EXPÉRIENCE AND REASON—Briefly Recorded

“In Medicine one must pay attention not to plausible theorizing but to experience and reason together. . . . I agree that theorizing is to be approved, provided that it is based on facts, and systematically makes its deductions from what is observed. . . . But conclusions drawn from unaided reason can hardly be serviceable; only those drawn from observed fact.” Hippocrates. Precepts. (Short communications of factual material are published here. Comments and criticisms appear as letters to the Editor.)

How Accurately Can Bruises Be Aged in Abused Children? Literature Review and Synthesis

The clinical aging of bruises has been described in many forensic pathology texts.1-6 Recommended techniques have included histologic7 biochemical and enzyme histochemical,8 and visual observation. The most frequently used technique compares the visible color of a bruise to established charts.9 Because the aging of bruises is an important component of many child abuse assessments, the accuracy of these charts is critical. What is the scientific basis for these charts? What precision can bruises be aged?

This review will synthesize what is known about the aging of bruises, how the cumulative literature may be interpreted best, and why it remains difficult to age bruises precisely. Suggestions for research to clarify this medicolegally critical topic further also will be presented.

A bruise is caused by blood that has escaped from damaged capillaries into the interstitial tissues. It is the process of hemoglobin degradation and its expression through the “window” of the skin that determines the color of a bruise.10 Other factors, such as ambient light and skin color, may affect the apparent color of a bruise.

Comparing the clinically estimated age of a bruise to the described age is critical to many child abuse assessments. Practitioners are often asked by child protection and law enforcement agencies and the courts to offer opinions about the age of a child’s bruise to assess the credibility of the history and to aid in perpetrator identification. An inconsistent history is a hallmark of child abuse.11

DIFFICULTIES INHERENT IN AGING BRUISES

Depth, location, and skin complexion affect the time of appearance and the color of a bruise. Even which color should be assigned to a bruise is ill defined. Langlois and Gresham12 use any amount of a particular color to assign that color to a bruise, whereas most references do not indicate whether the presence of a color or its predominance is used.

How soon bruising first appears after an injury depends on the depth of the injury.13 A superficial bruise may discolor the skin immediately,14 whereas deep bruising may take days to appear.11,12

When a particular color appears also varies in part according to injury depth. Smith and Fiddes1 estimate that yellow generally appears in 7 to 10 days but may appear in 3 days if the bruise is superficial. Langlois and Gresham12 also note that yellow develops quicker in superficial bruises. This suggests that if a child has been bruised deeply and superficially at the same time in nearby locations, the bruises may be different colors and may seem to have occurred at different times.

Another factor in determining the appearance of a bruise is its location. Periorbital and genital bruises (where tissue is loose and blood vessels are poorly supported) will appear sooner than extremity bruises.11

Still another factor is skin color. Light-complexioned children may seem to bruise from relatively minor impacts, whereas bruises in dark-complexioned children may be masked by their skin color.13,15

The chronicity of bruising may affect the aging process. Hamdy et al10 found that bruises in chronically injured animals healed on average 2 days sooner than bruises in acutely injured control animals. If also true of humans, this suggests that a chronically or repetitively injured child may heal more quickly than an acutely injured one.

Although bruises of different ages have been described as a characteristic of the battered child syndrome,17,18 the wide variability in bruise development and healing urges caution in aging bruises. Yet, many current texts (Table) portray bruise aging as relatively straightforward. Where did these tables come from?

THE LITERATURE ON AGING BRUISES BEFORE WILSON

Many forensic pathology texts have described how bruise color changes over time. Wilson9 reviewed five such texts.2-6 These forensic opinions were disparate. For example, Adelson4 stated that yellowish-green appears in “at least several days,” whereas Polson and Gee8 noted that bruises yellow “at the end of about two weeks.” Adelson noted that brown appears at 1 to 3 days, whereas Spitz5 reported that brown appears later than 1 week. Spitz and Adelson independently stated that their opinions were based on their own clinical experience with postmortem adult subjects and were intended to serve only as general guidelines for the aging of bruises, not hard

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TABLE. Dating of Bruises

<table>
<thead>
<tr>
<th>Color</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>0–1 d</td>
</tr>
<tr>
<td>Blue, purple</td>
<td>1–4 d</td>
</tr>
<tr>
<td>Green, yellow</td>
<td>5–7 d</td>
</tr>
<tr>
<td>Yellow, brown</td>
<td>8–10 d</td>
</tr>
<tr>
<td>Cleared</td>
<td>1–3 wk</td>
</tr>
</tbody>
</table>

* A typical table (differing only slightly in different texts) found in numerous texts,22–25 adapted from Wilson,9 presenting the aging of bruises as a seemingly simple and accurate technique.

and fast rules (W. U. Spitz and L. Adelson, personal communications, August 1994). Color changes in adult cadavers may not be generalizable to living children. In adults, especially the elderly, extravasated blood can remain unaltered in appearance longer than in children.19 Conversely, a bruise of a similar size heals quicker in a child than in an adult.20,21

The five texts, tabulated by Wilson,9 taken together variously described the following time lines for color change: new, red, violet, black, and bluish red; 3 days, blue (dark blue) and brown (blue-brown); 1 week, brown, yellow-green, green, and yellow; and 2 weeks, yellow and clear. They also described divergent opinions of when a particular color appears: red, violet, black, and bluish red, new; blue (red-blue and dark blue), new vs 3 days; brown-blue (brown-brown), 1 to 3 days vs more than 1 week; green, 5 to 7 days vs 5 to 6 days vs 1 week; yellow (yellow-green), 8 to 10 days vs 7 to 10 days vs 2 weeks; resolution, 1 to 3 weeks vs 13 to 18 days vs 14 to 15 days vs 2 to 4 weeks.

These various texts portray significant variation not only when a color appears but even in describing the colors (e.g., yellow-green versus yellow). There does seem to be broad agreement that bruises go through an evolution in color, that bruises initially appear red, violet, or black (perhaps blue as well), and that successive colors include brown, green, and yellow, although in no clearly predictable order or chronology.

THE LITERATURE ON AGING BRUISES AFTER WILSON

Wilson’s9 1977 tabulation of these disparate opinions has been cited by many texts on child abuse,22–25 emergency medicine,26–29 and trauma,30,31 as well as in journals on pediatrics,32 surgery,33 dentistry,34 family practice,35 and forensic medicine.12 Yet Wilson’s table, despite its unqualified portrayal in recent texts and journals, did not present a single opinion of bruise evolution but, rather, tabulated various opinions.

Wilson,9 recognizing the difficulties inherent in bruise age determination and the lack of consensus in the literature, concluded that the estimation of a contusion’s age is imprecise. He cited Adelson1 in recommending that practitioners, rather than stating categorically that a bruise is precisely so many days old, should state that the appearance of a contusion is consistent with its being so many days old. Despite these cautions, recent texts22,24–25 generalize Wilson’s summary into a single predictive chart (Table). Others list virtually the same guidelines but do not cite their sources.36–42 These texts rarely caution that such charts are based on conflicting information.

Even texts referencing Wilson9 vary. For example, Brodeur and Monteleone22 state that the color of a bruise changes to green and gradually to brown in 3 to 6 days, whereas Richardson24 and Schmitt25 describe green at 5 to 7 days and brown at 10 or more days.

LANGLOIS AND GRESHAM’S ATTEMPT AT RESEARCH-BASED ANALYSIS

The only published study of the visual aging of bruises appeared in 1991.12 Langlois and Gresham attempted to determine how accurately the age of a bruise can be estimated by looking at its color. Three hundred sixty-nine photographs were taken of the bruises of 89 inpatients, staff, and patients in an emergency department. Only bruises with known ages and origins were photographed. Each photograph was accompanied by a color chart to assure accurate color reproduction. The data on color and age were then analyzed statistically using logistic regression. The authors concluded the following:

1. A bruise with any yellow must be older than 18 hours;
2. Red, blue, and purple or black may occur anytime from 1 hour of bruising to resolution;
3. Red has no bearing on the age of the bruise, because red is present in bruises no matter what their ages; and
4. Bruises of identical age and cause on the same person may not appear as the same color and may not change at the same rate.

This research suggests that the development of bruise color is variable, and that yellow, although a reliable sign of an older bruise, may appear relatively early, certainly earlier than many current forensic charts indicate.

CONCLUSION

Unlike the severe abuse that was reported in early child abuse literature, more moderate injuries comprise 60% of physical child abuse.43 These less-severe abuse cases, many with limited, ill-defined bruising, may be more difficult to diagnose than a severe case with multiple-system injury or a child with specific, clearly imprinted bruising. Additionally, as the US Supreme Court observed, "Child abuse is one of the most difficult crimes to detect and prosecute in large part because there often are no witnesses except the victim."44

Estimates of ages of bruises along with the aging of other injuries such as fractures and brain trauma may offer the only way to associate an injury with a particular perpetrator. Yet, as an aid to child abuse diagnosis and perpetrator identification, visual aging of bruises remains an inexact science, despite recent composite charts that suggest otherwise.

Even though it has been stated that it is not possible to age bruises accurately based on color,13,45
these opinions have not been represented in the child abuse literature. The study of Langlois and Gresham,12 to date the only research-based study of bruise aging by appearance, has not yet been cited in the medical literature (Science Citation Index search, August 1994).

The available literature does not permit the estimation of a bruise’s age with any precision based solely on color. Even for the practitioner to state, as Wilson8 suggests, that a particular bruise is “consistent with” a specific age implies a level of certainty not supported by the literature.

Bruises may be described as “older” if yellow, brown, or green are present, but practitioners should note the limitations of bruise age analysis. Of course, the practitioner must continue to describe the size, shape, location, and color of each bruise accurately. This is best done by written description and drawings along with careful photographic representation.46 Photographs of a bruise, however, depending on available light and technique, may not represent color accurately. A standard color wheel in the photograph may help.

Future research should focus on a number of questions. A study of the aging of bruises, using consistencies of known age and history-blinded examiners, could determine how accurate clinical estimates are. Interobserver reliability may also be assessed in such a study. The study of Langlois and Gresham12 should be repeated to confirm or to refute their findings. A photographic sequence of various bruises from appearance to resolution would give researchers and clinicians a reference of possible colors in differentiated bruises for standardized description.

The estimated age of a bruise should never be the sole criteria for a diagnosis of child abuse, but, rather, one component of a comprehensive assessment that incorporates a careful history of the injury, past medical history, family history, associated risk factors, a detailed physical examination, and appropriate laboratory testing.

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Cutaneous Necrosis After Contact With Calcium Chloride: A Mistaken Diagnosis of Child Abuse

Necrosis of the skin after contact with calcium chloride has been described in a variety of situations, including that of oil field workers and prolonged electroencephalographic testing (contact paste). Circumscribed dystrophic dermal calcification was reported for the first time in 1935 and may follow the application of dry calcium or calcium-containing solutions. The authors report a case of percutaneous penetration of a defrosting, industrial calcium salt, which was followed by deep-dermal thigh necrosis in a child. This uncommon injury raised concern about child abuse.

CASE REPORT

An 8-year-old boy was referred to our hospital in October 1993, after progressive dermal necrosis developed on a part of his left thigh. Three days earlier, he had walked in the Swiss Alps; at the beginning of his hike, he had collected three whitish stones from the edge of a mountain path, each approximately 2 cm in diameter, and had stored them in his left trouser pocket. In the shower a few hours later, he had noticed that a mildly itchy but painless erythema had appeared on the anterolateral aspect of his left thigh, at the site of his trouser pocket.

During the next 2 days, the lesion increased in size to approximately 30 cm² and became progressively black, dry, slightly raised, and necrotic (Fig 1). The patient was admitted, and a debridement was performed under general anesthesia. The necrosis was found to extend to the fascia cruris, which remained intact; a simple dressing was applied. On day 6, a superficial skin graft, taken from the scalp, was performed. The patient's postoperative course and healing were uneventful.

Initially, because the child had offered no clear history that could explain the lesion, even when he was interviewed alone, child abuse was considered. This diagnosis was furthermore sustained by the fact that the patient's living conditions were poor and that his mother was known for drug addiction. It was only with repeated questioning that the patient was able to recall the details of his mountain hike and provided the stones, which he had kept at home. In addition, on the 20th postoperative day, a yellowish fragmented material appeared, scattered on the edges of the grafted and healed wound (Fig 2). This was easily removed, revealing a mild inflammatory reaction underneath.

Von Kossa's staining and mass spectrometry of these concretions, as well as the analysis of the stones kept by the child, confirmed the presence of calcium chloride, which had accumulated in the upper dermis and was progressively extruding from the wound. In the meantime, local investigation revealed that an open bag of calcium chloride, used as a deicing salt, had been forgotten by a road worker on the side of the path where the child had walked.

The extrusion phenomenon progressed and intensified for 2 months. Treatment consisted of repeated removal of the crystals and simple dressings. After 60 days, the extrusion of calcium salts decreased and definitely ceased after 5 months. A final inspection at the 12-month follow-up showed a depressed and slightly atrophic scar.

DISCUSSION

Although subcutaneous necrosis has been recognized for many years as a predictable complication after extravasation of intravenously administered calcium salts, few cases of skin necrosis caused by external contact have been reported in the literature.

In 1935, an ice cream maker developed papules on his feet and legs, at areas of contact with a concentrated calcium chloride solution, used in the freezing procedure. Calcium chloride necrosis also occurred in British coal miners and American oil field workers. The latter handled the so-called "drill mud," which contains calcium chloride among other substances and is used to protect the drill; these workers had papulonodular lesions on their hands.