

Evaluation of Wrist Function in Scaphocapitate Fusion For Management of Kienböck's Disease: A Prospective Study

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Abstract

Background: Kienböck's disease is a condition characterized by avascular necrosis due to loss of blood supply of the lunate bone in the wrist. Scaphocapitate fusion is one surgical option for managing advanced stages of Kienböck's disease. This work aimed to evaluate the scaphocapitate fusion outcome for treatment of Kienböck's disease. **Methods:** In this prospective study, 70 patients with Kienböck's disease, stage II & III were recruited from Orthopedic surgery department of Benha University Hospitals. All included patients were subjected to full history taking, clinical evaluation, radiographic evaluation, medical assessment and laboratory investigation. **Results:** The mean range of motion of the wrist was 32.58 ± 2.79 and 32.46 ± 2.71 degrees preoperatively in flexion and extension, respectively, it was increased to 42.18 ± 2.81 and 42.44 ± 2.69 degrees postoperatively in flexion and extension, respectively. Comparison between preoperative and postoperative values showed statistically significant difference ($p = 0.011$ & 0.013 , respectively). The final outcome after the follow-up period indicated that 8 patients (16%) were excellent, 31 cases (62%) were good and 11 cases (22%) were fair measured clinically by Mayo score system. Minimum complications were recorded 2 cases with persistent pain; 1 mild and 1 moderate and only one case with malunion and infection. **Conclusions:** Scaphocapitate fusion for Kienböck's disease stage II and III with preservation of the lunate and radiocarpal joint maintains wrist motion and significantly relieves pain. Scaphocapitate arthrodesis achieved a high rate of satisfactory clinical and radiological results with minimal complications and preserves carpal height.

Keywords: Wrist Function, Scaphocapitate Fusion, Kienböck's Disease

Introduction

Kienböck's disease is a condition characterized by avascular necrosis due to loss of blood supply of the lunate bone in the wrist. When conservative treatments fail to relieve symptoms, surgical interventions may be considered. Scaphocapitate fusion is one surgical option for managing advanced stages of Kienböck's disease. This procedure involves fusing the scaphoid and capitate bones in the wrist to stabilize the joint and alleviate symptoms ^[1].

The cause of Kienböck's disease is still unclear. It was initially considered as osteomalacia, before being recognized as avascular necrosis of the lunate. Its functional prognosis is doubtful, given that the progression often leads to wrist degeneration ^[2].

Conservative treatment does not provide good results in adults; thus, surgery is often needed. Certain anatomical factors such as the ulnar variance, configuration of the lunate or orientation of the radial glenoid have turned out not to contribute to necrosis but may contribute to lunate fracture ^[3].

The lunate's vascularization can be precarious and mostly depends on the capsular arterioles. The lunate is a very mobile bone that participates in wrist movements, both in the radiocarpal joint and especially in the mid-carpal joints during activities of daily living. The lunate makes contact with the radius and triangular fibrocartilage complex and is often subjected to high shear loads at the edge of the radius that can cause it to

fracture. MRI and arthroscopy can contribute to the assessment ^[2].

Kienböck's disease is likely an inflammatory, biological venous thrombosis disorder that leads to local damage due to intraosseous compartment syndrome ^[4]. The disease etiology and progression are probably linked to the altered regional anatomy and vascular supply. Repetitive external microtrauma and various intrinsic factors, such as low radial inclination angle and negative ulnar variance are associated with the development of Kienböck's disease. It results in altered wrist biomechanics producing debilitating pain at the wrist. The disease is staged according to radiological and clinical findings and the stage guides the treatment ^[5].

The basis of surgical treatment is to decompress the lunate to shield it from shear and compression loads. Existing osteotomy procedures described and compared to better understand their biomechanical effects. Some osteotomies do not reduce the loads transmitted to the lunate but can reduce the risk of intraosseous shear. Some osteotomies may place excessive pressure on the lunate on its ulnar side. Some techniques are extra-articular and preserve the capsule's vascularization along with the anatomy of the mid-carpal joint ^[2]. When the lunate damage is so severe that the bone's viability is compromised, bone grafting or replacement have been proposed. The palliative techniques typically used for wrist degeneration are indicated in the terminal stages ^[6].

Scaphocapitate fusion is an effective procedure for the management of Kienböck's disease, providing satisfactory functional and radiological outcomes. It is associated with significant improvements in pain scores, grip strength, and wrist range of motion. However, there is a significant reduction in radial deviation after surgery ^[1].

Scaphocapitate fusion can provide effective pain relief by eliminating motion at the diseased lunate bone. This is particularly beneficial for patients who have persistent pain despite conservative treatments. The degree of pain relief may vary among individuals, and some patients may experience residual discomfort or pain due to other factors such as arthritis or joint stiffness ^[5].

Additionally, scaphocapitate fusion results in a decrease in carpal height, scapholunate angle, and radioscapoid angle. The overall complication rate and reoperation rate are 24% and 14%, respectively ^[7]. Long-term outcomes studies have shown that the benefits of an arthroscopic approach may be worth the learning curve ^[1].

There are currently no effective biological treatments. While the origin of Kienböck's disease is still unknown, we now know that decompression osteotomies, while they do not heal the necrosis, protect the lunate from collapse, which hopefully provides enough time for biological healing to occur ^[2].

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

Patients and Methods

In this prospective study, 50 adult patients aged above 19 years with Kienböck's disease, stage II & III were recruited from Orthopedic Surgery Department in the period between October 2022 and April 2024. The study was performed in the Orthopedic Surgery Department, Faculty of Medicine, Benha University, Egypt

Informed written consent was obtained from all patients. The study was done after approval from the Ethics Committee on research (approval code: MD 3-2-2022) involving human subjects of Benha faculty of Medicine

Exclusion criteria

Patients with Kienböck's disease stages I and IV, age below 19 years, Patients with extensive degenerative changes in the wrist, patients with radio-scaphoid joint arthritis, patients with previous surgical interference in the wrist, and patients who are not fit for surgery

Inclusion criteria

Patients who signed the informed consent for participating in the study.

All included patients were subjected to full history taking: Personal history: (name, age, sex, residence, phone number, occupation, and dominance), Past history: (History of previous medical illness or chronic disease (hypertension and diabetes mellitus), History of previous surgical intervention and anesthesia, History of previous bone diseases), Present history: (Patient's first complaint, onset of the disease, medication, duration of the disease and its progression), Clinical

Evaluation: Clinically patients were evaluated using the modified Mayo Wrist Score which consists of functional status, pain intensity, grip strength, and range of motion.

The score was graded as: (Excellent: a score ranged from 80–100 points, Good: a score ranged from 65–79 points, Moderate (fair): a score ranged from 50–64 points, Poor: a score ranged from 0 to 49 points), Radiographic Evaluation: Posteroanterior (PA) and lateral radiographs, and MRI were performed, Medical Assessment: Full medical assessment to exclude systemic diseases such as hypertension, diabetes mellitus, liver or kidney diseases, Laboratory Investigation: (Complete blood count (CBC) and hemoglobin concentration, Fasting and postprandial blood glucose as well as glycosylated hemoglobin (HbA1c), Liver function tests, Kidney function tests, Hepatitis markers for viruses (C & B)).

Operative procedure: Scaphocapitate arthrodesis were performed for the patients. 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. 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. The radiocarpal and mid-carpal spaces were evaluated for arthritic lesions. Any rotational subluxation of the scaphoid was reduced. The scaphoid and capitate were

freshened down to bleeding cancellous bone. Then two K-wires and screws were inserted to preserve the reduction and provide provisional scaphocapitate fusion to get a permanent scapho-capitate fusion. 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 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.

Follow-up was done clinically and radiologically after an average of 6 months (range, 6–12 months).

Study Outcomes:

Primary outcomes include (Range of wrist motion, Grip strength).

Secondary outcome parameters include (Union time, Occurrence of complications)

Statistical analysis:

Statistical analysis was done by SPSS v28 (IBM Inc., Armonk, NY, USA). Quantitative variables were presented as

mean and standard deviation (SD) and compared between the two groups utilizing ANOVA (F) test. Qualitative variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test. A two tailed P value < 0.05 was considered statistically significant. Pearson correlation was done to estimate the degree of correlation between two quantitative variables.

Results

In this study seventy patients with Kienböck's disease stage II & III in whom scaphocapitate fusion was done were included. They were 26 males (37.1%) and 44 females (62.9%). The age ranged from 23 to 59 years with mean \pm SD of 41.56 ± 9.51 years and median of 41.5. Diabetes mellitus represented in 12/50 cases (24%) and hypertension was found in 16 cases (32%). Most of the patients were right side 31 cases (62%) and the left side was found in 19 cases (38%). Most of patients were stage II in 20 cases (40%), then stage IIIb in 18 cases (36%) and stage IIIa in 12 cases (24%). The ulnae were in neutral position in most of cases 32 (64%), then they show positive position in 16 cases (32%) and in negative position in only 2 cases (4%). Ring sign was found in 44 cases (88%) and not found in 6 cases (12%). **Table 1.**

The mean carpal index was 0.454 ± 0.013 , Youm index was 0.495 ± 0.013 , RSA was 56.72 ± 1.838 . The mean visual analogue scale for pain was 7.74 ± 1.23 where VAS was 0 represent no pain, 1-3 represent mild pain, 4-6 represent moderate pain, 7-9 severe pain and 10 was very severe. **Table 2**

Grip strength showed highly significant increase in postoperatively than preoperatively ($p=0.001$). The mean range of motion of the wrist was 32.58 ± 2.79 and 32.46 ± 2.71 degrees preoperatively in flexion and extension, respectively, it was increased to 42.18 ± 2.81 and 42.44 ± 2.69 degrees postoperatively in flexion and extension, respectively. Comparison between preoperative and postoperative values showed statistically significant difference ($p = 0.011$ & 0.013 , respectively). **Table 3**

The final outcome after the follow-up period indicated that 8 patients (16%) were excellent, 31 cases (62%) were good and 11 cases (22%) were fair measured clinically by Mayo score system. The time of union was ranged from 10 to 14 weeks with mean of 11.72 ± 1.09 weeks. Minimum complications were recorded 2 cases with persistent pain; 1 mild and 1 moderate and only one case with malunion. No other complication was observed in our cases. **Table 4**

Table 1: Analysis of demographic data, Risk factors, Laterality, Preoperative radiographic evaluation of the cases of the study

Age (years)		Cases (n = 70)	
		41.56 ± 9.51	
Gender	Male	26	68.0%
	Female	44	32.0%
Risk factors	Diabetes mellitus	12	24.0
	Hypertension	16	32.0
	Total	50	100
Laterality	Right side	31	62.0
	Left side	19	38.0
	Total	50	100
Lich stage	Stage II	20	40.0
	Stage IIIa	12	24.0
	Stage IIIb	18	36.0
Ulnar variance	Neutral position	32	64.0
	Positive	16	32.0
	Negative	2	4.0
Ring sign	Yes	44	88.0
	No	6	12.0

Quantitative data are expressed as Mean ± SD or Median (Range), Qualitative data are expressed as number (percentage)

Table 2: Baseline radiological and pain indices.

		Mean ±SD
Index	Carpal index	0.454 ± 0.013
	Youm index	0.495 ± 0.013
	RSA	56.72 ± 1.838
	VAS for pain	7.74 ± 1.23

RSA: Radioscaphoid angle, VAS: visual analogue scale

Table 3: Pre- and post-operative grip strength and range of motion of the wrists of the studied cases.

Grip strength	Preoperative	Postoperative	t	P
	38.5 ± 4.96	73.7 ± 4.85	5.862	0.001*
Flexion	32.58 ± 2.79	42.18 ± 2.81	1.634	0.011*
Extension	32.46 ± 2.71	42.44 ± 2.69	1.629	0.013*

t: unpaired t-test, *P: statistically highly significant.

Table 4: Final outcome by Mayo score system for union and Postoperatively complications.

MSS for union	No.	%
Excellent	8	16.0
Good	31	62.0
Fair	11	22.0
Total	50	100
Time of union	Weeks	11.72 ± 1.09
Infection	0	0.0
Persistent pain	2	4.0
Loss of reduction	0	0.0
Transient paresthesia	0	0.0
Malunion	1	2.0
Non-union	0	0.0

MSS: Mayo score system.

Discussion

Both scaphotrapeziotrapezoid (STT) and scaphocapitate arthrodesis (SCA) have been reported as valuable limited wrist arthrodesis (LWA) treatment options for advanced Kienböck's disease. More recently, proximal row carpectomy (PRC) have also been reported as a valuable therapeutic option with favorable long-term functional results^[8].

The study cases were 26 males (37.1%) and 44 females (62.9%). The age ranged from 23 to 59 years with mean \pm SD of 41.56 ± 9.51 years and median of 41.5. Diabetes mellitus represented in 12/38 cases (24%) and hypertension was found in 16 cases (32%). Most of the patients were right side 31 cases (62%) and the left side was found in 19 cases (38%). The ages of our patients are consistent. which was 36.6 years (range, 24 to 55 years).

Most of patients were stage II in 50 cases (40%), then stage IIIb in 18 cases (36%) and stage IIIa in 12 cases (24%). The ulnae were in neutral position in most of cases 32 (64%), then they show positive position in 16 cases (32%) and in negative position in only 2 cases (4%). Ring sign was found in 44 cases (88%) and not found in 6 cases (12%).

The mean carpal index was 0.454 ± 0.013 , Youm index was 0.495 ± 0.013 , RSA was 56.72 ± 1.838 . The mean visual analogue scale for pain was 7.74 ± 1.23 where VAS was 0 represent no pain, 1-3 represent mild pain, 4-6 represent moderate pain, 7-9 severe pain and 10 was very severe. There is a significant reduction of pain postoperatively.

In agreement with our study, ^[10] found a significant reduction in wrist pain at rest ($p < 0.001$) and during activity ($p < 0.002$). These data are consistent with those from the literature^{[11], [12], [13], [8]}.

In an Egyptian study of 14 patients (70 %) had mild pain after performing stressful activities and 6 patients (30 %) had moderate pain in their twenty patients with Kienböck's disease.^[14]

In contrast to these results, it was found that four patients (36%) 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. Grip strength showed highly significant increase in postoperatively than preoperatively ($p = 0.001$). In agreement with our study, found a significant improvement in grip strength (+10 Kg, $p = 0.001$)^[10]

The mean range of motion of the wrist was 32.58 ± 2.79 and 32.46 ± 2.71 degrees preoperatively in flexion and extension, respectively, it was increased to 42.18 ± 2.81 and 42.44 ± 2.69 degrees postoperatively in flexion and extension, respectively. Comparison between preoperative and postoperative values showed statistically significant difference ($p = 0.011$ & 0.013 , respectively). The results of our study were comparable to other series as regards the range of wrist motions; study found a significant post-operative improvement in wrist flexion ($p = 0.034$) and extension ($p = 0.007$). The total active motion (TAM) of 91° at 69 months' follow-up in their study compares favorably. However, wrist movements slightly improved post-operatively in

study^[14]. In their study, the postoperative extension of the wrist averaged $42.9^{\circ} \pm 1.5$ (range: $40-45^{\circ}$), and the postoperative flexion of the wrist averaged $42.7^{\circ} \pm 2.4$ (range: $36-46^{\circ}$). All patients had a functional range of motion for their needs.^[10]

The final outcome after the follow-up period indicated that 8 patients (16%) were excellent, 31 cases (62%) were good and 11 cases (22%) were fair measured clinically by Mayo score system. The time of union was ranged from 10 to 14 weeks with mean of 11.72 ± 1.09 weeks

According to Mayo Score System, the results obtained after six months follow up were encouraging^[14]. Their results of treatment of 20 patients were excellent in 6 patients (30%), good in 10 patients (50%), and fair in 4 patients (20%).

In contrast, there were significant functional alterations of the operated wrists. A study noted a decrease of about 20° in TAM radial/ulnar deviation between the preoperative state and the final assessment. Similarly, extension was the most restricted motion at the final follow-up compared to the contralateral side.^[10]

Conclusions

Scaphocapitate fusion for Kienböck's disease stage II and III with preservation of the lunate and radiocarpal joint maintains wrist motion and significantly relieves pain. Scaphocapitate arthrodesis achieved a high rate of satisfactory clinical and radiological results with minimal complications and preserves carpal height.

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