Scaphoid fractures

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Scaphoid fractures

- **Diagnosis**
  - Don’t miss them,
  - other fractures when using advanced imaging
- **Guidelines**
  - Not widely used, junior staff could use a consistent approach
  - No Australian guideline.
- **Management**
  - “clinical scaphoid fracture”
  - Confirmed - operative vs non operative, more details?
Scaphoid Fractures

- Common
- High frequency of complications,
- this increases when the diagnosis is delayed.
- Non-union, delayed union, osteonecrosis and delayed osteoarthritis have been shown to result from scaphoid fractures, with the chance of complications increasing with delayed diagnosis (Langhoff and Anderson 1988).

- Mechanism of injury
  = fall on outstretched hand.
- Clinical sign
  = tenderness - anatomic snuffbox.
Clinical examination is not specific as most injuries that result in joint effusion produce snuffbox tenderness.

- Anatomical snuff box
- Axial compression of thumb
- AP compression scaphoid

X-ray good, but not perfect

- Leslie and Dickson reported that 98% of fractures were visible on initial x-ray in their study of 222 confirmed scaphoid fractures, however this number has been reported to be as low as 75-80%.
- MRI and CT both demonstrate fractures when the initial x-ray was normal.
WHAT NEXT?

- Patients who have a normal x-ray but still have clinical suspicion of fracture are defined as having a “clinical scaphoid fracture”.
- Historically these patients are treated with plaster cast immobilization and day 10 review, repeat imaging
  - Still common, especially in kids.
- Recent studies have advocated the use of early advanced medical imaging to limit the time spent in plaster, which affects both patient and community.
  - MRI
  - Bone scan
  - CT
  - Ultrasound
MRI

- MRI has proven to be good for the early diagnosis of scaphoid fracture. Several studies have confirmed that it provides reliable results, and as such have advocated its use.
- The American Medical Association list MRI as the gold standard for scaphoid fracture diagnosis.
- In Australia:
  - MRI is expensive (MBS $440) and is difficult to obtain, and a specialist provider number is required for medicare rebate.
MRI - critical evaluation

Demonstrated accurate diagnosis of scaphoid and other nearby fractures, with reported 100% negative predictive value, sensitivity and specificity. MRI very reliable (precise) with kappa values of 0.8-0.95. MRI is very sensitive at detecting bone marrow oedema.

It is now well documented that patients with clinical scaphoid fracture, have not only scaphoid fractures but other fractures demonstrated on MRI. The prevalence of scaphoid fracture ranges from 13-19%, and other fractures collectively from19% to 24%. This leaves approximately two thirds of patients with no demonstrable fracture.

The significance of the MRI finding of bone marrow oedema, a bone bruise: without fracture, following trauma to the scaphoid has been debated, with recent evidence that it is a benign injury and is unlikely to result in long-term morbidity in the form of non-union.

A definition of fracture has normally been a disruption of the cortex (edge) or trabecular pattern (within the bone). There is evidence to suggest that MRI is superior in detecting trabecular fractures than CT, but CT is superior in detecting cortical fractures.

Kappa is only reported between pairs of observers for MRI.

When advanced medical imaging depicts fractures not evident on the existing reference standard, it is inappropriate for authors to suggest that bone scan is prone to false positives when it suggests a fracture that is not evident on delayed x-rays, but to then declare that MRI detects fractures not evident on plain x-ray and is thus more accurate than delayed x-rays.


Raby N. Magnetic resonance imaging of suspected scaphoid fractures using a low field dedicated extremity MR system. Clinical radiology. 2001; 56: 124-

Robinson P. Gold--now you see it, now you don't. Br J Radiol. 2003; 76: 923-.
For scaphoid fracture, gold standards...like Australian Political Parties sample sizes, <100.

<table>
<thead>
<tr>
<th>TEST</th>
<th>Author</th>
<th>Year</th>
<th>n</th>
<th>Reference standard</th>
<th>Prevalence of fractures</th>
<th>Prevalence of fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scaphoid</td>
<td>Other</td>
</tr>
<tr>
<td>&lt; D4</td>
<td>Raby</td>
<td>2003</td>
<td>56</td>
<td>MRI altered in 89%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>D10-42</td>
<td>Raby</td>
<td>2003</td>
<td>53</td>
<td>MRI altered in 69%</td>
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<td>23%</td>
</tr>
<tr>
<td>&lt; 7 days</td>
<td>Breitenseher</td>
<td>1997</td>
<td>42</td>
<td>Delayed x-rays</td>
<td>33%</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>Brydie &amp; Raby</td>
<td>2003</td>
<td>195</td>
<td>Delayed x-rays</td>
<td>19%</td>
<td>19%</td>
</tr>
<tr>
<td>D2-10</td>
<td>Bretlau</td>
<td>1999</td>
<td>52</td>
<td>Delayed x-rays</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>&lt; 7 days</td>
<td>Kusano</td>
<td>2003</td>
<td>52</td>
<td>None</td>
<td>35%</td>
<td></td>
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<tr>
<td>&lt; day 7</td>
<td>Thorpe</td>
<td>1996</td>
<td>59</td>
<td>Subsequent follow up</td>
<td>7%</td>
<td>17%</td>
</tr>
<tr>
<td>Day 1</td>
<td>Kumar</td>
<td>2005</td>
<td>52</td>
<td>MRI repeated D10 if tender, n=8 all normal</td>
<td>27%</td>
<td>14%</td>
</tr>
<tr>
<td>D2-10</td>
<td>Bretlau</td>
<td>1999</td>
<td>52</td>
<td>x-rays 8-14 weeks</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>BONE SCAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Buul</td>
<td>1992</td>
<td>60 x 3</td>
<td>Intraobserver reliability</td>
<td>unclear</td>
<td>unclear</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Murphy</td>
<td>1995</td>
<td>100</td>
<td>D10 review &amp; x-rays, BS if equivocal</td>
<td>27%</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>Beeres</td>
<td>2005</td>
<td>56</td>
<td>Ortho clinic</td>
<td>27%</td>
<td>41%</td>
</tr>
</tbody>
</table>
Bone scans have also shown to aid the diagnosis of scaphoid fracture at an early stage, Day 4.

However, it has been reported that bone scan has a false-positive rate of up to 25% when compared to delayed x-ray.

Bone scan (MBS $300) also involves a high radiation dose compared to CT (4.6mSV compared to 0.5mSV).
Several small studies have advocated the use of CT (MBS $220) in the diagnosis of scaphoid fracture. Sensitivity and specificity have been reported to be as high as 100%.
Early computerized tomography accurately determines the presence or absence of scaphoid and other fractures

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Abstract

Objective: To validate the use of early CT in predicting scaphoid fracture and other fractures in patients with suspected scaphoid fracture.

Method: A prospective observational study of adult patients with a diagnosis of clinical scaphoid fracture presenting to a regional ED. Patients were immobilized in a scaphoid plaster and had a CT (wrist and carpals) same or next day. The gold standard used was the diagnosis on Day 10 with clinical examination and X-rays, with MRI performed in patients with persistent tenderness but normal X-rays.

Results: Forty-seven patients completed the study protocol from September 2004 until February 2006. For all fractures, early CT had a 96.8% negative predictive value and 100% positive predictive value (94.4% sensitive, 100% specific). No scaphoid fracture was missed by early CT. One patient had a trapezium fracture on CT, with a coexistent subtle capitate fracture only detected on MRI.

Conclusion: Early CT scans show promise in the diagnosis of scaphoid and other fractures of the wrist and carpals. Further study is warranted to validate early CT in clinical scaphoid fracture as an alternative to other early advanced imaging, or plaster immobilization and 2 week review.

Key words: computerized, tomography, emergency department, magnetic resonance imaging, scaphoid fracture, wrist injury.
An International Survey of Hospital Practice in the Imaging of Acute Scaphoid Trauma

OBJECTIVE. Scaphoid fractures are relatively common. If not treated promptly there may be risk of long-term disability. However, unnecessary wrist immobilization is inconvenient and may hinder professional activities. Therefore, early accurate diagnosis is essential. Currently, the American College of Radiology deems MRI and radiographs as the most appropriate investigations in imaging acute scaphoid trauma. Our objective was to assess scaphoid imaging protocols.

MATERIALS AND METHODS. To assess scaphoid imaging protocols, an international survey of imaging practice was performed. Two hundred hospitals worldwide were sent a survey regarding their scaphoid trauma imaging protocols. Only replies from hospitals that had full CT, MRI, and scintigraphy facilities were accepted.

RESULTS. Data were obtained from 105 hospitals, of which 23 had fixed protocols. The number of scaphoid radiographic views varied from two to six. Before second-line investigations were initiated, repeat radiographs were usually performed in 76 of the 105 hospitals. In 29 hospitals, other imaging techniques were used without further radiography. The usual second-line investigation was MRI in 31/105, CT in 19/105, and scintigraphy in 14/105. Further protocols included CT or MRI in 10/105, CT or scintigraphy in 6/105, scintigraphy or MRI in 6/105, CT then MRI (if CT was negative) in 1/105, both CT and scintigraphy in 1/105, and scintigraphy then CT (if positive) in 1/105. There was equal preference among MRI, CT, and scintigraphy in 10/105 centers, and clinical examination and radiographs were used alone in 6/105.

CONCLUSION. The survey reveals marked inconsistency in the imaging of acute scaphoid injury. Although other factors may have played a role, limited scientific evidence regarding the ideal imaging in acute scaphoid trauma may be the root of this inconsistency.


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Management of suspected scaphoid fractures in accident and emergency departments – time for new guidelines

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ABSTRACT

INTRODUCTION The objectives of this work were to assess the clinical knowledge of clinicians in the accident and emergency (A&E) departments in England & Wales and evaluate the current trend for the acute management of radiologically normal, but clinically suspected, fractures of the scaphoid.

SUBJECTS AND METHODS We conducted a telephone survey on 146 A&E senior house officers (SHOs) in 50 different hospitals. This survey assessed the clinicians’ experience, their clinical and radiological diagnostic methods, and their initial treatment of suspected scaphoid fractures.

RESULTS The majority (55.8%) of SHOs performed only one clinical test to diagnose suspected scaphoid fractures. Overall, 41% were unable to cite the number of the radiographic views taken and only 10% of departments have direct access to further radiological investigation. There is wide variation in the early treatment of this injury, with the scaphoid cast used most commonly (46%). The majority of SHOs (89%) were unable to describe the features of immobilisation. The mean follow-up period was 10 days, and 53% of cases were followed-up by the senior staff in A&E. Of SHOs, 54% were not aware of any local guidelines for the management of suspected scaphoid fractures in their departments, and 92% were not aware of the existence of the 1992 British Association for Accident and Emergency Medicine (BAEM) guidelines.

CONCLUSIONS The clinical knowledge and the management of suspected scaphoid fractures in A&E are unsatisfactory. We, therefore, suggest that the dissemination of up-to-date guidelines could help to educate clinicians to provide better care to the patients.

KEYWORDS
Scaphoid – Suspected fractures – Fracture management – Guidelines
How to implement guidelines according to Grimshaw

<table>
<thead>
<tr>
<th>Probability of being effective</th>
<th>Development strategy</th>
<th>Dissemination strategy</th>
<th>Implementation strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Internal</td>
<td>Specific educational intervention</td>
<td>Patient-specific reminder at time of consultation</td>
</tr>
<tr>
<td>Above average</td>
<td>Intermediate</td>
<td>Continuing education</td>
<td>Patient-specific feedback</td>
</tr>
<tr>
<td>Below average</td>
<td>External, local</td>
<td>Mailing targeted groups</td>
<td>General feedback</td>
</tr>
<tr>
<td>Low</td>
<td>External, national</td>
<td>Publication in journal</td>
<td>General reminder</td>
</tr>
</tbody>
</table>

Table 5: Classification of clinical guidelines
Guidelines for evaluation of wrist injuries

? impact of such guidelines on the quality of care, patient outcomes, and patient satisfaction.
Results

- 53 patients with normal CT
- Time off work mean = 1.6 days
- Plaster mean = 2.7 days
- MRI if ongoing pain confirmed no fractures missed.
- Satisfied patients mean 4.2/5 score.

- 28 fractures, 25 patients
- 6 scaphoids *
- 5 triquetral *
- 4 radius
- 2 lunate
- 2 trapezium
- 2 trapezoid
- 3 metacarpals (1st 2nd 3rd)
- 1 capitate and hamate
- * one with lunate
INTEROBSERVER RELIABILITY - is the gold standard precise, repeatable?

What the radiology journals do not want to publish.
Literature – interobserver reliability

**MRI**
- Interobserver reliability has been reported as near perfect ($k > 0.8$, and $k = 0.95$).

**BONE SCAN**
- Interobserver reliability has been reported as excellent for static phase bone scans ($k = 0.81$)

**CT**
- Interobserver reliability has been reported as high ($k = 0.76$) between different specialties, and excellent ($k = 0.86$) between two radiologists.
Our study (intraobserver reliability of CT in clinical scaphoid fracture)

- 9 radiologists report 15 CT scans each, a sample size of 135.
- Sample - stratified randomisation - scaphoids, others, normals.
- Kappa value = 0.88 (95% CI = 0.80 – 0.96) scaphoid fracture
- 0.56 (95% CI = 0.48 – 0.64) for any fracture.
- One radiologist diagnosing twice as many fractures as the rest…
  - K = 0.93… and 0.7
- Extrapolate…?
- Interobserver reliability for CT between nine observers similar to MRI, between two observers.

<table>
<thead>
<tr>
<th>DIAGNOSIS</th>
<th>KAPPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaphoid Fracture</td>
<td>0.88</td>
</tr>
<tr>
<td>Level of Agreement*</td>
<td>Near Perfect</td>
</tr>
<tr>
<td>Any Fracture</td>
<td>0.56</td>
</tr>
<tr>
<td>Level of Agreement*</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

*Based on the benchmarks for interobserver reliability described by Landis and Koch.
<table>
<thead>
<tr>
<th>Patient</th>
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<th>Agreement</th>
<th>False Positives</th>
<th>False Negatives</th>
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<tbody>
<tr>
<td>A</td>
<td>Triquetrium</td>
<td>9/9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>No Fracture</td>
<td>8/9</td>
<td>Radius (1)</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>No Fracture</td>
<td>7/9</td>
<td>Metacarpal (2), Scaphoid, Lunate, Trapezium (1)</td>
<td>-</td>
</tr>
<tr>
<td>D</td>
<td>Scaphoid</td>
<td>9/9</td>
<td>Lunate (3)</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>Triquetrium</td>
<td>9/9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>F</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Metacarpal</td>
<td>9/9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G</td>
<td>No Fracture</td>
<td>9/9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>H</td>
<td>No Fracture</td>
<td>7/9</td>
<td>Lunate, Triquetrium (1)</td>
<td>-</td>
</tr>
<tr>
<td>I</td>
<td>No Fracture</td>
<td>7/9</td>
<td>Radius (2)</td>
<td>-</td>
</tr>
<tr>
<td>J</td>
<td>No Fracture</td>
<td>8/9</td>
<td>Radius (1)</td>
<td>-</td>
</tr>
<tr>
<td>K</td>
<td>No Fracture</td>
<td>6/9</td>
<td>Radius (3)</td>
<td>-</td>
</tr>
<tr>
<td>L</td>
<td>No Fracture</td>
<td>7/9</td>
<td>Trapezium, Triquetrium (1)</td>
<td>-</td>
</tr>
<tr>
<td>M</td>
<td>Scaphoid &amp; Trapezium</td>
<td>9/9 &amp; 6/9</td>
<td>Metacarpal (1)</td>
<td>Trapezium (3)</td>
</tr>
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<td>No Fracture</td>
<td>4/9</td>
<td>Radius (4), Scaphoid, Triquetrium (1)</td>
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</tr>
<tr>
<td>O</td>
<td>No Fracture</td>
<td>8/9</td>
<td>Capitate (1)</td>
<td>-</td>
</tr>
</tbody>
</table>
Guidelines

- National guidelines would be good
- Local implementation is required
- Implementation of a change in practice in a research setting allowed strict adherence to pathway, patient consent, evaluation of a number of outcomes.
- www.scaphoidfracture.com.au
Conclusions

- CT has excellent interobserver reliability for diagnosis of scaphoid fracture, comparable to MRI.
- CT may have an important role to play in the clinical pathway leading to diagnosis of scaphoid fracture, but clinicians and patients need to be aware of the limitations.
  - CT is expensive compared to plain radiographs,
  - and there is a risk of false-positive diagnoses.
  - This particularly applies to fractures other than the scaphoid.
Management of scaphoid fractures

Colles cast versus scaphoid cast: One trial only compared Colles cast to scaphoid cast (Clay 1991). The trial investigated 291 patients, 148 in the Colles cast group and 143 in the Scaphoid group. The main outcome was the union rate. The union was diagnosed on clinical and radiological bases (plain X-ray only). There has been no significant difference between the two treatment groups (Odds ratio 0.96 [0.45-2.07], p-value 0.92).
“of scaphoid fracture”...not all the same

Figure 3. A dorsal view of the scaphoid bone demonstrates various fracture orientations. Determining the orientation on radiographs is important because the orientation helps guide treatment decisions.
Operative vs. non-operative treatment

Seven trials (Bond 2001; Arora 2007; Dias 2008, McQueen 2008; Adolfsson 2001; Saeden 2001; Vinnars 2008).

Studied outcomes included union rate, time to union, ROM, Grip strength, complications and cost.

Pooled data - higher union rate in the operative group (Odds ratio 2.81[1.13-6.96]; p-value 0.03).

Higher rate of complications in the operative group (Odds ratio 4.20 [2.33-7.65]; p-value 0.0001).

Subgroup analysis showed that there was no significant difference in the union rate and complication rate in trials that used percutaneous techniques.

In contrast to open technique, there was significant difference in the union rate as well as complications. The ROM, grip strength and return to work data can not be pooled because they have been reported in variable ways. Cautious analysis of the result shows that there is no substantive difference in the ROM, but there is a consistent trend that operation may improve strength and early return to work. However, this remains to be proven.

Two trials provided data about the cost effectiveness of operative treatment versus non operative treatment (Arora 2007 and Vinnars 2008). As expected the data was non parametric and could not be pooled. Non operative treatment cost is relatively similar in both trials (2363 Euros and 2507 Euros respectively), but the operative cost is surprisingly low in Arora's study (2097 Euros and 3155 Euros).
Now. The future

- Don’t miss the diagnosis
- Local guidelines
- Future research; better, bigger.
- Multi-centre research
  - Diagnosis
  - Management
  - Patient outcomes
- Good summary:

Diagnosing Suspected Scaphoid Fractures
A Systematic Review and Meta-analysis
Zhong-Gang Yin MD, Jian-Bing Zhang MD, Shi-Lian Kan MD, Xiao-Gang Wang MD

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