An exploratory study of the impact of firecracker-induced hand injuries on adolescents and their parents

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Abstract

Background Severe hand injuries due to firecrackers are unfortunately common in the Netherlands. These injuries are expected to have long-term functional and psychological sequelae. We performed a study to assess the long-term impact of such injuries on the victims and their parents.

Methods Eight sequential adolescent patients that underwent surgery for firecracker-induced severe hand injuries between September 2012 and March 2015 were included. The patient files were assessed for data on hand function. The impact of the injuries was measured by questionnaires and measure instruments: VAS for pain, CHEQ2.0 and COPM-DLV for activities and participation, PedsQL-4.0 for participation and quality of life, RSES for self-esteem, and DT-P for impact on parents.

Results Seven of the eight patients underwent (partial) hand amputation. Three adolescents still reported pain at a mean of 3.2 years post-trauma. All adolescents required more time than peers performing activities. Seven showed a total of 34 activity and participation problems. One adolescent showed no problems at all. The adolescents showed a mean score of 81 on the PedsQL-4.0, which was not different to healthy adolescents. None had problematic low self-esteem. Six out of eight parents had elevated distress; three parents stated that they still needed psychological support.

Conclusions Severe hand trauma due to firecrackers has an evident impact on hand function and activities in all adolescents. The injuries have a significant long-lasting psychological impact on the parents. Prolonged psychological help is recommended for the adolescents as well as their parents with a more family-centered approach.

Level of evidence: Level IV, therapeutic study.

Keywords Firecracker · Adolescent · Amputation · Hand injury · Quality of life

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Introduction

Although fireworks are popular worldwide for celebrating events, they can be very dangerous due to improper use or unexpected explosions. Hands, eyes, head, and face are the most frequently injured body parts (Figs. 1, 2, and 3) [1, 2].

A recent data collection in the Netherlands showed that one quarter of all firework victims in the Netherlands has hand/finger injuries [3]. The majority of victims are male [4–8]. Adolescents are an increasing group of victims over the years with more than a third (36%) of the victims younger than 20 years of age. Illegal fireworks (firecrackers) caused most of the traumatic amputations [5–8].

In the Netherlands, it is allowed to use fireworks only 1 day a year within restricted hours. There are also restrictions in the devices sold. Despite these regulations and enforcement efforts by the government, illegal firecrackers

Fig. 1 The hand at admission

Fig. 2 X-ray at admission

Fig. 3 X-ray at 8 months following the trauma

such as Cobra-6 are readily available [5]. Most accidents occur outside the legal period, and most severe hand injuries are caused by illegal firecrackers [3].

Severe hand injuries have impact on activities and participation due to limitations in function and also due to psychological impacts such as affecting the patient's appraisal

of their own self-worth [9]. After surgery and long-term rehabilitation, patients are frequently lost to follow-up [10]. The aim of this study is to explore the impact of firecracker-induced hand injuries in adolescents on hand function, activities, participation, self-esteem, QoL, and the impact on parents after an average of 3.2 years.

Methods

Patients

Adolescents with severe firecracker-induced hand injury, who were admitted at the Department of Plastic, Reconstructive, and Hand Surgery at the Amsterdam UMC, location Academic Medical Center (AMC) in the Netherlands between September 2012 and March 2015, were included in this exploratory study. Severe firecracker-induced hand injury was defined as blast injury requiring surgery. The measuring moment was March 2017 at the Amsterdam UMC, location AMC. The follow-up period varied between 2 and 4 years and 4 months. Informed consent for participation in this study was received from adolescents and parent(s). The Medical Ethical Committee of the AMC confirmed that the Medical Research involving Human Subjects Act (WMO) does not apply to this study. Therefore, an official approval of this study by the committee was not required.

Data collection

Medical records

Medical records were reviewed to collect patient characteristics (including age, gender, hand dominance) and to obtain information about and time since trauma in months, the type of firework, type of injury, operative details, duration of hospital stay, duration of rehabilitation, and usage of devices such as prostheses.

Measurement instruments

Validated, reliable, and clinically useful questionnaires and measure instruments were used to investigate the impact of firecracker-induced hand injuries on pain, activities, participation, self-esteem, quality of life (QoL), and the impact on parents [11–25].

For measuring pain the visual analog scale (VAS) was used [11]. The VAS gave information about pain in the week preceding the visit on a scale from zero (no pain) to ten (worst pain possible).

The impact on activities was measured by the Children's Hand-use Experience Questionnaire 2.0 (CHEQ 2.0) [12]

and the Dutch language version of the Canadian Occupational Performance Measure (COPM-DLV) [13]. The CHEQ 2.0 (age 6 to 18) consists of 27 questions and gives information about the experience of using the affected hand in two-handed activities. The adolescents described whether the activity was performed with one or two hands, or with help from others. A rash analysis reveals the outcome (score 0–100) of the subjective hand function (1), time use in comparison to peers (2), and experience of feeling bothered while doing the activity (3). In addition to this questionnaire, the COPM-DLV was used for measuring individual activity problems. The COPM-DLV is a patient-centred semi-structured interview for identifying occupational performance problems on the areas of self-care, productivity, and leisure and administered by a COPM-trained occupational therapist [13]. The most important problems (maximum of 5 problems) identified by the adolescents were rated with regard to performance and satisfaction. A score of 1 indicates “not able to do it at all” and “not satisfied at all,” while a score of 10 (maximum score) indicates “able to do it extremely well” and “extremely satisfied.” A mean performance score and satisfaction score were obtained by summing the scores and dividing them by the number of identified problems.

To evaluate participation and QoL, the Pediatric Quality of Life Inventory (PedsQL4.0) [14, 15] was assessed, and in addition, the COPM-DLV was analyzed. PedsQL 4.0 has been validated in Dutch and measures the core dimension of health as delineated by the World Health Organization [16]. The PedsQL 4.0 was completed by adolescents and parents. Both questionnaires are validated [17, 18]. Per adolescent, one parent reported on the QoL of their child. Higher scores indicate better health-related quality of life (HRQoL) which means perceived physical and mental health over time.

The COPM-DLV gave additional information about occupational performance problems in leisure and at school. An additional question was asked about their ideas of future careers.

The Rosenberg Self-Esteem Scale (RSES) was used to assess the impact on self-esteem [19, 20]. This self-report measures the global self-worth by scoring both positive and negative feelings (range 0–30). Scores between 15 and 25 are within normal range. Scores lower than 15 are assessed as problematic low self-esteem.

The Distress Thermometer for Parents (DT-P) was used as screening instrument to identify the impact of distress and problems in parents due to their child’s condition [21]. The DT-P consists of (1) a “thermometer” ranging from 0 (no distress) to 10 (extreme distress) on which parents rate their overall distress in the past week, where a thermometer score of 4 or higher indicates clinically elevated distress; (2) a problem list which inquires the occurrence of 34 (child age ≥ 2 years) everyday problems over the past week across six problem domains (practical (7 items), social (4 items),

emotional (9 items), physical (7 items), cognitive (2 items), and parenting (5 items)), where problem domain scores are the sum of item scores (yes = 1, no = 0) within that problem domain to indicate wants for help or the presence or absence of a need; and (3) additional questions of which only 3 relevant questions were used (Table 5).

Statistical analyses

Due to the study outline, observational descriptive study with one measuring moment, no statistical analysis was performed.

Case report

A 13-year-old boy was admitted to the emergency room with a blast injury to his right non-dominant hand. He reported he was injured by a Cobra that exploded near him.

A trauma survey did not identify other major trauma. The hand had a severe explosion trauma with shards of skin, bone fragments, and avulsed tendons and nerves (Fig. 1).

Radiographs demonstrated amputations at the base of metacarpals 1 and 2 and distal for metacarpals 3 to 5 (Fig. 2). The other injuries were a corneal abrasion on the right eye and bilateral ear drum perforations.

The patient was taken to the operating room where damage control was performed, the base of the second metacarpals was stabilized with 2 parallel K-wires, metacarpals 3 to 5 were shortened, the flexor carpi ulnaris tendon was reinserted with a Mitek anchor, and the extensor carpi radialis longus was reinserted using a suture. The nerve ends were identified and buried; the stump was closed using the available muscles and skin flaps. Two remaining defects were covered using full-thickness skin grafts from the amputated fingers (Fig. 3).

He was discharged on postoperative day 6 and was followed up at the plastic and the hand rehabilitation outpatient clinics. The eye and ear injuries healed spontaneously.

Seven weeks following the trauma, a remaining skin defect was covered with a split thickness skin graft. Four months after the injury, the patient fell on his hand and had a non-displaced fracture of the distal radius that healed uneventfully.

Two years following the trauma, the patient was able to flex and extend his wrist as well as perform ulnar and radial deviation, pronation, and supination. He was using the stump for assistance when performing bimanual tasks, he had received a cosmetic prosthesis; however, he had used it only three times; he usually resorted to hiding his stump in his clothing. The amputation influenced his choice of vocational training switching to a less physical demanding career

than previously planned. The amputation did not seem to be an issue during his sport activity playing soccer (Fig. 4).

Results

Patients

Nine adolescents fulfilled the inclusion criteria. One adolescent was lost to follow-up. The remaining 8 adolescents and their parents consented to participate in this study.

Seven out of eight adolescents were male. The age at the time of trauma varied between 10 and 14 years, with a mean of 11.9 years. The age at time of measurement varied between 12 and 16 years. The accident was on average 3.2 years ago. All adolescents had unilateral hand injury due

to the illegal firecracker Cobra-6. The dominant hand was injured in two adolescents (Table 1).

Seven adolescents had traumatic amputations of metacarpal bones and/or phalanges, whether or not combined with fractures and dislocations; one had tendon and soft tissue injuries and a fracture (Table 2). Five adolescents had additional injuries to other body regions (abdomen, colon, spleen, eyes, ears, thorax, left upper arm, right upper leg) from the same blast.

Treatment

Three adolescents underwent hand amputation at the level of the carpometacarpal joint and two at the level of the radio-carpal joint. Two adolescents had partial finger/hand amputations, and one adolescent had tendon and fracture repair.

Fig. 4 Pictures of the 8 included hands as seen at follow-up the patient described in the case report are at the bottom right

Table 1 Patient's characteristics

Patient	Gender (male/female)	Age (years) at time of measurement*	Time since accident (years)	Injured hand Dominant/non-dominant
1	M	15	3.2	Non-dominant
2	M	15	2.0	Dominant
3	F	15	4.1	Non-dominant
4	M	15	4.0	Dominant
5	M	15	4.4	Non-dominant
6	M	13	2.2	Non-dominant
7	M	12	2.2	Non-dominant
8	M	16	3.2	Non-Dominant
8 patients	7 M/1F	Mean: 14.5 ($\pm 1.3SD$)	Mean: 3.2 ($\pm 1.0SD$)	2 Dominant 6 Non-dominant

The injured dominant hands are reported in bold. These patients changed their hand dominance
SD standard deviation

*The measuring moment was March 2017

Table 2 Results

Patient Gender (MF)	Injury Traumatic amputation	Injury Fracture	Injury Dislocation	Injury Other	Surgery	Rehabilitation in months	CHEQ ¹ Subjective hand function [1]	CHEQ ¹ Required time compared to peers [2]	CHEQ ¹ Hampered by hand dysfunction [3]	COPM Total n of problems	PedsQL ² Total score	PedsQL ² Physical health	PedsQL ² Psychosocial health	RSES ³
1. M	MC1, mid-MC2-5 Dig 1-5	-	-	Soft tissue	Amp CMC	15	48	67	69	6	64	91	50	27
2. M	MC1, Dig 2-5	-	-	Soft tissue	Amp RC	16	45	60	60	4	79	78	80	21
3. F	Tip dig 3, 4 MC1-5, Dig 2-5	MC1	MC1	Soft tissue	Amp prox phalanx dig 3, mid-phalanx dig 4, K-wires	48	58	51	55	9	73	81	68	19
4. M	Dig 1-5	Trapezium, MC1-5	-	Soft tissue	Amp CMC, extirpation trapezium bone	12	58	67	74	2	95	94	95	26
5. M	Dig 3-5	MC1,4,5	MC1,4,5	Soft tissue	Amp dig 1, distal phalanx dig 2 and MC4, K-wires, FTG	4	77	61	100	0	100	100	100	30
6. M	MC1-5, Dig 1-5	-	-	Soft tissue	Amp RC	26	44	42	53	2	88	97	83	22
7. M	-	Dig 3	-	Soft tissue, FDP rupture, epidistal phal dig 4	K-wires, insertion tendon	3	68	74	77	8	50	56	47	15
8. M	MC1-5, Dig 1-5	-	-	Soft tissue, tendon rupture	Amp CMC, SSG/FTG, reinser-tion tendon	25	49	57	68	3	97	100	95	29
							Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)	Mean (±SD)
							19 (15)	60 (10)	70 (15)	4 (3)	81 (18)	87 (15)	77 (20)	24 (5)

Abbreviations: MC metacarpal bone(s), Dig digit(s), FDP flexor digitorum profundus, Epi epiphysiolysis, Phal phalanx, CMC carpometacarpal, RC radiocarpal, FTG full-thickness graft, SSG split skin graft, Amp amputation

¹The CHEQ2.0 scores are transformed on a scale from 0 to 100 by means of the Rasch analysis. [1] 0 score: bad hand function; 100 score: good hand function. [2] 0 score: more time required; 100-score: same time required in comparison with peers. [3] 0-score: experience of totally hampered by hand malfunction; 100-score: not hampered

²The Child-reporting PedsQL scores are transformed on a scale from 0 to 100. Higher scores indicate better health-related quality of life (HRQoL). The Psychosocial Health Score of the PedsQL is computed as the sum of the items over the number of items answered in the emotional, social, and school functioning scales. The Physical Health Score is the same as the Physical Functioning Scale Score of the PedsQL

³The RSES scores are transformed on a scale from 0 to 30. The higher the score, the higher the self-esteem. Scores between 15 and 25 are within normal range. Scores lower than 15 are assessed as problematic low self-esteem

The average hospital stay of all adolescents was 6 days (± 2.6 SD, 3–10). Four adolescents needed reoperations of the injured hand (wound dehiscence, neuroma, contracture, foreign bodies, intrinsic tightness, and necrosis). Rehabilitation including psychological help was started during admission in all adolescents.

The total mean rehabilitation period from the first until the last check-up was 19 months (± 15 SD, 3–48 months), with a variable number of visits in between. A thumb splint was offered to one adolescent who only uses the splint occasionally. Five adolescents were referred to a center specialized in prostheses of the hand. They received custom-made prosthesis; four a myoelectric and one a cosmetic prosthesis. One switched from a myoelectric to a cosmetic prosthesis, he uses the prosthesis daily. Three adolescents stopped using the prostheses. Only one adolescent uses the cosmetic

prosthesis occasionally. Most of the rehabilitation focusing on the use of the prosthesis was done in our hospital.

The impact of hand injuries

Pain

Five adolescents were pain-free (VAS) at time of measurement. Two adolescents had VAS score 2 and one had a VAS score 6. One adolescent with VAS score 0 reported occasional complaints of cold intolerance.

Activities

The CHEQ2.0 showed that six adolescents performed activities with one hand that usually require both hands and therefore required more time compared to peers. Four of them needed help from others in performing specific activities such as tying laces and cutting food. Two adolescents performed all the activities two-handed. All adolescents required more time in performing activities compared to peers, ranging from one to all (27) activities. Seven adolescents felt bothered by hand dysfunction in at least one activity. The rash analysis revealed a mean of 56 (SD ± 12) out of 100 (maximum) of the subjective hand function, a mean of 60 (SD ± 10) out of 100 (maximum) of the time used in comparison to peers, and a mean of 70 (SD ± 15) out of 100 (maximum) in the experience of feeling bothered while doing an activity.

The COPM-DLV confirmed the results of the CHEQ2.0, showing problems mainly with tying shoelaces and cutting meat. In addition, the COPM-DLV showed that cutting nails, lifting heavy objects, and sport activities were also perceived as a common problem.

The COPM-DLV showed in seven adolescents a total of 34 problems in performance of everyday activities. All had

Table 3 Comparisons between mean PedsQL4.0 scores reported by adolescents and parents ($\pm$ SD)

PedsQL scale	Adolescents ($n=8$)	Parents ($n=8$)
Total score	81 (18)	79 (16)
Physical health	87 (15)	80 (20)
Psychosocial health	77 (20)	78 (20)
Emotional functioning	74 (25)	74 (23)
Social functioning	83 (16)	86 (17)
School functioning	75 (24)	76 (24)

The Child-reporting PedsQL scores are transformed on a scale from 0 to 100. Higher scores indicate better HRQoL. The total score is the sum of all items over the numbers of items answered on all the scales. The physical health score is the same as the physical functioning scale score. The psychosocial health score is computed as the sum of the items over the number of items answered in the emotional, social, and school functioning scales

Table 4 PedsQL 4.0: comparisons between our mean scores and mean normative data ($\pm$ SD)

Age group	Number of points	PedsQL subscale	Our study scores	Normative scores [15]
8–12	1	Total score	50	82 (9)
		Physical health	56	85 (9)
		Psychosocial health	47	81 (10)
		Emotional functioning	55	77 (14)
		Social functioning	55	86 (12)
		School functioning	30	79 (12)
13–18	7	Total score	85 (14)	82 (9)
		Physical health	92 (9)	86 (10)
		Psychosocial health	82 (18)	80 (10)
		Emotional functioning	76 (26)	77 (15)
		Social functioning	87 (12)	90 (12)
		School functioning	81 (16)	75 (13)

The PedsQL scores have been transformed on a scale from 0 to 100. Higher scores indicate better HRQoL

Table 5 Distress Thermometer for Parents (DT-P)

DT-P problem domains	Mean (SD)
Distress thermometer	6.1 (3.4)
Practical problems	1.5 (1.4)
Social problems	0.8 (1.2)
Emotional problems	3.4 (2.6)
Physical problems	3.4 (2.7)
Cognitive problems	0.4 (0.7)
Parenting problems	1.4 (1.7)
Additional questions	
Perceived support from surroundings	6 yes—2: emotional support - 1: practical support - 2: emotional & practical support - 1: not appointed 2 no
Perceived lack of understanding from people concerning their situation	3 yes 5 no
Whether or not the parent would like to talk to a professional about his or her situation	3 yes 5 no

The distress thermometer: 0 (no distress) to 10 (extreme distress), a score of ≥ 4 is indicative of elevated distress; the problem list (individual items) can be seen as a checklist using dichotomous items (yes or no) to indicate wants for help or the presence or absence of a need

at least two problems in the performance of daily activities (Table 2) with a mean performance score of 4.16 (± 1.56 SD) and a mean satisfaction score of 4.50 (± 1.41 SD) on a scale from one to ten. One adolescent did not perceive any problems in daily activities.

Participation

The COPM-DLV revealed that three out of eight adolescents experience participation problems on areas of school functioning and sports/hobbies. These results of the COPM-DLV were confirmed by the PedsQL4.0.

The PedsQL4.0 scores per adolescent and the mean scores are shown in Table 2. One adolescent reported lower quality of life scores (all scores ≤ 56) than other adolescents.

The PedsQL4.0 was also reported by parents. One adolescent and his parent scored the best quality of life with maximum scores of 100. In Table 3, the mean PedsQL4.0 scores reported by adolescents and parents are shown. Most adolescents scored higher on the physical health scale than parents. The scores on the psychosocial health scale differ hardly between adolescents and parents.

The mean PedsQL scores reported by adolescents are compared with normative data [15]. Adolescents were divided into two age groups as used by the PedsQL4.0. In seven adolescents (age group of 13–18 years), there were no clinical relevant differences found regarding normative scores (Table 4). There was one adolescent aged under 12 in which all the PedsQL scores were lower than the normative data. We cannot attribute this to age as there was only one adolescent in this age group.

Only one adolescent mentioned that he changed his career choice due to the injury. The desired education was not possible because of the loss of his hand. Two adolescents did not think about a career yet (age 12 and 13).

Self-esteem

The RSES showed a mean score for self-esteem of 24 (± 5 SD). Scores between 15 and 25 are within normal range. No one had a problematic low self-esteem (< 15).

The impact on parents

The mean distress score thermometer in parents was 6.1 (± 3.4 SD) (Table 5). A score of 4 or higher indicates elevated distress. In this study, a score of 4 or higher was found in 6 out of 8 parents.

The DT-P showed that emotional and physical problems were common in parents. They mentioned intrusive and recurrent thoughts about the firecracker accident (6/8) and complaints of tension (5/8). Six out of eight parents also mention sleeping problems since the firecracker accident.

Discussion

To our knowledge, this is the first study describing the impact of firework-induced hand injuries in adolescents. On an average of 3 years following an accident with a firecracker, all adolescents had an evident impairment of their hand function. The percentage of functional loss due to

upper extremity amputation is usually calculated according to the American Medical Association (AMA) guidelines [26], but there is growing evidence that psychosocial factors (mindset and circumstances) should be taken into account [27]. We therefore choose to focus on the impact of limitations in activities, participation, and self-esteem. Moreover, we also assessed the limitations on participation of the adolescents observed by the parents and the distress experienced by their parents.

All adolescents, regardless of their physical limitations, needed more time than healthy peers and sometimes help from others. In seven adolescents, performing activities is hampered by hand malfunction. Two adolescents of whom the dominant hand was injured made a switch to the other hand.

The two adolescents with the least severe injuries (no. 3 and 7 in Table 2) scored more pain on the VAS than adolescents with the more extensive injuries (radiocarpal (RC) or carpometacarpal (CMC) amputation). All adolescents experienced limitations in activities but the ones with a RC or CMC amputation scored more limitations (CHEQ 2.0). However, when specifically asked which activities are limited (COPM), the adolescents with the least severe injuries and higher VAS scores on pain pointed out more problems than the ones with amputations. The value of the semi-structured interview of the COPM to assess limitations in activities was shown additional to the CHEQ 2.0 questionnaire. We used the COPM to detect functional problems in addition to the CHEQ2 and not to compare results if the COPM is conducted at different moments in time [28–30]. After extensive rehabilitation, the mean performance score and the mean satisfaction score are strikingly low, respectively 4.16 and 4.50 (scale 1–10). This is suggestive that the adolescents have not found an alternative way to perform the activities in a way that they are satisfied with.

The adolescents with the least severe injuries and highest scores on the VAS on pain also scored more problems in participation (PedsQL) for physical as well as psychosocial health compared to the adolescents with an amputation. Hence, there was no trend that adolescents who experienced more limitations in activities also experienced more limitations in participation. Remarkably, all adolescents scored within the normal range of the self-esteem questionnaire (RSES). In accordance with different diagnose groups in literature, adolescents with high scores for self-esteem (29/30) also had high scores for quality of life (97/100) and the adolescent with the lowest score for self-esteem (15/30) had the lowest score of quality of life (50/100) [31, 32].

Changes in future career choices are hard to measure in this group. Since the mean age at time of the accident was young (11.9 years), most of them did not have distinct future

plans yet. One adolescent did have plans to change a possible future career because of limitations in hand function.

Following the DT-P results, the elevated stress of the parents is striking even after such a long time. For rehabilitation, we recommend not only to provide early psychological counseling for both child and parent but also for a prolonged period. Given the impact of the injury on the entire family, we think a family-centered approach could be of additional value.

In the treatment of children with firecracker trauma, the PedsQL and DT-P should be administered by default to monitor the impact. Following the results of the coping styles of parents with adolescents with acquired brain injury, the evaluation of coping styles of the parents in patients with hand injury could be of additional value [33]. The results of Undheim et al. underscore that awareness of different coping strategies is important during rehabilitation and that consultation of a psychologist should be taken into consideration [34].

The level of distress in parents was found high, especially in parents of the adolescents with an amputation. After an average of 3.2 years, three out of eight parents perceived lack of understanding from people concerning their situation and three out of eight parents would like to talk to a professional about his or her situation. In comparison with the study of van Oers et al. [21] in which the scores of parents of healthy children were given, the mean distress score (6.1 ± 3.4 SD) in our study was higher than the mean distress level score (3.2 ± 2.7 SD) of parents with healthy children and then the mean distress level score (4.2 ± 2.9) of parents with children with chronic conditions.

All but one adolescents with an amputation were referred to a specialized rehabilitation outpatient clinic for the evaluation of the feasibility of an individual prosthesis. All received individual prostheses, myoelectric or cosmetic prostheses. None of the myoelectric prostheses is in use after on average 3 years post-trauma. Two adolescents use the cosmetic prosthesis of which one uses the prostheses for functional and esthetical use. In previous studies, a higher rejection rate of myoelectric and cosmetic prostheses was found in the pediatric population compared to the adult population. The overall rejection rate is one in five prostheses [35].

Limitations of this study are the small sample size of eight adolescents and having only one measuring moment in their adolescence. A larger study with long-term follow-up could be interesting in order to investigate the quality of life and coping strategies over time and to analyze the impact in later life for example the impact on education/career. This is a study in a high-income country and the results may possibly not be extrapolated to the situation in less developed countries.

Conclusions

The injuries have an evident physical impact on hand function, activities, and participation in all adolescents. They also have a significant impact on the distress level in parents. Prolonged psychological help is recommended for both adolescent and parent with a more family-centred approach. Extra attention on the prevention of firework injuries such as better education and a ban on free sale of fireworks is advised.

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Availability of data and material All data and materials comply with field standards.

Code availability Not applicable.

Declarations

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Medical Ethical Committee of the AMC confirmed that the Medical Research involving Human Subjects Act (WMO) does not apply to this study. Therefore, an official approval of this study by the committee was not required.

Informed consent Written informed consent was obtained from the adolescents and parent(s) for their anonymized information to be published in this article.

Conflict of interest Annekatrien van de Kar, Elianne Eijffinger, Oren Lapid, Chantal van der Horst, and M. de Haart declare no competing interests.

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