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Research Article

Prevalence and patterns of cracker blast injuries of the hand

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ABSTRACT

Background: Firecrackers are used to celebrate Diwali, Christmas, New Year, after matches, during wedding and death processions. The purpose of this study is to review the prevalence and patterns of cracker blast injuries of the hand in the community and to outline the possible pathomechanics of these patterns of injuries.
Methods: A retrospective study of patients admitted with cracker blast injuries of the hand in our department between 2012 and 2015 was made. The patients with cracker blast injuries of the hand were grouped as mild, moderate or severe with the help of X-rays, clinical photographs and operative notes.
Results: 120 patients of cracker blast hand injuries were treated in the department of plastic surgery between 2012 and 2015. Most of the patients were males. The age group was 6-58 years with an average of 26 years. The commonest cause of injury was firework misuse (56%), followed by device failure (40%). Superficial burns were treated with dressings. Certain wounds needed only thorough cleansing of the wound and primary suturing. Patients with severe injuries had amputations of part or whole of the hand. Other patients were managed with tendon repair, neurovascular repair, fracture fixation, and flap cover.
Conclusions: Stiffness is common after blast injuries and the functional loss is long lasting or permanent. By creating awareness regarding safety precautions, encouraging professional displays and motivating manufacturers to adhere to strict quality control the disability due to cracker blast hand injuries can be reduced.

Keywords: Hand, Cracker blast injuries, Disability, Stiffness

INTRODUCTION

Firecracker-related injuries have been identified as one of the more important causes of burns. Around Diwali, Christmas and New Year, these types of blast injuries result in hundreds to thousands of damages annually.[1] A firecracker is a small type of explosive device containing a fuse, which makes a loud sound on explosion. Most of the victims suffer from burns on the face, arms, and hands. Medical attention is most often needed; from simple cleaning of the wound to suturing and even to surgery. In some cases, amputation is warranted. Deaths have also been reported. Plastic surgeons are frequently involved in the primary care of these patients as many such injuries involve the hand. The predominance of the hand involvement in such injuries is due to accidental blast during handling a cracker as well as the injury sustained when a person tries to shield himself from a cracker blast with his hands.[2] The purpose of this study is to evaluate the most common pattern of hand injuries due to cracker blast and the pathomechanics of cracker blast injuries to the hand and the treatment plan in our series.

METHODS

A retrospective study of 120 patients admitted with cracker blast injuries of the hand in our department between 2012 and 2015 was made. Most commonly, patients suffered hand injuries while holding the crackers in their hands, while a few suffered injuries when

attempting to shield themselves from the cracker blast. All of these injuries occurred from commercially available as well as homemade fire crackers, which varied in their intensity. The anar (flower pot) was found to be the most common causative agent, closely followed by bombs, chakri and rocket (Figure 1).

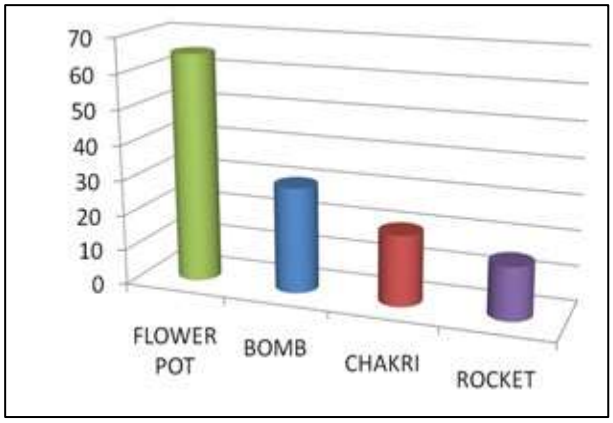

Figure 1: Causative agents in cracker blast injuries of hand.

A quick history was taken following which the patients were taken to the operating room as early as possible. The patients with cracker blast injuries of the hand were grouped as mild, moderate or severe with the help of X-rays, clinical photographs and operative notes. All patients were subjected to primary debridement followed by primary closure if possible. In others, serial debridement followed by either healing by secondary intention or definitive flap coverage was done. Joint disruptions were managed with K-wire fixation on an immediate basis and associated reconstruction. Fractures were managed with definitive wound closure followed by fixation with either K-wire or mini plates.

Patients with mild injuries had only involvement of the soft tissues with no involvement of bone or joints which permitted early motion after repair and an excellent outcome. Moderate injury was described in patients having injuries to bones and joints in addition to soft tissues but no amputations of any kind so that the eventual outcome was satisfactory with some degree of residual stiffness in the hand. Patients with severe injuries had amputations of part or whole of the hand, which led to terminalisation operations in many cases and to severe disability and stiffness. Cracker blast injuries of the hand were treated with both repair and replacement depending on the extent of the injury, which was highly variable. The flaps commonly used were the groin flap, random pattern abdominal flap and chest flap. The primary aim of management was maximal preservation of function. All patients except those with a terminalisation operation proceeded to an immediate intensive postoperative physiotherapy program and were subsequently rehabilitated.

RESULTS

Fire crackers caused a spectrum of injuries ranging from mild to severe due to variable blast potentials and differing distance of the explosive from the hand at the time of the blast. The commonest cause of injury was firework misuse (56%), followed by device failure (40%). Cracker was lit in the hand and exploded before it could be thrown in seventy patients (58.33%); an unexploded cracker was picked up off the floor in thirty five patients (29.08%), child playing with a cracker resulting in either child or supervising adult being injured in ten patients (8.33%) and events were not clear in five patients (4.16%).

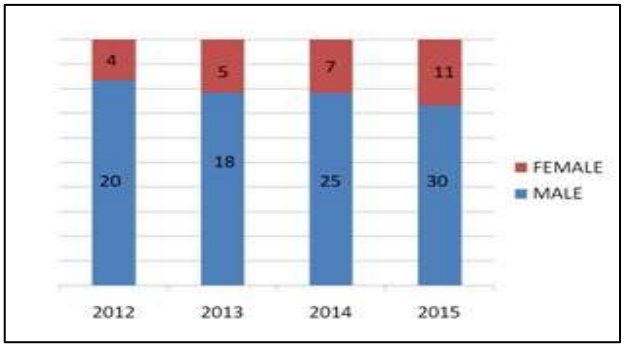

Figure 2: Gender distribution in cracker blast injuries of hand.

The spectrum ranged from soft tissue injuries to amputations of the whole hand. The degree of injury varied with the type of firecrackers. Most of the patients were males (78%) (Figure 2). The age group was 6-58 years with an average of 26 years. Eighteen (15%) patients admitted to using alcohol around the time of the injury. About 38% patients were illiterate. The dominant hand was involved in 65% of cases (78 patients) with bilateral hand injuries being encountered in 33.3% of patients (40 patients) and only 2 patients (1.7%) had injury of only the non-dominant hand. 24 patients had mild injuries (20%) (Figure 3(a)). About 84 patients had moderate injuries (70%) (Figure 3(b)) 12 patients had severe injuries (10%) (Figure 3(c)).

Figure 3: (a) Mild cracker blast injuries.

Figure 3: (b) Moderate cracker blast injuries.

Figure 3: (c) Severe cracker blast injuries.

Associated injuries included soft tissue and bony injuries to the face (8.4%), the torso (12.6%) and the forearm and arm (39%). Associated injuries comprised mostly of a combination of superficial and deep burn injuries with soft tissue lacerations in some cases distributed over the face, torso and upper limbs.

Figure 4: (a) Radial to ulnar trend with the thumb injuries.

The pattern of injuries to the hand showed a radial to ulnar trend with the thumb being the most frequently injured digit (Figure 4(a)) There were severe lacerations in the mid- palm and radial fingers (Figure 4(b)). Tissue destruction was noted primarily at the first web space. Amputations of the thumb and digits were predominantly at the metacarpophalangeal (MCP) and interphalangeal (IP) joints (Figure 4(c)) Fractures of the metacarpal bones, carpometacarpal disarticulations, and avulsions of the hand at the wrist were less common.

Figure 4: (b) Mid-palm and radial fingers injuries.

Figure 4: (c) Amputations of the thumb and digits.

The mode of injury in most of the patients revealed a common mechanism. Most of them while throwing or holding the fire cracker in the dominant hand sustained hyperextension and hyper abduction of the hand and digits. The joint hyperextension was associated with soft tissue avulsion and finger disarticulation. The hyper abduction at the web spaces was associated with avulsion injuries of the palm (Figure 5).

Figure 5: Avulsion injuries of the palm.

Postoperative vigorous physiotherapy resulted in a near normal function in mild injuries; stiffness and restricted range of motion in severe injuries. Moderate injury

patients varied in their recovery of full range of motion of the fingers. The length of hospital stay was the shortest in patients with mild injuries but was commonly more than 2 weeks in patients with moderate and severe injuries. Stiffness was especially marked when metacarpal fractures were encountered and was even resistant to intensive physiotherapy.

DISCUSSION

Firecrackers are commonly used during celebrations because of their sound, sparkle and sudden burst of colours, expressing the festive mood.[1] They are used during Tihar in Nepal, Hari Raya in Malaysia, Day of Ashura in Morocco, Guy Fawkes Night or bonfire night in the United Kingdom, Independence Day and Halloween in the USA, Bastille Day in France, Spanish Fallas and New Year's Day in Guatemala, Chinese New Year by the Chinese and many other festivals all over the world.[1] Puri et al have mentioned that there had been a decrease in the prevalence of firecracker injuries over 10 years of their study period.[2] Firecracker injuries in the USA affected approximately 10,000 persons annually from 1980 to 1989 as per the National electronic surveillance system, while during 1990-2003, 85, 800 paediatric firework related injuries were treated.[3,4] In the UK, the number of firework related injuries peaks during Halloween and Night GF.[5] In Denmark, over a 12 years period from 1995-1996 to 2006-2007, there were 4447 patients of firecracker related injuries during 2 days of New Year.[6] Injuries caused by fireworks are a national problem in Greece too. The reported incidence is 7 per 100,000 children annually, out of which 70% are in the age group of 10-14 years.[7] Hence, firework related injuries are encountered the world over. Both the developed and developing countries are facing the problem of firecracker related injuries in large numbers. These are the national statistics of different countries. Safdarjung hospital, only one of the many, though the largest in the Delhi national capital region catering to most of the firecracker related injuries, has encountered 1373 patients over a 9 years period.[1]

In our study the age group was 6-58 years with an average of 26 years. In the USA, high incidence of firework related injuries among children has been reported. In different reports, children below 15 years formed 40-50% of the victims.[8] It was observed that the states in USA which are liberal in allowing fireworks for personal use have 7 times greater incidence than the states where more restrictions are imposed.[9] It has been suggested that public fireworks should be encouraged and fireworks for individual use should be banned.[10] In a recent publication from Bangalore, India, while presenting 51 patients of firework related ocular injuries, it was concluded that firework related injuries result in significant morbidity and the authors emphasized upon public education to reduce them.[11]

Blast Injuries to the hand are three times more common from low explosives than from high explosives. Some of the more frequently used explosives include firecrackers, pipe bombs and dynamites. In a significant number of cases, homemade firecrackers are the cause of explosion.[12] The predominance of the right hand in such injuries may be an accident while hurling a cracker or due to mischievous behavior of firing the cracker with bare hands.

The most common pattern of injury in our study comprised of a first web space split with variable degrees of thinner muscle injury, dorsal dislocation of the CMC joint of the thumb, which was occasionally associated with 2 and 3 metacarpal injuries. In many patients, this was associated with amputations of portions of the 2 and 3 fingers. The pathomechanics of cracker blast hand injuries are as follows: the hand comprises of 4 discrete units of which the thumb is the most mobile owing solely to the mobility of the CMC joint which is bi saddle in nature. The index finger is the next most mobile unit attached to the fixed unit of the hand comprised of the central metacarpals. The rest of the fingers and the metacarpals take part in power grip of the hand.[12]

For gripping an object like a bomb, the primary action is provided by the thumb and the index finger with a supportive part played by the ulnar fingers while the long finger stabilizes the grip.[12] Therefore, when an explosion occurs with the object being held in the hand or in close contact with the hand, there are several injury vectors acting in a centrifugal direction radiating from the major point of contact with the hand which is the thinner eminence. This is subject to the brunt of the damage by the injury vectors which leads to a first web split.[13]

As the injury vector radiates outside, it next disrupts the loose fitting bisaddle joint of the thumb causing a dorsal dislocation of the same since it has the lowest stability. The centrifugal injury vectors go on to affect the fingers and also travel to the center of the hand. The MCP joints in the other fingers resist disruption to some extent because the proximally unattached volar plate in these joints permits some degree of hyperextension and shock absorption.[12] The IP joints have fixed volar plates and are therefore unyielding and usually disrupt from the injury leading to amputations of these fingers. The center of the hand comprises of 2 and 3 metacarpals fixed to the carpus in the hand and their shafts become the weakest target and are subject to fracture from the effect of the blast.

Once the immediate life threatening conditions have been treated and the injured extremity has been stabilized, a plan for reconstruction of bone and soft tissue is formulated.[13-15] although revascularization of ischemic tissues and replantation of amputated parts are time honored procedures, repair at the acute setting after an explosion has been limited because of the destructive forces exerted during the blast.[16] Completion amputations, delayed primary closure, and local wound

care are the mainstay of initial treatment when revascularization is not a viable option.[17] During the early phase, debridement and skeletal fixation are essential components in preparation for major reconstructive procedures.

Figure 6: (a) Random pattern chest flap.

A variety of flaps are used for adequate wound coverage mainly in the delayed primary setting (Figure 6(a)). The groin flap was the most favoured in our series and there was good outcome eventually in these patients. The next most common was the random pattern abdominal flap and the chest flap (Figure 6(b)). The posterior interosseous artery and the reverse radial flap are other flaps used in the reconstruction process.[17,18] Stiffness was marked in our patients in the post-operative phase in those with moderate and severe injuries, which was quite resistant to even intensive physiotherapy programs.

Figure 6: (b) Thumb reconstruction.

Firework related injuries are considered as preventable, and to reduce their menace, many countries have formulated legislations during the past two decades. National electronic injury surveillance system data in 1994 suggested banning the rocket, restrictions in access to young ones and educational programmes to reduce firework related injuries. Fogarty and Gordon and Puri et al have recommended restriction in the use of firecrackers by children under 5 years of age.[2,20] Public education in schools, strict standardization of firecrackers, supervision by adults, restriction in personal use of firecrackers and promotion of public display of firecrackers are the other means suggested.

Do's and Don'ts related to Fire crackers

- Do light firecrackers outdoors, as they are potential fire hazards
- Do light one firecracker at a time
- Do not hold a firecracker while lighting it
- Do not pick up failed firecrackers, they can still explode
- When lighting fireworks like a fountain, do not bend directly over the pyrotechnic devices
- Do not throw firecrackers at passing people or vehicles
- Do not allow children to hold firecrackers

CONCLUSION

Cracker blast injuries of the hand can have a spectrum of effects ranging from a mild injury to amputation of the whole hand. The key to management is attention towards early debridement and wound coverage with post-operative splinting in the functional position. Caregivers and parents are responsible for strictly prohibiting children from picking up failed firecrackers. People should be educated about the dangers of firecrackers.

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