RESEARCH ARTICLE

Short-Term Clinical Outcomes of Radial Shortening Osteotomy and Capitates Shortening Osteotomy in Kienböck Disease

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Abstract

Background: There is no consensus on the best surgical treatment in Kienböck disease. We compared the short-term outcomes of radial shortening osteotomy and capitate shortening osteotomy in patients affected with this disease.

Methods: In a retrospective study of 21 patients with Lichtman stage IIIA of Kienböck disease, 12 patients with an average follow up of 3.2 ± 0.6 years had radial shortening osteotomy (group I) and 9 patients with an average follow up of 3.1 ± 0.7 years had capitate shortening osteotomy (group II). The two groups were comparable in age, sex, operated side, initial Lichtman stage, and follow-up duration. At the last follow-up the patients were evaluated for pain, wrist range of motion, grip strength, wrist functional status and change in their Lichtman stage. The overall results were evaluated by the Cooney wrist function score and DASH score.

Results: All the patients in the two groups had improvement of their wrist pains. According to the Cooney wrist function score group I had 1 excellent, 9 good, and 2 fair scores and group II had 1 excellent, 6 good, and 2 fair scores. Comparisons between the means of pain VAS scores, wrist range of movement, grip strength, DASH score, and Cooney wrist function score in the two groups were not significant. Also, the changes of the Lichtman stage in the two groups were not significant.

Conclusions: Both groups had reasonable short-term outcomes. We were unable to recognize a substantial clinical difference between the two surgical treatments in short-term outcomes.

Key words: Capitate shortening osteotomy, Kienböck disease, Radial shortening osteotomy

Introduction

The development and progression of avascular necrosis in Kienböck disease is likely to be multi factorial including anatomic factors, interrupted circulation, and traumatic events (1- 4). Patients may seek treatment because of pain, reduced wrist range of motion and power grip, and restrictions in their occupations. In the early Lichtman stages (II and IIIA) of Kienböck disease, patients may have better outcomes with surgical treatments (1- 4). Different osteotomies procedures to unload the lunate, direct revascularization techniques and core decompression techniques may be offered to patients in the early stages of the disease to induce revascularization of the lunate and prevent further collapse and progression of the disease (1- 4).

There is no consensus on the best surgical treatment in Kienböck disease (1-5). Among different osteotomy procedures described for Kienböck disease, radial shortening osteotomy may be the first option offered to patients with ulnar negative variance. Radial shortening osteotomy has reasonable short and long term clinical outcomes (6-11). However, capitate shortening osteotomy

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has gained interest in recent years for the treatment of Kienböck disease (12-21).

Unfortunately, there are few comparative studies on available treatments for patients with Kienböck disease (22-25). To the best of our knowledge, comparison between the clinical outcomes of radial shortening osteotomy and capitate shortening osteotomy in these affected patients has yet to be reported. The purpose of this study was to compare the short-term clinical outcomes of radial shortening osteotomy and capitate shortening osteotomy in patients affected with Kienböck disease.

Materials and methods

In a retrospective study, we reviewed our hospital database and identified patients with Kienböck disease who were treated either by radial shortening osteotomy (group I) or capitates shortening (group II) between 2009 and 2012. The diagnosis and indications for surgery were based on standard wrist radiographs. The institutional review board approved the study.

From a total of 32 patients, twenty-one patients participated in this study and were treated by one surgeon. All the patients had stage IIIA Kienböck disease according to the Lichtman classification. Patients with negative ulnar variance were offered a radial shortening osteotomy and those with neutral ulnar variance were offered a capitate shortening osteotomy.

In group I, 12 patients (10 males and 2 females) with ulnar negative variance and a mean age of 33.7±9.3 years had radial shortening osteotomy. There was no negative ulnar variance of more than 2 mm and none of the patients had more than 2 mm radial shortening. The mean follow-up was 3.2±0.6 years. Radial shortening osteotomy was performed by the dorsal approach. The patients achieved a neutral ulnar variance at the distal radioulnar joint. The osteotomies were internally fixed with a six-hole 3.5 mm DCP plate. All the osteotomies were fixed with a similar plate.

In group II, 9 patients (7 males and 2 females) with a mean age of 29.6±5.6 years had capitate shortening osteotomy. The mean follow-up was 3.1±0.7 years. Capitate shortening osteotomy was performed by a dorsal approach over the capitate (12-14). At the level of the distal dorsal articular surface of the scaphoid, a 2-mm wafer of bone was removed using an oscillating saw. The 2 cut surfaces were compressed manually and fixed with 2 K-wires that were left out of the skin, and the wrist was protected by a short-arm cast. The K-wires were removed in the office after the osteotomy site healed (about 6 weeks) and rehabilitation was started. The 2 groups of this study were comparable in age, sex, operated side, initial Lichtman stage, and follow-up duration [Table 1].

At the final follow-up, each patient's pain was evaluated by the Visual Analogue Scale (VAS) (0 = no pain, 1-3 = mild pain, 4-6 = moderate pain, and 7-10 = severe pain) and compared with their preoperative VAS. Pain was graded as none, mild (occasional and on strenuous activity), moderate (tolerable and on light work), and severe (intolerable and unable to work because of pain) according to the Cooney wrist function score (6, 26). Wrist Range of Movement (ROM) of the affected side was measured, and its percentage to the normal side was calculated. Grip strength (kg) of the affected side and its percentage to the normal side (Jamar dynamometer, Sammons Peterson, Bolingbrook, IL, USA) was also measured. The functional status of the wrist was determined and graded as: return to regular work, restriction in work, able to work but unemployed, and unable to work because of pain according to the Cooney wrist function score. The pain grade, wrist ROM, grip strength, and functional status of the wrist scores were added to calculate a total Cooney wrist function score, ranging from 0 to 100 with the higher scores indicating more favorite outcomes (6, 26).

The functional status outcome was also evaluated at the final follow up using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and compared with the pre-operative DASH scale. DASH scale ranges from 0 to 100 and the higher scores indicate more disability.

Progression of the disease was verified by the change in the Lichtman stage. The interviews and examinations were performed by one of the authors who was not involved in performing any of the surgeries.

The t-student test, non-parametric Mann-Whitney U test, Wilcoxon signed ranks test, Chi square, and Fisher exact test were used to compare the data of the 2 groups. *P* values less than 0.05 were considered statistically significant.

Results

All the patients in group I had concerns about the presence of hardware in their forearms. Table 2 shows the clinical results of group I and Table 3 shows the clinical results of group II. There was no nonunion, avascular necrosis, or carpal malalignment in the patients with capitates shortening osteotomy. All the patients in the two groups had improvement in their wrist pain. In group I, the mean of the preoperative

Table 1. Patients characteristics are compared in the two groups

Comparison of patient characteristics in the 2 groups	Age	Sex	Operated side	Follow-up (years)
Group I (12 patients)	33.7 ± 9.3	10 males, 2 females	5 right, 7 left	3.2 ± 0.6
Group II (9 patients)	29.6 ± 5.6	7 males, 2 females	6 right, 3 left	3.1 ± 0.7
P (Statistic test)	*P*=0.26 (t student)	*P*= 0.59 (Fisher Exact test)	*P*= 0.25 (Fisher Exact test)	*P*= 0.74 (t student)

P values less than 0.05 were considered statistically significant.

Table 2. The results of the 12 patients with radial shortening osteotomy (group I)

Cases	Age	Sex	Operated side	Ulnar variance	Occupation	Lichtman initial stage	Follow up (years)	Pre op Pain (VAS Score)	Final Pain (VAS Score)	Wrist range of movement (percentages of normal side)	Grip strength (kg) (percentages of normal side)	Lichtman stage at final follow up	Cooney score at final follow up	Pre op DASH score	Final DASH score
1	47	M	Left	-2	Verterian	IIIA	3	8 (severe)	2 (Mild)	170 (77%)	35 (86%)	IIIA	85 (Good)	59.1	22.1
2	35	F	Right	-1	House keeper	IIIA	3	9 (severe)	1 (Mild)	160 (70%)	27 (100%)	IIIA	90 (Excellent)	60.8	22.1
3	25	M	Left	-2	Student	IIIA	2	8 (severe)	2 (Mild)	160 (71%)	29 (73%)	IIIA	80 (Good)	70.0	17.5
4	30	M	Right	-2	Manual worker	IIIA	3	8 (severe)	2 (Mild)	135 (67%)	15 (55%)	IIIA	80 (Good)	68.3	24.1
5	35	M	Right	-2	Manual worker	IIIA	3	9 (severe)	2 (Mild)	120 (54%)	32 (51%)	IIIA	80 (Good)	79.1	26.2
6	50	M	Left	-2	Teacher	IIIA	3	9 (severe)	2 (Mild)	140 (62%)	25 (60%)	IIIA	75 (Fair)	71.6	18
7	25	F	Left	-2	House keeper	IIIA	3	8 (severe)	1 (Mild)	185 (80%)	17 (61%)	IIIA	80 (Good)	65	27.5
8	37	M	Left	-2	Shop keeper	IIIA	3.5	8 (severe)	2 (Mild)	145 (72%)	24 (66%)	IIIB	80 (Good)	73.3	30
9	24	M	Right	-1	Manual worker	IIIA	4	8 (severe)	1 (Mild)	160 (72%)	44 (86%)	IIIA	80 (Good)	75	20.1
10	23	M	Left	-2	Farmer	IIIA	4	8 (severe)	2 (Mild)	150 (65%)	42 (80%)	IIIA	85 (Good)	58.3	22.1
11	44	M	Left	-2	Shop keeper	IIIA	3	9 (severe)	3 (Mild)	145 (69%)	23 (60%)	IIIA	80 (Good)	72.5	31.3
12	29	M	Right	-2	Manual worker	IIIA	4	9 (severe)	2 (Mild)	110 (57%)	27 (63%)	IIIA	70 (Fair)	71.6	30

M: male; F: female.
Wrist range of movement is the sum of flexion, extension, radial deviation, and ulnar deviation movements.
Pain, wrist range of movement, and grip strength were evaluated at the final follow up examination.
Visual Analogue Scale (VAS) ranges from 0 to 10. (0, no pain; 1-3, mild pain; 4-6, moderate pain; 7- 10, severe pain)
Cooney's scores from 0 to 100 and the higher scores indicate more favorite outcomes. (Excellent, 90-100; good, 80-90; fair 65-80; poor, 0-65)
DASH score ranges from 0 to 100 and the higher scores indicate more disability.

VAS scores was 8.4±0.5 and the mean of the final VAS scores was 1.8 ± 0.6 and the difference was significant (*P*=0.002). In group II, the mean of preoperative VAS scores was 8.4±0.7 and the mean of final VAS scores was 2.5±0.9 and the difference was significant (*P*=0.007). The difference of the means of the final VAS scores in the two groups was not significant (*P*=0.13).

The mean ROM in group I was 148.3±20.8 and in group II it was 144.4±23.1 and the difference was not significant (*P*=0.92). The mean grip strength in group I was 28.3±8.8 and in group II it was 29.3±11.3 and the difference was not significant (*P*=0.86).

According to the Cooney wrist function score, there were 1 excellent, 9 good, and 2 fair scores in group I and 1 excellent, 6 good and 2 fair scores in group II. The mean Cooney wrist function score for group I was 80.4±4.9 and 80.6±4.6 for group II and the difference was not significant (*P*=0.91).

In group I, the mean preoperative DASH score was 68.7±6.5 and the mean final DASH score was 24.2±4.7, with significant difference (*P*=0.002). In group II, the mean preoperative DASH score was 65.8±5.3 and the mean final DASH score was 20.5±4.5, with significant difference (*P*=0.008). The difference of the means of the final DASH scores in the two groups was not significant (*P*=0.11).

In each group the Lichtman stage progressed from IIIA to IIIB in one patient and the difference was not significant (*P*=0.83).

Discussion

The aim of the radial and capitate shortening osteotomies in Kienböck disease is to reduce load transmission across the radiolunate joint. Reducing stress

Table 3. The results of the 9 patients with capitate shortening osteotomy (group II)

Cases	Age	Sex	Operated side	Ulnar variance	Occupation	Lichtman initial stage	Follow up (years)	Pre op pain (VAS Score)	Final pain (VAS Score)	Wrists range of movement (percentages of normal side)	Grip strength (kg) (percentages of normal side)	Lichtman stage at the final follow up	Cooney Score at final follow up	Pre op DASH scores	Final DASH scores
1	25	M	Right	0	Manual worker	IIIA	3	9 (severe)	2 (Mild)	125 (55%)	33 (71%)	IIIA	80 (good)	60.0	12.5
2	23	M	Left	0	Manual worker	IIIA	4	8 (severe)	1 (Mild)	175 (74%)	33 (100%)	IIIA	90 (Excellent)	60.8	27.5
3	31	F	Right	0	House keeper	IIIA	3	7 (severe)	2 (Mild)	120 (57%)	20 (69%)	IIIB	75 (Fair)	62.5	17.5
4	32	M	Right	0	Engineer	IIIA	2.5	9 (severe)	2 (Mild)	160 (68%)	29 (70%)	IIIA	80 (Good)	74.1	23.3
5	22	M	Right	0	Farmer	IIIA	2.5	8 (severe)	2 (Mild)	165 (80%)	16 (66%)	IIIA	80 (Good)	60.0	17.5
6	27	M	left	0	Mason	IIIA	3	9 (severe)	3 (Mild)	115 (53%)	25 (58%)	IIIA	75 (Fair)	65.0	23.3
7	35	F	Right	0	House keeper	IIIA	2	9 (severe)	3 (Mild)	125 (60%)	17 (61%)	IIIA	80 (Good)	70.0	21.8
8	33	M	Left	0	Taxi driver	IIIA	4	8 (severe)	3 (Mild)	150 (71%)	41 (82%)	IIIA	85 (Good)	69.1	17.5
9	38	M	Right	0	Teacher	IIIA	4	9 (severe)	4 (Moderate)	165 (76%)	50 (100%)	IIIA	85 (Good)	70.8	23.3

M: male; F: female.
Wrist range of movement is the sum of flexion, extension, radial deviation, and ulnar deviation movements.
Pain, wrist range of movement, and grip strength were evaluated at the final follow up examination.
Visual Analogue Scale (VAS) ranges from 0 to 10 (0, no pain; 1-3, mild pain; 4-6, moderate pain; 7- 10, severe pain)
Cooney's scores from 0 to 100 and the higher scores indicate more favorite outcomes (excellent, 90-100; good, 80-90; fair 65-80; poor, 0-65)

on the lunate bone probably induces revascularization of the bone and prevents further changes in the shape of the lunate and collapse of the carpus.

Ines and Strauch have suggested that subjective pain in Kienböck disease improves regardless of surgical treatment (5, 27). Blanco and Blanco performed osteotomy of the radius without shortening in Kienböck disease patients with an average of 1.8 mm negative variance. Bekler et al. performed capitate forage to treat Kienböck disease (21). Ines and Strauch have suggested that a cortical disruption is effective in the treatment of Kienböck disease. They have theorized that cortical disruption, which may be proximal or distal to the lunate bone, alters the local circulation and improves the biologic environment of the lunate bone (5, 27). Capitate shortening osteotomy as well as several other treatments such as lunate core decompression, capitates forage, distal radius, and ulnar core decompression is independent from the ulnar variance (1, 2). Several studies have questioned the importance of the ulnar variance in Kienböck disease (27-29). In the current study, the negative ulnar variance in group I patients was not more than 2 mm initially and no patient had more than 2 mm radial shortening. Therefore, the initial difference of the ulnar variance in the two groups does not preclude the comparison between the clinical outcomes of the two surgical treatments.

The radial and capitate shortening osteotomies are both effective in reducing the load across the radio-lunate joint (18, 19, 30, 31). However, capitate shortening is a more effective surgery to reduce the load across the radio-lunate joint. Horii et al. have demonstrated that the shortened capitate transfers less load (66% reduction) across the radio-lunate joint than the shortened radius (45% reduction) (18). Radial shortening is an extra-articular procedure, while capitates shortening is an intra-articular procedure. In the current study, both procedures were effective in reducing pain and the differences of the final pain VAS, grip strength, wrist ROM, and DASH scores in both groups were not significant.

Vander Grend et al. investigated the blood supply of the capitates bone (32). They found three patterns of intraosseous circulation in the capitate bone. The common denominator of the three patterns was a retrograde flow from the distal to the proximal. Therefore, surgeons may have concerns about developing non-union and avascular necrosis of the proximal fragment in capitate osteotomies. Another concern may be developing carpal malalignment, since the transverse osteotomy through the capitate waist reduces the length of the capitate and

it may predispose the scaphoid to adopt a palmar flexed position because of the increased load across the adjacent inter-carpal joints. In the current study there was no nonunion, avascular necrosis, and carpal malalignment in the patients who had capitate shortening osteotomies.

In the current study, the capitate osteotomies were fixed by K-wires for 6 weeks, and then the K-wires were removed in an outpatient clinic. In the radial shortening group, all the patients had concerns about the presence of a plate and screws on their radiuses. Some of them insisted the hardware be removed in the future.

In the current study, changes of the Lichtman stage was not remarkable. However, radiological findings do not necessarily correlate with clinical outcomes (7, 12).

This study had several limitations. It was a retrospective study and the two groups had a small number of patients. However, it should be remembers that Kienböck disease is an uncommon disease. Also, this study was a short term study, however; we plan to continue follow up of the patients for a longer period of time.

Comparison between radial shortening osteotomy and vascularized bone graft based on the distal radius 4+5 extensor compartmental artery used for treatment of Kienböck disease did not show substantial clinical and radiological difference in long-term outcomes (24).

In the current study, both groups had reasonable short-term outcomes. Subjective pain and DASH scores improved in both groups. Both procedures reduced the load on the lunate and improved the local biology by increasing the local circulation. However, we were unable to recognize a substantial clinical difference between the two surgical treatment outcomes. It seems that a reasonable clinical outcome in the treatments of Kienböck disease depends on multiple factors.

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