Capitate shortening versus limited carpal fusion in grade IIIA Kienböck disease, comparative study.

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Abstract

Background
The aim of the capitate shortening osteotomy in Kienböck disease is to reduce the load transmission across the radio-lunate joint, while scapho-capitate fusion aims to unload the lunate and delay the development of radiocarpal and midcarpal arthritis.
Objective
this study is to compare capitate shortening osteotomy and limited carpal fusion in grade IIIA Kienböck disease.
Patients and Methods
this study was a prospective comparative study on 20 patients with grade IIIA Kienböck disease, aged between 21 and 48 years, eleven male and nine females, dominant hand affected in 13 patients versus seven non-dominant. Ten patients were treated by capitate shortening (group A) and ten with scapho-capitate fusion (group B). This study was randomized by closed envelope method with a minimum of six months postoperative follow-up.
Results
At final follow up, the grip strength (% of normal side) improved from 46.5% to 79.4% in group A and from 54.6% to 88.3% in group B. ROM (% of normal side) improved from 58.2% to 73% in group A and from 52.8% to 65.7% in group B. The mean MAYO wrist score improved from 40.5 to 72.5 in group A and from 41.5 to 77 in group B.
Conclusion
Capitate shortening osteotomy and scapho-capitate fusion are effective procedures in the treatment of grade IIIA Kienböck disease with no statistically significant difference found between both groups.

Keywords
Kienböck disease, capitate shortening, scapho-capitate fusion, lunate.

Introduction

In 1910, Robert Kienböck, the Austrian radiologist published the radiological findings of collapsed lunate bone, and he named it “Lunatomalacia”. [1] After that many studies have focused on this disease, its etiology, pathogenesis, classification, prognosis, and treatment outcome. It has been theorized that a vascular insult to the scanty lunate blood supply is the cause of lunate osteonecrosis. [2]

Presenting symptoms include chronic wrist pain, decreased range of motion, and weakness. [3] The radiographs may be normal early in the disease process. With time, a characteristic pattern of deterioration occurs, beginning with sclerosis of the lunate, followed by fragmentation, collapse, and finally arthritis. [4] A radiographic staging system for Kienböck disease, proposed by Lichtman, helps describe the extent of the disease and guiding treatment. [5]

There are several treatment options available for managing Kienböck disease, and they are primarily based on the stage of the disease on presentation. The goals for treatment include pain relief, motion preservation, and maintenance of strength and function. [6] Although there is insufficient evidence supporting the superiority of any single treatment procedure that can consistently and reliably achieve these goals. [7]

The capitate shortening osteotomy aims to reduce the load transmission across the radio-lunate joint. Reducing stress on the lunate bone probably induces revascularization of the bone and prevents further changes in the shape of the lunate and the collapse of the carpus.[7] Scapho-capitate fusion aims to unload

the lunate and delay the development of radiocarpal and midcarpal arthritis. Biomechanical studies have suggested that scapho-capitate fusion decreases force across the radio-lunate and luno-capitate articulations while resulting in increased joint force across the radio-scaphoid joint. [8-10]

Patients and Methods

This prospective study was conducted on 20 patients with grade IIIA Keinbock disease presented to Menoufia university hospital and Elzayton specialized hospital in Cairo from March 2018 to January 2020. Ten patients were treated by capitate shortening (group A) and ten with scapho-capitate fusion (group B). This study was randomized by closed envelope method with a minimum of six months postoperative follow-up. Written and informed consent was taken preoperatively from all patients.

Inclusion criteria: Patients from 20-60 years old, with grade IIIA Keinbock disease, and fit for surgery.

Exclusion criteria: Patients with failed previous surgery, other grades of Kienböck disease, and patients with general and local causes that may contraindicate surgery.

In this study, there were eleven males and nine females, aged between 21 and 48 years with a mean of 31.50 ± 8.29 years. There were 13 patients with dominant hand affected and seven non-dominant hands affected. There were nine manual workers, seven housewives, two teachers, one student, and one driver. Two patients were hypertensive, and one diabetic.

All involved patients were subjected to clinical assessment: history, general and local examination, and evaluated by radiographs (AP and lateral views). Preoperative imaging was used to determine ulnar variance and the stage of the disease.

Surgical technique

Group A (capitate shortening): A 5 cm longitudinal dorsal incision extending from the Lister tubercle proximally to the 3rd metacarpal distally was made. The subcutaneous tissue was dissected down to the extensor retinaculum creating radial and ulnar skin flaps. The extensor tendons were retracted radially or ulnarly during the procedure. The capsule of the wrist joint was opened in a u-shaped manner based ulnarly. (fig 1A) the capitate ridge was identified, which divides the head of the capitate into the scaphoid facet and the lunate facet. This ridge runs almost parallel to the capitate-hamate articulation. Osteotomy of the capitate was done with a bone saw with a sharp, thin blade. The first osteotomy line was located longitudinally on the capitate ridge and the second transversely of 2-3 mm distal to the edge of the articular surface of the lunate fossa of the capitate, forming a “reverse L”-shaped osteotomy line, which was composed of 2 straight lines crossing at almost a 90° angle. (fig 1B) The volar capsule and ligaments were preserved. The cut segment was removed with a small curette in a piece-by-piece manner. The mobile segment then was easily compressed against the more distal segment by using a curved blunt instrument, without disturbing the articular surface. Then the mobile segment was fixed to the distal segment by two or three k wires crossing the osteotomy line. (fig 1C) The capsule and the dorsal intercarpal ligament were closed with absorbable suture. The skin was closed subcuticular using absorbable sutures.

Group B (scapho-capitate fusion): A dorsal slightly radial longitudinal incision was made midway between the Lister and styloid tubercles extending 4-5 cm distally. The subcutaneous tissue was dissected down to the extensor retinaculum creating radial and ulnar skin flaps. The extensor tendons were retracted radially or ulnarly during the procedure. The capsule of the wrist joint was opened in a u-shaped manner based ulnarly with identification of scaphoid, lunate, and capitate. Then decortication of scaphoid and capitate was made down to the cancellous bone, including only their opposing surfaces. (fig 2A) Then grafting between scaphoid and capitate bones was done. The graft was taken from the floor of the second extensor compartment, where a cortical window was marked. The corticotomy was performed by drill holes. The underlying cancellous bone was exposed and harvested with the help of curettes. (fig 2B) Following this, two or three K-wires were utilized for fixation of the scapho-capitate junction. Careful repair of the wrist capsule and extensor retinaculum using fine absorbable sutures was done. Then the skin was closed subcuticular using absorbable sutures. A short arm cast was applied for all patients in both groups.

Clinical Assessment

Each patient was assessed at the final follow-up for flexion and extension range of motion (ROM), grip strength, pain, satisfaction, and the MAYO wrist score.

Radiographic Assessment

post-anterior and lateral x-rays were done postoperatively, every two weeks till healing, and then every one month for follow-up.

The collected data were tabulated and analyzed by SPSS (Statistical package for social science) version 23 on IBM compatible computer.

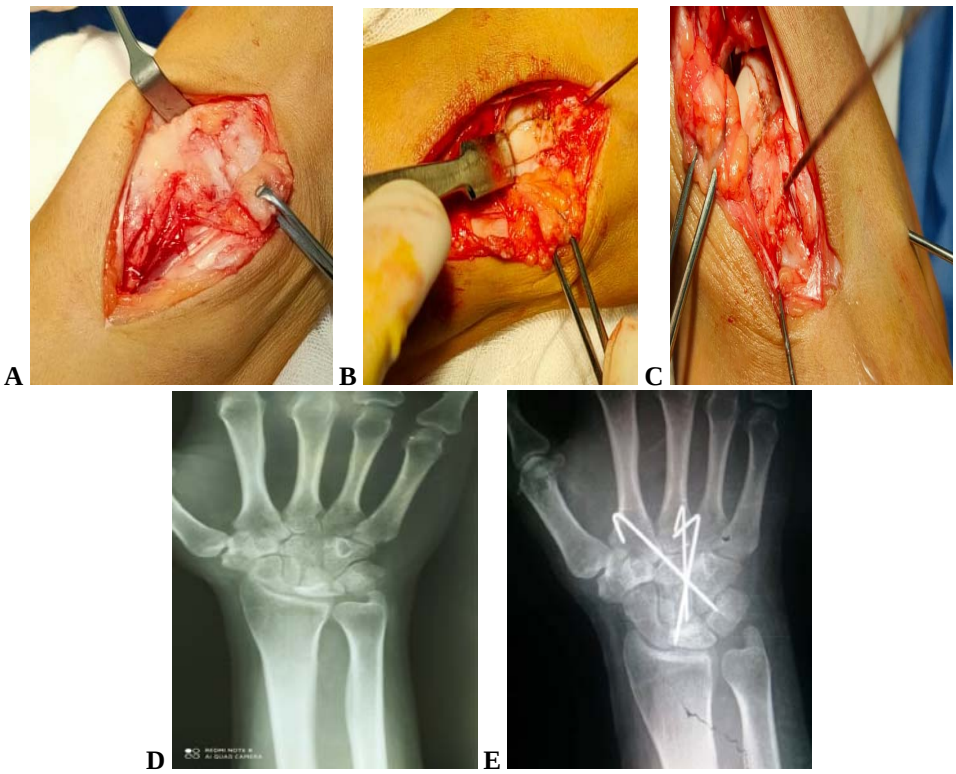

Figure 1: (A) Opening of the capsule. (B) Reverse L"-shaped osteotomy of the capitate. (C) Fixation of the mobile segment of capitate by k-wires. (D) Pre-operative x-ray of the patient with grade IIIA Keinbock disease. (E) Post-operative x-ray showing capitate shortening.

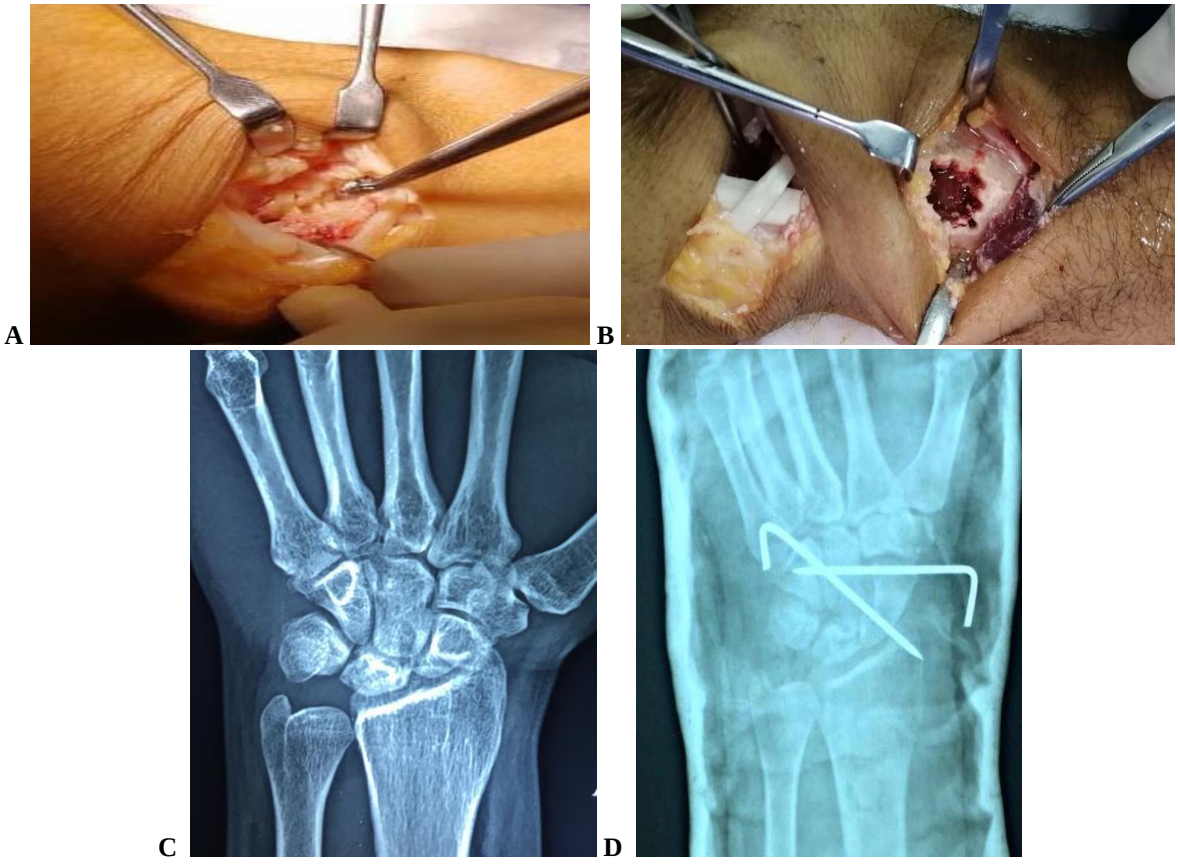

Figure 2: (A) Decortication of scaphoid and capitate bones. (B) Grafting from the floor of the second extensor compartment. (C) Pre-operative x-ray of the patient with grade IIIA Keinbock disease. (D) Post-operative x-ray showing scapho-capitate fusion.

Results

The mean pre-operative grip strength was 46.50 ± 10.55 (range, 30-65) which was improved to 79.40 ± 16.74 (range, 55-100) six months post-operatively in group A, while it was 54.60 ± 11.76 (range, 35-70) which was improved to 88.30 ± 12.43 (range, 75-100) in group B.

The mean pre-operative (ROM) was 58.20 ± 6.71 (range, 50-70) which was improved to 73.00 ± 9.14 (range, 58-85) six months post-operatively in group A, while it was 52.80 ± 5.35 (range, 45-60) which was improved to 65.70 ± 11.05 (range, 50-79) in group B.

The mean pre-operative pain score was 11.00 ± 5.16 (range, 5-15) which was improved to 19.00±5.68 (range, 5-25) six months post-operatively in group A, while it was 10.00 ± 5.27 (range, 5-15) which was improved to 21.00 ± 2.11 (range, 20-25) in group B.

The mean pre-operative satisfaction score was 12.00 ± 4.22 (range, 10-20) which was improved to 23.00±2.58 (range, 20-25) six months post-operatively in group A, while it was 14.00 ± 5.16 (range, 10-20) which was improved to 22.50±2.64 (range, 20-25) in group B.

The mean pre-operative MAYO score was 40.50 ± 5.99 (range, 30-45) which was improved to 72.50 ± 14.19 (range, 45-85) six months post-operatively in group A, while it was 41.50 ± 8.18 (range, 30-55) which was improved to 77.00 ± 10.85 (range, 65-90) in group B.

Discussion

Kienböck's disease is a rare, painful disorder of the wrist of unknown etiology and characterized by avascular necrosis of the carpal lunate bone. [11] Although various procedures have been proposed for treatment, a uniform algorithm has not been organized. [12] Most of the surgical procedures aim to unload the lunate in stages II and IIIA. [13]

According to grip strength, in this study, the mean pre-operative grip strength was 46.5% improved to 79.4% six months post-operatively in group A, which was similar to the results of Afshar et al.[14] 75% in capitate shortening group and Citlak et al.[15] 73%, and better than Singer et al.[16] 63% and Atiyya et al.[17] 67% (in which they performed isolated Capitate shortening in 15 patients and combined with hamate osteotomy in two). While it was 54.6% improved to 88.3% in group B, which was better than Collon et al. [18] 76%.

According to a range of motion, in this study, the mean pre-operative range of motion was 58.2% improved to 73% six months post-operatively in group A, which was better than the results of Afshar et al.[14] 66% in the capitate shortening group, Atiyya et al.[17] 66% and Singer et al.[16] 65.5. While in group B, the range of motion was 52.8% which was improved to 65.7%. Which was similar to the results of Collon et al. [18] 64%.

Union was obtained in 20 patients (100%), only one patient had delayed union (5%) which united after 20 weeks which is similar to the results of Singer et al.[16] and Afshar et al.[14] in which there is the union in all cases and better than the results of Collon et al.[18] in which there is nonunion in four cases (23%), three of them; the scapho-capitate joint was fixed with staples which may be the cause of nonunion.

No avascular necrosis of the capitate occurred after partial capitate osteotomy similar to the results of Atiyya et al. [17], Singer et al. [16] and Afshar et al. [14] the posterior approach may be safer as the blood supply of the capitate comes mainly from the volar side according to Gelberman et al.[19] Also, the main blood supply coming from the body to the head is not completely violated with this partial osteotomy.

The results of this study are compared to the results of Fujiwara et al. [20] in which they performed vascularized bone graft for ten grade IIIA Kienböck patients. The mean grip strength postoperatively was 88.5% which was better than group a 79.4% and like group B 88.3%. The mean range of motion postoperatively was 78.3% which was like group A 73% and better than group B 65.7%. The post-operative MAYO score was excellent in five (50%) patients, good in four (40%), and fair in one (10%) which was better than the results of this study.

The results of this study are compared to the results of Matsumoto et al. [21] in which they performed vascularized bone graft to lunate combined with temporary scapho-capitate fusion for grade III Kienböck disease. The mean grip strength postoperatively was 87.7% which was better than group A 79.4% and like group B 88.3%, while the mean range of motion postoperatively was 79.2% which was like group A 73%, and better than group B 65.7%. The post-operative MAYO score was excellent in two (12.5%) patients, good in six (37.5%), fair in six (37.5%), and poor in two (12.5%) which was like the results of this study.

The results of this study are compared to the results of Afshar et al. [14] in which they performed Radial Shortening and Capitate Shortening Osteotomies in

Kienböck Disease. The mean grip strength postoperatively was 70% for the radial shortening group which was worse than both groups A 79.4% and B 88.3%, while the mean range of motion post-operatively was 68% which was like both groups A 73% and B 65.7%.

The results of this study are compared to the results of Waitayawinyu et al. [22] in which they performed Capitate shortening osteotomy with vascularized bone graft. The mean grip strength postoperatively was 78% which was like group A 79.4% and worse than group B 88.3%. The mean range of motion postoperatively was 78% which was like group A 73% and better than in group B 65.7%.

The limitations of the current study include the short period of follow-up, the limited number of patients. However, it should be remembering that Kienböck disease is an uncommon disease and finally no assessment was performed for revascularization of the lunate postoperatively.

Future recommendations include a larger number of patients and longer follow-up periods are required. Post-operative MRI is required to assess revascularization of lunate. Multiple studies can be done in different centers and surgeons to collect more data about this technique.

Conclusion

Capitate shortening osteotomy and scapho-capitate fusion are effective procedures in the treatment of grade IIIA Kienböck disease with no statistically significant difference found between both groups in this study.

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