



## Development of a clinical decision tool for suspected scaphoid fractures

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Scaphoid fractures are the most common carpal fractures ; their overall incidence is however low. Missing a scaphoid fracture may lead to a non-union with a possible disastrous outcome for the patient ; for this reason, treatment of a suspected scaphoid fracture, even without a proven fracture on the first radiograph, has been conservative with plaster treatment. There are many clinical tests developed to diagnose a scaphoid fracture. However not all tests are equally practical, and their sensitivity and specificity are not always known, or are very low. In this study 18 clinical tests were evaluated and a subset of 7 tests remained, which were found to be practical and/or had a high enough sensitivity. A clinical decision protocol was developed using a combination of these seven tests, in order to improve diagnostic accuracy and at the same time reduce unnecessary plaster cast treatment of patients with a suspected scaphoid, who turn out to only have a sprained wrist.

**Keywords :** scaphoid ; fracture ; diagnosis ; clinical decision tool.

### INTRODUCTION

The incidence of scaphoid fractures is low : it is estimated to concern about 1 in 10,000 attendances at an emergency department (1). Suspicion of a scaphoid fracture arises in any patient with snuffbox tenderness after an acute wrist injury. However, in many patients with snuffbox tenderness after an acute wrist injury, adequate radiological examination fails to show any signs of a scaphoid fracture. Moreover, a problem with

anatomical snuffbox tenderness is that the cutaneous branch of the radial nerve lies directly over the scaphoid bone, and compression over that area will almost always elicit pain. Therefore, a patient may too hastily be suspected of a scaphoid fracture just based on snuffbox tenderness (9). On the other hand, missing a fracture of the scaphoid may have

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serious implications, for non-union can occur. There are many different surgical treatment options for non-union, but overall prognosis remains poor.

In the year 2000, a total of 74 patients visited the University Emergency Department with a wrist injury suspected for scaphoid fracture. In 53% of the patients, no fracture was seen on the initial radiograph. They were all treated according to protocol with a below-elbow plaster cast with immobilisation of the thumb. The eventual diagnosis in all these patients remained sprained wrist, for which on average 15 days of plaster was applied. We hypothesised that a combination of clinical tests and the treatment of patients in a scaphoid decision-protocol could reduce our overtreatment, without missing scaphoid fractures. In this article we would like to discuss different clinical tests, and the way in which we combined them in a clinical scaphoid decision-protocol. The two main reasons were improving not only diagnostic accuracy but also to initiate adequate radiological examination (like MRI or bone-scan) in an earlier phase when needed in order to diagnose scaphoid fractures in an early stage and to prevent long plaster casting for sprained wrists.

## METHODS

### Search for clinical tests and examination and testing of the clinical tests

To develop a clinical decision tool for suspected scaphoid fractures, the literature was searched for clinical tests on scaphoid fractures. Clinical tests, identified from the literature, were examined and tested over a 6-month period by the first and third author in predicting the presence or absence of a fracture of the scaphoid. According to these results, a selection of tests was made based on sensitivity and specificity and combined predictive value regarding scaphoid fracture. Unpractical tests were excluded.

### Selection and weighing of clinical tests

For each included test, a weighed score was calculated based on the combined predictive value of the tests using likelihood ratios for each single test. A cut-off value of the weighed score for the decision to perform X-ray series was also determined.

## RESULTS

### Search for clinical tests and examination and testing of the clinical tests

A Pubmed search was undertaken using the words “scaphoid”, “fracture” and “diagnosis”. All relevant references were studied. We identified 18 different clinical tests for predicting the presence or absence of a fracture of the scaphoid : (I) loss of concavity of the anatomic snuff box (3), (II) snuff-box tenderness (1, 2, 6, 7, 8, 16, 18, 19, 20, 27, 28), (III) the clamp sign (11, 28), (IV) palmar tenderness of the scaphoid (19), (V) axial compression of the thumb along its longitudinal axis (2, 5, 7, 19, 27, 28), (VI) site of pain on resisted supination (26), (VII) site of pain on ulnar deviation (6, 22, 28), (VIII) discoloration of the snuffbox (1), (IX) dorsal tenderness of the scaphoid, (X) painful palmar flexion, (XI) painful dorsal flexion, (XII) the scaphoid shift test or Kirk Watson’s test (17), (XIII) site of pain on pronation and radial deviation of the wrist (28), (XIV) site of pain on resisted pronation (26), (XV) compression of the third finger in full radial deviation leads to pain in the anatomical snuffbox (10), (XVI) restriction of thumb movement (19), (XVII) swelling of the wrist measured in cm (7), and (XVIII) diminished grip strength (7, 27). The most frequently found tests were loss of concavity of the anatomic snuffbox and snuffbox tenderness (1, 2, 6, 7, 8, 16, 18, 19, 20, 27, 28).

After the six months test period, eleven tests were found to be impractical or had a low sensitivity or specificity. These included the above-mentioned tests numbered VIII to XVIII. The other seven were included in the scaphoid decision-protocol (see Appendix).

### Selection and weighing of clinical tests

Based on the performance outcomes of the tests (table I), 5 clinical tests were selected because of good performance : (III) the clamp sign (11, 28), (IV) palmar tenderness of the scaphoid (10), (V) axial compression of the thumb along its longitudinal axis (2, 5, 7, 19, 27, 28), (VI) site of pain on resisted supination (26), (VII) site of pain on ulnar

Table I. — Sensitivity and specificity of the selected clinical tests, included in the Scaphoid decision-protocol

	Based on Literature			
	Sensitivity	Specificity	ln OR	Weight factor
Swelling (I)	0.609	0.517	0.5	1
Snuffbox tenderness (II)	0.933	0.165	1.0	1
The 'clamp' sign (III)	0.894	0.810	3.6	4
Palmar tenderness (IV)	0.916	0.461	2.2	2
Axial compression of the thumb (V)	0.845	0.605	2.1	2
Resisted supination (VI)	0.899	0.667	2.9	3
Ulnar deviation (VII)	0.976	0.657	4.4	4
Scaphoid decision-protocol ( $\geq 5$ pts)				
Scaphoid decision-protocol ( $\geq 7$ pts)				

ln OR : natural log of the Odds Ratio.

deviation (28). Two tests were additionally included to increase physician acceptability of the decision tool : (I) loss of concavity of the anatomic snuff box (20), and (II) snuffbox tenderness (1, 2, 6, 7, 8, 16, 18, 19, 20, 27, 28).

These 7 are easily performed and taught to different doctors (Appendix I). For each test, we calculated a weighed score based on their performance according to the literature (table I), and a summary of the tests was made for clinical use on the so-called "Scaphoid-decision-protocol" (table II). A minimum score of 0 could be reached and a maximum of 17 points. A sum of the weighed scores of 5 and higher prescribes that a scaphoid X-ray series should be made.

### Protocol development

The final scaphoid decision-protocol is shown in figures 1 and 2. Based on the clinical tests on the "Scaphoid decision-protocol" the decision was made whether scaphoid radiographs should be made. If a fracture is found, these are treated to the standard norm in the hospital, meaning 7-13 weeks of plaster or operation if failure of conservative treatment or operation if a primary indication is there. If a scaphoid fracture cannot be proven on the initial visit, the patient is treated with a bandage only. After two weeks the patient returns and the same clinical tests are performed. If a patient still

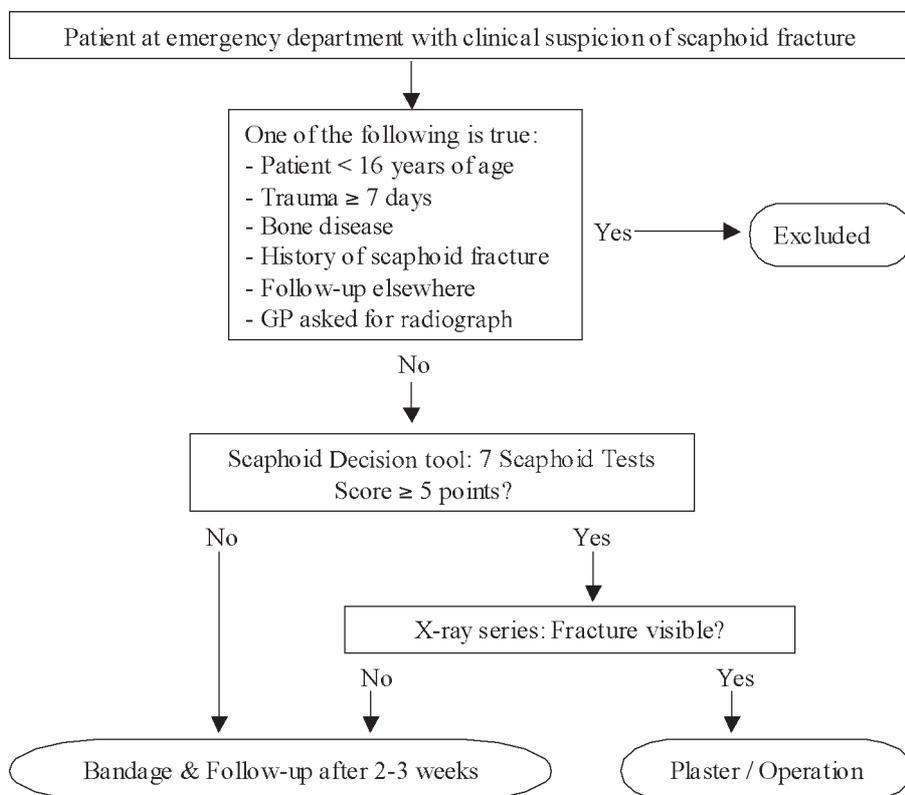
Table II. — The Scaphoid decision-protocol including 7 clinical tests

Clinical Tests	Points
Loss of the concavity of the anatomic snuff box	1
The 'clamp' sign.	4
Palmar tenderness of the scaphoid.	2
Axial compression of the thumb along its longitudinal axis.	2
Site of pain on resisted supination.	3
Ulnar deviation, from a position of full pronation.	4
Snuffbox tenderness.	1
<b>Total number of points</b>	
<b>Radiographs made ? (<math>\geq 5</math> points)</b>	
<b>Other reason for radiographs</b>	
<b>Outcome of radiographs, if made</b>	

has a score of 5 or higher, further radiological examination has to be performed. If the initial radiographs were of good quality, these should not be repeated. Instead MRI or a bone-scan should be made. All patients that score on the follow-up below 5 points are discharged without further radiological work-up.

### Medical literature on which the protocol is based

The scaphoid bone serves as the principal bony block to wrist extension. For this reason, excessive forced extension (as with a Fall On the



**Fig. 1.** — Entry protocol at the Emergency Department regarding suspected scaphoid fractures

Outstretched Hand, the so-called FOOSH-mechanism) transfers force across the scaphoid, leading to its fracture (3, 4, 20). A fall on the outstretched hand was found to be the trauma mechanism in 73-97% of the cases (13, 23). It is advocated to treat all patients with clinical suspicion of a scaphoid fracture, even without radiological confirmation, with a short-arm thumb spica splint (20), as a missed and inadequately treated fracture may result in delayed union, avascular necrosis, and pseudoarthrosis, thus leading to instability and, ultimately, osteoarthritis (27). This strategy, however, leads to overtreatment of many patients who ultimately only will be diagnosed with a sprained wrist (21). Moreover, an immobilisation delay of up to 4 weeks or the use of simple supportive bandage during an observation period does not negatively affect the healing of a primarily overlooked scaphoid fracture (9, 12, 24).

Modern radiographic techniques should make almost all fractures of the scaphoid visible on primary radiographs, and secondarily detected fractures are often incomplete fractures with intact periosteal envelopes, that heal regardless of immobilisation (9, 13, 14, 15, 30). Current practice shows, however, that after a first initial negative radiograph, often a second or even a third radiograph is made after a few weeks. Various authors report a range of 1 to 30% of false-negative initial films (1, 9, 13, 16, 27). Large series indicate that second radiographs made two weeks after initial examination only reveal 1-2% initially missed fractures (9, 13, 16). The fractures that present after 10-14 days are likely to be incomplete compression fractures and might even heal without immobilisation, as they heal under almost any circumstances and need not be treated with plaster immobilisation. A follow-up radiograph after an initial negative film therefore

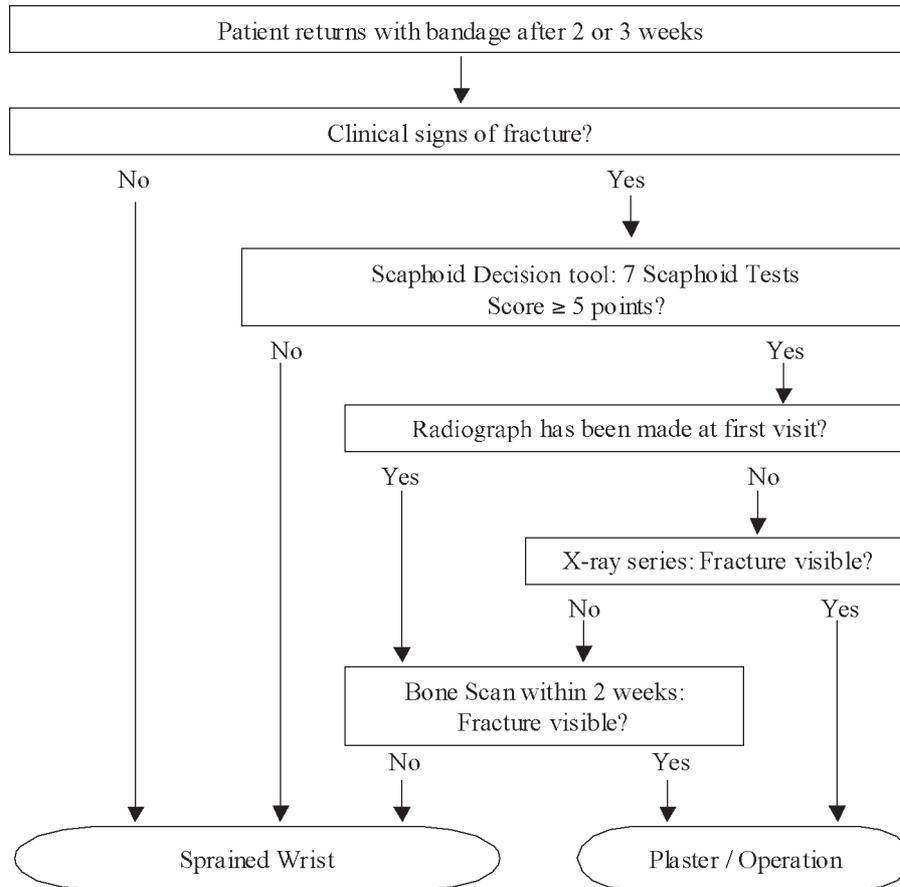


Fig. 2. — Follow-up protocol at the Fracture Outpatient Department after initial suspected scaphoid fracture

appears not useful. It means, furthermore, that 70-99% of patients are unnecessarily treated with plaster immobilisation. Overtreatment does not only mean that people are unable to do their daily activities or are even not able to drive a car for a period of two weeks, they are also at risk of developing significant loss of bone mineral and muscle mass in a few weeks while in a plaster cast.

In a prospective study of 108 patients with clinical signs of a scaphoid fracture but without radiological evidence, bandaging the arm compared to plaster immobilisation reduced sick leave from 14 to 4 days, without resulting in any complications (24). In a prospective multicentre study, a total of 898 patients with clinical suspicion of a scaphoid

fracture, but with negative initial radiological examination, only 6 of 898 (0.7%) eventually were diagnosed with a scaphoid fracture (16).

A thorough initial clinical examination by the emergency department physician should limit the number of patients suspected of having a scaphoid fracture. These findings suggest a more restrictive policy, in which supportive bandage therapy should be treatment of choice, when radiologically no fracture is present, instead of plaster immobilisation. The aim of this study was to develop a clinical decision tool for suspected scaphoid fractures in order to make more accurate diagnoses, and to provide consequent and adequate treatment and to reduce unnecessary radiographs.

## DISCUSSION/CONCLUSION

In this article we have discussed why scaphoid fractures should be treated based on a scaphoid decision-protocol. We believe diagnostic accuracy could be improved by combining different clinical diagnostic tools. With this combination, and treatment in a decision-protocol, we believe a reduction of overtreatment could occur, without missing scaphoid fractures. A pilot-study on the protocol was undertaken and will be published in this issue as well.

Note :

It is important to note that the proposed protocol will work fine in an institution where those who receive patient in the emergency department are trained and motivated, but in a number of small clinics, individuals who are in charge of minor trauma probably have insufficient training and motivation to adequately apply our proposed system.

### Appendix

Seven Clinical Tests of the "Scaphoid decision-protocol"

In this appendix a description is given of all seven clinical tests that are included in the "Scaphoid Clinical Decision Tool".

Loss of the concavity of the anatomic snuff box

The 'clamp' sign

Snuffbox tenderness

Palmar tenderness of the scaphoid

Axial compression of the thumb along its longitudinal axis

Site of pain on resisted supination

Site of pain on ulnar deviation

#### I. Loss of the concavity of the anatomic snuff box.

The anatomic snuffbox is bordered volarly by the tendons of the abductor pollicis longus and extensor pollicis brevis, and dorsally by the tendon of the extensor pollicis longus (8). In case of a fracture, swelling will obscure the anatomic snuffbox (28). The test is considered positive if there is swelling of the anatomic snuffbox. Diffuse swelling of the whole wrist, including the anatomic snuffbox, or no swelling at all is considered negative.

**II. The 'clamp' sign.** The patient is asked to mark the most painful spot with a simple X-sign, made by a pencil. The test was initially advocated by Kondoyannis ; he asked the patient to mark the most painful site by pointing it out between the thumb and index finger of the other hand. If the patient marks the scaphoid region as the most painful site, this test is considered positive (11).

**III. Snuffbox tenderness.** Snuffbox tenderness can be compared to the non-injured hand. Snuffbox-tenderness is present if more pain can be elicited in the injured hand compared to the uninjured hand (2, 6, 7, 16, 18, 19, 27, 28).

**IV. Palmar tenderness of the scaphoid.** The hand is held in a neutral position, the palmar side of the scaphoid is compressed. If this elicits more pain on the injured side than on the normal side, this sign is considered positive (6, 7, 19).

**V. Axial compression of the thumb along its longitudinal axis.** The patient's thumb of the injured wrist is held with one hand. Pressure is then applied along the first metacarpal. If pain is elicited the test is considered positive (2, 5, 6, 7, 19, 27, 28).

**VI. Site of pain on resisted supination.** The patient grasps the examiner's hand in the manner of a handshake and attempts to move from pronation to supination against resistance, the patients reports pain and stops supinating. Then this test is considered positive (26, 27, 28).

**VII. Site of pain on ulnar deviation.** The hand is in maximal pronation, and then gently stressed in the ulnar plane. In case of a fractured scaphoid, this will produce pain in the anatomical snuffbox (22). If pain is produced, the test is considered positive.

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