Scaphocapitate Arthrodesis

F. Delétang

1 Introduction

Chronic scapholunate instability is a serious ligamentous wrist injury.

Whether of traumatic or degenerative origin, these lesions cause a functional disability of the wrist with limitation of mobility, loss of force and pain with force and grip.

The progression of this instability to arthritis is due to deficiency of the constraints of the scapholunate ligaments causing rotatory and posterior dislocation of the scaphoid [1]. The timeline of the arthritic progression of this instability has been well defined. The resulting articular congruence between the scaphoid fossa on the radius and the proximal pole of the scaphoid leads to radioscaphoid arthritis.

The ligament constraints for scapholunate stability are well known – these are the distal scaphotrapezoidal ligament complex [2] or the scapholunate attachments of the dorsal intercarpal ligament [3, 4]. However, it is difficult to determine the importance of each of these lesions in the genesis of instability and especially the predominance in culpability of one ligamentous structure over another.

In chronic scapholunate instability, ligament lesions are not reparable. The different surgical techniques available are destined to restore radioscaphoid congruence, decrease functional signs, alleviate pain and allow return to work or recreational activity. They also presume to avoid recurrence of instability and protect the carpus from the progression to arthritis. Soft tissue as well as bony procedures such as fusion have been proposed.

The aim of scaphocapitate arthrodesis is to permanently restore this radioscaphoid congruence to protect from carpal arthritis while improving wrist function.

F. Delétang
SOS Hand Emergencies Orléans Val de Loire, Polyclinique des Longues Allées,
25 rue Mondésir, Saint-Jean-de-Braye 45800, France
e-mail: dr.fabiendeletang@me.com

E. Camus, L. Van Overstraeten (eds.), *Carpal Ligament Surgery*,
DOI 10.1007/978-2-8178-0379-1_29, © Springer-Verlag France 2013

2 Surgical Technique

Scaphocapitate arthrodesis is performed under locoregional anaesthesia with an upper arm tourniquet after exsanguination of the upper limb to maintain a bloodless field. A posterior approach is used, the extensor retinaculum which is incised between the third and fourth compartments. The EPL and finger extensors are retracted. Partial wrist denervation is systematically performed by resection of the posterior interosseous nerve. An H-shaped or Berger capsulotomy with a triangular flap on an ulnar hinge is used to access the joint [5] (Fig. 1).

The radiocarpal and midcarpal intervals are examined to exclude a cartilage lesion with subchondral osseous lesion, which – if present – is a contraindication to this arthrodesis. The scapholunate ligament remnants are excised to allow optimal reduction of the scaphoid. Scaphocapitate interval surfaces are freshened down to cancellous bone. Rotatory subluxation of the scaphoid is reduced with a 10/10-mm Kirschner wire introduced into the proximal pole of the scaphoid and used as a 'joystick' (Figs. 2, 3 and 5). A temporary scaphocapitate arthrodesis using a 12/10-mm Kirschner wire maintains this reduction. Good scaphocapitate congruence is verified: the radioscaphoid angle should be about 45° on lateral view on intraoperative fluoroscopy.

A cancellous bone graft is harvested from the radius at the tubercle of Lister after radial corticotomy through the same approach. The graft is used to improve congruence at the arthrodesis interface. The fixation is secured using 2–4 standard or shape memory scaphocapitate staples (Fig. 4). Intraoperative wrist mobilization is done to exclude dorsal conflict with the hardware. A radial styloidectomy may be performed if a styloscaphoid conflict is detected. The capsule and retinaculum are reconstructed. Skin is closed in two planes with a suction drain. The preoperative forearm wrist splint is replaced by a fibreglass splint until radiological consolidation as judged by the surgeon is achieved. This is around 10 weeks. Rehabilitation is then begun.

Fig. 1 Dorsal approach 3–4, capsulotomy design

Fig. 2 Joystick K-wire in the pole of the scaphoid is used for reduction of rotatory subluxation

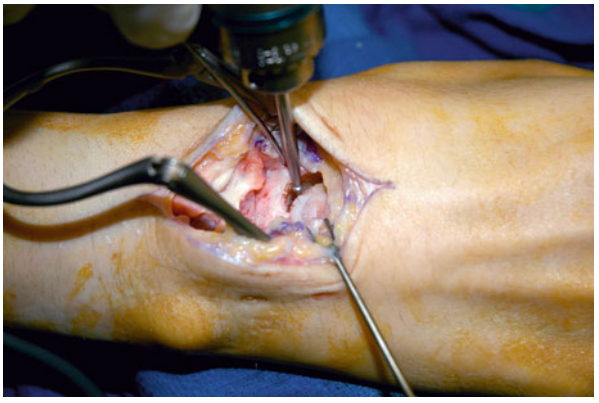

Fig. 3 Scaphocapitate freshening

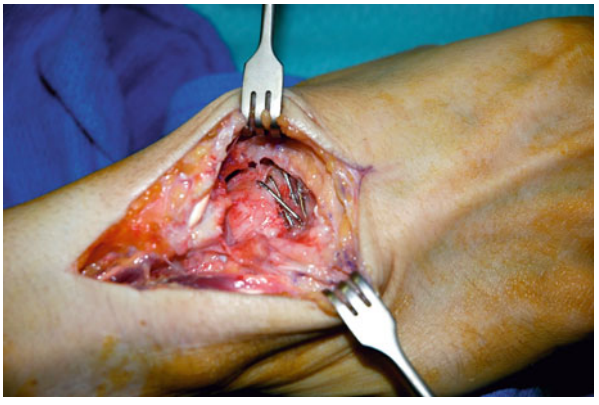

Fig. 4 Scaphocapitate arthrodesis using bipodal staples

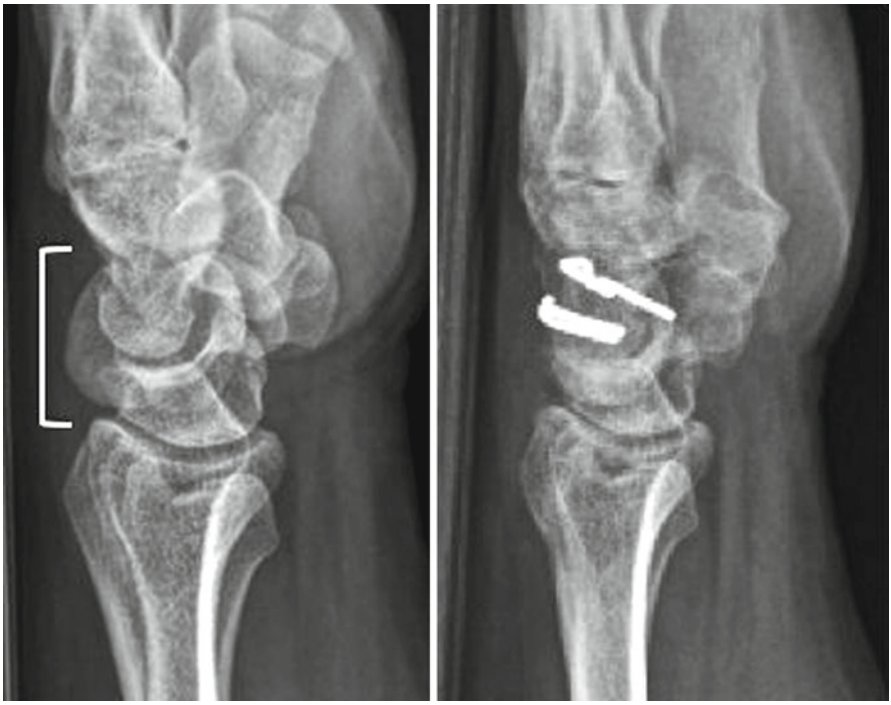

Fig. 5 Restoration of radioscaphoid congruence by scaphoid reduction

3 Surgical Indications of Scaphocapitate Arthrodesis

In chronic scapholunate instability, a complete description of ligament lesions, cartilage lesions and scaphoid reducibility should be precise and documented by CT arthrogram and arthroscopy. A reducible scaphoid is essential for the success of soft issue stabilization techniques [6] (Fig. 5).

Scaphocapitate arthrodesis is indicated in late, fixed chronic scapholunate instability with a scaphoid that is hardly reducible or irreducible. This corresponds to stage 5 in the algorithm of Garcia-Elias et al. [6]. It is also indicated if surgical approaches at the dorsum of the wrist preclude soft tissue procedures. It can also be used after failure of stabilization or failed primary ligament repair. Radioscaphoid arthritis and more advanced arthritis are contraindications to scaphocapitate arthrodesis.

4 Clinical Series

4.1 Material

Our study is retrospective monocentric including 58 scaphocapitate arthrodesis procedures for chronic scapholunate instability performed in our unit between 1999 and

2007. Thirty-one arthrodeses in 30 patients (24 men and 6 women) were reviewed by an independent examiner. Mean age at operation was 43 years (20–65). Mean follow-up was 5 years (8 months–8 years). The dominant hand was affected in 70 % of cases. Distribution of injury mechanisms was as follows: indirect wrist trauma 74 % (23/31) with associated high-energy lesions in 16 % (3 articular distal radius fractures, 1 perilunate dislocation, 1 distal radius fracture with perilunate dislocation), without trauma in 26 % (7/31) and with one case after trapezectomy for basal thumb arthritis. The series included 57 % work accidents. All patients presented with symptomatic chronic scapholunate instability, with 35 % after failed primary ligament surgery – either by attempt at reinsertion or after bone-ligament-bone procedures. The arthrodesis was performed at an average of 25 months after the first surgery (8–72). All patients had clinical and radiological evidence of scapholunate instability. Diagnostic arthroscopy was performed in 23 wrists to exclude a possibility for ligament reinsertion and any contraindication to scaphocapitate arthrodesis as in radiocarpal or midcarpal arthritis. Scapholunate instability was of grade 3 in 61 % and grade 2 in 39 % according to the classification of Dréant and Dautel [7]. The delay between the onset of symptoms and the surgery was on average 15.8 months (1–48). The mean time-off work duration was on average 5.2 months (0–36).

4.2 Method

Follow-up included clinical examination, radiologic and functional assessment.

Bilateral wrist examination was used to compare mobility of the operated wrist to the contralateral one, grip strength and pinch grip using the Jamar dynamometer. Preoperative and follow-up X-rays were used to compare carpal height and index of lateral deviation in the frontal view [8] before and after. Radioscaphoid, radiolunate and scapholunate angles were also compared. The duration of consolidation, the degree of nonunion, radiocarpal or midcarpal arthritis and styloscaphoid conflict were assessed. Complications to the procedure were documented.

Functional assessment was done using DASH and PRWE scores [9].

The PRWE evaluates overall wrist disability more precisely, comparing it to healthy wrist. The patient reports on pain at rest or on activity and the ability of performing specific activities involving the wrist. Values are reported as disability percentages. The time-off work was noted, as well as return to same position versus vocational reclassification.

4.3 Results

Scaphocapitate arthrodesis diminishes wrist mobility (Table 1). Flexion was at 41° (−37 % of contralateral) and extension 39° (−29 %). Radial inclination was limited to 11° (−52 %), and ulnar inclination is at 32° (−18 %). Flexion-extension range was at 80°, and radioulnar inclination was 43°.

Table 1 Scaphocapitate arthrodesis series

	Delay (months)	n-SLI	Follow-up (months)	Age	% TOW	F°	E°	RI°	UI°	Jamar (kg/force)	Nonunion %
Pisano et al. [11]	16	11–4	23.4	32	–	32	42	10	24	29	12
Chantelot et al. [12]	16	13–13	26	40	38	28	48	13.8	25.8	14	23
Saffar [19]	18	33–33	26	39.4	40	37.2	51.3	10.3	29.2	–	15
Delétang et al. [27]	16	31–31	60	43	57	41	39	11	32	32.5	13(8)

Mean grip strength Jamar was 35.5 kg (−19 %), and the pinch grip was minimally affected at 6 kg (−10 %).

DASH score was 27 %. PRWE score showed global disability of 25 % compared to the healthy side. Pain at rest was absent in 50 % of fused wrists and scored 1.5/10 for the other patients. It increased with increased loading or repetitive movements, reaching a maximum of 4/10. Ninety-four percent of patients were satisfied with the procedure and would choose to have it done again. Return to work was 71 % with 22 % professional reclassification. The mean time-off work postoperative was 5.8 months.

Radiologic analysis showed duration of consolidation to be 10.1 weeks postoperative [6–13]. The carpal height and index of deviation on front view were conserved at follow-up – they were normal preoperatively. Radioscaphoid angle went from 60° preoperative to 55° postoperative; the radiolunate angle showed little change, −6° to −9°. The mathematical resultant – the scapholunate angle – showed a small shift from 66° to 63° postoperative.

In 84 % of cases, there was no radioscaphoid arthritis. A radial styloscaphoid conflict was found in 22 % of wrists with little clinical impact. A complementary styloidectomy (same setting) had been performed in 32 % of operated cases to avoid styloscaphoid conflict.

Radiocarpal or midcarpal arthritis was found in 16 % of operated wrists; these had all presented with distal radius fractures +/− perilunate dislocation. Two wrists required an additional palliative procedure: four-corner arthrodesis in one and total wrist arthrodesis in the other due to symptomatic progression of arthritis.

The fixation was performed using bipodal staples with no shape memory in 86 % of cases. A radial cancellous bone graft was used in 81 % of fusions.

Nonunion was found in 13 % of cases – 8 % for the 58 scaphocapitate arthrodesis performed in the unit.

We had CRPS type I in 5 % cases and no infections.

Several criteria may influence results analysis: arthrodesis in a patient over 40, preoperative time-off work of more than 12 months, the ‘work accident’ concept and a previous scapholunate ligament repair. There were no statistically significant differences for clinical, functional and radiological results in relation to these criteria. However, patients with work accidents did tend to have worse functional results and longer time-off work (8.3 months on average).

5 Discussion

5.1 Functional Results

The technical description of scaphocapitate arthrodesis dates back to 1950 [10, 13], yet clinical series using this technique are sparse in the literature (Table 1 and Fig. 6).

Fig. 6 Late chronic scapholunate instability

Arthrodesis diminishes wrist mobility in all series. Experimentally, this limitation comes from blocking the scaphocapitate joint during wrist movements [14]. In flexion and radial inclination, the scaphoid has no more flexion pronation around the capitate which limits the mobility of the scaphocapitate unit. Extension and ulnar inclination are less affected since the default mobility of the scaphocapitate unit is smaller during these movements. However, clinical mobility is smaller than experimental mobility probably due to capsuloligamentary scarring and scarring from previous operations.

These movements allow most daily activities and work. Most of our patients returned to work with 78 % at the same job post despite the high rate of work accidents (57 %).

Force restoration and pain relief also contribute. This pain relief varies in the literature, and a pain-free state for all patients is not achieved. At rest, 50 % of our patients are pain-free, and 50 % have bouts of seasonal pain that decreases with time (13–46 %) [11, 12, 15]. Pain increases with forceful activities and daily activities but is overall moderate (23–41 %) [11, 12, 15]. The PRWE is a good test which allows breakdown of pain to correlate to different activities. Experimentally, on a wrist in

neutral position, scaphocapitate arthrodesis transfers load from the radiolunate to the radioscaphoid joint [16–18]. Forced movements of the scaphoid in radial inclination against the radial surface add to this load transfer. The load increase to cartilage on the proximal pole of the scaphoid may account for the residual pain.

5.2 *The Osteosynthesis of the Scaphocapitate Arthrodesis*

Nonunion is a dreaded complication with dire impact on functional results and prognosis. The rate of nonunion varies between 12 and 23 % in the literature [11, 12, 15, 19].

It falls to 8 % for arthrodesis performed in our unit. The mode of osteosynthesis is still debated. Compression is not a guarantee for consolidation. As in any arthrodesis, the quality of freshening of the articular surfaces is crucial. A graft usually taken from the radius is indispensable, and exaggerated compression should not artificially decrease the prepared scaphocapitate space. Compression screws frequently require an additional approach with risk to the radial nerve. We used two or three bipodal staples; this seems to be a good compromise compared to compression screws. Strict immobilization of the wrist in a below-elbow splint is routine in all cases until evidence of consolidation.

5.3 *Scaphocapitate Congruence and Protection Against Carpal Arthritis*

The scaphocapitate congruence and the radioscaphoid angle are the two most important control criteria intraoperatively. The reduction of scaphoid subluxation using a joystick K-wire as well as the temporary scaphocapitate arthrodesis are key steps in this technique. Experimentally, a radioscaphoid angle between 30° and 57° allows the achievement of 60 % mobility of a healthy wrist compatible with most habitual daily activities [20]. The radioscaphoid angle should be verified by intraoperative fluoroscopy and ideally set at 45°. The aim of this arthrodesis is the restoration of physiological radioscaphoid congruence. The stability of this congruence protects the wrist from major scaphocapitate arthritis in the long run.

Scaphocapitate arthrodesis does not reduce the DISI deformity of the lunate since the constraining ligaments of the scapholunate complex are damaged. The postoperative scapholunate angle is thus less important than for soft tissue techniques since only the radioscaphoid angle is deliberately modified.

A radiologic styloscaphoid conflict exists in 22 % of cases with little clinical impact.

The benefit of routine radial styloidectomy in scaphocapitate arthrodesis in terms of pain relief and mobility has not been shown in the literature or in this study, as for STT arthrodesis. We have performed complementary styloidectomy in only 7 % of cases (Fig. 7).

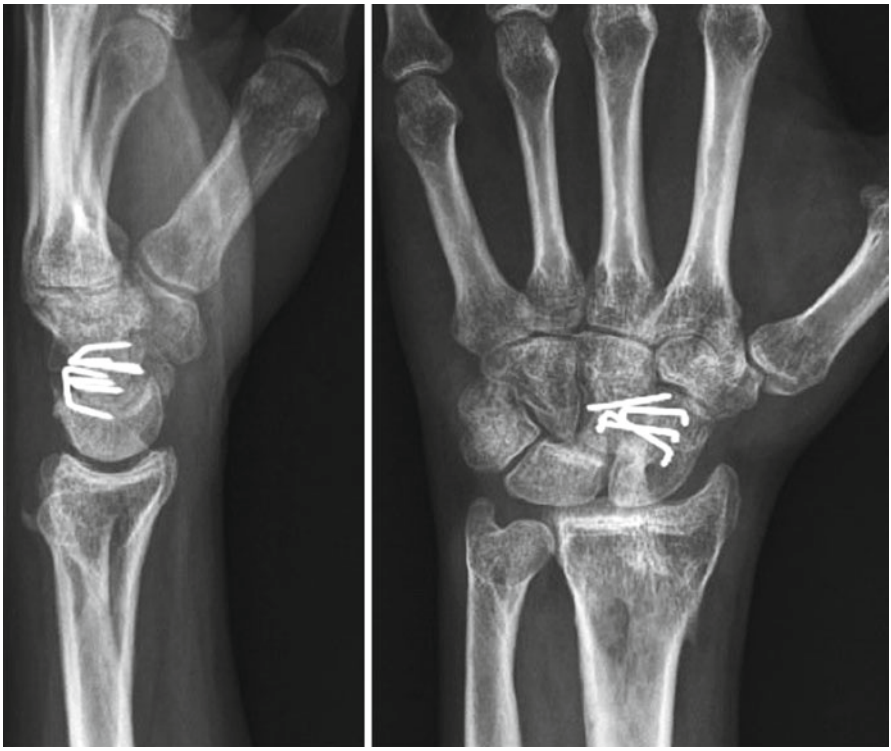

Fig. 7 Scaphocapitate arthrodesis

From this study and from the literature, we can conclude that scaphocapitate arthrodesis protects against carpal arthritis with at least 5 years of follow-up. The few identified failures can be explained by severe cartilage lesions upon initial injury.

5.4 Other Techniques for Treatment of Chronic Scapholunate Instability

Other partial arthrodesis techniques are used for the treatment of chronic scapholunate instability.

STT arthrodesis is used by many authors and follows the same logic of stabilization of the horizontal 'rocking chair' tilt of the scaphoid. Watson et al. [21], who promoted this technique, published excellent results with better mobility, less pain and frequent return to the same work post. These results are generally superior to those with scaphocapitate arthrodesis or soft tissue procedures.

A meta-analysis on 258 cases by Siegel and Ruby [22] showed different results than Watson. In comparison to our study, range of motion was identical; strength was similar with a similar nonunion rate. However, the complication rate (excluding nonunion) was 43 %, which included hardware-related infections, radioscaphoid arthritis, CRPS type I or persistent irritation of the radial nerve. In our study, the complication rate was 5.4 %. STT fusion is technically more difficult. It is more difficult to set the angle of the scaphoid on its base; the experimentally defined radioscaphoid angle needed to obtain acceptable wrist range of motion is more acute, between 30° and 47° [20]. In the light of these results, we no longer perform STT fusion in scapholunate instability.

Scaphocapitate arthrodesis and other techniques aiming at mechanically competent fibrous nonunion [23] have been described. Experimentally, this fusion causes minimal limitation of wrist mobility. However logical, it does not compensate for all lesions of the scaphoid ligament constraints, especially the distal scaphoid ligament complex. A high rate of nonunion of 35–72 % [24] is reported with this fusion, and the results are less predictable even if good clinical results have been observed, with better subjective than objective assessment values [25].

Scaphocapitolunate arthrodesis has also been described [26] aiming at a better radial load distribution on the scapholunate complex to avoid overloading of the radioscaphoid interval leading to degenerative arthritis. Experimental as well as clinical mobility is smaller than in scaphocapitate fusion. Results in terms of pain and return to work are inferior to those of scaphocapitate fusion. At 5-year follow-up, the radioscaphoid compartment does not show degenerative arthritis in scaphocapitate fusion. In the light of these results, scaphocapitolunate arthrodesis is not included in our armamentarium for treatment of scapholunate instability.

Soft tissue procedures follow the same logic of improving function and scaphoid stabilization. They aim to reduce mobility limitation by not blocking the midcarpal joint. Capsulodesis and ligamentoplasties require a reducible scaphoid – a key prerequisite that must be properly assessed. These techniques are probably indicated at an earlier stage of scapholunate instability than scaphocapitate arthrodesis. These techniques and their indications will be discussed elsewhere in this work.

6 Conclusion

Scaphocapitate arthrodesis promotes better wrist function with less pain in daily activities at the expense of mobility. It allows many patients to return to work. It protects against carpal degenerative arthritis for at least 5 years' follow-up while restoring radioscaphoid congruence. It is the treatment of choice in chronic late fixed scapholunate instability, with a barely reducible scaphoid.

It is also the treatment of choice in failed ligament repairs or other failed soft tissue procedures.

References

1. Watson HK, Ballet FL (1984) The SLAC wrist: scapholunate advanced collapse pattern of degenerative arthritis. J Hand Surg Am 9(3):358–365
2. Boabighi A, Kuhlmann JN, Kenesi C (1993) The distal ligamentous complex of the scaphoid and the scapho-lunate ligament. An anatomic, histological and biomechanical study. J Hand Surg Br 18(1):65–69
3. Mitsuyasu H, Patterson RM, Shah MA, Buford WL, Iwamoto Y, Viegas SF (2004) The role of the dorsal intercarpal ligament in dynamic and static scapholunate instability. J Hand Surg Am 29(2):279–288
4. Viegas SF, Yamaguchi S, Boyd NL, Patterson RM (1999) The dorsal ligaments of the wrist: anatomy, mechanical properties, and function. J Hand Surg Am 24(3):456–468
5. Berger RA, Bishop AT, Bettinger PC (1995) New dorsal capsulotomy for the surgical exposure of the wrist. Ann Plast Surg 35(1):54–59
6. Garcia-Elias M, Lluch AL, Stanley JK (2006) Three-ligament tenodesis for the treatment of scapholunate dissociation: indications and surgical technique. J Hand Surg 31A:125–134
7. Dréant N, Dautel G (2003) Development of a arthroscopic severity score for scapholunate instability. Chir Main 22(2):90–94
8. Youm Y, McMurthy RY, Flatt AE, Gillespie TE (1978) Kinematics of the wrist. I. An experimental study of radial-ulnar deviation and flexion-extension. J Bone Joint Surg Am 60(4):423–431
9. Voche P, Dubert T, Laffargue C, Gosp-Server A (2003) Patient-rated wrist questionnaire: preliminary report on a proposed French version of a North American questionnaire designed to assess wrist pain and function. Rev Chir Orthop Reparatrice Appar Mot 89(5):443–448
10. Sutro CV (1946) Treatment of nonunion of the carpal navicular bone. Surgery 20:536–540
11. Pisano SM, Peimer CA, Wheeler DR, Sherwin F (1991) Scaphocapitate intercarpal arthrodesis. J Hand Surg Am 16(2):328–333
12. Chantelot C, Becquet E, Leconte F, Lahoude-Chantelot S, Prodomme G, Fontaine C (2005) Scaphocapitate arthrodesis for chronic scapholunate instability: a retrospective study of 13 cases. Chir Main 24(2):79–83
13. Helfet AJ (1952) A new operation for ununited fracture of the scaphoid. J Bone Joint Surg 34:329
14. Garcia-Elias M, Cooney WP, An KN, Linscheid RL, Chao EY (1989) Wrist kinematics after limited intercarpal arthrodesis. J Hand Surg Am 14(5):791–799
15. Young Szalay MD, Peimer CA (2002) Scaphocapitate arthrodesis. Tech Hand Up Extrem Surg 6(2):56–60
16. Horii E, Garcia-Elias M, Bishop AT, Cooney WP, Linscheid RL, Chao EY (1990) Effect on force transmission across the carpus in procedures used to treat Kienbock's disease. J Hand Surg Am 15(3):393–400
17. Short WH, Werner FW, Fortino MD, Palmer AK (1992) Distribution of pressures and forces on the wrist after simulated intercarpal fusion and Kienbock's disease. J Hand Surg Am 17(3):443–449
18. Viegas SF, Patterson RM, Peterson PD et al (1990) Evaluation of the biomechanical efficacy of limited intercarpal fusions for the treatment of scapho-lunate dissociation. J Hand Surg Am 15(1):120–128
19. Saffar P (2007) Arthrodèse scapho-capitale. In: Cours européen de pathologie chirurgicale du membre supérieur et de la main. Sauramps Médical, Montpellier, pp 199–204
20. Minamikawa Y, Peimer CA, Yamaguchi T, Medige J, Sherwin FS (1992) Ideal scaphoid angle for intercarpal arthrodesis. J Hand Surg Am 17(2):370–375
21. Watson HK, Wollstein R, Joseph E, Manzo R, Weinzweig J, Ashmead D 4th (2003) Scaphotrapeziotrapezoid arthrodesis: a follow-up study. J Hand Surg Am 28(3):397–404
22. Siegel JM, Ruby LK (1996) A critical look at intercarpal arthrodesis: review of the literature. J Hand Surg Am 21(4):717–723

23. Rosenwasser MP, Miyasajsa KC, Strauch RJ (1997) The RASL procedure: reduction and association of the scaphoid and lunate using the Herbert screw. Tech Hand Up Extrem Surg 1(4):263–272
24. Chick G, Daunois O, Alnot JY (2007) L'arthrodèse scapho-lunaire dans la dissociation scapho-lunaire. In: Cours européen de pathologie chirurgicale du membre supérieur et de la main. Sauramps Médical, Montpellier, pp 205–213
25. Zubairy AI, Jones WA (2003) Scapholunate fusion in chronic symptomatic scapholunate instability. J Hand Surg Br 28(4):311–314
26. Rotman MB, Manske PR, Pruitt DL, Szerzinski J (1993) Scaphocapitolunate arthrodesis. J Hand Surg Am 18(1):26–33
27. Deletang F, Segret J, Dap F, Dautel G (2011) Chronic scapholunate instability treated by scaphocapitate fusion: a midterm outcome perspective. Orthop Traumatolo Surg Res 97(2):164–171.