

Pattern and Clinical Outcomes of Road Traffic Accident-Related Orthopaedic Injuries Presenting to a District Hospital: A Prospective Observational Study

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Abstract

Background: Road traffic accidents are a significant cause of orthopaedic trauma in India, especially among young adults and two-wheeler users. This study aimed to assess the pattern, management and short-term outcomes of injuries in a district hospital.

Methods: This was a prospective observational study of 430 patients with orthopaedic injuries due to road traffic accidents. Demographic, accident-related, injury, treatment and in-hospital outcome variables were obtained. Logistic regression was used to determine factors associated with a composite adverse clinical outcome.

Results: Mean age was 38.1 ± 17.4 years; 77.9% were male and 63.0% were two-wheeler users. The most common injuries were those of the lower limbs (48.1%), while fractures or fracture-dislocations occurred in 76.3%. Of all fractures, 18.6% were open. Adverse clinical outcomes occurred in 36.0%, and in-hospital mortality was 2.6%. Increasing age (aOR 1.18 per decade; 95% CI 1.05–1.33) and open fracture (aOR 2.54; 95% CI 1.43–4.51) were independently associated with adverse outcome.

Conclusion: Open fractures and increasing age were independently associated with adverse clinical outcomes in RTA-related orthopaedic trauma.

Keywords: Road Traffic Accidents, Orthopaedic Trauma, Open Fractures, Two-Wheelers, Clinical Outcomes.

Introduction

Road traffic accidents (RTAs) are a leading cause of traumatic injury, disability and premature death globally and disproportionately affect low- and middle-income countries. Survivors frequently have fractures, dislocations, soft-tissue injuries, and complex limb trauma that demand significant emergency, orthopaedic, surgical, and rehabilitative resources. Motorcyclists and pedestrians are especially exposed due to the lack of physical protection they have in case of impact¹. India bears a substantial share of this burden—national estimates have indicated that road injuries are a major cause of death among younger adults, with males being at greater risk than females, and two-wheelers making up a significant proportion of serious injuries and deaths².

Surveillance in hospitals is essential as mortality data reflect only part of the clinical effect of road traffic trauma. Injury surveillance studies in India have shown that RTAs form a significant proportion of emergency trauma presentations and two-wheeler occupants and pedestrians are often represented³. A significant proportion of this workload is due to musculoskeletal injuries. Foote et al., in a multicentre prospective study in India, reported that road traffic crashes accounted for a significant proportion of musculoskeletal trauma, the most common injury type being fractures, and open fractures had higher early morbidity and mortality⁴. The same trend has been observed in trauma hospitals in North India, which have also reported a high burden of road traffic injuries requiring hospital care, particularly those involving motorcycles⁵.

Two-wheeler injuries are a significant concern in India due to their prevalence and preventability. Wearing helmets can help prevent injuries and reduce the severity of those that do occur, but helmet use is not always observed. Bhoi et al. found that injured two-wheeler users were mostly young adults and noted more favourable injury patterns among those using appropriate helmets⁶. However, road-user behaviour is only one of the factors that affects clinical outcome; the severity of the injury, physiological compromise, transport delay, and access to organized trauma care are also factors. Chandrasekharan et al. emphasized that prehospital delay and inadequacies in emergency transport are critical factors in the outcome of road traffic injuries in India⁷.

Open fractures and severe injuries to the lower limbs are of particular interest from an orthopaedic point of view, as they often need debridement, fixation, multiple interventions, long hospital stays, or referral to higher-level centres. Complications and the risk of limb loss may be further increased by associated vascular or soft-tissue injury. Motor vehicle crashes were the most common cause in a North Indian series of lower-limb fractures with vascular injury, while open injuries and amputations accounted for a significant proportion of severe trauma.⁸ These observations are useful for assessing fracture type, injury burden, management, complications, referral and early clinical outcomes as well as anatomical injury patterns.

While a few studies have been conducted in tertiary hospitals in India, prospective data from district hospitals are still limited. District hospitals are frequently the initial major contact point for a wide range of orthopaedic injuries related to RTAs and hence are a valuable setting in which to gain insight into the

patterns of injuries and outcomes of treatment under routine service conditions. The present prospective observational study was conducted at District Hospital, Moradabad, to describe the demographic and accident-related profile of patients with orthopaedic injuries following RTA, to describe the pattern of injuries and management, and to identify factors associated with adverse in-hospital outcome.

Methods

Study design and setting

The study was a prospective observational study carried out at District Hospital, Moradabad, Uttar Pradesh, India, from April 2024 to August 2026. A total of 430 patients with road traffic accident (RTA)-related orthopaedic injuries were included in the study.

Study participants and eligibility criteria

Patients with orthopaedic injuries who presented during the study period as a result of a road traffic accident were included. Patients who had injuries not related to road traffic accidents or who did not have orthopaedic involvement were excluded. Only the index presentation for each patient was taken into account to ensure that each patient contributed one observation.

Data collection and study variables

Demographic characteristics were age, sex, residence and occupation. Variables associated with the accidents were road-user category, collision type, high-energy mechanism, injury-to-hospital time, referral from another facility, ambulance transport, prehospital first aid, helmet or seatbelt use where applicable, and suspected alcohol use.

At the initial clinical assessment, systolic blood pressure, heart rate, respiratory rate, Glasgow Coma Scale score, shock on arrival, polytrauma and associated head, chest and abdominal injuries were assessed.

Orthopaedic injuries were classified by anatomical region, detailed injury site, injury type and number of injuries. Fractures were categorized as open or closed and open fractures were then categorized by the Gustilo classification. Where applicable, comminution, intra-articular involvement and multiple fractures were noted.

Management and hospital course

Initial treatment included immobilization, wound debridement, antibiotics, tetanus prophylaxis and blood transfusion as appropriate. Primary orthopaedic management was classified as conservative treatment, closed reduction and casting, internal fixation, external fixation, debridement with fixation, amputation or referral prior to definitive treatment.

The following data were collected: operative status, time to operation, number of procedures, admission to the intensive care unit, and hospital stay. In-hospital complications were surgical-site or wound infection, delayed wound healing, compartment syndrome, deep-vein thrombosis/pulmonary embolism, neurovascular complications, and repeat surgery.

Outcome measures

Clinical outcomes were discharge destination, referral to a higher centre, in-hospital mortality and functional status at discharge. The primary composite outcome (adverse clinical outcome) was defined as the presence of at least one of the following: any in-hospital complication, referral to a higher centre, amputation, repeat surgery, or in-hospital death.

Prolonged hospitalization was considered to be a length of stay greater than the 75th percentile of the study population.

Statistical analysis

Continuous variables were reported as mean $\pm$ standard deviation or median (interquartile range), as appropriate,

and categorical variables as n (%). The chi-square test or Fisher's exact test was used to assess associations with adverse clinical outcome, and where applicable, crude odds ratios (ORs) and 95% confidence intervals (CIs) were reported.

Multivariable binary logistic regression was used with adverse clinical outcome as the dependent variable. Clinically relevant predictors were age, sex, high-energy mechanism, shock, polytrauma, open fracture, multiple orthopaedic injuries and associated head injury. Adjusted odds ratios (aORs) with 95% CIs and p-values were presented. All tests were two-sided and $p < 0.05$ was regarded as statistically significant.

Results

Patient and accident characteristics

A total of 430 patients were included, with a mean age of 38.1 ± 17.4 years. Males accounted for 335 (77.9%), and 237 (55.1%) patients were from rural areas. Two-wheeler riders or pillion passengers constituted 271 (63.0%) of presentations. High-energy mechanisms, shock at arrival, and polytrauma were recorded in 220 (51.2%), 54 (12.6%), and 55 (12.8%) patients, respectively (Table 1).

Table 1: Demographic and accident characteristics of the study participants (N=430)

Characteristic	Category/Statistic	Value
Age, years	Mean $\pm$ SD	38.1 ± 17.4
Age group	<18	30 (7.0%)
	18-39	228 (53.0%)
	40-59	103 (24.0%)
	≥ 60	69 (16.0%)
Sex	Male	335 (77.9%)
	Female	95 (22.1%)
Residence	Rural	237 (55.1%)
	Urban	193 (44.9%)

Road-user type	Two wheeler rider	208 (48.4%)
	Two wheeler pillion	63 (14.7%)
	Pedestrian	54 (12.6%)
	Car occupant	31 (7.2%)
	Auto rickshaw occupant	29 (6.7%)
	Cyclist	20 (4.7%)
	Heavy vehicle occupant	20 (4.7%)
	Other	5 (1.2%)
Collision type	Vehicle	205 (47.7%)
	Vehicle pedestrian	55 (12.8%)
	Skidor fall	104 (24.2%)
	Vehicle fixed object	31 (7.2%)
	Rollover	12 (2.8%)
	Other	23 (5.3%)
Helmet used among applicable riders with known status	Yes	103 (39.5%)
	No	158 (60.5%)
Injury-to-hospital time, hours	Median (IQR)	2.8 (1.7–4.6)
High-energy mechanism	Yes	220 (51.2%)
Shock at arrival	Yes	54 (12.6%)
Polytrauma	Yes	55 (12.8%)
Referred from another facility	Yes	122 (28.4%)
Ambulance transport	Yes	160 (37.2%)

Pattern of Orthopaedic injuries

Lower-limb injuries were most frequent, involving 207 (48.1%) patients; the tibia was the most common detailed injury site, accounting for 68 (15.8%). Fracture or fracture-dislocation was present in 328 (76.3%) patients. Among fracture cases, 61 (18.6%) were open, while multiple Orthopaedic injuries occurred in 134 (31.2%). The complete injury distribution is shown in Table 2 and Figure 1.

Table 2: Pattern of Orthopaedic injuries

Characteristic	Category/statistic	Value
Primary anatomical site	Upper limb	95 (22.1%)
	Lower limb	207 (48.1%)
	Pelvis	39 (9.1%)
	Spine	27 (6.3%)
	Multiple regions	62 (14.4%)
Detailed primary injury site	Clavicle	18 (4.2%)
	Humerus	20 (4.7%)
	Elbow	7 (1.6%)
	Forearm	23 (5.3%)
	Wrist	17 (4.0%)
	Hand	10 (2.3%)
	Pelvis	32 (7.4%)
	Hip	26 (6.0%)
	Femur	42 (9.8%)
	Knee	23 (5.3%)
	Tibia	68 (15.8%)
	Ankle	39 (9.1%)
	Foot	16 (3.7%)
	Cervical spine	12 (2.8%)
	Thoracic spine	4 (0.9%)
	Lumbar spine	11 (2.6%)
	Other	62 (14.4%)
	Fracture	310 (72.1%)

	Fracture dislocation	18 (4.2%)
	Dislocation	31 (7.2%)
	Soft tissue injury	34 (7.9%)
	Tendon ligament injury	18 (4.2%)
	Crush injury	11 (2.6%)
	Amputation	8 (1.9%)
Fracture status	Closed	267 (81.4%)
	Open	61 (18.6%)
Gustilo grade among open fractures with known grade	I	8 (13.3%)
	II	17 (28.3%)
	IIIA	18 (30.0%)
	IIIB	15 (25.0%)
	IIIC	2 (3.3%)
Orthopaedic injury burden	Single	296 (68.8%)
	Multiple	134 (31.2%)
Associated head injury	Yes	76 (17.7%)
Associated chest injury	Yes	61 (14.2%)
Associated abdominal injury	Yes	30 (7.0%)
Multiple fractures	Yes	76 (17.7%)

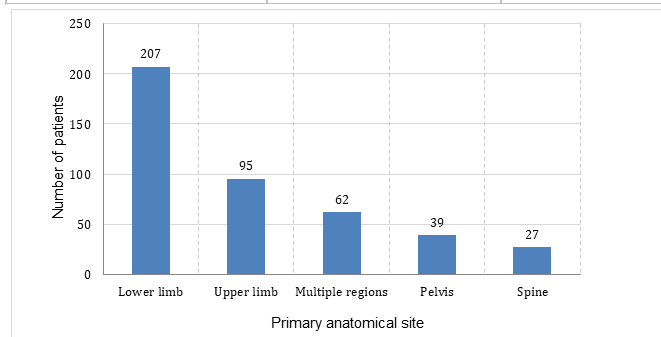


Figure 1: Distribution of road traffic accident-related Orthopaedic injuries by primary anatomical site (N=430).

Treatment characteristics

Operative management was undertaken in 178 (41.4%) patients, with internal fixation being the most frequent operative modality (120 [27.9%]). The median time to operation was 26.4 hours (IQR 16.5–38.7). ICU admission and blood transfusion were required in 39 (9.1%) and 38 (8.8%) patients, respectively (Table 3).

Table 3: Management and hospital course

Characteristic	Category/statistic	Value
Primary Orthopaedic management	Conservative	113 (26.3%)
	Closed reduction cast	96 (22.3%)
	Internal fixation	120 (27.9%)
	External fixation	16 (3.7%)
	Debridement and fixation	32 (7.4%)
	Amputation	10 (2.3%)
	Referred before definitive treatment	43 (10.0%)
Operative management	Yes	178 (41.4%)
Initial immobilization	Yes	369 (85.8%)
Wound debridement	Yes	77 (17.9%)
Antibiotics given	Yes	151 (35.1%)
Tetanus prophylaxis	Yes	183 (42.6%)
Blood transfusion	Yes	38 (8.8%)
ICU admission	Yes	39 (9.1%)
Time to	Median (IQR)	26.4 (16.5–

operation, hours		38.7)
Number of operations	Median (IQR)	1 (1–2)

Clinical outcomes

The median length of stay was 3.0 days (IQR 2.0–6.0). In-hospital complications occurred in 73 (17.0%) patients, 76 (17.7%) were referred to a higher centre, and 11 (2.6%) died during hospitalization. The composite adverse clinical outcome occurred in 155 (36.0%) patients (Table 4A).

Table 4A: Clinical outcomes

Outcome	Category/statistic	Value
Length of stay, days	Median (IQR)	3.0 (2.0–6.0)
Any in-hospital complication	Yes	73 (17.0%)
Surgical-site infection	Yes	21 (4.9%)
Wound infection	Yes	29 (6.7%)
Delayed wound healing	Yes	19 (4.4%)
Compartment syndrome	Yes	3 (0.7%)
DVT/PE	Yes	4 (0.9%)
Neurovascular complication	Yes	12 (2.8%)
Repeat surgery	Yes	20 (4.7%)
Higher-centre referral	Yes	76 (17.7%)
Amputation	Yes	14 (3.3%)
In-hospital mortality	Yes	11 (2.6%)
Adverse clinical outcome	Yes	155 (36.0%)

Prolonged hospitalization	Yes	91 (21.2%)
Discharge destination	Home	331 (77.0%)
	Higher centre referral	76 (17.7%)
	Left against medical advice	12 (2.8%)
	Death	11 (2.6%)

among those with open fractures. Grade III open fractures showed the highest adverse-outcome frequency among the Gustilo groups. High-energy mechanism showed a borderline association, whereas sex, road-user type, polytrauma, multiple orthopaedic injuries, associated head injury, and operative management were not significantly associated with the composite outcome in unadjusted analyses (Table 4B).

Factors associated with adverse outcomes

Adverse outcomes differed across age groups and were more frequent among patients presenting with shock and

Table 4B: Factors associated with adverse clinical outcome

Variable	Category	N	Adverse outcome n (%)	Crude OR	95% CI	Test statistic	p-value
Age group	<18	30	9 (30.0%)	0.97	0.42–2.22	$\chi^2=8.48$ (df=3)	0.037
	18–39	228	70 (30.7%)	Reference	—	—	—
	40–59	103	44 (42.7%)	1.68	1.04–2.72	—	—
	≥60	69	32 (46.4%)	1.95	1.13–3.39	—	—
Sex	Female	95	27 (28.4%)	Reference	—	$\chi^2=3.08$ (df=1)	0.079
	Male	335	128 (38.2%)	1.56	0.95–2.56	—	—
Road-user type	Two wheeler rider	208	73 (35.1%)	Reference	—	$\chi^2=3.60$ (df=7)	0.824
	Two wheeler pillion	63	22 (34.9%)	0.99	0.55–1.79	—	—
	Pedestrian	54	18 (33.3%)	0.92	0.49–1.74	—	—
	Car occupant	31	14 (45.2%)	1.52	0.71–3.26	—	—
	Auto rickshaw occupant	29	13 (44.8%)	1.50	0.69–3.30	—	—
	Cyclist	20	8 (40.0%)	1.23	0.48–3.15	—	—
	Heavy vehicle occupant	20	5 (25.0%)	0.62	0.22–1.76	—	—
	Other	5	2 (40.0%)	1.23	0.20–7.55	—	—
High-energy mechanism	No	210	66 (31.4%)	Reference	—	$\chi^2=3.80$ (df=1)	0.051
	Yes	220	89 (40.5%)	1.48	1.00–2.20	—	—
Shock at arrival	No	376	128 (34.0%)	Reference	—	$\chi^2=5.22$ (df=1)	0.022
	Yes	54	27 (50.0%)	1.94	1.09–3.44	—	—
Polytrauma	No	375	130 (34.7%)	Reference	—	$\chi^2=2.42$ (df=1)	0.120
	Yes	55	25 (45.5%)	1.57	0.89–2.78	—	—
Orthopaedic injury burden	Single	296	104 (35.1%)	Reference	—	$\chi^2=0.34$ (df=1)	0.559
	Multiple	134	51 (38.1%)	1.13	0.74–1.73	—	—
Associated	No	354	127 (35.9%)	Reference	—	$\chi^2=0.03$ (df=1)	0.874

head injury	Yes	76	28 (36.8%)	1.04	0.62–1.74	—	—
Operative management	No	252	86 (34.1%)	Reference	—	$\chi^2=0.97$ (df=1)	0.324
	Yes	178	69 (38.8%)	1.22	0.82–1.82	—	—
Fracture status*	Closed	267	85 (31.8%)	Reference	—	$\chi^2=13.96$ (df=1)	<0.001
	Open	61	35 (57.4%)	2.88	1.63–5.09	—	—
Gustilo grade†	I	8	4 (50.0%)	Reference	—	$\chi^2=16.66$ (df=2)	<0.001
	II	17	3 (17.6%)	0.21	0.03–1.38	—	—
	III	35	27 (77.1%)	3.38	0.68–16.63	—	—

*Restricted to patients with fracture or fracture-dislocation. †Gustilo grade analysis restricted to open fractures with known grade; grades IIIA–IIIC were grouped as grade III. OR, odds ratio; CI, confidence interval.

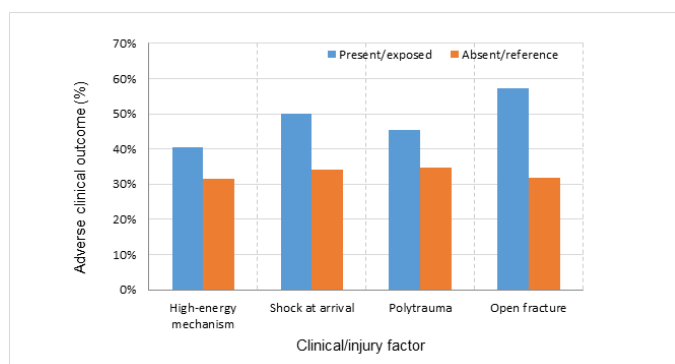


Figure 2: Proportion of patients with an adverse clinical outcome according to selected injury-severity indicators. The open-fracture comparison is restricted to fracture/fracture-dislocation cases.

Multivariable analysis

After multivariable adjustment, increasing age and open fracture remained independently associated with adverse clinical outcome. Male sex showed a borderline association, while high-energy mechanism, shock at arrival, polytrauma, multiple orthopaedic injuries, and associated head injury did not retain statistically significant independent associations (Table 5).

Table 5: Multivariable logistic regression for adverse clinical outcome

Predictor	Adjusted OR	95% CI	Wald χ^2	p-value
Age per 10 years	1.18	1.05–1.33	7.51	0.006
Male sex	1.62	0.96–2.73	3.30	0.069
High-energy mechanism	1.25	0.81–1.93	1.06	0.304
Shock at arrival	1.32	0.71–2.45	0.75	0.387
Polytrauma	1.27	0.68–2.39	0.57	0.452
Open fracture	2.54	1.43–4.51	10.05	0.002
Multiple Orthopaedic injuries	0.97	0.62–1.53	0.02	0.897
Associated head injury	0.98	0.56–1.70	0.01	0.933

Model N=430; adverse-outcome events=155; likelihood-ratio $\chi^2=29.37$ (df=8), $p<0.001$; McFadden pseudo- $R^2=0.052$. Age was modeled per 10-year increase.

Discussion

In this prospective cohort of Orthopaedic trauma patients in a district hospital setting, young and middle-aged males were the predominant group and two-wheeler users formed the largest road-user group. The most common injuries were to the lower limb, with over

three-quarters of patients having a fracture or fracture-dislocation, and almost one-fifth of fractures being open. About one-third had more than one orthopaedic injury. Thirty-six percent had adverse clinical outcomes, and 2.6% died in hospital. After multivariable adjustment, increasing age and open fracture were independently associated with adverse outcome.

The demographic pattern was similar to previous Indian hospital-based studies. Singh et al. reported that 74.4% of RTA victims were male, with the age group 20–30 years accounting for 40.6% of the victims, and extremity injuries accounting for 53.5% of the body regions involved⁹. Similarly, Mahajan et al. reported that 73.4% of patients were aged 20–49 years, with a marked male predominance and lower-limb fractures being the most common major musculoskeletal injury¹⁰. The current results thus reinforce the disproportionate burden of road trauma in economically productive age groups.

Sixty-three percent of the present cohort were two-wheeler users. A large study by Sharma et al. in Rajasthan showed that the majority of patients with road injuries were young males and that two-wheelers made up the bulk of the patients at both urban and rural facilities¹¹. The results underscore the ongoing need for two-wheeler safety interventions, especially helmet use, enforcement and road-user education.

Lower-limb injuries accounted for 48.1% of all primary injuries, with the tibia being the most common individual site, accounting for 15.8%. Fracture or fracture-dislocation was seen in 76.3% of patients. This distribution is similar to previous Indian research showing that extremity injuries are more common following road crashes^{9,10}. These injury patterns have important service implications as they create substantial

demand for radiographic evaluation, immobilization, operative fixation, wound care and rehabilitation.

Poor outcome was especially associated with open fractures. Of the fractures, 18.6% were open, and open fractures were found to have nearly three times the crude odds of adverse outcome, which persisted after adjustment (aOR 2.54, 95% CI 1.43–4.51). The adverse-outcome frequency was highest for Grade III injuries. In a prospective study of Gustilo Grade III open lower-limb fractures, Hariharan et al. found that 36.4% of patients developed clinical infection and that there was substantial morbidity even in those who were culture-negative¹⁶. The results highlight the need for prompt antibiotic treatment, debridement, stabilization, and timely referral in cases of severe open injuries.

Initial physiological compromise also influenced outcome. Unadjusted analysis showed that shock at presentation was associated with adverse outcome, but this association was attenuated after multivariable adjustment. Mitra et al. reported that outcomes were worse and injury-severity measures were higher in patients with more serious road traffic injuries, especially when protective measures and timely first aid were absent¹². The attenuation of shock in our adjusted model could be due to overlap with injury severity, high-energy mechanisms, and open fracture status.

The in-hospital mortality rate for the present cohort was 2.6%, which is substantially lower than the reported in-hospital mortality rates of major trauma registries. Roy et al. reported a 30-day in-hospital mortality rate of 21.4% among trauma patients treated at four university hospitals, with non-survivors having lower SBP and GCS scores¹³. Likewise, Bhandarkar et al. found 12.4% 30-day mortality in a multicentre trauma registry, with mortality concentrated among those with more severe

physiological derangements¹⁴. The lower mortality observed here is likely related to the overall orthopaedic case mix and the transfer of some patients with more severe injuries to higher-level centres.

Referral was an important part of outcome, with 17.7% of patients requiring transfer to a higher centre and 10.0% being referred prior to definitive orthopaedic treatment. District hospitals thus serve a dual purpose, providing definitive care for many injuries while referring patients who require advanced orthopaedic, vascular, neurosurgical or reconstructive services. In a study of fatal RTAs in rural Maharashtra, Farooqui et al. found that a substantial proportion of victims had died before reaching definitive hospital care and that head injury was a major cause of death¹⁵. While their population was different from the current cohort, their results highlight the need for effective prehospital transport and referral systems.

The odds of adverse outcome increased by 18% for each decade increase in age after adjustment for other factors. Older patients may be at greater risk for complications due to decreased physiological reserve, comorbidity, and poorer bone quality. Sex, polytrauma, multiple orthopaedic injuries, and associated head injury, on the other hand, were not independently associated with the composite endpoint. These non-significant findings must be viewed with caution because multiple overlapping clinical and referral-related factors affected the composite outcome.

The major strengths of this study are its prospective design, relatively large cohort, detailed characterization of injury patterns, open-fracture classification, and evaluation of treatment, complications, referral and hospital outcomes in a district-hospital setting. There are a number of limitations, however. The single-centre

design reduces generalizability, and the composite adverse outcome included heterogeneous events including complications, referral, amputation, repeat surgery and death. Referral may also be influenced by the availability of local resources and not just the severity of injury. Long-term outcomes such as fracture union, functional recovery, late infection and disability were not evaluated. There is also the possibility of residual confounding because standardized trauma severity scores were not available for all patients.

In general, RTA-related orthopaedic trauma in this district hospital predominantly affected young males, while two-wheeler involvement and lower-limb fractures were common. Open fracture and increasing age were the most consistent independent predictors of adverse clinical outcome. Therefore, two-wheeler injury prevention, early management of open fractures and timely referral pathways could be important priorities for district-level trauma care.

Conclusion

Road traffic accident (RTA)-related orthopaedic injuries at this district hospital predominantly affected young males and two-wheeler users, with lower-limb fractures forming a major injury burden. Open fractures and increasing age were independently associated with adverse clinical outcomes. Early recognition of high-risk injuries, timely treatment of open fractures and effective referral systems may improve district-level trauma care.

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