Outcome of management of Kienböck disease by limited carpal fusion

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Objectives
To evaluate the clinical and radiological outcome of Kienb?ck's disease treatment by scaphocapitate fusion in 20 patients.
Background
Kienböck's disease remains a difficult entity to treat till understanding the etiology and natural history of the disease. Treatment will continue to be based on trails to decrease load across the lunate or revascularizing it.
Patients and methods
This study was retrospectively performed on 20 patients, with age of 19–59 years. All of the patients presented with Kienböck disease grades II and IIIa and with no evidence of arthritis. They were treated with scaphocapitate arthrodesis using the dorsal approach. The mean follow-up period was 6 months. Complications and adverse events were recorded.
Results
The clinical results were classified on subjective base and were graded as excellent outcome in six (30%) patients, good in 10 (50%) patients, and fair in 4 (20%) patients.
Conclusion
Scaphocapitate arthrodesis is a good procedure that mechanically decompresses the lunate and prevents progressive carpal instability with minimal complications.

Keywords:
arthrodesis, Kienböck's disease, scaphocapitate

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Introduction

Kienböck's disease is the lunate bone breakdown, which is a carpal bone in the wrist articulates with the radius in the forearm. Avascular necrosis is another name for Kienböck's disease (death and fracture of bone tissue owing to interruption of blood supply) with fragmentation and collapse of the lunate [1].

Kienböck's disease is classified as a 'rare disorder.' It usually affect adults between 20 and 40 years old, predominantly male manual workers [2]. The condition is typically unilateral, but both sides are equally affected. Moreover, there is a considerable association between Kienböck disease and negative ulnar variance.

There is probably no single cause of Kienböck's disease [2]. Its origin may involve multiple factors, such as skeletal variations, in which the ulna can be shorter than the radius, causing issues, or the shape of the lunate bone may be irregular. Moreover, trauma, isolated or repeated, may possibly be a factor in some cases [3,4].

The lunate centrally articulates directly with the radius and the triangular fibrocartilage proximally.

Clinical features of Kienböck's disease usually come with wrist pain and tenderness directly over the lunate bone. Moreover, there is decreased motion or stiffness of the wrist, and there may be swelling. Diagnosis can often be made by reviewing history, performing a physical examination, and taking radiography. In early stages of this disease, the radiography results may be normal, and other tests, most likely MRI, are needed to confirm the diagnosis.

Treatment options depend upon the severity and stage of the disease. Early stages can be as simple as observation or immobilization [5]. For more advanced stages, surgery is usually considered, like joint leveling, lunate revascularization, limited carpal fusion, and total wrist fusion [6,7].

Aim

The aim is to evaluate the scaphocapitate fusion outcome for treatment of Kienböck's disease.

Patients and methods

This study was retrospectively performed on 20 wrists of 20 patients, with age range of 19–59 years. All of the patients who presented with Kienböck's disease were treated with scaphocapitate fusion in orthopedic operation room under complete sterile condition.

Inclusion criteria were as follows: Kienböck's disease without response to conservative treatment (physical and medical) for over 6 months. The patients are analyzed hematologically and biochemically with no significant alterations that contraindicate intervention. This study was approved by the ethical committee of Menoufia Faculty of Medicine. Informed consent was taken from each patient.

Exclusion criteria were as follows: patients with extensive degenerative changes in the wrist, those with radioscaphoid joint arthritis, those with stages I and IV, and those with previous surgical interference.

Clinical evaluation

Clinical history and examination were performed preoperatively and at the final review of each patient using the modified Mayo Wrist Score (Table 1), which consists of functional status, pain intensity, grip strength, and range of motion. It was graded as excellent to a wrist that has a score of more than 80–100 points; good, more than 65–80 points; moderate (fair), more than 50–65 points; and poor, from 0 to 50 points.

Table 1 Modified Mayo wrist score

Functional status		Points
Severe disability		0
Moderate disability		10
Limited only in special situations		20
Normal no disability		30
Pain		
Severe to intolerable		0
Pain after activities and at rest		10
Pain after strenuous activities		15
No pain		20
Grip strength per cent of contralateral side		
0–25		0
>25–50		10
>50–75		20
>75–100		30
Range of motion		
Ex/Flex	Pro/Sup	
<30	<80	0
>30–60	>80–110	10
>60–100	>110–140	15
>100	>140	20

A rating of excellent was assigned to a wrist that has a score of more than 80–100 points; good, more than 65–80 points; moderate(fair), more than 50–65 points; and poor, from 0 to 50 points.

Range of motion of both wrists was measured from apposition of reference [8], with a standard hand-held goniometry. Grip strength was measured with a sphygmomanometer as described by Kauer [9].

Radiographic evaluation

PA, lateral radiographs, and, in some cases, MRI were performed. The following parameters were measured:

(1) Carpal height ratio (the carpal index) [10].
(2) Ulnar variance.
(3) Staging of Kienböck's disease for selection of stages II and IIIa as the inclusion criterion according to Lichtman classification [11].
(4) Flexion deformity of the scaphoid 'ring sign' appearance.
(5) Radioscaphoid arthritic changes to exclude wrist-evolving arthritis and follow-up of cases postoperatively [12].

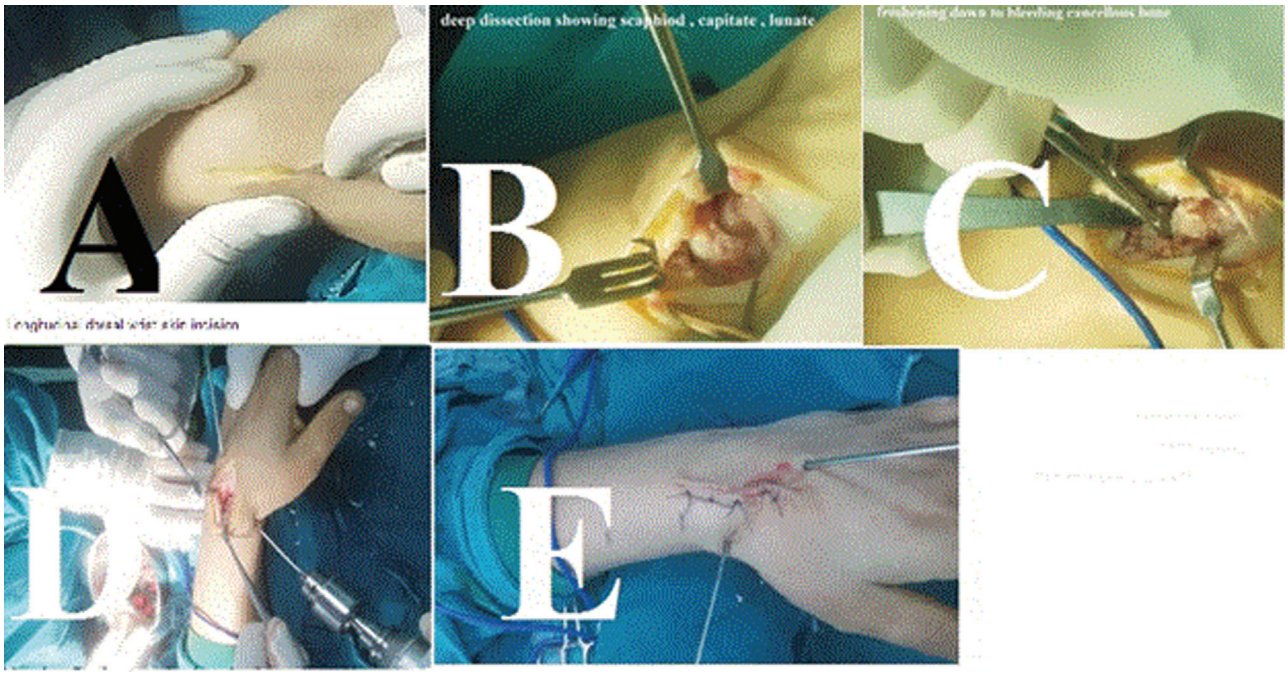
Operative procedure

Scaphocapitate arthrodesis was performed under general anesthesia (18 patients, 90%) or regional anesthesia (two patients, 10%). A tourniquet was placed on the upper arm to obtain a bloodless operative field. The skin was incised in a longitudinal dorsal wrist incision centered just ulnar to Lister's tubercle that extends 4 cm proximal and distal from Lister's tubercle (Fig. 1).

The branches of the radial sensory nerve were carefully avoided. The extension retinaculum was incised between the third and fourth compartment. Then the extensor pollicis longus and extensor digitorum muscles were released and retracted radially. Subsequently, a capsulotomy with a radial-based triangular flap was performed [13]. The radio-carpal and mid-carpal spaces were evaluated for arthritic lesions, which would be a contraindication for fusion (Fig. 2).

Any rotational subluxation of the scaphoid was reduced by using an external 'Joy Stick' maneuver. The scaphoid and capitate were freshened down to bleeding cancellous bone (Fig. 3). Two K-wires were inserted to preserve the reduction and provide provisional scaphocapitate fusion (Fig. 4) or using Herbert screw to get a permanent fusion. A cancellous bone graft may be harvested through a small cortical window

Figure 1

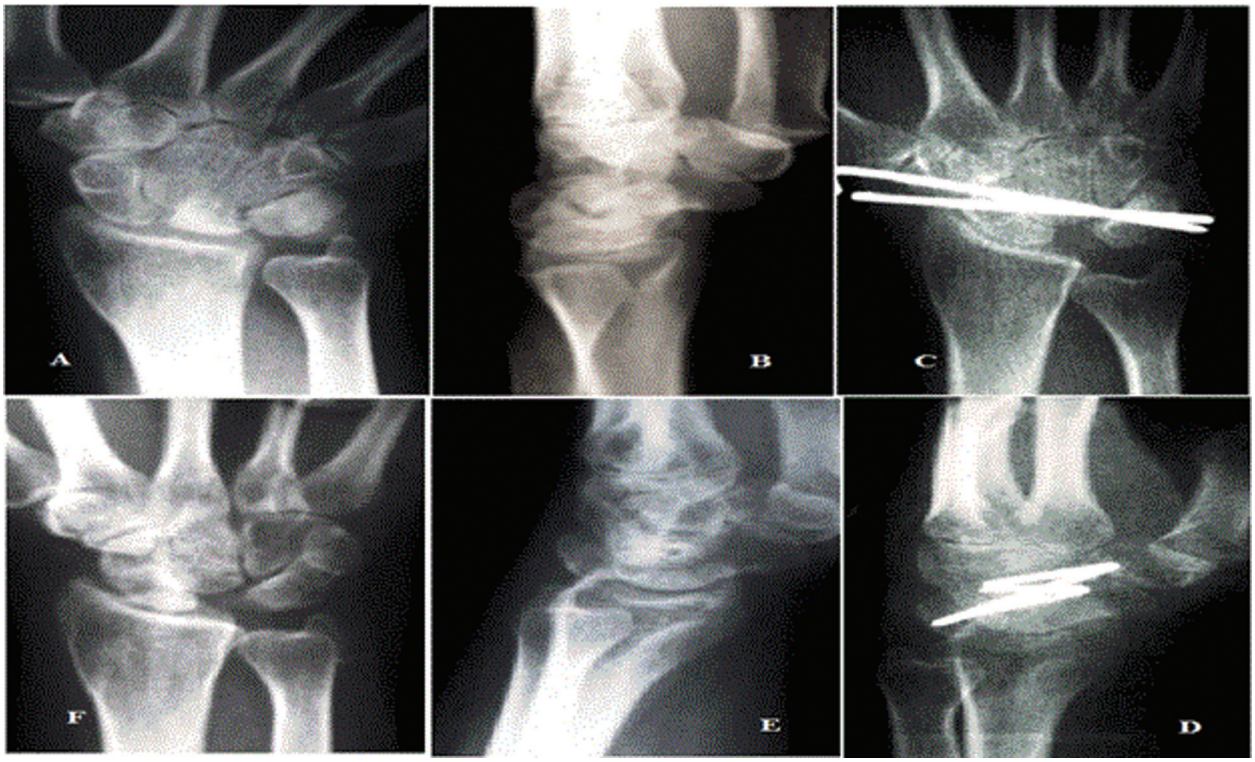


Anterio-posterior and lateral views preoperatively and postoperatively.

Figure 2

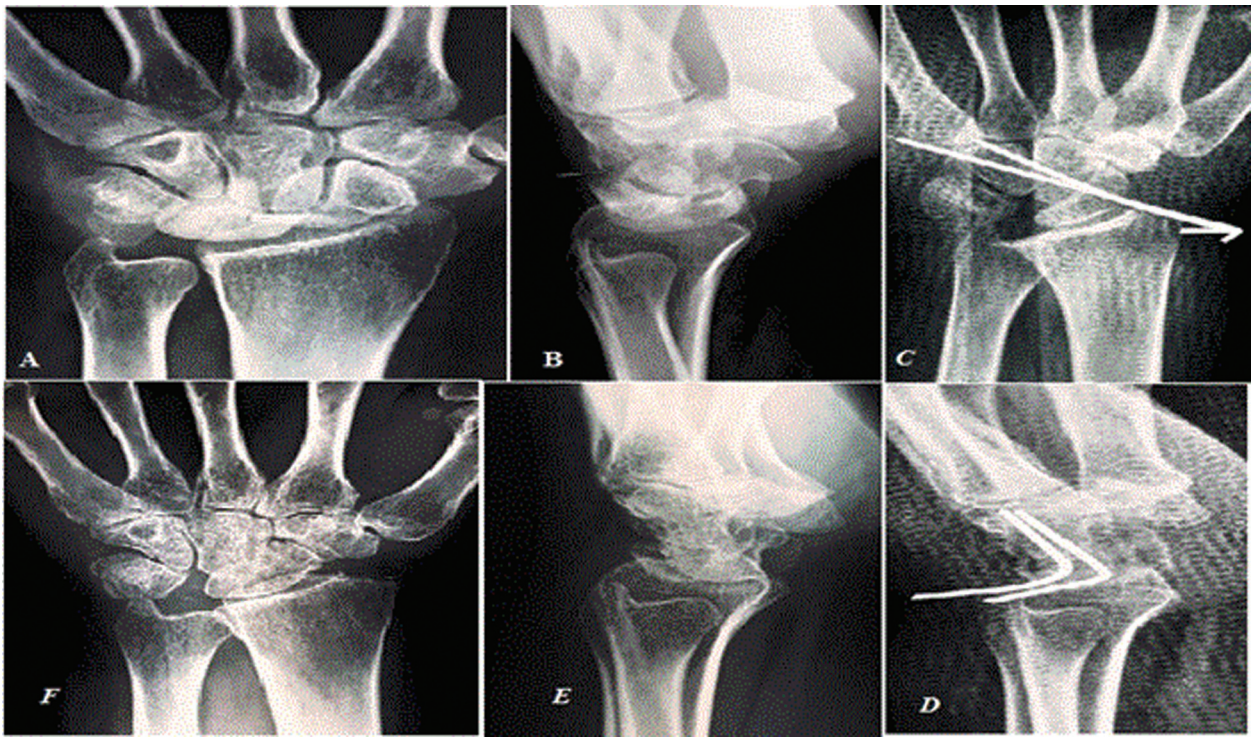
Excellent example of scaphocapitate fusion by Herbert screw.

Figure 3



Good example scaphocapitate fusion by Herbert screw.

Figure 4



Fair example scaphocapitate fusion by Herbert screw.

in the dorsal distal radius without doing additional skin incision, which is used to improve the congruence of the freshened areas.

Finally, the tourniquet was deflated and homeostasis obtained. The articular capsule and retinaculum were reconstructed. The extremity was immobilized in a

short thumb spica cast with slight wrist extension and neutral to slight radial wrist deviation.

Postoperative management

The short arm thumb spica cast was kept for 6–14 weeks after surgery, until radiographs showed a consolidation of fusion at scaphocapitate Joint. At this point, removal of the cast and K-wires was performed. The patient was placed in a removable volar wrist splint, and a physiotherapy program was begun for the wrist. Protective splinting for an additional 4–6 weeks was kept. The physical therapy concentrates on passive and active wrist motion and progressive muscle strengthening. Recovery of maximum wrist motion required at least 6 months, and in six (33.33%) patients, it continued to improve up to 12 months after surgery. Maximum grip strength recovery took at least 12 months.

Follow-up

The follow was done clinically and radiologically after an average of 6 months (range, 6–12 months).

Results

A total of 20 scaphocapitate fusions were performed in 20 patients (14 men and six women). The mean age of the patients at the time of operation was 36 years (range, 19–59 years). All patients were available for follow-up. Patients with stages II and IIIa Kienböck's disease according to Lichtman classification were included in the study. Eleven (55%) patients presented with ulnar minus variance, three (15%) with ulnar plus variance, and six (30%) with ulnar neutral variance. Union was obtained in all cases as proved by clinical examination and radiographic evaluation. On radiographs, the arthrodesis had consolidated in all cases. The union mean time was 11 weeks (range, 10–16 weeks).

Pain

Preoperatively, 18 (90%) patients had severe pain (severe to intolerable) and two (10%) patients had moderate pain (pain after activities and at rest). At the final follow-up, five (25%) patients had no pain, 14 (70%) patients had pain after strenuous activities, one patient had pain after activities and at rest, whereas none of the patients had severe pain (Table 2).

Grip strength

Preoperatively, grip strength ranged from 180 to 250 of normal side with the mean of 204.7±17.2. At the final follow-up, it ranged from 200 to 225 of the normal side, with mean of 224.7±16.5. There was a statistically significant difference in the degree of grip strength preoperatively and at the final follow-up (Table 3).

Range of motion

The mean wrist motion showed no significant change. In flexion, it ranged from 30.6±2.43 to 30.7±2.61, in extension from 38.5±3.63 to 38.6±2.76, in ulnar deviation from 23.0±4.27 to 23.2±4.26, and in radial deviation from 19.0±1.05 to 18.5±1.73. All patients had functional range of motion for their needs. The improvement of range of motions was slow and very progressive after more than 6 months (Table 4).

Complications

One patient had superficial wound infection that resolved within 1 week.

Discussion

There are similar goals of limited wrist and total wrist arthrodesis in providing pain relief, and improved function by fusing across arthritic or unstable joints, with the added benefit of motion preservation. Between 30 and 50% of sagittal motion at the wrist occurs through the mid-carpal joint, with the remainder

Table 2 Pain results

Studied variables	Pain [*n* (%)]		McNemar test	*P* value
	Preoperative	Postoperative (after 6 months)		
Severe to intolerable	18 (90.0)	0 (0.00)	37.3	0.001*
Pain after activities and at rest	2 (10.0)	1 (5.00)		
Pain after strenuous activities	0 (0.00)	14 (70.0)		
No pain	0 (0.00)	5 (25.0)		

Table 3 Preoperative and postoperative grip strength among the studied group

Studied variables	Grip strength		Paired *t* test	*P* value
	Preoperative	Postoperative (after 6 months)		
Mean±SD	204.7±17.2	224.7±16.5	5.51	0.001*
Range	180–250	200–225		

Table 4 Range of motion

Studied variables	Range of motion		Paired *t* test	*P* value
	Preoperative	Postoperative (after 6 months)		
Flexion				
Mean±SD	30.6±2.43	30.7±2.61	0.066	0.948
Range	25–35	25–35		
Extension				
Mean±SD	38.5±3.63	38.6±2.76	0.071	0.944
Range	30–45	32–42		
Ulnar deviation				
Mean±SD	23.0±4.27	23.2±4.26	0.364	0.720
Range	17–30	18–30		
Radial deviation				
Mean±SD	19.0±1.05	18.5±1.73	1.47	0.157
Range	17–20	15–20		

through the radio-carpal joint [14,15]. Sparing of either the radio-carpal or the mid-carpal articulations avoids complete loss of wrist motion, and a compensatory increase in motion at the unfused joint has been shown for up to 1 year postoperatively [16,17].

The primary treatment goal for Kienböck's disease remains decompression of the lunate. Scaphocapitate fusion mechanically decompresses the lunate and prevents progressive carpal instability. It can successfully unload the lunate by transferring the carpal load to the radioscaphoid joint. However, load transfer to the radial column might result in degenerative arthritis of the radioscaphoid joint.

Sutro [18] first described scaphocapitate arthrodesis for the treatment of difficult scaphoid nonunion. Its use in the treatment of Kienböck's disease was described 45 years later in a report by Pisano *et al.* [19]. Several biomechanical studies have been published detailing the wrist forces resulting from different types of limited wrist arthrodesis that suggest that scaphocapitate arthrodesis fusion results in increased axial load across the radioscaphoid joint and also decreasing the joint force across the lunocapitate and radiolunate joints compared with the intact wrist [20,21].

This study was retrospectively performed on 20 patients with stages II and IIIa Kienböck's disease, treated by scaphocapitate fusion using internal fixation by K-wires or Herbert screws with the dorsal approach. The average age of patients in this study ranged from 19 to 59 years. Most of our patients were manual workers, 10 patients were heavy manual workers, and five housewives were from country-side with daily heavy manual works. This was consistent with the agreement of Allan [18] and Garcia [18] in their papers, when they stated that Kienböck's disease affects young individuals between the age of 20 and 40 years, especially those engaged in manual works. It is also similar to the average age reported by Sennwald and Ufenast [22], which was 30 years (range, 19–52 years), and comparable to that reported by Rongieres *et al.* [23], which was 36.6 years (range, 24–55 years).

Table 5 Mayo score system distribution among studied group (N=20)

Studied variables	*n* (%)
Mayo score system	
Excellent	6 (30.0)
Good	10 (50.0)
Fair	4 (20.0)

According to Mayo score system, the results obtained after 6 months follow-up were encouraging. The results of treatment of 20 patients were excellent in six (30%) patients, good in 10 (50%) patients, and fair in 4 (20%) patients (Table 5).

As regards pain, in this study five (25 %) patients had absolutely no pain, 14 patients (70 %) had pain after performing stressful activities and only one patient (5%) had pain at rest. Compared with the series of 14 patients by Rongieres *et al.* [23], eight (57.14%) patients were very satisfied, four (28.57%) were satisfied, and two (14.29%) were poorly or not satisfied. In the series of 17 patients [19], Pisano reported seven (41%) patients with mild to moderate pain after surgery with work or recreational activities, thus none required additional surgery. In the series by Zdravkovic and Sennwald [24], four (36%) patients had pain on performing stressful activities; of them two (18%) patients had to change their profession, whereas two (18%) continued their work at a reduced level of activity.

Table 6 Motion range of different study groups

Study	Rongieres (deg.)		Yang (deg.)		This study	
	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
Flexion	33.3	33.9	30	29	30.6±2.43	30.7±2.61
Extension	39.6	39.3	41	41	38.5±3.63	38.6±2.76
Ulnar deviation	18.8	17	19	16.94	23.0±4.27	23.2±4.26
Radial deviation	20	23.7	21	21.69	19.0±1.05	18.5±1.73

In this series, the mean grip strength improved from 71% of the normal side preoperatively to 83% of normal side postoperatively. This was compared with 48% of the normal side preoperatively increasing to 67% postoperatively in the series of Young Szalay *et al*. [25]. Moreover, comparable with many published studies, Rongieres *et al*. [23] obtained grip strength that reached 64.5% of the contralateral side. In the study by Pisano *et al*. [19], grip strength was 74%, whereas better results were obtained by Sennwald and Ufenast [22] when grip strength reached 83% of unaffected side.

Wrist movements slightly improved postoperatively, and the results of this study were comparable to other series regarding the range of wrist motions (Table 6).

The results of this study suggest that the treatment of stage III Kienböck's disease with scaphocapitate fusion is a useful method of treatment that maintains the carpal height ratio, prevents carpal collapse, and retains a useful although decreased wrist range of motions [26–30].

Conclusion

The scaphocapitate arthrodesis is a good option for the Kienböck's disease treatment of stages II and IIIa. It achieved a high rate of satisfactory clinical and radiological results with minimal complications and preserved carpal height [26–30].

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Conflicts of interest

There are no conflicts of interest.

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