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Patient profiles of below knee-amputation following road traffic accidents – An observational study from a level 1 trauma centre in India

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ABSTRACT

Background: Primary amputation below the level of the knee joint is the most frequently performed amputation following trauma; however, data about incidence, patient profiling, and causative factors are seldom available in India.
Objective: To evaluate the profile and incidence of trauma-related amputations below the level of the knee joint at a level 1 trauma center.
Methods: An observational study over six months was conducted at a level 1 trauma center of north India. Epidemiological data such as age, sex, occupation, socioeconomic status, mechanism of injury, time of surgery, single or staged procedure, and complications were recorded from the admission files.
Observations: 125/3047 (4.1%) trauma patients underwent amputation, of which 32.8% (41 of 125) had amputation below the level of the knee joint. Unilateral transtibial amputation was the most common (85.3%) involving 40/41 males with a mean age of 37.2 years of low socioeconomic status. Road traffic accidents were the most common cause (85.36% of cases). 39 of 41 cases presented within 24 h of injury and underwent surgery within 24 h of presentation. Secondary surgery was needed in 24.4% of the patients and revision amputation was done in only 2.4% (n = 1/41). No patient developed medical complications, and the average hospital stay was 8.7 days with a range from 2 to 14 days.
Conclusion: We have documented a significant amputation rate in trauma cases (4.1%) reflecting on the seriousness of patients seen at our center. Most patients are young males at the peak of their productive lives, and from low socioeconomic status. Road Safety is essential, and specialized services for the amputees may be the need of the hour.

1. Introduction

Amputation is often the outcome following severe open fractures, mangled extremity, and vascular injuries, especially in developing countries.[1,2] With improved road safety measures and modes of transportation, the incidence of post-traumatic amputation has significantly decreased in the developed world.[3] Although innovative microsurgical techniques have made limb salvage a viable option, amputations are still being done at various hospitals, with multiple confounding factors being the precipitating cause.[4] Several factors contribute to the burden of amputation following road traffic accidents in developing countries; the significant vehicular load on the roads, inadequate traffic infrastructures, poor road safety sense, dearth of appropriate health infrastructure and on the spot stabilization teams, and delay in definitive treatment[5–7] all contribute. Even when the patient reaches an appropriate trauma center in time, the rate of secondary complications and ensuing disability may be relatively high.[8]

An understanding of demographic and etiological aspects of trauma-related amputations would help in constructing appropriate and timely management protocols for these patients. Many countries have National trauma banks where such data is documented, and an understanding of the causative factors, demographic patterns, and socioeconomic impact is appropriately documented. In India, however, this data is lacking, and the published literature on this subject is scanty. In an effort to see the available literature, the authors conducted a PUBMED search in July 2020 with keywords traumatic

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[All Fields] AND below [All Fields] AND ("knee" [MeSH Terms] OR "knee" [All Fields] OR "knee joint" [MeSH Terms] OR ("knee" [All Fields] AND "joint" [All Fields]) OR "knee joint" [All Fields]) AND ("amputation" [MeSH Terms] OR "amputation" [All Fields] OR "amputations" [All Fields]). The data collated showed 2564 hits, 354 out of which were studies focused on India. However, we could not identify a single study documenting the epidemiology and patient profiles of the patients undergoing traumatic below-knee amputation in India. The major void in the published literature and the scarcity of relevant clinical data on this subject led us to evaluate the epidemiology of trauma-related below-knee amputations. The study was done in a level 1 trauma center in North India, to evaluate the incidence, patient profiles, and compounding factors; an attempt to improve the patient outcomes in the long term. A specialized team has been created to manage these cases via a 'Focussed Amputee Clinic'.[9]

2. Aims and objectives

The study aimed to evaluate the demographic profiles and the incidence of below-knee amputations in trauma patients seen in our level 1 trauma center.

3. Materials and methods

We did a prospective evaluation of retrospective cases, with an attempt to document all the patients with below-knee amputations seen in our level 1 trauma center of a tertiary care teaching hospital. In addition to the Institute Ethics clearance to evaluate amputee data (NK/3690/Study/259), The clearance specific for this project was obtained (DRB/ORTHO/2020/51).

Data of consecutive patients admitted to the Advanced Trauma Centre, PGIMER, between 1st January 2018 and 30th June 2018, and who underwent amputations below the level of the knee joint after trauma was prospectively collated. Any patient with an amputation done for other causes such as diabetes, malignancy, peripheral vascular disease, or congenital anomalies was excluded. Medical case records of all these included patients were retrieved, and data were recorded in a pre-structured proforma. Variables evaluated were patient age, sex, occupation, socioeconomic status, Injury mechanism, the timing of presentation to the trauma center, any delays in the surgical procedure, level of amputation, complications, and methods of early rehabilitation. The amputation decision was taken based on the MESS score (Mangled extremity Severity Score) and limb viability. Two separate consultant orthopedic surgeons were involved in deciding for amputation.

The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 22.0 for Windows). The mean and median were calculated for all quantitative variables. For measures of dispersion, standard deviation or interquartile range was calculated. Qualitative or categorical variables were described as frequencies and proportions. All statistical analyses were two-sided, and significance was placed at a level of 5%.

4. Observations and results

During the study period, 3047 trauma cases visited our emergency, out of which 125 patients (4.1%) ultimately required amputation. Out of these 125 amputees, 41 patients (32.8%) were of amputations below the level of the knee joint. Of these, 35 (85.36%) patients had unilateral transtibial, two (4.8%) patients underwent bilateral transtibial amputations, and four (9.7%) patients underwent foot amputations at various levels.

Evaluation of data revealed that there was significant male sex predominance; only 1 out of 41 cases was female. There was also a predominance of the young population, with the mean age being 37.2-+16.9 years (median-33) (Table 1). Road traffic accidents were the most common cause of amputation, with 35/41 (85.4%) patients having sustained road traffic injuries. 18/35 patients were riding two-wheelers which got hit by four-wheelers.12.2% (5 out of 4) patients had railway accidents and 2.4% (1 out of 41) had the traumatic machine cut injury in a local wood factory. The amputation decision was taken based on the MESS score, which comes out to be 9.58, ranged from 7 to 12.

The most common associated injury seen was a fracture in other parts of a body in 9 patients, followed by head-injury in 4 patients. Overall, 39 (95.1%) patients presented within 24 h of injury, while 2 (4.9%) cases were referred to our center>24 h post-injury. 37/39 (90.2%) patients were operated within 24 h after the presentation; Of the four patients with delayed surgery, two had associated spine and head injury, and the other two were operated after the failure of a primary vascular repair with external fixation. In the latter 2, secondary amputation was done three days after the primary procedure due to the development of ischaemic changes. The average hospital stay of patients was 8.7 days, with a range of 2–14 days.

The majority (n = 29, 70.7%) of patients were discharged after primary surgery within 5 days, while 12 patients (29.3%) required prolonged admission due to various causes (delayed stump closure in 10 patients, revision amputation in one patient, and need for multiple debridements due to uncontrolled infection and persistent discharge in one patient). All patients seen at our center belonged to the low or lower-middle socioeconomic status according to the modified Kuppuswamy scale.[10]

From our data, we could infer that the majority of amputees were males, at a young age and were involved in road accidents. A very high incidence (4.1%)of trauma patients presenting to our center had undergone an amputation, with 32.8% (41/125) being below-knee amputations.

Table 1
Demographic and injury patterns in patients with amputation below the level of knee.

Variables	Value (n = 41)
Mean age±SD	37.2 years + -16.9
Male gender	40 (97.5%)
Mode of Injury	
;- Roadside accident	35 (85.4%)
;- Railway injury	5 (12.2%)
;- Machine cut	1 (2.4%)
Level of amputation	
;- Unilateral transtibial amputation	35 (85.4%)
;- Bilateral transtibial amputation	2 (4.9%)
;- Syme's amputation	1 (2.4%)
;- Chopart's amputation	1 (2.4%)
;- Trans-metatarsal amputation	1 (2.4%)
;- Forefoot amputation	1 (2.4%)
MESS Score	9.58 (7–12)
Associated Injuries	17 (41.5%)
;- Associated fractures	9 (52.9%)
;- Head injury	4 (23.5%)
;- Blunt Trauma Chest	2 (11.8%)
;- Spine Injury (D10 fracture with paraplegia)	1 (5.9%)
;- Blunt Trauma Abdomen	1 (5.9%)
Timing of surgery	
;- Early surgery (within 24h)	37 (90.2%)
;- Delayed surgery (after 24h)	4 (9.8%)
Duration of hospital stay	
;- Early discharge (within 5 days)	29 (70.7%)
;- Prolonged admission	12 (29.3%)

5. Discussion

Traumatic limb amputations in the civilian population are a significant cause of limb loss, second only to non-traumatic conditions like peripheral vascular diseases and gangrene.[11–15] The rising number of traumatic amputations in developing countries is of concern because of its associated significant morbidity and mortality.[2] Below knee amputation is a significant disability, both in terms of function and mental disturbance, with social factors in the poor playing a significant role.

A study in 1986 documented that India has 0.62 amputees per thousand population, and every year there was an addition of around 23,500 amputees to the pool.[16] We could not find any data in PubMed for the intervening 35 years; our population has multiplied manifold; our traffic has become more congested and our vehicles go faster. Potentially, the amputation rates could be higher, and we have also noted alarming rates from our data. An amputation rate of approximately 4.1% (125/3047) of patients presenting after trauma, with almost one third undergoing a below-knee amputation, is high by any standards.

The high number of amputations seen by us might be attributed to the fact that we are a tertiary care referral trauma center, where cases of high-velocity trauma, a higher proportion of open fractures, vascular injuries, and polytrauma cases are referred for treatment. Nevertheless, these numbers are alarming and indirectly reflect the compromised healthcare infrastructures, poor health policies, and deranged traffic conditions and road safety measures. Lack of public awareness and civic responsibilities has further added to this problem,[7] as patient transport facilities could significantly help in minimizing trauma-related limb-threatening complications.

Worldwide too, road traffic accidents are the most common cause of vascular injuries and mangled extremities requiring amputation.[17,18] The World Health Organization estimates that India has 1% of the world's vehicle population but contributes to nearly 10% of the road traffic fatalities,[19] which further reflects on the poor driving in congested traffic conditions. Currently, road traffic fatalities are 2nd only to HIV/AIDS as the leading cause of ill-health and premature death in adult men aged 15–44 years.[20] Aeron-Thomas et al. reported similar findings from the United Kingdom with roadside accidents as the most common mode of injury, and pedestrians, motorcyclists, and bicyclists being the most common victims.[21]

One significant fact of note reflected even in the published literature worldwide [22,23], is the male preponderance and young age of the amputees (mean 37.2 years). This age-group is the primary workforce for any developing economy, and amputations thus lead to a significant socioeconomic burden and communal disability, not only to the nation but to the family also. The predominance of amputees from low socioeconomic strata of life is another significant point noted in this study since social support systems are lacking in our country.

Secondary data collation related to these cases gave some insights too. The duration between the injury and definitive management is the most crucial factor which determines the morbidity and mortality [24]. In our study, 90% of the patients were operated within 24 h after presentation to the hospital. Although this seems fair in the overall context of an overburdened health delivery system in our country, with poor patient transport, the delay is often a significant factor in amputation rates. This is something that needs to be addressed to reduce the current level of morbidity to the limbs.

The reoperation rate in our study was nearly 30% (n = 12/41). The primary reason for the reoperations was delayed stump closure in 83.3% (n = 10/12 reoperations). However, the revision amputation rate was significantly low in our cohort, being only 2.4% (n = 1/41). The single case of the revision amputation at a higher level was associated with persistent infection. Low et al.[25] studied 2879 amputees in the USA and described a very high revision rate of 41.9%.; the majority had a revision of the amputation stump and a few were revised to a more proximal level. They had collated data retrospectively from a centralized data bank. The lower revision rate seen by us may be related to the lesser number of patients in our study and early primary amputations that were done. Also, since the amputation decisions are jointly taken by a team of faculty members, this practice may have led to a reduced rate of revision and complications (Table 2).

Low et al.[25] reported that 27.5% of amputees had experienced complications in their post-operative period like pneumonia, acute kidney injury, and DVT/thrombophlebitis being the most common ones. They also noticed that complications were common in patients with compartment syndrome, associated neurovascular injury, and patients with delayed surgery.[25] None of the patients in our hospital developed any medical complications during the hospital stay, as reported in some of the other studies.[15,17,25] The reason for this could be the relatively shorter hospital stays, conduction of surgeries within 24 h, and early discharge policy. The duration of hospital stay not only increases the chances of infection but also impacts the psychological well-being of the patient who is already under the trauma and stigma of limb-loss.[3]

An outcome of our overall data for amputation evaluation has led to the formation of 'focused amputee clinics' which help to rehabilitate these young patients of poor socioeconomic status. This consists of a core specialized team, which often starts with

Table 2
Literature review of Trauma related lower limb amputations.

S. No	Authors	Number of Patients	Gender	Mean Age (years)	Hospital stay (days)	Inference
1.	Lars Bo Ebskov[15], *JOT*,1994	912	66.3% male	49.4	49 days	In hospital mortality-7.2% (females) and 4.4% (males) varies with age, sex and level of amputation. Incidence is 1.4 per 100,000 population per year.
2.	Dillingham et al.[13], *Arch Phys Med Rehabil*,1998	992 (major amputations)	72.7% male	43.5	28 days	Incidence 1.07 per 100,000 population of major amputations. Patient demographics don't influence discharge rate. Major amputations with head injuries increased inpatient length of stay.
3.	Mackenzie et al.[26], *JOT*, 2000	179	81.5% male	16-44 (79.2%)	19 days	Patient characteristics were not significant when comparing limb salvage versus amputations
4.	Low et al.[25], *Injury*, 2016	2879	80.4% male	42.3 males,47.5 females	22.7 days	High rate (27.5%) of complication and revision amputation among trauma related amputee patients. 6.2% mortality
5.	Present study	41	97.5% male	37.2 years	8.7 days	No mortality. Duration of hospital stay is increased in patients with associated injuries.

primary care of these amputees while in hospital.[9] The availability of clinical psychologists, psychiatrists, physiotherapists, prosthetists, and plastic surgeons as required, supplements the efforts of orthopedic surgeons and provides holistic care under one roof, which continues in the rehabilitation period.

The limitations of this study covering only 6 months; nevertheless, we had a large number of serious trauma patients due fact that we are a level 1 trauma center. Another limitation was the emotional component score of patients was not recorded. Large data pools are available in the United States consisting of LEAP study (Lower Extremity Assessment Project), which was a multicenter project recording the data of patients with lower extremity trauma.[26] Similar studies should be advocated in countries like India for better results and guidelines in the future.

6. Future directions

Road safety measures are the need of the hour in developing countries. The increasing vehicular movement on the roads[27] and poor adherence to traffic rules puts the population at risk for severe traumatic injuries.[28] In public interest, the Indian Orthopaedic Association (IOA) also filed a writ petition in 2012 in the supreme court of India against the Govt. of India asking them to recognise the huge loss of life and financial burden seen in road traffic victims; this led to the formation of an apex body that is coordinating all activities involved in road safety. The Indian Orthopaedic Association (IOA) also formed a road traffic safety committee to improve road safety awareness among public.[27] At the community level, road safety measures should be included in the curriculum of all teaching programs of the younger generation and the national health program of the countries. Information, education and awareness for the prevention of this group of orthopaedic conditions can go a long way in ensuring improved safety measures on the roads.

At the institutional level, maintenance of local and nationwide registries will help to identify the burden of amputation, improve the management of cases and assess the long-term outcomes in patients. Such data will also help in formulating policies for the improvement of road traffic accident-related safety measures and development of trauma centres on the highways so that these patients receive timely care. The data can also be utilized to formulate standard operating procedures at the peripheral centres so that the patients can seek early care and do not waste precious 'limb-time' in travelling to the higher centres. For this, the peripheral centres need to be upgraded in handling trauma-related surgical emergencies and performing amputation surgeries.

7. Conclusion

Our study highlights a significant amputation rate in trauma cases (4.1%) reflecting on the seriousness of patients seen at our center and road traffic accidents are the most common cause of traumatic limb amputations, and that too during the productive years of life; one-third of these are transtibial amputations. The majority belong to a poor socioeconomic background, warranting ongoing social support and psychological rehabilitation, maybe in the form of amputee clinics. The implications of limb loss are far-reaching; at one end, our study points towards the need of implementing better road safety measures and awareness amongst the masses, and at the other end, the fact that the healthcare system needs to be strengthened for early and appropriate care.

CRediT authorship contribution statement

Uttam Chand Saini: Conceptualization, Methodology. **Aman Hooda:** Data curation, Writing - original draft, preparation. **Sameer Aggarwal:** Software, Validation, Writing - review & editing. **Mandeep Singh Dhillon:** Visualization, Investigation, Supervision.

Declaration of competing interest

NIL.

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