

Original Article

Traffic injuries after orthopaedic surgery

Sine Savas Andersen^{1, 2}, Jonas Ammundsen-Ipsen^{1, 2}, Oddrún Danielsen^{1, 2} & Jens Lauritsen^{1, 2}

1) Department of Orthopedic Surgery and Traumatology, Odense University Hospital, 2) Orthopedic Research Unit, Clinical Institute, University of Southern Denmark, Denmark

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ABSTRACT

INTRODUCTION. Orthopaedic surgery and post-operative immobilisation can impair the ability to remain safe in traffic and potentially increase the risk of traffic-related incidents. The aim of this study was to assess the incidence of traffic-related injuries during the first year after orthopaedic surgery.

METHODS. This cohort study included patients who underwent orthopaedic surgery at Odense University Hospitals, Denmark, from 1 January 2019 to 31 December 2024 with a 12-month follow-up. Traffic-related injuries were identified from emergency department records. Descriptive statistics summarised patient characteristics, surgical types, and outcomes. We analysed time to traffic incident and mode of transportation to assess temporal patterns.

RESULTS. A total of 17,526 orthopaedic patients were included; 53.7% were women. Only 117 patients (0.7%), 55.6% male, were treated for traffic-related injuries. The proportion of traffic-related injuries was highest among younger patients, with 2.3% aged 18-24 years. Most injuries involved cyclists (44.4%), followed by motorised transport (30.8%), and were mainly solo incidents (60.7%). No clear clustering by transportation mode was observed. Fewer incidents occurred in the early post-operative period, with a gradual increase being observed over time.

CONCLUSIONS. Within the first year after surgery, 0.7% experienced a traffic incident requiring emergency department contact. This proportion appeared comparable to the background rate of traffic-related emergency department contacts in Denmark.

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Traffic incidents are among the leading causes of mortality worldwide, resulting in approximately 1.19 million deaths annually [1]. For patients recovering from injuries, transportation by bike, car or walking is instrumental in regaining autonomy, returning to work and resuming everyday life [2].

Safe transportation requires physical function and cognitive alertness [3]. These abilities may be impaired after orthopaedic surgeries, e.g. due to pain, reduced strength and the use of pain medications [3]. An Australian cohort study of patients with wrist fractures found a bimodal distribution of car crashes, peaking at 20 days and ten weeks after treatment [4]. Driving simulator studies have further supported these findings, reporting impaired brake-response time for several weeks after orthopaedic surgeries [1].

According to Section 54 of the Danish Traffic Act, patients are not allowed to drive if their physical and cognitive function poses a threat to traffic safety. Therefore, treating surgeons must assess if the patients have recovered sufficiently to drive. However, evidence regarding orthopaedic patients' involvement in traffic incidents after surgery remains limited [5]. Improved knowledge of such incidents may help describe mobility patterns and

traffic incident involvement following orthopaedic procedures [6, 7].

Hence, this study aimed to assess the prevalence of traffic incidents involving post-surgical orthopaedic patients within the first year after orthopaedic surgery. Additionally, it aimed to characterise the patients involved and the types of traffic incidents.

Methods

Study design

This was a retrospective cohort study including all orthopaedic patients surgically treated at Odense and Svendborg University Hospital (OUH) in the period from 1 January 2019 to 31 December 2024. The follow-up period was 12 months, and contacts to the emergency department (ED) were registered. Reporting followed the standards for Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement [8].

Setting

The ED at OUH handles an average of 48,117 visits annually and provides 24-hour access [9]. The OUH is located on the island of Funen and serves a mixed rural and urban population of approximately 500,000 inhabitants, corresponding to about 9% of the Danish population [10]. The region is demographically and industrially comparable to the national average, making it representative of the broader Danish context for injury and traffic-related research. Under Danish law, registry-based health research that do not involve human biological material generally do not require approval by the research ethics committee system (Danish Act on Research Ethics Review of Health Research Projects and Health Data Research Projects § 14(2)).

Patients

All patients who underwent any orthopaedic surgery were included and followed for 12 months. The exclusion criterion was age under 18 years, as this was the minimum legal driving age in Denmark at the time of the analysis.

Data sources and measurement

Information about patients who presented to the EDs at OUH has been registered systematically and consistently for many years by the Accident Analysis Group. This registration includes, among others, patient-specific information such as age and sex as well as injury-specific information such as mode of transportation and the injured person's role (driver or passenger). Using the Civil Registration Number (CPR), a unique number assigned to every Danish citizen, we identified all persons who had undergone orthopaedic surgery and subsequently experienced a traffic incident [11].

Patient-specific information such as sex, age and anatomical region of surgery were reported. The orthopaedic surgeries were categorised by procedure codes as back and neck surgery (KNA*), upper extremity surgery (KNB*, KNC* and KND*) and lower extremity surgery (KNE*, KNF*, KNG* and KNH*).

Traffic injury-specific information included mode of transportation (pedestrians, bicycles, active assisted (E-bikes, E-scooters, or small mopeds), or motorised (cars, trucks, buses, or other)), role (driver or non-driver), severity (minor or major) [12] and use of helmet or seatbelt. Pedestrians were registered as non-drivers. For multiple contacts due to the same injury, we included only data from the first contact.

Outcomes

The primary outcome was any contact with the ED due to a traffic incident within 12 months after surgery. For patients who underwent multiple surgeries, the date of the first surgery was used as the index event to define the start of the 12-month follow-up period.

Secondary outcomes included transportation mode, injury severity, driver role and crash type. Number of traffic incidents over time was presented in scatterplots, and the cumulated proportion of traffic incidents over time was estimated.

Analysis and statistics

Descriptive statistics were used to summarise patient demographics, types of surgery and outcome frequencies. For continuous variables, means and SD were reported. For categorical variables, frequencies were reported. Proportions were reported with 95% CI. No regression analysis was completed. All analyses were conducted using STATA/IC v19.0.

Data sharing statement

The data underlying this study consist of retrospective, de-identified registry data collected by the Accident Analysis Group. Due to restrictions related to Danish data protection legislation and registry governance, the data are not publicly available. Data may be available upon request by contacting the last author.

Trial registration: not relevant.

Results

Patient demographics

A total of 17,526 orthopaedic patients were included. Among these, 9,405 patients were women (53.7%), and the mean age was 59 (SD 20) years. Lower extremity surgery accounted for 11,725 (66.9%), upper extremity surgery accounted for 5,651 (32.2%) and back, neck and spine surgery for 150 (0.9%) (**Table 1**).

TABLE 1 Baseline characteristics of the orthopaedic cohort.

	No traffic injuries, (N _{no} = 17,409 (99.3%))	Traffic injured (N _{yes} = 117 (0.7%))		Total (N _{tot} = 17,526 (100.0%))
	n (%)	n (%)	relative to subgroup population, %	n (%)
<i>Sex</i>				
Female	9,353 (53.7)	52 (44.4)	0.6	9,405 (53.7)
Male	8,056 (46.3)	65 (55.6)	0.8	8,121 (46.3)
<i>Age group</i>				
18-24 yrs	1,262 (7.2)	29 (24.8)	2.3	1,291 (7.4)
25-34 yrs	1,452 (8.3)	15 (12.8)	1.0	1,467 (8.4)
35-49 yrs	2,321 (13.3)	19 (16.2)	0.8	2,340 (13.4)
50-64 yrs	4,249 (24.4)	25 (21.4)	0.6	4,274 (24.4)
65-74 yrs	3,479 (20.0)	14 (12.0)	0.4	3,493 (19.9)
≥ 75 yrs	4,646 (26.7)	15 (12.8)	0.3	4,661 (26.6)
<i>Body region: procedure code</i>				
<i>Upper extremity</i>				
Shoulder and upper arm: KNB*	1,483 (9.4)	11 (9.4)	0.7	1,494 (8.5)
Elbow and forearm: KNC*	1,622 (9.3)	12 (10.3)	0.7	1,634 (9.3)
Hand and fingers: KND*	2,493 (14.3)	30 (25.6)	1.2	2,523 (14.4)
Subtotal	5,598 (33.0)	53 (45.3)	0.9	5,651 (32.2)
<i>Lower extremity</i>				
Pelvis: KNE*	508 (2.9)	4 (3.4)	0.8	512 (2.9)
Hip and thigh: KNF*	5,157 (29.6)	17 (14.5)	0.3	5,174 (29.5)
Knee and lower leg: KNG*	3,748 (21.5)	29 (24.8)	0.8	3,777 (21.6)
Foot and ankle: KNH*	2,248 (12.9)	14 (12.0)	0.6	2,262 (12.9)
Subtotal	11,661 (66.9)	64 (54.7)	0.5	11,725 (66.9)
Back, neck and spine*: KNA*	150 (100)	0	0	150 (0.9)
<i>Surgeries, n</i>				
1	15,923 (91.5)	105 (89.7)	0.66	16,028 (91.5)
≥ 2	1,486 (8.5)	12 (10.3)	0.8	1,498 (8.5)

a) Back and neck surgeries were limited as most surgeries are referred to a specialised unit outside of Odense University Hospital.

Among the 17,526 patients, 117 (0.7%) were involved in a traffic incident. The relative proportion of traffic injuries was highest among younger patients, with 2.3% of patients aged 18-24 years being involved in a traffic incident compared with 0.3% of those aged ≥ 75 years (Table 1). Likewise, males represented 55.6% of those involved in traffic incidents, whereas 0.8% of all male patients experienced a traffic incident in the follow-up period. Lower-extremity surgery accounted for 54.7% of patients involved in traffic incidents, whereas upper-extremity surgery accounted for 45.3%.

Most traffic incidents involved active modes of transportation, the majority being cyclists (44.4%), followed by motorised transport (30.8%) and active assisted modes such as E-bikes or E-scooters (22.2%) (Table 2). Most traffic incidents were solo crashes (60.7%).

TABLE 2 Characteristics of traffic injuries^a.

Traffic incidents, N	117
<i>Transportation mode, n (%)</i>	
Pedestrian	3 (2.6)
Bicycle	52 (44.4)
Active assisted: E-bikes or E-scooters or small mopeds	26 (22.2)
Motorised: cars or trucks or bus or other ^b	36 (30.8)
<i>Driver role, binary, n (%)</i>	
Non-driver ^c	12 (10.3)
Driver	104 (89.7)
<i>Crash type: solo or with a counterpart, n (%)</i>	
Crash with a counterpart	46 (39.3)
Solo crash	71 (60.7)
<i>Injury severity, n (%)</i>	
Minor	85 (72.6)
Severe	32 (27.4)
<i>Helmet/seatbelt use status, n (%)</i>	
Pedestrians	
Helmet used	0
Helmet not used	3 (100)
Unknown	0
Bicycles	
Helmet used	27 (51.9)
Helmet not used	23 (44.2)
Unknown	2 (3.8)
Active assisted: E-bikes, E-scooters or small mopeds	
Helmet used	15 (57.7)
Helmet not used	10 (38.5)
Unknown	1 (3.8)
Motorised: cars or trucks or bus or other	
Seatbelt used	32 (88.9)
Seatbelt not used	1 (2.8)
Unknown	3 (8.3)

a) Data are reported for complete cases. Missing data are not reported due to patient anonymity concerns.

b) No injuries were recorded for motorcycles or mopeds/scooters with a maximum permitted speed of 45 km/h.

c) This category included all pedestrians.

Among pedestrians and cyclists, helmets were used in approximately half of traffic incidents 27 cases (49.1%). Among users of active assisted transportation, 15 (57.7%) used a helmet and ten (38.5%) did not. Lastly, seatbelt use in motorised transportation was reported in 32 cases (88.9%), whereas one individual (2.8%) did not use a seatbelt (Table 2).

Traffic incidents were observed throughout the follow-up period without clear clustering in time overall or by mode of transportation (**Figure 1**). Only a few incidents occurred in the early six-week post-operative phase, with a gradual increase in cumulative incidents over the 12-month follow-up (**Figure 2**).

FIGURE 1 Scatterplot of time to injury and mode of transportation.

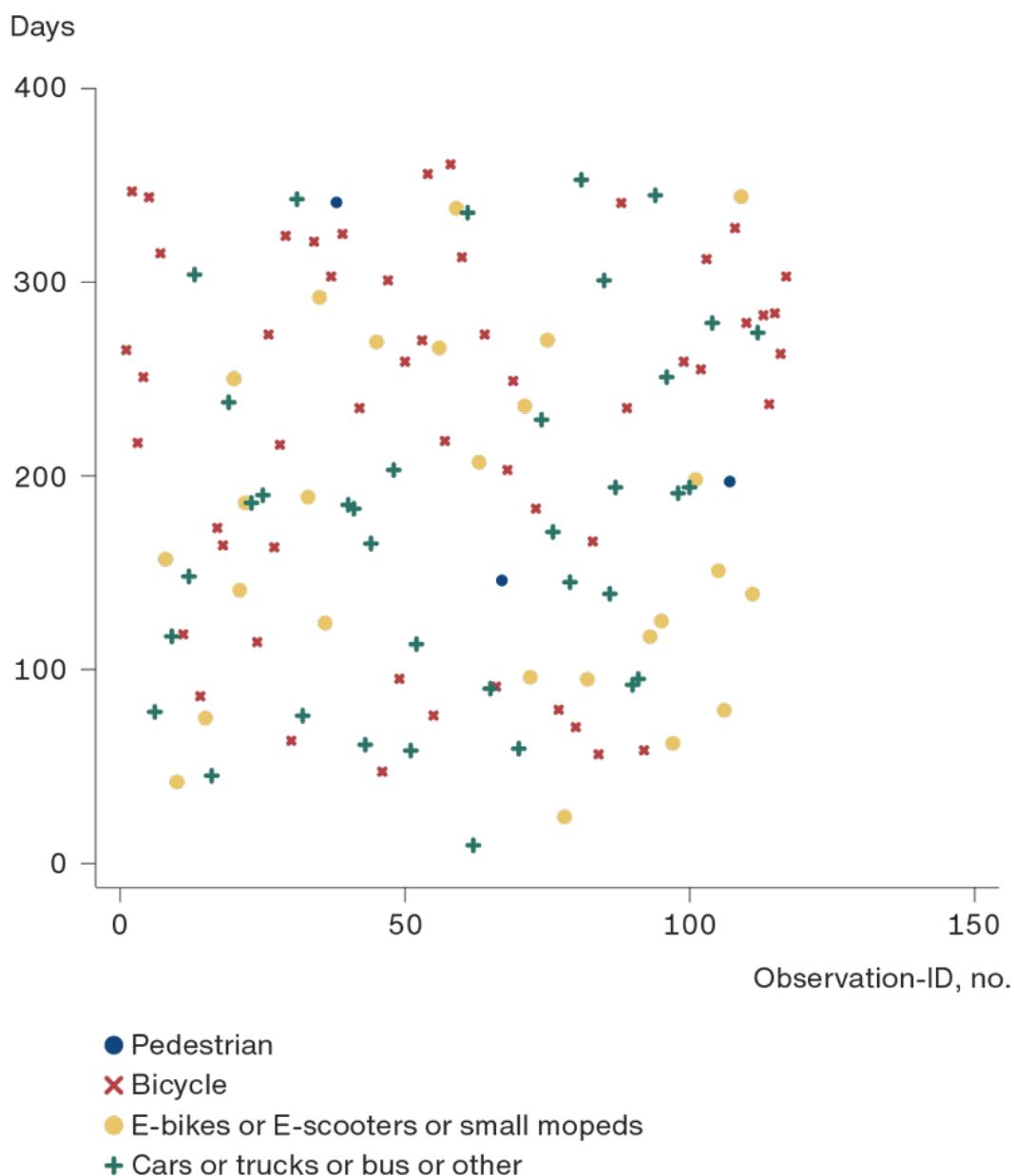
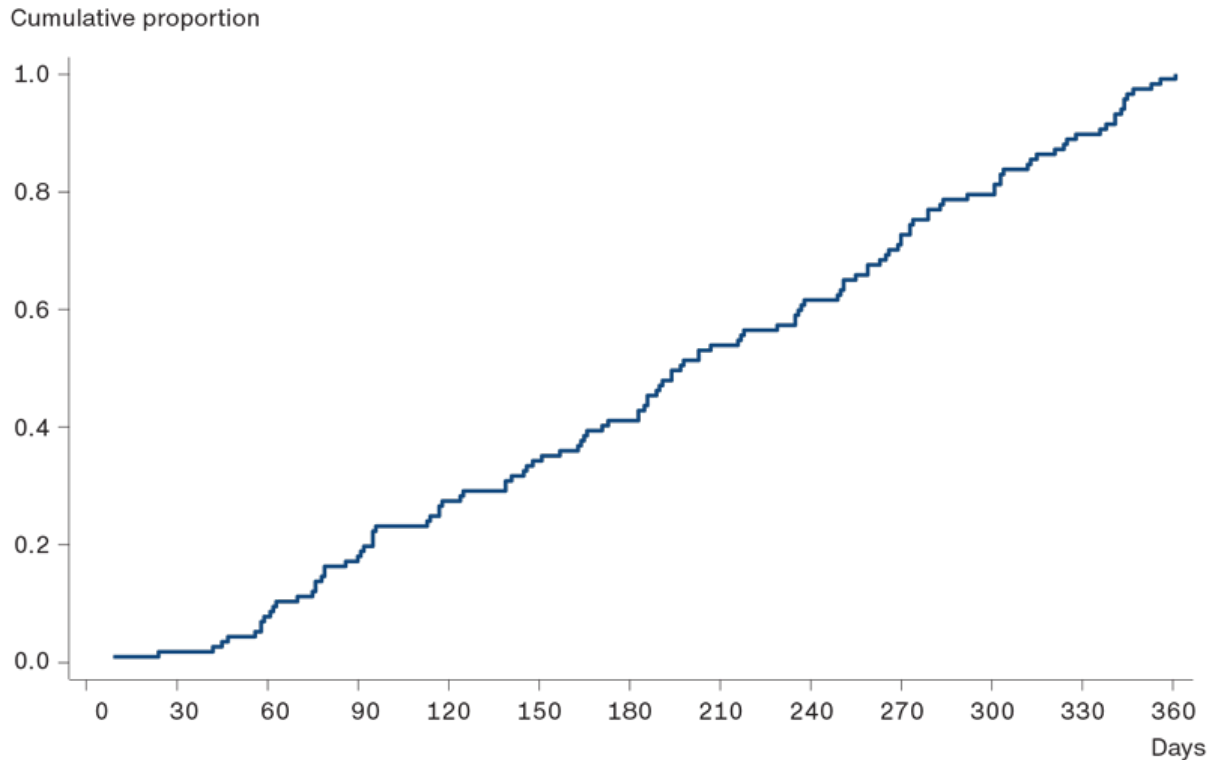


FIGURE 2 Cumulative proportion of traffic injuries over time.



Discussion

In this retrospective cohort study encompassing 17,526 orthopaedic patients, 117 (0.7%) experienced a traffic incident requiring contact to the ED within the first year after orthopaedic surgery. Among the patients involved in traffic incidents, the proportion of younger patients and of males was higher. Nearly half of all recorded traffic injuries occurred while patients were cycling (44.4%). Few incidents occurred in the early post-operative period, particularly within the first six weeks after surgery. Thereafter, incidents appeared more evenly distributed throughout the remainder of the follow-up period. This pattern may reflect reduced mobility and limited exposure to traffic during the initial recovery phase after surgery.

The proportion of patients involved in traffic incidents within 12 months after orthopaedic surgery was 0.7%. Previous studies examining traffic incident involvement in other patient populations have reported similarly low rates. A Danish nationwide study found that adults suffering from dementia had significantly lower odds of road traffic incidents than those without dementia (odds ratio = 0.43, 95% CI: 0.32-0.60), which may reflect more sedentary behaviour and self-regulation of driving activity [13]. Similarly, Gaulton et al. reported that among 70,722 drivers undergoing general surgery, only 263 (0.3%) were involved in a motor vehicle crash within 28 days post-operatively, showing no increase in short-term car crashes compared with control periods [14]. This is consistent with the findings of our study. The proportion observed in the present study appears comparable to the annual proportion of ED contacts related to road traffic incidents in Denmark, which is estimated at approximately 0.5-0.7% of the population annually. Thus, the proportion observed in this cohort was within the range of the estimated annual population rate [13, 14].

Young patients and males constituted a larger proportion of the patients involved in traffic incidents in this study than in the general population. This pattern is consistent with previous research showing that young males are generally overrepresented in traffic incidents [5, 15]. Possible explanations include greater driving exposure and a higher prevalence of risk-taking behaviors such as speeding, driving under the influence of alcohol, lower seatbelt use and men driving more kilometres [16]. Because the present study did not compare these findings with background population rates, we cannot determine whether this pattern differs from the general distribution of traffic incidents. Furthermore, lower extremity surgery accounted for 54.7% compared with 66.9% in the overall cohort; whether the distribution differs according to surgical region should ideally be explored in a national cohort.

Denmark has a strong culture of active transportation. The higher proportion of incidents involving pedestrians and cyclists in our study likely reflects these national commuting patterns.

International and national studies have shown that walking and cycling injuries are concentrated at intersections and are sensitive to infrastructure quality [17, 18].

This study has several strengths. To our knowledge, it is the first Danish study to describe traffic incident involvement among orthopaedic patients after surgery [6]. The use of hospital data ensured a more complete capture of non-fatal traffic injuries than police data, particularly for cyclists [19]. We included all orthopaedic surgery performed within the study period, which minimises the risk of potential selection bias and enhances the generalisability of our findings to the broader orthopaedic patient population.

However, the findings should be interpreted as descriptive and exploratory. Back and neck surgeries were underrepresented, as most spine procedures in the region are performed at a specialised spine unit outside the OUH, thus reducing generalisability for this subgroup. Additionally, regional differences in transportation patterns and cycling prevalence may limit generalisability. For patients undergoing multiple orthopaedic procedures, only the first surgery was used as the index procedure for follow-up. Consequently, traffic incidents occurring after subsequent procedures were attributed to the initial surgery. This may have introduced variability in the time between surgery and incident and may potentially have obscured clustering of incidents in relation to the most recent procedure. Furthermore, the study population consisted of patients undergoing a wide range of orthopaedic procedures with varying degrees of surgical intervention and recovery times. These differences may influence post-operative physical function, pain levels and mobility, which could, in turn, affect the likelihood of being involved in a traffic incident. Surgical indication, procedure extent and recovery trajectory may also have influenced the patient's functional and cognitive capacity to safely resume transportation activities. Exploring the impact of these factors was beyond the scope of this study due to the limited number of traffic incidents observed.

Because hospital data were not linked with police or insurance records, the study was limited to traffic incidents resulting in ED contact. Consequently, the study did not include minor non-fatal traffic incidents not requiring hospital care or fatal incidents not presented to the ED. Traffic incidents were identified through the Accident Analysis Group Registry, where injuries presented to the ED are systematically classified according to mechanism of injury. Although some degree of misclassification cannot be excluded, previous linkage with police data has shown high agreement at the individual level [19]. The number of incidents unrecorded by both systems remains unknown because insurance data are not available. Nonetheless, the total number of fatal traffic injuries in Denmark was only 145 in 2024 [20]. Hence, underreporting of fatal incidents in this study is likely limited.

Conclusions

In this cohort of orthopaedic patients, fewer than 1% experienced a traffic incident requiring ED contact within the first year after surgery. The observed proportion appeared comparable to the background rate of traffic-related ED contacts in Denmark. Younger patients and males constituted a greater proportion of patients involved in traffic incidents, reflecting known patterns in traffic injury epidemiology.

Correspondence Sine Savas Andersen. E-mail: sine_savas@hotmail.com

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