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TRAUMA SURGERY

Traumatic limb amputations in polytrauma ICU admissions

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Background: KwaZulu-Natal bears a significant trauma burden, with polytrauma patients often experiencing traumatic limb amputations. This study investigates traumatic limb amputations in the subgroup of severely injured polytrauma patients admitted to the trauma ICU in KwaZulu-Natal. This study aims to describe the management and outcomes of traumatic limb amputations in polytrauma patients at the trauma ICU.
Methods: This retrospective observational study utilised data from the trauma ICU registry (BCA207/09). Descriptive methods were employed to analyse demographics, injury mechanisms, timing of amputations, anatomical sites affected, injury complexes, injury severity scores, and patient outcomes.
Results: Twenty-three patients were included, with a mean age of 32 years. The most common injury mechanism was motor vehicle collision pedestrian (43%), 82% of included cases underwent early amputation. The left lower leg was the most frequently affected site (62%), with a median injury severity score (ISS) score of 25 (13–42) and median new injury severity score (NISS) of 34 (20–43). Most were ultimately above-knee amputations but started as below-knee amputations. Most patients were discharged to base (60.8%), while 22% died.
Conclusion: This study provides valuable insights into traumatic limb amputations in polytrauma patients, emphasising the need for comprehensive management strategies. The outcomes of traumatic limb amputations require optimised patient care and better rehabilitation services.
Keywords: trauma, amputation, polytrauma, outcome, mangled limb

Introduction

KwaZulu-Natal (KZN) bears a significant trauma burden,[1] with polytrauma patients often experiencing traumatic limb amputations either directly from the injury or requiring early amputation due to non-viable limbs. This study aims to describe the management and outcomes of severely traumatised limbs requiring amputations in a subgroup of severely injured polytrauma patients admitted to an accredited level 1 trauma intensive care unit (TICU).

Polytrauma is defined as multiple-injured patients with physiological derangement,[2] which arise from these common injury mechanisms – motor vehicle collisions (MVC), industrial incidents, sports injuries, or even in conflict situations. In this context, the trauma severity impacts the likelihood of amputation. Importantly for survivors, there are both psychological and emotional effects affecting the rest of their life.

Care in the emergency department may ensure that stabilising the patient can allow for reconstruction; however, unstable patients are more likely to require ablation as the method of both haemorrhage and sepsis control. Wound coverage and closure remain challenging aspects of amputation for trauma. Survivors experience many challenges in regard to rehabilitation in the South African public sector, with limited in-patient facilities and limited access to prosthesis despite the advances in prosthetics. Even access to psychological support is limited.[3] Finally, there are significant financial and economic implications after traumatic limb amputations. Amputation may remain the best therapy in saving a patient's life even though it is potentially devastating for the patient.[4]

Material and methods

This was a retrospective quantitative, observational, descriptive chart review of a prospective dataset captured in the TICU trauma registry (BCA207/09) approved by the University of KZN Biomedical Research Ethics Committee to identify factors relating to traumatic amputation.

All admitted polytrauma patients in trauma ICU or who died in the resuscitation area were reviewed and index cases with traumatic limb ablation extracted. All patients admitted in TICU between 1 January 2015 until 30 September 2022 were reviewed for those who had trauma-related limb amputations including at-scene amputation, or where the amputation was performed at the hospital.

Statistical analysis used SPSS version 28 (IBM Corp, Armonk NY) to analyse the data. Descriptive statistics were used to summarise the data. Mean, standard deviation and range were used for continuous variables which were normally distributed, while median and interquartile range were used for continuous non-normal variables. Categorical variables were described using frequencies and percentages.

Results

Demographics

During the period under review, 2340 patients with major trauma were admitted to the TICU. One thousand eight hundred and eleven cases were blunt trauma and 529 were penetrating trauma. Twenty-three patients (1% of the total) who had an amputation in the context of polytrauma were identified and included in the analysis. The mean age was 34 years with a standard deviation of 13 years and a range from 5 to 55 years. The majority of amputees were in the age group 32–40 years. The sex-distribution was in keeping with the trauma male predominance at 73.9% male admissions.

Regarding the mechanism of injury (MOI), with the exception of two cases (mixed blunt-penetrating and burns), all the amputations were the result of blunt injury. Of these injuries, the most prevalent was pedestrian MVC (43.5%). This was followed by MVC passenger (26.2%). In total, 20 out of 23 patients (86.9%) who required limb amputation were injured in MVC events. The frequencies of the types of injury are shown in the graph below (Figure 1).

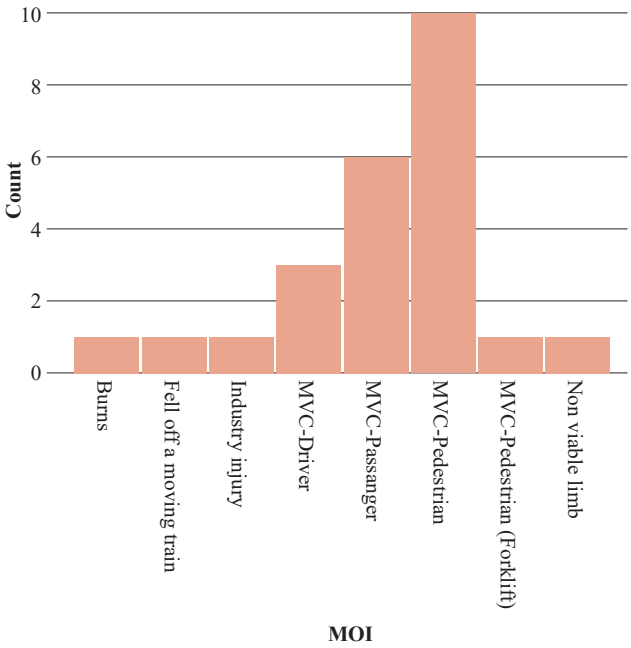

Figure 1: Mechanism of injury of traumatic amputation

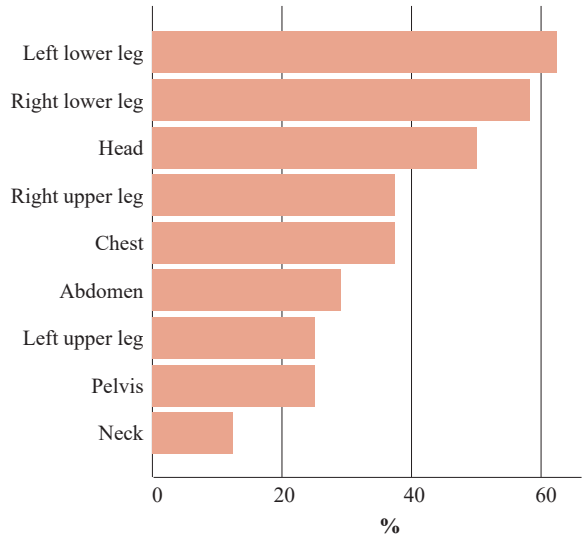

Figure 2: Injury sites

In terms of the anatomical regions injured, the left leg (62%) was amputated more often than the right leg. Most above-knee amputations started as below-knee procedures to formalise a partial amputation or non-viable mangled limb in the context of unstable physiology. The commonly associated other regions injured included the head (50%) and chest or abdomen (30–38%). Spinal fractures were uncommon. Figure 2 illustrates the frequently affected sites. Neck injury was much less common (16%).

Median ISS was 25 with a range from 9 to 75. The interquartile range for ISS was 13–42. The NISS scores ranged from 11 to 75 and the median was 34, with an interquartile range of 20–43. This indicates severe to critical injury patterns in these polytrauma patients.

Regarding the timing and level of amputation, the high frequency of early amputations (amputations within 24 hours of the time of injury) is noteworthy (82.7%) compared to late amputations (amputations after 24 hours) (4.3%). Two patients died before they could reach theatre, as demonstrated in Table I. These findings underscore the vulnerability of the lower extremities to severe trauma and the subsequent need for limb ablation in many cases where there are competing priorities and physiological abnormality. Most cases were above-knee amputations, constituting 38% of the total. This is reflected in Table II.

Table I: Timing of amputation

		Count	%
Theatre time	Early amputation	19	82.7%
	Died before theatre	2	8.7%
	For amputation at base (delayed ICU referral)	1	4.3%
	Late amputation	1	4.3%
	Total	23	100.0%

Table II: Amputation type

Type of amputation	Total: 21	Percentage
Above knee	8	38%
Below knee	5	24%
Above elbow	4	19%
Through knee	3	14%
Below elbow	1	5%

The median number of operations on the limb to achieve closure or adequate wound care prior to discharge was two and the range from zero (in those patients who demised prior to theatre) to six, with half of patients needing either 2 or 3 operations. In three cases no surgery was required at the trauma centre, with two deaths prior to surgery and in one case the surgery had been performed as a single-stage procedure prior to transfer to TICU at our institution.

Only nine patients (40%) had primary stump closure prior to discharge to their base hospital. Of these nine, six had primary closure on the second operation, while three required split skin grafts. The rest were either discharged to their base hospital for wound care and closure or skin grafting. Four did not survive and one was sent back to base

for the primary amputation due to a non-viable limb with no other indication for ICU admission.

Most patients were discharged to base hospitals for further rehabilitation (60.8%) while 22% were discharged to mortuary. Only two cases were transferred to rehabilitation facilities, and these were cases covered by the road accident fund. The outcome disposition is illustrated in Table III.

The five mortalities included two deaths in the resuscitation area prior to ablation surgery for partially amputated mangled extremities, both severely injured polytrauma cases; one on day four who demised from severe traumatic brain injury and one on day ten with multiple severe injuries, while the sole burn patient succumbed to burn sepsis after two months, despite extensive wound care.

Table III: Discharge disposition

		Count	%
Outcome	Discharged to base	14	60.8%
	Discharged to mortuary	5	21.8%
	Discharged to rehab centre	2	8.7%
	Discharged home	2	8.7%
	Total	23	100.0%

Discussion

This retrospective observational study sheds light on the spectrum of traumatic limb amputations in polytrauma patients. Understanding the nuances of these injuries is essential for improving patient care and outcomes in the TICU setting. Adult males with a mean age of 34 years suffering blunt injury in MVC are the commonly identified pattern, with early amputations (without attempts at reconstruction) being the most common finding.

In our experience, most post trauma amputations occur early for unsalvageable injuries, 15% occur late after reconstructive attempts. In a study to identify factors contributing to late amputation, it was noted that patients managed with late amputation were more likely to have soft tissue injury requiring flap coverage and have their limb salvage course complicated by infection.[5] A study from a large trauma centre in India reviewed all major trauma admissions, of which 5.8% underwent extremity amputations and they report a mortality of 8.6%. They emphasise that the majority of the patients were young and required above-knee ablations, followed by below-knee procedures.[6] The significant factors that predicted outcome in India were delayed presentation, haemorrhagic shock at the time of presentation, higher ISS, NISS and mangled extremity severity score levels, surgical-site infection, and the presence of associated other injuries. This is similar to the polytrauma population in the current study, where shock or mangled limbs in the context of unstable polytrauma were factors leading to early amputation without attempts at reconstruction. However, unlike our population, they had more above-knee than below-knee ablations. Another recent study from India records that, overall, limb loss due to trauma remains very high.[7] That study included all trauma admissions in a level 1 trauma centre in northern India, with an overall rate of amputation of 2.5%, including all levels and limbs, mostly related to MVC and industrial incidents, similar to the local findings. Also similar to local findings, outcome was worse for the polytrauma cohort, with head, chest or abdominal injury co-existing with limb trauma.[6,7] These findings underscore the significant role of MVC in causing severe limb trauma and subsequent amputations. Other mechanisms, such as falls and industrial injuries, also contributed to the cohort, highlighting the diverse nature of traumatic limb injuries.

The median ISS score of 25 and NISS score of 34 indicates severe to critical polytrauma among the study cohort. It is recognised that in this context the choice of life-over-limb will often be the deciding factor, and this group is therefore very different to isolated limb-threating injury.

Regarding the extent and technique of amputation, it is relevant for eventual mobility that most of the ablations in this series were at the above-knee level, despite having started at a lower level, since a number of papers support the concept of length-retention for better outcomes, and that below- or through- knee procedures have better mobility and societal reintegration than above-knee ablations. This is particularly important in unstable polytrauma patients where the "completion of amputation" allows for haemorrhage control and where other injuries are of higher importance.[8,9] Wound closure may be delayed until re-evaluation and revision surgery and is not uncommon in this patient cohort, as was noted also in our series.[8-11] Indeed, international studies show that decision-making by a multi-disciplinary team of senior practitioners is useful in the early phases of care.[8,9] There is no real difference in the surgical site sepsis rate and revision surgery in those with primary stump closure or secondary closure.[12]

Outcomes

Despite this, the majority of patients were discharged to base (60.8%), suggesting favourable outcomes for a significant proportion of survivors. However, it is noteworthy that almost a quarter of patients were discharged to the mortuary, highlighting the life-threatening nature of polytrauma patients, in particular those who require a traumatic limb amputation, suggesting significant energy transfer causing these injuries. The distribution of outcomes underscores the complexity of managing traumatic limb injuries and the need for multidisciplinary care to optimise patient recovery. Literature suggests that about half of patients will be able to return to work after rehabilitation and most will be productive members of society provided bio-psycho-social-spiritual rehabilitation is aggressively instituted.[11,13,14] Early limb ablation remains an acceptable management plan, which reduces hospital stay hence enabling an early rehabilitation process, with some evidence that an early ablation has better long-term outcomes than failed attempts at reconstruction with a later amputation.[13,14] Reconstruction may have some benefit over amputation in the long-term return to work group, but not in the early phase of care, which is particularly relevant to the polytrauma patient, with amputation favouring less infections, readmissions and revision surgery.[11,13,14]

The findings of this study have several implications for clinical practice. Firstly, early recognition and intervention in cases of severe limb trauma are crucial for preventing delayed amputation with adverse outcomes and improving patient survival, especially in the context of polytrauma where life-over-limb decisions during the resuscitation-phase are important. This is particularly important in light of the risk of missed injury in the polytrauma subgroup.[15]

Secondly, the diversity of injury mechanisms underscores the importance of implementing comprehensive trauma prevention strategies, particularly focusing on road safety and occupational hazards. Thirdly, the predominance of lower extremity injuries highlights the need for specialised care and rehabilitation services to facilitate optimal recovery and functional outcomes for affected individuals.[3,13,14] The challenge of trauma-related amputations remains an important global health issue, of increasing proportions, making further studies on this topic essential.[16]

Limitations and future directions

The limitations of this study are acknowledged, including its single centre retrospective nature and reliance on data from a small number of patients included in the study. Future research should aim to conduct multi-centre studies including other hospitals in the province to enhance the generalisability of findings and explore potential predictors of outcomes following traumatic limb amputations in polytrauma patients. Additionally, qualitative research methodologies could provide valuable insights into the lived experiences of individuals undergoing limb ablation and their long-term bio-psycho-social-spiritual adjustment.

Conclusion

In conclusion, in this trauma cohort, young adult male polytrauma patients who are haemodynamically unstable on arrival undergo early ablation prior to admission to the TICU. Timely intervention in severe limb trauma cases allows for the focus on the life-threatening truncal and neurotrauma. The distribution of anatomical sites affected reflects the diverse nature of trauma-related injuries seen in polytrauma patients. The lack of rehabilitation facilities in the public sector remains a concern for eventual reintegration into productive society.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

Ethical approval was obtained from the Biomedical Research Ethics Committee (BREC), College of Health Sciences, University of Kwazulu-Natal BREC, UKZN (Ref No: BREC 00001929/20).

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