COMBINING THE CLINICAL SIGNS IMPROVES DIAGNOSIS OF SCAPHOID FRACTURES

A prospective study with follow-up

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This is a prospective study evaluating the efficacy of four clinical signs believed to be useful in the diagnosis of scaphoid fracture. Two hundred and fifteen consecutive patients with suspected scaphoid fracture were examined on two separate occasions to evaluate tenderness in the anatomical snuff box (ASB), tenderness over the scaphoid tubercle (ST), pain on longitudinal compression of the thumb (LC) and the range of thumb movement (TM). At the initial examination ASB, ST and LC were all 100% sensitive for detecting scaphoid fracture with specificities of 9%, 30% and 48% respectively. These clinical signs used in combination, within the first 24 hours following injury, produced 100% sensitivity and an improvement in the specificity to 74%. TM had 69% sensitivity and 66% specificity. Our results suggest that these clinical signs are inadequate indicators of scaphoid fracture when used alone and should be combined to achieve a more accurate clinical diagnosis.

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The majority of scaphoid fractures are diagnosed with certainty by examination of the initial or repeat radiographs. However, it is known that some fractures may be imperceptible on initial radiographs or those taken at a later date (Dias et al, 1990; Tiel-van Buul et al, 1992; Waizenegger et al, 1994). The incidence of false negative initial radiographs varies between 1 and 16% according to published literature, and occasionally an observer may diagnose a “fracture” where the scaphoid bone is intact (Dias et al, 1990; Leslie and Dickson, 1981; Tiel-van Buul et al, 1992; 1993; Waizenegger et al, 1994). Early diagnosis and treatment is necessary if complications such as nonunion, pseudarthrosis and avascular necrosis are to be avoided (Eddeland et al, 1975; Langhoff and Anderson, 1988). However prolonged immobilization of patients, who have clinical features of a scaphoid fracture with negative radiographs, leads to unnecessary hospital attendance, investigations and loss of earnings for those patients who may not have had a scaphoid fracture (Tiel-van Buul et al, 1995).

The clinician is faced with a diagnostic and management dilemma in identifying patients with scaphoid fractures, even in the absence of radiographic evidence, without immobilizing the majority who do not have scaphoid fractures.

Previous studies have suggested that a number of clinical signs, including tenderness in the anatomical snuff box (ASB), pain on longitudinal compression of the thumb (LC), tenderness over the scaphoid tubercle (ST), and restriction of thumb movement (TM), are useful in the diagnosis of scaphoid fractures (Brittain, 1938; Chen, 1989; Freeland, 1989, Waizenegger et al, 1994). No prospective study has evaluated the use of these signs in combination.

This study was designed to evaluate the efficacy of the various clinical signs in diagnosing scaphoid fracture and to determine the incidence of false negative radiographs, with the aim of improving the accuracy of clinical diagnosis of scaphoid fractures.

PATIENTS AND METHODS

This prospective study was conducted over a 12-month period. Two hundred and fifteen consecutive patients presenting to the Accident and Emergency Department were recruited. All patients were within 24 hours of acute wrist injury by a mechanism which suggested possible scaphoid fracture. Patients who had a definite fracture, other than scaphoid, or any carpal instability on the radiographs were excluded.

The clinicians involved in the initial examination were all of Senior House Officer grade within the Department of Accident and Emergency. Before starting the study, the attending doctors were given instruction in the examination and recording of the four clinical signs being investigated:

**Anatomical snuff box (ASB)** was defined as the groove between the tendons of extensor pollicis longus, on the ulnar side, and extensor pollicis brevis and abductor pollicis longus, on the radial side. Tenderness was elicited by digital pressure in the floor of this groove.

**Scaphoid tubercle (ST)** was defined as the palpable prominence at the level of the distal flexor crease of the extended, radially deviated wrist. Tenderness was elicited by digital pressure at this point.

**Longitudinal compression (LC)** tenderness was elicited by claspimg the extended, mid-abducted thumb between the examiner’s thumb and index finger and pressing towards the scaphoid.
**Thumb movements (TM)** of active extension, flexion, abduction, adduction and opposition were tested.

All tests were compared with the uninjured hand and recorded as positive or negative in the patient's notes.

Following initial examination, standard "scaphoid view" radiographs (antero-posterior, lateral and oblique views in 15° of pronation and supination) were taken. All patients, with or without obvious radiological evidence of scaphoid fracture, had the wrist splinted until they were seen at the next available fracture clinic (12–48 hours later). A repeat standardized examination was performed by an orthopaedic surgeon of registrar grade or higher. All radiographs were reviewed by a consultant orthopaedic surgeon and a consultant radiologist at the same time. These observers were blinded to the clinical findings. At this time patients were categorized into one of three groups:

- **Group 1** Radiologically confirmed scaphoid fracture.
- **Group 2** Patients with normal radiographs, but strong clinical suspicion of a scaphoid fracture, ie one or more of the examined signs were positive.
- **Group 3** Patients with pain but no clinical or radiological sign of fracture.

Group 1 patients were immobilized in scaphoid plasters and reviewed at 2-weekly intervals. Immobilization was continued until there was clinical and radiological union at which point patients were discharged. Group 2 patients were immobilized in a scaphoid plaster for 2 weeks at which time further radiographs were taken. If patients continued to have any clinical signs of fracture but normal repeat radiographs, a radioisotope bone scan was done. Those patients who had no clinical signs at 2 weeks and had normal radiographs were mobilized and reviewed at 6 weeks. Group 3 patients were assumed to have soft tissue injury and mobilized in a support bandage and reviewed at 2 weeks.

The diagnosis of scaphoid "fracture" was made on the appearance of initial radiographs, the radiographs at 2 weeks or radioisotope bone scan where an isolated “hot spot” in the region of the scaphoid was presumed to represent a fracture (Rolfe et al., 1981; Tiel-van Buul et al., 1993). All other cases were termed “non-fracture”. The presence or absence of clinical signs at the initial assessment was correlated with ultimate fracture status of each case. Patients in group 2 (clinical suspicion of fracture but no radiological confirmation) were followed up for a 6-month period to ensure that no missed fracture or instability occurred. Patients lost to follow-up in this group were assumed to be non-fractures.

**Statistical methods**

The sensitivity, specificity, positive predictability value (PPV), negative predictability value (NPV) of each test and combination of tests were calculated with a confidence interval of 95% (Appendix, pp 00–00). This form of statistical method is simple but appropriate to the aims of the study which is to improve the specificity of the clinical examination without reducing the sensitivity to anything less than 100%.

**RESULTS**

Fifty-six (26%) of the 215 patients who attended the Accident and Emergency Department with a history suggestive of scaphoid fracture were ultimately shown to have a scaphoid fracture. The median age of patients in the study was 36 years (range, 6–79). In the group of patients ultimately proven to have a fracture the median age was 28 (range, 6–68). Fifty two percent of the study group as a whole were male and among the proven fractures 59% were male.

The fracture was visible on initial radiographs in 48 cases (86%), repeat radiographs (at 2 weeks) in three cases (5%) and radioisotope bone scan in five cases (9%) (Table 1). The cases of proven fracture included two fractures through bone cysts, four were part of a perilunate dislocation, two were recurrent fractures (ie the patient’s case notes confirmed previously healed scaphoid fractures) and two were associated with fractures of the radius and ulna.

Thirty-eight patients were lost to follow-up. Eighteen of these were lost between 2 and 6 weeks and 20 thereafter from group 2. All “lost-patients” were contacted, through their general practitioners and confirmed to be asymptomatic.

At the initial assessment, within 24 hours of injury, all cases with a scaphoid fracture had ASB and ST tenderness and pain on longitudinal compression, a sensitivity of 100%. The corresponding specificity for these signs at the initial examination were 19%, 30%, 48% and 66% for ASB, ST, LC, and TM respectively (Table 2). Thumb movement was impaired at the initial assessment in 37 of the 56 proven fracture cases, corresponding to a sensitivity of 69%. The false positive rate, at the initial examination, for the ASB, ST, LC and TM were 84%, 71%, 58%, and 50% respectively.

If the diagnosis is based upon finding two or more of ASB, ST or LC being positive, specificity is improved to 54% (Table 2). Where all three signs are positive at the initial examination the specificity improves to 74%. Immobilization based on ASB, ST and LC all being positive, rather than ASB alone, corresponds to an improvement in specificity from 19% to 74% with no loss of sensitivity.

Eight percent of patients with scaphoid fracture did not have ASB tenderness when reexamined in the fracture clinic 24 to 48 hours after the injury. ST remained tender in 79% of the fracture group and 54% of the non-fracture group while LC remained tender in 83% of the fracture group and 41% of the non-fracture group (Table 2). In a number of cases a clinical sign was negative at the initial examination but became positive at the time of the
Table 1—Sub-groups of patients based on clinical and radiological findings. The figures for group 1 represent the cumulative numbers of patients who were diagnosed as having scaphoid fractures at the different stages of the study. The imaging at presentation and 2 weeks was by plain radiographs and at 6 weeks by radioisotope bone scan (n = 5). Group 3 patients were assumed to have soft tissue injury and had one X-ray examination only. The decrease in group 2 throughout the study corresponds to the increase in group 1. Patients in group 1 by the end of the study are termed “fractures”. Patients in groups 2 and 3 at the end of the study are the “non-fractures”.

<table>
<thead>
<tr>
<th></th>
<th>At presentation</th>
<th>At 2 weeks</th>
<th>At 6 weeks</th>
</tr>
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<tbody>
<tr>
<td>Fracture diagnosed by imaging (Group 1)</td>
<td>48</td>
<td>51</td>
<td>56</td>
</tr>
<tr>
<td>Normal imaging (Group 2)</td>
<td></td>
<td>141</td>
<td>138</td>
</tr>
<tr>
<td>Normal imaging: clinically non-tender (Group 3)</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Within this number are included 18 patients who failed to attend for 6 week review.

Table 2—Sensitivity, specificity and predictive value of clinical signs in diagnosis of scaphoid fractures. The total number of patients in which the sign or combination of signs evaluated was positive is recorded in the first two columns.

<table>
<thead>
<tr>
<th></th>
<th>Fracture group</th>
<th>Non-fracture group</th>
<th>Sensitivity (95%CI)</th>
<th>Specificity (95%CI)</th>
<th>PPV (95%CI)</th>
<th>NPV (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASB</td>
<td>56</td>
<td>129</td>
<td>1.0 (0.94, 1.0)</td>
<td>0.19 (0.13, 0.26)</td>
<td>0.30 (0.24, 0.37)</td>
<td>1.0 (0.88, 1.0)</td>
</tr>
<tr>
<td>ST</td>
<td>56</td>
<td>111</td>
<td>1.0 (0.94, 1.0)</td>
<td>0.30 (0.23, 0.38)</td>
<td>0.34 (0.26, 0.41)</td>
<td>1.0 (0.93, 1.0)</td>
</tr>
<tr>
<td>LC</td>
<td>56</td>
<td>83</td>
<td>1.0 (0.94, 1.0)</td>
<td>0.48 (0.40, 0.60)</td>
<td>0.40 (0.32, 0.49)</td>
<td>1.0 (0.95, 1.0)</td>
</tr>
<tr>
<td>TM</td>
<td>37</td>
<td>54</td>
<td>0.66 (0.52, 0.78)</td>
<td>0.66 (0.58, 0.73)</td>
<td>0.41 (0.31, 0.52)</td>
<td>0.85 (0.77, 0.91)</td>
</tr>
<tr>
<td>ASB+LC</td>
<td>56</td>
<td>73</td>
<td>1.0 (0.94, 1.0)</td>
<td>0.54 (0.46, 0.62)</td>
<td>0.43 (0.35, 0.52)</td>
<td>1.0 (0.96, 1.0)</td>
</tr>
<tr>
<td>ASB+LC+ST</td>
<td>56</td>
<td>41</td>
<td>1.0 (0.94, 1.0)</td>
<td>0.74 (0.67, 0.81)</td>
<td>0.58 (0.47, 0.68)</td>
<td>1.0 (0.97, 1.0)</td>
</tr>
</tbody>
</table>

DISCUSSION

The present study confirms that the diagnosis of scaphoid fracture may be difficult, even by experienced observers, due to the failure of initial radiographs to demonstrate all fractures (Tiel-van Buul et al, 1992; 1993). Our data shows that 5% of scaphoid fractures were not seen in the initial radiographs prospectively, or even retrospectively, by two experienced observers. The incidence increased to 14% if a hot spot, in the region of scaphoid, on the bone scans was taken to represent fracture as suggested by Rolfe et al (1981). The value of repeat radiographs and bone scans in the diagnosis of scaphoid fracture is still disputed. The present study supports previous investigators who report that radiographs cannot be regarded as the best available method for the diagnosis of scaphoid fracture (Amadio et al, 1990; Brittain, 1938; Dias et al, 1990; Eddeland et al, 1975; Freeland, 1989; Leslie and Dickson, 1981; Tiel-van Buul et al, 1992). The clinician must maintain a high index of suspicion even in the absence of radiographic evidence of fracture.

The complications of missing a fracture can be considerable and yet inappropriate diagnosis has cost to the patient, health service and economy. Based upon clinical findings, the clinician needs to identify patients with normal radiographs who have scaphoid fractures.

Tenderness over the anatomical snuff box is advocated as the cardinal sign of scaphoid fracture (Rockwood et al, 1993). Our results show that this sign carries a low specificity (16%) and immobilization, based on anatomical snuff box tenderness alone, leads to overtreatment of 85% of patients with acute wrist injury. Many other clinical signs have been found to be unreliable in the diagnosis of scaphoid fracture (Waizenegger et al, 1994).
It would be inappropriate to improve the specificity of the clinical assessment of scaphoid fracture at the expense of safety (ie sensitivity). Our findings support others who have shown that ASB alone is inferior to ST tenderness or LC pain in discriminating fractures (Leslie and Dickson, 1981; Waizenegger et al, 1994). By simply using one of these other signs for diagnosis, specificity could be improved to 30% and 48% without any loss of sensitivity (Table 2). Although TM has even better specificity, its lower sensitivity makes it an unreliable sign in the diagnosis of scaphoid fracture. The use of combination of clinical signs further improves specificity. If the diagnosis is based upon finding two or more of ASB, ST or LC being positive, specificity is improved to 54%. When all three signs are positive at the initial examination the specificity would be improved to 74% and still no fractures would be missed. Thus, immobilization based on ASB, ST and LC all being positive, rather than ASB alone, would result in an improvement in specificity from 9% to 74% with no loss of sensitivity. This figure may be an underestimate since the clinician has much more information (such as radiographic evidence of a fracture elsewhere around the wrist) to guide diagnosis.

Reexamination of the patients 24 to 48 hours after the injury revealed that there may be early resolution of clinical signs even when a fracture is present. This reexamination was therefore unhelpful and indicates that our findings are only valid in the first 24 hours following injury.

Recruitment of patients for the study took place over the 6-month period of a single Senior House Officer post. One might have expected that a learning curve for the doctors involved in the initial assessment would affect the results. This was safeguarded by the fact that the ultimate diagnosis was made at consultant level. The study illustrates that Senior House Officers who are given clear instruction at the beginning of their posts are competent to elicit the clinical signs, to diagnose scaphoid fracture and instigate treatment.

The results of this study suggest that all patients with acute wrist injuries should be specifically examined for tenderness in the anatomical snuff box, tenderness over the scaphoid tubercle and pain on longitudinal compression of the thumb. The initial treatment decision for patients with suspected scaphoid fractures should depend upon the combination of the clinical signs rather than any one alone. This policy would reduce the false positive diagnosis by 65% with no false negative diagnosis.

### APPENDIX

<table>
<thead>
<tr>
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<th>Patients correctly diagnosed by test(s) as fracture</th>
<th>All patients with scaphoid fracture</th>
</tr>
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<tbody>
<tr>
<td><strong>Sensitivity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Positive predictive value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Negative predictive value</strong></td>
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### References


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