The movements of the carpal bones during the scaphoid shift test were evaluated radiographically in 60 wrists. The clinical results were graded according to the degree of subluxation of the scaphoid and pain on the dorsum of the wrist. Lateral radiographs at rest and under stress were taken and the relative movements of the scaphoid with respect to the radius and lunate, and the rotation of the scaphoid and lunate were calculated.

Dorsal displacement of the scaphoid with respect to the radius was significantly associated with the clinical grade of subluxation. There was correlation between the amount of pain and the displacement of the scaphoid from the lunate, but not from the radius. The wrists with a painful shift test had greater relative displacement of the scaphoid from the lunate than those with painless subluxation.

These observations support the view that pain associated with subluxation of the scaphoid during the shift test is a significant finding, and that radiographic analysis of the test may confirm a positive result when dynamic scaphoid instability is suspected.

Received 22 July 2002; Accepted 11 September 2002

The scaphoid shift test is useful for the evaluation of the stability of the scaphoid in the injured wrist.1-5 It involves radial deviation of the wrist with the examiner’s thumb opposing the normal volar rotation of the distal scaphoid, causing the scaphoid to shift dorsally.6 Although this provocative manoeuvre is particularly helpful in establishing the diagnosis of dynamic instability of the scaphoid, the pathomechanics of a positive scaphoid shift are poorly understood. The test does not offer a simple positive or negative result, but rather a variety of findings. Many authors have stressed that it is subjective and requires considerable experience to correlate the degree of mobility of the scaphoid with pathological significance.2,6,7 It has also been recorded that a proportion of the normal population has a positive scaphoid shift without symptoms or a history of trauma to the wrist.8,9

There is little information about the exact behaviour of the carpal bones during the test. Wolfe, Gupta and Crisco10 observed the movements of the carpal bones fluoroscopically and related the results to the clinical findings in uninjured normal subjects. The movements have, however, not been described in patients with pathological conditions of the wrist.

Our aim was to observe carpal movement radiographically during the scaphoid shift test in patients with symptoms in the wrist.

Patients and Methods

We studied 60 patients with pain in the wrist. Those with a fracture or recent injury were not included. There were 32 men and 28 women with a mean age of 37.5 years (22 to 49). Posteroanterior and true lateral radiographs of the wrist were taken. No wrist had radiographic evidence of static scapholunate instability, as shown by an increase in the scapholunate angle of >70° on the lateral radiograph or an increase in the scapholunate gap of >3 mm on the posteroanterior film. Neither was there any evidence of carpal lesions or degenerative changes in the wrist.

The scaphoid shift test was performed as described by Watson et al6 on each wrist and the amount of shift and any clunk or pain which was induced was recorded. The test was graded according to the degree of subluxation of the scaphoid and to the pain felt on the dorsum of the wrist during the test. With regard to the mobility of the scaphoid, grade 0 indicated no palpable subluxation, grade 1+ mild displacement of the scaphoid, but without definite subluxation and grade 2+ true subluxation from the scaphoid fossa, with a palpable clunk as it reduced on release of force to the scaphoid tubercle. Dorsal pain was graded as follows: grade 0 no pain, grade 1+ mild pain, and grade 2+ significant pain on the dorsum as the scaphoid was dorsally stressed.
of the dorsal and volar lips of a) the distal radius and b) the lunate.

These are defined as the distance between the vertices of pre-test and loaded scaphoid images. 'RL' is the radial length, and 'LL' the lunate length. These are defined as the distance between the vertices of the dorsal and volar lips of a) the distal radius and b) the lunate.

The scaphoid-radius displacement index (SRDI) was defined. Both scanned images were overlapped by matching the contours of the radius using Photoshop 6.0 software (Adobe Systems Incorporated, San Jose, California) with an image printing system was used to record the images. The intensifier was positioned to give a lateral view of the wrist without interfering with the examination. Starting from the position of ulnar deviation, a firm and constant force was delivered to the tubercle of the scaphoid, while the wrist moved from ulnar deviation to neutral. During the procedure, the wrist was maintained in neutral flexion/extension. Images which represented both the resting state and the loaded state were selected to evaluate movement of the bones.

As the first step in calculating the displacement of the scaphoid when responding to dorsal stress, the bony contours of the scaphoid, lunate and distal radius were outlined using a fine marker on both the resting and loaded images. The images were scanned (ScanJet 5370C; Hewlett-Packard Company, Palo Alto, California) and saved for analysis. By comparing different carpal positions between the resting and loaded images, the following indices were defined and calculated (Fig 1).

**The scaphoid-radius displacement index (SRDI).** This represents the amount of displacement of the scaphoid with reference to the radius. To calculate the displacement between the resting and loaded images, the most proximal point of the scaphoid on a line perpendicular to the longitudinal axis of the radius was defined. Both scanned images were overlapped by matching the contours of the radius using Photoshop 6.0 software (Adobe Systems Incorporated, San Jose, California). The displacement of the scaphoid was measured. In order to compensate for the different sizes of the carpal bones between individuals, the displacement was expressed as a percentage of the radial length which was defined as the distance between the vertices of the dorsal and volar lips of the distal radius.

**The scaphoid-lunate displacement index (SLDI).** This represents the amount of displacement of the scaphoid with reference to the lunate. The most proximal point of the scaphoid was marked on a line perpendicular to the longitudinal axis of the lunate, and both images were overlapped by matching the contours of the lunate. The index was defined as the amount of displacement related to the length of the lunate, expressed as a percentage.

The rotational movements of the scaphoid and lunate which occurred during the test were calculated by measuring the changes in the radioscaphoid and radiolunate angles. They were defined as positive if the carpal bones were extended in response to the applied load and as negative if they were flexed.

The displacement indices and rotational movements were compared with the results of the clinical scaphoid shift test (grade 0, 1+, and 2+).

**Statistical analysis.** Comparisons of these parameters among different clinical grades were performed using a non-repeated one-way ANOVA and least significance difference as a post-hoc test. Pearson’s correlation test was performed to determine the relationship between the rotational movements of the carpal bones and the displacement indices. Significance was determined when p < 0.05.

**Results**

Sixteen wrists had a clinical scaphoid shift of grade 0, 28 of grade 1+, and 16 of grade 2+. There were 41 wrists with pain of grade 0, 12 with grade 1+ and seven with grade 2+. The radiological indices showed substantial variations. The SRDI varied from 0% to 36.5%, and SLDI from 0% to 42.1%

When the radiological indices of scaphoid displacement were compared among different grades of clinical subluxation, the SRDI increased significantly as the grade of sub-

### Table I. Displacement indices (mean ± SD) of the scaphoid compared with the grades of clinical subluxation during the scaphoid shift test

<table>
<thead>
<tr>
<th>Grade</th>
<th>SLDI (%)</th>
<th>SRDI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (n = 16)</td>
<td>3.68 ± 3.2</td>
<td>6.12 ± 4.8*</td>
</tr>
<tr>
<td>1+ (n = 28)</td>
<td>8.59 ± 5.8*</td>
<td>15.47 ± 4.9*</td>
</tr>
<tr>
<td>2+ (n = 16)</td>
<td>18.83 ± 13.6*</td>
<td>25.09 ± 6.0*</td>
</tr>
</tbody>
</table>

* *significant difference between the grades (p < 0.05)

### Table II. Displacement indices (mean ± SD) of the scaphoid compared with the grades of dorsal pain during the scaphoid shift test

<table>
<thead>
<tr>
<th>Grade</th>
<th>SLDI (%)</th>
<th>SRDI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (n = 41)</td>
<td>4.82 ± 3.3*</td>
<td>13.21 ± 8.0</td>
</tr>
<tr>
<td>1+ (n = 12)</td>
<td>16.07 ± 6.9*</td>
<td>16.74 ± 6.2*</td>
</tr>
<tr>
<td>2+ (n = 7)</td>
<td>30.03 ± 9.0*</td>
<td>27.15 ± 6.5*</td>
</tr>
</tbody>
</table>

*significant difference between the grades (p < 0.05)
luxation increased. The wrists with grade 2+ subluxation had significantly greater SLDI than those with grade 0 or 1+, but there was no significant difference in the SLDI between grade 0 and 1+ subluxation (Table I). Comparisons of the indices between different grades of pain showed a statistically significant difference in SLDI. There was a significant difference in SRDI between the wrists with grade 2+ and those with grade 0 or 1+, but not between those with grade 0 and 1+ (Table II). These findings indicate that clinical scaphoid shift correlates well with the amount of dorsal displacement of the scaphoid with respect to the radius, while the degree of pain correlates well with the amount of displacement with respect to the lunate.

Analysis of the rotation revealed that the scaphoid either extended or flexed, while the lunate tended to extend in response to the scaphoid shift test. There was, however, no significant relationship between carpal rotation and the results of clinical findings (Table III).

In order to evaluate the significance of pain evoked by the test, 19 wrists which showed grade 1+ or 2+ pain were compared with 25 which demonstrated painless grade 1+ or 2+ shifts. The SLDI in wrists with pain during the test (mean 21.22%, SD 10.2) was significantly greater than that of the wrists with a painless shift (mean 5.55%, SD 3.2), while the SRDI showed no significant difference between the two groups (mean 20.58%, SD 8.0 v mean 17.75%, SD 6.1).

A correlation test comparing rotation of the scaphoid and lunate to two displacement indices of the scaphoid showed no statistically significant relationship.

**Discussion**

Dynamic instability of the scaphoid is currently diagnosed from the history and the clinical signs of abnormal carpal movement. Imaging modalities, such as stress views, MRI, or cinéradiography, rarely help to confirm the diagnosis. The scaphoid shift test is difficult to perform and experience is necessary to interpret the findings. Watson et al. emphasized that it is not so much a test as a provocative manoeuvre. They observed that patients’ responses varied markedly and that extremes of mobility should not in themselves be considered to be abnormal. Several studies have shown that there is a spectrum of mobility of the scaphoid during the test and up to one-third of an uninjured population shows a painless positive scaphoid shift. Easterling and Wolfe showed a prevalence of 32% of a painless scaphoid shift in the uninjured population and a high correlation between an asymptomatic subluxable scaphoid and generalised ligamentous laxity.

The exact behaviour of the carpal bones during the test remains unclear because the appropriate kinematic studies have not been performed. Wolfe et al. examined 25 uninjured subjects clinically and fluoroscopically, but their
study considered only normal subjects and the absolute movement of the scaphoid. We observed patients with various conditions of the wrist, including dynamic instability of the scaphoid, and analysed the movement of the scaphoid relative to both the radius and the lunate. Calculation of the movement of the scaphoid relative to the radius (SRDI) represents the amount of shift, but does not necessarily reflect the pathological ligamentous changes which are associated with instability of the scaphoid. It can be analysed by calculating the movement of the scaphoid relative to the lunate (SLDI) rather than the absolute amount of dorsal shift.

It has been stressed that the scaphoid shift test should be considered to be positive only when subluxation of the scaphoid is accompanied by pain which is referred to the dorsum of the wrist.1,3-6 Our study supports the current interpretation of this test by comparing the radiographic observation of carpal behaviour with the clinical results. The wrists with a painful shift showed greater displacement of the scaphoid with respect to the lunate than those with painless shift. The grades of pain during the test were also significantly related to the degree of scaphoid-lunate displacement (Figs 2 and 3).

A limitation of our study may be the difficulty in calculating the true displacement between the carpal bones on radiographs. It is well known that carpal movements are three-dimensional and very complex.12,13 However, our study was based on a two-dimensional static analysis. There may be considerable axial rotation of the scaphoid during scaphoid shift, which cannot be determined by this two-dimensional model. We considered displacement and rotation in the sagittal plane because the scaphoid shift test involves simple dorsal stress of the scaphoid. We believe that this two-dimensional method of calculating the relative amount of carpal displacement is appropriate and reliable.

Wolfe et al10 noted an interesting relationship between the dorsal displacement and rotation of each carpal bone in response to the scaphoid shift test. Dorsal displacement of a carpal bone was associated with flexion, while bones which did not shift dorsally extended. We attempted to find a correlation between the rotation and displacement of carpal bones in order to confirm their findings, but failed to demonstrate such a relationship with the numbers available in our study. We have shown that observation of the rotational behaviour of carpal bones does not aid the assessment of scaphoid stability.

There is much individual variation of ligamentous laxity in normal wrists.14-16 Positive scaphoid shift in an asymptomatic wrist is related to ligamentous laxity and not to occult carpal injury. Our study confirmed that pain associated with subluxation of the scaphoid during the test is a significant finding in diagnosing dynamic scaphoid instability. Asymmetry between the two sides is also a highly suspicious finding,6 although we did not include bilateral comparison in our study. Our data showed that radiographic observation during the scaphoid shift test with comparison between the two sides can provide valuable information for objective evaluation of stability of the scaphoid.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References