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Pattern, Etiology, and Outcomes of Isolated Blast Injuries to the Hand: A Malaysian Tertiary Center Experience

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Abstract
Background: Blast injuries to the hand can have devastating consequences due to the loss of critical hand functions. However, the epidemiology of such injuries remains poorly characterized in Malaysia. This study aimed to investigate the pattern, etiology, and outcomes of isolated blast hand injuries presenting to the Hand and Microsurgery Unit, Hospital Selayang. Materials and Methods: A single-center, retrospective, cross-sectional study was conducted including all patients with isolated blast injuries to the hand between January 2020 and December 2025. Demographic data, injury characteristics, surgical interventions, length of stay, and complications were analyzed using descriptive statistics. Results: Twenty-five patients were included, with a mean age of 24.8 ± 14.1 years. The majority were male (88%, n=22) and of Malay ethnicity (72%, n=18). Right-hand dominance was reported in 96% of patients. Misuse of the explosive device was the primary mechanism (64%, n=16). The most common injury types were abrasion (96%), amputation (52%), and fracture (48%). Fingers were the most frequently injured region (68%, n=17). Moderate injuries accounted for 60% of cases. Surgical management consisted of wound debridement alone (44%), refashioning (44%), K-wire fixation (8%), and joint disarticulation (4%). The mean length of hospital stay was 4.4 ± 3.3 days. Postoperative joint stiffness occurred in 12% of patients. Conclusion: Blast hand injuries in Malaysia predominantly affect young males, with finger involvement and amputation being common. Device misuse is the leading mechanism, highlighting the preventable nature of these injuries. Specialized hand surgery services and structured rehabilitation are essential for optimal outcomes.

Keywords: Blast injury, hand injury, Malaysia, amputation, hand trauma

1. Introduction

Hand injuries consistently rank among the most common musculoskeletal conditions encountered in emergency departments worldwide [1, 2]. In recent years, there has been a marked surge in such injuries, largely attributable to the increased use of machinery, the handling of fireworks, and violence-related incidents [3]. The clinical presentation of hand injuries is highly variable; they may occur in isolation or

in conjunction with trauma to other anatomical regions [4]. Similarly, the severity of these injuries spans a broad continuum, from minor soft tissue damage to catastrophic tissue loss, necessitating an equally wide range of therapeutic interventions, from conservative wound care and splinting to complex reconstructive surgery or amputation [5, 6].

Patients who sustain acute hand trauma often face temporary or permanent impairment of hand function. Given the hand's essential role in daily activities, occupational tasks, and non-verbal communication, such functional loss can profoundly diminish quality of life, both in the immediate post-injury period and over the long term [7] The psychosocial and economic burdens are considerable, particularly when injury results in chronic disability or disfigurement.

Among the various mechanisms of hand trauma, isolated blast injuries represent a distinct and often devastating subset. In civilian populations, these injuries most frequently arise from accidental explosions involving firecrackers or fireworks, gunshot wounds, or the mishandling of low-grade explosives such as tear gas shells [6]. The extent of injury is largely determined by the proximity of the hand to the explosive source and the size of the explosive charge [6]. Blast injuries present with a diverse array of wound types, including lacerations, avulsions, traumatic amputations, thermal burns, vascular disruption, compartment syndrome, crush injuries, and degloving injuries [6]. Individually or in combination, these wound types can lead to rapid functional deterioration and, in severe cases, permanent disability or loss of the limb.

Despite the clinical importance of this injury pattern, to date, only few studies have systematically examined the epidemiology of blast-related hand injuries, particularly in specific geographic regions such as Malaysia. To address these critical research gaps, the present study was designed to investigate the pattern, etiology, and functional outcomes of blast hand injuries reported to the hand and microsurgery unit, Hospital Selayang.

2. Materials and Methods

This was a single-center, retrospective, cross-sectional study conducted at the Hand and Microsurgery Unit, Hospital Selayang, Malaysia. Hospital Selayang is a tertiary referral center and serves as a national hub for specialized hand and microsurgery services, receiving complex upper extremity trauma from across the country. The study aimed to investigate the epidemiological pattern, etiology, injury characteristics, and functional outcomes of isolated blast injuries to the hand presenting to this unit.

All patients with isolated blast injuries to the hand who presented to the emergency department and were subsequently referred to the Hand and Microsurgery Unit between 1st January 2020 and 31st December 2025 were considered for inclusion. Patients medical were traced based on blast injury registry. Inclusion criteria included (1) sustained a blast injury primarily involving the hand (unilateral or bilateral) and (2) Had not undergone any major surgical intervention prior to presentation at Hospital Selayang. Patient were excluded if there is missing data.

Demographic and clinical data were collected prospectively using a standardized data collection form. Variables recorded included (1) Age, sex, and occupation, (2) hand dominance, (3) mechanism and source of blast (e.g., firecrackers, tear gas shells, stun shells, gunpowder, or other low-grade explosives), (4) Region of hand injury (coded as: thumb only, fingers only, palm, dorsum, multiple regions, or whole hand), (5) presence and type of associated fractures (documented radiologically using plain radiographs), (6) associated soft tissue injuries (laceration, avulsion, degloving, burn, crush, compartment syndrome, vascular injury) (7) Surgical interventions performed (e.g., debridement, revascularization, replantation, fracture fixation, flap coverage, amputation), (8) length of hospital stay; and (9) complications.

Data were entered into Microsoft Excel (Microsoft Corp., Redmond, WA) and analyzed using SPSS version 29.0 (IBM Corp., Armonk, NY). Descriptive statistics were calculated for demographic, clinical, and injury-related variables. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages

3. Results

A total of 25 patients with isolated blast injuries to the hand were included in the study. The mean age of the study population was 24.8 years (standard deviation [SD] ± 14.1) (Table 1). The majority of patients were male (22, 88%), with only three female patients (12%). In terms of ethnicity, the largest group was Malay (18, 72%), followed by Chinese (4, 16%), Indian (1, 4%), Orang Asli (1, 4%), and one foreign national (1, 4%). Right-hand dominance was reported in 24 patients (96%), while only one patient (4%) was left-hand dominant. Highest number of blast injury was seen in age group 11-15 years old, 16 -20 years old and 31-35 years old (Figure 1).

Table 1. Demographic and Clinical Characteristics of Patients with Isolated Blast Hand Injuries (n=25)

Demographic		
Age		24.8 (14.1)*
Gender		
	Male	22(88) ^
	Female	3 (12) ^
Ethnicity		
	Malay	18 (72) ^
	Chinese	4 (16) ^
	Indian	1 (4) ^
	Orang asli	1 (4) ^
	Foreigner	1 (4) ^
Hand dominant		
	Right	24 (96) ^
	Left	1 (4) ^
Mechanism of injury		
	Misuse	16 (64) ^
	Devise failure	9 (36) ^

* Mean (Standard deviation)

^ Frequency (percentage)

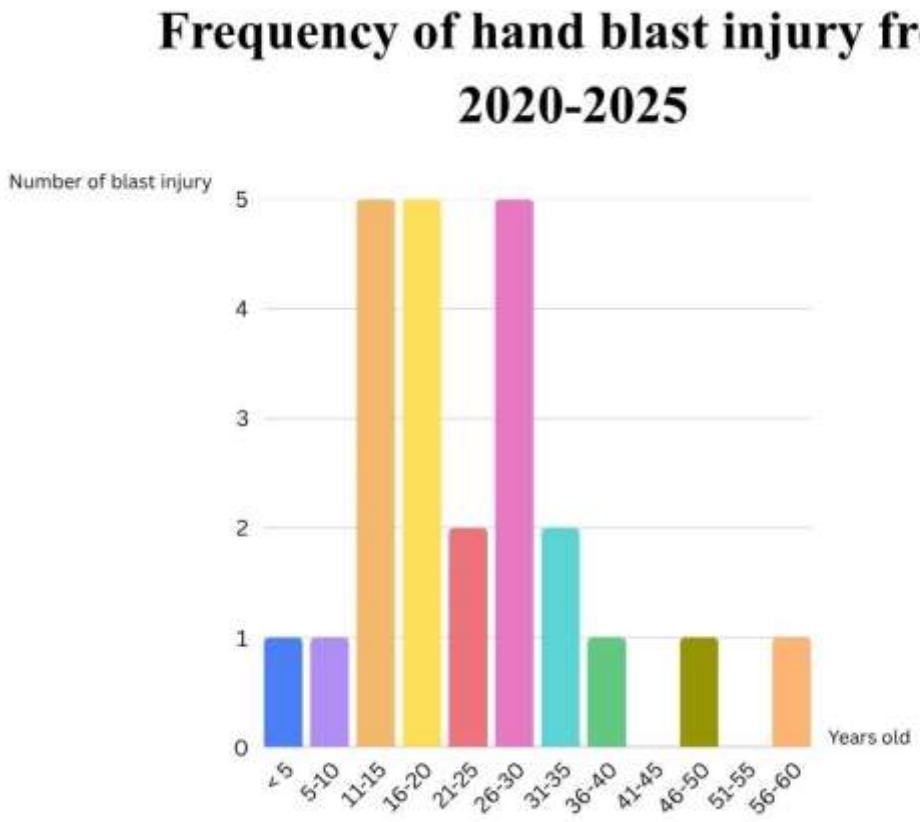

Figure 1 showed distribution of blast injury in different age category.

Regarding the mechanism of injury, misuse of the explosive device was the most common cause, accounting for 16 cases (64%), while device failure was responsible for the remaining nine cases (36%). The most frequently observed injury type was abrasion, present in 24 patients (96%). Amputation occurred in 13 patients (52%), fractures in 12 patients (48%), and laceration in six patients (24%). With respect to anatomical location, the fingers were the most commonly injured region, involved in 17 patients (68%). The palm was affected in seven patients (28%), while isolated thumb injury was observed in only one patient (4%).

The majority of patients (15, 60%) sustained moderate injuries. Mild and severe injuries were each observed in five patients (20% each). Among the 25 patients, 11 (44%) underwent wound debridement only, and another 11 (44%) underwent refashioning. Two patients (8%) required wound debridement combined with K-wire fixation for fracture stabilization. One patient (4%) underwent joint disarticulation at the level of distal interphalangeal joint. The mean length of hospital stay was 4.4 days (SD ± 3.3). Postoperative complications were documented in three patients (12%), all of whom developed joint stiffness requiring hand therapy (Table 2).

Table 2. Injury Characteristics, Surgical Interventions, and Postoperative Outcomes (n=25)

Type of injury		
	Abrasion	24 (96) ^
	Amputation	13 (52) ^

	Fracture	12 (48) ^
	Laceration	6 (24) ^
Location of injury		
	Thumb	1 (4) ^
	Finger	17 (68) ^
	Palm	7 (28) ^
Severity		
	Mild	5 (20) ^
	Moderate	15 (60) ^
	Severe	5 (20) ^
Type of surgery		
	Disarticulation	1 (4) ^
	Wound debridement and k wire	2 (8) ^
	refashioning	11 (44) ^
	Wound debridement	11 (44) ^
Length of stay		4.4 (3.3)*
Complication		
	stiffness	3 (12)^

* Mean (Standard deviation)
^ Frequency (percentage)

4. Discussion

The present study investigated the pattern, etiology, and functional outcomes of isolated blast injuries to the hand among patients presenting to the Hand and Microsurgery Unit, Hospital Selayang. Our findings demonstrate that blast hand injuries predominantly affect young males, with the dominant hand being most commonly involved, consistent with the existing literature on blast-related hand trauma.

In our cohort, 88% of patients were male with a mean age of 24.8 years. This male predominance aligns closely with previous studies. Hazani et al. reported that 92% of their 62 patients with blast hand injuries were male, with an average age of 27 years [8]. Similarly, in a study of 33 hand blast injuries, found that 93.3% of patients were male, with a mean age of 25.2 years [9]. The predominance of young males in these injuries has been attributed to higher rates of risk-taking behavior, handling of explosive devices, and participation in activities involving fireworks or low-grade explosives. Marinković et al. emphasized that hand injuries comprise up to one-fourth of all injuries and carry a high potential for causing long-term physical and functional disability affecting quality of life [10].

Right-hand dominance was observed in 96% of our patients, and the dominant hand was injured in 84.62% of cases. This finding corroborates the observations of Hazani et al., who reported that 89% of blast injuries involved the dominant hand, with the common mechanism being a young man holding a low explosive in his dominant hand at the time of detonation [8]. Giessler et al. similarly documented that the majority of blast injuries occur while the patient is holding or manipulating the explosive device, typically in the dominant hand [11]. Grassi et al. also reported more frequent involvement of the right hand in their series of fireworks-related blast injuries .

The mechanism of injury in our study revealed that misuse of the explosive device accounted for 64% of cases, while device failure was responsible for the remaining 36%. This distribution highlights the preventable nature of these injuries, as most occur during active handling rather than passive exposure.

The anatomical distribution of injuries in our study showed finger involvement in 68% of cases, palmar injuries in 28%, and isolated thumb injury in only 4% of patients. Hazani et al. identified a distinctive pattern of hyperextension and hyperabduction of the hand and digits, with the radial digits (thumb and index finger) being most severely affected [11]. They noted that finger disarticulation amputations were worse at the radial digits, and significant tissue destruction was observed primarily at the first web space and mid-palm region. In contrast, our study found a lower proportion of thumb injuries. This discrepancy may be explained by differences in the type of explosives used or variations in hand positioning at the time of detonation in our population.

Amputation occurred in 52% of our patients, fractures in 48%, and lacerations in 24%. The high rate of amputation is consistent with the findings who reported that amputations constituted 69.7% of surgical interventions in their series [9]. Giessler et al. noted that larger explosive shells led to traumatic subtotal amputations of the exposed fifth finger ray and thenar ray, while smaller explosives caused multiple lacerations in the palm, subcutaneous flexor tendon ruptures, and closed fingertip fractures [11].

In our study, 44% of patients underwent wound debridement only, 44% underwent refashioning , 8% required K-wire fixation, and 4% underwent disarticulation. The predominance of debridement and amputation procedures over microsurgical repair reflects the destructive nature of blast injuries. Hazani et al. noted that given the mechanisms of injury with significant tissue loss, surgical intervention generally involved tissue replacement rather than tissue repair, with only five of 45 microsurgical procedures performed at the acute setting [11]. They emphasized that completion amputations, delayed primary closure, and local wound care are the mainstay of initial treatment when revascularization is not a viable option.

Giessler et al. reported that all 50 patients in their series required primary operative intervention, with subsequent operations necessary in 19 cases (range 1-4 operations, median 1) [11]. They concluded that blast injuries of the hand require a fast, strategically planned surgical approach, and profound skills in reconstructive and microvascular hand surgery are essential to achieve optimal clinical outcomes. Postoperative complications occurred in 12% of our patients, all of whom developed joint stiffness requiring hand therapy. This finding underscores the importance of early rehabilitation in blast hand injury management. The mean length of hospital stay was 4.4 days. Marinković et al. emphasized that hand injuries require excellent surgical skills and aggressive physical therapy due to their high potential for causing long-term physical and functional disability [10].

Several limitations of this study warrant acknowledgment. First, the sample size (n=25) is relatively small, limiting the generalizability of our findings and precluding detailed subgroup analyses. Second, the follow-up period of six weeks may be insufficient to capture long-term functional outcomes, as recovery from blast hand injuries often continues for months to years. Third, the single-center design may introduce selection bias, as Hospital Selayang is a tertiary referral center that may receive more severe injuries than community hospitals. Fourth, the lack of a control group prevents direct comparison with other mechanisms of hand injury. Finally, we did not assess psychological outcomes or return-to-work rates, which are important dimensions of recovery following traumatic hand injuries.

5. Conclusion

Blast injuries to the hand predominantly affect young males, with the dominant hand being most commonly involved due to the handling of explosive devices. In our Malaysian cohort, misuse of explosives was the primary mechanism, with fingers being the most frequently injured anatomical region. Surgical management primarily involves debridement and amputation procedures rather than microsurgical repair, reflecting the destructive nature of blast forces that cause significant tissue loss and contamination. Postoperative joint stiffness remains a common complication, highlighting the critical need for early and aggressive hand therapy.

From a public health perspective, the predominance of injuries due to device misuse suggests that many of these injuries are preventable through educational interventions, stricter enforcement of fireworks regulations, and public awareness campaigns targeting young males. Healthcare systems serving populations at risk for blast hand injuries should ensure the availability of specialized hand surgery services and structured rehabilitation programs.

Future multicenter studies with larger sample sizes and longer follow-up periods are needed to better characterize the epidemiology of blast hand injuries in Malaysia, to identify risk factors for poor outcomes, and to evaluate the effectiveness of different reconstructive and rehabilitative strategies. Additionally, research examining the psychosocial and economic impact of these injuries would provide a more comprehensive understanding of the burden they impose on patients, families, and society.

References

1. Shrestha, S., S. Tamrakar, and A.K. Banskota, *Outline of Hand and Wrist Injuries Presenting to an Emergency of a Tertiary Care Centre in Nepal.* J Nepal Health Res Counc, 2019. **17**(3): p. 340-344.
2. Arroyo-Berezowsky, C. and J. Quinzanos-Fresnedo, *Epidemiology of hand and wrist injuries treated in a reference specialty center over a year.* Acta Ortop Mex, 2021. **35**(5): p. 429-435.
3. Panse, N. and P. Sahasrabudhe, *Hand injury prevention in India: Are we doing enough?* Indian J Plast Surg, 2011. **44**(3): p. 532.
4. Gupta, A., et al., *Demographic profile of hand injuries in an industrial town of north India: a review of 436 patients.* Indian J Surg, 2013. **75**(6): p. 454-61.
5. Bakhach, J., G. Abu-Sitta, and S. Dibo, *Reconstruction of blast injuries of the hand and upper limb.* Injury, 2013. **44**(3): p. 305-12.
6. Sandvall, B.K., K.A. Keys, and J.B. Friedrich, *Severe Hand Injuries From Fireworks: Injury Patterns, Outcomes, and Fireworks Types.* J Hand Surg Am, 2017. **42**(5): p. 385 e1-385 e8.
7. Rivedal, D.D., et al., *Blast Injury to the Hand: Assessing the Injury Pattern and Functional Outcome of the Thumb.* Plast Reconstr Surg Glob Open, 2021. **9**(9): p. e3767.
8. Hazani, R., R.F. Buntic, and D. Brooks, *Patterns in blast injuries to the hand.* Hand (N Y), 2009. **4**(1): p. 44-9.
9. Allah, K.C., et al., *[Blast injuries of the hands in precarious health situation].* Ann Chir Plast Esthet, 2014. **59**(3): p. 181-8.
10. Marinkovic, M., Z. Janjic, and J. Nikolic, *Estimating disability and quality of life after different degrees of hand and forearm trauma.* Vojnosanit Pregl, 2015. **72**(2): p. 155-9.
11. Giessler, G.A., et al., *[Blast injuries of the hands. Patterns of trauma and plastic surgical treatment].* Unfallchirurg, 2006. **109**(11): p. 956-63.