

## Research Article

# Clinical and Radiological Results of Radial Shortening Osteotomy versus Proximal Row Carpectomy in Kienböck's Disease

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**Abstract**

In this prospective study, we aimed to evaluate the clinical and radiological results of our patients treated with Radial Shortening Osteotomy (RSO) and Proximal Row Carpectomy (PRC) together with a short review of the literature. The study included 35 patients with the diagnosis of Kienbock disease RSO was performed for 17 patients and 18 patients underwent PRC. 15 of the patients had Lichtman Stage 2, 14 patients had Stage 3A and 6 patients had Stage 3B disease. Q-DASH Score, Preoperative and postoperative Carpal Height Ratio (CHR), revised CHR, stahl index, radial inclination values were noted. Preoperative and postoperative flexion-extension range of Motion (ROM) and ulnar deviation angles were also obtained. Nakamura's clinical evaluation system was performed to each patient. Results of clinical evaluation revealed significant progression at postoperative sixth month follow-up. Our results showed clinical improvement following surgeries of both RSO and PRC for Lichtman Stage 2, 3a and 3b disease. We consider that experience and technical familiarity of the surgeon is key factor to decide the type of the procedure to be performed.

**Keywords:** Kienböck's disease; Proximal row carpectomy; Radial shortening; Lichtman' classification

**Introduction**

Etiology of Kienbock disease remains unclear, this is mainly due to the rarity of the disease and lack of enough number of prospective studies. The treatment for Kienböck's disease ranges from conservative modalities such as immobilisation to operative options such as radial shortening [1-4] ulnar lengthening [5] proximal row carpectomy [6] / silastic arthroplasty [7,8] intercarpal fusions [9] and revascularisation procedures [10,11].

Negative ulnar variance has been accepted as a predisposing factor to Kienbock disease, Hulten [12] in his study stated that in the case of negative ulnar variance, axial load on radial side of lunatum is increased which is a predisposing factor for lunatomalacia. Radial Shortening Osteotomy (RSO) is indicated in the case of negative ulnar variance as a joint leveling procedure [13-22]. Besides early stages of the disease, RSO has been found to be beneficial also in advanced stages [2,22]. Radial osteotomy has been found to increase vascularity of lunate and also made decompression [23-25]. Fragmentation and degenerative changes that occur particularly at proximal articular surface of lunate may ultimately lead collapse of the bone and the entire corpus. If carpal instability occurs in advanced disease, Proximal Row Carpectomy (PRC) can be considered [26]. PRC is a procedure used for the treatment of wrist arthritis, and has been reported to relieve pain and preserve wrist range of motion and grip strength [27-29]. Long-term outcomes of the most PRC and RSO procedures applied for treatment of Kienbock's disease are satisfactory (Tables 1 & 2).

In this prospective study we aimed to evaluate the clinical and radiological results of patients treated with RSO and PRC.

**Materials & Methods**

Approval was obtained from the local scientific department of our hospital and consent to study participation from all subjects for this prospective study. The study included 15 patients with the diagnosis of Kienbock disease who underwent operation between 2009 to 2012. RSO was performed for 17 patients (Group I), (Figures 1 & 2) and 18 patients underwent PRC (Group II) (Figures 3 & 4). Mean follow-up time was 18.4 months for Group I patients and 19.0 months for Group II patients. Mean age of Group I patients was 35 years and Group II patients was 41 years. 16 of the patients were male and 19 of them were female. 15 of 35 patients had dominant side disease and were operated from their dominant wrists. 14 of the 35 patients had a history of trauma (40%). According to Lichtman's classification, [30] at the time of diagnosis, 15 of the patients had Stage 2, 14 patients had Stage 3A and 6 patients had Stage 3B disease. (Table 3) Palmer's technique [31] was used to assess ulnar variance, according to this technique; 21 patients (60%) had a negative ulnar variance and 14 patients (40%) had a neutral ulnar variance.

**Surgical method for radial shortening**

Surgery was performed through a volar approach; an incision was centered over the radial border of the FCR tendon. The tendon sheath was released and the FCR was retracted radially to protect the radial artery. The flexor pollicis longest end on was retracted to the ulnar side to protect the median nerve. The pronator quadratus was released from the radial border of the radius and retracted ulnarly. A forearm-shortening osteotomy plate was placed on the volar aspect of the radius (Figure 1). A locking screw was placed in the most

**Table 1:** Long term follow-up results treated by proximal row carpectomy.

Author	Surgical method	Number of patients	Follow-up time	Comments
Liu et al. [58]	PRC	10	10-29 years	Satisfactory results,reserved their previous work
Lumsden et al. [44]	PRC	17	15 years	Good clinical results
Culp RW et al. [29]	PRC	20	3.5 years	Patients with mild preoperative arthritic changes had better results
Croog AS et al. [42]	PRC	21	10 years	Reliable procedure for Lichtman Stage 3a and 3b
De Smet L et al. [43]	PRC	21	67 months	Satisfactory clinical results
Ali MH et al. [51]	PRC	61	19.8 years	Unsatisfactory results.Manyof the patients were unable to return to manual labor type jobs.
Lecamte F et al. [57]	PRC	25	30 months	Recommend for Lichtman Stage 3 disease

**Table 2:** Long term follow-up results treated by radial shortening osteotomy.

Author	Surgical method	Number of patients	Follow-up time	Comments
Matsui et al. [17]	Radial shortening	11	10 yrs	Satisfactory clinical results
Salmon et al. [18]	Radial shortening	15	26 yrs	Recommend RSO for patients with carpal collapse accompanying severe pain
Raven et al. [16]	Radial shortening	12	22 yrs	Recommend RSO for Lichtman Stage 3a or less disease with a (-) ulnar variance
Altay et al. [53]	Radial shortening	23	7 yrs	Reliable long-term treatment for Lichtman Stage 3b disease
Rodrigues- Pinto	Radial shortening	18	10.3 yrs	Effective for Lichtman Stage 2,3a,3b disease.
Axelsson et al. [19]	Ulnar lengthening	22	22 yrs	All patients returned to work
Trail et al. [5]	Ulnar lengthening and Radial shortening	20	11 yrs	Satisfactory clinical results
Wada et al. [20]	Radial wedge osteotomy	13	14 yrs	Good clinical results
Koh et al. [14]	Radial wedge osteotomy and Radial shortening	25	14.5 yrs	Good clinical results
Zenzai et al. [15]	Radial shortening with or without ulnar lengthening	35	19 yrs	Satisfactory results,reliable method
Viljakka et al. [13]	Radial shortening	16	32 yrs	Provides decade-long improvement in 75% of patients
Watanabe et al. [21]	Radial shortening	13	21 yrs	Satisfactory clinical results



**Figure 1:** Preoperative AP view before RSO.

distal screw hole, and a 3.5-mm nonlocking screw was placed in the reduction slot. The osteotomy was performed over the oblique lag screw hole. This area was marked on the radius with the plate in place. The plate was then removed. A transverse or oblique osteotomy to the distal radius was performed. The plate was then replaced and fixed to the radius. The most distal 3.5-mm locking screw was placed first. The radius was shortened, and the 3.5- mm nonlocking screw



**Figure 2:** Postoperative AP view after RSO (same patient).

in the reduction slot was tightened. The remaining 3.5-mm locking screws were placed. Patients were casted until osteotomy site healed, at approximately 6 weeks.

**Surgical method for proximal row carpectomy**

A dorsal longitudinal incision was performed. Extensor retinaculum was divided over the fourth compartment. Extensor Digitorum Communis was retracted to the ulnar side. Extensor pollicis longus and wrist extensors were retracted to the radial side. Posterior interosseous nerve was resected, wrist capsule was opened



Figure 3: Preoperative AP view before PRC.



Figure 4: Postoperative AP view after PRC (same patient).

longitudinally and lunate fossa and the articular surface of the capitate were exposed. Capsular incision was extended transversely to the either side to facilitate exposure of the scaphoid. Scaphoid was osteotomized in its mid-portion. After osteotomy of the scaphoid, its proximal pole was removed. Lunate was grasped with a towel clip and was excised. Triquetrum was removed in a similar fashion. Finally the distal pole of the scaphoid was removed. Passive flexion/extension of the hand was made in neutral and slight radial deviation to detect any impingement of the trapezium and the radial styloid. The wound was irrigated and capsule was closed and a suction drain was placed. At two weeks, the sutures were removed, and motion was started by a flexible splint.

Six months after the operation, patients were re-evaluated and modified Nakamura clinical scoring system [32] (Table 4) was used for clinical evaluation [3,4,33-38]. In Nakamura's evaluation system, radiological evaluation makes 9 points in total. Because insufficient radiological evaluation would affect the final result, we excluded 9 points and thus total points were calculated [3]. Preoperative and postoperative angular examination was made using a goniometer. Range of motion (ROM) of wrist was noted while patient was in a sitting position and hands were put on the table. Preoperative

Table 3: Distribution of the patients according to Lichtman's classification.

Stage	Radial Shortening	Proximal Row Carpectomy	Overall
1			
2	15		15
3a	2	12	14
3b		6	6
4			
Overall	17	18	35

Table 4: Content of modified Nakamura clinical scoring system.

Clinical Assessment	Points
Pain in the wrist	
None	10
Mild with strenuous activity	7
Mild with light work	4
Grip strength (percentage of unaffected side)	
90%	5
80%	4
70%	3
60%	2
50%	1
Increase in range of flexion and extension	
>20°	6
10°- 19°	5
5°- 9°	3
Overall grade	Total Points
Excellent	15-21
Good	14-Sep
Fair	8-Mar
Poor	0-2

Table 5: Mean jamarimeter and pinchmeter values of both groups, pre- and postoperatively.

	Pre-treatment Values	Post-treatment Values	P- Value
Jamarmeter			
Group 1	20.05±9.30	29.80±14.50	p<0.05
Group 2	17.70±4.40	27.80±14.0	p<0.05
Pinchmeter			
Group 1	7.05±1.70	8.22±1.50	p<0.05
Group 2	4.95±1.15	6.30±0.90	p<0.05

and postoperative grip strength was examined by jamar hand dynamometer [39], dominant side was 5% decreased to equalize dominant and non-dominant sides. Grip strength was measured while shoulder was in adduction and neutral rotation, elbow at 90 degrees flexion, forearm and hand in neutral position. Test was repeated 3 times and means value was noted. Pinchmeter was used to evaluate pinch strength of 1st and 2nd fingers. Patients were in a sitting position and elbow in 90 degrees flexion. For upper extremity functional evaluation Q-DASH score [40] was used. Preoperative and

**Table 6:** Preoperative and postoperative mean flexion arc, extension arc and ulnar deviation values of both groups.

		Pre-treatment (mean±SD)	Post-treatment (mean±SD)	P- Value
Radial Shortening	Range of flexion	48.90±10.40	65.70±6.80	p<0.05
	Range of extension	43.70±15.75	59.60±6.80	p<0.05
	Ulnar deviation	35.30±9.40	41.70±5.70	p<0.05
Proximal Row Carpectomy	Range of flexion	31.20±11.80	34.80±6.40	p<0.05
	Range of extension	29.90±11.20	31.80±9.80	p<0.05
	Ulnar deviation	29.90±11.20	31.80±9.80	p<0.05

**Table 7:** Stahl index, Radial inclination, mean carpal height ratio and revised carpal height ratio values of both groups, pre- and postoperatively.

		Pre-treatment mean±SD	Post-treatment mean±SD	P- Value
Radial Shortening	CHR	0.50±0.05	0.48±0.05	0,674
	RCHR	1.38± 0.10	1.36± 0.12	0,88
	SI	0.45 ±0.10	0.43 ±0.08	0,58
	RI	22.20± 3.90	22.00 ±0.40	0,59
Proximal row carpectomy	CHR	0.48± 0.03	0.26 ±0.05	<b>0,018</b>
	RCHR	1.30± 0.05	1.02 ±0.05	<b>0,018</b>
	SI	0.30 ±0.04	0.28± 0.02	0,169
	RI	22.40 ±3.00	21.80± 0.05	0,791

postoperative Carpal Height Ratio (CHR), revised CHR, stahl index, radial inclination values were noted. Preoperative and postoperative flexion-extension Range of Motion (ROM) and ulnar deviation angles were also obtained.

SPSS for Windows programme 17.0 version was used for statistical analysis. Categorical comparisons were made using Pearson chi square, Fisher's  $\chi^2$  and Yates  $\chi^2$  tests. Paired samples t-test and Wilcoxon test were used for preoperative and postoperative comparison.

## Results

Results of clinical evaluation revealed significant progression at postoperative sixth month follow-up. Mean preoperative Jamarmeter value was 20.05±9.30 and postoperatively it was 29.80±14.50 for Group 1 and 17.70±4.40 and postoperatively it was 27.80±14.0 for Group 2, mean preoperative pinchmeter value was 7.05±1.70 and postoperatively it was 8.22±1.50 for Group 1 and for Group 2 preoperatively it was 4.95±1.15 and postoperative mean value was 6.30±0.90 (Table 5). Preoperative and postoperative mean flexion arc, extension arc and ulnar deviation values were found to be significantly increased following both radial shortening osteotomy and proximal row carpectomy ( $p<0.05$ ) (Table 6). Mean time of union for the osteotomy sites was 6.5 weeks in Group 1 patients. According to the results of radiological evaluation, carpal height ratio, revised carpal height ratio, Stahl index and radial inclination did not change significantly following radial shortening osteotomy (Group 1) and Stahl index and Radial inclination values did not significantly change following proximal row carpectomy (Group 2) ( $p>0.05$ ). However mean carpal height ratio and revised carpal height ratio values were found significantly different following proximal row carpectomy ( $p<0.05$ ) (Table 7). Postoperative mean Q-DASH scores in Group 1 and 2 patients were found to be 15.9 (4-29) and 28.4 (9-50) respectively preoperatively it was 56.3 (13-86) for Group 1 and 56.3 (25-72) for Group 2 (25-72).

According to the results of Nakamura's clinical evaluation system 4 patients in Group 1 had excellent result (57%) and 3 patients had good result (38%), among Group 2 patients 1 had excellent result, 3 had good results, 2 had fair results and 2 had poor results.

## Discussion & Conclusion

There are several options for surgical treatment of Kienbock disease. Experience of the surgeon is key factor for decision of the type of surgery. There are conflicting results regarding the type of surgery performed for Kienbock disease. Prior studies have confirmed that conservatively treated patients had progression of the disease both clinically and radiologically [41]. Treatment method of choice at different stages of the disease still remains a debate. Some authors do not recommend radial shortening at advanced stages of lunatomalacia [39] this is due to the fact that osteotomy at this stage does not correct position of scaphoid. In their study Croog et al. [42] stated that proximal row carpectomy was a reliable surgical method for Lichtman Stage IIIA and IIIB disease. Smet et al. [43] and Lumsden et al. [44] had satisfactory outcomes in patients who they performed proximal row carpectomy, and they recommended this procedure in patients with advanced Kienbock's disease. In their systematic review, Chim H et al. [45] recommended PRC particularly for individuals greater than 35 years of age and involved in less demanding activities with the criteria PRC preserves a functional range of wrist motion which was found to be flexion-extension arc of 73.5 degrees and radial/ ulnar deviation of 31.5 degrees in their systematic review and can preserve up to 68% of grip strength.

Long-term outcomes of the most PRC and RSO procedures applied for treatment of Kienbock's disease are satisfactory (Tables 1-2).

Several studies have demonstrated pain relief and minimal functional limitation following proximal row carpectomy [46,47]. Some prior studies indicated that patients were more likely to

complain of weakness in grip strength and feelings of wrist instability, however more recent studies have demonstrated good recovery of grip strength [48-50]. In their long-term follow-up study of PRC, Ali et al. [51] found that wrist motion and grip strength remained comparable to pre-operative values.

In contrary to some previous studies which did not recommend RSO for advanced Kienbock disease [34], some authors had satisfactory results [2,4,22,34,52-54]. Hulten [12] proposed that negative ulnar variance was a predisposing factor for KD however there are conflicting results in literature regarding this proposal [4,55,56]. Even though radial shortening procedure was primarily described for ulnar minus wrist joints, some authors performed radial shortening osteotomy to enable decompression of lunate rather than as a joint leveling procedure therefore they performed the procedure for ulnar zero and plus variance cases too.

In a study of 25 PRC operations, Lecomte et al. [57] recommended PRC for advanced Kienbock disease particularly for Lichtman Stage III due to risk of early degeneration of capitate and radial head. Liu et al. [58] recommended PRC in advanced disease; they had satisfactory long-term clinical results. Parallel to this result, the only radiological significance in our study observed for advanced disease was found in PRC operated patients, the difference between preoperative and postoperative values of carpal height ratio and revised carpal height ratio were found to be significantly different. Our results showed clinical improvement following surgeries of both RSO and PRC for Lichtman Stage 2, 3a and 3b disease. We consider that experience and technical familiarity of the surgeon is key factor to decide the type of the procedure to be performed.

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