Capitate-hamate fusion for treatment of Kienböck's disease (stages II and IIIA)

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Background
Kienböck's disease is described as avascular osteonecrosis of the lunate. The capitate-hamate fusion is another means of relieving pressure on the lunate. This procedure is designed for patients with Kienböck's disease.
Aim
To evaluate clinical and radiological outcomes of the surgical technique capitate-hamate fusion for the treatment of stages II, III A of Kienböck's disease with neutral ulnar variance and whether this technique resulted in pain relief, improvement in wrist motion, or changes in the radiographic evaluation.
Patients and methods
This randomized controlled clinical trial included 20 patients with early stages (stages II and IIIA) of Kienböck's disease with neutral ulnar variance. The study was carried out in the orthopedic unit of Al-Helal Hospital during the period from March 1st to July 31, 2023.
Results
Postoperatively, pain, grip strength, range of motion, and the modified Mayo wrist score all increased significantly. There was a significant decrease in carpal height index and lunate height index postoperatively. 65% of patients had stage II Kienböck's disease, and 35% had stage IIIA Kienböck's disease. 12 (60%) of patients were excellent, and five (25%) of patients were good. While two patients were fair, and one patient was poor.
Conclusion
The current study showed that surgical treatment of stages II and IIIA of Kienböck's disease with neutral ulnar variance by capitate-hamate fusion technique resulted in significant pain relief, improvement in wrist motion, and a significant decrease in carpal height index and lunate height index, with high patient satisfaction.

Keywords:
capitate-hamate fusion, kienböck's disease, lichtman classification

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Introduction

Kienböck's disease is an osteonecrosis of the lunate; however, the exact mechanism has not been fully elucidated. It is thought to be an interplay between altered vascular perfusion, repetitive microtrauma, variable lunate anatomy, altered loading and kinematics, and potential systemic disease [1].

The diagnosis of Kienböck's disease requires a high index of suspicion, particularly in young males presenting with pain and stiffness in the dominant wrist. They may have reduced grip strength and the pain can be isolated to the dorsal lunate [2].

The onset is usually insidious, beginning with a dull intermittent ache over the central dorsal wrist. The pain can be aggravated by activities and is usually relieved by rest and immobilization [3].

The treatment options for Kienböck's according to (Lichtman classification) are diverse. At the earliest stages of Kienböck disease, nonoperative management is predominantly advised. The main goal in treating stage II is revascularization, unloading, and decompression of the lunate [4]. Stage IIIA often requires lunate reconstruction, while IIIB and IIIC frequently involve partial wrist arthrodesis. Salvage procedures such as wrist arthrodesis are limited mainly to Lichtman IV [5].

Treatment options as radial shortening, ulnar lengthening, or ulnar shortening osteotomies to decrease the compressive loading of lunate, or vascularized bone graft to the lunate combined with capitate shortening osteotomy [6].

The capitate-hamate fusion, as reported by Chuinard and Zeman (1980), is another means of relieving pressure on the lunate. This procedure is designed for patients with Kienböck's disease who have relatively minor architectural changes in the aseptic lunate, no arthritic changes, and no ulnar-minus variance. When these criteria are met, the clinical results have been encouraging and lasting [7].

Aim

This work aimed to evaluate clinical and radiological outcomes of surgical technique capitate-hamate fusion for the treatment of stages II and IIIA of Kienböck's disease with neutral ulnar variance and whether this technique resulted in pain relief, improvement in wrist motion, or changes in the radiographic evaluation.

Patients and Methods

This randomized controlled clinical trial included 20 patients with early stages (stages II and IIIA) of Kienböck's disease with neutral ulnar variance. The study was carried out in the orthopedic unit of Al-Helal Hospital during the period from 1st March 1st to 31 July 31, 2023. An informed consent was obtained.

Inclusion criteria

Patients 18–60 years old, Stages II or IIIA disease according to the Lichtman classification, normal ulnar variance, and no arthritic changes.

Exclusion criteria

Skeletally immature patients, Bilateral disease, positive ulnar variance, wrist arthritis (late stages), low demand patients, previous wrist surgery and previous wrist joint disease.

All patients were subjected to complete history taking, physical examinations, investigational studies (Routine laboratory investigations and Radiological investigation that including plain radiography (posteroanterior and lateral radiographs of the wrist), magnetic resonance imaging (MRI) and Computerized tomography scan (CT).

Surgical technique

Performing a dorsal transverse incision to expose the capitate-hamate joint and performing a capitate-hamate fusion using a Herbert screw typically involves the following steps.

Positioning and anesthesia

The patient was positioned appropriately, typically lying on their back with the affected hand placed on a hand table or hand holder. Anesthesia, such as regional anesthesia (e.g., brachial plexus block) or general anesthesia. A nonsterile tourniquet was placed on the proximal of arm and inflated 100 mm hg over the patients' systolic blood pressure

Incision

Through universal dorsal wrist approach. The following anatomic landmarks were identified ulnar styloid, radial styloid, and radio-carpal joint. Transverse incision 1 cm distal to ulnar styloid parallel to bistyloid line and skin creases.

Soft tissue dissection

we carefully dissect through the subcutaneous tissue and fascia to expose the joint capsule and underlying joint structures. Retractors may be used to protect and retract the surrounding tissues, allowing better visualization of the joint.

Joint exposure and preparation

During exposure Elevate flaps at the level of the extensor retinaculum, Extensor policies Longus identified and taken with third compartment radially, Extensor digitorum taken ulnarly with fourth compartment, Longitudinal capsulotomy was done to identify the underlying radiocarpal and midcarpal joints, Capitate and hamate were exposed by capsular elevation. The articular and subchondral surfaces between capitate and hamate were removed by osteotomes.

Bone grafting

The bone graft must be of adequate quality and size. Bone from the distal radial epiphysis is generally harvested through a longitudinal incision over the styloid radius. The harvested cancellous bone is then packed down into the gap between each bone

Herbert screw placement

We select an appropriately sized Herbert screw and carefully inserts it across the capitate-hamate joint, aligning the bones in the desired position for fusion. The screw was usually inserted in a direction perpendicular to the joint surface.

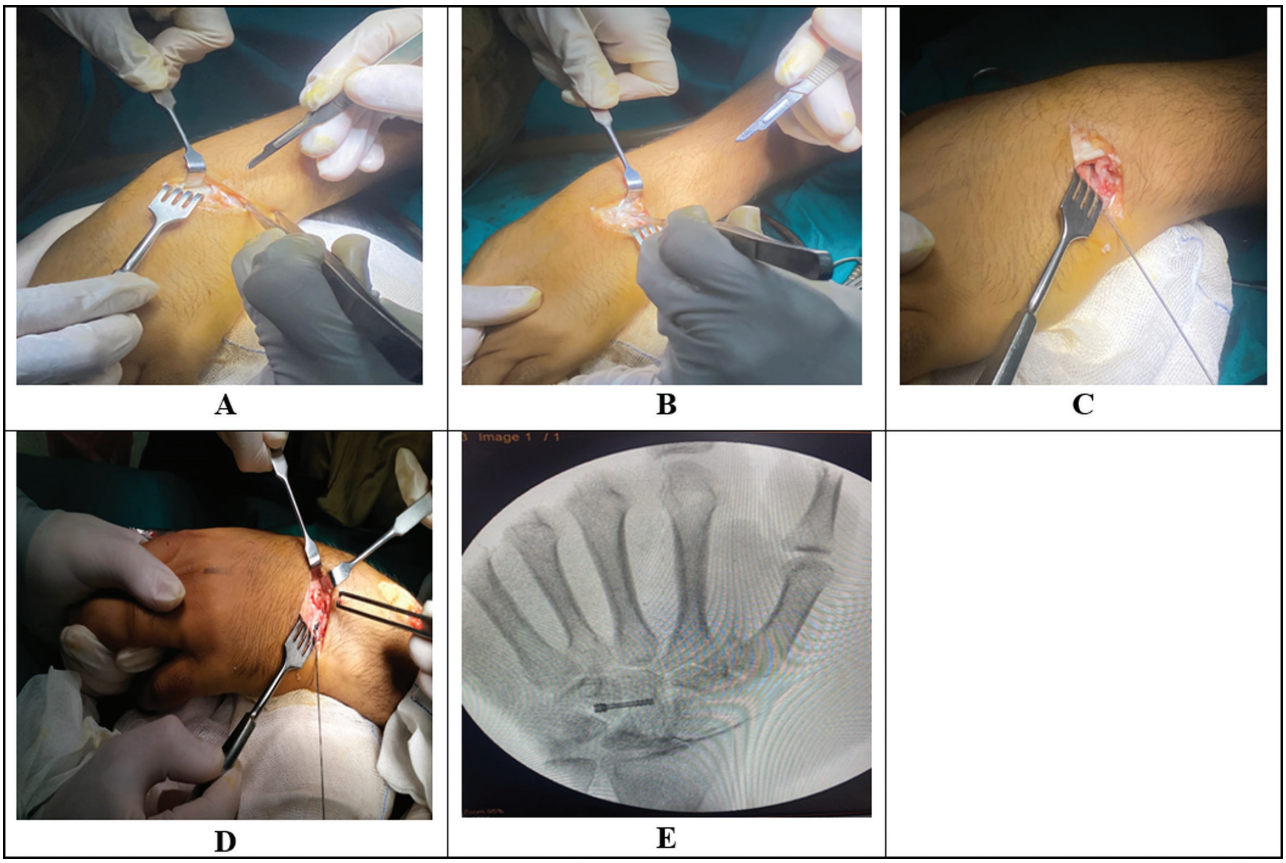
Screw tightening and fusion

Once the Herbert screw was in place, the surgeon carefully tightens it, applying compression forces across the joint.

Wound closure

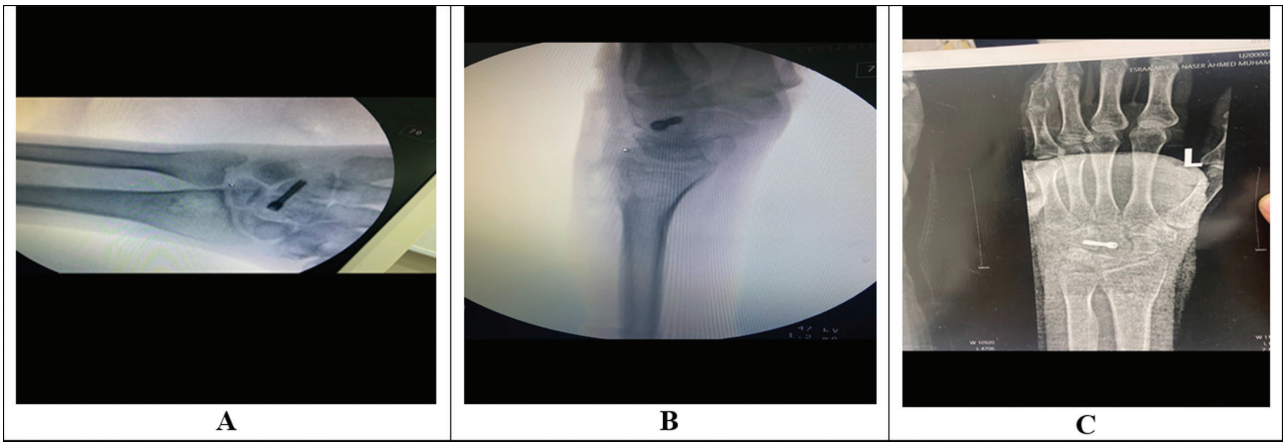
After ensuring proper screw placement and joint alignment, we closed the incision using sutures or staples. The wound was then dressed and bandaged Figs. 1 and 2.

Figure 1



Showed (A): dorsal transverse incision over capito-hamate joint. (B): soft tissue dissection over capito-hamate joint (C): wire passing from hamate to capitate to facilitate passing Herbert screw (D): Herbert screw placement (E): AP radiograph of wrist showing capito-hamate fusion by Herbert screw.

Figure 2



Showed (A): Intraoperative radiograph AP view of wrist showing Capito hamate fusion using Herbert screw. (B): Intraoperative radiograph lateral view of wrist showing Capito hamate fusion using Herbert screw. (C): Postoperative AP view

Postoperative care

All the patients were initially immobilized in a thumb spica splint with thumb interphalangeal joint not included, Active fingers motion started immediately after surgery, 10 to 14 days postoperative sutures were removed and the splint changed to a short arm thumb spica cast, and wrist joint motion was allowed 6 weeks after surgery. The postoperative radiographs were obtained immediately after surgery, every 4 weeks until capitate-hamate fusion was achieved, and then every 2 months during the follow-up period. All patients achieved consolidation of the fused joint within 2 months. Complications and reoperations may have been underreported for patients who potentially had their follow-up elsewhere.

Statistical analysis

All data were collected, tabulated, and statistically analyzed using SPSS 22.0 for Windows (SPSS Inc., Chicago, IL, USA). Data were tested for normal distribution using the Shapiro–Walk test. Qualitative data were represented as frequencies and relative percentages. Quantitative data were expressed as mean±SD for parametric and median and range for nonparametric data. Independent *T* test, Mann–Whitney test, χ^2 test, paired *t* test, Wilcoxon signed ranks test, and Fisher exact were used. All statistical comparisons were two tailed with significance Level of *P* value less than or equal to 0.05 indicates significant, *P* less than 0.001 indicates a highly significant difference while *P* greater than 0.05 indicates a nonsignificant difference.

Results

This table showed mean age was 36.54±10.62 years with BMI of 26.31±3.77 kg/m^2. 55% of the patients were males and 45% were female Table 1.

This table shows that 65% of patients had stage II Kienböck's disease, and 35% had stage IIIA Kienböck's disease Table 2.

This table showed that there is a significant increase in pain, grip strength, ROM, and modified mayo wrist score (MMWS) postoperatively Table 3.

This table showed that the range of motion measurements was significantly lower among the operated side compared with contralateral side Table 4.

This table showed that there is a significant decrease in carpal height index and lunate height index postoperatively Table 5.

Table 1 Demographic data of the studied patients

Variable	Studied patients (*N*=20) [*n* (%)]
Age (years)	
Mean±SD	36.54±10.62
Sex	
Male	11 (55)
Female	9 (45)
BMI (kg/m^2)	
Mean±SD	26.31±3.77

Table 2 Lichtman classification distribution of the studied patients

	Studied patients (*N*=20) [*n* (%)]
Stage	
II	13 (65)
IIIA	7 (35)

This table showed that 12 (60%) of patients were excellent, and five (25%) of patients were good. While two patients were fair, and one patient was poor [Table 6].

Discussion

Kienböck's disease is classified as rare and its prevalence is about 7 per 100 000 [8,9]. Kienböck's disease shows male predominance, with a peak incidence in patients aged 20–40 years [10]. Repetitive manual labor was reported as a risk factor but currently is recognized as a factor aggravating symptoms of an already established disease [11].

The aim of surgical management has been proposed to slow the progression of osteonecrosis and secondary carpal damage or collapse. Factors defining the proposed treatment include severity of lunate damage, carpal stability, and presence of degenerative changes [12].

The main results of this study were as follows:

The current study showed that the mean age was 36.54±10.62 years with BMI of 26.31±3.77 kg/m^2. 55% of the patients were males and 45% were females.

This was agreed with White *et al*. [10] who stated that Kienböck's disease shows male predominance, with a peak incidence in patients aged 20–40 years.

However, Mahmoud *et al*. [13] hat the patients with early-stage KD were predominantly males (65%) with mean age of 26.8 years.

The current study showed that 65% of patients had stage II Kienböck's disease, and 35% had stage IIIA Kienböck's disease.

Comparable with the current study Al-Ashhab *et al*. [14] showed that stage II Kienböck's disease was more prevalent among (60%) of patients while 40% had stage IIIA Kienböck's disease. Moreover, better outcome was

Table 3 Clinical evaluation among the studied patients

	Studied patients (*n*=20)		*P*
	Preoperative	Postoperative	
Pain			
Mean±SD	10.36±4.23	23.26±1.45	**<0.001**
Grip strength			
Mean±SD	15.75±1.82	28.49±4.87	**<0.001**
ROM			
Mean±SD	14.85±5.86	28.54±4.13	**<0.001**
Modified Mayo wrist score			
Mean±SD	18.25±2.39	84.57±8.64	**<0.001**

Table 4 Range of motion measurements between operated side and contralateral side among the studied patients

	Studied patients (*n*=20)		*P*
	Operated side	Contralateral side	
Flexion (°)			
Mean±SD	40.89±11.59	68.93±4.91	**<0.001**
Extension (°)			
Mean±SD	38.75±9.53	64.75±5.43	**<0.001**
Ulnar deviation (°)			
Mean±SD	21.32±5.32	32.61±6.71	**<0.001**
Redial deviation (°)			
Mean±SD	14.38±4.86	25.47±6.31	**<0.001**

Table 5 Radiographic evaluation among the studied patients

	Studied patients (*n*=20)		*P*
	Preoperative	Postoperative	
Carpal height index			
Mean±SD	0.507±0.006	0.431±0.026	**0.001**
Lunate height index			
Mean±SD	0.486±0.032	0.467±0.021	**0.025**

Table 6 Satisfaction distribution among the studied patients

	Studied patients (*N*=20) [*n* (%)]
Excellent	12 (60)
Good	5 (25)
Fair	2 (10)
Poor	1 (5)

found in patients with Lichtman stage II than in stage IIIA (P<0.001).

Regarding clinical evaluation among the studied patients, it was revealed that there was a significant increase in pain, grip strength, ROM, and MMWS postoperatively. However, the range of motion measurements was significantly lower among operated side compared with contralateral side.

Oishi *et al.* [15] reported a case series of 45 patients with stage I, II, and III Kienbock's disease treated with capito-hamate arthrodesis. 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).

Also, capitate shortening osteotomy accompanied by capito-hamate fusion technique was assessed by Al-Ashhab *et al.* [14] among 20 patients with Kienböck's disease (Lichtman stage II or stage IIIA) with neutral ulna variance. After 1 year follow-up, 16 patients continue their original work, while four patients need to change their work. Average grip strength improved from 15.5 (SD 1.5) Kg to 22.5 (SD2.5) Kg postoperatively (P<0.001). Flexion and extension range of motion was changed from 15 to 22.5° postoperatively with a (P<0.001). The study also showed that the final postoperative MMWS increased from 17 (SD 2.5) to 88.5 (SD7.3). Median pain score was 15 points preoperatively and 22.5 postoperatively with (P<0.001).

The current study showed that there was a significant decrease in carpal height index and lunate height index postoperatively compared with preoperative values.

In line with the current study, Al-Ashhab *et al.* [14] showed that the carpal height index, showed a statistically significant decrease from 0.51 (SD 0.005) to 0.4 (SD 0.02) (P<0.001), but in contrast to the current study the lunate height index showed non-significant decrease 0.5 (SD 0.03) to 0.47 (SD 0.02) (P>0.05), and finally the scapho-capitate angle showed a statistically significant increase 45.4 (SD 4.3)° to 51 (SD 0.03)° (P<0.001), among patients treated by capitate shortening osteotomy accompanied with capito-hamate fusion.

Regarding patients' satisfaction, the current study showed that 12 (60%) of patients were excellent, and five (25%) of patients were good. While two patients were fair, and one patient was poor.

However, Tahta *et al.* [16] showed that the mean patient satisfaction score was 3.2 0.4 over 4 points, among patients treated with lunate excision combined with capito-hamate fusion.

This study has some limitations, including the relatively small number of patients, the relatively short follow-up period, and the absence of a comparative control

group. Future randomized clinical trials comparing our technique with other types of limited carpal fusion, with long-term follow-up, are needed to properly evaluate the functional, and radiological outcomes. Moreover, a biomechanical study is needed to estimate the load transmission through the radio-lunate and radio-scaphoid joints following CH fusion.

Conclusion

In conclusion, the current study showed that surgical treatment of stages II and IIIA of Kienböck's disease with neutral ulnar variance by capitate-hamate fusion technique resulted in significant pain relief, improvement in wrist motion, and a significant decrease in carpal height index, and lunate height index, with high patient satisfaction.

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Nil

Conflicts of interest

There are no conflicts of interest.

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