

Igwe WC
Igwebuike VO

Bruising in children: Evaluation in cases of suspected non-accidental injuries in children (physical child abuse)

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Igwe WC (✉)
Department of Pediatrics,

Igwebuike VO
Department of Histopathology
College of Health sciences,
Nnamdi Azikiwe University,
PMB 5001, Nnewi Campus,
Anambra State, Nigeria
Email: wc.igwe@unizik.edu.ng

Abstract: *Background:* Bruises commonly occur in children and are often due to minor accidental injuries. However, they can also occur in bleeding disorders or inflicted injuries (physical abuse) and is often the most common visible manifestation of child physical abuse.

Objective: This paper aims at highlighting the factors that should raise concern about non-accidental injury (physical abuse) in children presenting with bruising and the approach to their evaluation.

Method: This paper is based on a manual literature search and re-

view of relevant papers sourced from Pubmed using the search terms “bruising, non-accidental injuries in children, evaluation.

Conclusion: It is instructive to carefully and thoroughly evaluate bruise in children utilizing peer review and the necessary ancillary tests. It is also advisable to always consider other possible causes of bruise and bruise-like lesions in forming opinion about suspected bruise as implications of false diagnosis are grave.

Keywords: Bruise, bruise-like lesions, physical child abuse, evaluation.

Introduction

A bruise is an escape of blood into the skin or subcutaneous tissue, or both, following the rupture of blood vessels, usually capillaries, by the application of blunt force. There may be associated swelling. Bruises do not blanch on pressure but may vary in color, depending on their age. Bruising may be confused with paint or pen marks, dye from clothes, capillary hemangioma and periorbital swelling resulting from allergy or infection.¹ In dark-skinned children, bruises may be confused with café-au-lait spots.

Petechiae are tiny blood spots in the skin, each about the size of a pinhead, of fairly regular size and circular in shape and are usually red at initial presentation. These are seen in conditions associated with reduced/dysfunctional platelets or clothing disorders such as Idiopathic thrombocytopenic purpura, meningococcal infection and leukemia. Petechiae may also arise in children with normal clothing and platelet count as a result of trauma. Examples of petechial bruising are, bruising affecting the pinna when it is squeezed or slapped, bruising on the cheek or around the orbit as a result of a slap mark to the face.¹

Bruising is one of the most common and most readily visible injuries resulting from non-accidental injury (physical child abuse).² Although it may be overlooked

because it is not usually a significant injury, yet in cases of abuse it may be the only visible sign of internal injuries.³ Bruising may be due to physical abuse, accidental trauma or traditional scarifications and each of these have characteristics which distinguish them.

Bruises in childhood need careful evaluation, particularly in the borders of child protection and forensics. Therefore care must be taken to forestall faulty evaluation and flawed forensic opinion(s) about bruise particularly in children which presents peculiar challenges. Very young children cannot communicate verbally; when the child is a little older, he may not be able to give coherent history of events, and those who have reasonable cognitive attainment may present factitious accounts: all these pose problems to the clinical assessment of bruising in children.⁴

Sugar et al⁵ noted that non bruising infants rarely bruise and any bruise seen in such age groups must be investigated thoroughly to exclude non accidental injury. They observed also that bruising due to accidental injuries in mobile children is seen only on the bony prominences of the body. Certain sites such as the torso, ear and neck, rarely bruise in the non-abused child but are common sites of bruising in the physically abused child.⁵

Based on the available studies and published recommendations, this paper will help clinicians to know what factors should raise concern about inflicted injury

(physical abuse) when clinicians observe bruising and how to investigate them. It will also discuss the assessment to be performed to distinguish other causes of bruising in children. The implications for pediatric practice will also be highlighted.

Bruising in children

The non-accidental bruise may be self-inflicted or as a result of abuse or traditional practices. There are other bruise-like lesions caused by congenital and acquired conditions. The segregation of these different causes and mechanisms of bruise including proper diagnoses of lesions that have similar features is pertinent to the holistic management of the child-patient. Error in evaluation and interpretation of bruise can be immeasurably hurtful to the child-patient, the family and the community. Causes of bruise may be broadly categorized as shown below.

Classification of bruising

Accidental

- Self-inflicted
- Non self-inflicted

Non-accidental

- Abuse
- Non-abuse

Non-abuse: (a) cultural practices, resuscitation procedures, disorders of clotting/bleeding disorders (deficiency of clotting factors, thrombocytopenia, Vitamin K deficiency, hemophilia, drugs e.g. aspirin, heparin), chronic diseases e.g. chronic renal failure, liver failure.

Non-accidental injury in child is an injury in a child which is neither non-self-inflicted nor accidental. The likelihood of bruise occurring and its extent depends on several factors including the force applied, the area struck, site and nature of tissue, age of patient, presence or absence of certain disease conditions, drugs and so on. These multi-factorial determinants of the outcome of bruise make the exactness of predicting cause and mechanism difficult.

Some features of bruise may aid prediction of the etiology and the reconstruction of the events leading to it. For instance a tram-line bruise crossing multiple planes from the position of the clavicle to the back will make attack with a linear wrap-round object highly probable. Also a slap on a child's cheek may leave characteristic parallel finger imprint-bruises with sparing or pallor in between.⁶ Perineal redness in early childhood is not enough to diagnose abuse, however sexual abuse is highly probable when it is associated with infection by pathogens atypical with the child's age, for instance *Neisseria gonorrhoea* and *Chlamydia trachomatis*. Bruises caused by bites often show two symmetrical (or one) arched-bruises with inter-canine diameter usually more than 3 cm if bite is by an adult human.⁶

When evaluating bruise in children, the child's develop-

mental status is an important index to determining whether the injury is accidental or otherwise. Sugar et al⁵ noted that bruise is a rarity in infants under 6 months of age. In their study only 0.6% of infants below 6 months had bruise, while a total of 1.7% under 9 months presented with bruise. Expectedly the occurrence of bruise in childhood increased as the child becomes more ambulant and independent. The incidence of bruising increased to about 17.8% in cruising children and 51.9% in children who were walking.

In the court, lawyers often demand that the expert witness quantify, usually with some level of precision, the amount of force involved in wound causation. This may probably be used by the court to adduce possible intent of the offender among other issues. It suffices to say that calibration of the force should not be attempted, rather a broad categorization should be used (for instance, insignificant, moderate and significant force) where it is possible. In simple terms, the degree of traumatic skin bruise is a function of the force applied.

In practice however, the determinant of the extent and pattern of bruise is exceedingly multi-factorial. At least the area impacted is important. The larger the area the lesser the bruise expected and vice versa.

The pattern and extent of bruise also depends on age of the bruise, skin color and thickness, site of trauma and the depth at which bleeding occurred.⁷ Some disease conditions (for instance bleeding disorders) can exaggerate bruise, so also can anti-thrombotic medications such as aspirin and heparin, Vitamin K deficiency and or any of the clotting factors.⁸

Bruises spread more easily if the underlying connective tissue is loose as is seen in eyebrow injuries. Infants and the elderly tend to show more bruising because their skin is looser, more delicate and have more subcutaneous fat.

A bruise should not be examined in isolation if reasonable inference is to be reached. The distribution and collective assessment of all bruises and other associated injuries on the patient is pertinent to the investigation of the child abuse and particularly when reconstructing events leading to the injuries. Table 1 below summarizes observations that will suggest accidental or non-accidental injuries. However, it is important to note that these signs are not pathognomonic.

Table 1: Features associated with accidental and non-accidental bruise in childhood

	Accidental injury	Non-Accidental injury/abuse
Age	Ambulatory children may sustain bruise	Non-ambulatory children (particularly below 6 months old).
Site	Over bony prominences, anterior part of the body, shins, lower arms, under chin, forehead, hips, elbows, ankles	Upper arms, upper anterior thighs, trunk, genitalia, buttocks, face, ears, neck
Body plane	Often on one body plane	May involve more than one plane
Number	More often single isolated injuries but may be few	often multiple but may be single
Stage of healing	Often have similar stage of healing	Bruises at different stages of healing
Grouping and bilateralism	Rarely grouped and bilateralism is uncommon	Grouped and bilateral injuries are suspicious of abuse in young children who have not attained cognitive function for factitious attitude
Consistency	Often consistent with history	Often inconsistent with history
Presence of other injuries	Usually isolated injuries	There may be other injuries including fractures.

Good and detailed history is the key to evaluating bruise in children including bruise resulting from abuse. Unfortunately such reliable history is not always available; and most times the history is mired by poor communication or deliberate lies. When it is possible, it is advisable to interview the child and care-giver separately.

The setting of child abuse is often complex and its understanding is pertinent to identifying pointers from history taking. The background for child abuse ranges from sudden isolated loss of temper by the adult care-giver(s) to persistent premeditated acts of abuse.⁹

When abuse is the case, often there is a delay on the side of the 'guilty' care-giver in accessing health care for the affected child. The history volunteered by the care-giver is often inconsistent with the injuries and the history may change with time¹⁰. Sometimes the index child or sibling or others may be blamed for the injuries. History of previous accidents and prior attendance by child protective service for the child or sibling should increase suspicion and scrutiny.

Other signals for suspicion of child abuse are family disharmony, intra-family violence, and drug and/or alcohol abuse by one or both parents or care-giver. Furthermore, previous criminal conviction of the care-giver(s) is a risk factor for child abuse.⁹ Research has shown that adults who suffered abuse in childhood tend to be abusers later in life, the so called "*victim-to-victimizer cycle*" and that women have more tendencies to abuse children particularly in the setting where they were also victims of family violence.¹⁰

There is controversy on the influence of socio-economic status and poor educational attainment of child's care-giver on child abuse. Review by Cacain et al¹¹ showed significant positive correlation. However, earlier review by Katz et al¹² did not find significant association with low socio-economic status and education attainment. It is pertinent to add that the potential for child abuse is not limited to dysfunctional families but also exists in families living in apparent harmony. There are also cul-

tural differences in the tendency for child abuse; for instance, corporal punishment is used to discipline "erring" children in Africa. Other risk factors for child abuse include delayed development, children with special needs, crying persistently, unwanted children, and children less than 4 years of age.¹³ When the child for any reason is not wanted, the risk of abuse is high. Children with intellectual disability, such as autism and hyperactivity disorders are prone to accidents, yet they are often victims of abuse.¹³

Conditions that may exaggerate or cause easy bleeding include bleeding disorders due to hemophilia, deficiency of clotting factors, thrombocytopenia, and Vitamin K deficiency, use of anti-thrombotic drugs like heparin or aspirin, chronic illnesses like hepatic or chronic renal failure. These conditions must be excluded in children presenting with bruise through appropriate history, physical examination and laboratory tests.

Some conditions which may resemble bruise in children include allergic dermatitis, amoniacal napkin dermatitis, drug reactions, and skin staining by dyes or chemicals.

Sometimes pseudo-bruise may be encountered in the setting of post-mortem. Tissue disruption after death either by hitting the corpse, inadvertent fall of the corpse or by autopsy procedure can cause seepage of blood into the tissues and may mimic bruise thereby confounding interpretation. Post-mortem pseudo-bruise emphatically is not bruise since they occurred after death by which period active circulation would have ceased; the blood seepage is rather passive. However, interpreting perimortem "bruise" is a difficult issue in forensics.

Livor-mortis is the gravitational settling of blood in dependent areas after death. If unfixed, livor-mortis can shift with the change in the position of the corpse, unlike ante-mortem bruise.¹⁵

The onset of the body decomposition and putrefaction process can further confound the picture by effacing important clues for discrimination between inflicted injuries and pathological lesions.¹⁶

The choice of laboratory and radiological investigations is determined by the information drawn from history and physical examination findings.

The basic laboratory investigations to exclude bleeding disorders include:

- Complete blood count (CBC)
- Platelet aggregation test
- PT/PTT (Prothrombin time/Partial thromboplastin time)
- Thrombin clotting time and fibrinogen level
- Screening for Von Willebrand disease- estimation of Factor VIII, Von Willebrand factor antigen, and ristocetin co-factor levels

In blood clotting disorders the above laboratory tests will be abnormal while they are normal in inflicted injuries.

Depending on the results, other tests may be recommended. In death, post-mortem histological and histochemical investigations of the suspected "bruised" tissue are helpful in distinguishing ante-mortem and post-mortem bruise.

Significant bruise on the lower trunk particularly the abdomen may warrant abdominal radiologic examination, urinalysis and estimation of the pancreatic amylases, aspartate aminotransferase, and alanine aminotransferase to exclude rupture of the intra-abdominal viscera. There is high index of suspicion if positive physical examination is supported by microscopic hematuria and elevation of these pancreatic and hepatic enzymes.^{17,18} In cases of recurrent physical abuse, skeletal survey or bone scan is advisable which may show multiple fractures in different stages of healing.

Accurate and prompt diagnosis of bruise no matter how subtle is important to forestall untoward morbidity and adversity on the child-victim. However, opinion in support of abuse must be given after thorough assessment and peer review, when it is available. False diagnosis of abuse dislocates the affected child from family environment and causes immeasurable psychological pains to the child and family. Wheeler and Hobbs¹⁹ reported a case of a 3-year-old Asian child who was referred for excessive bruising and child abuse was suspected. After appropriate evaluation he was subsequently diagnosed as a case of hemophilia A. Similarly Schwer et al²⁰ reported a case of a 10-month infant with severe bruising involving multiple parts of the body with a healing clavicle fractures. Child abuse was suspected until the partial thrombin time (PTT) was found to be abnormal. The suspicion of child abuse was dropped when hemophilia was confirmed.

Evaluating the child with Bruising and suspected physical abuse

Pediatricians are often consulted in the clinic or during legal proceedings for an opinion when child abuse is suspected in the setting of bruising. About 75% of cases of child physical abuse may be

missed because pediatricians fail to recognize the early signs of child abuse.^{21,22} This leads to lost opportunities to intervene and prevent repeat abuse.

Pediatricians managing children must be able to distinguish bruising due to accidental injury, physical child abuse or bleeding disorders. They must understand the patterns of bruising in children based on child's developmental stage, social and environmental factors including the explanation given by the care giver. Any bruise in non mobile children raises the suspicion of physical abuse more so if the explanation given is not compatible with the extent of the bruise sustained.²³ Cases where the pattern of bruising is not in keeping with the explanation given must be investigated further. Child physical abuse cuts across cultures and socio-economic classes.²²⁻²⁴ The clinical approach to evaluation of suspected abuse includes detailed medical history, thorough physical examination, ordering of the appropriate ancillary laboratory tests to identify occult trauma and exclude other causes of bruising, and treatment. Adequate measures must be put in place to prevent further abuses.

The medical history should include details about the onset and progression of the bruising, associated symptoms and any known events leading to the bruising. Past history of previous bleeding or easy bruising such as after injections, circumcision, venipuncture or ear piercing will assist in confirming bleeding disorders. Family history of bleeding or easy bruising should also be excluded. A drug history is also important to exclude drug-induced bleeding disorders. The behavior of the child and relationship with the caregiver must be observed during the interview.

The careful pediatrician will however note in the history whether:

- The explanation given is appropriate for the injury, child's physical development or timing of seeking for treatment.
- The details of the history are consistent or changes with time.
- The information provided by different informants is markedly in agreement with explanations for the injuries.

A complete physical examination should be conducted with particular attention to general appearance, hydration, vital signs, nutrition, growth and development. If child abuse is suspected, the general examination may reveal evidence of neglect, oral injuries like torn frenulae in infants and injuries in different stages of healing. The entire skin must be examined with special attention to site, number, pattern of the bruises and associated injuries. Careful documentation of visible injuries with clinical photographs will be helpful in adducing evidence in law courts.

The general physical examination may suggest abuse in the following settings:

- Any significant unexplained injury in non-mobile child.
- Patterned injuries.
- Multiple injuries in different stages of healing.
- Injuries located away from bony prominences, or other unusual sites.

- Co-existence of injuries in different body planes.

When child abuse is confirmed, other siblings should also be assessed for possible abuse.

Laboratory tests are often invaluable in not only identifying other injuries but also to exclude other causes of bruising in suspected child abuse. Useful tests to exclude bleeding disorders in non-accidental injuries include : Full blood count & blood film, Platelet count, size & shape, Prothrombin time (PT), Partial thromboplastin time (PTT), thrombin time, fibrinogen levels, Bleeding time, levels of Factors II, VIII, & IX.

In cases of suspected associated abdominal injuries it is needful to assay pancreatic amylases, and liver enzymes. Radiologic studies such as skeletal survey, ultrasonography, and computerized tomography scan (CT) will prove invaluable in confirming associated occult injuries involving the bone and abdominal organs.

It is the responsibility of the pediatrician to recommend appropriate treatment based on examination findings or refer the child for further care if required. Efforts must be made to remove the child from the abusing environment with assistance of Child welfare services.

Implications for pediatric practice

It is the responsibility of the pediatrician to identify the

abused child for appropriate care, report suspected abuse to child welfare services for further investigation, support the families of the abused child, and coordinate other healthcare services to provide both immediate and long term treatment and prevention of abuse and to provide court testimony when needed.

Conclusion

Evidently bruise is a common sign of child physical abuse. However, bruise in children can originate from diverse causes and some non-traumatic lesions can mimic bruise. No feature is pathognomonic of bruising due to physical abuse. The occurrence, pattern and extent of bruise are dependent on several interacting factors. A careful and detailed history supported by thorough physical examination is imperative if informed opinion about bruise is to be achieved. Relevant investigations and peer review is helpful for optimum evaluation.

Continuing medical education on child abuse for first-line emergency physicians and pediatricians is important to boost human capacity and quality service delivery in this area.

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