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ORIGINAL STUDY

Carpal scaphoid fracture in the skeletally immature : A single centre one-year prospective study

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We report up-to-date one-year prospective data on the incidence of scaphoid fracture in skeletally immature patients managed in a Fracture Clinic of a Level I Trauma Centre in a University Hospital in the UK. All scaphoid fractures were immobilised until union was achieved. One hundred twenty one skeletally immature patients were referred for a suspected fracture of the scaphoid. Fourteen patients (11.5%) did have a scaphoid fracture, an incidence of 15 per 100,000 (0.55% of all paediatric injuries referred). Mean delay in being seen was 2.6 days, and mean follow-up time was 52.3 days. Only plain radiography was used to diagnose and follow up scaphoid fractures. Fractures of the scaphoid in skeletally immature individuals are uncommon, are usually undisplaced, occur more commonly in the distal portion of the bone, and carry a good prognosis.

Keywords : scaphoid fracture ; children ; skeletally immature ; epidemiology.

INTRODUCTION

Scaphoid fracture is the commonest carpal bone injury in children, and is considered rare before skeletal maturity (*1,4*), accounting for 0.34% of all fractures in children (*4*). Nevertheless, a significant number of children are referred for suspected fracture of the scaphoid. It is widely believed that the incidence of scaphoid fractures in children may be rising from the increasing popularity of competitive contact youth sports (*2,3,25*). There are differences between scaphoid fractures in adults and children (*9,13*), but it is possible that the presentation of fractures of the scaphoid in skeletally immature patients might be changing to resemble the adult pattern (*23*). Furthermore, there is a marked difference in outcome of these fractures in this age group between countries despite similar management modalities (*4,24,27*). Therefore, this study aimed to establish up-to-date local epidemiological data related to the natural history of scaphoid fractures in skeletally immature patients. The results of a prospective study on incidence of such fractures presenting to a Fracture Clinic over a one-year period is reported.

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MATERIAL AND METHODS

Between 25th September 2005 and 25th September 2006, 130 consecutive skeletally immature patients aged under 17 years were referred with a suspected fracture of the scaphoid to the Fracture Clinic at the Royal Infirmary, University Hospital of North Staffordshire. All these patients were prospectively identified. Their medical records and radiographs from the point of presentation to discharge from follow-up were scrutinised. Sources of referral were our local Accident and Emergency Department, regional walk-in minor injury centres, and general practitioners.

All Fracture Clinics were led by a Consultant Trauma and Orthopaedic Surgeon. The management implemented in all patients was consistent throughout this period. Firstly, all patients with a suspected fracture of the scaphoid received a scaphoid cast - a below-elbow plaster cast with the metacarpal of the thumb immobilised in abduction and opposition. If a patient already had a plaster cast applied in the Accident and Emergency Department, the walk-in minor injury centres or general practitioners, this would be removed in the Fracture Clinic for full assessment. During the first examination, the patient would have plain radiographs (if not already available) with five views for diagnosis – posterior (P) - anterior (A) with ulnar deviation, PA oblique with ulnar deviation, AP oblique with ulnar deviation, lateral, and PA with ulnar deviation in 30 degree cranial angulation. During follow-ups, the patient would have the four former views only (*5,19,21*).

Throughout the period of follow-up, if no fracture was suspected, the patient was immediately discharged, with a note to the general practitioner to encourage the patient's parents to bring them back to the clinic should the wrist still give problems after three weeks from the injury. All fractures were immobilised until union was achieved. Those patients who initially had no radiographic evidence of a fracture were followed up after 2-3 weeks from the first attendance to determine the need for further immobilisation. Fracture union was defined as absence of pain, return to full wrist and hand function, and obliteration of fracture line on plain radiographs. If persistent pain or decreased function were present, further imaging would be considered to plan further treatment (*21*).

Since all patients referred for suspected fracture of the scaphoid would have either the scaphoid cast removed or applied in the plaster room, which runs alongside the Fracture Clinic, the data from the Fracture Clinic were checked every two weeks by examining the register in the plaster room. The Orthopaedic and Accident and emergency records, and the radiographs of each patient were stored in the dedicated Orthopaedic records department until discharge. Referrals unrelated to a suspected scaphoid fracture were excluded from analysis.

Statistical Methods

Continuous data were presented as means with standard deviation and range. Comparison of means was performed using Student's t-test. Significance was set at $p \geq 0.05$.

RESULTS

The Electronic Patient Record ascertained that 2555 new patients aged under 17 years attended the Fracture Clinic during the study period. Fourteen (11.5%) of the 130 skeletally immature subjects (8 boys and 6 girls, with mean age of 12.8 years ; range 10 to 15 years) referred with a suspected fracture of the scaphoid had a documented fracture of the scaphoid (fig 1 & 2). The follow-up notes of nine of the 130 patients were incomplete, and were excluded ; the remaining 121 skeletally immature patients (66 boys and 55 girls, with mean age of 12.6 years, range 8-16 years) were followed up for a mean duration of 26 days (SD : 19.0, range : 0-115 days) until discharged. As the total population of North Staffordshire is 459,181, of which 90,479 (19.8%) are children under the age of 17 (*17*), the incidence of a fracture of the scaphoid in skeletally immature subjects within the region using available population analysis is 15 per 100,000, accounting for 0.55% of all paediatric injuries referred to our Fracture Clinic. Other non-scaphoid injuries referred to the Fracture Clinic during the study period were 11 fractures of the distal radius (9.1%), two fractures of the first metacarpal (1.7%), and two ligamentous injuries (1.7%).

No concomitant ipsilateral upper limb injury was diagnosed in any of the patients diagnosed with a fracture of the scaphoid. Although the low numbers prevented formal seasonality analysis, 10 of the 14 (71%) patients with a scaphoid fracture sustained their injury between September and February. Also, 10 (71%) of the injuries in the group with an established fracture of the scaphoid occurred during

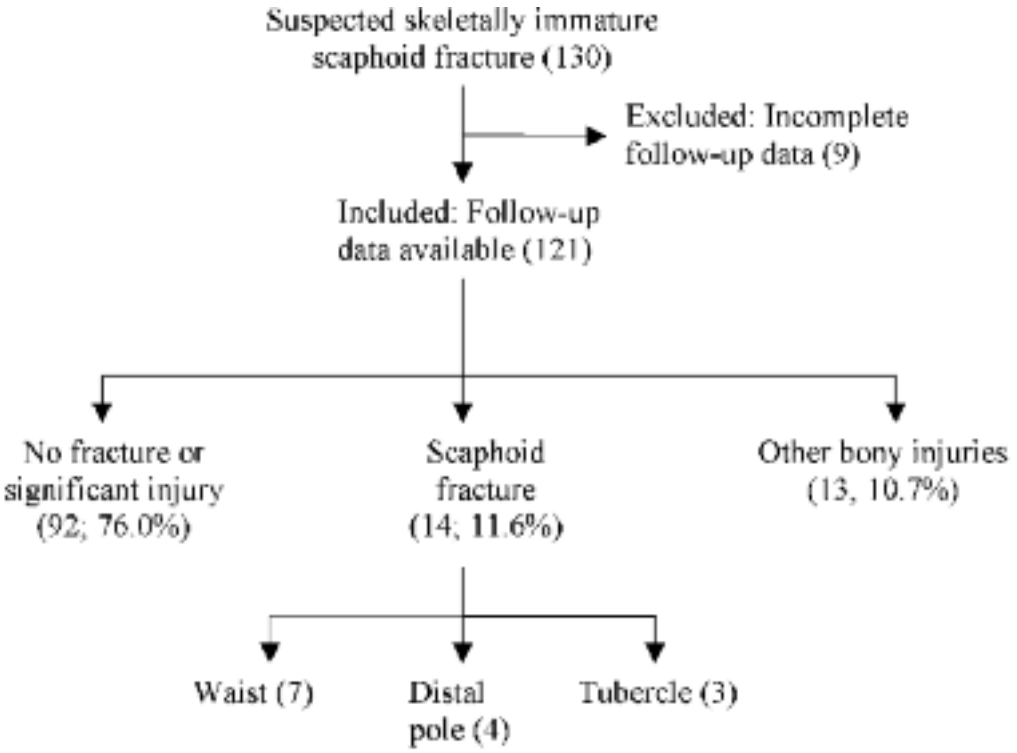

Fig. 1. — Patient selection

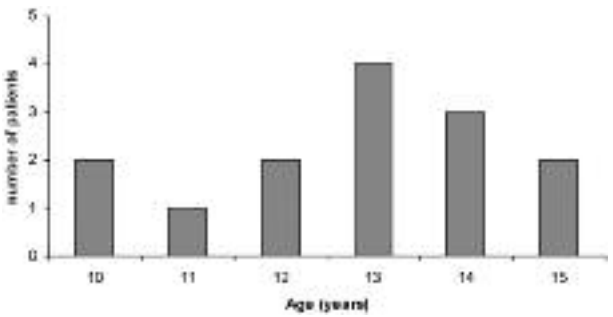

Fig. 2. — Age distribution of scaphoid fractures

sporting activities, with soccer being the most commonly involved sport (table I). Tenderness in the anatomical snuff box was elicited in all patients at presentation to clinic, but other inconsistent features elicited were tubercle tenderness and axial compression tenderness. These clinical tests were however of dubious importance, and no analysis was possible of these examination findings.

The mean interval between injury and being seen in the Fracture Clinic was 2.6 days (SD : 1.45, range : 1-6 days), and the mean follow-up time from the initial clinic appointment was 52.3 days (SD : 21.7, range : 16-97 days). Upon discharge, all these patients were confirmed to have achieved union based on the definition aforementioned. All 14 patients were diagnosed with a fracture of the scaphoid based on clinical findings and plain radiographs, and none required any further imaging. The scaphoid was fractured at the waist (7 patients), at the distal pole (4 patients), and at the tubercle (3 patients). All fractures were undisplaced based on plain radiographs. In only nine patients (64%) was a fracture of the scaphoid radiographically apparent at first presentation. The other five were identified following subsequent follow-up radiographs between 18 and 32 days from the date of injury (table I).

Delayed union occurred in 5 patients who required cast immobilisation for 8 weeks or more

Table I. — Profile of patients

No.	Age (yr)	Sex	Events related to injury	Site of scaphoid fracture	Radiological evidence of fracture since 1st x-ray (days)	Delay in attending clinic since injury (days)	Follow-up since injury (days)
1	13	M	Hanging on beam	Tubercle	Immediate	2	44
2	13	M	Slip on embankment	Tubercle	22	2	43
3	14	F	Running	Waist	18	3	66
4	15	M	Accidental fall	Waist	Immediate	1	71
5	14	M	Soccer	Waist	Immediate	6	97
6	15	M	Soccer	Distal pole	Immediate	1	44
7	11	M	Soccer	Distal pole	Immediate	3	41
8	13	M	Skate boarding	Tubercle	29	1	57
9	14	M	Soccer	Waist	20	4	76
10	13	F	Trip over a brick	Waist	Immediate	1	72
11	12	F	Fell off swing	Waist	32	4	32
12	10	F	Running	Distal pole	Immediate	3	16
13	12	F	Pushed by friend	Distal pole	Immediate	3	39
14	10	F	Accidental fall	Waist	Immediate	2	34

due to either significant pain or radiographical appearance of incomplete union, or both. All these patients had a fracture at the waist of the scaphoid. In comparison, the mean follow-up length was significantly longer in patients suffering a waist fracture (64 days) than other more distal fractures (40 days) ($p = 0.04$). No patient developed non-union or avascular necrosis.

DISCUSSION

There appear to be no major changes in the incidence, natural history and pattern of injury in our paediatric population compared with other UK data presented up to 20 years ago (*4,15,16*).

The reported mean age of patients with a fracture of the scaphoid ranges from 25 to 35 years (*10,13, 22*). The incidence of true fracture among patients with suspected scaphoid fracture is between 6.7 and 12% (*15,18*). Most epidemiological data available are based on the general adult population, and scaphoid fractures in children are rarer (*1,4*). The carpal kinetics of a scaphoid fracture in adults demonstrated that such injury requires the wrist to be hyper-dorsiflexed, with impact on the radial aspect of the wrist, to cause tension on the palmar aspect of the bone whilst compression on the dorsal aspect, leading to fracture (*26*). However, it is possible that, in the skeletally immature, the growth plate of the distal radius is a point of greater weakness which is more likely to take the impact of a fall, and hence result in a physeal injury or buckle fracture of the distal radius more commonly than a fracture of the scaphoid.

Scaphoid fractures in children usually involve the distal third of the scaphoid, are more often incomplete, and are usually undisplaced (*4,9,13*). Our results were consistent with these historical findings. Furthermore, scaphoid fractures in the paediatric population tend to heal better, and are often successfully managed with cast immobilisation, with non-union being rare (*4,9*). However, it has been suggested that the pattern of adolescent scaphoid fractures is changing towards a more adult pattern, in that malunion and displaced fractures may be observed more frequently, with increasing need for surgical intervention (*23*). Unfortunately, epidemiological data on skeletally immature scaphoid fractures in the UK date back to the 1980s (*4,16*).

We performed a prospective survey over one year in a single large trauma centre. Such approach was attempted to minimise data loss and to enable higher quality data collection than a retrospective approach offered by most previous studies. Unfortunately, we did lose nine patients during follow-up. Furthermore, despite accurate planning and data collection, the low incidence of such injury in this age group has produced relatively low numbers of such fracture, although ours is a level I trauma centre with a very busy Accident and Emergency Department. Ideally, data collection could be improved with a proforma, but this proved difficult in our study because of the large number of medical and nursing staffs involved in assessing these patients in the Accident and Emergency unit and the Fracture Clinic. We suspect that, given the present structure of health care in the UK, it would be difficult to improve on the process of data collection. Hence, we decided to concentrate not on the initial clinical findings, since such information was found to be subject to variation in documentation of dubious validity, but to focus on radiographical findings and subsequent progress during follow-up. Despite these shortcomings, the standardised approach to management of paediatric scaphoid fracture implemented in our unit, with reliable documentation from the Fracture clinic and the plaster room, made it possible to study the natural history of such injury. The availability of an Electronic Patient Record system also confirmed the accuracy of the epidemiological data thus obtained. The prospective nature of the study offered the opportunity to obtain the best possible data.

In our setting, scaphoid fractures in skeletally immature individuals is uncommon, especially under the age of 10 years. Of the skeletally immature patients referred for a suspected fractured scaphoid, 14 of 121 (11.5%) actually had such injury, and 15 of 121 (12.4%) had other non-scaphoid injuries. Therefore, albeit uncommon, a suspected scaphoid fracture among these patients may implicate a significant number of important injuries missed, had careful assessments, including removal of cast for examination and serial radiographs, not been performed. High risk activities associated with paediatric scaphoid fractures are skate boarding, skating and snowboarding in Norway (*3*). Although soccer was the commonest cause of scaphoid fracture (4 patients, 28.5%), it was surprising that the number of children sustaining this injury from soccer was not higher, given the large number of children in the UK community who take to this highly popular sport. This was probably due to the fact that soccer injuries are usually associated with low-energy impact, as reported by N'Dow *et al* in 1998 (*15*). We observed more scaphoid fractures between September and February, possibly associated with reduced sunlight and increased surface slipperiness. There may be a role for wrist protection in preventing such injury (*3*), especially during the darker months of the year.

Diagnosis of these fractures can be difficult : 5 of 14 (35.7%) scaphoid fractures in our cohort were not radiographically apparent initially. This is in contrast with another study which reported that 97.3% of the fractures were evident on the initial radiographs among 33 children with a scaphoid fracture (*27*). Such discrepancy highlighted the increased difficulty in the early diagnosis of undisplaced fracture of the scaphoid in the skeletally immature : our cohort of children all had undisplaced fractures. Although tenderness on palpation of the snuffbox was present in all our patients with a fracture of the scaphoid, on its own this sign could represent injury to scaphoid, extensor tendon, or dorsal soft tissues, making it non-specific. The present argument is whether overtreatment of most of the other patients who have not suffered a bony injury, and therefore warrant no cast immobilisaton, can be justifiable (*18*). The need for sound clinical assessment and a rational approach to diagnosis is required to prevent overtreament (*8*). The policy of our unit consists of cast removal for full assessment by a senior surgeon in the Fracture Clinic, with cast immobilisation and prompt follow-up radiographs within two weeks for a clinically suspicious but radiographically unapparent fracture. The '5 radiographs views for each wrist' approach to study the scaphoid on the first visit was the standard (*19,21*) adopted by our department because radiographs are generally readily available 24 h a day, compared to other forms of radiological imaging. However, if

Fig. 3. — Patient no.1. (a) A 13-year-old boy with apparent scaphoid tubercle fracture and (b) healing following 6 weeks of immobilisation in a scaphoid cast.

Fig. 4. — Patient no. 9. (a) A 14-year-old boy with radiographically unapparent scaphoid waist fracture which became obvious with (b) sclerosis at fracture site three weeks following injury.

available, higher level of imaging such as CT, MR, or bone scintigraphy may have a role in excluding low risk patients and allow earlier discharge without cast immobilisation (*7,11*). In fact, a negative MR has been reported to have a negative predictive value as high as 100% in the skeletally immature group of patients (*6*).

Our cohort is unique in that no apparent displaced fracture was found on plain radiographs. Half of our patients sustained a fracture of the distal pole or to the tubercle of the scaphoid. These were associated with markedly shorter follow-up, and less risk of a delayed union, compared with those who sustained a fracture at the waist of the scaphoid. This is expected to be due to the superior blood supply in the distal scaphoid. Although plain radiographs cannot accurately identify displacement of scaphoid fractures and confirm healing (*12*), we still use them as a first line tool for achieving diagnosis and making assessments at follow-ups. Our experience of using serial plain radiographs at follow-up (fig 3 & 4) offered reassurance that most paediatric scaphoid fractures would heal provided that they are treated within one week of the injury, and immobilisation is maintained until radiographic union is achieved. This is consistent with a Dutch study (n = 100) that, when a fracture of the scaphoid is diagnosed within the first week followed by cast immobilisation, non-union of the scaphoid could be prevented, although all those patients received a bone scintigraphy for immediate diagnosis if plain radiography was dubious (*20*). Conversely, in a Japanese study (n = 64), owing to delayed presentation to hospital, 52 of 64 (81%) of the paediatric scaphoid fractures required surgery, as the percentage of non-union was high at 46 of 64 (72%) (*24*).

Our results showed that fractures at the waist of the scaphoid took longer to achieve union. Percutaneous screw fixation of a scaphoid waist fracture leads to quicker union by more than 4 weeks and earlier return of function, compared to cast immobilisation. Such finding was only significant in the initial 8 weeks of follow-up, and long-term difference in outcome had not been observed (*14*). However, such evidence in adults may not be applicable to our cohort of skeletally immature children under 17 years. One has to consider the anaesthetic and surgical risk as well as the psychological impact on children being admitted to hospital for an operation, when treating scaphoid fractures conservatively by cast immobilisation (*9*).

CONCLUSION

In the UK, scaphoid fractures in skeletally immature patients are uncommon, exhibit similar gender distribution, and tend to occur in the darker months of the year. Fractures of the distal portion of the scaphoid are not uncommon, and displacement of

the fracture is unusual. There is a risk of overlooking other wrist injuries, and therefore appropriate clinical and radiographical evidence of a non-scaphoid injury should be actively sought for.

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