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ORIGINAL ARTICLE

The Efficacy of Surgical Treatment for Kienböck's Disease with 4-5 ECA Pedicled Osseous Flap: A Retrospective Study

Kienböck Hastalığında 4-5 ECA Pediküllü Kemik Flebi İle Cerrahi Tedavinin Etkinliği: Retrospektif Bir Çalışma

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ABSTRACT

Aim: The aim of this retrospective study is to assess the effectiveness of surgical intervention for Kienböck's disease using 4-5 Extensor Compartmental Artery (4-5 ECA) pedicled osseous flap.
Method: Patients who underwent 4-5 ECA pedicled bone grafts for Kienböck's disease between January 2012 and January 2022 were included in the study. The patient files were analyzed retrospectively for age, gender, follow-up time, and complications. Disease staging was performed preoperatively using direct X-ray and MRI, and radiological improvement was evaluated postoperatively using radiography. The functional and clinical assessment was made by comparing preoperative and postoperative VAS, Q-Dash, and Mayo scores.
Results: This study included 23 patients (12 female and 11 male) with Kienböck's disease who underwent 4-5 ECA pedicled bone graft surgery. 13 cases were right side- left side handed while 10 were left-handed. The mean age was 37.5 ± 12.5 years, and the mean follow-up time was 68 months. The mean preoperative Q-Dash score was 78.8 (± 9), the VAS score was 6.5 (±1.2, and the Mayo wrist score was 34.34 (±11.8). The mean postoperative Q-Dash score was 33.1(±10), the VAS score was 2.4 (±1.7), and the Mayo wrist score was 73.9 (±14.5). The differences between preoperative and postoperative Q-DASH scores ($p<0.05$), VAS scores ($p<0.05$), and Mayo wrist scores ($p<0.05$) were statistically significantly improved. Disease progression was observed in only two patients based on the Lichtman Classification in their follow-up radiographs.
Conclusion: Our study demonstrates that the surgical treatment of Kienböck's disease using a 4-5 ECA pedicled osseous flap is a reliable and effective surgical treatment option.

Keywords: Kienböck's disease, Pedicled osseos flap, Osteonecrosis

ÖZ

Amaç: Bu retrospektif çalışmanın amacı, Kienböck hastalığında 4-5 Ekstansör Kompartman Arteri (4-5 ECA) pediküllü osseöz flep kullanılarak yapılan cerrahi girişimin etkinliğini değerlendirmektir.
Yöntem: Ocak 2012 ile Ocak 2022 tarihleri arasında Kienböck hastalığı nedeniyle 4-5 ECA pediküllü kemik grefti uygulanan hastalar çalışmaya dahil edildi. Hasta dosyaları yaş, cinsiyet, takip süresi ve komplikasyonlar açısından retrospektif olarak incelendi. Preoperatif direkt röntgen ve MRG ile hastalık evrelemesi yapıldı ve postoperatif radyografi ile radyolojik iyileşme değerlendirildi. Fonksiyonel ve klinik değerlendirme preoperatif ve postoperatif VAS, Q-Dash ve Mayo skorları karşılaştırılarak yapıldı.
Bulgular: Bu çalışmaya 4-5 ECA pediküllü kemik grefti ameliyatı yapılan 23 kienböck hastası dahil edildi (12 kadın 11 erkek). 13 vakanın sağ tarafından 10 vakanın sol tarafından ameliyatı gerçekleştirildi. Ortalama yaş 37,5 ± 12,5 yıl ve ortalama takip süresi 68 aydı. Ortalama preoperatif Q-Dash skoru 78,8 (± 9), VAS skoru 6,5 (±1,2) ve Mayo bilek skoru 34,34 (±11,8) idi. Postoperatif ortalama Q-Dash skoru 33,1(±10), VAS skoru 2,4 (±1,7), Mayo bilek skoru 73,9 (±14,5) idi. Ameliyat öncesi ve sonrası Q-DASH skorları ($p<0,05$), VAS skorları ($p<0,05$) ve Mayo bilek skorları ($p<0,05$) istatistiksel olarak anlamlı derecede iyileşme gösterdi. Lichtman Sınıflamasına göre sadece iki hastada takip radyografilerinde hastalık progresyonu gözlendi.
Sonuç: Çalışmamız, Kienböck hastalığının 4-5 ECA pediküllü osseöz flep kullanılarak gerçekleştirilen cerrahi tedavinin güvenilir ve etkili bir cerrahi tedavi seçeneği olduğunu göstermektedir.

Anahtar Kelimeler: Kienböck hastalığı, Pediküllü kemik flebi, Osteonekroz

Introduction

Avascular necrosis of the lunate bone, commonly known as Kienböck's disease, is a progressive disease that, if left untreated, could result in wrist arthritis. (1, 2) Although it was originally called lunatomalacia, it was named after Robert Kienböck, who described the radiological features of the disease in 1910. (3) The clinical findings of the disease are a pain in the wrist joint, impaired movement, and decreased grip strength. The etiology of the disease has not been fully elucidated, but the negative ulnar variance and repetitive trauma are blamed for impaired lunate blood supply. (4, 5)Some anatomical studies suggest that variability in the vascular structure of the lunate bone may be a predisposing factor in Kienböck's disease. (6) In the treatment of the disease, broad-spectrum treatment options have been described, from conservative treatment to wrist arthrodesis. When the disease progresses to Lichtman(5) stage IIIb or IV, treatment options are limited and salvage procedures such as proximal row carpectomy(7) and partial (8) or total arthrodesis(9) are performed. However, in its early stages, joint leveling procedures such as radial shortening, capitate shortening, ulnar lengthening, and lunate revascularization procedures with vascularized

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bone graft are preferred.(10-12) Revascularization procedures, such as pedicled vascularized bone grafts, aim to prevent ongoing lunate collapse and symptoms by improving blood supply.

The using pedicled vascularized bone grafts has increased after of a better understanding of the dorsal side vascular nutrition of the distal radius. Various pedicled bone grafts, including the 4-5 Extensor Compratmental Artery (ECA), 1,2 intercompartmental supraretinacular branch of the radial artery (ICSRA), 2nd or 3rd metacarpal base, piriformis, and the volar side of the distal radius, as well as free vascularized bone grafts from the medial femoral condyle or the iliac crest, can be implanted to lunate bone in Kienböck's disease. (13) These vascularized grafts have positive results in preventing the progression of lunate collapse and avascular necrosis and have become an increasingly popular treatment option. (14)

The aim of this study is to analyze and present the clinical and functional outcomes of patients who underwent 4-5 ECA pedicled osseous graft surgery for Kienböck's disease.

Methods

The principles of the Helsinki Declaration were followed in this study, which was approved by the local ethics committee. Written informed consent was obtained from all patients in the study. This retrospective study included 24 patients who underwent 4-5 ECA pedicled bone graft surgery for Kienböck's disease between January 2012 and January 2022. Patients treated with 4-5 ECA flaps and no additional wrist pathology with a minimum one-year follow-up were included in the study. Patients who had wrist trauma or had systemic disease affecting the wrist and who had a follow-up period of less than one year were excluded from the study. One patient was excluded from the study due to lack of follow-up. Patient files were retrospectively analyzed for age, gender, follow-up time, and complications. Disease staging was performed according to Lichtman(5) classification preoperatively using direct X-ray and MRI (Figure 1) by a hand surgeon, and radiological improvement was evaluated postoperatively using radiography by the same hand surgeon. Radiological success was defined as no progression in the stage of the disease on direct radiographs. Function and clinical status were evaluated by comparing preoperative and postoperative VAS, Q-Dash, and Mayo scores. Surgical procedures were performed by the same senior surgeon. Preoperative and postoperative evaluations of the patients were made by the same specialist.

Surgical Technique

The patients undergo surgery in the supine position with local anesthesia or general anesthesia. A tourniquet is applied to the upper arm. The tourniquet is inflated without extinguishing the blood by keeping the arm in elevation. approximately 7*8 cm skin incision is made proximally and distally from the dorsum of the wrist between the 4th and 5th extensor compartments. (Figure 2a) The 5th extensor compartment is incised and retracted. Carefully preserving the dorsal carpal vascular arch, the extensor compartments are dissected from the capsule over the lunate bone. Starting from the 5th extensor compartment, a flap-shaped radial-based capsulotomy is performed and the lunate is determined under fluoroscopy control. At this stage, the intercarpal ligaments should be carefully protected. The cartilage surfaces and articular surfaces of the lunate bone are examined. If there is no arthrosis and the cartilage surface is healthy, pedicled bone graft surgery is considered. With the help of a burr or multiple K-wire drilling, the cortex is elevated dorsally while preserving the cartilage surface of the lunate bone. The intraosseous sclerotic bone of the lunate is removed by curettage under the control of fluoroscopy (Figure 3). In case of collapse, the collapse in the lunate is elevated with the help of the convex aspect of the curette, and the lunate bone is prepared for the application of the vascular bone graft. At this stage, the arteriovenous bundle between the 4th and 5th compartments is explored by using the surgical loop. The artery was followed proximally to the posterior branch of the anterior interosseous artery, where it protrudes dorsally from the interosseous membrane (Figure 2b). The 4th ECA originating from the same artery is also found and by following it distally, the bone area it feeds in the distal dorsal radius is determined. This area is approximately 1 cm proximal to the radiocarpal joint. The bone area fed by this artery is marked with a number 15 scalpel as much as the required bone size. With the help of a thin osteotome, the bone is lifted while protecting the vascular pedicle. Proximally, where the 4th and 5th ECA branch, the pedicle is ligated and separated from the anterior interosseous artery (Figure 2c and 2d). The vascular structures are carefully dissected together with the surrounding soft tissues and loosened enough that the bone graft can be transferred into the lunate. At this stage, the tourniquet is deflated and the hemorrhage of the bone graft is checked. Finally, the vascular bone graft is placed dorsal to the lunate without tension. Medical illustration of the technique can also be seen in Figure 4. At this stage, in order to protect the lunate bone collapsing, temporary K wires are placed from the scaphoid to the capitate (Figure 5) or scaphoid to capitate and triquetrum to capitate. The dorsal capsule of the joint is sutured while preserving the vascular structures. Then, the extensor compartment and skin closure are performed.

Postoperative Rehabilitation

A short arm cast is applied for 4 weeks and K wires are removed after 6-8 weeks. Active ROM exercises of fingers are encouraged while using the splint. After splint removal, passive and assisted active wrist movements are made under the supervision of the physiotherapist. After the 8th week, active movements are performed in patients with radiological improvement, and stretching exercises are performed in patients with limited movement.

Figure 1: MRI image showing Kienböck's disease in a patient.

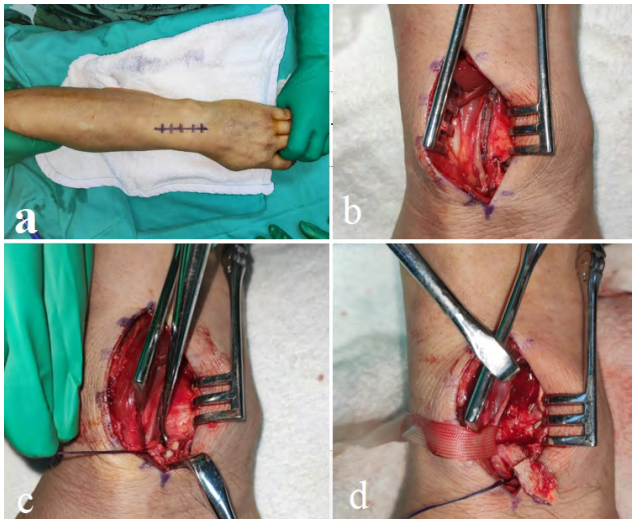

Figure 2: (a) Illustration of surgical incision made between the 4th and 5th extensor compartments. (b) Surgical exploration of the 4th and 5th extensor compartmental arteries. (c) and (d)Harvesting of the pedicled bone graft.

Figure 3: Fluoroscopy image of the lunate bone after removal of sclerotic bone fragments.

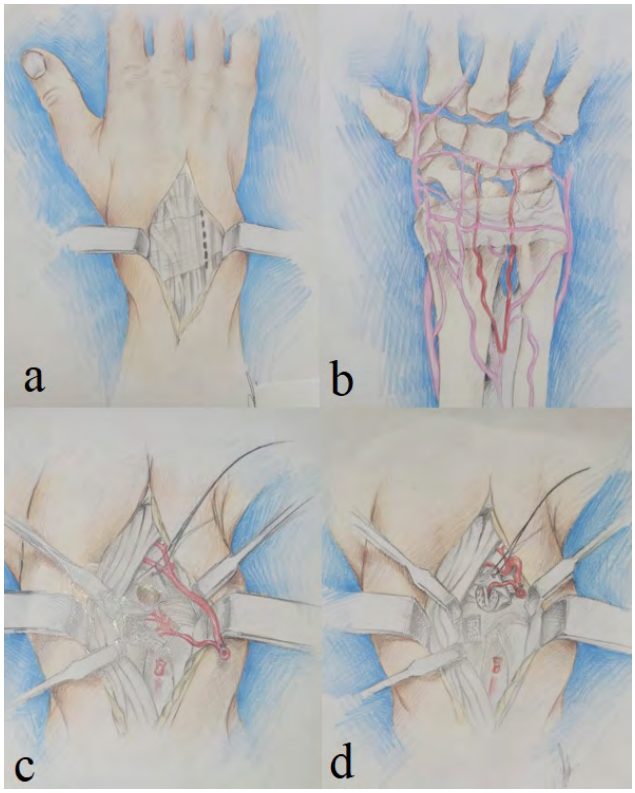

Figure 4: a) The incision over the 5th extensor compartment b) Schematic presentation of vascularization on the dorsal wrist c) harvesting of the pedicled bone graft and d) implantation of the graft.

Figure 5: Radiograph of temporary scaphocapitate fixation with K-wires.

Figure 6: Radiograph showing successful healing of Kienböck's disease post-surgery.

Table: Patients' demographics, Lichtman Classification grade of the disease, preoperative and postoperative functional scores.

Case	Age (Years)	Gender	Side	Follow-up (Months)	LC Grade	K-Wire	Preop Q-Dash	Postop Q-Dash	Preop VAS	Postop VAS	Preop Mayo	Postop Mayo
1	54	M	R	86	2	Yes	79,54	29,54	5	3	50	75
2	46	F	L	84	2	No	75,00	29,54	4	1	45	75
3	27	M	L	77	2	Yes	77,27	31,81	7	0	30	80
4	37	F	R	69	2	No	68,18	34,09	6	2	40	80
5	58	F	R	58	2	Yes	77,27	31,81	7	2	25	75
6	37	F	R	44	3A	Yes	75,00	45,45	7	3	50	80
7	44	F	R	75	2	No	77,27	47,72	8	4	45	85
8	55	F	L	87	3A	Yes	56,80	40,90	5	3	35	65
9	20	M	R	86	2	Yes	77,27	50,00	8	5	50	85
10	24	F	R	81	2	Yes	59,09	31,81	6	2	50	75
11	23	M	L	67	3A	Yes	72,72	34,09	6	1	35	75
12	31	M	L	122	2	No	88,63	20,45	7	0	25	85
13	22	M	R	131	3A	Yes	56,80	38,63	8	6	35	65
14	55	F	R	124	3B	Yes	88,63	20,45	8	0	15	85
15	30	M	R	61	2	Yes	72,72	9,09	6	2	35	65
16	56	F	L	52	3A	Yes	77,27	15,90	8	2	10	75
17	40	M	R	49	2	Yes	88,63	29,54	7	2	30	80
18	32	F	L	87	3A	Yes	79,54	31,81	7	3	30	70
19	45	M	R	46	2	Yes	81,81	47,72	8	5	40	80
20	38	M	L	16	2	No	75,00	31,81	6	2	45	65
21	24	F	R	19	3B	Yes	88,63	38,63	5	5	15	15
22	42	M	L	15	2	No	75,00	34,09	6	1	25	85
23	22	F	L	27	2	Yes	75,00	38,63	5	1	30	80

LC Grade: Lichtman Classification Grade, K-Wire: Kirschner Wire, Q-Dash: Quick Disabilities of Arm, Shoulder, and Hand, VAS: Visual Analog Scale

Statistics

Results were reported at 95% confidence intervals and with corresponding p-values. The normality distribution of the data was tested using the Shapiro-Wilk test, hologram, skewness, and kurtosis value. Preoperative and postoperative variables were compared using Wilcoxon Signed Rank Test for non-normally distributed data and Paired Sample t-test for normally distributed data. P<0.05 was considered statistically significant.

Results

There were 23 cases included in the study, comprising of 11 males and 12 females. Ten patients underwent surgery on their left wrist, while 13 patients underwent surgery on their right wrist. The mean age of the patients was 37.5 ± 12.5 (range: 20-58) years, and the mean follow-up time was 68 (range: 15-131) months. The Lichtman(5) classification was used to determine the grade. Fourteen patients were Grade 2, 7 were Grade 3a, and 2 were Grade 3b. Temporary Scaphocapitate fixation with K-wires was performed in 17 out of 23 patients to prevent lunate collapse. The K-wires were removed after 6-8 weeks. The mean preoperative Q-Dash score, VAS score, and Mayo wrist score were 78.8 (± 9), 6.5 (±1.2), and 34.34 (±11.8), respectively. The mean postoperative Q-Dash score, VAS score, and Mayo wrist score were 33.1(±10), 2.4 (±1.7), and 73.9 (±14.5), respectively. The differences between preoperative and postoperative Q-DASH scores (p<0.05), VAS scores (p<0.05), and Mayo wrist scores (p<0.05) were statistically significant. All patient demographic data, follow-up time, Q-DASH, VAS, and Mayo wrist scores, temporary K-wire fixation information, and grade of the Lichtman classification can be seen in the Table. Additionally, case 22 underwent radial shortening osteotomy concomitant to 4-5 ECA flap, and Case 21, whose grade was 3b, underwent lunate excision and scapho-capitate fusion because of the progression of the disease and persistent pain. In two patients with Grade 3a, there was no significant improvement in their pain, and their pain decreased slightly. Fourteen patients reported that their pain disappeared completely or they had mild pain that increased with force. In 6 patients, the pain decreased significantly compared to the preoperative period, but they still had pain.

Only five of the patients underwent MRI scans during their long-term follow-up. Among these patients, revascularization signs were detected in the lunate bone of three cases. Additionally, all patients had control radiographs at their final follow-up, and disease progression was observed in only two patients based on the Lichtman Classification in their follow-up radiographs.

Discussion

Various treatment methods have been defined according to the stages of Kienböck's disease. In this disease, which is characterized by the development of necrosis after the deterioration of the vascularity of the lunate bone, 4-5 ICA pedicled flaps are an attempt to increase vascularity. According to the data in our study, a significant improvement was obtained in the disease with this surgical technique. The advantages of this surgical technique are that it can be performed with a single small dorsal wrist incision under regional anesthesia and there is no need to a microsurgical anastomosis. The necessity of completing the procedure by preserving the blood flow from the small vessels with careful dissection is also a challenge of the surgery. In addition, the surgeon should have experience for this procedure. Another disadvantage is the inability to monitor the continuity of blood flow from the pedicled bone flap after the surgical procedure.

There are promising reports of regression of the disease and relieving pain with the use of vascularized bone grafts in Kienböck's disease. In the study conducted by Moran et al. in 2005, they obtained satisfactory results in parameters such as joint range of motion, grip strength and pain relief in patients who underwent 4-5 ECA flap. (15) Chung et al. reported satisfactory results with the same procedure applied to Kienböck Stage 3 patients. (16)

In Kienböck's disease, symptoms do not always correlate with the stage. Considering the etiology and stage of the disease, care should be taken when choosing the treatment option. Studies on revascularization procedures performed in the early stages are increasing in the literature. Our case series showed satisfactory results in Stage 2 and Stage 3A disease. In stage 3B patients, 4-5 ECA vascularized bone graft treatment may have promising results (15). However, in one patient with stage 3b in our study, the progression of the disease continued and was later treated with partial wrist arthrodesis.

This study has several limitations. First, it is a retrospective study, which may contain some bias in data collection and analysis. Second, the study included only a small sample size. Third, not all patients had MRI imaging at the final follow-up, which may limit the accuracy of our evaluation of treatment outcomes. Finally, lack of a control group of the study makes it difficult to compare results with other treatment options or draw firm conclusions about the efficacy of surgery. Limitations of our study also include the absence of measurements for pre- and postoperative wrist range of motion and grip power.

In conclusion, the efficacy of 4-5 ECA pedicled flap surgery in the treatment of Kienböck's disease was investigated in our study. The results showed significant improvement in both clinical and radiological outcomes, indicating that this surgical method is an effective and safe treatment option for patients with this condition. Although our study has some limitations, the promising results of 4-5 ECA pedicled flap surgery suggest that is a reliable treatment option for patients with Lichtman Grade 2 and 3 Kienböck's disease.

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References

1.Keith PP, Nuttall D, Trail I. Long-term outcome of nonsurgically managed Kienböck's disease. The Journal of hand surgery. 2004;29(1):63-7.

2.Kakar S, Shin A. Vascularized bone grafting from the dorsal distal radius for Kienböck's disease: technique, indications and review of the literature. Chirurgie de la main. 2010;29:S104-S11.

3.Wagner JP, Chung KCJTJohs. A historical report on Robert Kienböck (1871–1953) and Kienböck's disease. 2005;30(6):1117-21.

4.Gelderman R, Salamon P, Jurist J, Posch J. Ulnar variance in Kienbock's disease. J Bone Joint Surg[Am]. 1975;57:674.

5.Lichtman DM, Degnan GG. Staging and its use in the determination of treatment modalities for Kienböck's disease. Hand clinics. 1993;9(3):409-16.

6.GELBERMAN RH, GROSS MSJCO, Research R. The Vascularity of the Wrist: Identification of Arterial Patterns at Risk. 1986;202:40-9.

7.Özden E, Özçelik İB. Comparison of Clinical Outcomes in Open and Arthroscopically-assisted Mini Open Proximal Row Carpectomy for Lichtman Stage IIIB and IIIC Kienböck Disease. The Journal of Hand Surgery. 2022.

8.de Villeneuve Bargemon J-B, Peras M, Hasegawa H, Levadoux M. Arthroscopic Scaphocapitate Fusion: Surgical Technique. Arthroscopy Techniques. 2022;11(7):e1289-e94.

9.Rodríguez-Nogué L, Martínez-Villén G. Results of the total wrist arthrodesis with contoured plate in a series of 41 wrists with median follow-up of 6 years. Acta Orthopædica Belgica. 2022;88:636-41.

10.Woo S-H, Kim S-M, Ahn Y-S, Hyun J-H, Kim H-Y, Kim M-S. Combined radial wedge and shortening osteotomy versus scaphocapitate arthrodesis in advanced Kienböck's disease. Acta Orthopædica Belgica. 2022;88:739-47.

11.Matsui Y. Surgical Treatments: Capitate Shortening Osteotomy. Introduction to Kienböck's Disease: Basic Science, Diagnosis and Treatment: Springer; 2023. p. 97-102.

12.Park I-J, Kim H-M, Lee J-Y, Roh Y-T, Kim D-Y, Jeon N-H, et al. Treatment of Kienböck's disease using a fourth extensor compartmental artery as a vascularized pedicle bone graft. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2016;69(10):1403-10.

13.Tsantes AG, Papadopoulos DV, Gelalis ID, Vekris MD, Pakos EE, Korompilias AVJJoh, et al. The efficacy of vascularized bone grafts in the treatment of scaphoid nonunions and Kienbock disease: a systematic review in 917 patients. 2019;11(01):006-13.

14.Ye X, Feng J-T, Yin H-W, Qiu Y-Q, Shen Y-D, Xu W-DJHS, et al. Use of 4+ 5 extensor compartmental vascularized bone graft and K-wire fixation for treating stage II-IIIA Kienböck's disease. 2020;39(3):207-13.

15.Moran SL, Cooney WP, Berger RA, Bishop AT, Shin AYJTJohs. The use of the 4+ 5 extensor compartmental vascularized bone graft for the treatment of Kienböck's disease. 2005;30(1):50-8.

16.CHUNG U-S, KIM K-C, LEE K-HJJotKSfSotH. 4+ 5 Extensor Compartmental Vascularized Bone Graft for Stage III Kienbock's Disease: Preliminary Results. 2009:6-11.