Original Article

Incidence of Firework-Related Hand Injuries in Pediatrics and Cost of Treatment

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Objective: To study the incidence of firework-related hand injuries in children, sequelae of injuries, and cost of treatment.

Materials and Methods: A retrospective study of firework-related hand injury patients aged younger than 15 years that attended Khon Kaen Hospital between 2012 and 2016. The injury patterns, sequelae of injuries, and cost of treatment were reviewed.

Results: Ninety-seven patients were studied. All patients were male. The mean age of participants was 11.2 years. The incidence of firework-related injuries was 19.4 cases per year. Most patients were injured during the end of Buddhist Lent Day (93%) and most of them were active users (97%). Overall, the most commonly injured parts were index finger (59%), long finger (56%), first web space injuries (33%), and thumb (28%). Half of patients (46 of 97 patients) lost some part of their fingers, mostly were distal phalanx (87%) and two patients had long-term disability. The average duration of the subject's hospital stay was 4.7 days (1 to 33 days). The average cost per injury was $460.

Conclusion: The majority of firework-related hand injuries in Thailand were male active users during the end of Buddhist Lent Day. Fireworks can cause various degrees of injuries. Index and long fingers were frequently injured, resulting in many instances of long-term disability.

Keywords: Firework-related hand injuries, Sequelae of injuries, Cost of treatment

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Fireworks are part of ceremonies in many countries around the world. The hand is often injured by fireworks, as well as faces and eyes, according to one large study[1]. Fireworks-related injuries varies in severity, ranging from minor burns to devastating traumas. Currently, there are no studies in Thailand about the incidence of firework-related hand injuries and their medical costs. From experience of the researchers, many patients are children, similar to recent studies from the United States where one-third of the cases occurred in patients below 18 years[2]. The objectives of the present retrospective study were to review the incidence of firework-related hand injuries in children, sequelae of injuries, and cost of treatment.

Materials and Methods

A retrospective medical record reviewed of firework-related hand injury patients aged younger than 15 years admitted to Khon Kaen Hospital, an 867-bed, tertiary referral hospital, trauma center with an annual emergency department census of 25,322 cases, between 2012 and 2016. Ninety-seven patients were included in the present study. Demographic data, injury mechanisms, injury patterns, firework types, sequelae of injuries, and cost of treatment were reviewed. SPSS for window was used for statistical data analysis.

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Results

Demographic data and incidence of injury

There were 97 patients (all males) with a mean age of 11.2 years (range 3 to 15 years). The incidence of firework-related hand injuries was 19.4 cases per year (11 per 100,000). Most patients (93%) were injured during the end of Buddhist Lent Day (late September to early November). Most (97%) were active users.

Firework types

The fireworks that cause most injuries were unknown (56%), followed by plastic fireballs (22%), homemade (16%), and others (3%). The relationship of firework types, age, injury mechanism, and classification of injury is shown in Table 1.

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Table 1. Demographic data, use behavior, and severity of injury by firework types

	Types of firework			
	Plastic fireballs (n = 22), n (%)	Homemade (n = 16), n (%)	Unknown (n = 56), n (%)	Others (n = 3), n (%)
Age (years)				
3 to 6	0 (0.0)	0 (0.0)	3 (5.3)	0 (0.0)
7 to 10	8 (36.3)	6 (37.5)	18 (32.1)	1 (33.3)
11 to 15	14 (63.6)	10 (62.5)	35 (62.5)	2 (66.6)
Injury mechanisms				
Active user	21 (95.4)	16 (100)	54 (96.4)	3 (100)
Bystander	1 (4.5)	0 (0.0)	2 (3.5)	0 (0.0)
Classification of injury				
Low energy Injury	3 (13.6)	1 (6.2)	8 (14.2)	1 (33.3)
High energy injury	18 (81.8)	12 (75.0)	44 (78.5)	2 (66.6)
Very high energy injury	1 (4.5)	2 (12.5)	3 (5.3)	0 (0.0)
Extremely high energy	0 (0.0)	1 (6.2)	1 (1.7)	0 (0.0)

Classification of injury

The researchers have indexed various types of firework-related injuries as follow:

1. Low energy injury: a burn injury that did not exceed superficial second degree burn and/or laceration that was not deep to the muscle, tendon, and no fracture.
2. High energy injury: a fracture and/or dislocation of finger and traumatic amputation (at initial or later amputation) distal to distal interphalangeal joint level.
3. Very high energy injury: an injury that had fracture and/or dislocation of finger and traumatic amputation proximal to distal interphalangeal joint level but did not exceed metacarpophalangeal joint level.
4. Extremely high energy injury: a severe injury that had traumatic amputation beyond metacarpophalangeal joint level.

Injury patterns

Ninety-two of the 97 patients studied had injuries to their fingers, five patients had only palm injury. The most commonly injured parts were index finger (59%), followed by long finger (56%), first web space injuries (33%), and thumb (28%). The patients were classified according to the new classification as shown in Table 2.

Sequelae of injuries

Though, there were no deaths from firework injury, two patients received permanent long-term disabilities. The first patient had undergone wrist disarticulation and the second was treated by amputation of proximal phalanx of thumb and metacarpal bone of the rest fingers. Forty-seven patients (48%) lost some part of their fingers (90 fingers), mostly were distal phalanxes (87%). The most common complications were infections (6), followed by scar contracture (3), malposition of instrument (1), skin necrosis (1), and tetanus infection (1).

Table 2. Classification and detail of injuries

Classification	No.	Detail of injuries
Low energy injury	13	- Superficial second degree burn (2 patients) - Laceration to fingers or palms (11 patients)
High energy injury	76	- Amputation of distal phalanx (63 patients)
Very high energy injury	6	- Amputation of middle phalanx (4 patients) - Amputation of proximal phalanx (3 patients)
Extremely high energy injury	2	- Wrist disarticulation (1 patient) - Amputation of proximal phalanx of thumb and metacarpal bone of index to little fingers (1 patient)

Table 3. Hospital stay and number of patients

Hospital stay (day)	Number
1 to 3	58
4 to 6	19
7 to 9	8
10 to 12	4
13 to 15	4
25 to 27	3
30 to 33	1

Hospital stay and cost of treatment

The average length of stay in hospital was 4.7 days (1 to 33 days). The patient who stayed the longest time was treated by a plastic surgeon who performed an abdominal flap and later detachment. The detail of hospital stays are shown in Table 3. The total hospital cost of injuries were $44,636 ($8,927 per year) and the average cost per cases was $460 (range $28 to $2,216).

Discussion

In the present study, 97 patients received firework-related hand injuries. They were all males (100%). This was higher than the previous report (85%)[1-10]. Children who played with fireworks resulting in injuries were typically in elementary school (age range 7 to 12 years, 56%) and junior high school (age range 13 to 15 years, 39%). The time of injury was usually at the end of Buddhist Lent Day (late September to early November), similar to other countries' days of celebration such as Chaharshanbe Soori[4,7,9], the Fourth of July[1,11], and New Year's Eve[6,8]. The influx of patients coming to hospital during the short festival made the management of the hospital more difficult.

Most patients were active users (97%). Due to missing data, the authors had no information about the kind of fireworks' causing the injuries (56%). Researches from other countries found that fireworks that caused most of the injuries were firecrackers (41%). In Thailand, fireworks that frequently caused injuries were plastic fireballs and homemade fireworks. The mechanism of injury of plastic fireballs were from explosion and penetration of plastic fragments. The mechanism of homemade fireworks proved to be more violent, because the users were mostly juvenile. They resorted to dangerous homemade tricks, such as removing gun powder from several fireworks and repacking into PVC pipes or glass bottles, resulting in a more powerful explosion. Explosions from such homemade fireworks often caused devastating injuries, in extreme cases, death (30 of 38 patients).

The fingers most likely to be injured by fireworks from the present research were the index finger (59%), followed by long finger (56%), thumb (28%), and associated first web space (33%). This is less than those in the study of Sandvall et al[2] (84% and 60%) and Hazani et al[14] (48% and 21%).

To help the physicians communicating with the health care team, the authors grouped the injury patterns according to the severity of the injury into four groups. After evaluation complication of these firework-related hand injuries, the authors found half of the very high-energy injury group's infection rate were high (three out of six patients). One patient in this group was infected with tetanus, causing permanent neurological damage. In the group of extremely high-energy injury, the patients underwent early amputation of injured parts. They had no infections, however, the amputations resulted in long-term disabilities of the hand. The present review did not find any deaths from fireworks.

The average cost of treatment for each patient in the present study was $460. Compared to other studies such as those of Moore et al (United States, $11,582)[15] and Alinia et al (Iran, $156 for burns, $3,471 for lacerations, $48,597 for amputations)[4], prices for treatment in the present study were far lower.

Firework-related hand injuries in pediatric subjects are preventable. Firework regulation in Thailand asserts that children under the age of 14 must be under the supervision of adults while playing with fireworks. Moreover, firework distributors must first obtain a license to sell explosives. The previous study indicated that the target demographic group (boys in elementary, junior, and high school) showed lower rates of incidence when being shown with educational videography and comic books. Releasing the interventions (videography and comic books) during particularly risk-prone times of the year, such as prior to the end of Buddhist Lent day, would reduce the incidence of firework-related injuries[16,17].

Conclusion

Most of firework-related hand injuries in Thailand were male active users during the end of Buddhist Lent Day. Fireworks can cause various degrees of injuries. Index and long fingers were frequently involved, resulting in long-term disability of some patient's hands. Plastic fireballs and homemade fireworks caused devastating injuries and should to be banned. The cost of treatment also resulted in unnecessary economic burden for patients, an average of $460 was spent on medical treatment per case.

What is already known on this topic?

Firework-related hand injuries are common around the world, often associated with celebration as fireworks are launched during that time. The severity of injuries is strongly related to the type of fireworks used. Homemade fireworks result in far more severe injuries and sometimes even death. Injury prevention campaigns and legislation that ban the use of some types of fireworks are effective in many countries.

What this study adds?

Most of firework-related hand injury patients were injured during the end of Buddhist Lent Day in Thailand. Children and adolescents often build dangerous homemade fireworks. The incidence of firework-related injuries might be decreased if there were prevention campaigns directed towards these firework users, released prior to the celebration.

Potential conflicts of interest

The authors declare no conflict of interest.

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