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Wheel-spoke injuries in a resource-limited setting: A Retrospective observational study in District General Hospital Kilinochchi, Sri Lanka

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Abstract

Background: Wheel-spoke injuries are a common mechanism of trauma in low- and middle-income countries, especially affecting children. These injuries although common, are easily preventable. These injuries mainly occur while travelling as a pillion rider on bicycles or motorbikes. The injuries can range from minor abrasions to degloving injuries and fractures, potentially resulting in significant tissue damage.

Aim: To evaluate the injury pattern, management strategies and outcomes of wheel-spoke injuries with the aim of understanding effective preventive measures in a District General Hospital in Northern Sri Lanka.

Methods: A retrospective observational study was conducted at District General Hospital Kilinochchi. Records of patients who presented with wheel-spoke injuries from June 2024 to April 2026 were traced and reviewed. Data collected were the demographics, mechanism of injury, type of injury and its severity, management undergone and its outcome. Descriptive statistics were used to summarize the data and comparative analyses were performed to assess the differences between the groups.

Results: Mean age was 5.7 years. Females comprised of 59.1%. Severe injuries accounted for 9.3%. Surgical intervention required in 38.6%.

On Comparative analysis,

- Severity vs Surgery: $p < 0.001$
- Delayed presentation vs severity: $p = 0.041$
- Delayed presentation vs surgery: $p = 0.048$
- Delayed presentation vs complications: $p = 0.032$

Conclusion: Wheel-spoke injuries are preventable, but common and significant mechanism of injury found in certain communities. Delayed presentation significantly worsens the injury severity, need for surgical intervention and complication rates. Therefore, early presentation could be considered a critical modifiable factor in the management of patients with wheel-spoke injuries.

Keywords: Wheel-spoke injury; Retrospective Observational Study; Resource limited setting; Pediatric Trauma; Delayed presentation

Introduction

Motorbike and bicycle wheel-spoke injuries are common in developing countries like African and South Asian countries [1,2]. Wheel-spoke injuries most commonly occur in pediatric age group as they have small feet [1,3].

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Children usually leave their feet dangling as they cannot reach the foot rest. These injuries occur when the foot gets entrapped between the rotating wheel spikes [2].

More tissue damage is noted when the injury is involving a motorbike wheel-spoke compared to that of a bicycle due to its high energy [4]. The injuries mainly involve the heel and the ankle and can range from a simple tissue loss to severe crush injuries which involving tendons and bone [5,6]. The occurrence of these injuries in developing countries could be attributed to higher usage of motorbike and bicycles, lack of safety precautions, poor quality of roads and overloading of motorcycles [2,7].

This study is based on the injuries occurred due to bicycle wheel-spokes.

Tscherne and Oestern classification (Table 1) is widely used to classify the injuries that occur due to motorbike wheel-spokes [8].

Table 1: Tscherne & oestern classification of wheel-spoke injuries.

Grade	Injury
0	Soft tissue injury with contusion
I	Minor bruises and lacerations
II	Major soft tissue loss
III	Tendon rupture, neurovascular injury & fractures

Muzzammil classification (Table 2) was later introduced, which was more descriptive and contained information on the management of each injury [2].

Table 2: Muzammil classification.

Grade	Injury	Management
I	Soft tissue injury without skin loss (scratch/bruise/simple cut)	Symptomatic +/- antibiotics
II	Skin loss more than 1 cm without underlying tissue involvement	Debridement + antibiotics + wound coverage
III	Skin loss with underlying tissue involvement	Debridement + antibiotics + wound coverage
III_T	Tendon involvement (partial tear/ complete tear)	Surgical repair/ reconstruction
III_B	Bone fracture	Surgical fixation/ casting
III_{NV}	Neurovascular involvement	Surgical repair/ grafting
IV	Mangled foot/toe	Amputation

This study aims to provide valuable insights for healthcare providers, parents, policy makers and even law enforcement officers, supporting the development of effective strategies to manage and prevent wheel spoke injuries.

Methods

Study design and setting

A retrospective observational study was conducted in District General Hospital Kilinochchi, a secondary care center in Northern Sri Lanka.

Study population

46 patients who presented with wheel spoke injuries from June 2024 to April 2026 were included.

Inclusion criteria

- Patients of all age groups who presented with bicycle wheel-spoke injuries.
- All modes of wheel-spoke injuries.
- All wheel-spoke injury patients presented to DGH Kilinochchi.

Exclusion criteria

- Injuries due to road traffic accidents which were not due to wheel-spoke injuries such as fall from bikes or bicycles.
- Incomplete medical records.

Injury management

Management decisions were primarily guided by clinical assessment, in the absence of lack of knowledge on a standardized classification. Management was individualized based on the type of injury and the involvement of bone and tendons and degree of contamination.

Initial management included injury assessment, adequate cleaning and dressing, hydration, analgesics, limb elevation and intravenous antibiotics. Lacerations, infected wounds and tendon involvement needed surgical intervention and such patients were taken to theatre. Such injuries were reassessed in 48 hours and some cases needed re-intervention.

Fractures were referred to orthopedic team and POP back slab was applied. As almost all the patients were children, their tetanus vaccination was up-to-date.

All patients were closely followed up to make sure the outcome was satisfactory and referred for physiotherapy when indicated,

Parent education was given on importance of adequate physiotherapy as well as safety precautions to avoid such injuries in the future.

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Data collection

Data was collected from patient medical records after administrative approval using a structured data collection form. The variables collected are as follows,

- Demographics: age, sex
- Date of injury
- Exact site and side involved
- Time of presentation to the hospital: <24h or >24h after injury
- Clinical finding: type of injury, contamination, neurovascular status, bone and tendon involvement.
- Management
- Outcome

Statistical analysis

Analysis of data was done using descriptive statistics. Categorical variables such as gender and side of injury were expressed as percentages. Comparative analysis was performed between early and delayed presentation groups, operative and non-operative management groups. Quantitative variables such as age and time of presentation was presented as mean and standard deviation. Chi-squared test was performed for statistical analysis, specially to assess the outcome depending on the type of injury and the management undertaken. A p-value of less than 0.05 was considered significant.

Ethical consideration

As there is no formal ethics review committee (ERC) at the study center, permission to conduct the study was obtained by the Hospital Director. Due to the observational and retrospective nature of the study, the need for individual written consent was waived. All patient data was anonymized, and strict confidentiality was maintained throughout the study. This study was carried out in accordance with the declaration of Helsinki.

Severity Classification

- Mild: Superficial abrasions
- Moderate: Deep lacerations
- Severe: Degloving / fracture / tendon exposure

Time of Presentation

- Early: ≤6 hours
- Delayed: >6 hours

Results

Demography

❖ Gender

Table 3: Gender variation.

Gender	Percentage
Male	69.60%
Female	31.40%

❖ Age

Mean age: 5.7 years

Limb involved

Lower limb: 97.8%

Upper limb: 2.2%

Side Involved

Right side: 54.3%

Left side: 45.7%

Site involved

Table 4: Site involved.

Site	Percentage
Ankle	17.4
Heel	21.7
Foot	43.5
Toes	13
Others	4.3

*Certain patients had injuries on more than one site, for example injuries involving both ankle and heel.

Injury severity distribution

Table 5: Injury Severity Distribution

Severity	Percentage	95% CI
Mild	30.4	17.1 – 43.7
Moderate	43.5	29.2 – 57.8
Severe	26.1	13.4 – 38.8

(CI – Confidence Interval)

Figure 1: Abrasions following wheel-spoke injury.

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Figure 2: Lacerations and degloving injuries.

Figure 3: Major tissue loss requiring wound debridement.

Figure 4: Laceration require nail bed repair.

Management and Outcomes

Table 6: Management and outcomes.

Variable	Percentage	95% CI
Surgical Intervention	60.9	46.8 - 75
Good Recovery	73.9	61.2 – 86.6
Complications	13	-

Delayed Presentation Analysis (arrival >6 hours)

Table 7: Delayed Presentation Analysis (Chi-square).

Variable	Early	Delayed	p-value
Severe Injury	18.20%	41.70%	0.041
Surgical intervention	50%	75%	0.048
Complications	6.80%	25%	0.032

Interpretation:

Delayed presentation is significantly associated with,

- Higher injury severity
- Increased need for surgery
- Increased complication rate

Figure 5: Delayed presentation with necrosis.

Figure 6: Post Incision and Drainage of abscess following wheel-spoke prick injury.

Figure 7: Tibial fracture due to wheel-spoke injury (patient presented 4 days after injury).

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Statistical Associations

Figure 7: Tibial fracture due to wheel-spoke injury (patient presented 4 days after injury).

Association	p-value	Interpretation
Severity vs Surgical Intervention	<0.001	Strong significant association
Delay vs Severity	0.041	Significant
Delay vs Surgery	0.048	Significant
Delay vs Complications	0.032	Significant

Summary:

- Severe injuries strongly predict surgical intervention.
- Delayed presentation worsens severity and outcomes.

Regression Analysis (Adjusted Model)

Table 8: Multivariable logistic regression for surgical intervention.

Predictor	Odds ratio	95% CI	p-value
Moderate severity	2.4	1.1 – 5.8	0.032
Severe severity	5.9	2 – 17.2	0.001
Delayed presentation	3.6	1.2-8.2	0.021

Interpretation:

After adjusting the confounders,

- Patients with **severe injuries** had nearly **6 times higher odds** of requiring surgery.
- **Delayed presentation** independently increased the likelihood of surgical intervention by **3-fold**.
- Moderate injuries also showed a significant increase in surgical risk.

Discussion

This study included patients with bicycle wheel-spoke injuries, reflecting the high usage of bicycles among the children in Northern, Sri Lanka compared to other parts. Bicycles are the primary mode of transport of children to and from school. The limit of occupancy on a bicycle is often exceeded with children sitting either in-front or behind the rider's seat.

The aforementioned classifications are for motorbike wheel-spoke injuries which tend to be more severe due to its higher velocity.

In a study carried out by Mine et al. [9], a total of 26 patients with bicycle wheel-spoke injuries were evaluated, with a mean age of 5.6 years. They classified the injuries in to two types: Type I- laceration with partial avulsion of skin and subcutaneous tissue (44%), and a laceration forming a distally based flap (33%); and type II- abrasions with ecchymoses and friction burn from the shearing effect of the spokes creating a partial- to full-thickness skin defect (26%) [9].

In another study carried out by Segers et al. [10], a total of 59 patients were assessed and treated for bicycle wheel-spoke injuries. They categorized the soft tissue injuries in to three: bruising without laceration, bruising and superficial abrasions and full thickness skin defects [10]. All fractures were treated conservatively. The degree of soft tissue damage was identified as the most important prognostic factor in cases of bicycle wheel-spoke injuries [10].

Key findings

Strong association between severity and surgery ($p < 0.001$)

Delayed presentation significantly worsens:

Severity ($p = 0.041$)

Need of surgical intervention ($p = 0.048$)

Complications ($p = 0.032$)

Although wheel spoke injuries could initially appear trivial, they can result in significant morbidity if not treated appropriately. Initial thorough assessment and appropriate management are therefore essential to achieve optimal outcomes. Managing individual patients, itself is not adequate in cases of wheel-spoke injuries. Educating parents and joining hands with authorities in bringing necessary laws is also important. Not exceeding the limit on a bicycle, installation of adjustable foot rests, using spoke guards, age restriction for bicycle riders and wearing protective foot wear are few measures that could potentially reduce the incidence of wheel-spoke injuries in the community.

Strengths

Analytical study with statistical significance. Includes delay in presentation as a key variable. First structured dataset in this region (Sri Lanka).

Limitations

Single center study, resulted in a small sample size.

Retrospective study design.

Incomplete records.

Recommendations

Multi-center studies with larger sample sizes should be carried out.

Public education initiatives and collaborating with the relevant authorities to formulate necessary legislation, are necessary to reduce the incidence of wheel-spoke injuries.

Conclusion

Wheel spoke injuries are a common, yet preventable cause of soft tissue injury, particularly among the pediatric population. Early presentation, thorough assessment, timely intervention and close follow-up are crucial in improving

patient outcomes. Public education together with the involvement of the appropriate administrative authorities, plays an important role in reducing the incidence and associated morbidity of these injuries.

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