

Patterns of bruising in young boys subjected to paintballing: observational cohort study

Julia Thomson, Sultana Azam

Study question: Can paintball bruises provide evidence to help age children's bruises in cases of non-accidental injury?

Summary answer

This study has provided proof that supports the current evidence base that different colours appear in the same bruise at the same time, not all colours appear in every bruise and yellow is not seen in bruises less than 24 hours old. It does not provide enough evidence to change the current advice to paediatricians that they must not be drawn into ageing bruises in court. Further, well-designed, large studies are needed on this topic and there is no shortage of volunteers.

What is known and what this paper adds:

What is known:	What this paper adds:
<p>It is not possible to reliably "age" a bruise with the naked eye</p> <p>Paintballing is an expensive, fairly brutal activity enjoyed by young boys</p>	<p>Bruises caused by the same thing at almost the same time look very different on different subjects in the days following the acquisition of the bruise</p> <p>Using paintballing for research is time consuming, more enjoyable for the participants than the supervising researcher and becomes even more expensive when the participants get wind of the fact that further, larger studies are indicated.</p>

Abstract

Objectives

We set out to describe changes in bruises on 4 different paediatric subjects over time after a known insult delivered within a known 7 hour time period.

Design (Setting, participants, size and duration of study)

This is a cohort study of 4 friends on a paintballing trip on the outskirts of a big city in South East England in June 2014. All 4 were male and were 9 or 10 years old. 3 were white Caucasian and 1 was of mixed race. The paintballing session was 7 hours long. Photos were taken on days 1, 2, 4 and 7 after the session. Written consent was obtained from all the boys and their parents.

Results

3 out of the 4 boys sustained significant bruises. Paintball bruises have a characteristically pale middle, marking the point of impact, surrounded by the discolouration caused by broken capillaries and leakage of blood into the surrounding tissues. The bruises changed with age but the pattern of change was not consistent between the boys with one child's bruise going more blue with age and never showing an obvious yellow phase.

Conclusion

The nature of bruising is not consistent between different subjects. It is not possible to reliably age a bruise with the naked eye. Paintballing provides an ethical way of studying changes in significant bruises in children.

Introduction

All active children bruise. The nature and distribution of bruises and their relationship to the reason given for them is a constant source of consternation for all front line health professionals considering the possibility of non-accidental injury (NAI). In the past, much store was placed on the colour of bruises and the sequence of colour changes, which were thought to be a useful indicator of age and thus the potential cause of such injuries. Although judging the age of bruises with the naked eye is now known not to be backed up by clinical or scientific evidence(1), paediatricians can still be asked in court to age bruises and their clinical opinion often carries considerable weight in legal investigations and has played critical roles in several child protection cases.

The Cardiff Child Protection Systematic Reviews group(2) has looked in detail at patterns of bruising in children and whether they can be aged. The NSPCC leaflet on this topic is essential reading for anyone dealing with this issue and is available for download or purchase(3). Their current evidence-based position

statement is that the age of a bruise is virtually impossible to establish with the naked eye. Generally, bruises that tend to look more red/blue or purple are thought to be newer than yellow/green bruises but a study showed that the converse also applied, with 30% of bruises more than seven days old being identified as red/blue or purple(4). There are many factors, such as the developmental stage of the child, which can affect the assessment of bruising (5). It is not only the sequence of colour change that varies from child to child but the subjective nature of assessment makes the estimation of age extremely difficult; what is purple/brown to one doctor may be a dark red to another (4).

There are no large studies that investigate the age of bruises and a recent systematic review (6) found only three studies (1, 4, 5) that met the criteria for examining the accuracy of physician assessment and the age of bruises. Looking at bruises either *in vivo* or from photographs, the age cannot be correctly determined and conclusively, these studies suggest that physician estimations of accidental bruises are unreliable and urged extreme caution, particularly in child protection legal proceedings, due to the lack of scientific evidence (4, 7). Forensic experts have reached similar conclusions in cases of adult bruising however one study suggested that forensic experts are more capable of chronologically placing different bruises in the same individual (8).

We know that the distribution of bruises on a child and the presence of petechiae are relevant to a diagnosis of possible NAI, with bruises on softer, proximal areas of the body carrying a higher likelihood of being non-accidental (4,7). The behaviour over time of these bruises is the least well studied for obvious ethical and circumstantial reasons. Paintballing creates an ideal environment to investigate such injuries, particularly if the cohort includes children from different racial groups, as this is an area where more research has been called for(2).

Methods

5 children were invited to a paintballing birthday party on the outskirts of the city in South East England where they live. 4 were male, 1 female. 3 were white, 1 of mixed race and 1 black. Unfortunately for the study as well as for the girl involved, the black female study subject was unable to make it. 1 of the boys was either very good at hiding behind his mates or physiologically less likely to bruise, as he could not produce a good enough bruise on day 1 to have his photos included in the results table. The choice of party venue and activity was not of the paper's author i.e. the primary reason for the paintballing event was to have fun, not to provide the author with material for a research paper. The 4 remaining subjects' bruises were photographed using a Nikon D70 digital SLR camera in the early evenings of days 1, 2, 4 and 7. Boy A was not available for his photograph on day 7. Informed, written consent was taken from each boy and his parent. Formal ethical approval was not sought as no intervention took place.

Results

The results are presented as Table 1 below.

Discussion

This study is too small to generalise about how a bruise changes with time. There are also many confounding factors such as the distance from which the boys were hit, the speed of the paintballs at impact, the numbers of layers of clothing they had on and the exact time within the 7-hour playing period that they were hit.

Our findings concur with the information already on the Cardiff core-info site (2) from their systematic reviews on bruising. A hint of yellowing was seen in boy A by day 2 but was very obvious in both the white boys by day 4. Boy A shows nicely that many colours can be found in the same bruise at one time and Boy R illustrates that bruises of at least 7 days can still look purplish.

What this study does highlight is the urgent need for well-designed work looking specifically at bruising in a range of ethnic groups; the child of mixed race showed a very different progression of colour in his bruise over the time period and his bruise, although seemingly not as intense on day 1, lasted well beyond day 7 when his white friends' bruises had gone. The other strength of this study is that the bruises were all on soft areas of the boys' bodies where the likelihood of non-accidental injury is higher. Studying paintball bruising therefore extrapolates well to drawing conclusions about the nature and age of bruises in NAI cases.

The same experienced photographer took all the photographs with the same equipment in the early evening of days 1, 2, 4 and 7 but in a study in adults where forensic experts aged bruises from photographs, only 48% were accurate to within 24 hours of the true age (6). More recent research has explored the function of spectrophotometry and the degradation of haemoglobin in bruises as an indicator and determining factor of age (9, 10). Ultraviolet and infra-red photography and ultrasound have all been suggested as methods of accurately ageing bruises but are not in current clinical use.

This could all be looked at in future research using paintballing as long as Health and Safety laws allow children to continue playing without full body armour. A large enough study looking at a variety of bruises in each subject over time, with huge numbers of male and female children of different ages and different racial backgrounds initially shooting paintballs at each other for 7 hours and then all followed up at the same time points for up to 10 days afterwards with the photographs being taken by the same photographer with the same equipment and then analysed by a number of blinded paediatricians experienced in child protection work might give us the answers we are looking for. Anyone interested? I know the boys would be...

Conflict of interest:

JT is the mother of the paintball warrior pictured in figure 1 and the wife of the photographer and has personally funded other paintballing activities (but not this particular one).

Contributions of the authors:

JT had the idea for the study, organised the photographs and drafted the final write-up. SA did the background literature search and wrote much of the sensible introduction and the serious bit of the discussion.

Authors' affiliations:

Julia Thomson, Consultant paediatrician, Barts Health Trust, London, UK

Sultana Azam, final year medical student, Barts and The London School of Medicine and Dentistry, London, UK

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Table 1: bruising over time

	Day 1 (2 to 8 hours post injury)	Day 2 (26 to 32 hours post injury)	Day 4	Day 7
Boy A Aged 10 White Bruise on left anterior axilla				Subject out at football when the photographer called.
Boy R Aged 9 Mixed race Bruise on left calf				
Boy S Aged 10 White Bruise on right upper arm				