SCIENTIFIC ARTICLE

Severe Hand Injuries From Fireworks: Injury Patterns, Outcomes, and Fireworks Types

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Purpose The purpose of this study was to characterize injury patterns and outcomes of fireworks-related hand injuries and determine if there was an association with certain fireworks types.

Methods A retrospective cohort study was conducted on patients treated at a trauma center between 2005 and 2015. A total of 105 patients sustaining operative hand injuries due to fireworks were identified. Medical records were reviewed to identify injury patterns, treatment outcomes, and fireworks types.

Results Eighty-eight patients (84%) sustained 92 thumb and/or first web space injuries. There were 12 thumb soft tissue–only injuries (13%) and 80 thumb fractures/dislocations (87%). Of these, there were 52 thumb carpometacarpal (CMC) joint dislocations (57%) and 36 thumb fractures outside the thumb CMC joint (39%). Fifteen hands (16%) sustained both thumb CMC joint dislocations and additional thumb fractures. Twenty-three hands (25%) required thumb revision amputation. The number of surgeries for acute reconstruction ranged from 1 to 7, with 17 patients (19%) requiring 3 or more. Sixty-three hands had deep first web space injuries, and 11 (17%) required flaps acutely for first web space reconstruction. Six hands required secondary reconstruction of a first web space contracture. An external fixator was applied to 6 hands to maintain the first web space; none of these required secondary web reconstruction. Excluding isolated pin removals and dressing changes under anesthesia, 19 patients (22%) required later-stage surgeries. Shells/mortars (59%) were the most common fireworks type causing injury.

Conclusions Among operative hand injuries, fireworks most commonly fracture the thumb, destabilize the thumb CMC joint, and deeply damage the first web space. The first web space requires particular consideration because deep injury may result in adduction contracture and require secondary reconstruction if not prevented. *(J Hand Surg Am. 2017;■(■):■–■.*

Type of study/level of evidence Therapeutic IV.

Key words Blast, fireworks, first web space, pattern, thumb.

When fireworks inflict injury, they most commonly injure the hands. Injuries have been reported with every fireworks type. The U.S. Consumer Product Safety Commission estimates about 10,500 people were treated in hospital emergency rooms for fireworks-related injuries in 2014.[1] Of these, 36% were hand injuries.[1] Previous studies have shown many of these injuries are superficial, treated as outpatients, and do not require surgery.[1–4] However, some fireworks-related hand injuries are severe, require prolonged hospital stays with multistage reconstruction, and often result in amputations, stiffness, and long-term impairment.[1,5,6]

Although patterns of hand injury after blasts have been described, much of the information originates from studies assessing combat-related injuries or injuries due to a heterogeneous group of blast mechanisms including

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gunfire or bombs.[4–12] Furthermore, existing reports are often small, specifically exclude either children or adults, do not provide detailed hand injury patterns, and do not assess a variety of fireworks types.[4,6,7]

The purpose of this study was to characterize injury patterns and treatment outcomes among fireworks-related injuries and, if possible, identify fireworks types associated with specific injuries.

MATERIALS AND METHODS

Approval for this study was obtained from the institutional review board of our institution. The hospital trauma registry was queried to identify adult and pediatric patients with fireworks-related injuries. A retrospective cohort study was conducted on 105 patients who presented to our level 1 trauma/burn center between 2005 and 2015 with fireworks-related hand injuries requiring surgery. Medical records were reviewed to collect patient demographic information, fireworks type, injury characteristics, and operative details. Deep first web space injuries were defined as those in which the operative report specifically described a splayed-open first web space and debridement of necrotic muscle in that region. There were 102 males and 3 females, and the mean age was 28 years (range, 5–58 years). There were 16 pediatric patients (age, $\leq$ 17 years).

RESULTS

Injury patterns

Of the 105 patients with fireworks-related hand injuries requiring surgery, 12 patients (11%) did not have thumb or first web space injuries and 29 patients (28%) also had traumatic carpal injuries. Six patients (6%) underwent revision amputation of the hand through the wrist or forearm. Five of these 6 were excluded from the thumb/first web space subgroup. The sixth patient was included in the thumb/first web space subgroup owing to a contralateral thumb injury. Seventy-eight of the 105 patients (74%) sustained isolated hand and wrist injuries and 31 patients (26%) had additional injuries to other body regions (globe, face, brain, arm, trunk, and/or leg) from the same blast. All injuries were from consumer or after-market modified consumer fireworks; none sustained injuries at professional fireworks displays. The distribution of revision amputations among 105 patients with operative hand injuries is displayed in Figure 1.

In the thumb and/or first web space injury group, 88 patients (84%) sustained 92 hand injuries (4 bilateral). Fractures, dislocations, amputations, and soft tissue injuries for this group are summarized in Table 1. Sixty-one patients (69%) sustained 63 deep first web space injuries. Figure 2 shows an example of a deep first web space injury.

FIGURE 1: Revision amputations. Distribution and level of revision amputations among all fireworks-related operative hand injuries.

Thumb and first web space outcomes

Among patients with thumb and/or first web space injuries, the number of surgeries for acute repair and reconstruction ranged from 1 to 7. Acutely, 58 of 88 patients (66%) required 1 surgery, 13 (15%) required 2 surgeries, and 17 (19%) required 3 or more surgeries. One thumb revascularization was performed; however, it failed in the perioperative period, and subsequent thumb reconstruction using a groin flap and second toe transfer was completed.

Eleven hands required flaps acutely for first web space reconstruction. Three fillet flaps, 4 reverse posterior interosseous artery flaps, 1 second dorsal metacarpal artery flap, 1 reverse radial forearm flap, and 2 groin flaps were used. Among these, a combination of Kirschner wires and/or external fixation devices stabilized the thumb carpometacarpal (CMC) joint and maintained the first web space. Of 63 hands with deep first web space injuries, 7 hands (11%) received no first web space operative immobilization, 50 hands (79%) were treated with Kirschner wires alone, and 6 hands (10%) were treated with an