

## RATIONAL IMAGING

## Investigating suspected scaphoid fracture

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This series provides an update on the best use of different imaging methods for common or important clinical presentations. The series advisers are Fergus Gleeson, consultant radiologist, Churchill Hospital, Oxford, and Kamini Patel, consultant radiologist, Homerton University Hospital, London. To suggest a topic for this series, please email us at practice@bmj.com.

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Previous articles in this series

- ▶ Suspected left sided diverticulitis (BMJ 2013;346:f928)
- ▶ Investigating urinary tract infections in children (BMJ 2013;346:e8654)
- ▶ Investigating pleural thickening (BMJ 2013;346:e8376)
- ▶ Investigation of acute knee injury (BMJ 2012;344:e3167)
- ▶ Investigating the solitary pulmonary nodule (BMJ 2012;344:e2759)

The choice of imaging modality for suspected scaphoid fracture depends on factors such as age, patient activity, cost, and availability of services

A 26 year old previously healthy woman presented to the emergency department immediately after being involved in a road traffic incident. After clinical examination, scaphoid injury was suspected. A radiograph of the left wrist was obtained and found to be equivocal (fig 1).

**What is the next investigation?**

Scaphoid fractures should be suspected with trauma involving the hand and/or wrist, particularly falls onto an outstretched hand and road traffic incidents. Such fractures most commonly occur among men aged 20-30 years, with about 10% presenting with an associated fracture.<sup>1</sup> Less than 20% of patients with a clinically suspected scaphoid fracture have a true fracture.<sup>2</sup> In most of the patients with true scaphoid fracture, the fracture is diagnosed with wrist radiography, the initial examination recommended by the Royal College of Radiologists<sup>3</sup> and the American College of Radiology's "appropriateness criteria" (tables 1 and 2), which are based on a literature review incorporating robust meta-analyses, prospective studies, and retrospective case series).<sup>4</sup> If initial imaging fails to show a fracture, the hand or wrist is often put in a cast before any further imaging, with the presumption that there is a fracture (presumptive casting). Reflecting a paucity of consensus in the literature, the British and US colleges differ slightly in their recommendations for second line imaging. The British college recommends magnetic resonance imaging (MRI) as the second line approach, with bone scintigraphy and computed tomography as alternatives.<sup>3</sup> The US college favors MRI or presumptive casting with repeat radiography to detect subsequently formed fracture lines; it also suggests computed tomography as a third line option.<sup>4</sup>

**Radiography**

Obtain four total views—including posteroanterior, lateral, oblique, and ulnar-deviated posteroanterior with cephalad angulation—to evaluate patients with suspected scaphoid fractures.<sup>4 5</sup> Compared with other carpal bone injuries, scaphoid fractures are particularly difficult to identify on initial radiographs and may not be seen in 15-20% of cases.<sup>6 7</sup>



Fig 1 | Posteroanterior radiograph of the wrist showing an incomplete lucency at the waist of scaphoid suspicious for a fracture but not definitive (arrow)

Consider repeating radiographs 10-14 days after initial injury and presumptive casting to allow time for resorption to produce a visible fracture line.<sup>4</sup> Meta-analysis has shown that such repeat radiologic assessments have a relatively low sensitivity (91.1%).<sup>8</sup> The total cost of radiography is estimated at £24 (€28; \$36) per patient.<sup>2</sup>

**Magnetic resonance imaging**

MRI is an ideal diagnostic modality when initial plain films are negative. A recent meta-analysis of 30 studies has reported that MRI has excellent sensitivity and specificity (97.7% and 99.8% respectively), especially compared with bone scintigraphy (97.8% and 93.5% respectively) or computed tomography (85.2% and 99.5% respectively).<sup>8</sup> MRI is especially sensitive for detecting minor displacements, which is important for determining the need for surgery. Additional carpal, radial, or soft tissue injuries, which may otherwise be missed, can be simultaneously identified, though these injuries are not always clinically relevant. MRI is the most expensive modality, at £200 per patient.<sup>2</sup>

**Computed tomography**

Computed tomography is the investigation of choice according to the American College of Radiology's recommendations when (a) initial radiographs are normal and magnetic resonance imaging is not available, (b) casting is not wanted owing to the patient's wish for a quick return to activity, and/or (c) surgical planning of complex fractures is needed. Multiplanar and three dimensional reconstructions offer greater capabilities of showing minor displacements and depicting fracture morphology. Computed tomography is more sensitive than MRI for cortical fractures and may be used to evaluate specific injuries such as fracture dislocations of the

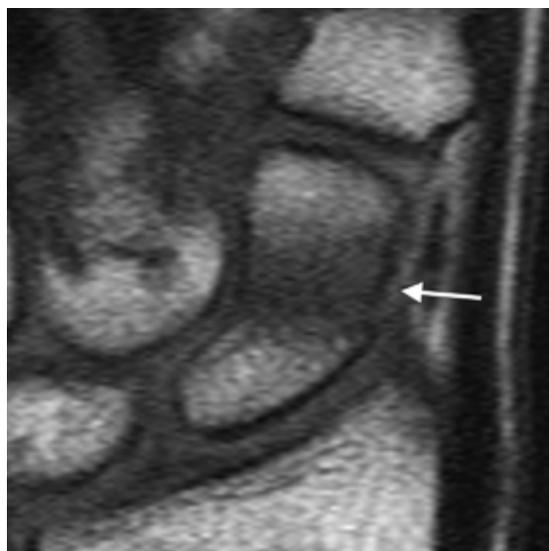
**LEARNING POINTS**

Initial evaluation for suspected acute scaphoid fracture requires radiography, but this modality misses 15-20% of fractures

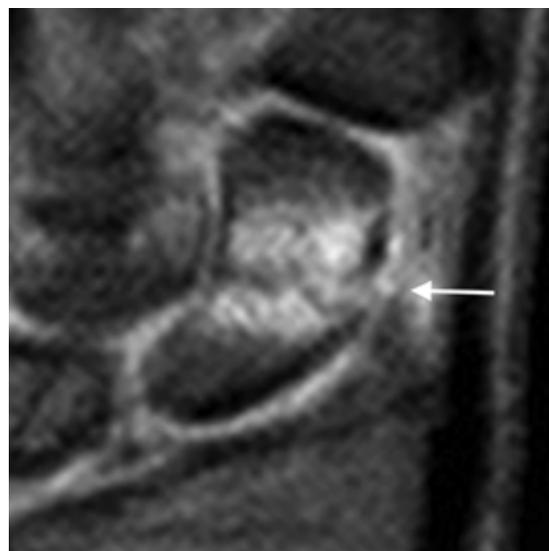
Occult scaphoid fractures may be examined by repeat radiography after casting, magnetic resonance imaging, computed tomography, bone scintigraphy, or ultrasonography

The American College of Radiology recommends magnetic resonance imaging or repeat radiography after 10-14 days of casting as the second line investigations of choice

The choice of imaging modality for occult scaphoid fracture depends on factors such as age, hand dominance, patient activity, cost, and availability of services



**Fig 2** | Magnetic resonance imaging of the wrist using coronal T1 with fat saturation showing a clear, non-displaced scaphoid waist fracture (arrow)



**Fig 3** | Magnetic resonance imaging of the wrist using coronal T2 with fat saturation showing a clear, non-displaced scaphoid waist fracture (arrow)

carpometacarpal joints.<sup>4-9</sup> However, computed tomography is otherwise not as sensitive as other modalities in the setting of negative initial radiographs.<sup>8</sup> Cost is estimated at £100 per patient.<sup>2</sup>

#### Bone scintigraphy

Bone scintigraphy shows fractures via increased tracer uptake at sites of metabolic changes, which are best detected after a period of at least 72 hours after injury. Some authors consider bone scintigraphy to be the optimal procedure for detecting occult fractures owing to its exquisite sensitivity.<sup>10</sup> However, a survey of worldwide protocols on scaphoid imaging found that bone scintigraphy was less commonly used than MRI or computed tomography as a second line investigation for suspected scaphoid fractures,<sup>11</sup> partly owing to its invasiveness, higher exposure of the whole body to radiation, and expense

(£140 per patient).<sup>2</sup> Bone scintigraphy is also limited by false-positive results,<sup>4</sup> though a few studies have found equal diagnostic ability when compared with MRI.<sup>12</sup>

#### Ultrasonography

Ultrasonography is typically readily available, quick to perform, and does not expose patients to radiation. In addition, ultrasonography is the cheapest imaging modality discussed here, at £10 per patient.<sup>2</sup> However, the fracture line, tubercle area, and the proximal and distal poles of the scaphoid are difficult to image, which contributes to the relatively low sensitivity.<sup>13</sup> Also, results are assessor dependent. Neither the Royal College of Radiologists nor the American College of Radiology recommends ultrasonography alone to detect scaphoid fractures. A recent study found that general radiologists were able to detect 92% of scaphoid fractures already

**Table 1** | Suspected acute scaphoid fracture: first examination<sup>4</sup>

Radiologic procedure	Rating*	Comments	Relative radiation level
Radiography of wrist	9	Including at least a posteroanterior, lateral, and semipronated oblique. The ACR recommends the inclusion of a fourth view: a posteroanterior projection with ulnar deviation and/or cephalad tube angulation (scaphoid view) if a scaphoid fracture is suspected	Minimum (adult dose <0.1 mSv, pediatric dose <0.03 mSv)
Computed tomography of wrist without contrast	1		Minimum
Magnetic resonance imaging of wrist without contrast	1		None (0 mSv)
Bone scintigraphy of wrist (nuclear imaging, technetium-99m)	1		Medium (adult dose 1-10 mSv, pediatric dose 0.3-3 mSv)
Ultrasonography of wrist	1		None

ACR= American College of Radiology.

\*1=least appropriate, 9=most appropriate.

**Table 2** | Suspected acute scaphoid fracture: radiographs normal, next procedure<sup>4</sup>

Radiologic procedure	Rating*	Comments	Relative radiation level
Make cast then repeat radiography of wrist in 10-14 days	8	Choice of casting or magnetic resonance imaging should be tailored to clinical circumstances in each individual case	Minimum (adult dose <0.1 mSv, pediatric dose <0.03 mSv)
Magnetic resonance imaging of wrist without contrast	8	Choice of casting or magnetic resonance imaging should be tailored to clinical circumstances in each individual case	None (0 mSv)
Computed tomography of wrist without contrast	4	A reasonable third option if the above two choices are contraindicated	Minimum
Bone scintigraphy of wrist (nuclear imaging, technetium-99m)	1		Medium (adult dose 1-10 mSv, pediatric dose 0.3-3 mSv)
US wrist	1		None

\*1=least appropriate, 9=most appropriate.

proved by computed tomography, with a negative predictive value of 97%.<sup>14</sup> The authors therefore recommended the use of ultrasonography in emergency room settings as a triage method of determining which patients should receive further imaging for suspected scaphoid fracture.

### Outcome

The patient's wrist was immobilized in a cast for two days until magnetic resonance imaging could be performed, which showed a scaphoid waist fracture (figs 2 and 3). After six more weeks of wrist immobilization, the cast was removed, and radiography of the wrist showed normal alignment of the fracture site. The patient retained normal function and sensation of the wrist and hand.

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**Patient consent not required (patient anonymised, dead, or hypothetical).**

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## EASILY MISSED?

### Delirium in older adults

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The daughter of an 80 year old woman with severely impaired vision from age related macular degeneration and diabetic retinopathy brought her mother to her primary care doctor, as she had been more apathetic and rejecting her meals in the past few days. Her daughter said there were times during the day when her mother looked almost her usual self, yet other times when she was confused and did not seem to be herself. Her doctor diagnosed delirium and referred the patient for assessment at the local emergency department.

#### KEY POINTS

Delirium can lead to poorer outcomes if untreated, yet is often missed, especially in patients aged ≥80 years, in the hypoactive subtype of delirium, and with pre-existing dementia or impaired vision

There are no diagnostic tests for delirium, which is diagnosed exclusively on clinical grounds

To increase the recognition of delirium healthcare professionals should routinely include a brief cognitive assessment during all encounters with older people  
In line with the confusion assessment method, diagnose delirium when the patient has (a) an acute change in mental status with a fluctuating course; (b) inattention; and either (c) disorganised thinking or (d) altered level of consciousness

Treat all modifiable predisposing and precipitating factors without delay—for example, review medications, treat underlying conditions such as infection, reduce sensory impairment

#### What is delirium?

Delirium is a neuropsychiatric syndrome characterised by disturbances of cognition, attention, consciousness, or perception that develop over a short period of time (hours to days) with a fluctuating course.<sup>1 2</sup> It usually results from the interaction of several precipitating factors (such as drugs, infections, metabolic disturbances, and myocardial infarction) and predisposing factors (such as old age, dementia, and multiple comorbidities).<sup>2</sup> There are three subtypes of delirium, according to its psychomotor features: hyperactive, hypoactive, and mixed.

#### Why is delirium missed?

The fluctuating nature of the symptoms of delirium, its frequent overlap with dementia, the lack of routine formal cognitive assessment, its diverse presentations, and the misperception that little can be done to prevent or treat delirium contribute to its under-recognition.<sup>2</sup> The hypoactive subtype of delirium (as our case was), the presence of pre-existing dementia, impaired vision, and being 80 years of age and older are independent risk factors for the under-diagnosis of delirium.<sup>6</sup>

#### Why does it matter?

Although delirium can be treated if dealt with urgently, failure to diagnose it can lead to poor outcomes and inappropriate treatment.<sup>1</sup> In-hospital mortality rates for older patients with delirium range from 14.5% to 37%.<sup>4</sup> After

This is one of a series of occasional articles highlighting conditions that may be more common than many doctors realise or may be missed at first presentation. The series advisers are Anthony Hamden, university lecturer in general practice, Department of Primary Health Care, University of Oxford, and Richard Lehman, general practitioner, Banbury. To suggest a topic for this series, please email us at [easilymissed@bmj.com](mailto:easilymissed@bmj.com)

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Previous articles in this series

- ▶ Cushing's syndrome (BMJ 2013;346:f945)
- ▶ Chronic exertional compartment syndrome (BMJ 2013;346:f33)
- ▶ Myasthenia gravis (BMJ 2012;345:e8497)
- ▶ Klinefelter's syndrome (BMJ 2012;345:e7558)
- ▶ Perilunate dislocation (BMJ 2012;345:e7026)

hospital discharge, a twofold independent increase in mortality risk was found to persist for about 12 months.<sup>3</sup> Delirium is also associated with worse functional recovery after admission to hospital and with increased risk of being admitted to a care home.<sup>2 4 5</sup> Direct costs attributable to delirium are extremely high—for example, in the United States these costs can exceed \$150bn (£99bn; €117bn) a year.<sup>7</sup> Additionally, the misdiagnosis of delirium can be associated with an eightfold increase in mortality risk.<sup>8</sup>

### How is delirium diagnosed?

There are no diagnostic tests for delirium, which is diagnosed exclusively on clinical grounds.<sup>2 5</sup> A systematic review concluded that the confusion assessment method is the bedside diagnostic instrument for delirium that is best supported by evidence, with positive and negative likelihood ratios of 9.6 and 0.16 respectively.<sup>9</sup> In line with this method, diagnose delirium when the patient has (a) an acute change in mental status with a fluctuating course; (b) inattention; and either (c) disorganised thinking or (d) altered level of consciousness. Ideally score the confusion assessment method on the basis of observations made during brief cognitive tests (such as the mini-mental state examination). However, when scoring the confusion assessment method, also take into account any observations made away from formal cognitive tests (such as during consent, conversation, and physical examination). Ascertaining the presence of acute cognitive change with a fluctuating course (that is, when symptoms come and go or vary in intensity during the day) requires information from people acquainted with the baseline status of the patient and who have observed him or her over time. Document inattention if the patient is unable to focus or to shift attention according to external stimuli (for example, the patient is easily distracted or his or her focus darts around the room) or has difficulty reciting the days of the week backwards or raising a hand whenever a certain letter is spoken out of a list.<sup>5</sup> Disorganised thinking is manifested by unclear flow of ideas, unpredictable changes in subject, rambling, or irrelevant conversation. Altered level of consciousness should be recorded if the patient is anything but alert (for example, hyperalert, lethargic, or comatose). An excellent interactive resource for learning how to use the confusion assessment method is available at [www.icam.geri.u.org](http://www.icam.geri.u.org).

Distinguishing delirium from dementia and diagnosing delirium superimposed on dementia represent frequent clinical challenges.<sup>10</sup> The determination of an acute change in the baseline pattern of mental functioning and behaviour of the patient is probably the most critical piece of information to be obtained. The finding of altered level of consciousness is also highly suggestive of delirium, even though its absence is not sufficient to rule out that diagnosis.<sup>10</sup> Any difficulty distinguishing between the diagnoses of delirium, dementia, and delirium superimposed on dementia should lead to the safest and most reasonable treatment decision possible—that is, treat for delirium first.<sup>1</sup>

### How is delirium managed?

Effective management of delirium requires approaching all modifiable predisposing and precipitating factors

### HOW COMMON IS DELIRIUM?

- Among individuals aged 85 years and older living in the community the prevalence of delirium can be as high as 14%<sup>2</sup>
- Among older people (aged 65 years and over), delirium usually occurs in 10–34% of those living in long term care facilities,<sup>3</sup> in 30% of those in emergency departments,<sup>2</sup> and in 10–42% during a hospital stay<sup>4</sup>
- Delirium complicates 17–61% of major surgical procedures and occurs in 25–83% of patients at the end of life<sup>2 5</sup>
- Despite the prevalence of delirium, healthcare professionals recognise only 20–50% of cases<sup>5</sup>

without delay.<sup>1 2 6</sup> This includes removing unnecessary and potentially harmful drugs and treating underlying infections, volume depletion, and cardiorespiratory and metabolic disturbances. A common mistake is to deal with only a few of the most obvious precipitating factors (such as a urinary tract infection) while leaving unattended other major contributing factors. Various non-drug measures are also advocated for the treatment of delirium. Some of those measures involve frequently helping the patient to reorientate; reducing sensory impairment by providing spectacles and hearing aids; adopting early and frequent mobilisation programmes; discouraging the use of unnecessary tethers; and supporting an adequate sleep-wake cycle by, for example, coordinating schedules for obtaining vital signs and administering medications to provide uninterrupted periods of sleep.<sup>3</sup> Reserve antipsychotic drugs for patients with hyperactive delirium whose agitation threatens their own safety or the safety of others despite the adoption of optimal non-drug interventions.<sup>1 2 11</sup>

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