

A virtual pathway reduced the need for physical review in patients with a suspected scaphoid fracture

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ABSTRACT

Objectives: Suspected scaphoid fractures are a common reason for referral from the emergency department to fracture clinics. Few patients actually have a fracture. Cross sectional imaging has the potential to improve early diagnosis and reduce unnecessary immobilisation. The aim of this audit was to investigate the effectiveness of a virtual pathway, incorporating early magnetic resonance imaging (MRI) scan, for suspected scaphoid fractures. The secondary aim was to investigate whether the accuracy of other clinical signs, such as anatomical snuffbox pain on wrist ulnar deviation, was sufficient to reduce the number of patients requiring a MRI scan.

Methods: A prospective audit was undertaken of 123 patients in an emergency department and associated minor injuries unit. These patients were managed with an early MRI scan. Where no significant injury was found, they were discharged after a phone call from a virtual fracture clinic nurse.

Results: There were 16 (13%) true scaphoid fractures. MRI scanning showed other injuries including significant soft tissue injuries (13%), other carpal fractures (17%) and fractures of the distal radius (19.5%). The number of clinical appointments required was 0.42 per patient. Eighty patients did not have any face-to-face review. Other clinical examination techniques, such as anatomical snuff box pain on ulnar deviation of the wrist were not sufficiently sensitive or specific to reduce the need for MRI scanning or review.

Conclusions: A virtual fracture clinic pathway and early MRI scanning reduced face-to-face reviews and unnecessary immobilisation. Clinical examination techniques are not sufficiently sensitive to reduce the need for scanning.

Keywords: Scaphoid, fracture, virtual fracture clinic

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The incidence of scaphoid fracture has been reported as 29 per 100,000 [1]. The “suspected” scaphoid fracture is a common reason for referral to fracture clinic from the emergency department (ED). The prevalence of a true fracture, where clinical sus-

picion exists but x-rays are negative, ranges from 5% to 25% [2]. This reported variation arises from differences in clinical examination experience. The final outcome of this group is unclear. There is a fear that failure to identify and immobilise may lead to



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nonunion and arthritis and missed scaphoid fractures are a cause for litigation [3, 4]. However, unnecessary immobilisation may lead to stiffness, time off work and avoidable healthcare utilisation.

Clinical diagnosis relies on the presence of anatomical snuffbox (ASB) pain on direct palpation. This sign, although sensitive, is not specific. Other signs, and combinations of signs, have been investigated to reduce the number of patients who require temporary immobilisation and advanced imaging. A recent study identified ASB pain on ulnar deviation of the wrist (within 72 hours of injury) and reported that no patient, without this sign, had a true scaphoid fracture [5]. Four factors were identified as predictive of actual fracture: male gender, sports injury, ASB pain on ulnar deviation of the wrist, and scaphoid tubercle tenderness. There have been a variety of clinical prediction rules suggested to improve diagnosis through examination [5-7]. Advocates of such signs and clinical predictions rules point to the potential overdiagnosis of clinical uncertain entities such as bone-bruising

and other soft-tissue injuries.

With increasing availability and reduced cost of advanced imaging, the cost-effectiveness of early magnetic resonance imaging (MRI) or computed tomography (CT) diagnosis has been revisited [8, 9] and found favourable. Our ED and fracture clinic has been an early adopter of universal use of MRI scanning to improve diagnosis and reduce unnecessary immobilisation. We have recently redesigned our fracture clinic service so that MRI scans were reviewed at Virtual Fracture Clinic (VFC) and patients only came to clinic if there was definite injury that required treatment. This protocol aimed to reduce healthcare utilisation and patient inconvenience.

The aim of this audit was to investigate the effectiveness of a virtual pathway, incorporating early MRI scan, for suspected scaphoid fractures. The secondary aim was to investigate whether the accuracy of other clinical signs, such as ASB pain on wrist ulnar deviation, was sufficient to reduce the number of patients requiring a MRI scan.

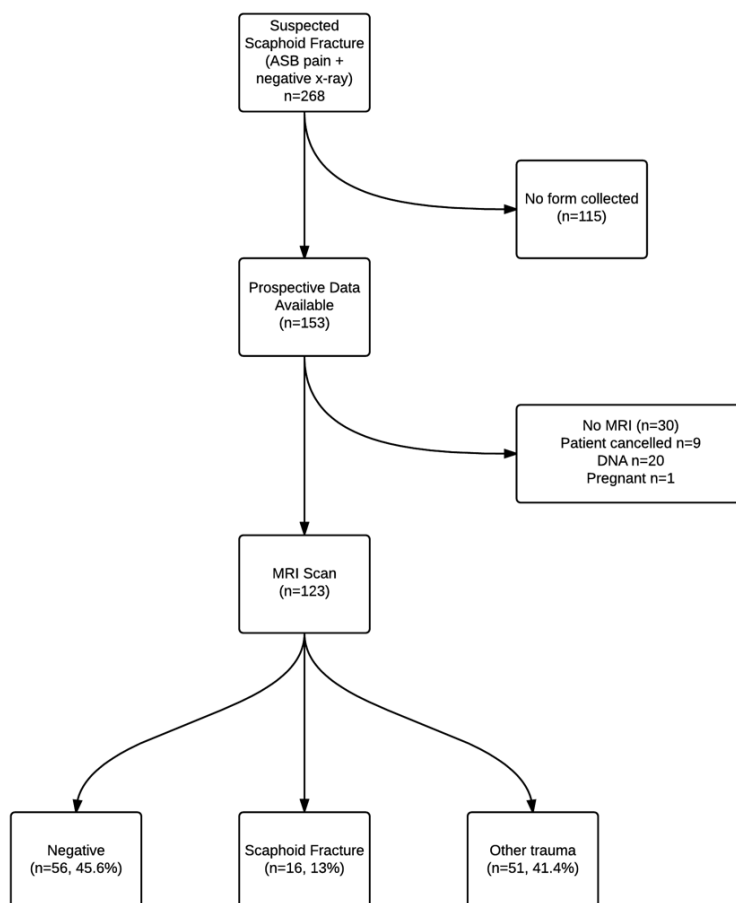


Figure 1. Flow chart of patients in study, along with clinical outcome

METHODS

A prospective audit was performed at our institution's ED and its associated Minor Injuries Unit (MIU). Patients were included if they had suffered an injury to the wrist, had pain in the anatomical snuffbox, and did not have evidence of fracture on their initial radiographs. A standardised clinical examination was performed and recorded on an audit form. The use of this form was to support a full and effective clinical examination. This form recorded basic demographic details and the mechanism of injury. It also recorded the presence or absence pain on: thumb-index pinch, scaphoid tubercle tenderness, axial compression of the thumb, ASB pain on ulnar deviation and pronation, ASB pain on radial deviation and pronation. Patients were provided with a wrist splint without thumb extension (Promedics Beta Wrist Brace, Promedics, UK) and were referred for a MRI scan if they had no contraindications to scanning. The scans were performed on a Philips Achieve 1.5T scanner. The following protocols were used: (1) T1 D3 Vista Coronal, fov 82×82, tr 400, te21, voxel size 0.4×0.4×0.4 mm, 150 slices scan time 4.35 minutes and (2) T2 mSpir Drive Coronal, fov 80×80 tr3355, te 70, voxel size 0.3×0.4 mm, slice thickness 3 mm 16 slices scan time 3.11 min.

A virtual scaphoid pathway was implemented in the Orthopaedic Department. The results of pending MRI scans were regularly checked and reviewed at a VFC. If the scan was normal the patient received a phone call from a fracture clinic nurse. They were advised that they had a simple soft tissue injury of the wrist and were provided with advice regarding

mobilisation and splint removal. This was followed up with written information sent via post. Where there was an MRI abnormality, and ongoing symptoms, patients were offered review in a dedicated hand and wrist trauma clinic.

The audit took place from 1 February 2015 to 31 January 2016. A total of 268 patients met the inclusion criteria (Figure 1). There were 200 patients presenting to the ED and a further 68 to the MIU. There were audit forms completed for 108 (58%) patients in the ED and 45 (66.2%) in the MIU. Out of 153 patients with audit forms, a total of 123 underwent MRI scanning.

The median time from injury to assessment was 1 day (range 0 to 70, IQR 0 to 3.25, mean 4.1, SD 9.0). The mean time to from presentation to MRI scan was 19.4 days (0 to 56, IQR 12 to 27, SD 11.0). 115 presented within 3 days of injury. Of these, 94 underwent MRI scan.

RESULTS

Out of 123 patients with a suspected scaphoid fracture there were 67 (54.4%) patient who had a traumatic lesion, of which 16 (13%) patients had a true scaphoid fracture (Table 1). A fracture was found in another carpal bone in 21 cases and in the distal radius in 24 cases. There were 16 soft tissue injuries.

There was a total of 52 physical appointments required for this group of 123 patients during a six-month follow-up period. The mean number of appointments per patient was patient was 0.42 (range 0 to 3, median 0, SD 0.65). There were 80 patients

Table 1. Total number of MRI abnormalities detected (n = 67).

MRI Finding	Abnormalities (n, %)
Scaphoid fracture	16 (13.0%)
Scaphoid bone bruising	2 (1.6%)
Other bone bruising	13 (10.6%)
Soft tissue injury	16 (13.0%)
Other carpal fracture	21 (17.0%)
Distal radius fracture	24 (19.5%)
Metacarpal fracture	9 (7.3%)

Some wrists had multiple abnormalities, therefore the column total exceeds 67. MRI = magnetic resonance imaging

Table 2. Diagnostic performance of clinical tests compared to MRI “gold standard” at diagnosis a true scaphoid fracture (in patients presenting three days or fewer after injury)

	TP	FN	FP	TN	Sens	Spec	PPV	NPV	Acc
ASB pain	13	0	76	5	100.0%	6.2%	14.6%	100.0%	94.7%
Pain on thumb-index pinch	5	8	41	40	38.5%	49.4%	10.9%	83.3%	48.9%
ST tenderness	8	5	49	32	61.5%	39.5%	14.0%	86.5%	60.9%
Pain on axial compression	8	5	50	31	61.5%	38.3%	13.8%	86.1%	61.7%
ASB pain on ulnar deviation	7	6	50	31	53.8%	38.3%	12.3%	83.8%	60.6%
ASB pain on radial deviation	7	6	42	39	53.8%	48.1%	14.3%	86.7%	52.1%
Decreased active ROM	6	7	35	46	46.2%	56.8%	14.6%	86.8%	43.6%

Acc = accuracy, ASB = anatomical snuff box, FN = false negative, FP = false positive, MRI = magnetic resonance imaging, NPV = negative predictive value, PPV = positive predictive value, ROM = range of motion, Sens = sensitivity, Spec = specificity, ST = scaphoid tubercle, TN = true negative, TP = true positive

who did not need a physical appointment in fracture clinic. They were phoned and discharged by telephone.

When the endpoint of true scaphoid fracture was examined in patients presenting 3 days or fewer after injury, pain in the ASB on palpation had a low specificity (6.2%), sensitivity (53.8%) and positive predictive value (12.3%). In this series, reliance on this finding would have resulted in six missed fractures. It would have also have identified 50 false positive cases. The other tests, applied individually, resulted in between 5 and 8 false positive findings (Table 2).

DISCUSSION

This prevalence of true fracture in this population was 13%. This is similar to comparable studies and supports the generalisability of these findings. There was a lower rate clinic attendance than would occur in a traditional pathway. In a traditional pathway a patient would normally be expected to return to fracture clinic at two weeks for repeat examination, with definitive immobilisation being instituted for some at that clinic, further imaging arranged for others, and the majority discharged. A sub-group may have been brought back for a further review after another short period. Our protocol allowed a definitive diagnosis to be reached and treatment to be confidently commenced. Where there was no significant injury, this also allowed the patient to be “virtually” discharged with confidence. As such, only 0.42 physical appointments were required per patient.

In a standard pathway, this would be expected to be greater than 1 per patients, as every patient returns at least once for a clinical examination at two weeks. Patients were virtually discharged if they had abnormality found on MRI. They were also virtually discharged in many cases of minor soft tissue injury and undisplaced fractures of the distal radius and other carpal bones. This was in keeping with our unit’s protocols. Patients with suspected scaphoid fractures are generally managed in splints, and therefore these can be removed by the patient when symptoms reduce, and promote self-care.

This study also demonstrated that none of the previously suggested clinical examination techniques were sufficiently sensitive or specific to avoid significant false negative diagnoses [2, 10]. As such, we do not consider that any clinical rule, other than the presence of tenderness in the ASB, is useful or safe at reducing the number requiring further review or cross-sectional imaging. In particular, we were not able to reproduce the recently reported finding that lack of pain in their ASB on ulnar deviation of the wrist, within 72 hours of injury, predicted no underlying fracture [5]. In our study, there were six patients, without ASB pain on ulnar deviation, who had a fracture. We believe a significant limitation of this paper was the inclusion of true scaphoid fractures that were obvious on radiographs at the time of presentation. The examination, diagnosis and management of these patients is not contentious, and it is possible that findings related to the overall group of all scaphoid fractures are not translatable to the subgroup of those with a clinically suspected fracture.

The true scaphoid fracture rate in our study was also similar to that reported in a study of a clinical prediction score [6]. This test allocated 3 points to a ASB pain on palpation in ulnar deviation, tenderness of the scaphoid tubercle was given 2 points and pain on longitudinal compression was given 1 point. The authors test the hypothesis that a total score greater than or equal to 4 would be useful in diagnosis true fractures. They reported that the test had a NPV of 96%. Of the 13 true fractures, the test correctly identified 10, but missed 3 patients. It also identified 62 patients as having fracture, who did not (out of 72 positive findings). These authors state that it is not practically, ethically or financially possible to scan every injured wrist with MRI to prevent overtreatment. This conclusion is not in keeping with recent cost-effectiveness studies [8, 9].

Clinicians have been historically been wary about recommending widespread scanning due to the fact that little is actually known about the long term outcome of missed occult fractures and the potential for overdiagnosis of entities with unclear significance, such as bone bruising. A small study suggested that early MRI management was equivalent financially to the traditional management [11]. The protocol had the potential to reduce unnecessary immobilisation, overall treatment time, and healthcare usage. Due to the small number of patients it was unable to demonstrate reduced time off work or school. An American study of overall cost effectiveness showed that advanced imaging was dominant over empiric cast immobilisation, with lower health costs and better outcomes [9]. This study considered anticipated healthcare and societal savings. It reported MRI to be slightly more cost-effective based on the mean published diagnostic performance. It reported that imaging would have to cost more than \$2000 (USD) to become less cost-effective than traditional management. This finding is likely to be accurate in the US health market, but may be less generalisable to other health systems where advanced imaging is more difficult to access, and with more of a treatment delay. A separate cost effectiveness study examined seven different strategies for diagnosis and management and that immediate CT or MRI were the most cost-effective strategy for diagnosing suspected scaphoid fractures [8].

A strength of this study is the large number of

patients studies, with the use of MRI as a gold standard for diagnosis. It was also pragmatic in nature, as it recorded the clinical examination findings of a group of ED clinicians and emergency nurse practitioners (ENPs). This is likely to be representative of the wider diagnostic performance of this clinical group. Previous studies have tended to clinical examination performed by a single, highly trained, observer.

CONCLUSION

This study demonstrated that a virtual pathway, in conjunction with MRI scanning, can reduce the need for physical review of suspected scaphoid fractures. It demonstrated that clinical signs, other than ASB tenderness on direct palpation, were associated with unacceptable false negative diagnosis rates, and could not be consistently used to reduce the need for MRI scanning.

ARTICLE SUMMARY

Article focus

- The aim of this audit was to investigate the effectiveness of a virtual pathway, incorporating early MRI scan, for suspected scaphoid fractures.
- The secondary aim was to investigate whether the accuracy of other clinical signs, such as ASB pain on wrist ulnar deviation, was sufficient to reduce the number of patients requiring a MRI scan.

Key message

- This pathway was safe and effective at reducing the need for face-to-face review
- This pathway reduced the need for unnecessary immobilisation
- Clinical examination is not sufficiently sensitive to reduce the need for cross-sectional imaging

Strengths and limitations of this study

- This study is unique in examining the impact of a virtual fracture clinic pathway on this common injury
- This study is pragmatic in that it has studied a typical UK ED and minor injuries unit rather than clinical examination limited to experienced

orthopaedic surgeons.

- This study is limited by failure to enroll all eligible patients to the audit

Contribution of authors

PJ conceived the study, designed the methodology, analysed the data and wrote the manuscript. SB led the study data collection in the Emergency Department and contributed to the manuscript. PM led the study data collection in the Minor Injuries Unit. KB collated and analysed the data and wrote the manuscript. DS assisted with data analysis. LAR conceived the study and wrote the manuscript.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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