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# Radioscapholunate Fusion in Kienböck's Disease

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## Introduction

Radioscapholunate (RSL) fusion is a partial wrist fusion for localized disease with an intact midcarpal articulation. It is indicated for degenerative, inflammatory, post-traumatic, and Kienböck's arthritis [1]. The midcarpal joint is preserved, which is responsible for the dart thrower's motion, which is essential for daily use of a functional hand [2, 3].

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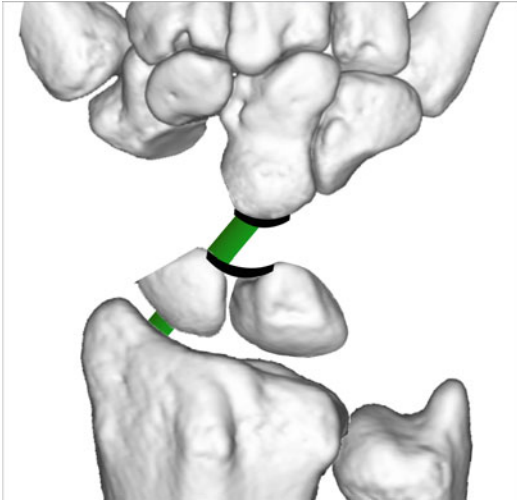
## Preoperative Assessment

### Indications

If conservative modalities, such as modification of activities, analgesics, and use of a splint, have failed, surgical management may be considered. It is essential to identify which joints are involved in the disease process. An absolute prerequisite for this procedure is a functional midcarpal articulation (Fig. 22.1), to achieve painless motion following the fusion [4]. In Kienböck's disease, the RSL fusion can be performed where the cartilage deformities are limited to the proximal lunate and/or lunate facet. That is, cases with a Bain and Begg grade 1 or 2a (Fig. 22.2) [5].

### Imaging

Plain radiographs should be performed to determine the diagnosis and to assess the extent of the disease, including the status of the midcarpal joint. Computed tomography (CT) scan and magnetic resonance imaging are also of value in determining the extent of the disease in the lunate, and the remainder of the carpus. Arthroscopy is the gold standard to determine the integrity of the articular surfaces. Intraoperative direct visualization of the articular cartilage can be the final decision as to whether or not to proceed with the limited fusion.



**Fig. 22.1** Prerequisite for radioscapholunate fusion: a functional scaphoid, lunate, and capitate articulation. The radioscaphocapitate ligament is important to maintain stability. Copyright Dr. Gregory Bain

## Fixation

There are many described methods of fixation for RSL fusion. These include K-wires, staples, plates, and screws [1, 6–9]. We used a set of principles when performing limited wrist fusions (Table 22.1) [1]. The insertion of K-wires allows for simple and accurate positioning to avoid impingement, however they do not offer compression. Non-locking plates have been associated with dorsal impingement, loss of fixation, and nonunion [8, 9]. We have used memory staples (Depuy International Ltd., Leeds, UK) as they are low profile and provide dynamic compress across the fusion site (Fig. 22.3a–c) [10]. Fixation devices with greater stability allow for earlier mobilization of the wrist.

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## Types of Fusion

### Radioscapholunate Fusion

#### Surgical Technique

A dorsal approach via the third extensor compartment is used to expose the carpus. Some authors recommend excision of the posterior interosse-

ous nerve, however we prefer to leave it intact to optimize proprioception. Using hand held curettes and rongeurs, the joint surfaces of the proximal scaphoid, lunate, and distal radius are thoroughly debrided. We avoid power instruments that may burn the bone. Using a closing fusion technique the radiocarpal fusion mass is stabilized (Fig. 22.4). That is, the full thickness of the articular surfaces are excised to allow the osseous structures to close [1]. To obtain a good long-term outcome, it is important to create a “stand-alone joint” which can potentially obtain a good long term outcome. Therefore the midcarpal joint surface of the scaphoid and lunate are perfectly aligned. We reduce the scapholunate interval, and stabilize it with  $2 \times 1.1$  mm K-wires. Bone graft from the iliac crest is used to supplement the fusion mass.

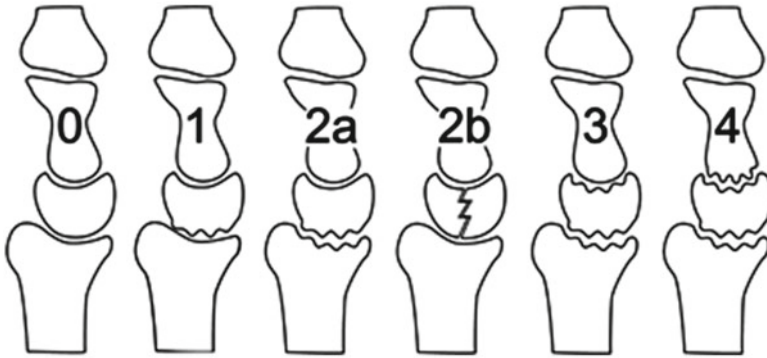
The radiocarpal joint is then stabilized in  $15^\circ$  of extension, in order to achieve maximum extension and grip strength. The fusion site is stabilized using one of the methods described earlier (see Fig. 22.3a). Intraoperative fluoroscopy is used to confirm the position of the fusion mass and the internal fixation.

A plaster slab is then applied and the patient encouraged to elevate the arm and mobilize the fingers. At 1 week, a full cast or removable splint is applied, depending upon patient factors and the fixation. At 6 weeks the wrist is mobilized with graduated wrist strengthening and motion exercises.

## Results

Variable rates of nonunion have been recorded between 0 and 25% [4, 11, 12]. This is thought to be due to the scaphoid acting as a long lever and increasing pressure through the fusion mass [1].

The patients usually obtain good pain relief; however, there is a reduction in wrist range of motion. Normally the scaphoid flexes during wrist flexion and radial deviation. Thus, a fused radioscaphoid joint will mostly affect wrist movement in these two directions. The range of motion is 33–40% of the normal wrist [12, 13], with a  $40\text{--}50^\circ$  flexion–extension (F-E) arc, and  $21\text{--}28^\circ$  radial–ulnar (R-U) arc [8, 14, 15].



**Fig. 22.2** Bain and Begg arthroscopic classification for Kienböck's disease [1]. The grade is determined by the number of nonfunctional articular surfaces. The grading system assists the surgeon to determine the surgical treatment, based on the pathoanatomic findings. RSL fusion is

indicated for grade 1 or 2a. Reproduced with permission Bain GI, Begg M. Arthroscopic assessment and classification of Kienböck's disease. *Tech Hand Up Extreme Surg.* 2006, 10(1): 8–13

**Table 22.1** Principles of limited wrist fusion<sup>a</sup>

Localized disease
Stand-alone joint
Mechanical debridement
Surface area of fusion mass
Respect the grid
Containment (e.g., triquetrum excision)
Closing fusion
Bone graft augmentation
Aim at extension

<sup>a</sup>Modified with permission Bain GI, McGuire DT. Decision making for partial carpal fusions. *J Wrist Surg.* 2012, 1(2): 103–114. Copyright © 2012, Rights Managed by Georg Thieme Verlag KG Stuttgart, New York

A long-term study by Nagy and Büchler reported an undesirable high complication rate with RSL fusion. Five of their 15 patients (33%) required a full wrist fusion at a mean of 8 years. Average range of motion was 18° flexion, 32° extension, 25° ulnar, and 3° radial deviation. More than half developed midcarpal arthritis and 27% had a nonunion. Good results were reported for only seven (47%) of their patients [8].

Shin and Jupiter reviewed a series of five patients with two angled 2.4 mm distal radius locking plates across the fusion mass to achieve complete union in all patients. Functional outcome was not reported [11].

## RSL with Distal Scaphoid Excision

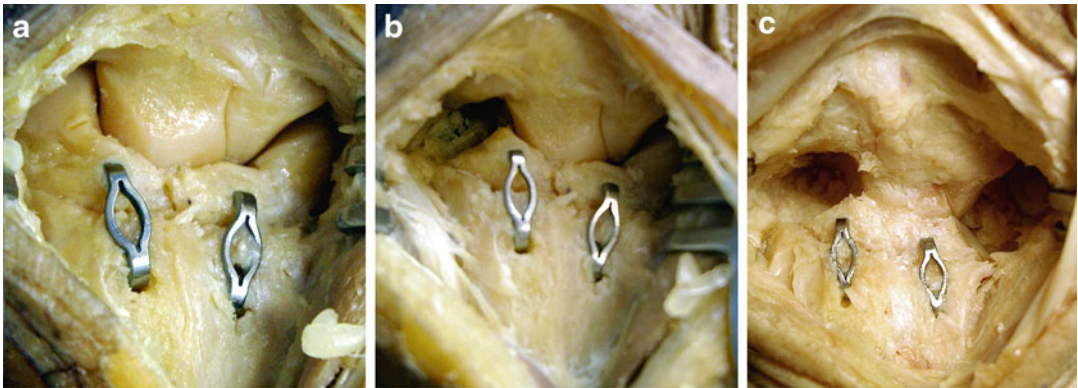
RSL fusion can be performed with excision of the distal scaphoid (see Fig. 22.3b), which can be used as bone graft. Clinical studies have reported that adding excision of the distal scaphoid improved motion [13], lowered the rate of non-union [6] and midcarpal arthritis [16].

A cadaveric study by McCombe et al. demonstrated that excision of the distal scaphoid increased in the mean F-E arc from 60° to 122° and R-U deviation from 34° to 43° [13]. A similar study by Bain et al. reported that excision of the distal scaphoid reduced the long lever arm of the scaphoid and unlocked the midcarpal joint to increase wrist flexion and radial deviation (Table 22.2) [17].

Garcia-Elias et al. completed a review of 16 patients with RSL fusion and distal scaphoidectomy and reported improvement in pain, flexion, and radial deviation compared to previous studies with RSL fusions only. They reported no non-unions and a lower rate of midcarpal arthritis [12].

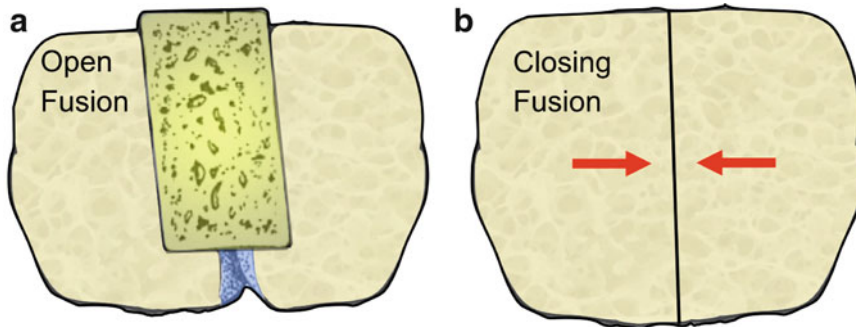
## RSL with Distal Scaphoid and Triquetrum Excision

Excision of the triquetrum decreases the containment of the midcarpal joint, and therefore increases the joint motion (see Fig. 22.3c and



**Fig. 22.3** (a) Cadaveric model of RSL fusion using memory staples. (b) Excision of the distal scaphoid increases flexion and radial deviation. (c) Excision of the distal scaphoid and triquetrum increases extension and ulnar deviation. Reproduced with permission Bain GI,

Sood A, Yeo CJ. RSL Fusion with excision of distal scaphoid and triquetrum: a cadaveric study. *J Wrist Surg.* 2014; 3(1): 37–41. Copyright © 2014, Rights Managed by Georg Thieme Verlag KG Stuttgart, New York



**Fig. 22.4** (a) Open fusion technique maintains height. (b) Closing fusion allows for bony apposition, stability, and increased union rate. Reproduced with permission from Bain GI, McGuire DT. Decision making for partial

carpal fusions. *J Wrist Surg.* 2012, 1(2): 103–114. Copyright © 2012, Rights Managed by Georg Thieme Verlag KG Stuttgart, New York

**Table 22.2** Measured wrist motion of RSL fusion; cadaveric study<sup>a</sup>

Procedures	Flexion	Extension	F-E arc	% <sup>b</sup>	RD	UD	R-U arc	% <sup>c</sup>
Capsulotomy	59	57	116	–	22	24	46	–
RSL fusion	36	38	74	64	14	18	32	70
Distal scaphoid excision	49	50	99	85	22	21	43	93
Triquetrum excision	56	56	11	97	23	29	52	113

Data are expressed as the mean measured ROM in degrees

<sup>a</sup>Modified with permission from Bain GI, Sood A, Yeo CJ. RSL fusion with excision of distal scaphoid and triquetrum: A cadaveric study. *J Wrist Surg.* 2014; 3(1): 37–41. Copyright © 2012, Rights Managed by Georg Thieme Verlag KG Stuttgart, New York

<sup>b</sup>Percentage from the baseline F-E arc

<sup>c</sup>Percentage from the baseline R-U arc

Table 22.2) [17, 18]. The triquetrum is the best bone graft as the scaphoid is often sclerotic.

Cadaveric studies have been published on the effect of additional triquetrectomy to RSL fusion

and distal scaphoid excision. Bain et al. reported that excision of the triquetrum will improve the R-U arc by a further 21% compared to RSL and distal scaphoidectomy alone (Table 22.3) [17].

**Table 22.3** Percentage change in ROM at each stage of the procedure<sup>a</sup>

Procedures	Flexion	Extension	F-E arc	RD	UD	R-U arc
RSL fusion	-39	-33	-36	-36	-25	-30
Distal scaphoid excision	36	32	34	57	17	34
Triquetrum excision	14	12	13	5	38	21

<sup>a</sup>Modified with permission from [17]. Copyright © 2012, Rights Managed by Georg Thieme Verlag KG Stuttgart, New York

Berkhout et al. reported that the RSL fusion decreased the range of motion in all directions [14]. They reported excision of the scaphoid typically improves the F-E arc, while R-U deviation is most improved after excision of the triquetrum.

We have performed a minimum 10-year follow-up study of our RSL fusions, which include excision of the distal scaphoid and triquetrum in 24 patients. A mean follow-up of 14.7 years found these patients to have a strong trend toward a greater R-U arc than RSL fusion alone and RSL fusion with scaphoidectomy. There were no non-unions and radiological results showed preservation of the midcarpal joint. Pain scores progressively improved from pre-operation, to 2 years to 10 years following surgery. Patient satisfaction rate was 94%.

### Long-Term Follow-Up of RSL Fusion in Kienböck's Disease

Of the 24 patients who had a RSL fusion, three patients had Kienböck's disease. They were all either Bain and Begg grade 2a or 1. One patient underwent RSL fusion, while two had RSL fusion with distal scaphoidectomy.

#### Patient 1

Patient 1 is a 61-year-old female who had a RSL fusion with K-wires and staples to her nondominant wrist. Preoperatively, she had visual analogue scale (VAS) pain score of 4/10.

Six months post-operatively, plain radiographs demonstrated union of the fusion. At 18.4 years she was satisfied, with VAS pain score

0/10. Quick DASH score 6.8/100 and Mayo wrist score 85/100, which is graded as a good.

#### Patient 2

Patient 2 is a 55-year-old male who had a RSL fusion with excision of the distal scaphoid. Once the necrotic part of the lunate was excised, the remaining lunate was thought to be too small for staples, and was therefore stabilized with K-wires. The K-wires were removed at 15 weeks. By 7 months he had return to full-time work with restricted duties.

At 17.7 years he was satisfied with VAS score 0/10, Quick DASH 11.4/100, and Mayo Wrist score 65 was satisfactory. Plain radiographs demonstrated a solid fusion and preservation of the midcarpal joint (Fig. 22.5).



**Fig. 22.5** Patient 2: Plain radiograph demonstrating solid fusion and preservation of the midcarpal joint at 17.7 years follow-up. Copyright Dr. Gregory Bain

### Patient 3

Patient 3 is a 72-year-old male who also had a RSL fusion with excision of his distal scaphoid on his dominant wrist, using staples. In view of the associated ulnar wrist pain symptoms, a matched hemiresection of the distal ulna was also performed.

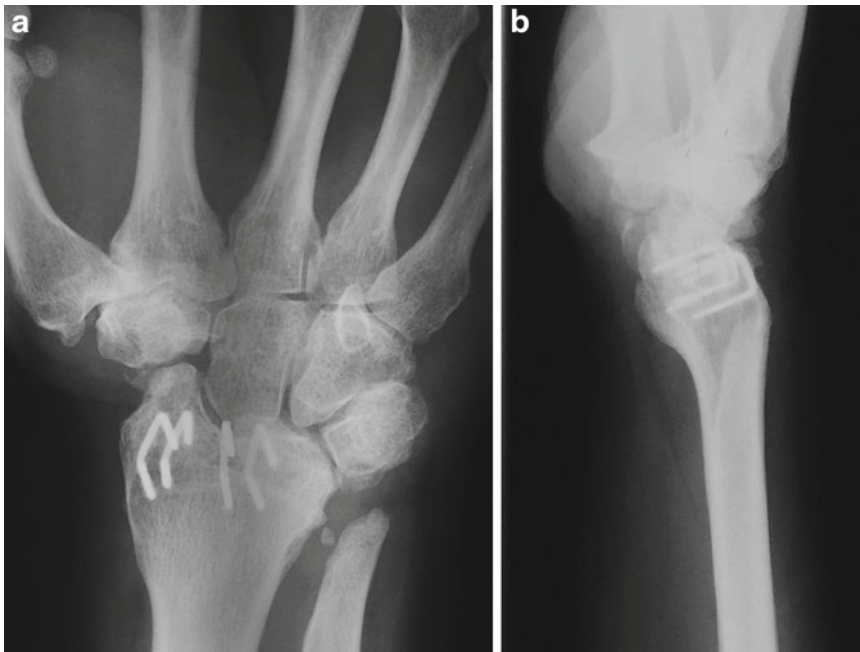
At 17.5 years follow-up he was satisfied with VAS pain score 1/10, Quick DASH 29.5/100 and Mayo wrist score 60. Plain radiographs confirmed union with preservation of the midcarpal articulation (Fig. 22.6a) and normal alignment (see Fig. 22.6b).

For the three Kienböck's patients, the mean F-E arc was  $46.6^\circ$  and R-U deviation arc  $20.8^\circ$ . There were no nonunions or other complications and none of them required a full wrist fusion. The mean scaphocapitate and lunocapitate joint spaces measured 2.0 mm and 1.7 mm respectively, reflecting negligible progression to midcarpal arthritis.

Clearly this is a small cohort; however, with such a long follow-up these results are certainly pleasing. We attribute the good results to:

1. Closely applied indications for surgery, in particular a well-preserved midcarpal joint.
2. Following the principles of limited wrist fusion (see Table 22.1) [1].
3. That a perfect reduction of the midcarpal joint is obtained.
4. Good stability of the radiocarpal joint until union.

As the reader would note, we began performing the RSL fusion for Kienböck's disease many years ago, in this very specific patient cohort. Since then newer methods of investigation have been introduced, such as gadolinium-enhanced MRI, which may further narrow the indication for this procedure.



**Fig. 22.6** (a) Patient 3: Plain radiograph demonstrating solid RSL fusion with distal scaphoid excision and ulnar hemiresection. There is preservation of the midcarpal

joint. (b) Patient 3: Plain lateral radiograph demonstrating normal radiocarpal alignment. Copyright Dr. Gregory Bain

## Conclusion

RSL fusion is indicated for patients with localized arthritis of the wrist with an intact midcarpal articulation. This procedure can include excision of the distal scaphoid and triquetrum, which increases the motion and union rate. Long-term outcome studies have shown RSL fusion to be sustainable with good clinical and radiological outcomes in those patients in which the midcarpal joint is anatomically reduced and fusion mass well stabilized.

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