Section: Plastic and Reconstructive Surgery

Original Research Article

PAEDIATRIC FIRECRACKER BLAST INJURIES: PATTERNS AND OUTCOMES AT A TERTIARY CARE INSTITUTION

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ABSTRACT

Firecracker-related injuries continue to pose a significant public health challenge in India, particularly during festive seasons. Children are especially vulnerable to these injuries due to their natural curiosity, lack of risk awareness, and frequent absence of adequate adult supervision. Despite ongoing public awareness campaigns and legal restrictions, the prevalence of such injuries remains high. This prospective observational study was conducted over a one-year period at a our institution to examine the patterns, severity, and outcomes of upper limb injuries in paediatric patients resulting from firecracker blasts. A total of 40 children below the age of 13 years who sustained upper limb injuries due to firecracker explosions were enrolled in the study. Detailed data were collected regarding age, gender, type of firecracker involved, mechanism of injury, clinical findings, and radiological assessments. Injuries were classified based on a severity grading system.Functional outcomes were evaluated during follow-up visits, and complications such as grip weakness, joint stiffness, psychological distress, and need for secondary surgeries were recorded. Male children were disproportionately affected, with a male-to-female ratio of 19:1, and the highest incidence was observed in the 6–10 year age group. Functional recovery was incomplete in a significant proportion of patients, with long-term consequences on hand function and psychological well-being. This study underscores the urgent need for stringent enforcement of firecracker regulations, increased public education targeting children and caregivers, and the promotion of safer alternatives. Clinicians must adopt a multidisciplinary approach in managing such injuries, integrating surgical expertise with rehabilitation and mental health support. Effective preventive and clinical strategies are crucial to reducing the morbidity associated with paediatric firecracker-related upper limb injuries.

INTRODUCTION

Firecrackers are an integral part of cultural celebrations in India, particularly during Diwali. However, their unregulated use often results in a spike in injury cases, especially among children. Despite existing laws and awareness campaigns, firecracker injuries persist, burdening healthcare systems and leading to long-term disability and psychological trauma in children. Children are naturally curious and are often left unsupervised during festive activities, making them highly susceptible to blast-related injuries. Nearly 70% of firecracker injuries are reported in the paediatric population, with the upper limbs being the most commonly affected due to direct handling of the explosives. This study focuses on understanding the epidemiology, injury patterns, and outcomes of upper limb injuries in paediatric patients caused by firecrackers. The aim is to inform future preventive strategies and clinical protocols for effective management.[1-3]

While firecracker injuries are well-documented in general, there is a significant gap in literature focusing exclusively on paediatric upper limb trauma. Considering the anatomical, physiological, and psychological differences in children compared to adults, this study addresses the need for age-specific clinical data and management strategies.[4,5]

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MATERIALS AND METHODS

This prospective observational study was conducted at our institution over a period of one year, from January 2024 to January 2025. The study focused exclusively on paediatric patients who sustained upper limb injuries resulting from firecracker blasts and were admitted to the Department of Plastic and Reconstructive Surgery. A total of 40 patients below the age of 13 years who met the inclusion criteria were enrolled in the study. Inclusion criteria required a confirmed history of firecracker-related trauma specifically involving the upper limb, and admission to the relevant department for management. Patients with upper limb injuries unrelated to firecrackers or with pre-existing congenital or acquired deformities of the upper limb were excluded to maintain the specificity of the dataset. Data collection was performed systematically using a pre-designed clinical proforma, which included detailed patient history, type and mechanism of firecracker involved, the context and location of the injury, time of incident, and whether adult supervision was present at the time.

Clinical assessment included a thorough physical examination to document the extent of soft tissue damage, neurovascular status, presence of bony injuries, and functional impairment. Radiographic investigations such as X-rays and, where necessary, CT or MRI scans were utilized to assess internal injuries and fractures. Each injury was categorized and graded using a four-tier injury severity classification developed for the study: Grade 1 for superficial injuries to skin and subcutaneous tissue, Grade 2 for deeper involvement including muscle injuries and phalangeal fractures, Grade 3 for complex injuries such as digit amputations, CMC joint dislocations, metacarpal fractures, or nerve and tendon involvement, and Grade 4 for extensive trauma including complete thumb amputations through the CMC joint, proximal digit amputations, or forearm-level fractures and amputations. Management strategies, including both surgical and non-surgical interventions, were meticulously recorded.

Postoperative outcomes were evaluated during scheduled follow-up visits at 1 month, 3 months, and 6 months, assessing wound healing, functional recovery (range of motion, grip strength), and complications. Psychological assessment was also noted in severe injury cases, particularly among patients requiring amputations or prolonged hospital stays. The data collected were anonymized and entered into a secure database for analysis, with ethical clearance obtained from the institutional ethics committee prior to the initiation of the study.

RESULTS

Table 1: Injury Frequency and Distribution

Type of Injury	Frequency
1st webspace blast injuries	30
Phalangeal fractures	26
CMC joint dislocations	22
Partial digit amputations	15
Digital neurovascular/tendon injuries	14
Metacarpal fractures	12
Total digit amputations	9
Forearm bone involvement (ulna/radius)	2

The most frequently observed injury was to the 1st webspace (75%), followed closely by phalangeal fractures (65%) and CMC joint dislocations (55%). These patterns suggest that direct handling of firecrackers particularly high-intensity ones puts the central and distal structures of the hand at risk.

Though forearm bone involvement was less frequent (5%), it represented severe, high-velocity trauma. The prevalence of partial and total digit amputations further indicates the devastating potential of uncontrolled firecracker blasts in children.

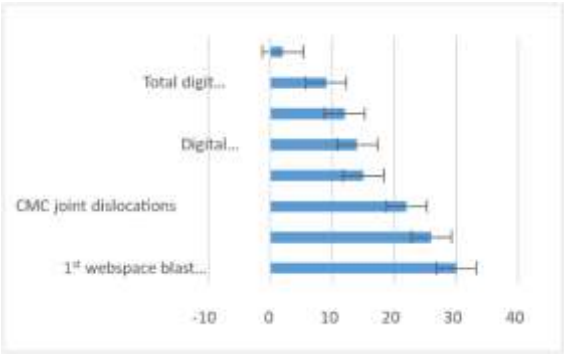

Table 2: Age and Gender Distribution

Age Group (years)	Number of Cases
0–5	4
6–10	18
11–14	12
15–17	6
Gender	Frequency
Male	38
Female	2

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The highest incidence occurred in the 6–10 years age group (45%), a developmental stage characterized by increased physical activity, curiosity, and limited risk perception. The study showed a high male predominance (95%), with only 2 female patients. This 19:1 male-to-female ratio reflects a behavioral trend where boys are more likely to be involved in outdoor or risky activities, particularly involving firecrackers. This calls for gender-specific preventive education, especially targeting young boys and their caregivers during high-risk festive.

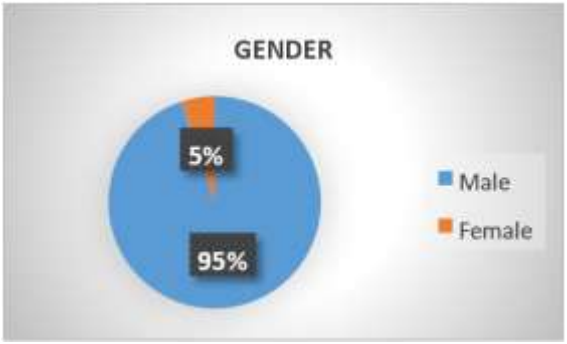

Table 3: Type of Firecrackers Involved

Type of Firecracker	Percentage (%)
Bomb-type (e.g., Sutli Bomb)	60%
Sparklers	25%
Series crackers (Laris)	15%

The bomb-type firecrackers were the most common cause of injuries (60%) and were directly associated with the most severe trauma, including amputations and complex fractures. While sparklers are often considered safe, they accounted for 25% of injuries, mostly superficial burns and minor trauma (Grade 1 and 2). Series crackers (laris) contributed to 15% of cases, often due to unexpected misfires or malfunctions. These findings highlight a crucial gap in public awareness regarding the actual danger posed by different types of fireworks.

Grading of Injury Severity: More than half of the cases (57.5%) were classified as Grade 3 or Grade 4, requiring complex reconstructive procedures, prolonged hospital stays, and extensive rehabilitation. These high-grade injuries not only represent a surgical challenge but also contribute to long-term functional disability in growing children. Grades 1 and 2, though less severe, still carried a risk of infection, scarring, and mild functional limitation. The injury grading underscores the spectrum of damage that firecracker injuries can cause—even in children with seemingly "minor" exposure.

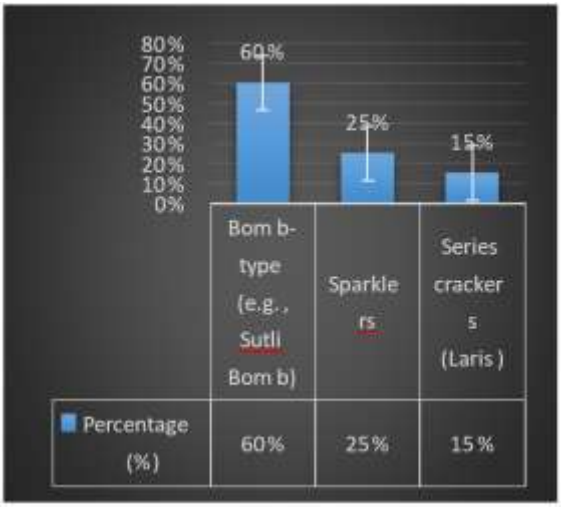

Table 4: Clinical Outcomes and Complications

Outcome/Complication	FRE
Complete functional recovery	14
Reduced grip strength	10
Persistent stiffness	8
Need for secondary surgery	6
Psychological issues (anxiety/PTSD)	9
Residual limb deformity	5

Only 35% (14 out of 40) of patients achieved complete functional recovery, demonstrating the long-lasting impact of these injuries. A notable number suffered from reduced grip strength and joint stiffness, while some required secondary reconstructive surgeries. Moreover, 9 children (22.5%) exhibited psychological effects, including anxiety, phobia, or social withdrawal, especially those with amputations or visible deformities. These findings reinforce the need for a multidisciplinary care model, involving not only surgeons but also psychologists and physiotherapists, to optimize the recovery and reintegration of affected children.

DISCUSSION

This study presents a comprehensive analysis of paediatric upper limb injuries caused by firecracker blasts, highlighting a concerning pattern of severe trauma in a vulnerable population. The predominance of injuries among boys aged 6–10 years suggests behavioral and societal influences that increase risk, including unsupervised play and gender-based norms surrounding risk-taking activities. The frequent involvement of the 1st webspace, phalanges, and metacarpals points to direct handling of high-energy explosive devices. The majority of patients in this study sustained Grade 3 and Grade 4 injuries,

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requiring complex reconstructive surgeries and long-term rehabilitation. These findings align with previous reports indicating that firecracker injuries in children often result in functional impairment, psychological distress, and substantial burden on healthcare systems. Despite regulations and awareness campaigns, dangerous firecrackers like sutli bombs remain accessible, pointing to enforcement failures. Cultural norms and commercial interests often override safety considerations, placing children at risk every festive season. The high rate of complications such as reduced grip strength, persistent stiffness, and psychological trauma further underscore the multidimensional impact of such injuries. A paradigm shift from reactive treatment to proactive prevention is necessary, involving community participation, stricter enforcement of bans, and safer alternatives.[6,7]

Clinical Implications: The clinical implications of this study are significant for both acute management and long-term care of paediatric patients with blast injuries. Early recognition of injury severity and timely surgical intervention can prevent complications such as infection, contractures, and functional loss. Grade 3 and Grade 4 injuries, in particular, require multidisciplinary management involving orthopaedic and plastic surgeons, physiotherapists, occupational therapists, and psychologists. Surgeons must anticipate the need for staged reconstruction, skin coverage, tendon repair, and even microsurgical techniques in cases involving amputations or nerve damage. This study also highlights the need for dedicated paediatric trauma protocols, including child-specific pain management, rehabilitation regimens, and mental health support, especially for those suffering from disfigurement or long hospital stays.

Strengths and Limitations: A major strength of this study lies in its prospective design and focused evaluation of upper limb injuries in the paediatric age group, a population that is underrepresented in firecracker injury literature. By categorizing injuries based on severity and type of firecracker used, the study offers valuable insights into preventable risk factors and injury patterns. The detailed follow-up assessing both functional and psychological outcomes provides a holistic view of the impact on affected children. However, the study has certain limitations. The sample size is relatively small and derived from a single tertiary care centre, which may limit generalizability. Regional and cultural factors specific to the study location may not reflect trends across India or globally. Additionally, long-term outcomes beyond six months were not assessed, which could underestimate the extent of chronic disability or psychological sequelae. Self-reported data on firecracker type and circumstances of injury may also be subject to recall bias. Despite these limitations, the study provides a strong foundation for future multicentre research and intervention strategies.

CONCLUSION

Firecracker-related injuries in the paediatric population, particularly to the upper limbs, represent a preventable yet persistent public health burden. This study reveals a high incidence of severe, functionally impairing trauma among children, most commonly caused by bomb-type firecrackers during festive seasons. The findings emphasize the urgent need for multifaceted interventions, including stricter enforcement of firecracker regulations, widespread public education targeting children and parents, and development of safer, child-friendly alternatives.

Clinical care should adopt a multidisciplinary, child-centered approach, incorporating early surgical intervention, comprehensive rehabilitation, and psychological support. Only through a combined effort of healthcare professionals, policymakers, educators, and communities can we hope to reduce the annual surge of such debilitating injuries and ensure safer celebrations for future generations.

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