Traumatically Ruptured Globes in Children

Jay C. Rudd, Edward A. Jaeger, MD, Suzanne K. Freitag, and John B. Jeffers, MD

ABSTRACT
This retrospective study was designed to document the etiology of traumatically ruptured globes in children and to determine the prognostic value of several clinical parameters with respect to visual outcome. Forty-six children 16 years of age and under seen in the emergency room over a 2-year period were found to have full thickness penetration of the globe.

Fifty-nine percent of injuries occurred during recreational activities, and 59% occurred outside of the home. Boys outnumbered girls by a 6:1 ratio. For children, initial visual acuity proved to be less valuable as a prognostic indicator with regard to final vision than has been reported in adults. Smaller corneal wounds offered better visual outcomes. Four eyes were enucleated. Ten ruptures (22%) were related to activity involving guns. Four of six BB gun injuries were the result of a ricocheted BB. Visual outcomes in gun-related injuries were particularly poor.

INTRODUCTION
Ocular trauma is one of the leading causes of visual morbidity and blindness in children in the United States. Niiranen and Ilkka found that 34.5% of hospital admitted ocular injuries occurred in children 0 to 15 years of age. Rapoport et al, reporting on 1,127 traumatic eye injuries in Israel, found that 47% were sustained by children 0 to 17 years of age. Similarly, Maltzman et al found 29% of serious eye trauma occurred in children 0 to 10 years of age. Thus, children represent a disproportionately large percentage of total ocular trauma.

There have been few reports documenting the causal factors and clinical course of ruptured globes in children. Vinger recently stressed the need to conduct more studies to document the circumstances that increase the risk of ocular injuries. Accordingly, this study retrospectively reviewed the records of 46 ruptured globes in children admitted to a large city hospital through the emergency room during a 2-year period. The setting, mechanism of injury, initial presentation, and hospital course were documented for each child. Post discharge follow-up was available in 39 of the 46 patients.

MATERIALS AND METHODS
The hospital emergency room log was reviewed for a 24-month period: March 1, 1989 to February 28, 1991. The records of all patients 16 years of age and under were examined for evidence of a ruptured globe. This diagnosis included any full thickness disruption of the integrity of the globe. Forty-six children met this criteria. They were admitted to the hospital under varying diagnoses which included ruptured globe, corneal laceration, scleral laceration, corneoscleral laceration, and intraocular foreign body.

Each record was reviewed for admitting diagnosis, age, race, sex, and home address. The hospital record was further examined for the mechanism of injury, setting of injury, length and location of the perforation, hospital course, and surgical procedures performed. The patient’s initial, discharge, and follow-up visual acuities were recorded where possible.

The setting in which the injury occurred was noted and placed into one of the following groupings: recreation in the home, recreation outside the home, random injury in the home, and random injury outside the home. Injuries were classified as “recreation” related when they occurred during play activity such as billiards, target shooting, darts, and sporting events. Injuries were considered “random” when they occurred during various activities such as falling when running, glass shattering, or struck in the eye.
with an eating utensil. Home setting consisted of any house or dwelling, including the garage. Accidents in the yard were classified as occurring outside the home setting. The specific mechanism of injury was recorded for each patient. When described in the patient's record, length and location of injury were noted. In the case of complex lacerations, the lengths of all segments of the entry wound were added to give a total length of injury. In perforating (through and through) injuries, entry wound size was used to designate the length of injury since exit wounds were often not sized. The injuries were then grouped into categories according to size (< 5 mm, 6 to 10 mm, 11 to 15 mm, > 15 mm) and location (corneal, scleral, and corneoscleral).

Visual acuities were recorded on initial presentation, discharge, and follow up. They were grouped into four categories: 20/20 to 20/50, 20/60 to 20/200, 20/400 to light perception (LP), and no light perception (NLP/enucleation (Enuc). Final visual acuities were compared with initial acuities, wound size, and location.

The hospital course of each patient was followed to the time of discharge. All surgeries performed during the initial hospital stay and any performed during subsequent admissions related to the original trauma were noted. The dates of surgeries were documented, allowing for comparison of the duration between trauma and specific procedures. Post discharge follow-up information was available for 39 of the 46 patients.

RESULTS
During the 2-year period of the investigation, there were 4186 patients 16 years of age and under treated in the emergency room. One hundred eighty seven (4.5%) were admitted. Boys outnumbered girls 157 to 30, a ratio of 5 to 1. Traumatic hyphema was the most common admitting diagnosis accounting for 91 (49%) patients. Fifty-one (27%) children were admitted with the suspicion of a ruptured globe. A review of the records of these 51 patients revealed that 46 definitely sustained a full thickness disruption of the globe and formed the basis of this study.

The 46 children suffering globe rupture ranged in age from 1 to 16 years with an average age of 9 years (Figure). There were 39 boys and 7 girls resulting in a 6 to 1 ratio. There were 32 white patients, 13 black, and 1 Hispanic. The admitted children were from a large geographic area. Only 11 patients had home addresses within the confines of the city limits.

Twenty-seven (59%) of the ruptures occurred during recreational activities while 19 (41%) resulted from random incidental trauma (Table 1). Nineteen injuries (41%) occurred in the home setting, whereas 27 (59%) patients were injured outside the home. The average age of those patients injured at home was 7 years, 6 months (range, 1 to 16 years), while patients injured outside the home averaged 10 years, 2 months (3 to 16 years). Seventy-one percent (5 of 7) of the girls in this study were injured at home, while only 36% (14 of 39) of the boys in the study were injured at home.

Forty-three of the 46 patients had recorded initial visual acuity (Table 2). Three children were too young to obtain a reliable vision. Thirty-four of the 43 (79%) presented with a visual acuity of 20/400 or worse. Forty-two of the 46 patients had recorded initial and final visual acuities (Table 3). One child had an initial acuity recorded but was uncooperative upon discharge and a vision could not be obtained. The discharge vision was considered a final vision in six children as no further follow-up was available. Thirty-two children had post-discharge acuities recorded on out-patient follow-up visits which ranged from 7 days to 35 months. Three children were too young to provide a vision and four eyes were enucleated. Nearly one third of the patients with poor initial visual acuity eventually recovered reading vision (20/50) or better, and 61% achieved at least 20/200. Only five patients (12%) suffered a decrease in visual acuity upon follow up. Two of these
five eyes had an initial visual acuity of LP and eventually required enucleation. One lost three lines of vision (20/30 to 20/60), and another lost one line of vision (20/40 to 20/50). The fifth eye dropped from count fingers (CF) to LP. Conversely, 25 patients (60%) experienced an improvement in their visual acuity by at least two lines from initial to final acuity.

Location of the injury was documented in 45 patients (98%). The cornea alone was perforated in 23 cases and was the most common site of injury (51%). There were 15 eyes (33%) with corneoscleral defects, and injuries to the sclera alone accounted for seven cases (16%). Five double perforating (through and through) injuries were seen. Two eyes with double-scleral perforation were grouped in the scleral injury category. The remaining perforating injuries were included in the corneoscleral category.

The size of the perforation was found to be a significant prognostic indicator. The length of the laceration was noted in 32 children. Eighteen (56%) had lacerations equal or less than 5 mm in length (Table 4). Twelve (67%) children with globe lacerations in this size category recovered 20/50 vision or better. Only 2 of 10 patients with lacerations of 6 to 10 mm in length recovered 20/50 or better, while 4 of 10 were left with 20/400 or worse. The largest wound was 27 mm and this eye was enucleated.

Mechanisms of injury were varied (Table 5). However, 10 injuries (21.7%) were associated with guns. Play with sticks and glass fragments also resulted in a significant number of injuries (19.6%). One 4-year-old boy presented with a 9-millimeter corneal laceration, total hyphema, flat anterior chamber, and various skin lacerations. This was suspected to be due to child abuse. Aside from these mechanisms, injuries were circumstantial and were associated with common childhood behavior.

Ruptured globes associated with "guns" occurred in 10 patients and deserve special attention (Table 6). Six globes were ruptured from the use of a BB gun. Four of these six were the result of a ricocheted BB. Globes in three of these six children resulted in enucleation. One enucleated globe sustained a double perforation. The BB was retained within the globe in the other two cases. The three BB-related cases not enucleated were double perforation type injuries. Final vision was limited to LP in two cases and hand motions (HM) in one case. A primary repair procedure was performed in all six cases. The other four gun (non BB) associated ruptures were "circumstantial." Two were the result of gun malfunction in a controlled, "range..."
TRAUMATICALLY RUPTURED GLOBES

TABLE 6

<table>
<thead>
<tr>
<th>Type</th>
<th>Age</th>
<th>Sex</th>
<th>Initial Visual Acuity</th>
<th>Final Visual Acuity (duration to follow up)</th>
<th>Description of Injury</th>
<th>IOFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>15</td>
<td>M</td>
<td>NLP</td>
<td>enucleation (4 days)</td>
<td>BB shot into left eye</td>
<td>+</td>
</tr>
<tr>
<td>BB</td>
<td>14</td>
<td>M</td>
<td>CF - Face</td>
<td>LP (22 days)</td>
<td>shot by other child</td>
<td>-</td>
</tr>
<tr>
<td>BB</td>
<td>11</td>
<td>M</td>
<td>NLP</td>
<td>enucleation (4 mos)</td>
<td>BB ricocheted into left eye</td>
<td>-</td>
</tr>
<tr>
<td>BB</td>
<td>16</td>
<td>M</td>
<td>HM</td>
<td>HM (3 mos)</td>
<td>BB ricocheted into left eye</td>
<td>-</td>
</tr>
<tr>
<td>BB</td>
<td>15</td>
<td>M</td>
<td>LP</td>
<td>enucleation (15 days)</td>
<td>BB ricocheted into right eye</td>
<td>+</td>
</tr>
<tr>
<td>BB</td>
<td>13</td>
<td>M</td>
<td>LP</td>
<td>LP (35 mos)</td>
<td>friend shot BB off target into left eye</td>
<td>-</td>
</tr>
<tr>
<td>Handgun</td>
<td>8</td>
<td>M</td>
<td>NLP</td>
<td>CF-6° (4 mos)</td>
<td>hammer of gun recoiled in right eye</td>
<td>-</td>
</tr>
<tr>
<td>Handgun</td>
<td>16</td>
<td>M</td>
<td>20/70</td>
<td>20/40 (24 mos)</td>
<td>target shooting gun exploded</td>
<td>+</td>
</tr>
<tr>
<td>Pellet gun</td>
<td>12</td>
<td>M</td>
<td>LP</td>
<td>LP (23 days)</td>
<td>shot with pellet gun in left eye</td>
<td>-</td>
</tr>
<tr>
<td>Shotgun</td>
<td>15</td>
<td>M</td>
<td>HM</td>
<td>20/200 (10 mos)</td>
<td>shot with shotgun - bystander</td>
<td>+</td>
</tr>
</tbody>
</table>

IOFB = intraocular foreign body, LP = light perception, NLP = no light perception, CF = counts fingers, HM = hand motion.

situation. Another child was struck in the eye with a pellet gun, and the fourth, a bystander, was hit by a shot gun pellet. One patient recovered 20/40 vision and another 20/200 vision. Otherwise, final vision was extremely poor in the remaining eight firearm cases. Review of the hospital course for each of the 46 patients revealed that primary repair was performed within 24 hours in 40 (87%) cases. Of the six cases not undergoing same-day repair, three were repaired the following day. Three cases were found to not need repair after sealing themselves. In five (11%) cases, an intraocular foreign body was present, requiring removal at primary repair. Cataract removal was performed on 11 of the 18 patients suffering a traumatic cataract.

Pars plana vitrectomy (PPV) was performed on 11 (24%) patients ranging from 4 days to 18 months post-trauma. The PPV was never performed during the primary repair. In all cases, preoperative vision was CF or worse. Vision remained at CF or less in all 11 patients undergoing PPV, regardless of when it was performed.

Enucleation was required in four cases after primary repair was unsuccessful in restoring vision. One enucleation was immediately post-repair (4 days), while the others followed within 4 months.

DISCUSSION

This study retrospectively analyzes 46 patients 16 years of age and under seen in the hospital emergency room over a 2-year period who were admitted with a diagnosis of ruptured globe. The hospital is located in a large urban setting; however, only 24% of these children had home addresses indicating that they lived within the city limits. Although the hospital does serve as an area-wide referral center, a higher proportion of injuries from the inner city population might have been anticipated. Wilson et al also found a proportionately lower number of children sustained ocular trauma in an urban setting. One explanation for the lower proportion of inner city youths in this study may be due to decreased availability of recreational facilities in the city, since most childhood injuries occur during recreational activities.6,7

Boys substantially outnumbered girls (6 to 1) in this series, and a similar male predominance has been reported in other studies.6,8 This ratio was only a slight increase over the boy/girl ratio of the total admitted ocular injuries (5 to 1) for the same 2-year period.

The majority of ruptured globes were sustained outside the home setting and occurred during recreational type activity. The classification of injuries into recreation versus random and home setting versus outside the home is somewhat artificial. However, this was done in an attempt to determine when children were most susceptible to serious eye trauma. Other studies have reported similar findings in serious childhood ocular trauma.6,7

Initial visual acuity has been shown to be a prognostic factor in adult eyes sustaining a ruptured globe. In a study by De Juan et al of patients 18 years and older sustaining a ruptured globe and presenting with a visual acuity less than 5/200, 72% remained at that acuity or worse.10 In those with 5/200 or better, 96% maintained at least that vision or better. However, in this study the initial vision was a less reliable predictor of final visual outcome. Seventy-nine percent of our patients presented with a visual acuity of 20/400 or worse. However, in two thirds of these cases, the vision improved, and in one third the vision improved to 20/50 or better. Several factors may account for the difference between injuries in adults and children with regard to initial vision as a prognostic factor. An accurate initial vision may be more difficult to obtain in a frightened child, the type of injury may be less severe (more corneal), and a child's eye may have greater healing capacity. However, all four of the eyes enucleated presented with vision of 20/400 or less.

There is a definite correlation between the size of the wound in a ruptured globe and eventual visual outcome. Freitag et al found that 71% of traumatic enucleations had

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lacerations > 10 mm,11 Barr showed that 87% of globes with lacerations > 9 mm were enucleated.12 In this study, an injury of 5 mm or less in length was associated with a favorable visual outcome. There were fewer large-length injuries in this study and this is in keeping with Nelson et al’s finding that children sustained less severe type injuries.13 Only four (13%) children in this study had lacerations > 10 mm. One globe sustained a laceration of 27 mm and the eye was enucleated. The glaring exception to the small wound—better prognosis correlation is the BB-gun-related injury. The entrance wound in these cases is usually round rather than linear, and the damage to the inside of a globe is severe. In addition, four globes had through and through BB injuries which is an additional insult to the eye.

In evaluating vision, the possible presence of pre-existing amblyopia was not considered because of the retrospective aspect of the study and the acute nature of the patients’ presentation. Likewise, amblyopia developing as a result of the injury was not included in this report because of the great variation in the follow-up period. However, no patient received treatment for amblyopia in our available records.

The potential visual consequences of children playing with guns deserve special emphasis. Three of our six BB gun injuries were enucleated. Two of the remaining eyes were limited to light perception and one eye retained hand motion vision.

Four of the six injuries from BB guns were due to a ricocheting BB rather than an aimed shot, indicating that protective eye wear must be worn by all persons in the immediate environment.

In a recent study, Klopf er et al reported that BB/air gun injuries accounted for 51% of children admitted for all ocular trauma.14 In this series, which was limited to ruptured globes, we found that 22% were firearm related. This type of injury is devastating to the globe and the child, and guns of any sort should not reach the hands of children except under rigidly controlled circumstances and responsible supervision.

Dannenberg et al, in a study on assault-related ocular trauma, found only 17% of injuries were sustained by children under 20 years of age.15 Only 2 (4%) of our 46 cases were due to assault. This is somewhat surprising given the inner city hospital setting. None of the ruptured globes associated with firearms in this study were the result of an assault. Children are less likely to sustain assault-related eye injuries.

PPV has been very helpful in many cases of traumatic injury to the globe.16 In this study, PPV was performed on 11 of the more seriously damaged eyes; however, none of these eyes achieved vision better than 20/400.

Eighteen children in this study developed traumatic cataracts. Eleven of these lenses were surgically removed. Four of the 18 were under the age of 7 years and would be susceptible to the development of post-injury amblyopia. None were treated for amblyopia during the recorded follow-up period but this potential exists.

Injuries resulting in disruption of the integrity of the globe continue to have a guarded visual prognosis despite significant advances in surgical techniques. Therefore, prevention is critical in reducing the occurrence of ocular morbidity in children. Successful preventive measures depend upon a vigilant awareness of the activities and situations in which children are injured.

REFERENCES