SCIENTIFIC ARTICLE

Arthroscopic Treatment of Kienböck Disease: Mid-Term Outcome of Arthroscopic Lunate Core Decompression

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Purpose This study evaluated the mid-term functional and radiological results of arthroscopic lunate core decompression for treating Kienböck disease.

Methods In a prospective cohort study, 40 patients with a confirmed diagnosis of Kienböck disease (Lichtman stages II to IIIb) underwent arthroscopic core decompression of the lunate bone. A cutting bur was used through the trans-4 portal with visualization from the 3-4 portal after synovectomy and debridement of radiocarpal joint using a shaver from the 6R portal. Disabilities of Arm, Shoulder, and Hand and visual analog scale scores, wrist range of motion, grip strength, radiological changes of Lichtman classification, carpal height ratio, and scapholunate angle were evaluated before and two years after the surgery.

Results The mean of Disabilities of Arm, Shoulder, and Hand score improved from 52.5 $\pm$ 13 to 29.2 $\pm$ 16.3. The visual analog scale score also improved from 7.6 $\pm$ 1.8 to 2.7 $\pm$ 1.9. There was also an improvement in hand grip strength from 6.6 $\pm$ 2.7 kg to 12.3 $\pm$ 3.1 kg. Wrist range of motion in flexion, extension, ulnar deviation, and radial deviation improved significantly. Lichtman classification remained the same in 36 (90%) patients. Carpal height did not change. Intergroup evaluation showed no functional difference in response to surgery for different radiological Lichtman stages. More improvement was observed in patients with Lichtman stage II, but was not statistically significant.

Conclusions Arthroscopic lunate core decompression appears to be an effective and safe surgery for treating Kienböck disease on the basis of mid-term follow-up. *(J Hand Surg Am. 2023;■(■):1.e1-e7. Copyright © 2023 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Core decompression, Kienböck disease, lunate bone osteonecrosis, wrist arthroscopy.

Online Exclusive

THE CAUSE OF KIENBÖCK disease is still under debate, but is probably multifactorial, including anatomic factors, interrupted vascularity, and traumatic insults to the lunate, especially repetitive loading.[1−3] Although the natural course of the disease is not yet fully known, the

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disease manifests in a series of stages culminating in osteoarthritis of the wrist. If untreated, destruction of the wrist joint, severe osteoarthritis, and loss of wrist movement can be observed.[2,4,5]

Various methods have been proposed for treating Kienböck disease. Many surgeons prefer to use joint leveling procedures when there is negative ulnar variance, but for neutral or positive ulnar variance there is controversy.[6] Although radial osteotomy is the most popular procedure,[7] complications including the need for implant removal during a second surgery, distal radioulnar joint incongruity following radial shortening, and radioscaphoid arthritic changes following radial wedge osteotomy are major concerns.[3]

Other treatments, like vascular grafting, wrist denervation, and lunate arthroplasty, have also been reported. However, none of these strategies have been shown to reverse the disease course and have often been associated with complications.[8] Treatments, such as lunate excision and intercarpal fusion, lead to decreased range of motion. Proximal row carpectomy is a reliable motion-preserving procedure with good clinical results for advanced stages of the disease in long-term follow-up.[8] The concept of relieving pressure on the lunate was introduced in 2001 by core decompression of the radius or ulna as a minimally invasive treatment method for Kienböck disease.[9]

Recently, there have been considerable advances in arthroscopic diagnosis and classification of Kienböck disease using wrist arthroscopy.[10−13] Menth-Chiari et al[14] debrided the necrotic bone and reported satisfactory results. Using arthroscopy, Bain et al[6] reported promising results for lunate core decompression. The dorsal aspect of the lunate was drilled with a 2-mm drill through a cannula in the 3-4 portal, which is a simple and less invasive technique that may be beneficial during the early stages of the disease.

Mehrpour et al[2] previously published results of open lunate core decompression for treating Kienböck disease; we conducted a cadaver study to find a safe and effective method to accomplish the surgery arthroscopically. We found that the trans-4 portal is best for performing arthroscopic lunate core decompression.[15] We started arthroscopic lunate core decompression as a treatment for Kienböck disease in two different academic centers separately. Our colleagues' results with this procedure have been published and showed similar results for arthroscopic lunate core decompression and radial shortening.[16] In this study, we report the mid-term outcome of arthroscopic lunate core decompression in our center.

MATERIALS AND METHODS

In this prospective cohort study, all patients who were referred to our center from June 2015 to December 2018 with the diagnosis of Kienböck disease (Lichtman stages II to IIIb, confirmed with T1 and T2 magnetic resonance imaging) were enrolled in the study, which was approved by our institutional review board. After hearing the full description of various treatments, the patients chose between radial osteotomy and arthroscopic lunate core decompression.

Our inclusion criteria included all patients with Kienböck disease in stages II to IIIb who chose arthroscopic lunate core decompression and completed 24 months of follow-up. The exclusion criteria included the following: (1) a history of any kind of wrist fracture or surgery, (2) $<$24 months follow-up, and (3) Lichtman stage IV, ie, osteoarthritis in wrist joint.

After obtaining written informed consent for surgery, we recorded wrist range of motion, point tenderness, and hand grip force (measured by Jamar dynamometer).[17] The radioscaphoid angle and carpal height ratio of the wrist were determined on lateral and anteroposterior radiographs.[18] The Disability of Arm, Shoulder, and Hand (DASH) score and visual analog score (VAS) scales were completed by patients.[19] All data were collected before surgery and during follow-up at 6 weeks and 3, 6, and 12 months after surgery and at final follow-up (at least 24 months after surgery). An experienced orthopedic hand surgeon (H.S) with $>$12 years of experience with wrist arthroscopy (level 4 expertise),[20] performed all surgeries and determined Lichtman classification. A second author (S.S) made clinical measurements of the patients before and after surgery.

Surgical technique

A standard wrist arthroscopy was carried out with the patient in the supine position, elbow flexed 90°, and 5 kg traction on the arm. We began with diagnostic arthroscopy of radiocarpal joint through the 3-4 portal, and performing debridement and synovectomy from the 6R portal. We used the trans-4 portal for lunate core decompression. We inserted a 0.078-inch diameter Steinman pin in the lunate bone from the trans-4 portal under fluoroscopic control (Fig. 1A−C). The length of penetration was estimated by comparison with a second Steinman pin of the same size. The Steinman pin was removed and a 2.5-mm cutting bur was inserted from the trans-4

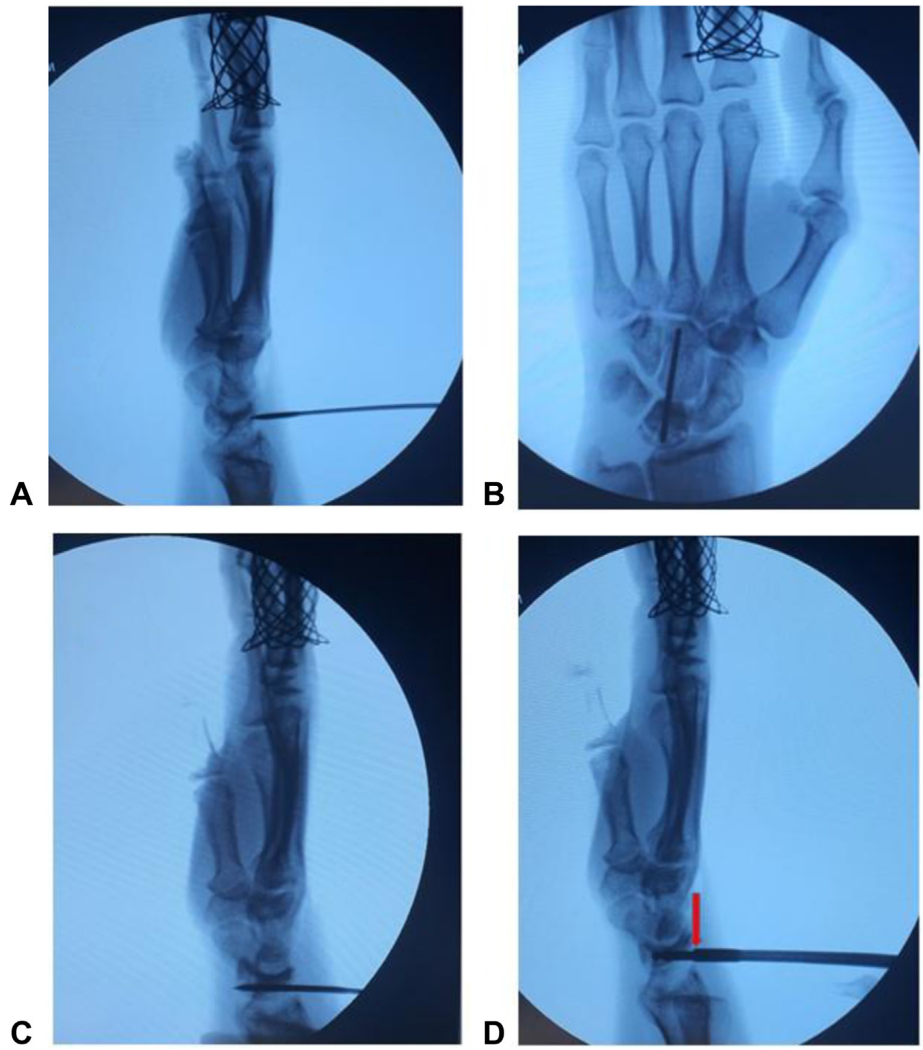

FIGURE 1: Inserting a Steinman pin from trans-4 portal and checking its correct position. **A, B** Pushing the Steinman pin forward until volar cortex of the lunate bone, and **C** inserting the cutting bur from the trans-4 portal and doing core decompression. **D** Shield of the bur prevents unwanted progression of the bur (red arrow).

portal. We confirmed the position of the bur using fluoroscopy during decompression (Fig. 1C).

Decompressing with posteroanterior progression under fluoroscopic control, we did not rotate the bur at a 20° angle in the lunate bone during decompression, in contrast to Kamrani et al's[16] study, because we believed this could damage the lunate bone, which is soft and at risk of fragmentation. To prevent damage to the extensor tendons during entry and rotation of bur, we used the same method described in our previous study on the first few patients.[15] However, we used a shield in the rest of the cases so that the distance of the tip of the bur and tip of the shield was equal to the anteroposterior diameter of the lunate. In addition to being faster, this strategy provided more control over the amount of progression in the lunate bone (Fig. 1D, red arrow). The volar lunate cortex can be penetrated cautiously. After core decompression, all debris was washed out from the joint. Next, we switched the scope to the trans-4 portal for visualizing the bone tunnel (Fig. 2). Punctate bleeding from the tunnel walls may be seen after releasing the tourniquet. (Fig. 3A, B).

Statistical analysis

Continuous variables are presented as means ± SDs and categorical variables were reported as frequencies. We used central indices, dispersion, and graphs as descriptive statistics and independent samples t test, paired t test, and chi-square as inferential statistics. P <.05 was considered significant. To determine the sample size with $\alpha = 0.05$

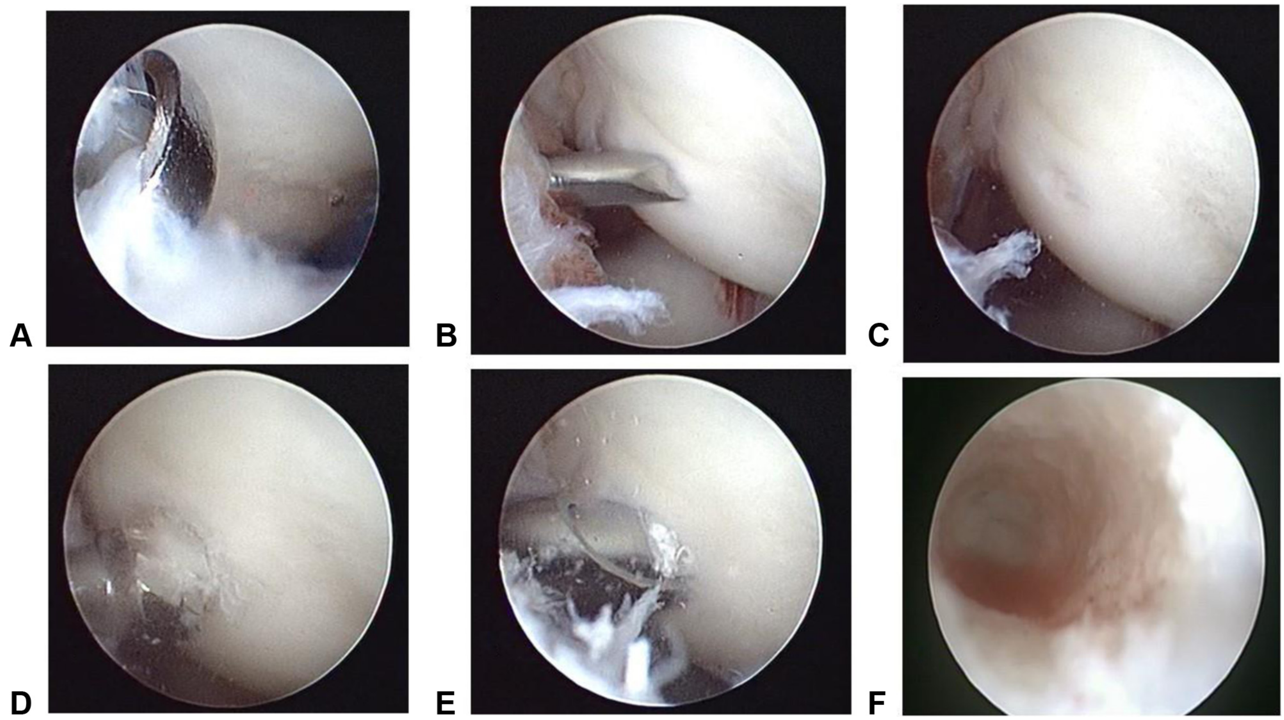

FIGURE 2: Arthroscopic view of lunate core decompression, A synovectomy, and debridement of the radiocarpal joint, B inserting a Steinman pin into the lunate bone from trans-4 portal after fluoroscopic control, C considering the entry point of the Steinman pin to start core decompression, D starting lunate core decompression using the cutting bur from trans-4 portal, E debridement of bone and cartilage debris, and F osteoscopy of decompression tunnel from trans-4 portal.

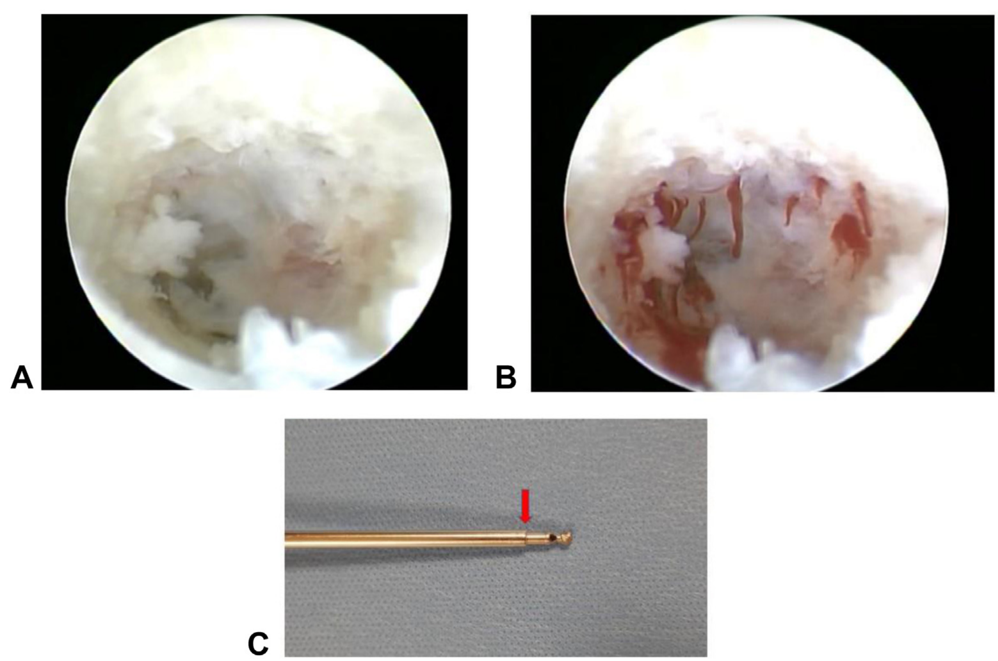

FIGURE 3: Lunate bone tunnel A before and B after deflating the tourniquet. C Burr is covered by a shield (red arrow) that protects extensor tendons and prevents overpenetration of the burr.

and $\beta = 0.2$, we assumed the mean and SD of the VAS score before and after the intervention in a similar study.[16] The sample size was calculated for all dependent variables with a power of 0.84, and the VAS score had the highest sample size. Therefore, for the rest of the variables, the power is ≥ 0.84.

TABLE 1. Demographic Data of Participants

		Number
Age, mean ± SD (y)		38.8 ± 10.8
Sex	Male	19
	Female	21
Lichtman stage	II	17
	IIIa	17
	IIIb	6
Follow-up, mean ± SD (mos)		36.2 ± 16.7

TABLE 2. Comparison of Functional and Radiologic Outcomes Before and After Surgery

	Before surgery, mean ± SD	After surgery, mean ± SD	*P* value
Flexion	17.5 ± 6.4	48.5 ± 10.3	<.05
Extension	17.5 ± 5	49.5 ± 8	<.05
Radial deviation	7.5 ± 2.8	13.4 ± 4.8	<.05
Ulnar deviation	8.7 ± 4.7	22.4 ± 9.5	<.05
Carpal height ratio	0.53 ± 0.05	0.51 ± 0.02	.131
Radioscaphoid angle	56.8 ± 11	59.5 ± 11.8	<.05
DASH score	52.5 ± 13	29.2 ± 16.3	<.05
VAS score	7.6 ± 1.8	2.7 ± 1.9	<.05
Hand grip	6.6 ± 2.7	12.3 ± 3.1	<.05
Tenderness			
None	0	20	
Mild	0	10	
Moderate	10	8	
Severe	30	2	

RESULTS

We had 44 patients with a diagnosis of Kienböck disease (Lichtman stages II to IIIb). Four patients refused this technique leaving 40 patients. The participant's mean age was 38.8 ± 10.8 years and mean follow-up was 39.2 ± 16.7 months (Table 1).

There was a significant improvement in wrist range of motion in all planes (flexion, extension, radial deviation, and ulnar deviation) ($P < .05$). Disability of Arm, Shoulder, and Hand score showed improvement from a mean of 52.5 ± 13 before surgery to 29.2 ± 16.3 after surgery ($P < .05$). Visual analog scale for pain also improved from 7.6 ± 1.8 before surgery to 2.7 ± 1.9 after surgery ($P < .05$).

TABLE 3. Comparison of Changes in VAS and DASH Score Before and After Surgery in Different Subgroups

Lichtman stage (no. of participants)	VAS, mean ± SD	DASH, mean ± SD	*P* value
II (17)	5.16 ± 1.33	25.49 ± 13.85	.477
IIIa (17)	4.70 ± 1.69	21.77 ± 13.99	
IIIb (6)	3.91 ± 1.22	19.11 ± 12.35	

TABLE 4. Lichtman Stages Before and After Surgery

Lichtman stage	Before surgery	After surgery
II	17	16
IIIa	17	15
IIIb	6	9
Total	40	40

We also observed improvement in hand grip strength from 6.6 ± 2.7 kg to 12.3 ± 3.1 kg ($P < .05$) (Table 2).

We compared the changes in VAS and DASH scores before and after surgery in our subgroups on the basis of Lichtman classification (Table 3). The means of VAS reduction in Lichtman stages II, IIIa, and IIIb were 5.2 ± 1.3, 4.7 ± 1.7, and 3.9 ± 1.2, respectively. The means of DASH reduction in Lichtman stages II, IIIa, and IIIb were 25.5 ± 13.8, 21.8 ± 14, and 19.1 ± 12.4, respectively, which was a similar response to surgery for the different radiological Lichtman stages. Although greater improvement was observed in Lichtman stages II, the difference between the groups was not statistically significant ($P = .477$). Range of motion of the wrist improved significantly in flexion, extension, radial deviation, and ulnar deviation (all $P < .05$) (Table 3).

In the radiologic assessment, there was a significant increase in radioscaphoid angle from 56.8 ± 11 to 59.5 ± 11.8 ($P < .05$). The carpal height ratio changed from 0.53 ± 0.05 before surgery to 0.51 ± 0.02 after surgery, which was not statistically significant ($P = .131$). There were 30 (75%) patients with severe wrist tenderness on physical examination before surgery, and 2 (5%) patients after the surgery.

The Lichtman stage stayed the same after the surgery in 36 (90%) patients and increased in 4 (1 patient from II to IIIa; 3 patients from IIIa to IIIb) (Table 4). There were no major complications, such as lunate fracture, infection, neurovascular injury, or complex regional pain syndrome. In the four patients whose clinical signs and symptoms did not decrease 6 months after the operation, or in whom Lichtman stage increased, the surgery was considered a failure.

DISCUSSION

Although there are reports of nonsurgical treatment of Kienböck disease,[21] recent studies show a predictable pattern of deterioration of motion, grip strength, and functional scores after nonoperative treatments.[22] There are many treatment options basically falling into the following three main groups: (1) procedures to unload the lunate, (2) procedures to promote revascularization of the necrotic lunate, (3) and salvage procedures, used when arthritic conditions exist.

The best treatment for Kienböck disease is still not clear. Recently, MacLean and Bain[23] reported their results using an articular-based approach to Kienböck disease on the basis of Bain and Begg's[10] arthroscopic classifications. They showed a high probability of good long-term results.[22]

We found significant improvement in DASH score, wrist range of motion, and pain in mid-term follow-up (Table 2). Bain et al[6] treated two cases of early-stage Kienböck disease arthroscopically and reported good functional outcomes for arthroscopic lunate core decompression. Kamrani et al[16] also reported significant improvement in *Quick*DASH score, wrist range of motion, and pain following arthroscopic core decompression, which was similar to radial shortening in their study.

We also compared DASH score and VAS improvement in different stages of Kienböck disease (Table 3). Results are similar in stages II, IIIa, and IIIb. The small number of patients in stage IIIb and lack of long-term follow-up could have been a reason of this observation.

Regarding radiological assessment, we saw no significant change in the carpal height ratio, but a small increase in the radioscaphoid angle. Kamrani et al[16] evaluated carpal height ratio with another method and found a statistically significant, but not clinically relevant, increase in carpal ratio and radioscaphoid angle.

Among our 40 patients, 36 (90%) stayed in the same Lichtman stage. This is a slightly better result compared with the 44 patients who had undergone arthroscopic core decompression in Kamrani et al's[16] study. They reported that 80% stayed in the same stage. We speculate that the reason might be our technique in which we did not make a 20° angle rotation of the bur during core decompression.

There were no major complications observed in our study, such as lunate fracture, infection, neurovascular injury, or complex regional pain syndrome. There were also no major complications for this procedure in Kamrani et al's[16] study, suggesting that the trans-4 portal seems to be safe for lunate core decompression.

As Kamrani et al[16] have emphasized, we agree that improvement of clinical scores without worsening of radiological signs after this surgery may not only be due to core decompression. Although the etiology, pathogenesis, and natural history of the condition is not clearly defined, and debridement and synovectomy may have a role in its improvement, arthroscopic core decompression appears to be an effective treatment method in nonfragmented cases of Kienböck disease.

This study included just six patients in stage IIIb. This small sample and the fact that progression of the disease to stage IV may take longer than the follow-up in the study, suggests caution in evaluating the results of core decompression in this group.

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