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PATTERNS OF UPPER AND LOWER LIMB FRACTURES AND THE OUTCOMES AFTER MANAGEMENT AMONG THE PEDIATRIC POPULATION AT JARAMOGI OGINGA ODINGA TEACHING AND REFERRAL HOSPITAL

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ABSTRACT

Objectives: **Primary objective was to determine the pattern of upper and lower limb fractures in the pediatric group at JOOTRH orthopedic ward. Secondary objectives were to determine the prevalence, mechanism of injury and outcome after management of upper and lower limb fractures in the pediatric group.**
Design: **Cross-sectional study**
Setting: **JOOTRH surgical ward, orthopedic room**
Subjects: **Pediatric patients (age 2-17 years) presenting at JOORTH orthopedic ward with a fracture or fractures between July 2018 and September 2018. 11 participants were enrolled.**
Results: **Most fractures occurred among females (58.3%) as compared to males (41.7%), most fractures were due to RTA, mostly involving girls. Fall from height contributed to most male fractures. The majority occurred on the road, home than school. Lower limb fractures were common as compared to upper limb fractures. Femoral fractures were the commonest lower limb fractures at 91.7%. Skin traction was the primary method of managing femoral fractures; however, 63.6% of them mal united after four weeks of traction, therefore warranted IM nailing. Upper limb, tibial and fibula fractures healed with union. Female gender was most involved due to their high risk of RTA as shown by the study. RTA accounted for lower limb fractures. The difference between the fracture site and age group was also directed by the risk behaviors at different age groups, and according to sex.**

Conclusion: **There is a changing trend in fractures according to the sex, site, and mechanism of injury, and a high rate of malunion after femoral fractures have been managed by traction.**

INTRODUCTION

Background Information: A fracture is an injury to soft tissue with a discontinuity in a bone structure. Much emphasis is put on the soft tissue injury as this is what determines the treatment approach and stipulates the healing outcomes of a bone (1). Soft tissue injury is of more importance than the fracture itself. Significant soft tissue injury may result in fracture complications like delayed union, nonunion and malunion. All these factors put together determines the fracture prognosis. Therefore, a fracture with significant damage to the neuro-vasculature and soft tissue is complicated. That with no or minimal damage to blood vessels, nerves, and other surrounding tissues is uncomplicated (2).

Fracture classification varies. It can be according to the following:

The direction of a fracture line

- Linear: fracture line is parallel to the bone axis.
- Longitudinal: Fracture line runs along the length of the bone but not parallel to the bone axis.
- Transverse: Fracture line runs across to the bone axis.
- Oblique: Fracture line that slants across the bone axis.
- Spiral: Fracture line coils or run oblique along around the bone. Often caused by a twisting force.

This classification is essential in determining the outcome of fracture healing. Transverse fractures tend to be in place after reduction. Oblique and spiral fractures are likely to re-displace even after reduction (3)

Fractures can also be classified to the communication of the fracture site to the external environment. An open fracture (compound) has the fracture site communicating with the external environment. Therefore, one of the treatment protocols is to give antibiotics and anti-tetanus drugs to prevent infections. A closed fracture (simple) has no break in the skin; therefore, there is no communication of the fracture site with the external environment (3).

The condition of the bone can also be used to describe a fracture as shown by (2).

- If a bone is wholly split apart, it is a complete fracture.
- Incomplete fractures mean that the bone is partly split. In displaced fractures, the bone ends are entirely out of alignment.
- Impacted fractures are those that bone ends are jammed into each other.
- In children, the bone is relatively weak, and greenstick fractures occur. The bone is partially bent, and there is no cortical destruction.
- Comminuted fractures are those that result when bone shatters into several fragments.

The extent of the impact also classifies fractures. High energy fractures cause significant soft tissue damage. They are mainly caused by high-velocity objects and also in a motor vehicle or motorcycle accidents. Low energy fractures cause minimal to moderate soft tissue injuries.

The pediatric group has a high burden of fractures, resulting in a significant public health problem. It is estimated that boys, in their childhood life, have a 42%-64% of

developing fractures while girls are at 27%-40% (4). Factors thought to contribute to the high prevalence of fractures in children include low bone mass and bone density, low intake of calcium and other dietary factors. These fractures are also distributed across the school going age, and the activities children are involved in during this period. Some of them include being active in sports and fights, and at the same time, dietary calcium intake reduces. Other risk factors for developing fractures in this age group include sex, season, socioeconomic status, ethnicity, and Body Mass Index (BMI). Obese children are likely to develop fractures easily due to lower bone mass relative to the body size (5). It has also been suggested that children and adolescents have a low index of suspicion concerning risk assessment thus likely to get fractures (6).

Generally, studies have revealed that upper limb fractures are more common in children than the lower limb because of increased mobility of the use of an upper limb. This is more common in westernized countries. Distal radius is the most frequent site of fractures in the upper limb of children, followed by metacarpals and phalanges. Lower limb fractures in children are attributed to twisting and road traffic accidents (7). Distal metaphysis of the tibia is the commonly fractured site (8), followed by ankle fracture. Lower limb fractures carry a high number of morbidities and time off for parents (9).

Management of fractures in children takes a particular course as compared to that in adults. Bones heal rapidly in children than in adults. It depends on the type of fracture. The likelihood of fracture complications depends on the greater remodeling potential and callus formation in bones. Because of this, conservative management is common and include pain relief, immobilization in a splint or cast and gradual return to activity in according to patient symptoms. In upper limb fractures management, non-circumferential splints are preferred. An angulation deformity is acceptable, and this usually depends on the patient's age. About 15 to 20 degrees of volar or dorsal angulation in the sagittal plane is acceptable. Closed reduction and immobilization are used for displaced fractures. Open fractures warrant use of broad-spectrum antibiotics and tetanus vaccination (6).

Population-based studies from Finland has shown that surgical management for upper and lower extremities fractures in children has been increasing. This is also true for fractures that warrant hospitalization (10). Evidence-based data on this management approach is scares. However, surgical options available include external fixation, internal fixation and other surgical methods depending on the fracture type.

Study Justification: Developing countries have limited scientific data on fractures among the pediatric group. Availability of a database for this ensures policy development for managing fracture in this unique age group. This study aims at determining the pattern of upper and lower limb fractures and the outcome after management in the pediatric group at JOOTRH orthopedic ward. It will form the hospital's database for sound decision making in managing the fractures.

Objectives

Primary objective: To determine the pattern of upper and lower limb fractures in the pediatric group at JOOTRH orthopedic ward.

Secondary objectives: To find out the prevalence of upper and lower limb fractures in the pediatric group

- To determine the outcomes after fracture management
- To look into the mechanisms of injuries for the upper and lower limb fractures in the pediatric age group
- To identify the types of fractures sustained while looking into the available management plan

Hypothesis: Upper and lower limb fractures take different patterns, and the prevalence is different in the male and female pediatric group. Mechanisms of injuries also differ across individuals.

MATERIALS AND METHOD

Study Design: Cross-sectional study

Study Site: Pediatric orthopedic ward at JOOTRH

Study Population: All children and adolescents older than two years of age and less than 16 years presenting at JOORTH orthopedic ward with a fracture or fractures between July 2018 and September 2018.

Exclusion criteria:

- Children older than 16 years
- Pathological fractures
- Healed fractures
- Parents/guardians who failed to give consent for the study

Sample Size:

The study utilized Fischer formula to calculate the total sample size as shown:

$$n = \frac{N}{1 + N(x^2)}$$

Where **n =** Sample size, **N=** Target Population, **x** = Margin of error (5% or 0.05)

From JOOTRH registry, ten pediatric patients **(N)** with upper and lower limb fractures were admitted between June and March 2018, then our sample size is calculated as:

$$n = \frac{10}{1 + 10(0.05^2)}$$

n = 9.7561 rounding off to 10

Adding 10% for non-responsive participants gives **11 participants.**

Sampling Technique: Purposive sampling was used for all children above two years of age and below 16 years who presented at JOOTRH pediatric orthopedic ward with fracture(s) of the upper and lower limb.

Participant Enrolment: The principal investigator or one of the research assistants enrolled the participants using purposive sampling method. Recruitment was done at the JOOTRH orthopedic ward between 8 AM to 5 PM and those not captured during this time were enrolled within 48 hours of the next study time in case of admission.

Consent: For participants below ten years of age, consent was obtained from the parent or guardian. Assent was obtained from the children above ten years of age. Once the consent and assent were collected, participants recruited into the study. A study number was assigned to the participants, and this was used in filling the questionnaires.

Data Collection: Data was collected using questionnaires by the principal investigator and the research assistants. Data captured in the survey include the age, gender, extremity involved (upper or lower limb), type of fracture (whether open or closed, displacement pattern and fracture pattern), mechanism of injury (cause and whether it is high or low energy) and the management principle for the fracture.

Data Management and Analysis: Collected data were analyzed using Microsoft Excel and summarized regarding mean, median and modes. Data presented in the form of tables and charts.

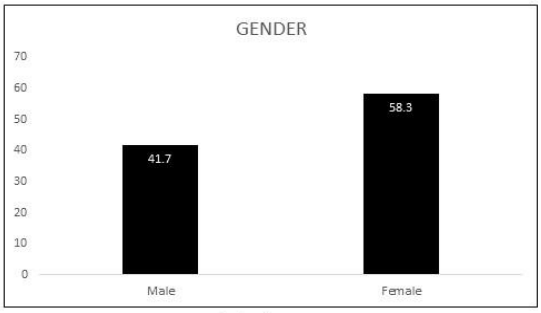
Ethical Considerations: Approval for the study was sought from the JOOTRH ethical and research committee. All guardians and parents were required to give consent on behalf of the participants before the start of the study. For participants above ten years of age, permission obtained after explaining the details of the study to them. Participants were not identified by names but by codes to ensure confidentiality.

Study Limitations: The following study limitations were identified, and mitigation measures put into place:

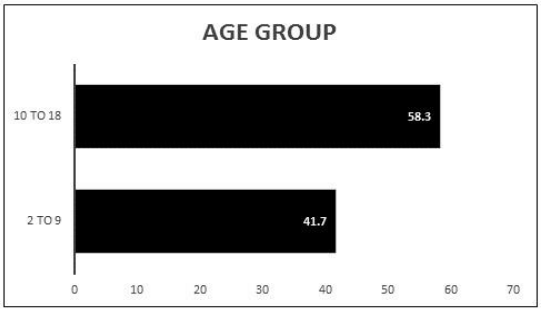
- Inter-observer variability in determining the types of fractures based on displacement, site, and pattern. We consulted the orthopedics consultants for accurate interpretation.
- Poor quality radiographs. This prompted us to seek an opinion from the consultants and radiographers.

RESULTS

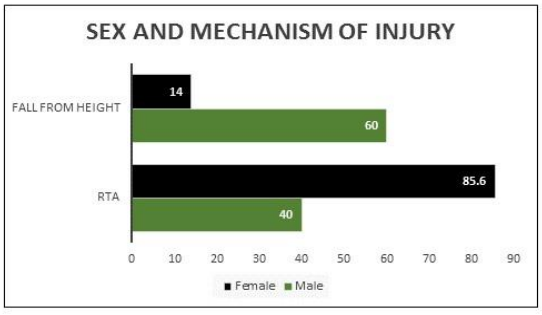
Demographics: Figure 4. 1 (A) shows the gender of the participants. 58. 3 % (n=7) were female while 41.7% (n=4) were of the male gender. Figure 4.1 (B) shows the age group of participants who sustained fractures. Most of them, 58.3% (n=7) aged between 10- 18 years. 41.7 % (n=4) were in the age bracket of 2-10 years. Figure 4.1 (C) shows the relationship between sex and mechanism of injuries. Most injuries caused by fall from heights in males (60%) and only 40 % of males were involved in RTA. On the contrary, injuries resulted from RTAs in females (85.6%). Only 14.4% of them sustained fractures after falling from height.



4.1 A



4.1 B

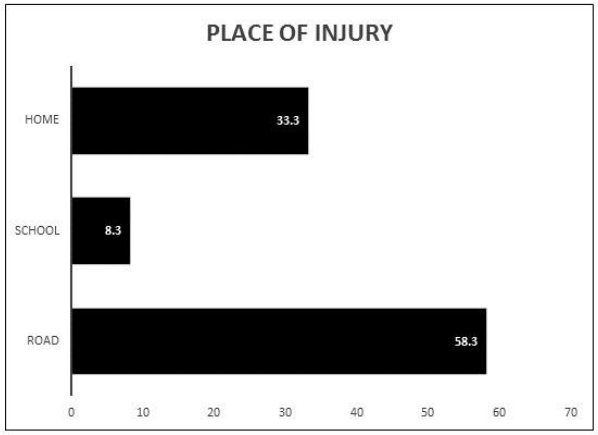


4.1 C

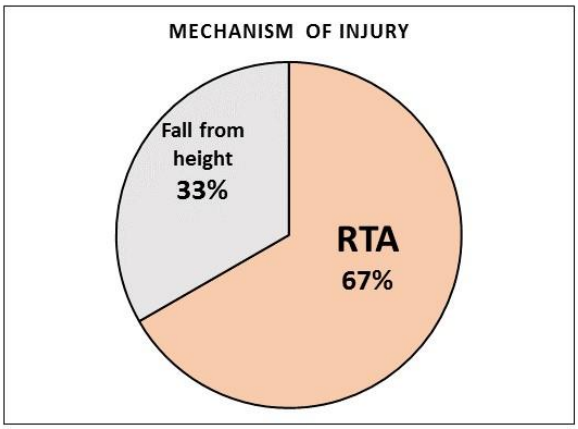
Figure 4.1: Demographics

Place and mechanism of injury: Figure 4.2 A states the place where participants got injuries from. Most of them sustained fractures from the road, representing 58.3 % (N=7). This is followed by 33.3% (N=3) injuries which occurred at home and 8.3% (N=1) that happened at school.

Figure 4.2 B shows the mechanism of injury. All of them were high energy injuries sustained after an RTA, 67% and after fall from height (33%). Most RTAs resulted from motorbike accidents.



4.2 A



4.2 B

Figure 4.2: Place and Mechanism of injury

Fracture types and management: Table 4.1 shows the femoral fracture, types, management, and outcome. Femoral fractures accounted for a majority of the fracture site, 91.7 % (N=11) among the participants. Midshaft femoral fractures were 45.5% and associated with the highest rate of malunion after traction. Most of the femoral fractures were displaced, 90.1% and all of them were closed. All femoral fractures were managed by about 4 weeks of skin traction, and 63.6 % (N=7) of them healed with malunion, warranting insertion of Intramedullary (IM) nail. Of the 63.6% of mal-united fractures, 71.4% of them repaired by inserting IM nail. 2 participants declined IM nailing, one of them citing a misconception regarding the nail and the other one financially constrained.

Table 4.1

Femoral fracture, management and outcome

Part (%)			**Type of Fracture (%)**				**Management (%)**		**Outcome (%)**	
Upper 1/3	*Mid-shaft*	*Lower 1/3*	*Closed*	*Displaced*	*Transverse*	*Oblique*	*Traction*	*IM nailing for mal-union*	*Mal-union*	*Union*
18.2	45.5	36.4	100	90.1	72.7	27.3	100	71.4	63.6	36.4

Outcomes of mid-shaft fractures and management: Table 4.2 shows that two tibial fractures were recorded among the participants and that one of them was a mid-shaft and the other distal 1/3 fracture. None of them was displaced. One was a closed fracture and the other one open fracture. Both fractures were managed by application of Plaster of Paris (POP), and both healed with union.

Table 4.2

Tibial fracture, types and outcome after management

Part (Number)		**Type of Fracture (Number)**			**Management (Number)**	**Outcome**
Mid-shaft	*Lower 1/3*	*Closed*	*Open*	*Transverse*	*PoP application*	*Union*
1	1	1	1	2	2	2

Table 4.3 shows that only one fibula fracture was recorded. It involved distal 1/3 of it, closed, un-displaced, managed by POP and healed with union.

Table 4.3

Fibula fracture, type, management and outcome

Part (Number)	**Type of Fracture (Number)**		**Management (Number)**	**Outcome**
Distal 1/3	*Closed*	*Non-displaced*	*PoP application*	*Union*
1	1	1	1	1

Table 4.4

Fractures of humerus, radius and ulna, their types, management and outcome

Upper Limb	**Part (Number)**	**Type of Fracture (Number)**		**Management (Number)**	**Outcome**
Humerus	*Distal 1/3*	*Closed, Transverse*	*Non-displaced*	*Back slab*	*Union*
	1	1	1	1	1
Radius	*Distal 1/3*	*Closed, Oblique*	*Non-displaced*	*Back slab*	*Union*
	1	1	1	1	1
Ulna	*Distal*	*Closed, Oblique*	*Non-displaced*	*Back slab*	*Union*
	1	1	1	1	1

DISCUSSION

Demographics, Place, and Mechanism of injury: From the results, most fractures occurred in the female population (58.3%) and 41.7 % occurred among males. This is not in line with the results of studies conducted by (11). 85% of female fractures resulted from RTAs while only 14.4% were due to fall from heights. Among the male gender, 60% of their fractures were as a result of fall from height as compared to 40% who were involved in RTA. This variation can be attributed to high risk playing by the boys and running of errands by the female gender since most RTAs occurred along the road and involved being knocked down by motorbike.

The 10-18 years age bracket bore the most fracture burden at 58.3% while participants between 2-10 years made 41.7% of the fracture burden. Female gender formed a majority of those in the 10-18-year age group at 54.5 %. This again translated to high fracture burden among the female population because of the assumption of running errands in this age bracket. Males formed only formed 25% of the age group between 2- 9 years. The higher age group of 10-18 years were the most involved. This is because they are very active and playful, therefore increasing their risk of getting fractures. This is also in line with literature from (4). The study conducted by (11) also showed that fractures became more as the age group increased in the pediatric population. The literature review by (6) also suggests that fractures are more common among children and adolescents because of their low level of risk assessment and low index of suspicion when it comes to fractures. Meta-analyses by (12) also showed that school going children have high fiber intake and low calcium intake from milk. Although this factor was not looked into, it may be a possible reason for fractures in that age group.

It was observed that most injuries (58.3%) occurred by the roadside and all of them involved motorbike accidents. Increased use of motorbike when going to school may also be a contributing factor for increased incidence of fractures in the school going age. Untrained motorcyclists also pose a significant risk for RTA. Another factor is that school going children may also be ignorant about road safety. 33.3% of fractures occurred at home and involved fall from heights.

Fracture types and Management: It was interesting to note that most fractures among the pediatric age group were lower limb fractures as compared to upper limb fracture. This is contrary to worldwide and local results conducted by (4) and (11) respectively. In the study, femoral fractures were the most common type of fracture (91.7%) in the body and the lower limb. This may be attributed to the risk of RTA as shown by (7) that lower limb fractures result from RTA. Of note is that RTA was the most frequent contributor to fractures in this study. Fall from heights are attributed to lower limb fractures (13) and that most of these are femoral fractures. It is also in line with this study that most fractures that resulted from fall from height were femoral fractures.

Since femoral fractures were the most, it is essential to look at the management protocol for them at JOOTRH. Of note was that all the femoral fractures were first managed by skin traction for an average of 4 weeks in the ward. After that, check X-rays and clinical assessment revealed mal-union in 63.6% of the femoral fractures that were on skin traction. After that, the orthopedic team resolved for an IM nail for all of them. Only 71.4% were managed by IM nail since the other patients declined an IM nail due to

financial constraint and myth about the nail. The concerns have been highlighted in the conclusion and recommendation part. Tibial and fibula fractures healed with union and their methods of management were POP cast application, which is the recommended way.

CONCLUSION

This study was a success in determining the incidence of upper and lower limb fractures among the pediatric group at JOOTRH and assessing management and outcomes of the fractures. From this study, we found out that:

- There was a changing pattern in fracture type according to sex that most females were involved as compared to male participants. This is the opposite of what many studies have shown, both globally and locally.
- There was also an interesting observation that the female gender sustained fractures after being involved in RTAs more than their male counterparts, while the male participants sustained fractures after falling from a height more than the females. This is with the pediatric age group.
- Lower limb fractures were more common than lower limb fractures in inpatient pediatric age group as compared to global and local results which state that upper limb fractures are common than lower limb ones.
- Both fall from a height and RTA were mostly associated with lower limb fractures.
- All femoral fractures were managed by skin traction, but majority healed with mal-union that warranted surgery with IM nail insertion. Within three months, there were only 11 pediatric patients who had been admitted and managed for fractures.

RECOMMENDATIONS

After completing the study, we saw a difference between literature and the results at JOOTRH. Therefore, we recommend that:

- More studies should be conducted to find out why there is a changing pattern in sex and fracture incidence, why there are many lower limb fractures as compared to lower limb fractures at JOOTRH, and whether this is the case in this region.
- More research should also be conducted to find out why RTA is the common cause of fracture among girls in the school going age and why to fall from heights contribute to most fractures in boys of the same age group.
- Data from the outpatient clinic be analyzed and compared with the inpatient data to find out whether most inpatient cases concerning are managed in the outpatient clinic.
- Method of managing femoral fractures be reviewed from skin traction as the primary management to surgical option. This is because of the poor outcome of limb length discrepancy and malunion that were observed in 63.6% of the 100% of femoral fractures managed by skin traction as the primary method. This is of concern because school going children lose a lot of class time when they sit in the wards for four weeks. Apart from that, despite sitting in the ward for that long, they still have to undergo surgery due to malunion. This, in turn, translates to a loss of valuable time and money, increased risk of complications arising from immobilization like Deep Venous

Thrombosis (DVT) and nosocomial infections.

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