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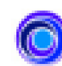
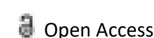


RESARCH ARTICLE



Comparative Evaluation of Pediatric Trauma Score and Trauma and Injury Severity Score in Predicting Outcomes in Pediatric Trauma: A Tertiary Care Centre Study from Central India

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ABSTRACT

Background: Pediatric trauma continues to be one of the leading causes of morbidity and mortality worldwide, particularly in low and middle-income countries where healthcare resources are often limited. Early and accurate assessment of injury severity is essential for effective triage and management. The Pediatric Trauma Score (PTS) and Trauma and Injury Severity Score (TRISS) are widely used tools, but their comparative utility in clinical settings remains under-explored. The present study was designed to compare the effectiveness of PTS and TRISS in predicting clinical outcomes in pediatric trauma patients.

Methods: The present study is a hospital-based observational study conducted over one year at a tertiary care center in Central India. Thirty pediatric patients aged 1-12 years with blunt trauma were included. PTS and TRISS were calculated at predefined intervals. Outcomes assessed included Intensive Care Unit (ICU) admission, duration of ICU stay, and mortality. Statistical analysis involved sensitivity, specificity.

Results: Most patients belonged to the 6-10 years age group (36.7%), with a clear male predominance (70%). Both PTS and TRISS showed significant correlation with patient outcomes. TRISS demonstrated higher predictive accuracy for mortality and ICU-related outcomes, while PTS proved useful for rapid initial assessment. Lower scores in both systems were consistently associated with worse outcomes.

Conclusion: While TRISS offers superior accuracy in predicting outcomes, PTS remains a practical and efficient tool for early triage, especially in resource-constrained settings. Using both tools together may provide the best clinical advantage.

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Introduction

Injuries in children are often sudden, unpredictable, and frequently preventable, yet they continue to claim a significant number of lives each year. Across the world, trauma is among the leading causes of death and disability in the pediatric age group, and the burden is particularly heavy in developing countries like India [1-3]. Rapid urbanization, increasing vehicular traffic, unsafe play environments, and gaps in emergency care systems all contribute to this growing problem. One of the biggest challenges in managing pediatric trauma is quickly identifying how severely a child is injured. Children are not simply "small adults"-their physiology is different, and they often compensate well until they suddenly deteriorate. This makes early assessment both critical and difficult.

Over the years, several trauma scoring systems have been developed to help clinicians make faster, more objective decisions. Among these, TRISS is widely regarded as a comprehensive tool. By combining physiological parameters with anatomical injury severity, it provides an estimate of survival probability and has been extensively used for research and quality assessment [5]. However, its practical use can be limited in busy emergency settings, particularly in hospitals where access to imaging or trained personnel is not always immediate [6]. On the other hand PTS was designed with simplicity in mind. It relies on

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basic clinical observation-such as airway status, blood pressure, and neurological response-and can be calculated within seconds at the bedside [7]. This makes it especially valuable in emergency rooms and prehospital settings, where rapid decisions are often life-saving. Despite their importance, there is limited data comparing these two scoring systems in Indian pediatric populations [9]. Understanding how they perform in real-world settings especially in resource-limited environments-is essential for improving trauma care. This study was therefore undertaken to compare PTS and TRISS in predicting outcomes among pediatric trauma patients in a tertiary care hospital in Central India.

Materials and Methods

The present study was designed to compare the predictive efficacy of PTS and TRISS in paediatric trauma to evaluate and compare the performance in predicting admission in ICU, duration of ICU stays, survival, disability, mortality in paediatric trauma study conducted over a duration of one year. Children aged 1-12 years who provided consent were included in the study. Children aged more than 12 years and who died on day 0 or day 1 following trauma were excluded. Data of each patient were recorded and analyzed including demographic details, mechanism and time of injury, vital signs at presentation, laboratory investigations, imaging findings Ultrasonography (USG)/ Contrast-Enhanced Computed Tomography (CECT), operative findings where applicable, PTS and TRISS scores on Day 1, 3, 7 and final day as well as final outcome (discharge or death). Data were entered in Microsoft Excel and analyzed using R Statistical Software. Continuous variables were summarized using mean ± standard deviation (SD). Categorical variables were expressed as frequency and percentages. Chi-square test and Fisher's exact test were used for qualitative variables. $p<0.05$ was considered statistically significant. The predictive performance of PTS and TRISS was assessed using: Sensitivity, Specificity, ROC (Receiver Operating Characteristic) curve, Area under curve (AUC). Ethical approval was taken from Institutional Ethics Committee (EC/MGM/NOV24/233) DCGI Reg No.ECR/397/inst/MP/2013/RR-20 DHR Reg No.EC/New/inst/2022/MP/0156 United States Dept of Health and Human Services, Rockville, MD 20852, USA: Reg No. IRB0000787.

Results

The majority of cases were observed in the 6-10 years age group, which constituted 36.7% (n=11) of the study population. This was followed by children aged ≤ 5 years, accounting for 30% (n=9) of cases. Participants in the 11-15 years age group comprised 23.3% (n=7), while the least number of cases were seen in those aged >15 years, representing 10% (n=3). Overall, the findings indicate a predominance of trauma cases in younger children, particularly those below 10 years of age. The gender-wise distribution shows male predominance with 70% (n=21) of the participants being male, while 30% (n=9) were female. Road traffic accidents were the most common cause, accounting for 50.0% (n=15) of cases. This was followed by assault and other causes, which constituted 36.67% (n=11) of injuries. Falls from height were responsible for 13.33% (n=4) of cases. These findings indicate that road traffic accidents were the leading mechanism of injury in study population. The abdomen was the most frequently involved site, seen in 36.7% (n=11) of patients. Injuries involving multiple sites were observed in 26.6% (n=8) of cases. Extremity injuries accounted for 13.3% (n=4), while head and neck injuries were seen in 10% (n=3) of patients. Injuries to the chest and abdomen with suprapubic region involvement were each observed in 6.7% (n=2) of cases. This distribution suggests a predominance of abdominal and multisite injuries. The mean pulse rate was 116.53 ± 16.90 beats/min, indicating tachycardia in several patients. The mean systolic blood pressure was 98.67 ± 6.29 mmHg. The mean respiratory rate was 22.67 ± 4.47 breaths/min. The mean PTS was 8.43 ± 2.53, suggesting that a substantial proportion of patients had moderate to severe trauma. The mean hemoglobin level was 12.17 ± 1.10 g/dL. The mean white blood cell count was 10,800 ± 2,993 /mm^3, reflecting a stress or inflammatory response in many patients. The mean INR was 1.23 ± 0.19. Major trauma (PTS ≤ 8) was observed in 43.3% (n=13) of patients, while nonmajor trauma (PTS>8) was seen in 56.7% (n=17). This indicates that nearly half of the study population sustained major trauma which were life threatening. A survival probability of >75% was noted in 46.7% (n=14) of patients. 30% (n=9) had a TRISS score between 50%-75%, while 23.3% (n=7) had a predicted survival of <50%. This distribution reflects a wide range of injury severity and predicted outcomes among the study participants. A strong positive correlation was observed between PTS and TRISS, with a correlation coefficient (r) of 0.98. This association was statistically significant ($p<0.001$), indicating that higher PTS values were strongly associated with higher predicted survival probabilities as assessed by TRISS. Among patients with PTS≤ 8 (n=13), abnormal imaging findings

were observed in 92.3% (n=12), while 7.7% (n=1) had normal imaging. In contrast, among patients with PTS>8 (n=17), abnormal imaging was seen in 76.5% (n=13) and normal imaging in 23.5% (n=4). Although a higher proportion of abnormal imaging findings was noted in the major trauma group, the difference between the two groups was not statistically significant (p=0.23). Out of the total 30 pediatric trauma patients included in the study, 11 patients (36.67%) required admission to ICU, whereas the majority, 19 patients (63.33%), did not require ICU care. This indicates that approximately one third of the study population had injuries severe enough to necessitate intensive monitoring and management. The relatively higher proportion of non-ICU cases suggests that a significant number of patients sustained moderate trauma that could be managed in general wards. With respect to ICU stay duration, 19 patients (63.33%) did not require ICU admission. Among the 11 patients who were admitted to ICU, 3 patients (10.00%) had a short ICU stay of less than 3 days, 7 patients (23.33%) stayed between 3-7 days, and only 1 patient (3.33%) required prolonged ICU care exceeding 7 days. The majority of ICU admissions were therefore of intermediate duration (3-7 days), suggesting that most critically injured patients stabilized within the first week of intensive management. Prolonged ICU stay (>7 days) was uncommon in the present cohort. Regarding clinical outcomes, more than half of the patients, 16 (53.33%), survived without any disability. Nine patients (30.00%) survived but developed some form of disability. The overall mortality rate in the present study was 16.67%, with 5 deaths recorded among the 30 cases. These findings indicate a favorable survival rate of 83.33%, although a considerable proportion of survivors (30.00%) experienced residual morbidity. The distribution of outcomes demonstrates a clear gradient ranging from full recovery to disability and death, which is essential for evaluating the prognostic performance of trauma scoring systems. On Day 1, the mean PTS was significantly lower in the death group (5.00 ± 1.00) compared to patients who survived with disability (8.44 ± 2.07) and those who survived without disability (9.50 ± 2.16). This difference was statistically significant (p=0.0007), indicating strong prognostic discrimination at initial assessment. Similarly, on Day 3, mean PTS values were 5.60 ± 0.55 in the death group, 9.33 ± 1.87 among survivors with disability, and 10.38 ± 1.82 among survivors without disability, with highly significant intergroup variation (p<0.001). The same graded trend persisted on Day 7, where mean PTS increased progressively from death (6.40 ± 0.55) to survival with disability (10.00 ± 1.94) and survival without disability (10.56 ± 1.71), showing significant difference (p = 0.0002). On the day of final outcome, the PTS continued to demonstrate clear separation across groups (7.40 ± 0.55 *vs* 10.78 ± 1.72 *vs*. 11.19 ± 1.38), with strong statistical significance (p= 0.0001). This consistent gradient suggests that higher PTS values are associated with improved clinical outcomes. TRISS values demonstrated even more marked separation between groups. On Day 1, mean TRISS was 24.16 ± 7.06 in the death group, compared to 67.07 ± 19.31 in survivors with disability and 76.68 ± 21.72 in survivors without disability (p=0.0001). Similar statistically significant differences were observed on Day 3 (25.40 ± 6.27 *vs*. 69.80 ± 19.05 *vs*. 78.56 ± 21.29; p<0.001) and Day 7 (28.00 ± 6.32 *vs*. 73.47 ± 17.77 *vs* 81.19 ± 20.44; p<0.001). On the day of final outcome, TRISS values remained significantly different among the three outcome groups (28.40 ± 8.73 in deaths, 76.18 ± 16.59 in survivors with disability, and 82.13 ± 21.09 in survivors without disability; p<0.001) (Table 1).

Table 1. Comparison of PTS and TRISS scores across outcome groups

Parameter	Death Mean ± Standard Deviation (SD)	Survived with disability Mean ± SD	Survived without disability Mean ± SD	p-value
PTS-1	5.00 ± 1.00	8.44 ± 2.07	9.50 ± 2.16	0.0007
PTS-3	5.60 ± 0.55	9.33 ± 1.87	10.38 ± 1.82	<0.001
PTS-7	6.40 ± 0.55	10.00 ± 1.94	10.56 ± 1.71	0.0002
PTS-On outcome day	7.40 ± 0.55	10.78 ± 1.72	11.19 ± 1.38	0.0001
TRISS-1	24.16 ± 7.06	67.07 ± 19.31	76.68 ± 21.72	0.0001
TRISS-3	25.40 ± 6.27	69.80 ± 19.05	78.56 ± 21.29	<0.001
TRISS-7	28.00 ± 6.32	73.47 ± 17.77	81.19 ± 20.44	<0.001
TRISS-on outcome day	28.40 ± 8.73	76.18 ± 16.59	82.13 ± 21.09	<0.001

Discussion

The findings of this study highlight an important practical reality in pediatric trauma care: no single scoring system is perfect, but each has its strengths depending on the clinical situation.

Bao, et al., [11] in a large multicenter Chinese cohort, where the highest burden of pediatric trauma was seen in children below 10 years, with 36.48% in the 0-3 year age group Similarly, Wendling-Keim, et al., [10] reported that younger children constituted a substantial proportion of pediatric polytrauma admissions, reflecting increased vulnerability due to developmental and behavioral factors. Dündar, et al., [13]. Observed male predominance among pediatric patients admitted with multiple trauma in intensive care settings. The male preponderance has been attributed to greater outdoor exposure, higher risk-taking behavior, and sociocultural factors, reinforcing the external validity of our findings. Similarly a marked male predominance was noted in the study, with 70% of patients being male and 30% female. Bao, et al., [11] stated that road traffic accidents constituted 45.77% of pediatric trauma, followed by low and high falls Similarly, Wendling-Keim, et al., [10] documented a high prevalence of traffic-related injuries among children with polytrauma requiring trauma bay admission. In the present study RTA accounted for 50% of all cases, followed by assault and other causes (36.67%), while falls from height contributed to 13.33% of injuries. Wendling-Keim, et al., [10]. Similarly reported a high frequency of abdominal trauma, with 45 out of 97 children sustaining abdominal injuries, many requiring surgical intervention Bao, et al., [11] also highlighted frequent involvement of multiple body regions in severe pediatric trauma cases This concordance emphasizes the need for systematic abdominal and multisystem evaluation in pediatric trauma patients. Similarly abdomen was the most frequently involved site, seen in 36.7% of patients, followed by multiple site injuries in 26.6%. Extremity injuries accounted for 13.3%, while head and neck injuries were seen in 10% of cases. Chest injuries and combined abdominal-suprapubic injuries were less common, each constituting 6.7%. Wendling-Keim, et al., [10] reported that a substantial proportion of children with polytrauma had pathological imaging findings, particularly involving the abdomen and head, which guided surgical decision-making The predominance of abnormal imaging in both studies reinforces the diagnostic value of CT and ultrasonography in pediatric trauma assessment. In present study also imaging evaluation revealed that solid organ injuries were present in 40% of patients, making them the most common finding. Free fluid without solid organ injury was seen in 20%, while bowel or mesenteric injuries accounted for 13.3%. Normal imaging findings were observed in 16.7%, and multiple injuries in 10% of cases. The high proportion of abnormal imaging findings highlights the diagnostic value of CT and ultrasonography in paediatric trauma and supports their role in early detection and management planning. Dündar, et al., [13] similarly noted that abnormal physiological parameters were common among children with severe trauma and were closely associated with lower trauma scores and increased mortality These findings highlight the importance of early physiological assessment as part of trauma severity evaluation. Similarly the physiological assessment showed a mean pulse rate of 116.53 ± 16.90 beats/min, indicating tachycardia in many patients, likely due to pain, hypovolemia, or stress response. The mean systolic blood pressure was 98.67 ± 6.29 mmHg, while the mean respiratory rate was 22.67 ± 4.47 breaths/min. The mean PTS of 8.43 ± 2.53 suggests that a considerable proportion of children sustained moderate to severe trauma. These physiological derangements reflect the systemic impact of injury and underline the importance of early physiological stabilization. Bao, et al., [11]. reported that laboratory derangements reflecting shock and hypoperfusion were more pronounced in severely injured children and correlated with higher injury severity scores and mortality Although specific BE values were not uniformly reported across studies, the direction of association between metabolic derangement and trauma severity is consistent. In present study also laboratory evaluation demonstrated a mean hemoglobin level of 12.17 ± 1.10 g/dL, with some patients likely experiencing occult blood loss. The mean WBC count was 10,800 ± 2,993/mm^3, suggesting a stress-related leukocytosis in many cases. The mean INR of 1.23 ± 0.19 indicates mild coagulation abnormalities in a subset of patients. Dündar, et al., [13] reported significantly lower PTS values among nonsurvivors compared to survivors, with PTS showing strong discriminatory ability for mortality (P<0.001) Similarly, Wendling-Keim, et al., [10] emphasized the utility of PTS in identifying children requiring intensive management Our findings corroborate the usefulness of PTS in stratifying trauma severity. In present study also major trauma, defined as PTS ≤ 8, was observed in 43.3% of patients, while 56.7% had PTS >8, indicating non-major trauma. The relatively high

proportion of patients with major trauma highlights the seriousness of injuries encountered in the study population. PTS proved useful in stratifying injury severity and identifying children at higher risk who may require intensive monitoring and intervention. Bao, et al., [11] demonstrated that increasing injury severity scores were strongly associated with mortality (ISS AUC 0.892) conceptually supporting the prognostic role of composite survival prediction models like TRISS. Wendling-Keim, et al., [10] similarly showed that trauma scores combining physiological and anatomical parameters had good prognostic value for outcomes Similarly TRISS analysis revealed that 46.7% of patients had a survival probability greater than 75%, while 30% had survival probabilities between 50-75%, and 23.3% had predicted survival below 50%. This wide distribution of TRISS scores reflects the heterogeneous nature of trauma severity among the study participants. The presence of nearly one-fourth of patients with TRISS <50% underscores the critical nature of injuries in a significant subset and highlights the utility of TRISS in prognostication. Dündar, et al., [13] who reported that trauma scores integrating physiological parameters showed strong predictive ability for mortality and outcomes in pediatric trauma patients Also Wendling-Keim, et al., [10] emphasized that structured trauma scoring systems correlate well with injury severity and clinical outcomes, supporting their routine use in emergency and critical care settings The near-perfect correlation observed in the present study validates the internal consistency of PTS and TRISS in pediatric trauma assessment. Similarly a very strong positive correlation between Pediatric Trauma Score and TRISS survival probability, with a correlation coefficient (r) of 0.98, which was statistically significant (p<0.001). This near-perfect correlation suggests excellent agreement between Physiological-Based Trauma Scoring (PTS) and outcome-based prediction (TRISS). The finding validates the internal consistency of trauma severity assessment in the present study and supports the combined use of PTS and TRISS for comprehensive evaluation, risk stratification, and prognostication in paediatric trauma. Wendling-Keim, et al., [10] reported that children with more severe trauma scores frequently had pathological imaging findings, particularly involving abdominal and thoracic structures, often necessitating surgical or intensive management Bao, et al., [11] also documented a strong association between injury severity and abnormal imaging findings in pediatric trauma cohorts. The lack of statistical significance in the present study may be attributable to the relatively small sample size, rather than absence of a true association. similarly Abnormal CT/USG findings were observed in 92.3% of patients with PTS ≤8, compared to 76.5% among those with PTS>8. Normal imaging findings were more common in the non-major trauma group (23.5%) than in the major trauma group (7.7%). Although a higher proportion of abnormal imaging findings was evident in patients with more severe trauma, the difference did not reach statistical significance (p=0.23). This lack of statistical significance may be attributed to the relatively small sample size. Nonetheless, the trend suggests that increasing trauma severity is associated with a higher likelihood of radiologically demonstrable injuries. Wendling-Keim., et al., [10] who observed that children with extensive radiological injuries were more likely to have worse clinical outcomes and require aggressive interventions Bao, et al., [11]. also highlighted that children with higher injury severity scores and poorer predicted outcomes frequently demonstrated multisystem involvement on imaging These findings collectively support the prognostic value of imaging findings in conjunction with survival prediction models like TRISS. Compares imaging findings with TRISS survival probability categories. All patients with TRISS <50% demonstrated abnormal CT/USG findings (100%), whereas among patients with TRISS ≥ 50%, abnormal imaging was seen in 78.3%, and 21.7% had normal imaging findings. Although this difference did not achieve statistical significance (p=0.18), the observation that every patient with low predicted survival had abnormal imaging highlights the close relationship between radiological injury burden and poor prognostic scores. This trend reinforces the importance of imaging in identifying high-risk trauma patients. In the present study, 36.67% of pediatric trauma patients required ICU admission, while 63.33% were managed outside the ICU. This distribution reflects a moderate proportion of severe trauma cases within the cohort. Published pediatric trauma studies have reported ICU admission rates ranging between 25% and 45%, depending on injury severity distribution and institutional referral patterns. Several trauma registry-based analyses have demonstrated that ICU admission is strongly associated with lower trauma scores and higher Injury Severity Scores (ISS). Similar to these observations, our findings suggest that a

significant minority of patients required critical care support, consistent with moderate-to-severe trauma burden.

Studies evaluating trauma scoring systems have shown that patients with lower PTS and lower TRISS probability of survival are more likely to require ICU admission. The proportion observed in the present study is therefore in line with literature demonstrating that approximately one-third of pediatric trauma admissions necessitate intensive monitoring and intervention [12,13]. Among ICU-admitted patients, most had an ICU stay between 3-7 days (23.33% of total cohort), while prolonged ICU stay (>7 days) was observed in only 3.33% of cases. Literature from pediatric trauma centers indicates that ICU stay duration correlates with physiologic instability at admission and associated organ dysfunction. Studies have reported that most pediatric trauma patients stabilize within the first week, and prolonged ICU stay is generally associated with complications, severe head injury, or polytrauma. Our findings demonstrate a similar pattern, with the majority of ICU stays being intermediate (3-7 days), and only a small proportion requiring extended critical care. This aligns with published reports suggesting that prolonged ICU dependency in pediatric trauma is relatively uncommon unless associated with major systemic injury [13]. The overall survival rate in the present study was 83.33%, with 53.33% surviving without disability and 30.00% surviving with disability. Mortality was 16.67%. Pediatric trauma mortality rates reported in literature vary widely (5-20%) depending on trauma severity, mechanism, and healthcare infrastructure. Studies from tertiary trauma centers frequently report mortality rates between 10-15% in moderate to severe trauma cohorts, which is comparable to the 16.67% observed in our study. Several trauma outcome studies have emphasized that survival without disability is the most meaningful endpoint in pediatric trauma research. The present distribution, with more than half of patients achieving full recovery, reflects favorable outcomes in the majority of cases, consistent with literature demonstrating improved survival rates due to advances in trauma care and early intervention protocols [15]. The present study demonstrated statistically significant differences in both PTS and TRISS values across the three outcome categories (death, survival with disability, and survival without disability) at all assessed time points ($p<0.001$ for most comparisons). Lower PTS and TRISS values were consistently associated with mortality, while higher values were associated with survival without disability. Published literature has consistently shown that both PTS and TRISS correlate strongly with mortality in pediatric trauma. However, multiple comparative studies have reported that TRISS demonstrates higher predictive accuracy for mortality when assessed using ROC analysis and area under the curve (AUC), often ranging between 0.85-0.95 (Figure.1). PTS, although simpler and clinically practical, generally demonstrates slightly lower AUC values (0.75-0.85) [13,15]. In the present study, TRISS showed wider absolute mean separation between outcome groups compared to PTS, indicating strong mortality discrimination. This finding is consistent with published data supporting TRISS as a robust mortality prediction model. However, serial assessment of PTS demonstrated progressive improvement over time, suggesting its usefulness in dynamic clinical monitoring, which has also been highlighted in bedside trauma assessment literature.

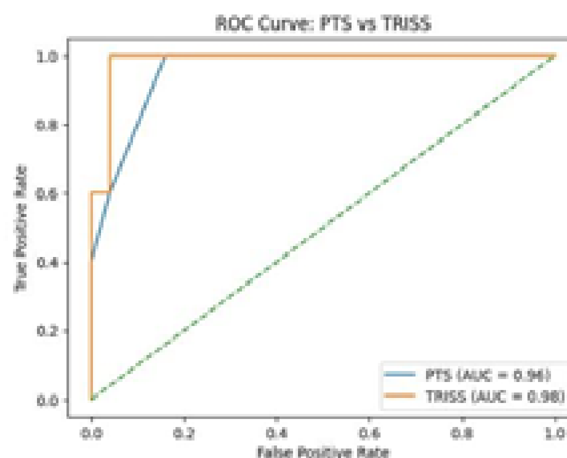

Figure 1. ROC curve

Conclusion

Scoring system may positively contribute to timely and proper planning, aid in pre-hospital and in-hospital evaluation and care, and ultimately reduce costs. Both PTS and TRISS play important roles in pediatric trauma care. PTS is a reliable and efficient tool for rapid triage, while TRISS provides a more accurate prediction of outcomes. Rather than choosing one over the other, integrating both into clinical practice may offer the best approach for improving patient outcomes, particularly in resource-limited settings. However, with data obtained from trauma children, scoring systems with higher sensitivity and specificity can be developed in the future.

Limitations

The study included a relatively small sample

size, which may limit its statistical power and generalizability. As it was conducted at a single tertiary care center, the findings may not be representative of other healthcare settings, particularly rural or resource-limited environments. The use of consecutive sampling along with specific inclusion and exclusion criteria may have introduced selection bias, affecting external validity. Exclusion of patients with incomplete data or early mortality may have led to underestimation of complication

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Author contributions

Conceptualization: Shashi Shankar Sharma; Data curation: Aditi Pahade; Formal analysis: S.S.S.A; Supervision: B.K. Lahoti, Validation: Ashok Kumar Ladda, Writing-original draft: Aditi Pahade, MJ and Writing-review & editing: Maneesh Kumar Joleya, Shashi Shankar Sharma

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