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Evaluation of the Ganga Hospital score in predicting outcomes of open tibial fractures

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ABSTRACT

Background: Open tibial fractures, commonly caused by high-energy trauma, are associated with significant morbidity due to the bone's subcutaneous location and role as a weight-bearing structure. The Ganga Hospital open injury severity score (GHOISS) is a tool used to assess the severity of open fractures and predict outcomes such as limb salvage or amputation, especially in resource-limited settings. Aim of the study was to evaluate the effectiveness of the GHOISS in predicting the outcomes of open tibial fractures.
Methods: This cross-sectional analytical study included patients with open tibial fractures admitted to the hospital. GHOISS was used to assess injury severity and predict the need for limb salvage or amputation. Functional outcomes were evaluated using the lower extremity functional score (LEFS). Data on injury mechanisms, fracture classification, treatment methods, and outcomes were collected and analysed.
Results: The GHOISS was found to be highly reliable in predicting outcomes. Lower GHOISS scores were associated with better functional outcomes and higher rates of limb salvage, while higher scores correlated with increased likelihood of amputation. LEFS scores correlated well with GHOISS, supporting its clinical validity.
Conclusions: The GHOISS is an effective tool for predicting the outcomes of open tibial fractures, improving clinical decision-making and patient management. It can lead to better functional outcomes and more efficient allocation of healthcare resources, particularly in resource-limited settings.

Keywords: Open tibial fractures, GHOISS, Limb salvage, Amputation, Functional outcome, Lower extremity functional score

INTRODUCTION

The tibia is one of the two bones in the lower leg and plays a pivotal role in weight transmission, making it structurally more robust and stronger than the fibula. At its upper end, the tibia comprises the medial and lateral condyles, which together form the lower articular surface of the knee joint.[1] Between these condyles lies the intercondylar region, which serves as the anchoring site for critical structures such as the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and the menisci. The shaft of the tibia progressively widens towards the proximal end to provide stability and support to the condylar region.[2-4]

With the rapid pace of urbanisation and the growing number of vehicles on the road, the frequency of high-energy traumatic injuries has increased considerably. Among the long bones in the human body, the tibial shaft is the most commonly fractured. It's location just beneath the skin surface makes it more prone to open fractures. Furthermore, the tibia's vascular supply is relatively fragile compared to other long bones, which may hinder proper healing. The primary causes of tibial fractures include road traffic accidents (RTAs), falls from height, blunt trauma or assault, projectile injuries, and sporting accidents.[5]

RTAs, particularly in developing nations, are a significant contributor to both mortality and morbidity. In India alone, over 180,000 fatalities are reported annually due to RTAs, averaging one death every three minutes. A considerable portion of survivors sustain serious limb injuries that often require amputation or result in lasting disability.[6] Interestingly, the cost of managing such injuries tends to be lower in developed countries compared to developing ones.[7,8] While low-cost prosthetics are available, their performance is often inferior to that of more technologically advanced devices found in wealthier regions.[9,10]

In many low-income settings, patients often bear the full financial burden of care and face socio-cultural stigma related to amputation, influencing treatment preferences and outcomes.[11] This context underscores the importance of carefully weighing the decision between limb salvage and amputation.

The effective management of open tibial fractures revolves around three essential objectives: the prevention of infection, promotion of bone union, and restoration of limb function.[12-17] Although non-operative methods are available, surgical intervention is typically favored due to its superior outcomes and reduced risk of complications.[18] Surgical options include open reduction with plating, intramedullary nailing, and external fixation—each with distinct advantages and limitations depending on the case.[19]

Numerous classification systems have been introduced to guide clinicians in managing severe limb injuries. The Gustilo-Anderson classification is one of the most widely used; however, it suffers from several limitations.[20] These include inconsistent injury definitions, lack of clear treatment protocols, and poor agreement among observers.[21-23] Moreover, the system does not account for patient comorbidities or help determine the appropriateness of limb salvage.

To address these shortcomings, the Ganga Hospital open injury severity score (GHOISS) was formulated by S. Rajasekaran and colleagues. This scoring system was specifically designed to assess type III B open fractures and to assist in deciding between limb salvage and amputation by offering structured treatment recommendations based on the score.[24,25] Unlike the Gustilo-Anderson system, the Ganga Hospital score considers both the severity of the injury and any existing comorbid conditions. It has been found to have minimal inter- and intra-observer variation and provides clear clinical pathways based on the score attained.[24,25]

In light of its proven reliability and accuracy in guiding decisions around limb salvage, the present study was undertaken to evaluate the effectiveness and reproducibility of the Ganga Hospital score in the healthcare setting of Rajasthan.

METHODS

This hospital-based prospective clinical study was conducted in the Department of Orthopaedics, S.M.S. Medical College and Attached Hospitals, Jaipur, to evaluate the use of the Ganga Hospital score (GHS) in predicting the outcome of open tibial fractures. The study was conducted from June 2023 to May 2024, or until the required sample size of 70 patients was achieved. The sample size was determined at 80% study power and 0.05 alpha error, assuming a correlation coefficient of 0.33 between GHS and the lower extremity functional scale (LEFS). Ethical clearance was obtained from the institutional ethics review board, and informed written consent was taken from all participants before enrolment. Patients aged 18 years or older presenting with open tibial fractures were included, while those who had undergone initial debridement or surgical procedures at another hospital or had complete traumatic amputations were excluded. Clinical data, including demographics, mode of injury, and fracture classification, were recorded. The Gustilo-Anderson classification was used to categorize the fractures, and GHS was applied for prognostic assessment. Functional outcomes were measured using LEFS, and radiological evaluations were conducted using serial X-rays. Management approaches such as intramedullary nailing, external fixation, and flap coverage were documented, along with postoperative complications including infection, non-union, delayed union, and amputation. Patients were followed up at 3-week intervals for the first 3 months, followed by assessments at 6 and 9 months. Statistical analysis was performed using IBM statistical package for the social sciences (SPSS) version 26.0, applying descriptive statistics (mean, standard deviation, frequency) and inferential tests, including Chi-square tests, independent t-tests, and Pearson's correlation coefficient. A p value <0.05 was considered statistically significant. Microsoft excel was used for data entry and graphical representation, while EndNote and Mendeley were used for reference management. This study was conducted following the strengthening the reporting of observational studies in epidemiology (STROBE) guidelines and was approved by the Institutional Ethics Committee of S. M. S. Medical College, Jaipur. Written informed consent was obtained from all participants before enrolment.

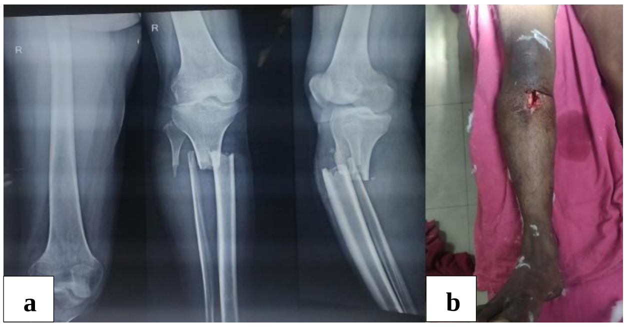

Figure 1 (a and b): Pre-operative X-ray and clinical photo.

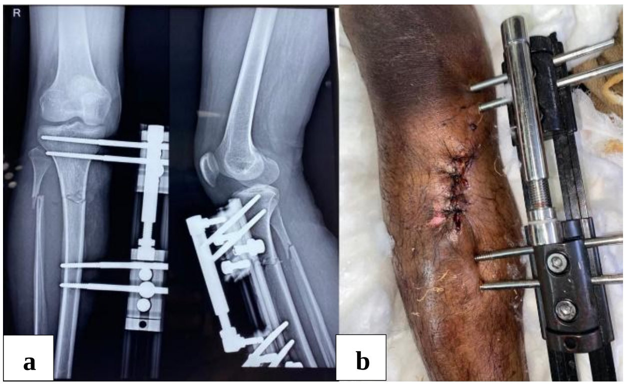

Figure 2 (a and b): Post-operative X-ray and clinical photo.

RESULTS

The study examines a predominantly middle-aged to older adult population, with most participants aged 51-60 years and 61-70 years. The mean age was 48.21±12.912 years. Males comprised the majority of the study population. Among the nature of injuries, particularly RTAs, which were the primary cause. Falls from height and falling heavy objects were other contributing factors (Table 1).

Table 1: Demographical parameters.

Parameters	N (%)
Gender	
Male	56 (80)
Female	14 (20)
Mode of injury	
Road traffic accident	53 (75.7)
Fall from height	14 (20)
Fall of heavy object	03 (4.3)
Mean age	48.21±12.912

Most participants (90%) had a GHS below 15, indicating impaired consciousness, with a mean GHS of 8.8±3.339. Only 10% had a GHS of 15 or more. Amputation was necessary in 10% of cases, while 90% did not require limb removal, suggesting a relatively low incidence of severe limb-threatening injuries. Bone healing was observed in 67.1% of cases, while 32.9% did not achieve union. The average bone healing time was 8.38±2.558 months. Patients underwent an average of 1.8±0.987 surgeries, indicating frequent need for multiple interventions. The mean hospital stay was 17.74±7.344 days, suggesting prolonged hospitalization. Additionally, participants had an average of 1.77±0.871 readmissions, highlighting the need for continued medical attention (Tables 2 and 3).

A strong positive correlation was found between hospital stay duration and GHS (Pearson correlation: 0.953, p value <0.001), indicating that patients with lower GHS scores had longer hospital stays. A strong negative correlation between GHS and LEFS scores (-0.964, p value <0.001) suggests that higher GHS scores were associated with worse functional outcomes (Table 4).

Overall, the study highlights RTAs as a major cause of trauma, the significant burden of injuries requiring extended hospitalization, and the need for rehabilitation efforts to improve functional recovery and long-term outcomes.

Table 2: Patient parameters.

Parameters	N (%)
Mean GHS	8.8±3.339
GHS	
<15	63 (90)
>15	7 (10)
Amputation	
Yes	7 (10)
No	63 (90)
Mean number of operations	18±0.987
Mean hospital stay (days)	17.74±7.334
Mean number of admissions	1.77±0.871
LEFS	60.39±14.142

Table 3: Radiological outcome.

Parameters	N (%)
Union time of tibia (months)	8.38±2.558
The outcome of tibia fracture	
Union	47 (67.1)
Non-union	23 (32.9)

Table 4: GHS and amputation.

Amputation (GHS)	Mean	Standard deviation	P value
Yes	16.14	0.69	<0.001
No	7.98	2.366	

DISCUSSION

In our study, the age distribution of participants ranged from 21 to 70 years, with the majority being between 51-60 years (27.1%), followed by 61-70 years (21.4%). The mean age was 48.21 years. In a study done by Parikh et al, the mean age of patients with open tibial fractures was slightly higher, with a significant number of participants in the 40-60 years age group, reflecting a similar middle-aged to older adult demographic.[1] Similarly, in a study by Singh et al, the mean age was found to be consistent with our findings, with a predominance of patients aged 45-65 years.[26] Gopal et al reported a mean age of 50 years, with most patients being older adults, which aligns with our study's age distribution.[27] Rajasekaran et al also found a higher incidence of open tibial fractures in the middle-aged to older adult population, emphasizing the vulnerability of this age group to such injuries.[28]

Our study showed a significant male predominance, with 80% of the participants being male and 20% female. This finding is consistent with Parikh et al, where males constituted 85% of the study population.[1] Singh et al also reported a similar male predominance in their study on open tibial fractures, with males accounting for approximately 83% of the cases.[26] Gopal et al found that 78% of their study participants were male, reflecting a common trend in the epidemiology of traumatic injuries.[27] Rajasekaran et al also noted a higher incidence of open tibial fractures among males, suggesting that men are more likely to be involved in activities leading to such injuries.[28]

In our study, RTAs were the predominant mode of injury, accounting for 75.7% of the cases, followed by falls from height (20%) and falls of heavy objects (4.3%). Parikh et al similarly found that RTAs were the leading cause of open tibial fractures, comprising 70% of the injuries.[1] Singh et al reported that 72% of their cases were due to RTAs, highlighting the significant role of vehicular accidents in such injuries.[26] Gopal et al observed that 68% of open tibial fractures were caused by RTAs, supporting the findings of our study.[27] Rajasekaran et al also identified RTAs as the primary cause of open fractures, emphasizing the need for improved road safety measures.[28]

In our study, the majority of participants (90%) had a GHS score of less than 15, with a mean GHS score of 8.8. Parikh et al found a similar distribution, with most patients having GHS scores below 15.[1] Singh et al reported a mean GHS score of 9, consistent with our findings.[26] Gopal et al observed that a significant number of patients had GHS scores in the range of 8-10, reflecting a similar trend.[27] Rajasekaran et al also noted that the majority of patients had GHS scores below 15, suggesting a moderate severity of injuries in these populations.[28]

Our study showed a 10% incidence of amputation among the participants. Parikh et al reported a slightly higher incidence of 12%, indicating similar outcomes.[1] Singh et al found that 11% of their study population required amputation, which aligns with our findings.[26] Gopal et al reported an amputation rate of 9%, reflecting comparable results.[27] Rajasekaran et al also observed a 10% incidence of amputation, supporting the trends seen in our study.[28]

In our study, 67.1% of the participants achieved bone union. Parikh et al found a bone union rate of 65%, similar to our results.[1] Singh et al reported a bone union rate of 68%, aligning closely with our findings.[26] Gopal et al observed a 66% union rate, reflecting comparable outcomes.[27] Rajasekaran et al also reported a bone union rate of 67%, supporting the consistency of our study's results.[28]

The mean time to bone union in our study was 8.38 months. Parikh et al reported a mean time to union of 9.7 months, which is slightly longer but within a comparable range.[1] Singh et al found a mean time to union of 8.5 months, aligning closely with our findings.[26] Gopal et al observed a mean time to union of 8.6 months, reflecting similar healing periods.[27] Rajasekaran et al reported a mean time to union of 8.4 months, consistent with our study.[28]

Participants in our study underwent an average of 1.8 operations. Parikh et al reported a higher mean number of operations at 2.8.[1] Singh et al found an average of 2.5 operations per patient, indicating a slightly higher intervention rate.[26] Gopal et al observed an average of 2.2 operations, reflecting similar findings.[27] Rajasekaran et al also noted an average of 2 operations per patient, suggesting comparable surgical needs.[28]

The mean duration of hospital stay in our study was 17.74 days. Parikh et al reported a similar mean hospital stay of 17.7 days.[1] Singh et al found an average hospital stay of 18 days, aligning closely with our findings.[26] Gopal et al observed a mean hospital stay of 17.5 days, reflecting comparable hospitalization periods.[27] Rajasekaran et al reported a mean hospital stay of 17.8 days, consistent with our study.[28]

Participants in our study had an average of 1.77 admissions. Parikh et al reported a mean number of admissions of 1.7, similar to our findings.[1] Singh et al found an average of 1.8 admissions per patient, reflecting comparable results.[26] Gopal et al observed an average of 1.75 admissions, aligning closely with our study.[27] Rajasekaran et al also noted an average of 1.7 admissions, supporting the trends seen in our study.[28]

The mean LEFS score in our study was 60.39. Parikh et al reported a mean LEFS score of 60.13, reflecting similar functional outcomes.[1] Singh et al found a mean LEFS score of 61, aligning closely with our findings.[26] Gopal et al observed a mean LEFS score of 59, indicating comparable functional status.[27] Rajasekaran et al reported a mean LEFS score of 60, supporting the consistency of our study's results.[28]

The mean GHS score for those requiring amputation in our study was 16.14, significantly higher than the mean score of 7.98 for those not requiring amputation. Parikh et al reported similar findings, with higher mean GHS scores in amputated patients.[1] Singh et al found that patients with higher GHS scores were more likely to undergo amputation.[26] Gopal et al observed a significant difference in GHS scores between amputated and non-amputated patients.[27] Rajasekaran et al also reported higher GHS scores in patients requiring amputation.[28]

Limitations

This study has certain limitations. The sample size was relatively small and conducted at a single tertiary care centre, which may limit the generalizability of the results to other settings. The follow-up duration was short, potentially missing long-term complications such as late infections or non-unions. Patients who had undergone prior procedures elsewhere or had complete amputations were excluded, possibly introducing selection bias. Although the GHS has good reliability, there may still be subjectivity in score assessment. The study also did not include a comparative analysis with other scoring systems like MESS or LSI. Additionally, socioeconomic and cultural factors that could influence outcomes were not evaluated. Finally, the absence of assessor blinding may have introduced an element of bias in the outcome assessment.

CONCLUSION

In conclusion, our study provides valuable insights into the demographics, clinical outcomes, and functional recovery of patients with open tibial fractures. The findings highlight the significant impact of road traffic accidents as a major cause of these injuries and underscore the importance of timely and effective medical interventions to improve patient outcomes. The GHS proved to be a useful tool in predicting the need for amputation and assessing the severity of injuries, with higher scores correlating with worse outcomes.

Moreover, the study demonstrates that the majority of patients achieved bone union within an average of 8.38 months, with a mean hospital stay of 17.74 days and an average of 1.8 operations. The LEFS scores indicated moderate functionality post-treatment, emphasizing the need for continued rehabilitation efforts to enhance recovery. These findings can inform clinical practice and guide treatment decisions, contributing to improved management strategies for open tibial fractures.

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