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Clinical and radiological outcomes in treatment of Lichtman stage IIIB Kienböck's disease by scaphocapitate fusion: hospital based prospective interventional study

Ravi Khurana*, Narendra Saini, Parakh Dhingra, Kartik Samaria, Praveen Mahala

Department of Orthopaedics, S.M.S. Medical College, Jaipur, Rajasthan, India

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***Correspondence:**
Dr. Ravi Khurana,
E-mail: rkhurana1995@gmail.com

ABSTRACT

Background: This investigation assessed the effectiveness of scaphocapitate (SC) arthrodesis with lunate preservation in treating patients with stage IIIB Kienböck's disease, characterized by neutral ulnar variance. Additionally, the study sought to identify potential differences in treatment outcomes among patients with stage IIIB Kienböck's disease.
Methods: A total of 38 patients with stage IIIB Kienböck's disease underwent scaphocapitate arthrodesis, stabilized using Herbert compression screws. Each participant underwent comprehensive pre- and post-operative evaluations, including assessments of pain (VAS score), range of motion (ROM), grip strength and functional outcomes (DASH score and PRWE score).
Results: The mean follow-up period for all patients was 17.81 months. Bony union was achieved at an average of 14 weeks, with most patients returning to work within 24 weeks. Comparing pre- and post-operative outcomes, significant improvements were observed: VAS scores decreased from 39.34 to 15.53, grip strength increased from 18.03 to 29.47% and the RS angle was corrected from 84.08° to 59.34°.
Conclusions: This study demonstrates that surgical intervention can significantly enhance wrist mobility, increase grip strength and alleviate pain, ultimately facilitating patients' return to a higher level of functional ability and overall well-being.

Keywords: Arthrodesis, Kienböck's disease, Scaphocapitate

INTRODUCTION

Kienböck's disease involves the deterioration of the lunate bone, a carpal bone in the wrist that connects with the radius in the forearm. This condition, also known as avascular necrosis, results from a disruption in blood supply, leading to bone tissue death, fragmentation and collapse of the lunate.[1] It is considered a rare disorder, primarily affecting adults aged 20 to 40, with a higher prevalence in male manual laborers. While it typically occurs in one wrist, both wrists can be affected over time.[2] The exact cause of Kienböck's disease remains unclear, but it is thought to arise from various risk factors associated with the lunate and wrist.[3] Repeated stress or abnormal loads on the lunate can disrupt its blood supply, causing osteonecrosis, collapse and changes in wrist joint mechanics.[4] Patients commonly experience wrist pain and tenderness over the lunate, along with reduced motion or stiffness and possible swelling.

The disease is classified into stages based on clinical and radiological evaluations, which inform treatment options.[5] Stahl and Decoulx initially described progressive radiological stages of Kienböck's disease.[6] In early stages (I and II), the lunate maintains its shape but may show changes in density. By stage III, flattening begins and stage

IV may present signs of radiocarpal osteoarthritis. Lichtman later refined stage III into subcategories A and B, indicating the presence or absence of carpal collapse.[7] Recent advancements in MRI and arthroscopic findings have led to new classification systems that could influence treatment strategies.[8] Treatment approaches for Kienböck's disease vary based on the clinical presentation and disease stage. Early intervention may involve observation or immobilization, while advanced stages often require surgical options such as joint leveling, lunate revascularization, limited carpal fusion or total wrist fusion.[9,10]

In stage III B, where the lunate is either collapsed or cannot be revascularized, the goal of treatment shifts to managing the collapse to delay osteoarthritis. Lichtman emphasized that while procedures to equalize the wrist may relieve pressure on the lunate, they are unlikely to restore normal wrist function. In such cases, fusions like scaphotrapeziotrapezoid (STT) or scaphocapitate (SC) may be advised and excision of the lunate may be necessary if significant inflammation is present.[11] However, there is ongoing debate regarding the best treatment methods due to varying patient outcomes.

The objective of this study was to assess the effectiveness of scaphocapitate (SC) arthrodesis with preservation of the lunate in the treatment of Lichtman Stage IIIb Kienböck's disease, specifically in patients with neutral ulnar variance. The study aimed to evaluate both clinical (pain, grip strength, range of motion, functional outcomes) and radiological outcomes following surgical intervention and to identify any variations in treatment response among this patient group.

METHODS

This was a hospital-based prospective interventional study conducted in the Department of Orthopaedics at SMS Medical College and Hospital, Jaipur. The study included patients with Lichtman Stage IIIB Kienböck's disease who underwent scaphocapitate fusion. Patients attending the outpatient department, wards or emergency with Lichtman Stage IIIB Kienböck's disease who underwent scaphocapitate fusion and met the inclusion criteria were included in the study from September 2022 to February 2024, following ethical clearance from the institutional review board.

Data collection was done using a pre-tested, structured pro forma for each patient and demographic information was gathered from case records. The study's inclusion criteria consisted of patients with a confirmed diagnosis of Kienböck's disease, as verified by MRI and staged via X-ray and who were deemed fit for surgery.

Conversely, exclusion criteria comprised patients with associated conditions, those who declined consent to participate in the study and individuals deemed unfit for surgery. Qualifying patients underwent a detailed history, clinical examination, laboratory and radiological investigations and their clinical history and examination findings were recorded prospectively. Patients who provided written informed consent were included in the study after being informed about their enrollment and the study's implications. The study began only after obtaining ethical approval from the institutional ethics committee.

A sample size of 34 patients was calculated based on an alpha error of 0.05 and 80% power, assuming a 10% absolute allowable error and a prevalence of 89% among patients whose range of movement outcomes were measured using a goniometer. Considering potential variations, a rounded sample size of 38 patients was deemed adequate, accounting for an additional 10% to ensure sufficient data.

Statistical analysis

Data were compiled and analyzed using IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY: IBM Corp). Descriptive statistics were used to summarize demographic and clinical characteristics. Paired t-tests were performed to compare preoperative and postoperative variables. A p-value of <0.05 was considered statistically significant.

Surgical technique

The surgical treatment aimed to unload the lunate, shielding it from harmful shear and compression loads. The procedure involved a longitudinal incision between the second and fourth dorsal compartments, followed by a standard ligament-sparing capsulotomy. The scaphocapitate articulation was exposed and remaining articular cartilage was removed. In cases of progressive scaphoid flexion, a 1.5 mm Kirschner wire was used to correct the deformity, aiming for a radio scaphoid angle of approximately 45º.

A 2.7 mm Herbert screw provisionally fixed the scaphocapitate joint. Postoperatively, a below-elbow slab was applied and mobilization of proximal and distal interphalangeal joints and metacarpophalangeal joints began immediately. Clinical evaluation occurred at 6 weeks, 12 weeks and 6 months postoperatively, assessing pain, range of motion and grip strength, supplemented by radiological evaluation via X-rays.

RESULTS

This study involved 38 patients diagnosed with stage IIIb Kienböck's disease, all of whom underwent scaphocapitate fusion. The results showed that 52.6% of the patients were female and 47.4% were male, with the majority (68.4%) aged 21-30 years. The right and left sides were equally affected and the mean follow-up duration was 17.81 months. Preoperatively, 36.8% of patients experienced moderately to severely painful intermittent pain, while 26.4% had mild pain.

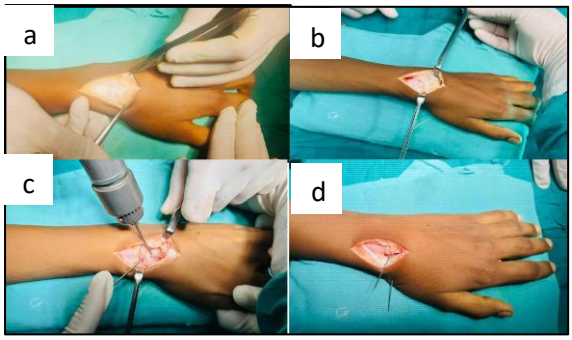

Figure 1: Scaphocapitate fusion surgical approach (a) opening of third dorsal wrist compartment. (b)The wrist capsule incised longitudinally and the joint was explored, (c) removal of SC articular cartilage while preserving the volar rim to maintain the space between the scaphoid and capitate bones, (d) scaphocapitate pinning done.

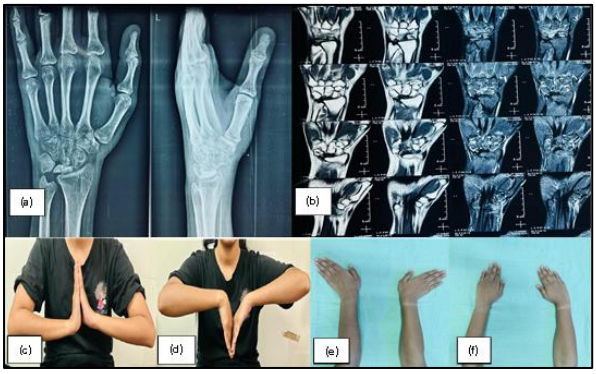

Figure 2: (a) Preop X-ray and (b) MRI film of 18 years/ f with stage IIIb Kienböck's disease left side. Pre-operatively, the patient demonstrated a range of motion at the wrist joint on the affected left side, with the following measurements (c) dorsiflexion of 45°, (d) palmar flexion of 35°, (e) ulnar deviation of 20° and (f) radial deviation of 5°.

Figure 3: (a) Immediate postop X-ray of wrist Anterior-posterior and lateral views left side showing Scaphocapitate fusion with Herbert screw. (b) Postop X-ray of wrist Anterior-posterior and lateral views at final follow up. At the final follow-up, the patient demonstrated improved range of motion at the wrist joint postoperatively on the affected left side, with the following measurements: (c) dorsiflexion of 60°, (d) palmar flexion of 40°, (e) ulnar deviation of 30°, (f) and radial deviation of 10°.

Postoperative improvements were significant, with mean dorsiflexion increasing from 30.26° to 40.26°, palmar flexion from 30.79° to 38.42° and ulnar deviation from 18.37° to 24.6°. Radial deviation showed no significant difference. The average VAS score decreased from 39.34 to 15.53 and grip strength increased from 18.03 to 29.47. The mean DASH score was 22.92, PRWE score was 34.68 and radioscaphoid angle improved from 84.08° to 59.34°. The scapholunate angle decreased from 65.13° to 44.74° and the mean MCHR was 1.57.

Table 1: Preoperative and postoperative results.

Variable	Preoperative (Mean±SD)	Postoperative (Mean±SD)	P value
Dorsiflexion (°)	30.26±10.33	40.26±6.25	0.001
Palmar flexion (°)	30.79±11.99	38.42±6.59	0.001
Radial deviation (°)	11.58±4.66	11.79±4.16	0.73
Ulnar deviation (°)	18.37±5.93	24.60±5.62	0.001
VAS score	39.34±5.59	15.53±5.90	0.001
Grip strength (mmHg)	18.03±6.53	29.47±5.55	0.001
Radio scaphoid angle (°)	84.08±14.79	59.34±10.73	0.001
Scapholunate angle (°)	65.13±8.74	44.74±8.30	0.001

Table 2: Demographic profile of patients (n=38).

Variable	Category	Frequency (N)	%
Age group (in years)	≤20	9	23.7
	21-30	26	68.4
	>30	3	7.9
Sex	Male	18	47.4
	Female	20	52.6
Side affected	Right	19	50.0

Continued.

Variable	Category	Frequency (N)	%
	Left	19	50.0
Pain severity (Pre-op)	Mild	10	26.4
	Moderate to severe	14	36.8
	Not Specified	14	36.8

DISCUSSION

The treatment of Lichtman Stage IIIb Kienböck's disease, characterized by lunate bone collapse and progressive carpal malalignment, presents significant clinical challenges. Scaphocapitate fusion has emerged as a viable surgical option, aiming to stabilize the wrist, reduce pain and preserve functional mobility. This procedure addresses the abnormal mechanics caused by lunate collapse, particularly fixed flexion of the scaphoid and disrupted load distribution, by fusing the scaphoid and capitate bones to restore carpal alignment and prevent further degeneration.

Clinically, outcomes have been assessed through metrics such as pain relief, functional improvement and preservation of wrist motion. Postoperative studies show marked pain reduction, attributed to carpal stabilization and reduced abnormal forces on the lunate, as well as improvements in grip strength. Functional assessments, like the DASH score, reflect overall wrist function and quality of life improvements. Radiologically, imaging techniques provide insights into carpal alignment, lunate status and fusion success. The procedure aims to unload the lunate and prevent secondary degenerative changes, although long-term studies are necessary. A key advantage of scaphocapitate fusion is its ability to preserve wrist motion compared to more radical options like total wrist arthrodesis or proximal row carpectomy.

However, limitations include reduced overall wrist motion and the risk of adjacent joint degeneration. This study is subject to several constraints. The small sample size of 38 patients and the single-center design may restrict the broader applicability of the results. Furthermore, the relatively short follow-up period of 17.81 months might not fully capture potential long-term complications, such as progressive joint degeneration.

Additionally, inherent limitations of the procedure itself include reduced wrist motion and the possibility of degeneration in adjacent joints. Although some wrist mobility was preserved, all patients experienced a reduction in motion compared to the normal range.

Complications may include progressive arthritis or degeneration in adjacent wrist joints, such as the lunotriquetral or radiocarpal joints. Despite improvements in pain scores, some patients may continue to experience chronic discomfort or stiffness, particularly during physically demanding activities. Further surgical intervention, including revision procedures, may also be necessary in cases of persistent symptoms or complications. This study's findings are discussed in the context of existing literature to assess their generalizability. In our study, 52.6% of patients were female and 47.4% were male, with 68.4% aged between 21 and 30 years and 23.7% aged 20 years or younger. Only 7.9% of patients were older than 30 years.

In comparison, Collon et al, reported 7 men and 10 women with a median age of 29 years, while Meena et al, included 23 patients (14 women and 9 men) with a median age of 30 years.[12,13] Luegmair et al, reported a mean age of 42.5 years and Rhee et al, included 27 patients (17 males and 10 females) with a mean age of 41 years.[14,15] In our study, the right and left wrists were equally affected (50% each) and the mean follow-up duration was 17.81 months. Preoperatively, 36.8% of patients experienced moderately to severely painful intermittent pain, while 26.4% reported mild pain.

These findings are consistent with previous studies. For example, Meena et al, conducted a long-term follow-up (minimum 7 years) on 23 patients and reported substantial functional improvement, with a mean DASH score of 26, comparable to the DASH score of 22.92 observed in the current study. Both studies reported a return to manual labor postoperatively, although Meena et al, confirmed the durability of results over a longer period.

Similarly, Collon et al, studied 17 patients over a mean follow-up of 7.5 years, finding that 88% experienced significant or complete pain relief and preserved 50–70% of contralateral wrist motion results that align with the motion improvements observed in the present study. Our study demonstrated favorable short-term outcomes, with notable reductions in pain and improvements in grip strength. However, the absence of long-term follow-up data limits the scope of these findings. Despite this, the consistency of our results with existing literature supports the effectiveness of scaphocapitate fusion in managing Stage IIIb Kienböck's disease.

CONCLUSION

In conclusion, scaphocapitate fusion offers a promising option for treating Lichtman Stage IIIb Kienböck's disease by providing pain relief, improving grip strength and preserving a functional range of wrist motion. Clinically, patients experience significant improvements in both pain and function, while radiologically, the procedure achieves stable carpal alignment and halts lunate collapse in most cases. Although the long-term risk of degenerative changes in adjacent joints remains a concern,

scaphocapitate fusion strikes a balance between joint preservation and disease control, making it an attractive alternative to more invasive procedures. Further studies with long-term follow-up are essential to refine the technique and better understand its role in the broader management of advanced Kienböck's disease.

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