European Journal of Radiology 84 (2015) 2296–2300

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Plain radiography in children with spoke wheel injury: A retrospective cohort study

Annelie Slaar[a,*,1], Ingrid H.C.M. Karsten[b], Ludo F.M. Beenen[a], Mario Maas[a], Roel Bakx[c], Rick R. van Rijn[a], Niels W.L. Schep[d]

[a] Department of Radiology, Academic Medical Centre, University of Amsterdam, The Netherlands
[b] Emergency Department, Academic Medical Centre, University of Amsterdam, The Netherlands
[c] Department of Paediatric Surgery, Academic Medical Centre, University of Amsterdam, The Netherlands
[d] Trauma Unit, Department of Surgery, Maasstad Ziekenhuis, Rotterdam, The Netherlands

ARTICLE INFO

Article history:
Received 23 March 2015
Received in revised form 5 July 2015
Accepted 9 July 2015

Keywords:
Pediatric radiology
Emergency care
Spoke wheel injury
Ankle injury
Conventional imaging

ABSTRACT

Background and purpose: Bicycle spoke injury (BSI) mostly occurs in children as a result of entrapment of the leg in the bicycle spokes. No guideline or protocol exists that defines what type of radiography is indicated to diagnose or rule out a fracture commonly associated with these injuries. The aim of this study was (1) to evaluate the type of radiographs that are obtained in children with BSI, (2) to assess in which anatomical regions fractures occur and (3) to evaluate on which radiographs a fracture can be detected in children with BSI.

Patients and methods: A retrospective cohort study was performed in paediatric patients presenting at the Emergency Department (ED) of a university hospital with a paediatric surgery department between June 2008 and December 2013.

Results: In 99 of the 320 children (31.4%) evaluated with radiography following BSI a fracture was diagnosed. In almost two third of the patients (63%) radiographic imaging of two or more anatomical regions was performed. In 98 children (99%) the fracture was located at the distal tibia or fibula. All fractures were diagnosed on a radiograph of the ankle or lower leg (including the ankle region). No fractures of the foot were diagnosed.

Conclusion: We suggest that in children with a clinical suspicion of a fracture at the ankle region, in which no fracture is seen at the radiograph of the ankle, no additional radiographs are necessary.

1. Introduction

Bicycle spoke injury (BSI) is defined as injury to the foot, ankle or the lower leg as a result of entrapment in the bicycle spokes, of most commonly the rear wheel of a bicycle [1–4]. Especially children sitting on the rear carriage of a bicycle, without proper safety precautions, are prone to this injury [1,5,6]. BSI mostly occurs in children under the age of 14 with a peak incidence between 2 and 6 years [7].

Izant et al. described three typical characteristics of BSI: (1) soft tissue laceration due to the knife-like trauma mechanism of entrapment between the spokes, (2) crush injuries due to impingement between the wheel and frame of the bicycle, and (3) shearing injuries from the coefficient of the forces [1]. Consequently, the most common diagnoses are lacerations of the skin, ankle sprains or fractures of the distal tibia and/or fibula [3]. With reported fracture percentages varying between 8.7 and 31% [3,5,7–11].

A previous study indicated there are no clinical signs that reliably predict the presence of a fracture, concluding that referral for

* Corresponding author at: Department of Radiology, Academic Medical Centre, University of Amsterdam, P.O. Box 22660, 1100 DD Amsterdam, The Netherlands.
E-mail addresses: a.slaar@amc.nl (A. Slaar), i.h.karsten@amc.nl (I.H.C.M. Karsten), l.f.beenen@amc.nl (L.F.M. Beenen), m.maas@amc.nl (M. Maas), r.bakx@amc.nl (R. Bakx), r.r.vanrijn@amc.nl (R.R. van Rijn), schepn@maasstandziekenhuis.nl (N.W.L. Schep).

[1] The corresponding author has the right to grant on behalf of all authors and does grant on behalf of all authors, a worldwide licence to the Publishers and its licensees in perpetuity, in all forms, formats and media (whether known now or created in the future), to (i) publish, reproduce, distribute, display and store the contribution, (ii) translate the contribution into other languages, create adaptations, reprints, include within collections and create summaries, extracts and/or, abstracts of the contribution, (iii) create any other derivative work(s) based on the contribution, (iv) to exploit all subsidiary rights in the Contribution, (v) the inclusion of electronic links from the contribution to third party material where-ever it may be located, and (vi) license any third party to do any or all of the above.

http://dx.doi.org/10.1016/j.ejrad.2015.07.013
0720-048X/

radiography after BSI is justified in all children sustaining BSI [7]. To date however, no guideline or protocol defines what type of radiograph of which anatomical region is indicated to confirm. Consequently, types of radiographs performed for BSI vary widely [7,8]. The goal of this study in BSI was threefold; first to define the type of radiographs that are obtained in children, secondly to assess in which region the fractures occur; and finally to evaluate in which radiographs a fracture can be detected in children with BSI.

2. Materials and methods

2.1. Study design

Retrospective cohort study in a university hospital with a paediatric surgery department, from June 2008 to December 2013.

2.2. Study population

All radiographs of the ankle, lower leg and/or foot performed at the ED in all consecutive children aged 0–18 years old were screened in the radiology department database (IMPAX version 6.5.2, Agfa, Mortsel, Belgium). Patients were included if the reason for referral for radiography was BSI. To prevent missing cases, electronic patient files of all children that were presented at the ED with the diagnosis wound, contusion and distortion of the foot or ankle were screened to assess if the trauma mechanism was BSI. The electronic patient database was used to detect if patients were readmitted within 3 months after they were presented following BSI.

2.3. Data collection and measurements

The radiographs were anonymized using dcm2nn-gui, version 1.1.4, Department of Radiology, Academic Medical Centre, Amsterdam, The Netherlands. All radiographs were independently reviewed for the presence of a fracture by two radiologists with over 10 years of experience in paediatric (RvR) or trauma (LB) radiology. Discrepancies in diagnosis were resolved in consensus reading. The radiologist scored the presence, location and type of fracture. They also scored on which type of radiography a fracture was detected. Demographic and clinical data scored were: sex, age, affected side, region of pain, the presence of soft tissue injury, type of radiograph, fracture type and location. Fracture location was subdivided into: ankle, lower leg, foot or a combination. The ankle region was defined as the region formed by the distal tibia, distal fibula, and the talus.

2.4. Definitions

A fracture was defined as a disruption of at least one of the bony cortices or as an osseous avulsion at the site of attachment of a ligament or tendon. Epiphysiolysis was defined according to the Salter Harris (SH) classification [12].

2.5. Radiographic protocols

In our hospital a radiograph of the ankle should consist of an antero-posterior view with 20° endorotation (Mortise-view) and a lateral view. At the Mortise view the joint between the lateral malleolus and talus, and the joint between the tibia and talus should be projected open. At the lateral view the base of the fifth metatarsal should be visible and the joint between the talus and tibia should be projected open. The fibulashaft should be projected in the middle and the calcaneus should be projected completely.

All radiographs of the lower leg should consist of a lateral and an AP view. The lower leg, the knee and ankle joint should be visible.

Table 1
Patient characteristic.

Characteristics	Fracture (n = 99)	No fracture (n = 221)	Total (n = 320)
Age, mean (SD)	3.9 (1.3)	4.4 (2.8)	4.2 (1.8)
Male, No. (%)	48 (48.5)	110 (49.8)	158 (49.4)
Side (left)	52 (52.5)	114 (51.2)	166 (51.9)

A radiograph of the foot should consist of a lateral and AP view. The interphalangeal and metatarsophalangeal joints should be visible, including the toes. The Lisfranc and Chopart joints should be projected open. At the lateral view the whole foot from calcaneus to toes should be visible.

2.6. Statistical analysis

Descriptive statistics were performed using PASW statistics, version 22.0 (SPSS, Chicago, IL, USA). Continuous variables are expressed as the mean ± standard deviation (SD) if normally distributed, or as median and interquartile ranges (IQR) for non-parametric data. Categorical variables are expressed as frequency (percentage).

3. Results

During the study period 320 patients reported to the ED following BSI. Patient characteristics are shown in Table 1. In five patients no radiography was obtained. The reason for physicians not to obtain radiography in these five patients was since they had minimal swelling or a small laceration and the patients did not complain about pain; moreover, all of them were able to walk. Follow-up of these five patients showed that they were not submitted in our hospital with a missed fracture due to BSI within the next 3 months.

There were 158 (49.4%) male patients with a mean age of 4.2 years (SD, 1.8). The age distribution of children with BSI was normally divided and displayed in Fig. 1. A total of 99 patients (30.1%) had a fracture, of which 48 were male. The peak incidence of both BSI and a fracture was at 4 years of age. The types of radiographs being obtained in patients with and without a fracture are shown in Table 2.

In 98 children (99%) the fracture was located at the distal tibia or distal fibula (Fig. 2). In one patient a midshaft fracture of the tibia was diagnosed (Fig. 3). This patient suffered pain, swelling and had

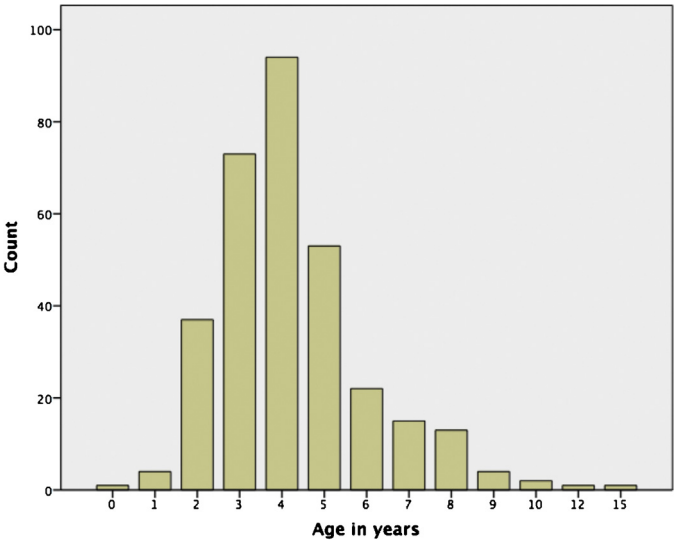

Fig. 1. Patients with BSI according to age, N = 320.