



Lunate excision with capitolhamate fusion in the treatment of stage IIIB and IIIC Kienböck's disease



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ABSTRACT

Objective: The aim of this study was to report our results of lunate excision combined with capitolhamate fusion in the treatment of Kienböck's stage IIIB/IIIC disease.

Methods: A total of 7 patients with a mean age 35.2 (SD 11.5) years were enrolled in the study. Pain was the principal reason for surgery. All operations were carried out by the same senior surgeon. Patients were evaluated in terms of range of motion, DASH and VAS scores, satisfaction, and grip/tip/palmar/key pinch strength compared with contralateral sides. Preoperative carpal height indexes and findings of osteoarthritis were determined radiographically and compared with postoperative evaluations.

Results: Mean duration of follow up was 15.2 months. Mean DASH and VAS scores were 13.8 2.7 and 2 1.1 respectively. The mean patient satisfaction score was 3.2 0.4 over 4 points. The mean grip strength in the operated hands was 66.4%, palmar pinch was 75.1%, tip pinch was 71.8% and key pinch was 70.4% when compared to the contralateral unaffected sides. The mean flexion range in the operated hands was 58.8%, extension range was 60.3%, radial deviation range was 65.2% and ulnar deviation range was 65.7% when compared to the contralateral sides. There was no significant difference between preoperative and postoperative carpal height ratios ($p = 0.086$).

Conclusions: Our early term results indicate that lunate excision combined with capitolhamate fusion may be an alternative treatment option in patients with stage IIIB and IIIC Kienböck's disease.

Level of Evidence: Level IV, Therapeutic study.

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Introduction

Treatment of Kienböck's disease is controversial and based on the stage of the disease. In the late stages, collapse of the carpus, joint incongruity and osteoarthritis develop, together with advanced necrosis of lunate.¹ Although there are several treatment options in the literature, none of them provides complete recovery.

Lunate excision has been proposed as a treatment option in late stages of Kienböck's disease when lunate revascularization is not possible and good results have been obtained^{2,3,4}. With this procedure, the sequestered bone will be removed; the amount of

synovitis and concomitant symptoms will be reduced.⁵ However, Kawai et al and Blanco et al reported progression of carpal collapse, as a disadvantage of the technique and abnormal carpal kinematics has been documented.^{3,6}

We suggested that such disadvantages could be eliminated, with the combination of capitolhamate fusion. With this combination, loading forces could be transmitted and shared through hamate and triquetrum towards ulna after lunate excision, thus proximal carpal migration could be prevented. Additionally, we think that, in contrast with other limited fusion alternatives including scaphoid bone, the kinematics of scaphoradial joint (which is the only remaining joint after lunate excision) could be preserved and good clinical results could be obtained.

In this case series study, we aimed to evaluate early clinical and radiological result of lunate excision with capitolhamate fusion in the treatment of stage IIIB/IIIC Kienböck's disease, which have not previously been reported.

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Materials and methods

A retrospective evaluation was performed of patients who underwent surgery and followed up in our clinic between January 2014 and January 2016.

We evaluated 7 patients (4 women and 3 men) with Lichtman stage IIIB (4 patients) and stage IIIC (3 patients) Kienböck's disease, undergoing lunate excision with capitoamate fusion with at least one year follow-up. Mean age at the time of intervention was 35.2 ± 11.5 years; the dominant hand was affected in three patients. None of the patients had history of wrist trauma and previous hand surgery. Pain was the principal reason for surgery. All preoperative radiographs (anteroposterior and lateral) of the wrists were available (Fig. 1) and the diagnosis was made by plain radiographs and confirmed by magnetic resonance imaging.

All operations were carried out by the same senior surgeon. After general anesthesia, all patients were operated supine over a hand table and fitted with a pneumatic tourniquet. Venous drainage was achieved with the help of an Esmarch bandage. Surgical procedure started with a dorsal skin incision over Lister tubercle in line with 3rd metacarpal. A longitudinal incision was made on the retinaculum at the level of the fourth compartment. Then, an H shaped capsular incision was performed in order to easily resect the lunate with an adequate view. The wrist was then placed in distraction and palmar flexion and the resection of collapsed lunate was performed. Care was taken to preserve volar capsule. The remaining space was left unoccupied. Then, the joint between capitate and hamate was identified and articular cartilage was removed with a thin osteotome. Capitoamate fusion was performed using one headless screw (Acumed, Hillsboro, OR, USA). The arthrodesis and position of screw was controlled with an image intensifier. The dorsal capsule and retinaculum has been repaired and closed in a layered fashion without imbrications and the skin was closed with a short arm cast. Postoperatively the wrist was immobilized in short arm cast extending to palmar crease to allow free motion in metacarpophalangeal joint. After 3 weeks of immobilization, wrist motion and active finger motion supervised by a therapist has began. At the end of the eighth week passive wrist movements were permitted.

Data were collected from medical records, functional and radiological assessments of patient at latest follow-up. The functional evaluation consisted of (1) the active ROM of the operated and contralateral wrists with a goniometer in flexion, extension, radial and ulnar deviations,⁷ (2) DASH⁸ and (3) VAS scoring systems (0: No pain, 10: The most severe pain), (4) Grip, tip, palmar and key pinch strength of both operated and contralateral wrists measured by a Jamar dynamometer (Model SH 5001, Saehan Corporation, Masan, South Korea) and a pinchmeter (Model SH 5005, Saehan Corporation, Masan, South Korea) (Hand dominance was ignored), (5) return to work, (6) satisfaction according to Gay scale⁹ (Between 0 and 4. 0: Not satisfied, 1: No change, 2: Slightly satisfied, 3: Satisfied, 4: Very satisfied). Radiological evaluation consisted of preoperative and postoperative carpal height indexes according to Youm¹⁰ on anteroposterior X-rays and findings of osteoarthritis, if present.

Statistical analyses of the data obtained in the present study were conducted with Statistical Package for Social Sciences, IBM 19.0 (SPSS, 2010) using the paired Student's t test. A value of $p < 0.05$ was considered statistically significant.

Informed consent has been obtained from each patient. The study protocol was approved by the local ethical committee.

Results

The patients were followed up for a mean of 15.2 ± 2.4 months after the operation. In functional evaluation, the mean VAS score at last follow up was 2 ± 1.1 and DASH score was 13.8 ± 2.7 . The mean time to return to work was 4 ± 1.5 months and none of the patients had to change their job. The mean patient satisfaction score was 3.2 ± 0.4 over the 4 point Gay scale. The mean grip strength in the operated hands was 66.4%, palmar pinch was 75.1%, tip pinch was 71.8% and key pinch was 70.4% when compared to the contralateral unaffected sides. The mean flexion range in the operated hands was 58.8%, extension range was 60.3%, radial deviation range was 65.2% and ulnar deviation range was 65.7% when compared to the contralateral side (Table 1). In radiologic evaluation, none of the patients had findings of advanced radioscaphoid osteoarthritis (Fig. 2) and no patients had non-union. The mean carpal height ratio was 0.43 ± 0.1 in preoperative period, 0.41 ± 0.1 in last



Fig. 1. Preoperative anteroposterior and lateral X-ray of a patient with stage IIIB Kienböck's disease.

Table 1
Mean range of motion measurements of the operated and contralateral wrists.

	Operated Side	Contralateral Side	Percent (%)
Flexion	40.7° ± 12.1	69.2° ± 5.3	58.8
Extension	39.2° ± 9.7	65.0° ± 5.7	60.3
Ulnar Deviation	19.2° ± 4.4	29.2° ± 5.3	65.7
Radial Deviation	13.5° ± 4.7	20.7° ± 4.4	65.2

IIIB Kienböck's disease, sequestered lunate is a pain source and causes synovitis.^{5,12,13} In addition, the necrosis of the lunate is irreversible and body of lunate is collapsed with fixed scaphoid rotation. Therefore, excision of lunate is a logical treatment of choice with regard to pain. In such patients, pain relief and functional improvement has been documented with lunate excision^{2,3,4}. However, after lunate excision, capitate remains unsupported



Fig. 2. Postoperative 12th month anteroposterior and lateral X-ray of the patient with lunate excision combined with capitolunate fusion.

Table 2
Comparison of preoperative and postoperative mean carpal height ratio measurements.

	Preoperative	Preoperative Mean	Postoperative	Postoperative Mean	p value*
Patient 1	0.45	0.43	0.41	0.41	0.086
Patient 2	0.43		0.43		
Patient 3	0.44		0.44		
Patient 4	0.41		0.41		
Patient 5	0.43		0.43		
Patient 6	0.42		0.38		
Patient 7	0.45		0.39		

*Comparison of mean values.

postoperative evaluation and there was no significant difference between ratios ($p = 0.086$) (Table 2).

Discussion

Our study showed that lunate excision combined with capitolunate fusion provided well pain relief, patient satisfaction, good clinical results, acceptable preservation of ROM with strength (Fig. 3) and no change in carpal height ratio on early term follow up, in patients with stage IIIB and IIIC Kienböck's disease.

Lichtman et al defined a new stage IIIC which can be defined as a complete coronal plane split regardless of the lunate or wrist morphology.¹¹ They discussed that treatment for this fracture should be excision of the lunate with either a PRC or a scapholunate arthrodesis to stabilize the carpus. Our treatment choice was lunate excision and capitolunate fusion, indeed. In patients with stage

and proximal migration of carpal bones may be expected, theoretically. Thus, problems may result due to such migration in follow up.³ Therefore, replacement procedures or limited carpal fusions have been proposed.^{14,15}

Capitolunate fusion was first described by Chuinard as a treatment option for patients with Kienböck's disease.¹⁶ It was reported that this procedure not only provides pain relief, but also preserves wrist motion and grip strength. Oishi et al reported a case series of 45 patients with stage I, II and III Kienböck's disease treated with capitolunate arthrodesis.¹⁷ They obtained pain relief in 93% of patients with preservation of wrist ROM and grip strength (52% of normal preoperatively to 72% of normal postoperatively). Compared to Oishi et al, our study included a comprehensive evaluation of a very specific group of patients with stage IIIB and IIIC disease. They also found that carpal height ratio did not change and discussed that the mentioned observation may have more



Fig. 3. Picture of the patient showing the final functional status.

clinical relevance than data derived from cadaver studies, although biomechanical studies on cadaver wrists have failed to show definite lunate unloading after capitoamate fusion.^{18,19} In this context, Chuinard et al concluded that the rationale for treatment of Kienböck's disease by capitoamate fusion lies in relieving the pressure from the nutcracker effect on the lunate caused by impingement between the capitate and the distal radius.¹⁶ Inoue reported good results in Grade 2/3 patients and he discussed his results supported Chuinard's theory.²⁰ Similarly, Viola et al reported that capitoamate fusion with capitate shortening osteotomy unloaded the radiolunate joint, in their biomechanical study. They concluded that such combination had a role in the treatment of Kienböck's disease.²¹ On the other hand, Kawai et al and Blanco et al reported progression of carpal collapse and decrease in ulnatriquetral distance after lunate excision.^{3,6} In this sense, we thought to combine lunate excision (In order to excise the "pain generator") with capitoamate fusion (In order to prevent proximal carpal migration) and our findings support this opinion. Although it was not supported or refuted by biomechanical studies, we think that by capitoamate fusion, loading forces could be transferred successfully through ulna from hamate and triquetrum after lunate excision and biomechanical studies on this subject would provide valuable data. Additionally, Gillespie et al reported that the diminution of ulnar deviation compared with radial deviation was striking, following excision of lunate and suggested that in unsatisfactory cases if the pain appears to originate at ulnar side of the wrist, removal of the lower end of the ulna might be considered in order to salvage a useful wrist.²² According to our results

(by combining capitoamate fusion with excision of lunate), ulnar deviation ranges were found to be similar to radial deviation ranges and there was no significant migration of proximal carpal bones.

On the other hand, the rotation of scaphoid is not addressed with described technique. Although early follow-up did not show any changes at the radioscapoidal joint, long-term results will undoubtedly show more important data on this subject. Ligaments are the primary stabilizers of the wrist. It could be thought that following lunate excision, scaphoid may become unstable. However, in a biomechanical study, it was concluded that none of the dorsal ligaments sectioning results in instability.²³ In this context, volar capsule and ligaments are protected in our described technique and we did not identify any arthrosis in our patients, in early term follow-up.

Advanced stage Kienböck's disease has been successfully treated with treatment options among lunate excision with or without replacement, limited intercarpal fusion, wrist fusion or proximal row carpectomy.²⁴ Since it has not been previously reported in the literature, we compared the result of our technique with similar alternative procedures. However, none of the studies included all of our evaluation parameters; therefore we could not make an exact comparison. In this context, Buluc et al reported results of proximal row carpectomy in patients with Kienböck's disease. They found that the average postoperative Q-DASH scores were 17.4, postoperative range of motion measurements (With an average of 39.2° flexion, 41° extension, 15° radial deviation and 25.4° ulnar deviation), power grip, and pinch strength values significantly decreased compared to the normal side).²⁵ Similarly Takase et al reported

results of lunate excision with capitate osteotomy and intercarpal arthrodesis for advanced Kienböck's disease and found that grip strength was restored to about 80% at one year postoperatively, the mean period between the operation and their return to work was 6.7 months and the radiocarpal flexion-extension arc remained the same as it had been before surgery or improved slightly for up to two years postoperatively.²⁶ Ozdemir et al reported results of lunate excision and scaphocapitate arthrodesis in Kienböck's disease and found that mean wrist extension was 27.7, mean wrist flexion was 40.5, mean grip strength compared to the healthy side was 71% and mean VAS score was recorded as 1.4, modified Mayo wrist scores were good in five and moderate in four patients and no patients had non-union or additional surgery.²⁷ Therefore, our clinical and radiological results are similar and comparable to the results of alternative treatment options in the literature.

Limited number of patients, lack of preoperative clinical results due to retrospective study design and relatively short follow-up time were major limitations of the current study. Hand dominance may affect the results, but the number of patients in the study was not big enough to make a comparison. Prospective comparative studies with longer follow up will give more strict conclusions. Lack of biomechanical evaluation of carpal joints following such procedure, was another weak point of the study. Further studies in this regard would contribute to improvement of such technique.

In conclusion, our early term results indicate that lunate excision combined with capitohamate fusion may be an alternative treatment option in patients with stage IIIB and IIIC Kienböck's disease.

Conflicts of interest and source of funding

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations that might pose a conflict of interest in connection with the submitted article. Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. There is no conflict of interest regarding publication of this manuscript.

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