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SHORT COMMUNICATION

Validity of parental recall of children's fracture: implications for investigation of childhood osteoporosis

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Abstract
Summary Fracture history is an important component of osteoporosis diagnosis in children. One in six parentally reported lifetime fractures in children were not confirmed on review of radiographs. Care should be taken to avoid unnecessary investigations for possible osteoporosis due to parental over-reporting of soft tissue injuries as fractures.
Introduction The diagnosis of osteoporosis in children requires either a vertebral compression fracture, or a significant fracture history (defined as ≥2 long bone fractures <10 years or ≥3 long bone fractures <19 years, excluding high impact fractures) and low bone mineral density. As children with frequent fractures might benefit from further evaluation, we determined whether parental reports of lifetime fracture were accurate compared to radiological reports and if they appropriately selected children for further consideration of osteoporosis.
Methods Parents of children (<18 years) with a musculoskeletal injury completed a questionnaire on their child's fracture history, including age, site and mechanism of previous fracture(s). Radiological reports were reviewed to confirm the fracture.
Results Six hundred sixty parents completed the questionnaire and reported 276 previous fractures in 207 children. An injury treated at our hospital was recorded in 214 of the 276 parentally reported fractures. Thirty-four of 214 (16 %) were not a confirmed fracture. An injury was recorded for all parentally reported fractures in 150 children, but for 21 % children, there were inaccurate details (no evidence of fracture, incorrect site or forgotten fractures) on parent report. Eighteen of 150 children had a significant fracture history on parental report alone, but following review of radiology reports, 2 of 18 (11 %) did not have clinically significant fracture histories.
Conclusions Approximately one in six fractures reported by parents to have occurred in their child's lifetime had not resulted in a fracture. One in nine children with a significant fracture history could have been investigated unnecessarily.

Keywords Fracture · Mental recall · Osteoporosis · Paediatric · Parent

Introduction

Osteoporosis is characterised by low bone mass and microarchitectural deterioration of bone tissue, resulting in increased bone fragility and propensity to fracture [1]. A diagnosis of childhood osteoporosis is important to enable appropriate management to be instituted to reduce future fracture risk. However, fractures are common in childhood and adolescence; approximately one third of children will sustain at least one fracture by 18 years of age [2, 3]. Case-control and prospective cohort studies suggest that children who sustain fractures have lower bone mineral density (BMD) compared to non-fracturing controls [4–7]. However, it is less clear whether bone densitometry alone is predictive of future clinically relevant fractures [8], and therefore, unlike in adults, a

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diagnosis of osteoporosis in children should not be based on BMD assessment alone [8, 9].

The International Society for Clinical Densitometry (ISCD) has defined osteoporosis in children based on the presence of either a vertebral compression fracture(s) or a combination of both a clinically significant fracture history and bone densitometry findings [8, 9]. A clinically significant fracture history is defined as two long bone fractures before 10 years of age or three long bone fractures before 19 years of age, after exclusion of fractures due to high impact mechanisms. This definition serves as a guide for the clinician to decide which children require further evaluation for osteoporosis, and thus, is it important to be able to identify a fracture history that merits more detailed investigations for bone fragility.

In adults, self-reporting of fractures, even when limited to those that occurred in the few years prior to reporting, tends to overestimate the actual number of fractures when compared to radiological reports and medical records [10–13]. The accuracy of parental recall of their children's health and illness events varies with childhood illness [14], but to our knowledge, there are no studies that have assessed the validity of parentally reported lifetime fracture prevalence in children, yet the accuracy of parental report is vital to making a diagnosis of osteoporosis in children. We therefore determined whether parental reports of their child's lifetime fracturing events were accurate and whether children with a clinically significant fracture history were correctly identified by parental fracture reports and referred for further investigation.

Methods

Children attending the children's orthopaedic outpatient clinic at University Hospital Southampton NHS Foundation Trust with an acute musculoskeletal injury between October 2012–May 2013 and October 2013–May 2014 were invited to participate in the study. Children are referred to this clinic from the Emergency Department following either a confirmed fracture or high clinical suspicion of a fracture. Children were excluded if they had a medical condition known to increase fracture risk. The study was approved by the Portsmouth Research Ethics Committee. Written informed consent was obtained from a parent or guardian accompanying the child, and assent was obtained from all children.

The parent/guardian accompanying the child was asked to complete a written questionnaire which included questions on the current injury and previous fractures. If the parent reported a previous fracture(s), details of the child's age, or approximate date of fracture, bone(s) involved and the mechanism of injury were obtained. Past medical history, ethnicity, number of siblings and family history of fractures were also documented. The questionnaire was completed in the outpatient department whilst awaiting the medical consultation. As such, whilst all children had an acute musculoskeletal injury, for some children, confirmation of a fracture as part of the incident injury might not have occurred prior to questionnaire completion. As this study focussed on parental reporting of previous fractures, the children who did not have a confirmed incident fracture were still included in the final dataset.

Hospital records including Emergency Department documentation, clinic letters and radiology reports were subsequently reviewed for evidence of an injury at the time, site and mechanism as stated by the parent on the questionnaire. An injury was considered to have resulted in a fracture if radiographic reports confirmed the presence of a fracture.

Participant postcode was used to calculate social deprivation index using the English 2010 Index of Multiple Deprivation from the UK Office of National Statistics. This has been demonstrated to serve as a surrogate measure of poverty within a geographic area [15].

For children in whom one or more previous fracture was reported and a previous injury could be confirmed for each reported fracture, it was determined whether, based on the parental report, they had a clinically significant fracture history, as previously defined [9]. A definition of a long bone is not provided in the ISCD position statement; therefore, we considered this to be radius, ulna, humerus, clavicle, tibia, fibula, or femur. Some parents did not name the bone involved but instead referred to a general body area. We considered the "arm", "shoulder", "elbow", "forearm", "wrist", "leg", "shin", or "ankle" to have involved long bones but not the "hand", "finger", "thumb", "foot", or "toe". A high impact mechanism was considered to be from a road traffic accident and falls from >3 m [16]. Finally, it was determined which children had a clinically significant fracture history from review of radiological reports.

Statistical analysis

Demographic details for children that did and did not report a previous fracture and between children with and without accurate parental fracture histories were compared using *t* test and Mann-Whitney *U* test for normally and non-normally distributed variables, respectively. The chi-squared test was used for comparison of categorical variables. Data analysis was performed using SPSS v21. A p value <0.05 was considered to be significant.

Results

Six hundred sixty children (432 [65.5 %] male, median age 11.8 years, range 1.2–17.3 years) participated in the study; 571 (86.5 %) of these children had a fracture confirmed by radiography during this injury episode. Parents of 207 participants (31.4 %) reported at least one (range 1 to 7) previous

fracture (Fig. 1). Children with a previous reported fracture were older (median 13.1 years, range 2.8–17.3 years) than those without a previous fracture (median 11.1 years, range 1.2–17.1 years, $p<0.001$), but there was no difference in sex distribution ($p=0.09$).

Two hundred seventy-six previous fractures were reported in these 207 children. An injury managed at our hospital was identified for 214 events, 34 (15.9 %) of which had not resulted in a radiograph confirmed fracture (Fig. 1). Thirty-one of 207 children (15.0 %) had at least one misreported fracture with 28, 2 and 1 child(ren) having 1, 2 and 4 misreported fractures, respectively. The over-reporting of non-skeletal injuries as fractures was similar for the upper (15.8 %) and lower limb (20.0 %, $p=0.51$). For 174 of the 180 confirmed fractures, the parents had stated a fracture site; 9 (5.2 %) were not at the parentally reported site. Additionally, seven fractures (six finger/thumb phalanges and one radius) were identified in seven children that had not been reported by the parent.

An injury managed at our hospital could be identified for all previously reported fractures in 150 children. In comparison to the 57 children in whom we could not identify all previously reported fractures as injuries managed at our hospital, they were of similar age ($p=0.90$), sex ($p=0.72$) and ethnicity ($p=0.26$) but lived in more deprived neighbourhoods ($p=0.026$) and reported fewer previous fractures (0 % reported ≥4 previous fractures compared with 8.1 %, $p=0.012$). For the 150 children for whom all injuries were identified, 31 (20.7 %) of these children had inaccurate fracture histories when incorrect fracture site, no evidence of fracture, and forgotten fractures were included. Age, sex, number of fractures reported, number of siblings, parental ages, ethnicity and social deprivation scores did not differ where the parent provided an accurate compared to an inaccurate fracture history ($p>0.05$ for all [data not shown]). In this group of 150 children, using only information obtained from parental fracture reports, 18 had a clinically significant fracture history (Fig. 2). Following confirmation of X-ray findings, for two of these 18 children, the fracture history was no longer clinically significant and would not have warranted further investigations. Both children were under 10 years of age and had a previous soft tissue rather than confirmed bony injury. However, three of five children for whom the parents provided insufficient information (e.g. site or mechanism of injury) did have clinically significant fracture histories on review of radiography and hospital records. None of those with a clinically significant fracture history had undergone bone densitometry or referral to the metabolic bone disease clinic for further evaluation.

Discussion

Appropriate identification of children who require further investigations for multiple fractures is important. Medical

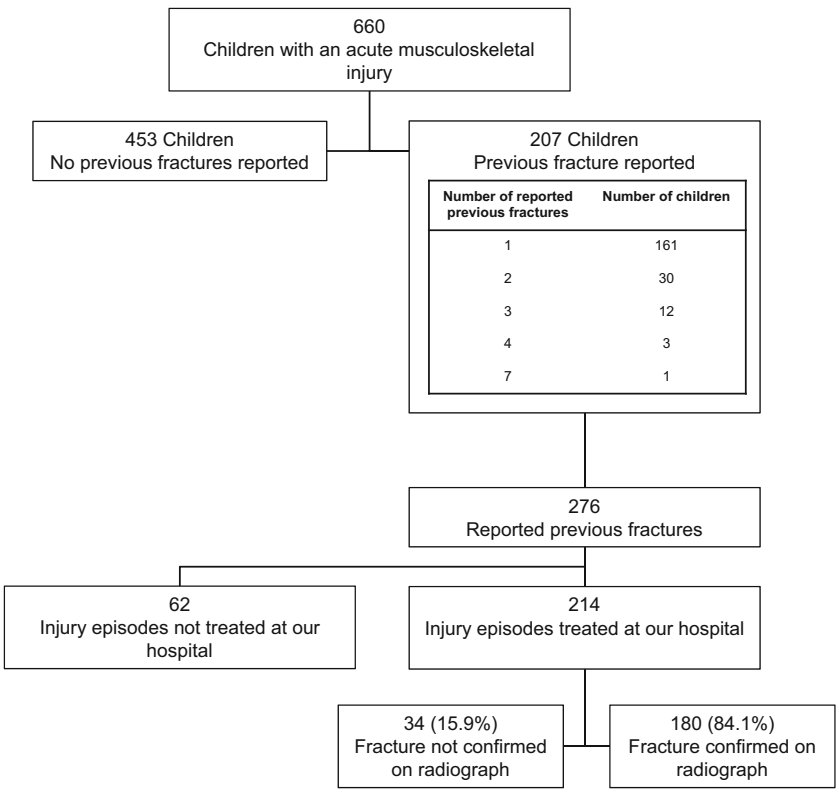

Fig. 1 Accuracy of parentally reported fracture histories in children and adolescents

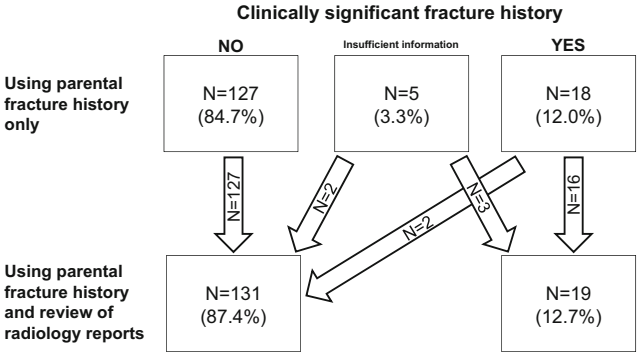

Fig. 2 The frequency of a clinically significant fracture history based on parental report only or parental report and X-ray review in children who reported multiple fractures that had all been treated at our hospital

investigations can evoke anxiety, may require additional hospital visits necessitating further missed school and parental employment, and are at a cost to the healthcare provider and/or family [17]. Thus, unnecessary over-investigation should be avoided.

Obtaining an accurate fracture history is essential for identifying children who may benefit from further evaluation for osteoporosis [9]. Fracture histories can be obtained from a variety of sources, including the parents and referral from another clinician, but in some cases, fracture records are not available to confirm previous fractures due to treatment in multiple healthcare facilities. The clinician is therefore reliant on accurate parental recall or referral information. In this study, we have demonstrated that approximately one in six injuries that were reported to be a fracture by parents were not a radiographically confirmed bony injury. Furthermore, one in five parental fracture histories contained incorrect information on either fracture occurrence or fracture site, or fractures were forgotten. The impact of inaccurate fracture histories is important; in this study, approximately 10 % of children with an apparently significant fracture histories based on parental recall alone were not considered to be significant following review of radiographic reports as the children had sustained soft tissue rather than bony injuries.

Referral to a metabolic bone clinic to enable evaluation for possible osteoporosis is likely to involve additional outpatient appointments and investigations including vertebral radiography to assess for asymptomatic vertebral compression fractures [5], densitometry [9] and blood sampling to eliminate causes of secondary osteoporosis, such as malabsorption [18]. The cost of each outpatient clinic appointment to the parent and child is 0.25 work days, 0.18 days wages and 0.54 days schooling [17]. Thus, unnecessary referrals should be avoided.

This is the first study to explore the accuracy of parental recall of lifetime fracture prevalence in children. Others have found that only 87 % of fractures reported in the preceding 2 years in children were confirmed on X-ray reports [4]. Three studies in older people in Europe, Australia and the USA found that between 10 and 13 % of fractures were falsely self-reported [10–12]. In each of these studies, only fractures that had occurred in a period of between 4 months and 3 years prior to the questionnaire were assessed, rather than lifetime fracture prevalence which was evaluated in our study. We were not able to determine more detailed information relating to what parents had been informed by health professionals about their child's previous injury. It is possible that some parents accurately reported what they had been informed at the time of injury but that the formal radiography reporting was not consistent with this.

In contrast to studies in older individuals in which it has been shown that men and younger adults were more likely to falsely report a fracture than women and those of advanced age [10], and that women with higher educational attainment were less likely to falsely report a fracture [12], we did not identify any sociodemographic factors which discriminated between children with and without accurate fracture histories. This is in agreement with a previous study which assessed parental recall of childhood illness and found that caregiver educational attainment and occupation were not associated with accuracy of recall [14]. We did not document whether the mother or father responded to our questionnaire, but it has been suggested that mothers recall health events more accurately than fathers [14].

This study is not without limitations. Fracture history was obtained through a written questionnaire, which did not allow for any clarification of parental responses or more detailed enquiry into the site of fracture when ambiguous answers, for example arm or ankle, were provided. This therefore did not reproduce a clinical consultation, although in our experience even in a consultation, many parents cannot provide a more accurate fracture site than "arm" or "leg". Furthermore, it is unlikely that a verbally obtained fracture history would have altered the number of incorrectly recalled or forgotten fractures. Additionally, we did not review the radiographic images but instead used the formal reports provided by a radiologist. This method does rely on the expertise of the radiologist who provided the initial fracture report, and it is possible that this could have resulted in misclassification of fractures as non-bony injuries and vice versa. However, this approach was felt to more closely reproduce the clinical setting when the decision to refer for further investigations is made. Furthermore, any clinical fractures (e.g. scaphoid tenderness), but without radiographic fracture, would not have been included. We did not attempt to verify any fractures which might have been treated at other hospitals, and the children for whom all reported fractures were not treated at our hospital did report more fractures. We therefore cannot be certain whether these children actually did have more fractures or whether their parents tended to over-report other injuries not requiring hospital management as fractures. The ISCD position statement does not provide a definition for a long bone [9]. We opted to

exclude metacarpals and metatarsals from the definition of a clinically significant fracture, as differentiating these from phalangeal and carpal/tarsal fracture from parental reporting is more difficult. In this study, we excluded children with a medical condition known to increase bone fragility, as these children might benefit from a routine assessment of bone health including DXA [19]. However, clinicians should be aware that the predictive value of a DXA measurement of BMD in fracture risk has also not been established in many childhood chronic diseases, and guidelines for the initiation of therapeutic interventions aimed at reducing fracture risk are currently lacking [19].

Our findings have implications for both clinical care and research utilising retrospective recall of fractures in children and young people. Although the majority of parents accurately reported their child's previous fractures, our findings highlight firstly that attempts should be undertaken to confirm parentally reported fractures where possible to minimise unnecessary investigations and, secondly, our findings further strengthen the need for the electronic sharing of medical records between healthcare providers.

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Conflicts of interests None.

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