SUSPECTED SCAPHOID FRACTURES

THE VALUE OF RADIOGRAPHS

JOSEPH J. DIAS, JOHN THOMPSON, N. J. BARTON, P. J. GREGG

From Glenfield Hospital, Leicester and Queen's Medical Centre, Nottingham

Twenty observers reported independently on the presence or absence of a fracture of the scaphoid on 60 sets of radiographs; these included initial and 2- to 3-week views in patients in whom the outcome was known, normal scaphoids and random copies of these.

Analysis of variance of the accuracy of observations revealed that the 2- to 3-week radiographs did not improve diagnostic ability and that this was independent of the experience or seniority of the observer. For normal radiographs, 20% of the observations reported a fracture. Reproducibility of opinion improved with experience but this did not help with accuracy. Radiographs without accurate clinical observation should not determine the management of the suspected scaphoid fracture.

There is controversy regarding the management of a clinically suspected scaphoid fracture in which initial radiographs are normal. Any patient presenting with marked tenderness in the anatomical snuffbox after an injury, and no obvious fracture on the initial radiographs is usually treated as having a possible fracture of the scaphoid. It has been suggested that a second set of radiographs taken about two weeks later will demonstrate any fracture because of resorption around the fracture line (Böhler, Trojan and Jahna 1954; Russe 1960).

Leslie and Dickson (1981) suggested that any fractures diagnosed only on the later radiographs were incomplete and would heal uneventfully. Duncan and Thurston (1985) confirmed this in a retrospective study, and concluded that in such cases it is probably not necessary to immobilise the wrist in plaster.

In a prospective study, all patients with clinical evidence of a scaphoid injury were reviewed by a single observer (JJD) in a special clinic which was held weekly for two years. Difficulty was experienced in deciding whether there was a fracture, even on the radiographs

obtained after two weeks. We therefore investigated whether these late radiographs provided reliable and reproducible information on the presence or absence of a fracture.

PATIENTS AND METHODS

Suspected fractures. Eighteen patients were selected at random from 69 who had been seen with clinical signs of scaphoid fracture. They had all sustained a wrist injury and had marked tenderness in the anatomical snuffbox. Initial radiographs had either failed to reveal a fracture or subtle changes had been missed by the doctor who first saw them. All 18 patients had at least three radiographic views of the scaphoid both at presentation and between two and three weeks later. The initial and 2- to 3-week radiographs of two other patients were added; in both a scaphoid fracture had been missed and had led to non-union. In both cases, the fracture, with hindsight, could be seen on the initial and interval radiographs. This gave initial and interval radiographs for 20 patients, a total of 40 sets for further analysis.

Normal radiographs. Scaphoid radiographs were taken of the opposite (uninjured) wrist of 64 patients, all of whom denied having any pain or previous injury in this wrist. Of these sets of radiographs, 10 were selected at random and added to the 40 previous sets of radiographs.

Duplicated radiographs. Ten sets of radiographs selected at random from the chosen 50 were copied and mixed in with them. Each observer therefore commented twice on 10 of the sets of radiographs.

Observers. The 60 sets of radiographs were shuffled and presented to each of 20 observers. There were five

J. J. Dias, FRCS, Senior Registrar
Derbyshire Royal Infirmary, London Road, Derby DE1 2QY, England.

J. Thompson, PhD, Lecturer in Epidemiology
N. J. Barton, FRCS, Consultant
University Department of Orthopaedic Surgery, Queen's Medical Centre, Clifton Boulevard, Nottingham NG7 2UH, England.

P. J. Gregg, MD, FRCS, Professor
University Department of Orthopaedic Surgery, Glenfield General Hospital, Groby Road, Leicester LE3 9QP, England.

Correspondence should be sent to Mr J. J. Dias.

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Table I. Percentage errors in the diagnosis of scaphoid fractures

Observers	Radiographs			
	Initial	2 to 3 week	Both	Mean
Registrars (5)	37	43	37	39
Senior registrars (5)	43	42	39	49
Consultants (5)	42	43	39	41
Radiologists (5)	42	43	43	43
Mean	41	43	40	41

analysis of variance for groups: DF 3 $\chi^2 = 0.86$, $p = 0.83$; for observers: DF 19 $\chi^2 = 31.3$, $p = 0.04$; for radiographs: DF 19 $\chi^2 = 297.7$, $p = 0.0001$

Table II. Interpretation of 10 normal radiographs by 20 observers

	Fracture	
	No	Yes
Observers		
Registrars (5)	36	14
Senior registrars (5)	38	12
Consultants (5)	43	7
Radiologists (5)	44	6
DF 3: $\chi^2 = 5.49$; $p = 0.1391$		
Radiograph		
1	16	4
2	16	4
3	15	5
4	15	5
5	20	0
6	15	5
7	17	3
8	12	8
9	17	3
10	18	2
DF 9 $\chi^2 = 7.49$; $p = 0.5861$		

Table III. Reproducibility: agreement between first and second viewing by 20 observers

Observers	Right twice	Wrong twice	Changed mind	Kappa value	s.e.
Registrar (5)	27	8	15	0.299	0.143
Senior registrar (5)	29	9	12	0.429	0.139
Consultant (5)	26	13	11	0.528	0.124
Radiologist (5)	34	12	4	0.802	0.094
All	116	42	42	0.513	0.065

kappa value can vary from -1 (complete disagreement) through 0 (chance agreement) to $+1$ (complete agreement) (Landis and Koch 1977). S.e. = standard error

registrars, five senior registrars, five senior consultants in orthopaedic and accident surgery and five consultant radiologists. Each observer was told that the radiographs were of patients who had fallen, injured a wrist and showed marked tenderness in the anatomical snuffbox. They were asked whether there was radiographic evidence of a fracture of the scaphoid, disregarding any associated injury. Five possible answers were allowed: definitely not, probably not, don't know, probably yes and definitely yes.

When they had studied all the radiographs, the observers were shown the first and interval radiographs of the 20 patients with clinically-suspected fractures, viewing them together and again commenting on the integrity of the scaphoid. The aim of this exercise was to reproduce the clinical situation, in which both sets of radiographs are usually viewed together.

Analysis. All 20 patients had been followed for at least one year, so the eventual outcome was known. Eleven had definitely sustained a fracture of the scaphoid, while nine had shown no evidence of fracture on six-week or 12-week radiographs. The observer's assessments were compared with the actual outcome and categorised as correct or incorrect. For example, if there was no fracture, an assessment of definitely not or probably not was considered to be correct.

Tables of the percentage of errors were prepared and the significances of differences were calculated using the logistic regression option, CATMOD, in the statistical package SAS (SAS users guide, 1985). The reproducibility for each observer was measured by calculating the degree of agreement with his own observations and measuring the kappa value (Cohen 1968; Landis and Koch 1977).

RESULTS

Value of 2- to 3-week radiographs. The percentage of errors made by each group of observers was comparable to that made by the other groups (degrees of freedom (DF) 3, $p = 0.83$) for the initial radiographs, the 2- to 3-week radiographs and initial and interval radiographs viewed at the same time. Table I also shows that the 2- to 3-week radiographs did not improve the accuracy of diagnosis. The mean percentage error for all 20 observers for the 2- to 3-week radiograph was 43%. When both the initial and interval radiographs were viewed together, the mean error remained essentially unchanged ($p = 0.56$) at 40%. Of the two scaphoid fractures which later developed non-union, one (Fig. 1) was considered to be normal in 77% of the observations while the other was considered normal in 92% of the observations.

Normal radiographs. Table II shows that almost all of the 10 normal sets of radiographs were thought by at least one observer to reveal a fracture. Of the 200 observations made on them, 39 were that a fracture was present. Again, there was no difference between the four groups

of observers (DF 3, $\chi^2=5.49$, $p=0.1391$), and no single set of radiographs was more likely than another to suggest a fracture, analysis of variance showing insignificant differences (DF 9, $\chi^2=7.49$, $p=0.5861$).

Reproducibility. The diagnosis first given on each of 10 sets of radiographs by each observer was compared with the diagnosis given on the second viewing; the level of agreement was calculated and expressed in terms of Kappa values. The mean value for each group of observers is listed in Table III. This shows that the ability to reproduce observations improved with experience from registrars ($k=0.299$) to consultants in orthopaedic surgery ($k=0.528$) although these differences were not statistically significant. The radiologists were best able to reproduce their observations, although the wrong diagnosis was often made.

DISCUSSION

Soon after Destot, one of the first to use radiographs, described scaphoid fractures, it was recognised that the lines in a normal scaphoid could be mistaken for a fracture (Lindgren 1949). To improve diagnostic accuracy, it has been suggested that three (Watson-Jones 1943), four (Russe 1960) or even 16 radiographic views (Graziani 1940) were advisable. Lindgren (1949) was convinced that a definite diagnosis could always be obtained with careful radiographic technique. Others, however, did not share this view and recommended that a clinically suspected fracture, with apparently normal initial radiographs, should be immobilised in plaster and have further radiographs after an interval of two to three weeks. It was suggested that the decalcification on either side of the fracture line would render any fracture visible on the subsequent radiographs. This has been the accepted method of management in Great Britain.

Recent studies have cast doubt on the need to immobilise such suspected scaphoid injuries. Duncan and Thurston (1985), in a retrospective study of 108 patients, concluded that the incidence of fracture in patients with normal initial radiographs was very low, and that it was inappropriate to treat them in plaster. Young et al (1988), in a partially retrospective study, also found that the incidence of subsequently proven fractures in these patients was very low, but acknowledged that 3% of these fractures may be missed by junior doctors. It has been suggested that the 2% of scaphoid fractures which become visible on later radiographs (Leslie and Dickson 1981; Duncan and Thurston 1985; Young et al 1988) represent incomplete fractures which invariably heal (McLaughlin and Parkes 1969). All these studies, however, assumed that the initial and interval radiographs provided objective evidence of the presence or otherwise of a scaphoid fracture.

Our study suggests that the errors in diagnosis made on the 2- to 3-week radiographs were comparable to those made on the initial films and that reliability did not

Fig. 1

Scaphoid radiograph taken two weeks after injury. This developed non-union. With hindsight, a fracture line is just visible, but of 60 observations during our study this was missed in 77%.

Fig. 2

In this normal radiograph the indicated line was considered to represent a fracture by eight of 20 observers.

Fig. 3

In this normal radiograph the indicated line was misinterpreted as a fracture by five of 20 observers.

improve when both sets were viewed together. The seniority and experience of the observer did not improve ability to interpret radiographs correctly. Most observers were unable to reproduce their opinion consistently.

Radiographs cannot provide conclusive proof that a scaphoid is not fractured. This is especially true in clinical practice with different observers and differences in imaging equipment and techniques. In our study, subtle changes which suggested a complete fracture were often missed, even by experienced observers. The initial and later radiographs of the two patients who had developed non-union were misdiagnosed as being normal by over 75% of the observers.

In addition, the radiographic diagnosis of a fracture may also be incorrect. As Lindgren (1949) observed, 'lines' in the normal scaphoid can sometimes be mistaken for fractures, and their presence can cause a mistaken diagnosis (Figs 2 and 3). Abnormalities of the surrounding soft tissues, such as the scaphoid fat stripe or dorsal swelling of the wrist are also not diagnostic of fracture (Dias et al 1987). The only unequivocal radiographic signs of a scaphoid fracture are, in our opinion, a clear lucent line across the scaphoid, a distinct break in continuity of the cortex or a distinct sharp step in the cortex.

It appears, therefore, that radiographs are of little value in the early management of suspected scaphoid injuries, and their management should depend upon careful clinical examination. An attempt should be made to arrive at a precise diagnosis by carefully palpating the scaphoid tubercle, the lunate and the radial styloid while observing them on radiographs. Traumatic tenosynovitis

(Dacruz, Harris and Jones 1986) and traumatic scapho-lunate instability (Linscheid et al 1972) as causes of radial wrist pain and tenderness must be considered.

If the diagnosis is still in doubt, the management should be based entirely on clinical assessment. This can be difficult and usually depends on the experience of the treating surgeon. However, if the patient is distinctly tender in the anatomical snuffbox, and stressing the scaphoid (Watson, Ryu and Akelman 1986) is very painful, treatment must be in a plaster or other splint to restrict wrist movement. If a repeated clinical examination two weeks later still shows marked tenderness, especially on stressing the scaphoid, the wrist must be immobilised for a further period even if repeat radiographs fail to reveal a fracture. We agree with Young et al (1988) that if, at six weeks, no fracture is seen on radiographs, it is probably safe to discontinue immobilisation.

Our study suggests that initial and 2- to 3-week radiographs of the scaphoid after an injury do not provide reliable or reproducible evidence of fracture. They cannot be relied on either to detect or to exclude such a fracture, while normal radiographs can be mistakenly interpreted. Radiographs cannot, therefore, form the sole basis of a decision about management.

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