

Escalator-related Injuries in Children

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ABSTRACT. *Objective.* Escalator-related trauma is uncommon but can cause significant injury. This study reviewed escalator-related injuries in children to determine risk factors, types of injuries, medical interventions, and long-term outcomes.

Design and Setting. Retrospective clinical patient series, Municipal Hospital Pediatric Emergency Service.

Participants. All children less than 18 years of age who presented to the Pediatric Emergency Service with an escalator-related injury from August 1990 through February 1995.

Methods. We reviewed the chart and interviewed the parent of each child by telephone. We collected the following information: age, gender, child's supervision and activity while on the escalator, escalator location, direction of motion, presence of escalator defects, nature and extent of injury, medical interventions, and outcome.

Results. Twenty-six children had escalator-related injuries. The average age was 6 years (range, 2–16). Thirteen children (50%) were 2 to 4 years old. There were 15 (57%) boys. Eighteen children (69%) were accompanied by an adult. All children 7 years and younger were accompanied by an adult; however, 50% were not holding the hand of their guardian. Eight children (31%) were injured while riding improperly, ie, walking, running, playing, or sitting on the escalator, and among these, all who were standing fell down before the injury. Six (23%) children were injured while stepping off the escalator. Of 9 children less than 4 years old, 7 (78%) were riding the escalator properly. Of 9 children 4 years or older, only 3 (33%) were riding properly. Circumstances of injury included falling down with subsequent blunt trauma, falling down with subsequent entrapment of an extremity, and entrapment of an extremity not related to falling down. Locations of entrapment were between two steps, between a step and the side-rail, and between the last step and the comb plate. Twenty-one (81%) injuries occurred in rail or subway stations. Eight escalators were reported to have functional or structural problems.

Seventeen (65%) children sustained lower extremity injuries and 8 (31%) sustained upper extremity injuries. Injuries included lacerations, avulsions and degloving injuries of the extremities, tendon and nerve lacerations, and digit fractures and amputations. Thirteen (50%) children were admitted to the hospital for operative management; the average length of hospitalization was 13 days

(range 1–29). Four children (15%) suffered significant functional loss, and 12 (46%) sustained permanent cosmetic deformities.

Conclusion. Children are at risk for sustaining severe injuries on escalators. Young age, inadequate adult supervision, improper activity while riding on the escalator, and escalator-related mechanical problems all increase the risk of injury. Public and parent education directed toward escalator safety issues may help to reduce escalator-related injuries in children. *Pediatrics* 1997;100(2). URL: <http://www.pediatrics.org/cgi/content/full/100/2/e2; escalator, injury, child>.

ABBREVIATIONS. PES, Pediatric Emergency Service; CPSC, Consumer Product Safety Commission.

Escalator-related trauma is uncommon but can cause significant injury. After evaluating several children with escalator-related injuries in our pediatric emergency service, we became interested in investigating this unusual mechanism of injury.

There are a number of case reports of escalator injuries in children,^{1–7} and one large series that includes three children.⁸ In addition, a small number of cases have been reported to the National Pediatric Trauma Registry.⁹ These reports suggest that younger children are more frequently injured than older children, that injuries occur when the child is riding the escalator improperly, and that injuries generally involve the hand, foot, or head.

We studied escalator-related injuries in children with respect to mechanisms and extent of injury, medical interventions required, and long-term outcome. Our goal is to use this information to inform and educate both health care personnel and parents about escalator-related trauma to prevent further injuries.

STUDY DESIGN

Bellevue Hospital is a municipal hospital serving a predominantly inner-city population in New York City and is a Level I Trauma Center. The Pediatric Emergency Service (PES) sees 25 000 children annually. We reviewed the logs of visits to the PES from August 1990 through February 1995. Children under the age of 18 years who sustained an escalator-related injury were included in this study. We reviewed the medical chart for each patient and abstracted the following historical information: age, gender, child's supervision and activity while on the escalator, escalator location, direction of escalator motion, presence of escalator defects, nature and extent of injury, medical interventions, and outcome. In addition, we interviewed each child's parent by telephone to review the events surrounding the injury and to collect additional information. Although all parents were contacted, some information was unavailable either because the parent could

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not remember certain details of the event or because the parent was not actually with the child at the time of the event.

RESULTS

Epidemiology

Twenty-six children with escalator-related injuries were identified. The average age was 6 years (range, 2–16; median 4.0 years). Thirteen children (50%) were 2 to 4 years old, 4 (15%) were 4 to 7 years old, 4 (15%) were 7 to 11 years old, and 5 (20%) were 11 to 16 years old. There were 15 (57%) boys. There was no difference in age between boys and girls.

Eighteen children (69%) were accompanied by adults, 3 teenagers (11%) were accompanied by friends, 1 5-year-old (4%) was accompanied by his 13-year-old sibling and 1 13-year-old (4%) was alone. Information regarding accompaniment of three children (12%) was unavailable. Of 12 children 7 years old or younger for whom information is available, 6 (50%) were not holding the hand of their guardian while on the escalator. Four of these children (67%) fell before their injury.

Ten (38%) children were injured while riding properly (standing and facing forward) on the escalator. Six of these children (60%) fell before their injury. Eight children (31%) were injured while riding the escalator improperly, ie, walking, running, playing, sitting, kneeling to tie a shoelace or facing backwards, and all fell down before the injury except for the 2 children already sitting or kneeling. Six children (23%) were injured while stepping off the escalator. The activity of 2 children (8%) is unknown. Of the 18 children who were injured while riding on the escalator, ie, not stepping off, and whose activity was known, 9 were younger than 4 years and 9 were 4 years of age or older. Among the younger age group, 7 (78%) were riding properly, while among the children 4 years and older, only 3 (33%) were riding properly. The age varied for the 6 children injured while stepping off the escalator.

There were three types of injury events: 1) falling down with subsequent blunt trauma, seen in 5 children (19%), 2) falling down with subsequent entrapment of an extremity, seen in 2 children (8%) and 3) entrapment of an extremity not related to falling down, seen in 11 children (42%). For 8 children (31%) this information is incomplete. Of the 13 children who suffered injury due to entrapment of an extremity, locations of entrapment were between two steps in 2 children (15%), between a step and the side-rail in 3 children (23%), and between the last step and the comb plate (the metal plate at the end where the last step slides in) in 8 children (62%).

Twenty-one injuries (80%) occurred in rail, bus, or subway stations, 3 (12%) occurred in department stores, 1 (4%) occurred in an office building, and 1 (4%) occurred at school. The escalator was going up in 11 (42%) cases.

Structural escalator defects or malfunctions were reported in 8 cases (31%) including step malfunction, missing parts, or sudden stops. These 8 children had a mean age of 9.1 years and 6 (75%) were riding properly or stepping off.

Medical Data

The mechanism of injury was generally cutting, tearing, or crushing. Seventeen children (65%) sustained lower extremity injuries and 8 (31%) sustained upper extremity injuries. Thirteen (50%) children were admitted to the hospital for operative management. The average length of hospitalization was 13 days (range, 1–29). Twelve hospitalized children (92%) sustained severe lacerations, avulsions or degloving injuries of the extremities, 3 (23%) sustained tendon lacerations, and 2 (15%) sustained nerve lacerations. Five hospitalized children (38%) sustained digit dislocations or fractures, and 2 (15%) had multiple digit amputations. Children who were discharged from the emergency department sustained minor lacerations, contusions or abrasions. One child fell and fractured a tooth and 1 had a fingertip avulsion and fracture.

At the time of follow-up, 4 children (15%) had significant functional loss, such as persistent abnormal hand function or limp. Twelve (46%) sustained permanent cosmetic deformities.

CASE REPORTS

Case A

A 2½ year old boy, was accompanied by his parents and 1-year-old sibling. After stepping onto a down-escalator located in a municipal office building, his father released the child's hand and the child fell. His leg was caught between the escalator step and the side-rail.

The child sustained a 15-cm degloving injury to the left calf (Fig 1). There were no fractures and vascular function remained intact. Operative management included irrigation and debridement, superficial peroneal nerve repair, and wound closure. Although he was discharged after 2 days in the hospital, he was readmitted for wound infection and necrosis. A skin graft was performed and he was discharged after 14 days. At follow-up the child had a viable skin graft and was ambulating normally.

Case B

A 9-year-old boy, accompanied by his father, was riding an up-escalator located in a subway station. The escalator was reported to be missing a piece of the comb plate creating a large gap. The patient's foot became entrapped in the escalator just before stepping off. The escalator was stopped and required disassembly to extricate the foot.

The child sustained an extensive plantar avulsion of the left foot with open fractures of the first and second metatarsal shafts, dislocation of the fifth metatarsal-phalangeal joint, and crush injury of the third metatarsal head. Open reduction and internal fixation and skin grafting were performed (Fig 2 and Fig 3). The child was hospitalized for 26 days, and convalesced at home for more than 1 month after discharge. At follow-up, the foot remained deformed with abnormal function.

DISCUSSION

There is little information in the medical literature about escalator-related injuries in children. Over the

Fig 1. Case A. Degloving injury to the calf in a 2½-year-old boy, due to entrapment between the escalator step and the side-rail.



Fig 2. Case B. Plantar avulsion of the foot with metatarsal fracture and dislocation in a 9-year-old boy, due to entrapment between the escalator step and the comb plate while stepping off the escalator. Intraoperative view.

26 years covered by the on-line Index Medicus, there are 25 case reports of children injured on escalators.¹⁻⁸ Of 32 754 injuries recorded by the National Pediatric Trauma Registry between 1988 and 1992, only 18 were escalator-related.⁹ The Consumer Product Safety Commission (CPSC) reported that 7300 escalator-related injuries were treated in emergency departments in 1994.¹⁰

It is apparent that, although uncommon, significant injuries can occur to children while riding on escalators. The most serious escalator-related injuries we observed were degloving injuries of an extremity with extensive soft tissue damage. There were also many neurovascular, tendon, and digit injuries. These injuries frequently required operative management and many resulted in functional or cosmetic deformity. Head and facial trauma may also occur after falling while riding an escalator.

Murphy and Moore⁸ reviewed 50 patients who sustained escalator-related trauma. Their conclu-

sions about a primarily adult population were that escalator-related injuries were associated with alcohol consumption, age over 70 years, and walking on a moving escalator.

In our review we tried to gain further insight into the epidemiology of escalator-related injuries in children and the behavioral factors that may play a role. There was no apparent relationship of gender to injury. Younger children were more likely to be injured while riding escalators properly, usually after falling down. Lack of supervision and hand-holding may have been causative factors for the initial fall. Older children were more frequently injured when riding the escalator improperly, ie, while playing, running, or walking, because these activities led to falls. According to the CPSC, 75% of reported escalator-related injuries are attributable to falls.¹⁰ Stairs are a common site for fall-related injuries in toddlers.^{11,12} It is not surprising, then, that young children should have difficulty with *moving* stairs.

Fig 3. Case B. The same foot as in Fig 2, after repair and skin graft procedure.



In our series, the action of stepping off the escalator was also associated with an increased risk of injury. Young children may remain standing on the escalator and allow their feet to slide off at the end, instead of actually stepping off. The small size of a child's foot might increase the risk of it slipping into the gap where the last step slides into the comb plate. While stepping off an escalator may seem like a simple and natural task to an adult, the developmental level of young children limits their ability to both anticipate and coordinate this action. In addition to feet becoming entrapped during the process of stepping off, children's small extremities may become lodged between two steps or between a step and the side-rail. According to the CPSC, 20% of recorded injuries occur when hands, feet, or shoes become entrapped.¹⁰

Structural or mechanical escalator defects may also contribute to injuries, especially in older children who are riding properly. Escalator direction was not related to the injury. Escalators in rail and subway stations were most frequently associated with injury in our sample. Contributing factors may be high volume, poor lighting, or an insufficient number of caution signs located on subway station escalators. Seven of eight escalators that were reported to have structural defects were located in rail and subway stations.

There are several limitations to this retrospective review. Some cases may have been missed. Parents were interviewed to obtain additional details and their recall may have been inaccurate or biased. Some parents did not actually witness the exact mechanism of injury, since it "all happened so fast." There may have been some ascertainment bias in this series because Bellevue Hospital is a regional Microvascular Surgery and Limb Replantation referral center and it is possible that we had an inordinate number of serious injuries triaged here from the field. Minor injuries may have been triaged to other institutions or may not have led to any medical eval-

uation whatsoever. Nonetheless, most of the patients were transported by prehospital providers from within our usual geographic catchment area. Another limitation is that the true injury risk cannot be calculated because the total number of children riding escalators (the denominator) is unknown. Additionally, we do not know the frequency with which children ride particular escalators. Although rail and subway stations were identified as the most common site for injury, it may be that escalators in these locations were more frequently utilized by children. Finally, the small sample size may limit our ability to generalize our conclusions; however, this is the largest single series of pediatric escalator injuries reported to date.

In conclusion, children are at risk for sustaining severe injuries while riding on escalators. Until health care personnel and parents become aware of these injuries, we cannot hope to prevent them. Prevention of escalator-related injuries should be a primary goal and efforts should be focused in two directions. Anticipatory guidance regarding injury prevention should include information about riding on escalators. Primary care providers can encourage increased parental supervision, such as hand-holding or even carrying of young children while riding on and especially while stepping off escalators. Children should be taught not to run, play, or sit while riding on an escalator. Children should face forward and hold the handrails. In addition, education can take place in other venues. The New York City Transit Authority promotes escalator safety through an educational campaign that includes elementary school programs, improved escalator safety caution signs and posters, and distribution of safety literature. One organization, The Elevator Escalator Safety Foundation, has developed a school-based education program to promote escalator and elevator safety.¹³ The CPSC has issued a "Safety Alert" regarding escalators (Fig 4).¹⁰

Passive preventive efforts may have greater bene-

CPSC SAFETY ALERT

1. Loose shoelaces, drawstrings, scarves, and mittens can become entrapped
2. Always hold children's hands
3. Do not permit children to sit or play on steps
4. Do not carry children in strollers, walkers, or carts
5. Always face forward and hold handrail
6. Avoid the edges of the steps where entrapment can occur
8. Learn where the emergency shut-off button is

Fig 4. Recommendations adapted from CPSC Escalator Safety Alert.¹⁰

fit than behavioral recommendations. Improved design and maintenance may reduce escalator-related injuries. Regulations must ensure frequent inspection and appropriate escalator function. Improved lighting and warning signs, painted borders on steps and easily accessible emergency shut-off buttons may also aid in injury prevention. The American Society of Mechanical Engineers/American National Standards Institute Escalator Committee have issued voluntary standards for safe escalator function and

maintenance.¹⁴ Central reporting of escalator injuries may serve to better delineate risk factors for injury and identify problem escalators.

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