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Virtual management of clinically suspected scaphoid fractures

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ABSTRACT

Aims: This study describes the introduction of a virtual pathway for the management of suspected scaphoid fractures and reports patient-reported outcome measures (PROMs) and satisfaction following treatment with this service.

Patients and Methods: All adult patients that presented with a clinically suspected scaphoid fracture that was not visible on presentation radiographs over a one-year period were eligible for inclusion in the pathway. Demographics, examination findings, and standard four view radiographs were collected at presentation. All radiographs were reviewed virtually by a single consultant hand surgeon, with patient-initiated follow-up on request. PROMs were assessed at a minimum of one year post presentation and included the QuickDASH, EQ-5D-5L, the Net Promoter Score (NPS) and return to work.

Results: There were 221 patients referred to the virtual pathway. The mean age was 41 (range 16-87; SD 18.4 years) and there were 99 men (45%). There were 189 (86%) patients discharged with advice and 19 (9%) patients were recalled for clinical review (seven undisplaced scaphoid fractures, six other acute fractures of the hand or wrist, two scapholunate ligament injuries, and four cases where no abnormality was detected). Thirteen patients (6%) initiated follow-up with the hand service; no fracture or ligament injury was identified within this group. PROMs were available for 179 (81%) patients at a mean of 19 months follow-up (range: 13 – 33 months). The median QuickDASH score was 2.3 (IQR, 0-15.9), the median EQ-5D-5L was 0.85 (IQR, 0.73-1.00), the NPS was 76, and 173 (97%) patients were satisfied with their treatment. There were no documented cases of symptomatic non-union one year following injury.

Conclusions: This study reports the introduction of a virtual pathway for suspected scaphoid fractures, demonstrating high levels of patient satisfaction, excellent PROMs, and no detrimental effects in the vast majority of cases.

Level of evidence: III (cohort study)

INTRODUCTION

Suspected or “clinical” scaphoid fractures are wrist injuries without an immediately obvious scaphoid fracture on presentation radiographs. They have traditionally been managed with immobilisation, followed by interval clinical examination and radiographs¹. This, however, places a significant clinical and financial burden on fracture clinic resources, as only a small proportion of these patients will be diagnosed with an injury requiring formal immobilisation and follow up.

The recent United Kingdom (UK) National Institute for Health and Care Excellence clinical guidelines recommended the consideration of Magnetic Resonance Imaging (MRI) as first-line imaging in patients with suspected scaphoid fractures following a thorough clinical examination². This has driven researchers to investigate the cost-effectiveness of MRI scanning in defining injury, with recent studies confirming that the increased cost is offset by the early diagnosis^{3,4}. However, MRI may not be freely and readily accessible in every institution⁵, potentiating a treatment disparity which already exists in the UK^{6–10}.

Although there is evidence to suggest that non-union of a scaphoid fracture is more likely to occur when there has been no initial immobilisation¹¹, there is no evidence to demonstrate that the natural history of an occult scaphoid fracture differs with a delay in splint or plaster immobilisation. The overall rate of scaphoid non-union in established fractures is approximately 10%¹², and this rate is likely to be far lower in undisplaced fractures^{13,14}. As a result, some of these occult injuries may become non-unions regardless of whether or not they are immobilised primarily. It is also possible that a proportion of the population will sustain a scaphoid fracture and never seek medical advice, believing the injury to be a minor wrist sprain. It is not feasible to investigate the natural history of that particular patient cohort, although a previous study has shown that the prevalence of asymptomatic

scaphoid non-unions detected as incidental radiographic findings in the general population is 0.14%¹⁵.

Fear of missing a fracture that could potentially become a non-union drives the concept that no fracture can be missed, diverting resources towards investigation and “over-treatment”, the onus being on the clinician to detect the injury. This is also associated with a large number of young and active patients receiving potentially unnecessary immobilisation and time off work. Virtual fracture clinics (VFC) have become the screening tool to pick up unstable injuries or definite fractures with treatment recommendations¹⁶. One of the fundamental principles of VFCs is the provision of information regarding the uncertainties surrounding a patients injury¹⁷; if this information is of sufficient quality, a significant proportion of patients can be relied upon to re-present if there are issues with ongoing disability. This principle has been demonstrated in previous reports of VFCs^{18,19}.

The ****BLINDED**** Virtual Hand Clinic was set up in 2012 with the express aim of informing and educating patients regarding the condition for which they had been referred, promoting a patient-initiated review (PIR) process for access to a face-to-face appointment in the hand clinic. In January 2019 we introduced a virtual pathway for suspected scaphoid fractures, discharging patients from the Emergency Department (ED) with an information sheet, recovery checklist, and PIR on request. The aims of this study are to describe the introduction and assessment of this pathway, and to report the patient-reported outcome measures (PROMs) and satisfaction following treatment with this service.

PATIENTS AND METHODS

Study setting

This was a prospective study evaluating the introduction and performance of a clinical pathway. The setting for this study was a single healthcare trust which provides trauma and orthopaedic services to an estimated population of 370,000. ED services are provided at a single large institution which represents a level III trauma centre, with an additional minor injuries unit staffed by nurse practitioners at a separate hospital.

Virtual Scaphoid Pathway

This study was registered with the local musculoskeletal quality improvement department. All skeletally-mature patients with clinically-suspected scaphoid fractures that were not visible on presentation radiographs were eligible for inclusion in the pathway. Patients with suspected fractures were placed into a removable velcro wrist support and discharged from the ED with advice to wean themselves out of this as pain permitted over the following six weeks. All patients were provided with an information sheet regarding suspected scaphoid fractures (Supplementary File 1) and instructed to contact the hand surgery service should they wish to arrange follow-up: there was no specific time limit following injury for patients to initiate review. When completing the virtual pathway referral, the ED staff member that had assessed and treated the patient was required to record patient demographics, mechanism of injury, and examination findings on a specific proforma (Supplementary File 2).

All radiographs and case notes relating to the injury and any relevant past medical history were reviewed virtually by a single consultant hand surgeon with level IV experience²⁰ at a weekly virtual clinic. Patients were contacted and brought back for clinical review if there was a visible fracture or significant abnormality on initial radiographs, or if the reviewing consultant was concerned that the documented mechanism of injury and patient demographics were more likely to be associated with a true scaphoid fracture²¹. Higher-

energy mechanisms of injury which were felt to be associated with a greater likelihood of true fracture and included a fall from a height of greater than 2 meters, a road traffic collision, sporting injuries, and punching injuries²²⁻²⁵. In all cases, the exact details of the mechanism of injury as documented on the ED referral sheet were reviewed. A summary of the virtual scaphoid pathway is presented in Figure 1.

Follow-up and patient-reported outcome measures

All patients reviewed were subsequently contacted at a minimum of one year by postal questionnaire. Those who did not return their postal form were followed-up with a telephone questionnaire. Electronic chart review and a search of the Scottish national picture archiving and communication system (PACS) was undertaken for all patients to determine if any patients had re-presented for further radiographs due to ongoing symptoms, either regionally or within the entire national system. When patients were uncontactable, a telephone call was made to their general practitioner (GP) to determine whether they had re-presented to them within the time period with ongoing problems relating to their injury.

To assess hand and wrist function, patients completed the Quick version of the Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire²⁶; the five-level EuroQol five-dimensions (EQ-5D-5L)²⁷ questionnaire was used to investigate health-related quality of life (HRQoL). We also asked patients “how normal is your hand?” and scored responses on a 100-point visual analogue scale (VAS) from 0 (least normal) to 100 (most normal). This represents a single-item adjunct to validated upper limb PROMs which has recently been utilised in patients with distal radius fractures²⁸ and Dupuytren’s disease²⁹. Patients reported overall satisfaction with the virtual service on a 100-point VAS: patients who scored 50 or more were considered satisfied, in line with previous studies

investigating patient satisfaction in hand surgery³⁰. Patients also completed the Net Promoter Score (NPS): this is a complex metric which is derived by asking how likely patients are to recommend a service to their friends or family member with the same condition. It is derived from the NHS “friends and family test”, and though originally developed to gauge consumer loyalty in business³¹, it has more recently been applied as an alternative PROM in hand³² and hip and knee surgery³³. Patients were asked “how likely are you to recommend the virtual scaphoid pathway to a friend or family member with the same injury?” and recorded responses on a 100-point VAS from 0 (“not at all likely”) to 100 (“definitely recommend”). Patients scoring 90 or over are classified as promoters and would recommend the service; those scoring 70-89 are passives, and would neither recommend for nor against the service; those scoring less than 70 are “detractors” and would actively discourage others from utilising the service. The percentage of promoters minus the percentage of detractors give the NPS, with positive scores (above 0) indicating a service which is highly valued by its users.

Statistical analysis

The Shapiro-Wilk test was used to check data for normality: parametric data are reported as mean and standard deviation (SD); non-parametric data are reported as median and interquartile range (IQR). Nonresponder analysis was undertaken: categorical variables were compared between groups using the chi-square test or Fisher’s exact test if there were fewer than 5 observations; continuous variables were compared using the student *t*-test for parametric data and the independent samples Mann-Whitney *U* test for non-parametric data. To investigate the likelihood of missed fractures in the nonresponder group, we retrospectively calculated the Clinical Scaphoid Score³⁴ (CSS) for each patient, based on the information provided on the original referral proformas. The CSS is a clinical prediction rule

which scores patients based on the presence of: anatomical snuffbox tenderness with an ulnar deviated wrist (3 points); scaphoid tubercle tenderness (2 points); and pain with axial thumb loading (1 point). It has been suggested that patients with a CSS \geq 4 are at higher risk for an occult fracture³⁴. In this study, the CSS was only calculated and applied retrospectively in order to describe the mechanisms of injury and likelihood of a true scaphoid fracture in the cohort. The CSS was calculated for patients once the follow-up PROMs were available, and all clinical decisions were made without the consideration of the CSS. The level of statistical significance was accepted as a *p*-value of less than 0.05.

RESULTS

Virtual scaphoid pathway utilisation

Over a 12-month period (January to December 2019) 221 eligible patients were referred to the virtual scaphoid pathway. There were 99 men (45%) and the mean age was 41 (range 16-87; SD: 18.4 years). One-hundred and eighty-nine patients (86%) were discharged with PIR and received no further treatment. Nineteen patients (9%) were recalled following consultant review in the virtual scaphoid clinic either because of an injury identified radiologically, or a concern regarding mechanism of injury. Of these recalled patients, seven were diagnosed with an undisplaced scaphoid fracture, two with a scapholunate ligament injury, one of which required acute repair, six patients with other fractures, and in four patients no injury was identified. Thirteen patients (6%) initiated follow-up with the hand service and were reviewed in the outpatient clinic at a mean of 41 days following their injury (SD: 23; range 10-83 days). In six patients, no injury was identified. Four patients were diagnosed as having a minor soft tissue injury to the wrist, one had base of thumb arthritis and two patients were found to

have incidental de Quervain tendinopathy. Diagnoses and utilisation of further imaging modalities are summarised in Table 1.

Mechanisms of injury

Sixty-one patients (28%) were identified as having injury mechanisms that were more likely to result in a true scaphoid fracture (33 road traffic collisions, 14 sporting injuries, seven each assault/punching injuries and fall from a height greater than 2 meters) and nine required review in clinic. There was no significant difference in the number of patients who returned for clinical review (15% vs 14%, chi square test $p=0.94$) or in the number of scaphoid fractures identified (2% vs 4%, Fisher's exact test $p=0.68$) between the mechanisms of injury.

Patient-reported outcome measures

PROMs were available for 179 patients (81%) at a mean of 19 months follow-up (range: 13 - 33.4 months). The median QuickDASH score was 2.3 (IQR: 0-15.9), the median EQ-5D-5L was 0.85 (IQR: 0.73-1.00), and the median hand normality score was 92 (IQR: 80-100). One-hundred and seventy-three patients (97%) were satisfied with the treatment they received and the NPS was 76. Of the patients who responded, 128 (72%) were employed at the time of injury: 96 patients (75%) returned to work at a median of 1 week post injury (IQR: 0-3 weeks), 15 patients (12%) changed jobs for reasons unrelated to their health, six patients (5%) stopped working due to health reasons, six patients (5%) were furloughed as a result of the COVID-19 pandemic, and five patients (4%) had retired.

Although the median PROM values indicated excellent hand function and symptoms, we were concerned regarding the possibility of missing significant symptoms in patients with potential undiagnosed injuries. We therefore selected all patients with a self-reported hand

normality score of less than 75 for further review (n=43). These patients were contacted by the senior author who also re-reviewed all available imaging and clinical notes. Thirty-one patients (74%) had clinical or radiographic evidence of other unrelated upper limb diagnoses which were felt to account for their ongoing symptoms (Table 2). Seventeen patients with ongoing symptoms and no obvious explanation were subsequently invited for a face-to-face clinic appointment with repeat radiographs. The uptake of this offer was poor with an overall attendance rate of just 35%. A single patient was identified at this follow-up clinic appointment who had sustained an undisplaced atypical proximal pole fracture that was not visible on presentation radiographs. This patient had sought advice from their GP who had referred them to a general fracture clinic, and wrist immobilisation was commenced at this appointment 25 days following injury, leading to uneventful fracture union. We are not certain why this patient contacted their GP rather than the virtual scaphoid clinic, and we only became aware of this case when reviewing one-year PROMs.

Nonresponder analysis

Nonresponder analysis is presented in Table 3. Of the 42 patients who did not return their questionnaires, three had died and one patient declined to participate when contacted. No statistically significant differences were observed in age or gender between responders and nonresponders, although a significantly greater proportion of nonresponders had an initial CSS ≥ 4 . Three nonresponders had accessed the service with ongoing symptoms: two underwent MRI, one of which revealed an undisplaced distal radius fracture which was treated non-surgically, and the other showed no abnormality. The third nonresponder who had accessed the service had been diagnosed with an undisplaced fracture of the base of their fifth metacarpal, which had been treated non-surgically. A review of the national PACS archive

revealed no radiographically-confirmed scaphoid fractures in the entire cohort. Moreover, none of the nonresponders had sought further treatment from their GP for ongoing wrist symptoms.

DISCUSSION

The study reports the introduction and evaluation of a virtual pathway for suspected scaphoid fractures that educates patients regarding their injury, and empowers them to initiate follow-up as desired with the use of a checklist for guidance. This contrasts with traditional pathways that mandate up to two weeks of immobilisation and repeat clinical assessment, as well as more recent studies that advocate advanced imaging modalities for all patients. This study has shown that a virtual approach is highly-regarded by patients with high levels of satisfaction and a high NPS. Moreover, the excellent PROMs and no cases of symptomatic non-union reported suggests that this management is not detrimental and is clinically appropriate in the vast majority of cases.

There will always be an element of uncertainty and risk when treating suspected scaphoid fractures, due to the potential for non-union and arthritis. The natural history of untreated nondisplaced (radiologically invisible) scaphoid fractures and fractures treated non-surgically that fail to unite is not well-understood³⁵ and the classical progression to symptomatic pancarpal arthritis is variable. Furthermore, the optimum treatment of established non-unions is yet to be defined, and surgical stabilisation does not necessarily prevent nonunion, advanced collapse, or arthritis³⁵. Therefore, the assumption that missed scaphoid fractures that are not even visible on presentation plain radiographs will go onto non-union advanced collapse unless stabilised with cast immobilisation or surgery is based on theory rather than evidence.

The evidence to suggest the use of early advanced imaging for all patients with suspected fractures is also debatable. Mallee et al in their Cochrane review reported that the positive predictive value of MRI was only 88%, and that for every 1000 suspected scaphoid fractures imaged, 24 would be missed³⁶. The main limitation of advanced imaging modalities such as MRI is that the prevalence of true fractures amongst suspected fractures is very low, particularly if all patients with radial sided wrist pain and normal radiographs are imaged on presentation. This situation of low prevalence greatly decreases the probability that a positive diagnosis will correspond to a true scaphoid fracture, and this is the situation that is routinely encountered in clinical practice. This is exemplified by our finding that a large proportion of patients referred with suspected fractures were female: this finding is inconsistent with the epidemiology of true scaphoid fractures²³, but is in keeping with previous studies describing the epidemiology of suspected, rather than confirmed, fractures³⁷. This is why clinical prediction rules that target further assessment and/or imaging only to higher risk patients would seem more logical and efficient³⁷.

The use of PROMs in our study represents a “safety net” at one year to identify patients with significant ongoing symptoms who have not initiated follow-up themselves, although it should be noted that in the majority of cases with poor 1-year PROMs an alternative cause for ongoing symptoms was identified. The majority of patients in this study reported excellent QuickDASH and hand normality scores suggesting that the clinical management was safe and effective for these patients. Despite offering patients with low scores face to face appointments, the utilisation of this service was low. This raises an important question regarding responsibility for ongoing symptoms in these patients: does this still lie with the treating surgeon, and what degree of information and administration is required before this responsibility can be transferred back to the patient?

The primary limitation of this study is the number of patients lost to follow-up, which raises the possibility of missed occult scaphoid fractures. The proportions of males in the responder and nonresponder groups were comparable, although the mean age was lower in the nonresponder group and this trended towards statistical significance. Moreover, a statistically significantly greater proportion of nonresponders reported a CSS ≥ 4 , which raises the possibility that a true scaphoid fracture was more likely in this cohort than in those who responded. We attempted to mitigate this by reviewing the National PACS archive and contacting the GPs of these patients, but we are unable to definitively report that no non-union occurred in this group. This limitation is analogous to an unexplained “did not attend” outcome in the more traditional fracture clinic. A further limitation is the absence of standardised radiographic follow-up for all patients irrespective of symptoms, which prevents calculation of the prevalence of true scaphoid fractures within this cohort. In combination, these limitations raise a degree of uncertainty regarding the ultimate diagnoses and clinical outcomes for the nonresponders in this study.

All pathways for this type of injury carry a risk. With traditional fracture clinics, unnecessary immobilisation may impact on patient’s ability to work normally. Routine MRI scanning may medicalise stable injuries that would not routinely be picked up and that do not require formal treatment. Furthermore, survey data suggests there is a wide variability in management protocols for suspected fractures both in the UK³⁸, and internationally⁸, whilst another survey reported that just over half of UK trusts had the capability to offer acute MRI for suspected scaphoid fractures⁷. VFCs have been increasingly implemented in hand surgery in recent years^{18,19}, although previous attempts to develop a virtual pathway for suspected scaphoid fractures mandated an MRI³⁹ or CT⁴⁰ scan prior to virtual review. Our study suggests that the virtual management of suspected scaphoid fractures without routine further imaging

is safe and appropriate as evidenced by excellent PROMs, high levels of patient satisfaction, and no documented cases of symptomatic nonunion at a minimum of one year following injury.

TABLES

Table 1: Summary of further investigations and diagnoses in the thirteen patients who initiated follow-up.

Diagnosis/Imaging modality	N (%)
Further radiographs	6 (46)
MRI	4 (31)
No abnormality detected	6 (46)
Thumb base arthritis	1 (8)
De Quervain's syndrome	2 (15)
Soft tissue injury	4 (31)
Dorsal carpal avulsion fracture	2 (5)
Radial head fracture	1 (3)
Chronic shoulder pain	1 (3)
Distal radius fracture	1 (3)

Table 2: Concurrent upper limb diagnoses in forty-three patients with self-reported hand normality scores of less than 75.

Diagnosis	N (%)
No abnormality detected	18 (42)
Thumb base arthritis	10 (23)
Triscaphoid arthritis	4 (9)
Carpal tunnel syndrome	3 (7)
Previous injury to hand	2 (5)
Rheumatoid arthritis	2 (5)
Radial head fracture	1 (2)
Cervical radiculopathy	1 (2)
Distal radius fracture	1 (2)
De Quervain's syndrome	1 (2)

Table 3: Nonresponder analysis

	Responders	Nonresponders	p-value
N	179	42	-
N male (%)	79 (44)	20 (48)	0.68*
Age (mean, SD)	42 (18.2)	36 (18.9)	0.06**
CSS \geq 4 (n, %)	55 (31)	23 (55)	<u>0.003*</u>

N: number

SD: standard deviation

CSS: Clinical Scaphoid Score

*: chi-square test

** : Student *t*-test

Figure legends:

Figure 1: Summary of the virtual scaphoid pathway

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