



# Scaphoid fractures with scapholunate ligament involvement: Instability or ligamentous laxity? Role of arthroscopy and pinning

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## Abstract

**Purpose** Percutaneous fixation of scaphoid fractures often does not allow the evaluation of potential ligamentous lesions. Arthroscopy is an useful tool in the management of scaphoid fractures to visualize potentially associated lesions. With arthroscopic assistance, we often found scapholunate ligament lesions. Our study's aim was to evaluate the role of arthroscopy in the treatment of scaphoid fracture and in particular if the alteration found was a real lesion causing instability or just a paraphysiologic laxity. Furthermore, we evaluated whether the scapholunate joint pinning alters the outcome.

**Methods** We performed a retrospective study on 39 patients (33 males and 6 females), with an average age at trauma of 31.2 years (range 15–67), who underwent surgery for scaphoid fractures between 2010 and 2016 in our Center of Hand Surgery. Patients were divided into four groups based on surgical technique and finding of scapholunate lesions.

**Results** Differences between the four groups analyzed, both in terms of clinical scores and ROM, were not statistically significant. This corroborates the hypothesis that all four treatments are equivalent.

**Conclusions** Based on our experience and the literature available, we believe the systematic use of arthroscopy to be useful in patients needing surgical treatment for scaphoid fractures. This is because arthroscopy allows the control of the fracture reduction, screw protrusion evaluation and ligamentous lesions assessment. In cases of partial scapholunate ligament alteration in which no sign of acute lesion is present (hemorrhage and clear rupture), pinning is not necessary since it might just be a paraphysiologic laxity.

**Level of evidence** IV

**Keywords** Arthroscopy · Fractures · Ligament · Treatment

## Introduction

Scaphoid fractures represent the most common type of fracture of the carpal bone in active adults [1–4]. Some surgeons believe that percutaneous reduction and fixation of acute scaphoid fracture could increase the clinical results and reduce healing problems in active patients [5, 6]. This procedure minimizes the damage to scaphoid's vascularization and the risk of carpal ligament lesions, both risks of open reduction with internal fixation [7]. Furthermore, percutaneous fixation is responsible for a quicker radiographic healing

and sooner faster recovery that can allow a sooner return to work and sport activities [5, 6, 8–10].

In most cases, this approach allows for an early mobilization, although the risk of potential ligamentous lesions requires further investigations beforehand [4]. Even if the fracture completely heals, if a ligament lesion is present, it can manifest itself as a biomechanical dysfunction and wrist pain. This kind of lesion can be difficult to diagnose because often it is not detectable in plain X-rays or CT scans. Arthroscopy can be a useful tool for the management of scaphoid fractures, not only for evaluating the reduction but also for identifying osteochondral or ligament lesions [4, 8, 11].

The aim of this study is to evaluate the role of arthroscopy in the treatment of scaphoid fractures; and we investigated whether ligament alterations found arthroscopically corresponded to actual lesions or just laxity. Furthermore,

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we evaluated whether treatment through the pinning of the scapholunate joint can alter the results.

## Materials and methods

We performed a retrospective study on 39 patients (33 males and 6 females), with a mean age of 31.2 years old (minimum 15; maximum 67), which underwent surgery from 2010 to 2016 for scaphoid fractures in our department of Hand and Wrist Surgery of the Policlinico di Modena. All surgical operations were performed by the same surgeon, thereby enhancing the uniformity of our sample. Patients were divided into four groups (A, B, C and D) based on the surgical technique adopted and the finding of a lesion of the scapholunate ligament:

- A. Fixation with a percutaneous screw without the use of arthroscopy (ten patients)
- B. Arthroscopy-assisted fixation with a percutaneous screw without signs of scapholunate ligament lesions (nine patients)
- C. Arthroscopy-assisted fixation with a percutaneous screw with signs of partial scapholunate ligament lesions, treated through pinning (ten patients)
- D. Arthroscopy-assisted fixation with a percutaneous screw with signs of partial scapholunate ligament lesions, not treated (ten patients)

The inclusion criteria were B-type scaphoid body fractures (B1 and B2). Exclusion criteria were proximal fractures, pseudarthrosis or severe arthritic degeneration.

The most common traumatic mechanism described by patients was direct contusive trauma with the wrist in extension. The most common causes were fortuitous falls with 16 cases, eight were secondary to road accidents (six riding motorcycles) and 15 during sport activities (13 playing soccer, one playing volleyball and one skiing).

The rehabilitation protocol was the same for all groups and consisted in a series of home exercises given to the patient by our physiotherapy center. This protocol consisted in a brace immobilization with the first ray included to the interphalangeal joint for 7 days. After this period, the brace could be removed for short sessions of active mobilization of the wrist (flexion–extension and pronation–supination). After 15 days, continuous passive flexion and extension of the wrist was integrated in the protocol, adjusting the range of motion with a gradual increase. At 1 month after surgery, the brace was removed after an X-ray check to exclude any contraindication and muscular strengthening exercises were started, aimed to restore wrist mobility and pinch strength. If the fracture was completely healed after 3 months, heavy duty work and sport activity were conceded.

In the C group (partial lesion of the scapholunate ligament treated through pinning), the Kirschner wires were removed after 6 weeks from the surgery. In this period, a brace immobilization of the wrist and the first ray was implemented, leaving only the interphalangeal joint free to move. After 6 weeks, a rehabilitation protocol like the one adopted for the other groups was used, albeit being more intense to avoid rigidity secondary to prolonged immobilization. The brace was used for another 15 days after the exercises and then abandoned.

Usually, X-ray checks were performed at 4 weeks (6 weeks if pinning was performed) and 3 months after surgery. If delayed healing was noted, another check was performed at 6 months, while not allowing the patient to perform high demanding activities.

Clinical scores and measures were obtained in the post-operative period: self-administered scores (PRWHE and DASH), Mayo Modified Wrist Score, evaluation of pinch strength (JAMAR and PINCHMETER), range of movement in flexion–extension, pronation–supination, ulnar and radial deviation measured with a goniometer, X-ray evaluation of the scapholunate and radio-capitate angles. Furthermore, for each patient age, time from trauma to surgery, work and sport activities and time needed to resume these.

The statistical analysis was performed by the Center for Medical Statistics of the Policlinico di Modena. The aim was to evaluate the relation between the four study groups based on VAS, flexion–extension ROM, MMWS, PRWHE and DASH. Attention was dedicated to the comparison between groups A and the other groups (absence or use of arthroscopy-assisted reduction) and group C versus group D (use of pinning vs. no use). The analysis was performed with a non-parametric Wilcoxon–Mann–Whitney test for the comparison of the outcomes of VAS, MMWS, PRWHE and DASH. For the  $\Delta$ ROM comparison, a logistic regression model was applied, considering the  $\Delta$ ROM as a binary parameter (present/absent) and not considering the absolute values. The strength recovery was not statistically analyzed because of the influence of many factors acting on this parameter (age, gender, work, sport and side).

## Results

Of the 29 cases treated with arthroscopy assistance, only in nine cases there were no scapholunate ligament lesions. In the other 20 cases, according to the Geissler classification, there were two type I lesions, five type II lesions and 13 type III lesions, no type IV lesion was detected. This result is significant because, in the absence of clear scapholunate dissociation on X-rays, these lesions would never be detected or treated without the use of arthroscopic assistance. It must be noted that these lesions must be identified and not confused

with ligamentous laxity, which does not require any type of treatment. A table with the principal results is reported (Table 1).

**Age**

Our population is consistent with the literature available, showing greater prevalence of scaphoid fractures in young male patients (33 males, six females; mean age for group A 41.9 years old, mean age for group B 28.9 years old, mean age for group C 30.1 years old and mean age for group D 23.6 years old).

**Follow-up**

The follow-up in group A is longer than in other groups due to the more recent introduction of arthroscopic assistance. Nevertheless, the mean follow-up in every group is longer than 1 year.

**Time between trauma and surgery**

The patients evaluated at our center received the indication and underwent surgery in a period variable from 2 to 3 weeks from trauma.

**Pain**

The pain was measured with PRWHE, MMWS and DASH scores along with other parameters. Furthermore, to better highlight this parameter the patients were submitted the

VAS pain index during the normal daily activities. Our results show the pain to be modest (mean VAS in group A was 1,4, mean VAS in group B was 1,67, mean VAS in group C was 2 and mean VAS in group D was 1,4). Most high VAS results (one patient with VAS 6 in group A, one patient with VAS 5 in group C and one patient with VAS 6 in group D) seemed to be secondary to pain due to the fixation devices used.

**ROM recovery**

The range of movement in flexion–extension was evaluated in both wrist bilaterally and the difference in the range of movement between the affected side and the healthy side ( $\Delta$ ROM). Results show this difference to be small; the average  $\Delta$ ROM was 6° in group A, 3,89° in group B, 10° in group C and 7,3° in group D. Furthermore, even the maximum  $\Delta$ ROM was small in size, rarely exceeding 20° between the two wrists, with a maximum of 35° in a C group patient who developed rigidity due to scarce compliance with the rehabilitation regimen. In two patients, the  $\Delta$ ROM was negative due to a greater motility of the operated wrist when compared with the healthy one; in these two patients, the  $\Delta$ ROM was – 5° and – 20°, respectively, although the latter one was biased by a recent trauma of the “healthy” wrist and so not considered for our calculations.

The range of movement in prono-supination and ulnar–radial deviation was normal in each patient and so not reported in our table.

**Table 1** Results in different groups

Study group	Age at trauma	Time between trauma and surgery (days)	Follow-up (years)	VAS during normal activities	$\Delta$ ROM	Scores		
						MMWS	PRWHE	DASH
<b>A</b>								
Mean	41.9	13.5	3.73	1.4	6	94	12.7	8.2
Min	25	8	1.89	0	– 20	70	0	0
Max	67	21	6.79	6	20	100	60	25.8
<b>B</b>								
Mean	28.9	31.56	1.75	1.67	3.89	94.4	10.17	4.9
Min	19	7	0.61	0	0	60	0	0
Max	50	65	6.44	5	15	100	50	18.3
<b>C</b>								
Media	30.1	31.2	2.59	2	10	87	17.2	11.4
Min	15	9	1.09	0	0	70	1	0.8
Max	48	85	6.32	5	35	100	45.5	26.6
<b>D</b>								
Mean	23.6	25.3	1.34	1.4	7.3	88.5	12.6	6.9
Min	17	7	0.38	0	0	70	0	0
Max	35	92	6.59	6	25	100	58	26.7

## Clinical scores

For the functionality evaluation in the postoperative period, three clinical scores were used to avoid any individual score deficiency. The scores chosen were the MMWS, the PRWHE and the DASH. The results were on average good to excellent in all groups. Of the four worst results, three were due to fixation devices and one due to postoperative rigidity. The strength was measured with Jamar and Pinchmeter and was compared with the contralateral side.

Additionally, the return to work and recreational activities were recorded. All patients resumed their work, and the majority resumed sport and recreational activities with small to no limitations. The two patients without a complete recovery complained in one case of pain due to the fixation screw (removed afterward) and in the second case the incomplete recovery was due to the sport practiced (fighting).

## Radiographic results

In our study, population consolidation of the fracture was achieved in 100% of the patients, without signs of scapholunate dissociation.

## Complications

In total, six complications were reported in our population. In five cases, it was pain secondary to the fixation devices used, and in one case, it was mild postoperative stiffness due to scarce compliance with the rehabilitation protocol. There were no infections, instability, scar hypertrophy or vascular and nervous complications.

## Statistical analysis

The differences between the four study groups are not significant, thereby having the meaning of equivalence between the treatment options. However, it must be noted that this study is limited by its sample size.

## Discussion

In our patient sample of 29 fractures treated with arthroscopic assistance, there were 19 reports of partial lesions of the scapholunate ligament. For a long time in the literature, it was reported that non-displaced and minimally displaced fractures should not be present with lesions of the scapholunate ligament [12, 13]. Recently some authors challenged this assumption by publishing cases of scapholunate lesions associated with isolated scaphoid fractures [3, 13–15]. Nevertheless, the majority of these studies are retrospective, and the lesion diagnosis was made on radiographic images [16,

17]. Only in few studies the diagnosis was supported by arthroscopic images, and only two of these were prospective studies [13–15, 18].

The incidence of scapholunate lesions in scaphoid fractures is variable in the literature. Thomsen et al. [18] analyzed with a prospective study 18 scaphoid body fractures in which the arthroscopic evaluation did not find any scapholunate lesion. This was the case even for the study published by Whipple [11] which did not find any scapholunate lesion in 20 patients treated for scaphoid fracture with percutaneous fixation arthroscopically assisted. These two results stand out from the other studies performed with the use of arthroscopic assistance which reported rates of scapholunate lesions ranging from 10 to 71% [4, 15, 16, 19, 20].

Jorgsholm et al. [14] performed a prospective study on 41 patients with scaphoid fractures arthroscopically evaluated; they observed a 71% rate of scapholunate lesions of which 24% were a complete rupture of the ligament (Geissler stage 4). The authors themselves admitted the rate found to be extremely high when compared with the literature that showed rates from 10 to 50% with no complete ruptures [4, 15, 16, 19, 20]. The high rate reported by Jorgsholm et al. could be explained since he was specifically aiming at finding ligamentous lesions and that in the literature other classifications were used.

Schädel-Höpfner et al. [13] found 13 scapholunate lesions in 34 patients treated with arthroscopic assistance for acute scaphoid fractures: Ten of which were causing instability and so classified as stage 2 according to Krimmer, five of them classified as stage 2 and the other five as stage 3 according to Geissler. An important bias of this study, apart from it being retrospective in nature, was that the arthroscopy was performed only if suspicion of a lesion emerged from the evaluation of the radiographic images. When considered, this bias makes the incidence of scapholunate lesions plummet to 7% if arthroscopy was to be performed on every fracture treated in the same time frame.

Caloia et al. [4] performed 24 arthroscopic evaluations on acute scaphoid fracture and reported 15 associated soft tissue lesions, of which five were scapholunate lesions of stage 1 or 2 according to Geissler. Every lesion was treated according to Lindau criteria: stage 1–2 lesions with debridement and immobilization and stage 3–4 with debridement and pinning.

Jui-TienShih et al. [21] performed a retrospective study on 15 patients with scaphoid fractures treated percutaneously with arthroscopic assistance and found toe scapholunate lesions. No correlation of the results with age, gender, time of surgery and type of fracture was found.

Wong et al. [15] performed 22 arthroscopic-assisted reductions and found two scapholunate lesions (one of stage 1 and one of stage 3 according to Geissler). Based on this paper, Wong found the incidence and severity of

ligamentous lesions associated with scaphoid lesions to be correlated directly with the trauma energy. Most of Wong patients suffered from low-energy trauma and therefore had few ligamentous lesions.

Cheng et al. [22] in their paper proposed that scaphoid fracture with associated scapholunate lesions have two main clinical presentations. The first is the carpal perilunate fracture luxation, the most common and the scaphoid complex fracture. In their paper, the only common mechanism responsible for these presentations was the high-energy trauma.

An important consideration to be made is the fact that the prevalence of SLAC lesions should be higher than expected in patients treated for scaphoid fractures because the postoperative rehabilitation period cannot guarantee the healing of scapholunate ligament lesions. Nevertheless, the literature does not report this association.

In our patients, sample high rates of scapholunate lesions were reported, but in many cases, it was difficult to discern between lesions and laxity using the Geissler classification. The diagnosis of scapholunate lesions is difficult since the examination is limited due to the acute fracture and plain X-rays lack the sensitivity needed to identify partial lesions. RMN is the most accurate imaging technique available, but even so its sensitivity and specificity are low. Hafezi-Nejad et al. [23] performed a systematic review of the literature and a meta-analysis which proved the arthro-RMN to be superior to the RMN 3T and the latter one is superior to the RMN 1.5T although the RMN 3T has the highest specificity for the detection of scapholunate lesions.

Arthro-RMN and arthro-TC are sufficiently accurate to detect partial lesions, but still lack the precision of the arthroscopic assistance [24, 25]. Furthermore, it is not economically viable to perform an RMN on every patient who suffers from a scaphoid fracture.

The use of arthroscopic assistance for the treatment of scaphoid fractures helps to obtain fracture reduction, correct positioning of the guide-wire, absence of screw protrusion in articulation and evaluate the associated ligament lesions. In our populations, there is no statistically significant difference of the outcomes of the patients treated with or without arthroscopic assistance. Nevertheless, we think that the advantages provided using arthroscopy can be justified for the treatment of scaphoid fractures.

In the literature, there is a lack of agreement if the association of scaphoid fractures with scapholunate lesions can worsen the outcome of the treatment. There are few papers addressing this subject, and there is no consistency between the surgical approaches.

Wong et al. [15] did not treat the Geissler 1 lesions, while the Geissler 2 lesions were treated by means of pinning. However, the patient sample is too little to do observations on the results.

Mrkonjic et al. [26] reported 32 scapholunate lesions on 51 patients treated with arthroscopic assistance for distal radial fractures. Ligamentous lesions were not treated with any significant difference between subjective, objective and radiographic outcomes. Even so, there were not any Geissler 4 lesion.

In the study by Caloia et al. [4], all scapholunate lesions were Geissler 1 or 2 and treated with debridement and postoperative immobilization. Outcomes were good, but the study is weakened by the small number of scapholunate lesions (15 ligamentous lesions on 24 arthroscopies, only five of which were scapholunate lesions) and the lack of a group control in which no treatment was performed.

In our study groups, we observed no statistically significant differences of the outcomes analyzed. Therefore, our opinion is that there should be indication to treat only the clear scapholunate lesions and not partial ones. This is because partial lesion could be frequently mistaken for laxities and their treatment requires longer immobilizations, a harder rehabilitation to avoid stiffness, and a slower return to work and recreational activities. However, our results are weakened by a small patient sample even if it is the study with most patients available in the literature.

Even if wrist arthroscopy is not free from risks [27], based on our experience and the available literature, we believe it to be useful in all patients suffering from scaphoid body fractures in which percutaneous fixation is mandatory. Arthroscopy can help verify the correct fracture reduction, correct positioning of the guide-wire, protrusion of the screw and evaluate potential-associated ligament lesions.

Individual variables, both patient-related (ligamentous laxity, etc.) and surgeon-related (arthroscopic experience) can alter the results of the evaluation of ligamentous lesions. From our experience and results, the treatment of acute partial scapholunate lesions through pinning is not necessary and so is not the wrist immobilization. The differences between our four study groups are not statistically significant and so the four treatment options should be considered equal.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Research involving human participants and/or animals** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the local ethical committee.

**Informed consent** Informed consent was obtained from all the individual participants included in the study; in case of underage patients, the informed consent was obtained from the parents.

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