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Clinical outcome of combined scaphocapitate fusion and posterior interosseous neurectomy for stage III Kienbock's disease

Hossam Elden A. Abodonia*, Mohammed H. Elbadawy, Ahmed A. Basha

Department of Orthopaedic Surgery, Kafr Eldawar General Hospital, Egypt

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***Correspondence:**
Dr. Hossam Elden A. Abodonia,
E-mail: dr_hossamabodonia@yahoo.com

ABSTRACT

Background: Treatment of Kienbock's disease is still controversial. Several authors have described various surgical treatment options for Kienbock's disease, all of whom reported successful treatment outcomes. The purpose of this study is to explore the clinical results of posterior interosseous neurectomy and scaphocapitate fusion as a treatment option for stage III Kienbock's disease.
Methods: This study evaluated the range of motion, grip and functional results after treatment of ten wrists of stage III Kienbock's disease. Four males and six females with average age of 26.3 years, seven dominant and three non-dominant wrists were included. Two patients were smokers while six were housewives, three manual workers and a lawyer. The average follow up period was 14.2 months.
Results: Four patients revealed excellent, three good and three fair results. The mean modified Mayo score was 81.5. Flexion-extension range was 105.5° representing 74.9% of the contralateral side range. The mean flexion and extension range of operated side was increased, while the flexion increase was nonsignificant. Regarding radial-ulnar deviation, the mean range was 33.5° representing 76.5% of the contralateral side. The mean ulnar and radial deviation was increased, while the radial increase was nonsignificant. The mean grip strength was significantly increased to 90 mmHg representing 93.2% of the contralateral side.
Conclusions: Scaphocpitate fusion is a recommended solution for treatment of late stages of Kienbock's disease with lunate collapse. Longer postoperative time has a positive impact on grip strength and flexion-extension range of motion.

Keywords: Kienbock, Scaphocapitate fusion, Posterior interosseous neurectomy

INTRODUCTION

Robert Kienbock, an Austrian radiologist, first described osteonecrosis of the lunate in 1910.[1] However Kienbock's disease is idiopathic, some theories implicate mechanical influences on the lunate. Several anatomical risk factors are proposed and include negative ulnar variance, variations in lunate shape and radial inclination and a greater palmar tilt of the distal radial articular surface.[2]

Kienbock's disease most commonly affects men between the ages of 20 and 40 years. Physical examination reveals tenderness over the dorsum of lunate and radiolunate facet. Motion in the flexion and extension arc is often decreased, and average grip strength may decrease up to 50% of the contralateral side.[3]

Kienbock's disease may be staged according to radiologic appearance using Lichtman classification (Table 1).[4-6]

Table 1: Lichtman classification for Kienbock's disease.

Stage I		Radiographically normal; increased T2 signal on MRI
Stage II		Sclerosis of lunate
Stage III	A	Lunate articular surface collapse, without scaphoid rotation
	B	Lunate articular surface collapse, with fixed scaphoid rotation
	C	Lunate articular surface collapse, with coronally oriented lunate fracture
Stage IV		Lunate collapse with secondary radiocarpal osteoarthritis

Transient increases of lunate bone density can be observed after trauma and should not be mistaken for Kienbock's disease.[7] An alternate classification of Kienbock's disease, the Bain and Begg classification, focuses on the number of nonfunctional articular surfaces of the lunate at arthroscopy.[8]

Treatment of Kienbock's disease is still controversial. Several authors have described various surgical treatment options for Kienbock's disease, all of whom reported successful treatment outcomes. Surgical treatment strategies fall into three main categories: biomechanical unloading of the lunate, vascularized bone graft, and salvage.[9] The procedures advocated for treating advanced Kienbock's disease include radius core decompression, vascularized bone graft, radial osteotomy, radial shortening, capitate shortening, limited wrist arthrodesis, implant resection arthroplasty, proximal row carpectomy and total wrist fusion.[10-17]

Wrist denervation grew in popularity as an adjunct or alternative to salvage procedures for many chronic wrist conditions.[18] The goal of wrist denervation is restored or improved hand motion achieved by severing the Aδ and C fibers to the wrist joint. By which pain to the joint theoretically is reduced without compromising motor or sensory function.[19] Posterior interosseous sensory neurectomy does not appear to be associated with decreased proprioception of the wrist.[20]

The purpose of the study was to explore the clinical results of posterior interosseous neurectomy and scaphocapitate fusion as a treatment option for stage III Kienbock's disease.

METHODS

After approval of ethics committee of orthopedic department, a retrospective cohort study of ten patients with Kienbock's disease stage III was performed. Through the period from May 2017 to November 2018, those patients went for lunate excision, scaphocapitate fusion and posterior interosseous neurectomy.

All patients presented by central dorsal wrist pain with limitation of wrist motion for months not responding to medical treatment. X-rays revealed sclerosis and collapse of lunate. In some cases, CT scan was used to differentiate Lichman stage III C at which there is coronal fracture of lunate.

One gram ceftriaxone was administered half an hour prior to tourniquet inflation. Dorsal longitudinal skin incision was centered over lister tubercle. Third dorsal compartment was opened and extensor pollicis longus was retracted laterally (Figure 1A).

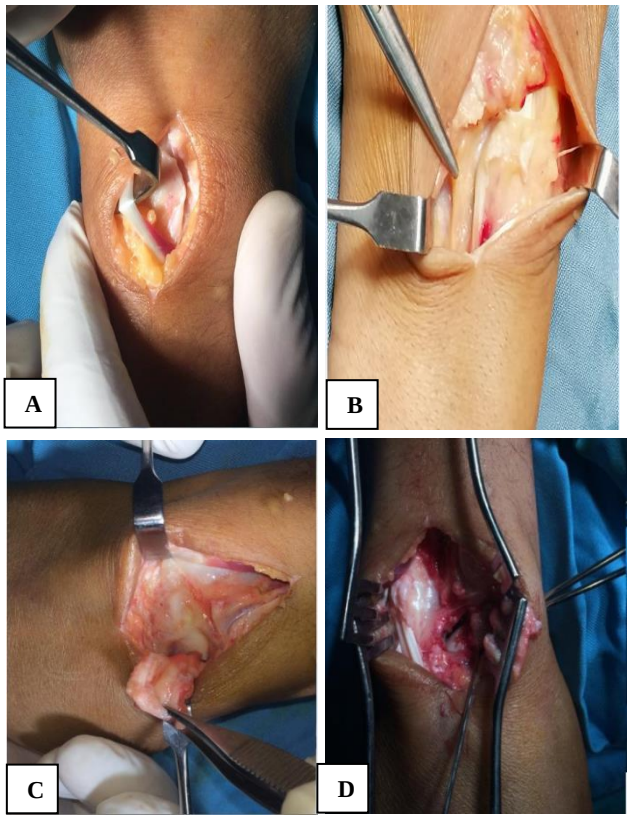

Figure 1: Scaphocapitate fusion surgical approach; (a) opening of third dorsal wrist compartment and lateral retraction of extensor pollicis longus, (b) posterior interosseous nerve was identified at the floor of the fourth compartment, (c) radially based flap of dorsal wrist capsule and (d) lunate excision and scaphocapitate pinning.

Posterior interosseous nerve was identified at the floor of the fourth compartment (Figure 1B), two centimeter of the nerve was excised using cautery then the edges were cauterized also. A radially based flap of wrist capsule was done through incisions parallel to dorsal radiotriquetral and intercarpal ligaments' fibers (Figure 1C). Collapsed lunate was excised and articular surfaces between scaphoid and capitate were removed. Multiple drilling of scaphoid and capitate was done and cancellous bone graft

from distal radius was obtained to enhance scaphocapitate union. A joystick K wire at scaphoid was used to correct its flexed position prior to scaphocapitate pinning with two or three K wires (Figure 1D). Wrist capsule and fourth compartment were closed while extensor pollicis longus was left superficial.

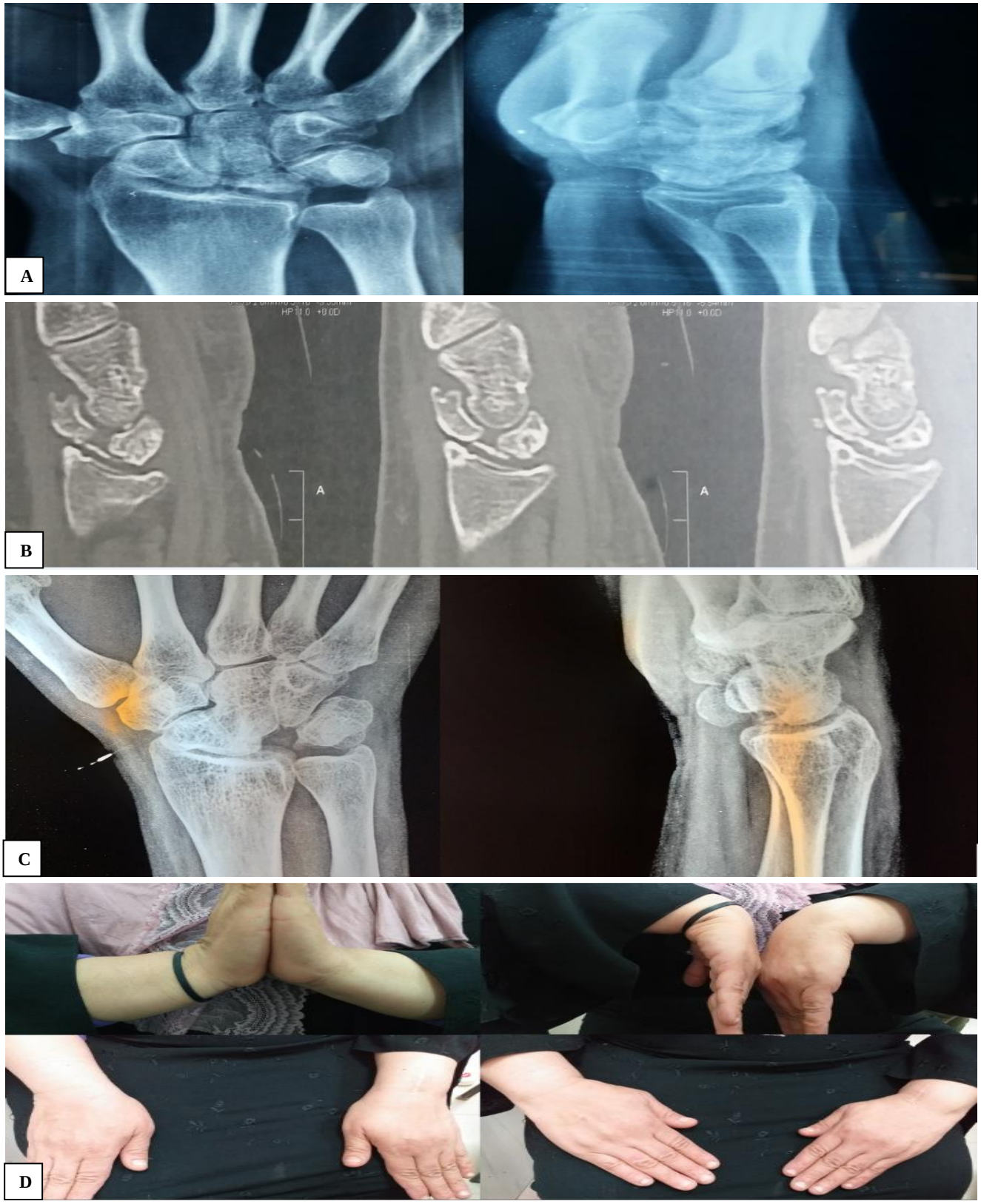

Figure 2: Case presentation; (A) preoperative X-ray of 37 years old housewife showed lunate collapse of left wrist; (B) preoperative CT scan showed coronal fracture of the lunate; (C) twenty four months follow-up X-ray showed scaphocapitate union and (D) twenty four months postoperative range of motion.

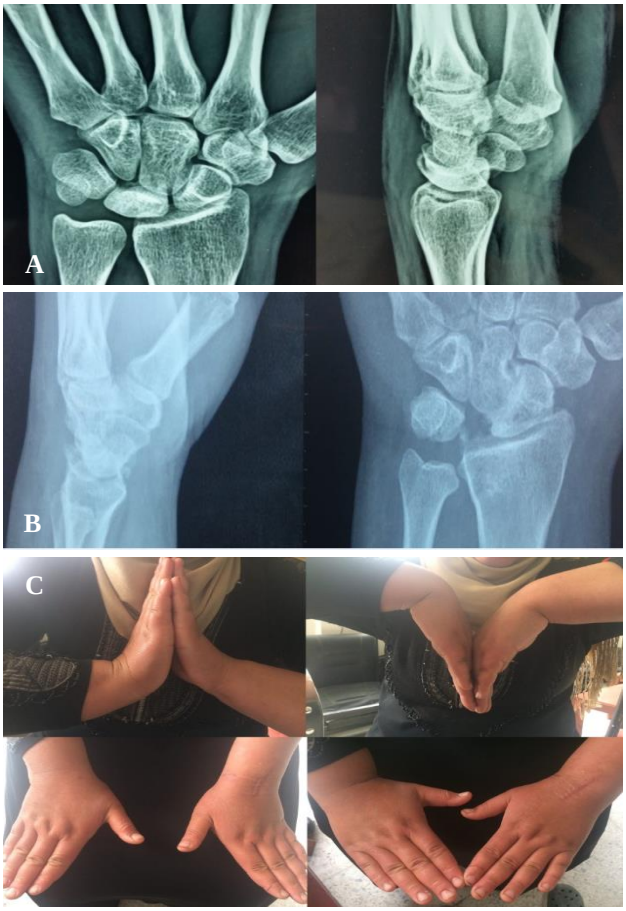

Figure 3: Case presentation: (A) Preoperative X-ray of 22 years old housewife showed lunate sclerosis and scaphoid flexion deformity of left wrist; (B) eleven months follow-up X-ray showed scaphocapitate union with restored scaphoid extended position and (C) eleven months postoperative range of motion.

Patients were casted in short arm cast for eight weeks while encouraged for fingers movement. Eight weeks postoperative, both cast and pins were removed. A physiotherapy program to enhance range of motion was commenced after cast removal (Figures 2 and 3).

Wrists were assessed for range of motion and function outcome using modified Mayo score at which there is a total of 100 points which are divided among the evaluator's assessment of pain (25 points), active flexion/extension arc as a percentage of the opposite side (25 points), grip strength as a percentage of the opposite side (25 points), and the ability to return to regular employment or activities (25 points). An excellent result is defined as 90-100 points, good is 80-89, fair is 65-79 points, and poor is less than 65 points.[21] Modified sphygmomanometer test was used to evaluate grip strength.[22]

RESULTS

This study included ten patients with Litchman stage III Kienbock's disease with average age of 26.3±7.8 (15-37) years. The average follow up period was 14.2±6.8 (6-24) months (Table 2).

The mean preoperative range of motion of affected wrists was 40±3.3 (35-45)° for flexion, 53±7.9 (40-65)° for extension, 19±3.9 (15-25)° for ulnar deviation and 10.5±2.8 (5-15)° for radial deviation. Using modified sphygmomanometer test, grip strength by mmHg was evaluated. The mean preoperative grip strength of affected wrists was 59.5±10.4 (45-75) mmHg.

Out of ten, four patients revealed excellent, three good and three fair results. The mean modified Mayo score was 81.5±11.8 (65-100).

Table 2: Demographic data.

Demographic characteristics	Numbers
Age (in years)	
<20	2
20-40	8
Sex	
Male	4
Female	6
Occupation	
Housewife	6
Manual worker	3
Lawyer	1
Smoking	
Smoker	2
Non-smoker	8
Side	
Dominant	7
Non-dominant	3

At the end of follow up, flexion-extension range of motion was 105.5±22 (155-85)° representing 74.9±15 (100-53)% of the contralateral side range. The mean flexion range of operated side was non-significantly increased to 47±12.7 (35-75)°, while extension range was significantly increased to 58.5±10 (50-80)°. Regarding radial-ulnar deviation, the mean range was 33.5±6.7 (45-25)° representing 76.5±16 (100-50)% of the contralateral side. The mean ulnar deviation of operated side was significantly increased to 22±3.5 (15-25)°, while radial deviation was non-significantly increased to 11.5±4.1 (5-20)°. The mean grip strength of operated side was significantly increased to 90±14.5 (70-110) mmHg representing 93.2±11 (100-75)% of the contralateral side (Table 3).

There was no statistically significant relation between results and neither age, gender, occupation, smoking nor hand dominance. Regarding follow-up period, It was found that grip strength (p=0.0096), extension-flexion range of motion (p=0.0094) and modified Mayo score (p=0.0007) revealed statistically better results with longer follow-up period. While there was no statistically significant difference between radial-ulnar range of motion and follow-up period (p=0.8577).

Table 3: Preoperative and postoperative results.

	Preoperative	Postoperative	P value
Flexion (°)	40±3.3 (35-45)	47±12.7 (35-75)	0.10527
Extension (°)	53±7.9 (40-65)	58.5±10 (50-80)	0.01744
Ulnar deviation (°)	19±3.9 (15-25)	22±3.5 (15-25)	0.02386
Radial deviation (°)	10.5±2.8 (5-15)	11.5±4.1 (5-20)	0.34344
Grip (mmHg)	59.5±10.4 (45-75)	90±14.5 (70-110)	0.00041
Modified Mayo score		81.5±11.8 (65-100)	

DISCUSSION

Although there are many theories explaining the etiology of Kienbock's disease, it is not fully proved what the cause of lunate necrosis is. Therefore, various techniques were described to deal with each stage of the disease. Regarding late stages with lunate collapse, both limited carpal fusions and proximal raw carpectomy are popular options. Scapho-trapezial-trapezoid and scaphocapitate are the commonest limited carpal fusions. Biomechanical studies have suggested that scaphocapitate fusion shifts forces across the radiolunate and lunocapitate articulations to the radioscaphoid joint.[23]

Nakamura et al compared 20 patients with Kienbock who were treated with either proximal raw carpectomy or limited carpal fusions.[24] Pain improvement was observed in 71% of patients underwent PRC and 85% of those with limited fusions. The average range of wrist flexion-extension did not improve with either method of treatment, although the postoperative range was greater with limited fusions. The average grip strength, compared with the contralateral side, was greater after limited fusions, although the difference was of no statistical significance.

On the other hand, Tambe et al retrospectively compared 18 patients with Lichtman stages IIIB and IV who were treated with total versus limited wrist fusions.[25] The authors stated that, although pain after total wrist fusion was significantly improved compared with limited fusions, the improvement of grip strengths and the DASH scores was slightly better in the limited fusion group which has no statistical significance. As expected, the partial wrist fusion group retained some movement while the total wrist fusion group had none.

Table 4: Aggregate results of scaphocapitate fusion for Kienbock disease in the literature.

Author	Treatm-ent	No. wrists	Stage	Follow up (months)	Range				Grip % of contral ateral side
					Extension	Flexion	Radial d.	Ulnar d.	
Rhee et al[27]	SC	27	III, IV	60 (12-192)	36	30	11	23	150
O' Zdemir et al[28]	SC	9	IIIB	17 (12-24)	28	41			71
Zakzouk[29]	SC	18	III	28 (18-61)	39	31	18	23	72
Charre et al[30]	SC	18	III, IV	128 (28-264)	45	40	12	30	74
Luegmair et al[26]	SC	10	IIIB, IV	94 (15-223)	45	39	16	25	64
Sennwald et al[26]	SC	11	II, III	36 (13-57)	64		28		83
Pisano et al[26]	SC	9	II,III,IV	23 (16-57)	42	32	10	24	74
Current study	SC	10	III	14 (6-24)	59	47	12	22	93

Luegmair et al reviewed ten patients who underwent scaphocapitate arthrodesis for stage IIIB and IV Kienbock disease (Table 4).[26] The authors concluded that, pain was substantially reduced. The mean QuickDASH score was 27. Radiographic analysis showed union in nine patients, maintenance of carpal height with a corrected radioscaphoid angle, and no evidence of ulnar translation. Budoff et al report two cases of ulnar translation of the wrist after scaphocapitate arthrodesis with lunate excision for the treatment of advanced Kienbock's disease, however; the radioscaphocapitate ligament was intact in both cases.[31]

Wrist arthroscopy has a rising role in both assessment and treatment of Kienbock's disease. Arthroscopy provides a direct visualization and allows probing of the articular surfaces which is a more reliable way to asses functioning articulations and hence guide to appropriate intervention. Arthroscopy also enables minimally invasive techniques to be performed.[32]

CONCLUSION

The presented results demonstrate that scaphocpitate fusion is a recommended solution for treatment of late stages of Kienbock's disease with lunate collapse. Posterior interosseous neurectomy offers a suitable option to deal with wrist pain. Longer postoperative time has a positive impact on grip strength and flexion-extension range of motion.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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