture lower extremity	124	0.4%	116	0.3%
Pelvic fracture	1994	5.7%	1800	4.8%
Acetabular fracture	694	2.0%	662	1.8%
Patella fracture	264	0.7%	249	0.7%
Femur fracture proximal	788	2.2%	770	2.1%
Femur fracture shaft	520	1.5%	495	1.3%
Femur fracture distal	310	0.9%	291	0.8%
Tibia fracture	1475	4.2%	1310	3.5%
Fibula fracture	1446	4.1%	1284	3.4%
Foot fracture	1727	4.9%	808	2.2%

TOTAL LOWER EXTREMITY	11009	31.2%	5943	15.9%
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Supplementary Files

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