SCIENTIFIC ARTICLE

Comparison of Clinical Outcomes in Open and Arthroscopically-assisted Mini Open Proximal Row Carpectomy for Lichtman Stage IIIB and IIIC Kienböck Disease

Erdem Özden,* İsmail B. Özçelik†

Purpose Proximal row carpectomy (PRC) can be performed in the late stages of Kienböck disease using the traditional open technique or arthroscopically. In this study, we describe the arthroscopically-assisted mini-open PRC technique. The aim of the study was to compare the functional results with the open PRC technique in advanced-stage Kienböck disease.

Methods The medical records of patients with Kienböck disease who underwent open PRC between 2006−2010 (Cohort A) and arthroscopically-assisted PRC (AAPRC) between 2010−2018 (Cohort B) were analyzed. The Quick Disabilities of the Arm, Shoulder, and Hand scores, visual analog scale, and Modified Mayo Wrist Scores were compared, which were obtained at the early postoperative (third month) and final follow-up.

Results Cohort A had 14 and Cohort B 21 patients. The preoperative, early, and final mean visual analog scale scores were 7, 3, and 0.3, respectively, for Cohort A, and 7, 0.3, and 0.1, respectively, for Cohort B. The preoperative mean Quick Disabilities of the Arm, Shoulder, and Hand scores decreased from 69 to 34 at the third-month and 6.1 on the final follow-up visit for Cohort A and from 77 to 18, and 5 for Cohort B. The final Mayo wrist scores were excellent in 4, good in 4, and moderate in 6 of the Cohort A patients, and excellent in 11, good in 8, and moderate in 2 of the Cohort B patients. Mean flexion increased to 52° from 43° for Cohort A and to 62° from 41° for Cohort B.

Conclusions AAPRC, compared to the open PRC, resulted in increased wrist motion and increased Mayo wrist scores in the long-term. Also, the third-month patient-related outcomes revealed favorable results in the AAPRC group. We attribute these findings to the earlier initiation of postoperative wrist motion and the less invasive character of the AAPRC procedure. *(J Hand Surg Am. 2022;■(■):1.e1-e8.*

Type of study/level of evidence Therapeutic IV.

Key words Kienböck disease, proximal row carpectomy, arthroscopically-assisted mini open surgery.

Online Exclusive

*From the *Surgeon Department of Orthopaedic Surgery and Traumatology, University Of Health Sciences Gaziosmanpaşa Training and Research Hospital, İstanbul, Türkiye; and †Surgeon, Professor, Department of Hand and Reconstructive Microsurgery, Yeniyüzyıl University Gaziosmanpasa Hospital and Nişantaşı University School of Health Sciences and El İstanbul Microsurgery-Rehabilitation Group, İstanbul, Türkiye*

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Corresponding Author: İsmail Bülent Özçelik, MD, Yeniyüzyıl University Gaziosmanpasa Hospital, Department of Hand and Reconstructive Microsurgery, 34000 Gaziosmanpasa, İstanbul, Türkiye; e-mail: bulent-ozcelik@hotmail.com.

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Lunatomalacia is characterized by osteonecrosis, fragmentation, and collapse of the lunate bone, followed by instability and degenerative changes in the carpus.[1] Repetitive trauma, negative ulnar variance, increased palmar tilt of the distal radius, and variations in the morphology of the lunate bone have been reported to have a role in the etiology.[1–4] The Lichtman staging system is the most commonly used system for Kienböck disease.[5–7] In the later stages of the disease, salvage procedures such as proximal row carpectomy (PRC), partial intercarpal fusions, or total wrist arthrodesis, may be used.[2,8] PRC has become our preferred technique for patients with advanced-stage Kienböck disease.[9–12] The conventional PRC is an open procedure performed through a dorsal approach; however, recent developments in arthroscopic techniques have made arthroscopic PRC more popular.[13–16]

While the dorsal capsule and ligamentous structures can be damaged in the classic open approach, these structures can be preserved with the arthroscopic technique.[13–16] However, few studies have compared arthroscopic and open techniques. Moldovan and Dogaru[17] compared open and arthroscopic surgery techniques for the treatment of Kienböck disease, but the study was a literature review and was not specific to PRC.

In this study, we describe the arthroscopically-assisted mini-open PRC (AAPRC) technique. The aim of this study was to compare the results of patients with Lichtman stage IIIB and IIIC Kienböck disease who underwent PRC using the conventional technique or AAPRC.

MATERIALS AND METHODS

This was a cohort study of patients with Kienböck disease who were treated using the open PRC approach (Cohort A) or arthroscopically-assisted PRC approach (Cohort B). Ethical approval was obtained from the institutional ethics committee, and the data were evaluated according to the Declaration of Helsinki.

The medical records of patients with Kienböck disease who underwent PRC surgery at our hospital between 2006 and 2018 were reviewed. Only patients with Lichtman stage IIIB and IIIC Kienböck disease were included in the study.[7] Patients who underwent scaphocapitate fusion, radial shortening, capitate shortening, and revascularization procedures were excluded (n = 34). In addition, patients with diagnoses other than Kienböck disease who underwent PRC (n = 6), who were lost to follow-up 2 years postoperatively (n = 2), and whose medical records were incomplete (n = 2) also were excluded. Minimum follow-up was 2 years. All patients were treated in the same clinic by the same senior surgeon (İ.B.Ö) an experienced wrist arthroscopist. A total of 14 patients in Cohort A were operated on between 2006 and 2010 and 21 patients in Cohort B underwent AAPRC between 2010 and 2018. Patient demographics are given in Table 1.

Open surgical technique

The AAPRC and open PRC procedures were performed with the patient under regional anesthesia, and a pneumatic arm tourniquet was used in both techniques. The surgical technique for the open PRC has been well described previously.[11,18,19] We performed posterior interosseous nerve neurectomy in every open PRC procedure and left the extensor pollicis longus out of the retinaculum while closing the wound.[20] Physical therapy was started after 4 weeks of plaster cast immobilization.

Arthroscopically-assisted mini-open surgical technique

Standard 3-4 and 6R radiocarpal portals and midcarpal portals were used. First, an arthroscopic joint examination was performed. The lunate bone, proximal joint surface of the capitate bone, and lunate fossa of the radius were evaluated. Then, while protecting the articular surface of the radius, the triquetrum, lunate (Figs. 1, 2), and proximal pole of the scaphoid bone were excised. Excision was started from the midcarpal radial portal with a 2.9-mm shaver and continued with a 4-mm burr when enough space was developed. The triquetrum, lunate, and proximal scaphoid were excised with a combination of burr and a pituitary rongeur or a hemostatic forceps (Fig. 3) inserted in a working portal as described previously.[16] We found excising the distal pole of the scaphoid to be the most challenging part of the procedure. Therefore, at the end of the arthroscopic procedure (Fig. 4), a small incision was made through the radial part of the wrist, starting 1cm radial to the 3-4 portal. The radial sensory nerve was protected, and the extensor pollicis longus tendon and tendons of the second extensor compartment were exposed (Fig. 5). The extensor pollicis longus was retracted radially, the capsule incised, and the distal pole of the scaphoid was excised through this incision while protecting the scaphotrapeziotrapezoid ligaments. If there are remnants of the previously removed proximal row bones, they also may be excised through this approach (Fig. 6). Final

TABLE 1. Patient Demographics

	Cohort A (n =14)		Cohort B (n =21)	
	Mean ± SD/n	Min−Max/%	Mean ± SD./n	Min−Max/%
Mean Ages (years)	33.9 ± 4.9	27−45	32.4 ± 6.4	24−47
Mean Follow-up (months)	141.3 ± 16.1	115−165	68.9 ± 28.4	24−111
Sex				
Male	4	(28.6%)	5	(23.8%)
Female	10	(71.4%)	16	(76.2%)
Lichtman grade				
Grade-3b	4	(28.6%)	9	(42.9%)
Grade-3c	10	(71.4%)	12	(57.1%)

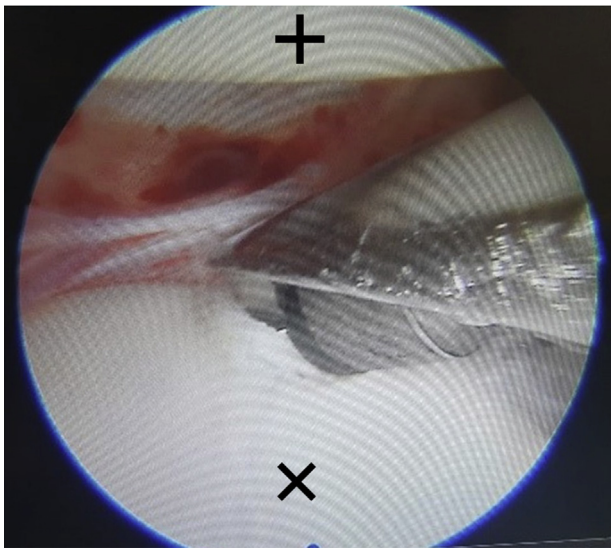

FIGURE 1: Excision of the triquetral bone with a burr starting from the midcarpal ulnar portal. +, hamate. x, triquetrum.

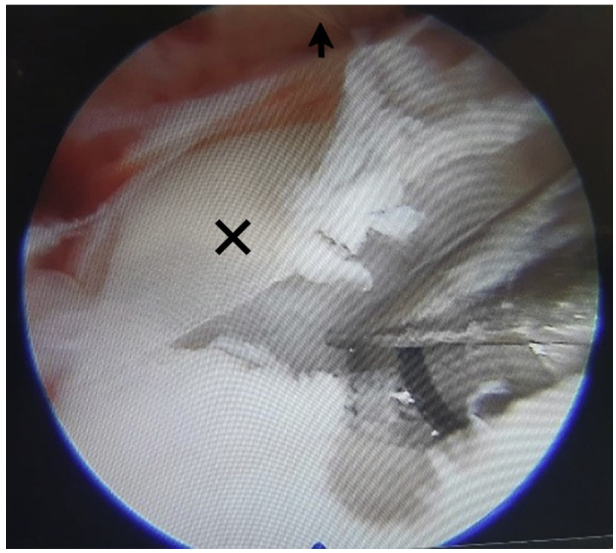

FIGURE 2: Excision continues through the centrum of the bone. *X*, eggshell part of the triquetrum. The burr is inside the triquetrum. *Black arrow* shows the upper part for orientation.

fluoroscopic views were obtained (Fig. 7). The capsule and skin were closed, and a thick bandage was applied to provide semirigid support. No splint was used, and physical activity was started 1 day postoperatively.

Active flexion and extension of the wrist were measured as the angle between the third metacarpal and the radial side of the radius using a goniometer. Grip strength was measured using a dynamometer (Jamar, Clifton, NJ), and we corrected the results according to hand dominance by assuming that the nondominant side is 10% weaker.[21] The preoperative Quick Disabilities of the Arm, Shoulder, and Hand (QDASH),[22] Visual Analog Scale (VAS), and Modified Mayo Wrist Scores[23] of the patients were compared with the early postoperative (third month) and final follow-up scores. All measurements and scoring were recorded by the same hand therapist. After examining the normality of the data distribution with the Shapiro-Wilk test, preoperative and postoperative scoring and joint range of motion were compared between the groups with the Mann-Whitney U test. $P < .05$ was evaluated as a significant difference, and the power of the sample was >0.8.

RESULTS

The mean time to final evaluation for Cohort A was 141 ± 16 (range, 115−165) months, and 69 ± 28 (range, 24−111) months for Cohort B. Demographic data are shown in Table 1. The preoperative patient-reported outcomes and range of motion are shown in Table 2. The initial, third-month and final follow-up

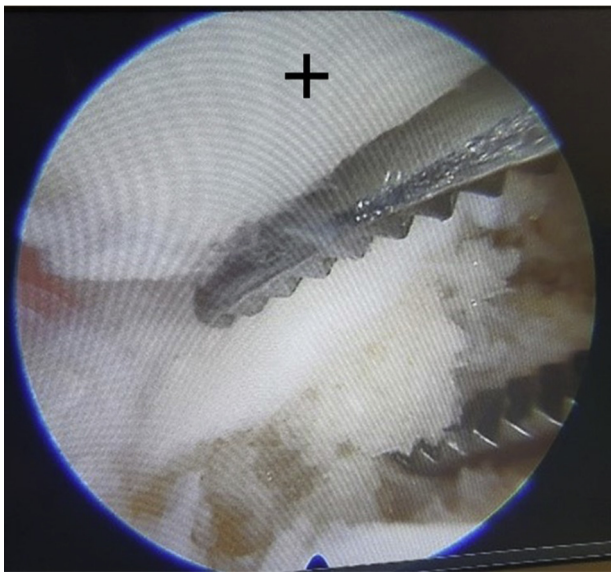

FIGURE 3: Removing the peripheric parts of the triquetral bone with hemostatic forceps. +, hamate.

FIGURE 4: The fluoroscopic view was obtained after the arthroscopic part of the procedure ended. The distal part of the scaphoid remains.

mean VAS, QDASH, and Mayo wrist scores are given in Tables 2 and 3. The third-month VAS and QDASH score differences were better in the AAPRC group ($P < .05$). The differences in the early and final Mayo wrist scores were significantly better in the AAPRC group ($P < .05$). The grip strength of the patients in Cohort A increased with a mean of 18%, reaching 89% of the opposite side's strength. In Cohort B, it reached 91% of the grip strength of the healthy hand with an increase of 21%. Changes in this parameter were similar between the groups. The preoperative, early, and final mean flexion and extension degrees are given in Table 4. The mean increase in flexion degrees was significantly better for the AAPRC group ($P < .05$). The early mean extension degrees also are better for the AAPRC group ($P < .05$). The average operative time of the open procedure was 66 ± 6 (range, 60−80) minutes and 106 ± 7 (range, 100−120) minutes for the AAPRC procedure.

One patient experienced capitate proximal pole cartilage damage during the arthroscopic debridement of the lunate. We converted to an open PRC procedure, and reconstruction of the capitate defect was performed using a chondral graft obtained from the bones that were excised during the PRC.[24] The graft was press-fit inserted into the defect and covered by the dorsal capsule. Despite the patient's satisfactory objective and subjective outcomes, this patient was not included in the AAPRC group because the procedure was completed by opening the dorsal capsule as in the classic PRC. None of the remaining patients had nerve damage, tendon injuries, or chondral damage.

DISCUSSION

This study demonstrates that AAPRC has better results concerning early VAS, QDASH, and Mayo wrist scores than open PRC. In addition, wrist flexion was also better in the early and final follow-up for the AAPRC group.

Prior investigators evaluated the results of open PRC 3 years after treatment, and Lumsden et al[12] reassessed the results 15 years after treatment[12,25]. Grip strength and total range of motion were improved over time, and none of the patients in their series required arthrodesis.[12] Wall et al[26] reevaluated the patients who underwent open PRC for different etiologies, first reported by DiDonna et al[19] in 2004. According to their data, range of motion increased, but grip strength decreased over time. The decrease in grip strength may be attributed to age-related muscle weakness. It has been emphasized in previous publications that there is no relationship between radiocapitate joint arthrosis and clinical symptoms in the long-term after open PRC procedure.[10,12] This statement should be considered controversial however, severe joint

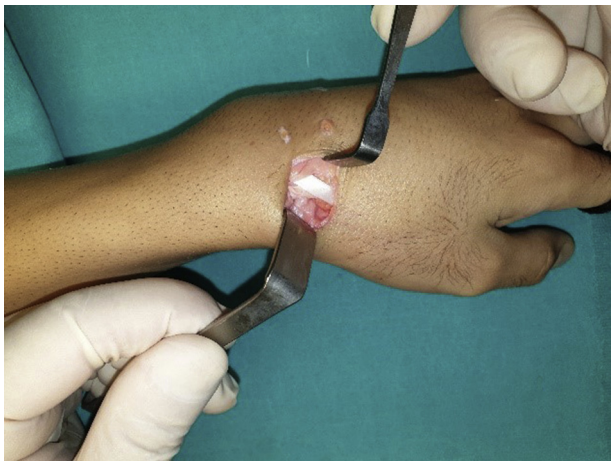

FIGURE 5: The mini-incision starting 1 cm radial to the 3-4 portal.

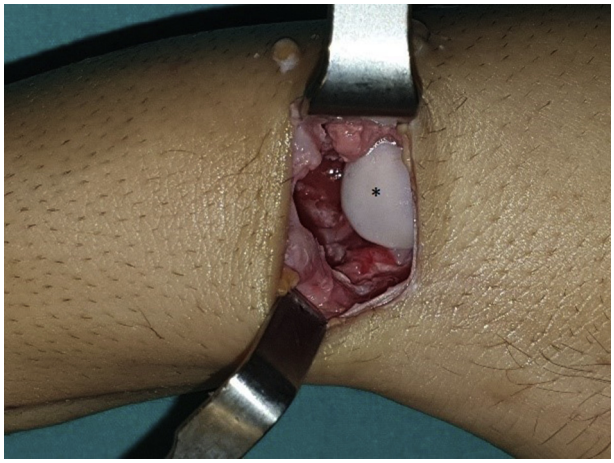

FIGURE 6: Checking for any remnant of the arthroscopically removed bones. *Capitate.

arthrosis was not detected in our patients, and none of them required radiocarpal arthrodesis. We found that the range of motion increased slightly over time (Table 4), as reported by Lumsden et al.[12]

In open PRC, the potential to perform partial wrist denervation by posterior interosseous nerve excision, and adding capsule interposition to the procedure, when necessary, can be considered advantages over arthroscopic PRC. However, Tahta et al[27] stated that combining PRC with posterior interosseous nerve neurectomy has no advantage, and Fukushima et al[28] showed that dorsal capsule interposition did not affect functional outcomes. In our study, posterior interosseous nerve excision was performed as a part of the open PRC procedure, but none of the patients required dorsal capsule interposition.

FIGURE 7: The final fluoroscopic view obtained after the mini-open part of the procedure ended.

After open PRC surgery, most publications recommend wrist immobilization for 3 to 6 weeks, but there is no consensus on the period.[9,11,12,18,26] The patients in the open PRC group in this study underwent immobilization in a short arm splint for 4 weeks. There also is no consensus on immobilization after the arthroscopic PRC.[13–16] We applied a bulky dressing after AAPRC, and the patients were allowed to begin joint movements to tolerance immediately.

There are few studies about arthroscopic PRC. Weiss et al[13] evaluated 17 patients who underwent arthroscopic PRC and reported subjective outcomes, but the study lacked a control group. In our study, the increases in the early and final flexion range, early extension range, and final total flexion and extension ranges were significantly higher in the AAPRC group. The differences might be due to minimal dorsal capsular damage in the AAPRC group. However, although the AAPRC group had better results than the open PRC group in terms of total grip strength and extension degrees, these differences were not statistically significant.

When the patient-reported and impairment outcomes were compared, the early (third month) postoperative VAS, QDASH, and Mayo wrist score results were better in the AAPRC group. In the longer term, the AAPRC group obtained significantly better Mayo wrist scores. The minimum clinically important difference for QDASH scores were defined as 14 (9–20) points by Sorensen et al,[29] and our results

TABLE 2. Changes in Subjective and Functional Outcomes

	Open PRC		Arthroscopic Assisted PRC		
	Mean ± s.d.	Min–Max	Mean ± SD	Min–Max	*P Values*
Initial QDASH	69.0 ± 14.3	43.2–84.1	76.7 ± 7.3	65.9–86.4	0.128
Early QDASH	33.8 ± 8.8	20.5–45.5	18.4 ± 4.2	13.6–29.5	**<0.05**
Final QDASH	6.2 ± 3.2	2.3–11.4	4.6 ± 2.6	2.3–11.4	0.132
Initial VAS	6.8 ± 1.4	5–9	6.7 ± 1.3	5–9	0.918
Early VAS	3.1 ± 1.2	2–5	0.3 ± 0.6	0–2	**<.05**
Final VAS	0.3 ± 0.6	0–2	0.1 ± 0.3	0–1	0.305
Initial Mayo	34.3 ± 14.5	15–55	36.0 ± 14.8	15–55	0.719
Early Mayo	55.0 ± 3.9	50–60	69.0 ± 6.6	55–80	**<.05**
Final Mayo	78.2 ± 9.3	65–90	85.0 ± 7.4	70–100	**<.05**

Mann-Whitney U Test. The boldfaced *P*-values indicate statistical significance.

TABLE 3. Mayo Wrist Scores

		Open RC		Arthroscopic Assisted PRC		
		n	%	n	%	*P Values*
Early postoperative period	Poor	10	(71.4%)	1	(4.8%)	**<.05**
	Moderate	4	(28.6%)	20	(95.2%)	
Final score	Moderate	6	(42.9%)	2	(9.5%)	0.082
	Good	4	(28.6%)	8	(38.1%)	
	Excellent	4	(28.6%)	11	(52.4%)	

Fisher Exact Test

exceeded this threshold in the early results. The early differences between the 2 procedures may be because the patients in the AAPRC group can start wrist movements immediately after surgery, and the dorsal capsule and ligaments were not damaged. The disappearance of this difference in the QDASH scores in the longer term might be explained by the increase in range of motion and the reduction of pain over time in both groups. This situation is consistent with the long-term follow-up results of Lumsden et al[12] and Wall et al.[26]

Hernandez et al[14] concluded that the use of the volar central portal shortened the operating time of the arthroscopic PRC. Although they further stated that the arthroscopic PRC was technically more challenging and time-consuming than the open approach, they did not specify the duration of surgery. It is known that operations, such as arthroscopy, need more experience and more preparation time for the procedure. In our series, the average operative time of the AAPRC group was longer than that of the open procedure group.

There are some limitations of our study. The patient data were collected from the medical records; 2 patients were not eligible for the study and 2 did not attend the final follow-up, which made the sample size relatively small. The difference in average times to the final exam between Cohorts A and B is another potential weakness of this study. As discussed above, the range of wrist motion of the patients who had open PRC increased over time. Despite the longer follow-up period for the open PRC group, the AAPRC group had better flexion and total wrist range of motion degrees in both the early and final assessments.

We also acknowledge that early motion also can be done after classic PRC and might have substantially affected the observed mobility of Cohort A. Jacobs et al[30] compared PRC with or without postoperative immobilization and concluded that immobilization is unnecessary, although there were no

TABLE 4. Changes in Range of Motion

	Open PRC (degree)		Arthroscopic Assisted PRC (degree)		
	Mean ± SD	Min−Max	Mean ± s.d.	Min−Max	*P* Values
Preoperative mean flexion degrees	42.5 ± 9.76	20−55	40.5 ± 8.05	20−55	0.399
Early mean flexion degrees	46.43 ± 7.45	30−55	57.14 ± 5.61	45−70	**<.05**
Final mean flexion degrees	51.8 ± 6.68	40−60	61.7 ± 6.58	50−75	**<.05**
Increase in flexion	9.3 ± 3.85	5−20	21.2 ± 6.87	10−35	**<.05**
Preoperative mean extension degrees	30.0 ± 8.09	20−45	31.4 ± 6.15	25−45	0.512
Early mean extension degrees	46.07 ± 5.61	40−55	50.95 ± 4.07	45−60	**<.05**
Final mean extension degrees	52.5 ± 5.80	45−65	54.8 ± 4.60	45−60	0.127
Increase in extension	22.5 ± 5.10	15−30	23.3 ± 6.58	10−35	0.651

Mann-Whitney U Test.

differences in the long-term outcomes. They also stated that immobilization may be necessary for pain relief in some patients.

Arthroscopic PRC is a technically demanding procedure. However, with a mini radial-sided incision, the distal part of the scaphoid can be excised easily without injury to the dorsal and volar ligaments. The most important advantage of AAPRC compared to open PRC is the initiation of early movement in the postoperative period, which may result in increased range of motion.

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