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Epidemiology, Clinical Profile, and Outcomes of Firecracker-Related Burns in the Paediatric Population during Diwali: A Prospective Study from a Tertiary Burn Unit in India

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KEYWORDS

Firecracker injuries; Paediatric burns; Diwali; Preventable injuries; Disaster management; India.

ABSTRACT:

Background: Firecracker-related burn injuries in children continue to be a preventable cause of morbidity during Diwali in India. Despite public awareness campaigns and regulatory measures, children remain disproportionately vulnerable, often requiring specialized emergency care.

Methods: We conducted a prospective observational study at a tertiary care hospital in Tamil Nadu during the pre-Diwali, Diwali, and post-Diwali days of 2024. A disaster management protocol supervised by the Ministry of Health and Family Welfare, Government of Tamil Nadu, was implemented for the study period. All children under 13 years presenting with firecracker-related injuries were included, while cases occurring outside Diwali or those unwilling to participate were excluded.

Results: Twenty-four children (n = 24) presented with cracker-related burns. The mean age was 7.5 years (range: 2–13 years), and boys constituted 79.1% (n = 19). Eleven children (45.8%) required inpatient admission, while 13 (54.2%) were treated on an outpatient basis. The most commonly affected site was the right hand (45.8%), followed by the face. The extent of burns ranged from 1% to 13% total body surface area (TBSA), with 75% of cases involving <5% TBSA. Flower pots (37%) and atom bombs (17%) were the most frequent causative crackers. Conservative management with wound wash and topical antimicrobials was sufficient in most cases. Three patients underwent surgical interventions, including wound debridement, suturing, ray amputation, and skin grafting. On follow-up, the majority showed good outcomes, with Vancouver Scar Scale scores of 0–4 in 66% of burn cases and 90% of surgical cases.

Conclusions: Firecracker-related injuries among children remain a significant public health concern during Diwali. Hands and face are the most vulnerable sites, with flower pots and atom bombs being the leading causes. While most cases were minor and managed conservatively, severe cases required complex surgical procedures. Implementation of disaster management protocols, strict enforcement

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of firecracker regulations, and intensified community awareness are essential to minimize such preventable injuries.

INTRODUCTION

Firecracker-related burns constitute a predictable surge of paediatric emergencies during Diwali in India, a festival widely celebrated with extensive use of fireworks. Children are disproportionately affected due to their curiosity, risk-taking behaviour, and frequent lack of supervision. Previous Indian studies consistently show that children under 15 years represent a significant proportion of firecracker-related burn cases during the festival season, with injuries ranging from minor superficial burns to severe, vision-threatening ocular trauma and disabling hand injuries(1-3).

The clinical impact of firecracker burns in children extends far beyond immediate injury. Many cases involve delicate areas such as the face, eyes, and upper limbs, with potential for disfigurement, functional limitation, and long-term psychosocial consequences(4-5). Firecracker-related ocular injuries, in particular, account for a large share of vision loss among affected children, with some requiring surgical intervention or prolonged follow-up(6). Furthermore, these injuries impose a heavy burden on families and healthcare systems, especially during festival peaks when outpatient departments and emergency services experience sharp increases in patient load(2-7).

Despite repeated awareness campaigns and regulations on firecracker use, studies have shown little decline in the frequency or severity of such injuries in the paediatric age group(1-3). This underscores the limitations of preventive efforts and the continuing need for systematic documentation of injury patterns and outcomes. Recognizing this recurring public health challenge, the Government of Tamil Nadu has instituted a disaster management protocol during Diwali to ensure preparedness of emergency burns care teams under the supervision of the Ministry of Health and Family Welfare.

The present prospective study was conducted during the Diwali season of 2024 in a tertiary care hospital in Tamil Nadu, focusing exclusively on paediatric firecracker injuries (<13 years). By systematically describing the demographic characteristics, types of firecrackers implicated, anatomical sites, severity of burns, and treatment outcomes, this study aims to provide contemporary evidence that can guide preventive strategies and reinforce the need for continued community education and strict regulation of firecracker use.

MATERIALS AND METHODS

This prospective observational study was conducted in the emergency burns outpatient clinic of a tertiary care teaching hospital in Tamil Nadu, India, during the Diwali festival season of 2024. The study period included the pre-Diwali day, Diwali day, and the following day, when a disaster management protocol for firecracker-related injuries was operational under the supervision of the Ministry of Health and Family Welfare, Government of Tamil Nadu.

Study Population

All children younger than 13 years presenting with firecracker-related injuries during the three-day study window were eligible for inclusion. Exclusion criteria were:

1. Injuries sustained outside the Diwali period.
2. Children whose parents/guardians declined participation.

Operational Definitions

a) **Minor burns**: <10% total body surface area (TBSA), without airway involvement, ocular injury, or need for surgical intervention.

b) **Moderate burns**: 10–20% TBSA, or <10% TBSA involving functionally/cosmetically critical sites (hands, face, feet, perineum), requiring inpatient admission.

c) **Severe burns**: >20% TBSA, or any burn associated with blast trauma, airway compromise, or vision-threatening ocular injury.

d) **Blast injury**: A firecracker-related trauma resulting in laceration, soft tissue disruption, fracture, or tissue loss in addition to burns.

e) **Conservative management**: Treatment with wound wash, topical antimicrobials (silver sulfadiazine), and advanced dressings (Cutimed Sorbact, silver sheet, Urgotul Ag), without operative intervention.

f) **Surgical management**: Any procedure performed under general or regional anaesthesia, including wound debridement, primary suturing, capsulorrhaphy, myorrhaphy, grafting, or ray amputation.

g) Favourable scar outcome: Scar outcome assessment was performed using the Vancouver Scar Scale (VSS), a validated tool widely used for evaluating burn scars[8]. The VSS assesses four parameters: pigmentation (normal, hypo-, mixed, or hyperpigmented; score 0–3), vascularity (normal, pink, red, or purple; score 0–3), pliability (normal, supple, yielding, firm, rope-like, or contracture; score 0–5), and height (flat, <2 mm, 2–5 mm, or >5 mm; score 0–3). Individual domain scores are summed to yield a total score ranging from 0 (normal skin) to 13 (worst scar). Lower scores indicate more favourable scar outcomes. In this study, scars were graded during follow-up visits, and the Vancouver Scar Scale score was used to document the quality of healing and early scar maturation.

Clinical Assessment and Management

On presentation, demographic and clinical details were documented using a structured proforma. Variables included: type of firecracker involved, supervision at time of injury, mechanism of ignition, anatomical site, depth, TBSA (calculated using Lund and Browder chart), and associated injuries.

Initial management included wound wash, pain relief, and aseptic dressings. Most children received silver sulfadiazine for superficial partial-thickness burns. Dialkylcarbamoyl chloride dressing (Cutimed Sorbact, ABIGO Medical AB, Sweden) was used for facial burns to preserve epithelium and maintain moisture balance. Silver sheets (Urgotul Ag , Laboratoires URGO, France) were applied for exudative hand and limb burns where atraumatic removal was desirable. Selected children with deep burns or ischemic margins were considered for adjunctive hyperbaric oxygen therapy.

Surgical interventions were performed as indicated. Wound debridement was performed with excision of necrotic tissue until punctate bleeding was visible. Primary suturing was used for clean lacerations with tissue viability. Capsulorrhaphy and myorrhaphy were performed to restore first web space stability and intrinsic muscle function in blast-injured hands. Ray amputation was undertaken in non-viable toes with tissue loss, followed by split-thickness skin grafting for residual raw areas. All procedures were performed under general anaesthesia, with regional blocks or sedation used where appropriate.

Outcomes Measured

Primary outcomes: site and severity of burns, type of firecracker implicated, requirement for admission, and surgical intervention.

Secondary outcomes: early scar quality (VSS at first follow-up), functional status of operated hands, and presence of complications.

Operational Definitions

h) **Minor burns**: <10% total body surface area (TBSA), without airway involvement, ocular injury, or need for surgical intervention.

i) **Moderate burns**: 10–20% TBSA, or <10% TBSA involving functionally/cosmetically critical sites (hands, face, feet, perineum), requiring inpatient admission.

j) **Severe burns**: >20% TBSA, or any burn associated with blast trauma, airway compromise, or vision-threatening ocular injury.

k) **Blast injury**: A firecracker-related trauma resulting in laceration, soft tissue disruption, fracture, or tissue loss in addition to burns.

l) **Conservative management**: Treatment with wound wash, topical antimicrobials (silver sulfadiazine), and advanced dressings [Dialkylcarbamoyl chloride dressing (Cutimed Sorbact, ABIGO Medical AB, Sweden), silver sheet (Urgotul Ag , Laboratoires URGO, France)], without operative intervention.

m) **Surgical management**: Any procedure performed under general or regional anaesthesia, including wound debridement, primary suturing,

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capsulorrhaphy, myorrhaphy, grafting, or ray amputation.

n) **Favourable scar outcome**: Scar outcome assessment was performed using the Vancouver Scar Scale (VSS), a validated tool widely used for evaluating burn scars. The VSS assesses four parameters: pigmentation (normal, hypo-, mixed, or hyperpigmented; score 0–3), vascularity (normal, pink, red, or purple; score 0–3), pliability (normal, supple, yielding, firm, rope-like, or contracture; score 0–5), and height (flat, <2 mm, 2–5 mm, or >5 mm; score 0–3). Individual domain scores are summed to yield a total score ranging from 0 (normal skin) to 13 (worst scar). Lower scores indicate more favourable scar outcomes. In this study, scars were graded during follow-up visits, and the Vancouver Scar Scale score was used to document the quality of healing and early scar maturation.

Ethical Consideration: The study protocol was approved by the Institutional Ethics Committee. Written informed consent was obtained from parents or guardians, and assent from children older than 7 years when feasible. All procedures adhered to the Declaration of Helsinki.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Continuous variables (age, TBSA) were summarized as mean ± standard deviation (SD) and median with interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. Given the modest sample size, the analysis was descriptive.

RESULTS

A total of 24 children sustained firecracker-related injuries during the 2024 Diwali period. The mean age was 7.5 years, with the majority in the 5–10 year age group (11/24, 46%). Three children (12%) were ≤5 years old and 10 (42%) were older than 10 years. Boys were more frequently affected than girls (19/24, 79% vs 5/24, 21%) (Table 1). **Table 1: Demographic characteristics of children with firecracker-related injuries in a Tertiary Burn Unit in India (n = 24)**

Characteristic	**Frequency (n)**	**Percentage (%)**
Age group (years)		
≤5	3	12
5–10	11	46
>10	10	42
Mean age ± SD	7.5	–
Sex		
Male	19	79
Female	5	21

Flower pots were the most common cause of injury (9/24, 37%), followed by atom bombs (4/24, 17%), pencil crackers (3/24, 13%), and cracker powder (3/24, 13%). Less common causes were chakris (2/24, 8%), Lakshmi bombs (2/24, 8%), and rockets (1/24, 4%) (Table 2).

Table 2: Circumstances and type of firecracker-related injuries among children in a Tertiary Burn Unit in India (n = 24)

Variable	**Frequency (n)**	**Percentage (%)**
Type of cracker		
Flower pot	9	37
Atom bomb	4	17
Pencil cracker	3	13
Cracker Powder	3	13
Chakri	2	8
Lakshmi Bomb	2	8
Rocket	1	4

With regard to severity, 18 children (75%) sustained burns involving <5% of body surface area (BSA), two children (8%) had 5–10% BSA burns, and four (17%) had burns involving >10% BSA (range 1–13%). The

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right hand was the most common site injured (11/24, 46%), followed by the face (8/24, 33%), left hand (4/24, 17%), anterior trunk (2/24, 8%), foot (2/24, 8%), and thigh (1/24, 4%). The majority presented with burns alone (20/24, 83%), while four children (17%) sustained burns associated with blast injuries (Table 3).

Table 3. Clinical profile of firecracker-related injuries among children in a Tertiary Burn Unit in India (n = 24)

Clinical variable	Frequency (n)	Percentage (%)
Severity of burns		
<5% BSA	18	75
5-10% BSA	2	8
>10%	4	17
Range: 1-13%		
Anatomical site involved		
Right hand	11	46
Face	8	33
Left hand	4	17
Anterior trunk	2	8
Foot	2	8
Thigh	1	4
Pattern of Injury		
Only burns	20	83
Burns with blast injury	4	17

In terms of management, most superficial burn cases (15 children) were managed conservatively with wound wash and silver sulfadiazine dressings, with satisfactory healing observed at follow-up (Vancouver scar score 0–4). Three children with facial burns were treated with Dialkylcarbamoyl chloride dressing (Cutimed Sorbact, ABIGO Medical AB, Sweden), and three with hand or lower-limb burns with silver sheets (Urgotul Ag , Laboratoires URGO, France). Two children (one with facial and one with lower-limb burns) underwent hyperbaric oxygen therapy as an adjunct.

Blast injuries required more extensive interventions. One child with a left-hand laceration underwent wound wash and primary suturing. Another with a first-web space blast injury underwent wound debridement, capsulorrhaphy of the first carpometacarpal joint, myorrhaphy of the adductor pollicis and first dorsal interosseous muscles, and skin closure. A third child with a foot blast injury required wound debridement, ray amputation of the fourth and fifth toes, and subsequent grafting to cover the raw area.

Of the 24 children, 11 (45.8%) required inpatient care and 13 (54.2%) were treated on an outpatient basis (Table 4). Surgical interventions (debridement, grafting, or reconstructive procedures) were performed in 4 children (16.7%). Follow-up demonstrated good healing outcomes in most cases, with 66% of burns managed with advanced dressings showing favourable Vancouver scar scores, and 90% of surgically treated blast injuries also demonstrating good recovery. No mortality was recorded during the study period.

Table 4. Management and outcomes among children with firecracker-related injuries in a Tertiary Burn Unit in India (n = 24)

Outcome/Intervention	Frequency (n)	Percentage (%)
Type of care		
Inpatient	11	45.8
Outpatient	13	54.2

DISCUSSION

This prospective observational study describes the epidemiology, anatomical distribution, and outcomes of paediatric firecracker-related burns during Diwali in South India. Children remain a vulnerable group, with boys disproportionately affected and most injuries occurring in the 5-10-year age group. These patterns mirror previous Indian reports and likely reflect unsupervised outdoor activity and direct handling of fireworks[1-3,5].

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The right hand and face were the most commonly injured sites, consistent with ignition biomechanics of ground-based devices such as flower pots, pencils, and chakris. In children, these areas are functionally and cosmetically critical, with high risk of hypertrophic scarring and contracture due to thin dermis and growth-related remodelling. Early oedema control, splinting, and low-shear dressings are therefore as important as antisepsis. For superficial-to-mid dermal facial burns, Dialkylcarbamoyl chloride dressing (Cutimed Sorbact, ABIGO Medical AB, Sweden) provided favourable epithelial preservation and early Vancouver Scar Scale scores. Similar anatomical patterns have been reported previously, underscoring the risks of dominant-hand ignition close to the body(2,4,5).

Flower pots and atom bombs accounted for over half of cases. Despite being perceived as safe, they are consistently implicated in paediatric burns and ocular trauma(1,3,6), reinforcing the need for regulatory attention to design and safety standards.

Most burns were minor (<5% TBSA) and managed conservatively with silver sulfadiazine dressings, yielding favourable outcomes. However, severe injuries still occurred: four children required operative intervention including debridement, suturing, capsulorrhaphy, myorrhaphy, ray amputation, and grafting. These highlight the destructive potential of explosive devices and the necessity of immediate surgical expertise during festival surges. Adjunctive therapies such as silver sheets (Urgotul Ag , Laboratoires URGO, France), and selected use of hyperbaric oxygen supported exudate control and marginal tissue survival, particularly where repeated anaesthesia was undesirable.

Nearly half the cohort required admission, comparable with other tertiary reports(2,7). Implementation of a disaster management protocol ensured triage, dressing availability, and operative readiness, contributing to favourable early outcomes. While ocular trauma was infrequent in this series, previous studies report significant rates, underscoring the importance of multidisciplinary preparedness including ophthalmology(1,6).

Strengths and Limitations: Prospective data collection, uniform protocols, and detailed characterization of both burn and blast injuries strengthen the findings. However, single-centre design, short surveillance window, and modest sample size, which restrict long-term outcome analysis, are the study's limitations. Nonetheless, prospective data collection, uniform protocols, and detailed characterisation of both burn and blast injuries strengthen the findings.

Conclusion: Paediatric `firecracker injuries remain a preventable cause of surgical morbidity. While most are minor, severe cases demand complex operative care. Preparedness during festival periods, alongside community regulation and parental supervision, is critical to reducing this avoidable burden.

Conflict of Interest: none declared

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