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Proximal row carpectomy for Lichtman stage III Kienböck's disease

Levent BULUÇ[1], Hakan GÜNDEŞ[2], Tuncay BARAN[1], Özgür SELEK[1]

[1]Kocaeli University Faculty of Medicine, Department of Orthopaedics and Traumatology, Kocaeli, Turkey
[2]Private Practice, İstanbul, Turkey

Objective: The purpose of this study was to investigate the objective and subjective outcomes of proximal row carpectomy (PRC) for stage III Kienböck's disease and determine if the physician's objective measurements correlate with the patients' subjective outcomes.

Methods: Twenty-four patients who underwent PRC for stage III Kienböck's disease with a follow-up period of more than 18 months were enrolled in the study. Clinical evaluation included preoperative and postoperative Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) questionnaire, postoperative Mayo wrist score, postoperative total joint range of motion (ROM), as well as grip and pinch strength measurements of the operated and normal side. Radiographic criteria such as carpal height ratio, subchondral cyst, and osteophyte formation were assessed during the follow-up period. Mean follow-up period was 41.7 months (range: 18–106 months).

Results: No wrists underwent total arthrodesis. Reflex sympathetic dystrophy was observed in 2 patients (8.3%). Postoperative ROM measurements, power grip, and pinch strength values significantly decreased in both stages (IIIA and IIIB) on the operated side compared to the normal side. In contrast, Q-DASH scores significantly increased in both stages compared to preoperative values. Average Mayo wrist score was 67.3 (range: 10–90).

Conclusion: PRC is a well-tolerated procedure for stage III Kienböck's disease with certain complications. While subjective values improved significantly, there was no correlation between this improvement in subjective values and objective measurements. PRC was not able to restore motion postoperatively to that of the normal side, even though this feature did not affect postoperative subjective patient satisfaction.

Keywords: Kienböck's disease; proximal row carpectomy.

Level of Evidence: Level IV Therapeutic Study

Kienböck's disease is the idiopathic avascular necrosis of the lunate.[1] The etiology of the disease is complex and still debated.[1,2] Because of the low incidence and unclear etiology, it is hard to establish evidence-based data to support any particular method of surgical treatment or to indicate the superiority of surgical treatment over conservative measures.[3–5] One retrospective cohort study indicates that the disease is progressive, leading to carpal collapse and arthritic changes in most of the cases treated with conservative measures.[6] As the natural history is unknown, it is not possible to predict whether all patients will progress to an advanced collapse pattern or

Correspondence: Özgür Selek, MD. Kocaeli Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Kliniği, Umuttepe, Kocaeli, Turkey.
Tel: +90 262 – 303 73 56 e-mail: drozgurselek@gmail.com

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whether some cases will stabilize over time.[1,2,4,5]

Several surgical methods intended to stop or slow the progressive nature of the disease in early stages have been described in the literature,[7–9] but pain management is the primary goal in treating cases with advanced collapse.[10–14]

The treatment algorithm for Kienböck's disease is based on Lichtman's classification of radiological changes in the lunate and the consequent carpal collapse pattern.[15] According to Lichtman's classification, radiologic staging correlates with the prognosis and clinical outcome.[15] Lichtman stage III represents collapse of the lunate bone. It is further subdivided into stage IIIB if carpal instability accompanies the affected lunate. Although classification and treatment of the disease have been based on radiologic findings, studies indicate that radiologic and clinical findings do not always correlate.[1,2]

In 1944, Stamm described proximal row carpectomy (PRC).[15] When applied to Kienböck's disease, the normal scaphoid and triquetrum are excised along with the diseased lunate, leaving a new articulation between the capitate and lunate fossa of the radius. Along with alternative surgical techniques such as partial or total wrist fusion, PRC has been accepted as a treatment option for advanced Kienböck's disease (stage IV) as a motion-preserving procedure with an acceptable loss of wrist power.[12–14,16,17]

We hypothesized that PRC would reproduce the same results in patients with a collapsed lunate (i.e., stage III Kienböck's disease). Additionally, we investigated whether there is an objective baseline for the subjective well-being (SWB) expressed by patients after PRC.

Patients and methods

A retrospective cohort study of patients who underwent PRC for stage III Kienböck's disease with a regular follow-up period of >18 months was performed. Institutional review board approval was obtained. Thirty patients with Lichtman stage III Kienböck's disease who were treated with PRC technique between 1997 and 2011 were included in the present study. Staging of the disease was based on radiographic evidence of collapse of the lunate bone on preoperative radiographs. Excision of the lunate and proximal row, along with other

Table 1. Patient demographics and subjective results.

Patient	Age (y)	Sex	Stage	Follow-up (m)	Dominant hand	DASH Pre-op#	DASH Post-op#
1	51	Female	IIIA	106	Yes	80.8	0.8
2	46	Female	IIIB	73	Yes	65.0	7.5
3	35	Male	IIIA	68	Yes	50.8	3.3
4	41	Male	IIIA	62	Yes	60.8	19.2
5	29	Female	IIIB	62	Yes	35.8	14.2
6	41	Female	IIIB	58	Yes	24.0	11.7
7*	48	Female	IIIB	53	Yes	60.0	60.5
8	31	Female	IIIB	47	Yes	45.8	18.3
9	42	Male	IIIB	47	No	56.9	22.5
10*	50	Female	IIIB	46	Yes	60.0	80.2
11	43	Male	IIIB	46	No	28.0	0.8
12	39	Male	IIIA	43	Yes	32.5	19.2
13	49	Male	IIIA	38	No	45.0	0
14	39	Female	IIIA	36	Yes	64.5	18.2
15	29	Female	IIIA	33	No	66.7	7.8
16	54	Female	IIIA	32	Yes	62.5	17.9
17	37	Female	IIIB	30	Yes	60.0	19.2
18	33	Female	IIIA	26	No	40.0	15.8
19	44	Male	IIIB	25	No	62.0	16.7
20	30	Female	IIIA	22	No	35.8	23.3
21	26	Male	IIIB	22	Yes	64.5	4.2
22	26	Female	IIIA	20	No	28.0	9.2
23	55	Female	IIIA	20	Yes	50.8	17.5
24	35	Female	IIIA	18	Yes	45.0	9.2

*: Reflex sympathetic dystrophy patients.

#: Scored from 0 to 100 points, with higher score representing greater disability.

conservative and surgical options, was discussed in detail with all stage IIIA and IIIB patients. Patients who had other types of treatment modalities were excluded from the study. Six patients were excluded because they failed to attend the final follow-up. Mean follow-up period was 41.7 months (range: 18–106 months).

The study consisted of 16 female and 8 male patients. The average age at the time of PRC was 39.7 years (range: 26–55 years). Thirteen patients had stage IIIA and 11 patients had stage IIIB Kienböck's disease at the time of diagnosis. Sixteen patients had involvement of the dominant hand (Table 1). The indications for PRC included wrist pain and limited motion that prevent activities of daily living (ADL). No patients were asymptomatic at time of diagnosis. No patients had a history of trauma or worker's compensation claims.

Indications for the procedure included wrist pain and limited range of motion (ROM) that prevent ADL associated with a collapsed lunate. All patients had magnetic resonance imaging (MRI) performed preoperatively in order to evaluate joint surfaces of the lunate fossa and distal capitate. Clinical evaluation included preoperative and postoperative Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) score measurements, postoperative Mayo wrist score measurements, final follow-up postoperative total joint ROM measurements of the index and normal wrist, and grip and pinch strength measurements of the index and normal side. All active and passive motion measurements were performed in the same manner using a standard goniometer. Wrist flexion, wrist extension, radial deviation, ulnar deviation, supination, and pronation were measured. Standard Jamar® dynamometer and pinch meter (Sammons Preston Inc., Bolingbrook, IL, USA) were used for measuring grip strength and key pinch, respectively. Direct radiographic criteria such as carpal height index, sclerosis, subchondral cyst, and osteophyte formation were evaluated at each follow-up (Figure 1 and 2).

All operations were conducted with the use of a pneumatic tourniquet. In all cases, PRC was performed by a 6- to 10-cm long dorsal longitudinal incision. The extensor retinaculum was sectioned through the fourth compartment, parallel to the incision. The third and fourth compartments were connected. Proximally, the terminal branches of the posterior interosseous nerve was identified on the ulnar ridge of the distal radius and excised. Tendons were pulled towards the ulnar side, and the capsule was exposed. The capsule was cut open through an H-shaped incision, allowing evaluation of the proximal part of the capitate and lunate fossa. Before excision of the proximal row, quality of the cartilage

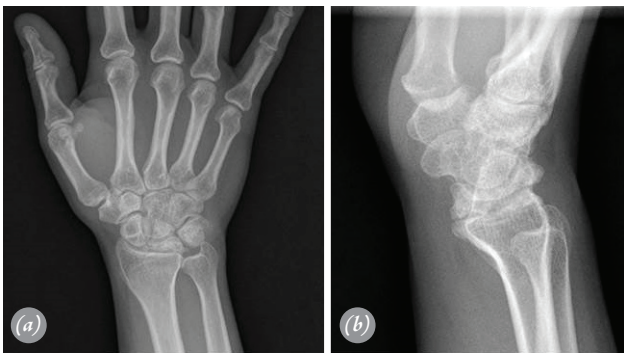

Fig. 1. Preoperative AP **(a)** and lateral **(b)** X-Ray view of 29-year-old female with Lichtman stage IIIB Kienböck's disease.

surface of the proximal capitate and lunate fossa of the radius were evaluated visually. The lunate was separated sharply from the intercarpal ligaments over the triquetrum and the scaphoid. In our experience, separating the lunate from intercarpal ligaments on both sides creates a more effective working space. The proximal row excluding the pisiform was excised, and the head of the capitate was placed in the center of the lunate fossa. In the first

Fig. 2. The patient was treated by PRC. Sixty-two months after surgery, postoperative radiographs showed reasonable radiographic parameters in **(a)** AP and **(b)** lateral views of both wrists (R: right).

4 cases, the position was fixed using a K-wire. In the following cases, immobilization was provided by a bulky dressing with a volar splint that was used for 3 weeks without K-wire fixation. Following 3 weeks of immobilization, rehabilitation was applied for 4 weeks. In the first 3 cases, limited radial styloidectomy was performed in order to prevent radial trapezial impingement. This part of the procedure was later abandoned in order to prevent iatrogenic volar wrist ligament injury.

The parametric data of ROM measurements and grip and pinch strength were compared throughout different stages of the disease using paired sample t-test. To determine any age, gender, or dominancy differences, groups were compared using Student's t-test and chi-square test. Mann Whitney-U test was used to analyze Q-DASH scores and Mayo wrist scores. Pearson's correlation test was used to analyze whether significant correlation existed between the Q-DASH scores and grip and pinch strength. Statistical significance was defined as $p<0.05$.

Results

No wrists underwent total wrist arthrodesis. Reflex sympathetic dystrophy (RSD) was observed in 2 patients (8.3%). All patients returned to their former occupations, including 8 heavy manual laborers. The MRI findings of the patients showed subtle changes of the lunate fossa and distal capitate, but these changes did not constitute a limitation for PRC. Postoperative ROM measurements (wrist flexion, extension, radial, and ulnar deviation), power grip, and pinch strength values significantly decreased ($p<0.001$) in both stages (IIIA and IIIB) compared to the normal side (Table 2). Postoperative pronation (mean: 76.9°; range: 60–80°) and supination (mean: 75°; range: 55–80°) values did not significantly decrease compared to the normal side. There was

Table 2. Objective and radiographic results.

				Flexion (°)		Extension (°)		Radial deviation (°)		Ulnar deviation (°)		Grip strength (kg)		Key pinch (kg)		
Patient	Age (y)	Sex	Mayo	N	Op	N	Op	N	Op	N	Op	N	Op	N	Op	Radiology +
1	51	Female	90.0	70	40	80	60	40	10	40	30	31.5	22.5	3.2	2.9	No
2	46	Female	70.0	80	50	70	45	45	5	30	10	29.3	22.5	7.2	6.8	Yes
3	35	Male	60.0	70	50	80	55	30	20	40	30	42.8	40.5	5.4	4.7	Yes
4	41	Male	75.0	70	30	80	30	20	10	30	15	31.5	31.5	4.3	3.6	Yes
5	29	Female	70.0	90	40	80	45	25	20	40	40	36.0	27.0	2.7	2.9	No
6	41	Female	90.0	90	80	60	50	20	10	50	40	36.0	31.5	2.7	2.9	Yes
7*	48	Female	40.0	90	10	80	0	20	5	30	5	31.5	4.5	2.7	1.8	Yes
8	31	Female	90.0	80	55	80	50	20	10	30	25	29.3	22.5	2.6	2.1	Yes
9	42	Male	65.0	90	45	80	35	15	10	50	35	36.0	18.0	4.2	3.5	Yes
10*	50	Female	10.0	90	20	80	45	30	20	45	30	27.0	9.0	2.5	1.0	Yes
11	43	Male	80.0	80	30	80	50	20	10	25	20	56.3	54.0	5.4	4.3	Yes
12	39	Male	70.0	90	40	80	40	40	10	50	40	45.0	42.8	5.2	4.3	No
13	49	Male	85.0	60	35	60	40	40	30	30	20	45.0	27.0	11.7	10.8	Yes
14	39	Female	40.0	90	20	80	30	20	10	30	20	31.5	13.5	2.7	2.3	No
15	29	Female	70.0	90	40	80	50	20	10	50	40	36.0	13.5	2.8	2.5	Yes
16	54	Female	40.0	80	0	80	20	20	0	10	10	27.0	4.5	3.7	1.7	No
17	37	Female	70.0	75	45	75	45	30	30	45	30	36.0	27.0	9.9	9.9	Yes
18	33	Female	65.0	80	60	80	60	30	30	30	30	36.0	20.3	7.2	5.0	Yes
19	44	Male	75.0	60	25	70	40	30	10	30	10	42.8	38.3	12.6	12.2	Yes
20	30	Female	65.0	70	40	70	30	30	20	40	30	36.0	22.5	6.8	5.4	Yes
21	26	Male	80.0	80	60	80	50	30	20	50	30	33.8	20.3	11.3	9.0	Yes
22	26	Female	70.0	70	30	70	30	30	20	40	30	36.0	27.0	9.5	9.5	Yes
23	55	Female	70.0	80	50	80	45	30	20	45	30	27.0	13.5	8.1	5.9	Yes
24	35	Female	75.0	80	45	75	40	30	20	20	10	40.5	27.0	5.9	5.9	Yes

*: Reflex sympathetic dystrophy patients.

Mayo Score: Excellent: 90–100 points; good: 80–89 points; fair: 65–79 points; poor: <65 points.

Radiology: Degenerative changes (any one of the factors such as subchondral cyst formation, sclerosis, and joint space narrowing).

N: Normal side; Op: Operated side.

an average of 39.2° flexion (range: 0–80°), 41° extension (range: 0–60°), 15° radial deviation (range: 0–30°), and 25.4° ulnar deviation (range: 5–40°) postoperatively. The average grip strength and key pinch values were 24.2 kg (range: 4.5–54 kg) and 5 kg (range: 1–12.2 kg), respectively. In contrast, Q-DASH scores were significantly better in both stage IIIA and IIIB patient groups compared to preoperative values ($p<0.001$). The average preoperative and postoperative Q-DASH scores were 51.1 and 17.4, respectively (Table 1). The Mayo wrist score yielded an average of 67.3 points (range: 10–90), composed of 3 excellent, 3 good, 13 fair, and 5 poor results. There was no correlation between the disease's stage (IIIA or IIIB) and the subjective and objective measurement results such as Q-DASH score, Mayo wrist score, and ROM measurements ($p>0.05$). There was no correlation between dominancy, gender, age at the time of the operation, and the subjective and objective measurement results such as Q-DASH score, Mayo wrist score, and ROM measurements ($p>0.05$). There was no correlation between the Q-DASH and Mayo wrist score and direct radiographic measurements of the wrist such as carpal height ratio, subchondral cyst, and osteophyte formation ($p>0.05$). Mayo score ($p=0006$), preoperative ($p=0.008$) and postoperative ($p=0.011$) DASH scores showed significant correlation with grip strength measurements. The same correlation was not observed with pinch power ($p>0.05$). PRC was not able to restore motion postoperatively to that of the normal side, even though this result did not affect postoperative subjective patient satisfaction.

Discussion

As Ring stated, the etiology and pathophysiology of Kienböck's disease and our ability to modify its course are open to debate. It is not known when or how the disease resolves. Lack of treatment does not inevitably lead to progressive collapse and arthritis. With or without treatment, the disease often stops at one of the earlier Lichtman stages.[5] A study by Innes and Strauch indicated that no active treatment is superior in the treatment of Kienböck's disease and there are insufficient data to determine whether the outcomes of any intervention are superior to placebo or no treatment.[4]

Although classification and treatment of the disease have been based on radiologic findings, some studies indicate that radiologic and clinical findings do not always correlate.[1,2]

While decision-making is relatively straightforward in the early (precollapse) and the late (arthritic) stages, considerable controversy still exists over the treatment for stages IIIA and IIIB Kienböck's disease.[1,3–5,7–9,12,16] Intercarpal arthrodesis, replacement arthroplasty, lunate excision, wrist denervation, revascularization, joint leveling, radius and ulna core decompression, and PRC have been reported as treatment methods.[12] Fujiwara et al. evaluated the long-term results of vascularized bone grafting on stage III Kienböck's disease.[7] Although the procedure improves lunate height immediately, patients often experienced gradual lunate collapse over time and ultimately, a return to preoperative condition.[7] Fujiwara et al. believed that dynamic load to the lunate should be reduced to minimize the risk of lunate collapse. Better clinical and radiologic results obtained by the authors with additional unloading procedures might be attributed to this factor, as there is a constant load on the lunate due to scaphoid rotation and carpal collapse at stage IIIB of the disease.

In reviewing the literature, no procedures were able to halt or reverse carpal collapse. Therefore, it might be rational to proceed with salvage procedures such as intercarpal or even pancarpal wrist fusions at advanced stages in order to palliate pain and regain function.

PRC was described by Stamm in 1944.[18] PRC restores wrist function by converting a complex link system to a simple ball and socket joint.[13] It has been known as a motion-preserving and pain-relieving procedure for arthritic wrist treatment.[13,18] With other surgical techniques such as partial or total wrist fusion as alternatives, PRC has been accepted as a treatment option for advanced Kienböck's disease (stage IV) as a motion-preserving procedure with an acceptable loss of wrist power.[12–14,16] According to Tang et al., contact pressure increases and contact area decreases significantly after PRC, which may explain its success even if there is articular damage to the lunate fossa of the radius and the head of the capitate.[19] There is significant contact translation after PRC, which may provide quantitative support to the theory that translational motion of PRC may explain its good clinical outcomes.[19] Debottis et al. investigated how the kinematics and tendon forces of the wrist altered after PRC and 4-corner arthrodesis.[11] Larger peak tendon forces were required to achieve identical wrist motions with 4-corner arthrodesis compared with the intact wrist. They observed smaller forces for PRC. They thought that these results might help to explain why PRC shows early clinical improvement yet may lead to degenerative arthritis.[11]

Despite perceived advantages of dividing stage IIIA and IIIB into 2 subgroups for treatment, there are few convincing clinical studies that support this. Considering this, PRC may be thought of as a treatment alterna-

tive in both stage IIIA and IIIB patients. In this study, postoperative ROM measurements, power grip, and pinch strength values were significantly less than those of the unaffected side; however, it was not possible to determine the degree of improvement obtained following surgery because preoperative measurements were not taken. It is the authors' opinion this feature has no negative effect on postoperative subjective patient satisfaction. In addition to the ease in technique, PRC may be advantageous by avoiding the issues of nonunion, delayed union, or hardware impingement documented with intercarpal arthrodesis. Furthermore, recovery may be more rapid. Q-DASH scores were significantly better in both stages compared to preoperative values. The only positive correlation with an objective measurement and better Q-DASH and Mayo wrist scores was a better postoperative power grip measurement.

There was no correlation between Q-DASH and Mayo wrist scores and direct radiographic parameters of the wrist such as carpal height ratio, subchondral cyst, and osteophyte formation. This finding is difficult to explain, but it demonstrates that radiologic and clinical findings do not always correlate.[1,2]

Reflex sympathetic dystrophy was observed in 2 cases (cases 7 and 10) (8.3%). Both cases were middle-aged women and who were in stage IIIB of the disease. They experienced persistent severe pain and edema in the early postoperative period, and consultation with the physical therapy department revealed the diagnosis. Despite medical treatment and physical therapy, stiffness of the wrist joint occurred. Their final postoperative objective and subjective scores were the lowest among others and negatively impact the overall results of the study.

Early in the series, a K-wire was used to immobilize the radiocapitate joint. This step was later abandoned, as the literature mentioned complications such as pin track infection, pin migration, and articular surface damage. We did not observe any untoward effects after abandoning the use of temporary pin fixation.[14]

In conclusion, PRC is a well tolerated procedure in stage III Kienböck's disease with a low complication rate. Subjective outcome indices improved significantly despite the fact that the procedure was not able to restore full motion. There was no correlation between the disease's stage and the objective and subjective results, confirming its utility even in late stage Kienböck's with advanced carpal collapse. With the exception of improved power grip, there was no correlation between the improvement in subjective values and objective measurements.

Conflics of Interest: No conflicts declared.

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