

Presence of periorbital and conjunctival petechial hemorrhages in accidental pediatric drowning

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Received 27 December 2006; received in revised form 27 February 2007; accepted 3 July 2007

Available online 23 August 2007

Abstract

The pathological findings of drowning are variable and non-specific. Petechial hemorrhages involving the periorbital region and the conjunctiva have been described in many causes of death, but are thought to be exceedingly uncommon in cases of drowning. However, such studies have not specifically addressed the pediatric population. The current study retrospectively examined 79 cases of accidental pediatric drowning for the presence of periorbital/conjunctival hemorrhages and analyzed factors that may have affected their presence. Ten victims had periorbital/conjunctival petechial hemorrhages (13%), with five having periorbital petechiae, three having conjunctival petechiae, and two having both periorbital and conjunctival petechiae. The age and gender of the victim, site of drowning, resuscitation history and the presence of other pathological findings were not significantly associated with the presence of periorbital/conjunctival petechiae. However, as the interval between the drowning episode and autopsy increased, the incidence of periorbital/conjunctival petechiae decreased (28% for <24 h; 7% for >24 h). The presence of periorbital/conjunctival hemorrhages in a significant proportion of pediatric drowning victims confirms that the pathologist must add this finding to the spectrum of changes seen in pediatric drowning.

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Keywords: Conjunctiva; Drowning; Pathology; Pediatric; Petechiae

1. Introduction

Petechial hemorrhages involving the periorbital region and conjunctiva have been described in both natural and non-natural causes of death where obstructed venous return from the head and neck, with a concomitant rise in pressure within the microvasculature, occurs in the immediate premortem period [1,2]. Such causes of death include hanging [3], strangulation [1], suffocation [4], electrocution [5], positional asphyxia [6,7], thoracic compression [8], cardiopulmonary resuscitation [9], pericardial tamponade [10], status epilepticus [11] and status asthmaticus [2].

The macropathological findings of drowned victims are often variable and non-specific, and may include a frothy exudate in the upper airways, pleural effusions, hyperinflated lungs and pulmonary edema [1,7,12]. Other, less common findings include hemorrhage into the temporal bone and petechial hemorrhages over the sinuses [13–15]. Some authors consider the occurrence of facial petechiae in drowning to be distinctly uncommon, if not rare [1,2], and one predominantly adult study found conjunctival and/or periorbital hemorrhages in only 4.1% of 171 victims who drowned [16]. However, many of the studies describing the pathology of drowning have not specifically addressed the pediatric population and the frequency of periorbital petechiae [12,16–22]. Given that the finding of periorbital petechiae may raise the possibility of alternative modes of death, the current study details the incidence of periorbital and/or conjunctival hemorrhages in a series of accidental pediatric freshwater drownings, and examines factors that may influence their presence. Furthermore, the incidence of petechial hemorrhages elsewhere is also addressed.

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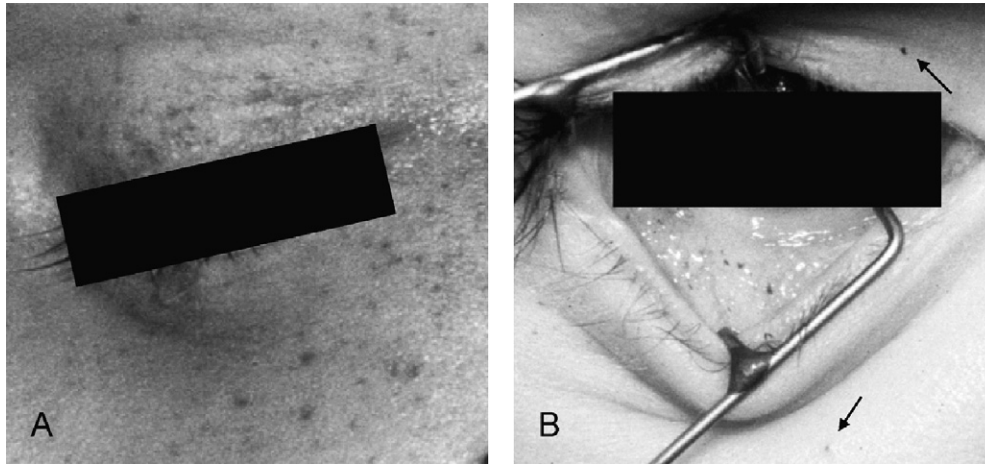


Fig. 1. Examples of periorbital (A) and conjunctival (B) petechiae in pediatric drowning victims. In (B), also note sparse periorbital petechiae (arrows).

2. Methods

A retrospective review of all autopsies held over a 20 years period (1984–2003) at the Hospital for Sick Children, Toronto, Ontario, was performed ($n = 4926$; 2422 medico-legal, 2504 clinical), and all cases of accidental drowning in victims under the age of 18 years were included in the study. The autopsy records were examined for demographic, pathological and circumstantial data as previously described [23,24]. Briefly, the decedents' age and gender were obtained. Pathological changes recorded included the presence of petechial hemorrhages of the conjunctiva and periorbital region, as well as petechiae of the oral and airway mucosa and thoracic viscera, and the presence of a frothy exudate in the upper airway, pleural effusions, and increased lung weights (defined as greater than the 95th confidence limit for age [24,25]). Circumstantial data included the site of drowning (defined as open water, pools, bathtubs and other), resuscitation history (divided into three groups: group 1 had no attempts at resuscitation; group 2 had a short period of attempted resuscitation without re-establishment of circulatory activity; and group 3 had successful restoration of circulatory activity for a variable period of time [24]), the post-mortem time of submersion (<2 h and ≥ 2 h) and the time between the drowning episode and the autopsy (≤ 24 h and >24 h). Statistical analysis was performed by the SAS software package for Windows version 8.02 and Microsoft Excel 2002 SPB version. Means were compared using the Student's *t*-test. For non-parametric data, Fisher's exact test and Chi-square analyses were used. Significance was defined as $p < 0.05$. The study was performed in accordance with the guidelines of the Hospital for Sick Children Research Ethics Board, and permission to publish the findings of this study was obtained from the Office of the Chief Coroner of Ontario.

3. Results

Seventy-nine cases of accidental pediatric drownings were found over the 20-year period. Detailed demographic and pathological data for these cases have been reviewed elsewhere [23,24]. Briefly, there were 52 males and 27 females with a mean age of 4 years 7 months (age range 5 months to 17 years). All drownings occurred in freshwater. Twenty-eight drownings occurred in open water, 28 in pools, 18 in bathtubs and four in other sites (two hot tubs, one bucket, one ditch). In one case the site of drowning was not recorded. Regarding resuscitation, 11 victims (14%) were in group 1, 32 (41%) were in group 2 and 34 (43%) were in group 3. In two victims, the resuscitation history was unavailable. Post-mortem submersion times ranged from a few minutes to 2 days, with eight victims being submerged for more than 2 h (four victims 2–6 h; four victims

approximately 2 days). Pathological findings included frothy exudate in 30 victims (38%), pleural effusions in 25 (32%) and increased lung weight in 59 (75%), with the combination of all three findings in six victims (8%). Petechial hemorrhages involving the thoracic viscera were found in 23 victims (28%; thymus 21, visceral pleura 17 and epicardium 4), and two victims had petechiae involving the mucosa of the oral and upper airway mucosa.

Periorbital and conjunctival petechial hemorrhages were found in 10 cases (13%), with five having only periorbital petechiae, three having only conjunctival petechiae, and two having both periorbital and conjunctival petechiae (Fig. 1). No other region of the face had petechial hemorrhages. Five occurred in males and five in females, and the mean and median age was 3 years 10 months and 2 years 8 months, respectively. In one case, the drowning episode occurred in open water; four occurred in pools; three occurred in bathtubs; and one case each occurred in a bucket and in a hot tub. Eight victims had prolonged periods of submersion after drowning, with four having submersion times close to 2 days. With regard to resuscitation, two victims were classified as group 1 (no attempts at resuscitation), six were classified as group 2 (attempted resuscitation without restoration of cardiac output) and two were classified as group 3 (resuscitation with restoration of cardiac output for a period of time). Seven victims had intervals between the drowning episode and autopsy of 24 h or less, whereas in three cases the interval was greater than 24 h (longest interval 60 h).

The presence of periorbital and/or conjunctival petechiae was not significantly associated with gender ($p = 0.2171$), age ($p = 0.5468$), site of drowning ($p = 0.1612$), post-mortem time of submersion ($p = 0.9408$), frothy exudate ($p = 0.8621$), pleural effusions ($p = 0.1035$), increased lung weight ($p = 0.8037$) or the resuscitation history ($p = 0.2564$). However, the presence of periorbital and/or conjunctival petechiae was significantly associated with the presence of petechiae upon the thoracic viscera ($p = 0.0053$). Furthermore, as the interval between the drowning episode and autopsy increased, the incidence of petechiae decreased (25% for <24 h, 7% for >24 h; $p = 0.0796$).

4. Discussion

The current study describes the occurrence of periorbital/conjunctival petechial hemorrhages in pediatric victims of accidental freshwater drowning. The incidence of 13% is the highest published with regard to drowning, and is at odds with the prevailing view that the occurrence of petechial hemorrhages in drowning is distinctly uncommon, if not rare [1,2,16]. Periorbital/conjunctival petechiae may be seen in both natural and non-natural causes of death where there is obstructed cephalic venous return in the immediate pre-mortem period; this was not thought to include drowning. Previous studies examining specifically the pediatric population have mainly associated conjunctival/periorbital petechiae with non-accidental mechanical asphyxia [8,26,27]. However, the possibility that periorbital/conjunctival petechial hemorrhage may occur in children who die of accidental and natural causes must always be considered; for instance, Byard and Krous [27] mention forceful vomiting and pertussis infection as a cause of periorbital and conjunctival petechiae. The current study has found that the deceased child can have periorbital and conjunctival petechiae as part of the spectrum of findings in accidental drowning.

Petechial hemorrhages arise when there is damage to the vessel wall by a mechanical force, such as a rise in intravascular pressure. This causes loss of coherence of the lining endothelium and predominantly affects those vessels without supporting walls, such as capillaries and venules [10,27]. Of note, the early events occurring during a drowning episode involve varying degrees of laryngospasm, vomiting and aspiration of water [28,29], as well as muscle contraction and venous congestion, all of which lead to an increase in cephalic intravascular pressure. Thus, it is not surprising that the victims of drowning in the current series have periorbital/conjunctival petechial hemorrhages.

Compared to the available literature [2,16], the incidence of periorbital/conjunctival petechiae is higher in the current series of pediatric drowning. It is of interest that children have an increased microvascular density, increased amount of elastin fibers and decreased amount of collagen fibers within the dermis when compared to adults [30–32]; such structural differences may partly explain the findings of periorbital/conjunctival petechiae in a significant proportion of our victims. Another possible explanation for the high incidence of periorbital/conjunctival petechiae in the present study is that some of the victims may have been the victims of homicide. As all deaths were the subject of detailed police investigation and full autopsy examinations, and none of the cases were associated with any evidence of non-accidental injury, this possibility seems to be highly unlikely. However, given that the present study is a retrospective review of pediatric victims, and no adult control group was included, conclusions regarding the relative incidence of periorbital/conjunctival petechiae in children as compared to adults must be interpreted with caution.

The presence of petechial hemorrhages upon the thoracic viscera is thought to be an uncommon finding in drowning victims [1], but was found in 28% of victims in our study. In

addition, the presence of thoracic visceral petechiae was significantly associated with the presence of periorbital and conjunctival petechiae, suggesting a common mechanism of development. The presence of periorbital and conjunctival petechiae was not significantly associated with any other demographic, pathologic or circumstantial feature, including the post-mortem time of submersion, the resuscitation history and the interval between the drowning episode and the autopsy. With regard to submersion times, Betz et al [33] have shown in an experimental system that conjunctival petechiae tend to disappear after 4 h of submersion in freshwater, possibly due to hemolysis caused by the hypotonic medium. The association of resuscitation and periorbital/conjunctival petechiae has received much attention in the literature. Whilst some authors conclude that cardiopulmonary resuscitation can produce periorbital and conjunctival petechiae [9,34], others have not found a convincing association [35,36]. In particular, Maxeiner [36] looked at 654 forensic autopsies and concluded that the presence of facial petechiae was associated with the cause of death rather than resuscitation. Finally, as the interval between the drowning episode and autopsy increased (in our series, solely due to maintenance on life-support systems), the incidence of periorbital/conjunctival petechiae decreased. This may be due to resolution of the hemorrhages while the victim was maintained on life support. Thus, clinicopathological correlation is important in interpreting the autopsy findings.

In conclusion, the current study has described the occurrence of periorbital/conjunctival petechial hemorrhages in a relatively high percentage of pediatric drowned victims. Thus the pathologist should be cautious when interpreting the significance of petechial hemorrhages in bodies found in water in suspected homicide cases.

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