

The classic metaphyseal lesion and traumatic injury

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Abstract

Background It is widely accepted that the classic metaphyseal lesion (CML) is a traumatic lesion, strongly associated with abuse in infants. Nevertheless, various non-traumatic origins for CMLs continue to be suggested in medical and legal settings. No studies to date systematically describe the association of CMLs with other traumatic injuries.

Objective The primary objective of this study is to examine the association of CMLs with other traumatic injuries in a large data set of children evaluated for physical abuse.

Materials and methods This was a retrospectively planned secondary analysis of data from a prospective, observational study of children <120 months of age who underwent evaluation by a child abuse physician. For this secondary analysis, we identified all children ≤12 months of age with an identified CML and determined the number and type of additional injuries identified. Descriptive analysis was used to report frequency of additional traumatic injuries.

Results Among 2,890 subjects, 119 (4.1%) were identified as having a CML. Of these, 100 (84.0%) had at least one additional (non-CML) fracture. Thirty-three (27.7%) had traumatic brain injury. Nearly half (43.7%) of children had cutaneous injuries. Oropharyngeal injuries were found in 12 (10.1%) children. Abdominal/thoracic injuries were also found in 12 (10.1%) children. In all, 95.8% of children with a CML had at least one additional injury; one in four children had three or more categories of injury.

Conclusion CMLs identified in young children are strongly associated with traumatic injuries. Identification of a CML in a young child should prompt a thorough evaluation for physical abuse.

Keywords Child abuse · Children · Classic metaphyseal lesion · Fractures · Radiography

Introduction

Almost 60 years ago, John Caffey [1] first reported on a cohort of children with long bone injuries who were found to also have subdural hemorrhages. Described early on as “chip” or “chunk” fractures, Caffey hypothesized these lesions represented stripping of the periosteum at points of tight anchoring to the epiphyseal cartilage, causing bone to detach from the metaphyseal margin under sufficient injurious force. Widely accepted for several decades, this hypothesis was challenged by Paul Kleinman and colleagues [2] in a 1986 study of four abused infants. The subjects were studied radiographically after sustaining abusive injuries and each received postmortem examination. Both normal and abnormal sections of metaphyseal bone as identified by radiography were sectioned and analyzed histologically. Based on this analysis, Kleinman concluded that “the histopathologic alterations defined ...

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Results

Among 2,890 subjects, 1,501 (51.9%) were ≤ 12 months of age. Of these, 119 (7.9%) were identified as having a CML. Demographics of the 119 children are shown in Table 1. Rates of additional injury types are shown in Table 2. More than 95% of subjects with CMLs had at least one additional injury. Non-CML fractures were identified in 84.0% of children. Cutaneous injury was identified in 43.7% of children. Traumatic brain injury was identified in 27.7% of children. More than 70% of children with a CML had three or more additional non-CML fractures, with long bone, rib, skull and hand/foot fractures being the most common locations.

One hundred eleven of 119 children (93.3%) were rated as a 5 (“very concerning for abusive injury”) or above using the 7-point scale of abuse likelihood.

When grouping other types of specific injuries into categories, 95% of children with a CML had at least one additional category of injury and 25% of children had three or more additional categories of injury (Fig. 1). Five children (4.2%) were found to have a CML without any additional injury. Clinical details of these children are summarized in Table 3. Two of these subjects had findings characterized as “irregularities” that were not confirmed as CMLs on follow-up skeletal survey and were ultimately coded as having a mild or indeterminate level of concern for abuse. One was thought to have CMLs as a result of a difficult obstetrical delivery. None was identified as having metabolic bone disease.

Table 1 Demographics of cohort of 119 children with classic metaphyseal lesion

	<i>n</i>	%
Male gender	64	53.8
Ethnicity		
Hispanic	30	25.2
Non-Hispanic	83	69.7
Not reported	6	5.0
Race		
Black/African American	31	26.1
Asian	1	0.8
White	74	62.2
More than 1 race	7	5.9
Not reported	6	5.0
Age		
0-2 months	57	47.9
3-4 months	30	25.2
5-6 months	13	10.9
7-8 months	9	7.6
9-10 months	8	6.7
11-12 months	2	1.7

n number of patients

Table 2 Frequency of other categories of traumatic injury in cohort of 119 children with classic metaphyseal lesion (CML)

	<i>n</i>	%
Additional non-CML fractures	100	84.0
1	1	0.8
2	13	10.9
3-5	29	24.4
6-10	36	30.3
>10	21	17.6
Location of additional non-CML fractures		
Long bone	78	65.5
Rib	53	44.5
Other	18	15.1
Skull	16	13.4
Hand/Foot	13	10.9
Cutaneous injury	52	43.7
Bruises	44	37.0
Burns	5	4.2
Other	4	3.4
Traumatic brain injury	33	27.7
Oropharyngeal injury	12	10.1
Abdominal/thoracic injury	12	10.1

n number of patients

Discussion

Recognition of signs and symptoms suggestive of trauma is critical in the young child. Failure to recognize a traumatic and potentially abusive injury carries significant morbidity and mortality for the child who may be returned to an environment where abuse is persistent or escalating [18–23]. Continued promotion of unsupported hypotheses such as those by Ayoub et al. [12], which creates the appearance of controversy, is confusing to health care providers and potentially places children at direct risk for harm. While this is the first multicenter study to our knowledge to look at the association of CMLs with other specific categories of traumatic injury in a large data set of children evaluated for physical abuse, the association of CMLs with trauma in general is well-described. Perez-Rossello et al. [24], for example, report 46 patients who had fatal abusive head trauma and CMLs but no evidence of rickets. Our study builds on this work with consideration of additional categories of traumatic injury.

If the hypothesis that a CML is the result of a non-traumatic etiology were correct, we would have expected the following findings in our study: 1) Children with CMLs would rarely have additional categories of injury and 2) children with CMLs would not be assigned high levels of concern for abuse by consulting physicians. Neither of these findings was observed in our study. In this study, nearly every child with a CML had at least one additional traumatic injury. More than

one in four children had three or more additional categories of injury. Furthermore, more than 90% of children were rated ≥ 5 (“very concerning for abusive injury”) using a 7-point scale of abuse likelihood and 115 of the 119 children (96.6%) were reported to child protective services. These findings support previous work that describes the co-occurrence of various types of traumatic injury when there is concern for abuse [23, 25] and argues against the hypothesis that CMLs have a non-traumatic etiology. These results also support those of Barber et al. [26] who described the rate of additional fractures identified by skeletal survey at a single referral center. Among 50 children with at least one CML identified, 87% were found to have additional fractures [26]. Our results expand on this important work by showing that, in addition to those children with non-CML fractures, nearly 12% of children had additional, non-fracture traumatic injuries.

This study has several limitations. While participating sites in the parent study agreed with a common standard of care for siblings and contact children, this was a purely observational study and all testing was undertaken at the discretion of the treating team. It is possible that some patients had other, occult injuries that were missed if some testing was omitted. If this were true, our estimate of the rate of subjects with CML but no additional injury would be inflated. We also note that while there are fewer cases and a statistically lower proportion of cases with single CMLs, we cannot completely rule out a low incidence cause of CMLs (such as birth injury) although we believe this is unlikely. Our results could be affected if a large number of children with CMLs and negative evaluations by front-line providers were not referred to child abuse physicians. We believe this is extremely unlikely. Given the widespread acceptance that CMLs are highly specific for abuse, identification of a CML prompts immediate child abuse physician consultation at the institutions that participated in the ExSTRA research network [17, 27, 28]. This is demonstrated by our identification of one child with a non-abusive CML as a result of the birth process (Table 3). These data also do not contradict prior reports that describe rare, non-abusive causes of findings similar to CMLs [7, 9, 11, 29, 30]. However, the hypothesis that CMLs are widely misinterpreted as traumatic lesions is not supported by these data. Given that the overwhelming majority of CMLs are seen in infants younger than 1 year of age, we restricted our analysis to infants ≤ 12 months of age. This resulted in the exclusion of 12 children from the final analysis, 10 of whom were also found to have additional categories of traumatic injury.

Two of the subjects coded as having CMLs but without additional injuries were noted to have findings that were unchanged and were ultimately coded as having an intermediate

concern for inflicted injuries. We believe this supports expert recommendations that CMLs can be subtle and require interpretation by a radiologist experienced in reading pediatric imaging to avoid under- or over-identification [17, 29, 31, 32]. We did not independently review images from subjects coded as having CMLs or others. While it is possible that independent review would have identified more or fewer CMLs, we think this is unlikely. Each participating center included a dedicated child protection team, including child abuse physicians and radiologists experienced in the identification of CMLs. Further, our methods represent real-world practice and produce results relevant for centers with dedicated child protection teams. Finally, radiologic findings were not entered directly into the database, but rather entered and potentially modified by the child abuse physician. This presents an unlikely opportunity for error with minimal impact on the overall results.

Conclusion

The vast majority of children in whom CML is identified have other evidence of trauma and abuse. In this large cohort, we did not find evidence of a non-traumatic origin for the CML. Clinicians should continue to follow guidelines that recommend careful consideration of abuse in all children with an identified CML.

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Compliance with ethical standards

Conflicts of interest Drs. Lindberg and Thackeray have given paid expert witness testimony in cases with concern for physical abuse.