Lunate Revascularization After Capitate Shortening Osteotomy in Kienböck's Disease

Ahmadreza Afshar, MD

Purpose The aim of surgical treatment in the early stages of Kienböck's disease is to decrease compressive loading of the lunate to promote revascularization. Capitate shortening osteotomy is one technique that has been advocated in Kienböck's disease with ulnar neutral or positive variance and Lichtman stage I to IIIA. The purpose of this study was to examine the revascularization process of the lunate after capitate shortening osteotomy.

Methods This was a retrospective study of 9 patients with Kienböck's disease with Lichtman stage II or IIIA and ulnar neutral or positive variance. I confirmed avascular necrosis of the lunate in all the patients by magnetic resonance imaging preoperatively. Capitate shortening osteotomy was performed through a dorsal approach and fixed with K-wires. I used magnetic resonance images with fat suppression to detect the revascularization of the lunate after surgery.

Results The mean follow-up was 12 months (range, 8–16 mo). All patients demonstrated partial revascularization of the lunate and the mean revascularization time was 4.7 months (range, 3–7 mo), which was interpreted as the beginning of the revascularization process.

Conclusions Capitate shortening osteotomy is an efficient technique to induce the revascularization process in the early stages of Kienböck's disease. *(J Hand Surg 2010;35A:1943–1946. Copyright © 2010 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Capitate shortening osteotomy, Kienböck's disease, lunate, revascularization process.

The strategy of surgical treatment in the early stages of Kienböck's disease (avascular necrosis of the lunate bone), where the disease is confined to the lunate, is to decrease compressive loading of the lunate to promote revascularization of the bone and prevent collapse.[1–3] Choosing the surgical technique to treat Kienböck's disease is based on the degree of ulnar variance and the pathologic changes in the lunate and wrist joint as represented by Lichtman's staging.[4–6] Nevertheless, how different procedures affect the revascularization of the lunate and at what time remain unclear.

Radial shortening osteotomy has been proven to be a safe, reliable surgical technique with relatively successful outcomes in treatment of Kienböck's disease with negative ulnar variance and Lichtman stages I to IIIA.[3,7,8] Nakamura et al. observed 24 patients with Kienböck's disease for 1 to 3 years with serial magnetic resonance imaging (MRI). Nineteen patients who had radial shortening or radial wedge osteotomies demonstrated an increase in signal intensity on T1- or T2-weighted images. They suggested that an increase in signal intensity of the lunate indicates revascularization.[9]

From the Department of Orthopedics, Urmia University of Medical Sciences, Urmia, Iran.

Received for publication June 19, 2010; accepted in revised form September 13, 2010.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Ahmadreza Afshar, MD, Department of Orthopaedics, Imam Khomeini Hospital, Modaress Street, Ershad Boulevard, Urmia 57157- 81351, Iran; e-mail: afshar_ah@yahoo.com.

0363-5023/10/35A12-0004$36.00/0
doi:10.1016/j.jhsa.2010.09.014

Capitate shortening osteotomy, described first by Almquist,[10,11] is a technique that has been advocated in Kienböck's disease with ulnar neutral or positive variance and Lichtman stage I to IIIA.[1,12,13] Capitate shortening decreases load transfer across the radiolunate joint.[14,15] Almquist reported 83% revascularization and healing of the fragmented lunate after capitate shortening with capitohamate fusion. He used radiographic evaluation including tomography to evaluate revascularization.[10,11]

Many authors have used MRI to detect and observe the revascularization process of the lunate in Kienböck's disease. Refinements in current MRI techniques permit early detection of the revascularization process.[9,16–20] The purpose of this study was to look for the revascularization process of the lunate by using MRI after capitate shortening osteotomy.

MATERIALS AND METHODS

This was a retrospective study based on 9 patients (7 men and 2 women) who had capitate shortening osteotomy because of Kienböck's disease. The patients were treated between January 2009 and September 2009. The patients' chief symptom was wrist pain. Eight patients had ulnar neutral and one had ulnar positive variance. At initial presentation, all patients had Lichtman's stage II or IIIA.[21]

The mean age of patients at the time of surgery was 25.8 years (range, 18–33 y). Eight patients were right-handed. Four surgeries were performed on the right hand and 5 were on the left hand. The research committee of the hospital approved the study.

Magnetic resonance imaging confirmed avascular necrosis of the lunate in all patients preoperatively. On T1-weighted MRI images, the lunate with Kienböck's disease showed diffuse decreased signal intensity. However, signal intensity varied from high to low on T2-weighted MRI images.[6,19,22]

The author performed all surgeries. Capitate shortening osteotomy was performed through a dorsal approach over the capitate. 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, and the wrist was protected by a short-arm cast. The wires were left out of the skin. The K-wires were removed in the office after the osteotomy site healed (usually about 6 weeks) and rehabilitation was started.

The patients were advised to obtain an MRI at 3 months after surgery to detect revascularization.[16,19] However, patients obtained an MRI at their convenience at a range of 3 to 7 months postoperatively. Four patients obtained a second MRI 3 months after the first because the first one was negative for revascularization. The beginning of revascularization of the lunate was established when high signal intensity was detected on fat suppression images in at least part of the lunate. MRI is specific for intraosseous blood flow and edema. Increase in signal intensity on fat suppression images, which corresponds to water, suggests revascularization.[17,22]

RESULTS

The mean follow-up was 12 months (range, 8–16 mo). All patients had achieved union at the osteotomy site by 6 weeks and there were no complications related to surgery. All patients had improved wrist pain, wrist range of movement, and grip strength after the surgery at the most recent follow-up examination. Six patients had resumed a regular work schedule. No changes in Lichtman's stage were detected postoperatively.

Patients demonstrated revascularization in at least 50% of their individual lunates (ie, partial revascularization): at 3 months in 3 patients, 4 months in 1 patient, 5 months in 1 patient, 6 months in 3 patients, and 7 months in 1 patient. The mean revascularization time of the 9 patients was 4.7 months (range, 3–7 mo).

Partial vascularization might lead to full revascularization but the process may take several months or years.[8]

Figure 1 (case 3) demonstrates decreased signal intensity of the lunate on preoperative T1-weighted MRI. Figure 2 (case 3), which indicates revascularization, demonstrates increased signal intensity of the lunate on MRI fat suppression image 3 months after surgery. The increased signal intensity of the capitate also seen in Figure 2 is a result of the osteotomy.

DISCUSSION

The aim of surgical intervention in the early stages of Kienböck's disease is to improve lunate circulation by unloading the bone.[1] In their experience using radial recession osteotomy in Kienböck's disease, Quenzer et al. found radiographic healing and improvement of the lunate density in some patients at least 12 months after surgery.[23] In their experience of height reconstruction and core revascularization of the lunate in early stage III of Kienböck's disease, Bochud and Buchler[24] found signs of revascularization in approximately half of their cases at 18 to 36 months after surgery.[3]

Radiographic conventional changes such as carpal height ratio, Stahl index, and Lichtman stages reflect the circulation and viability status of the lunate indirectly

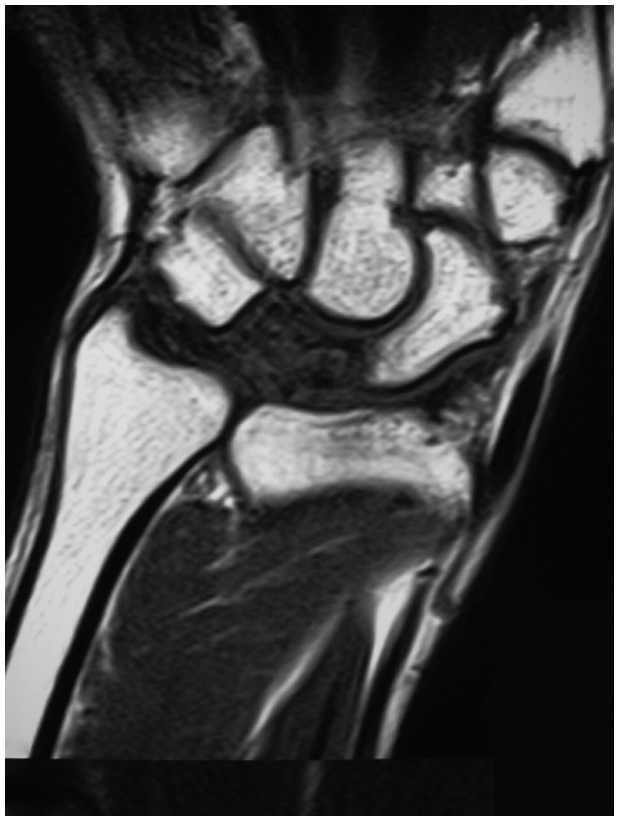

FIGURE 1: Preoperative T1-weighted MRI demonstrates decreased signal intensity of the lunate.

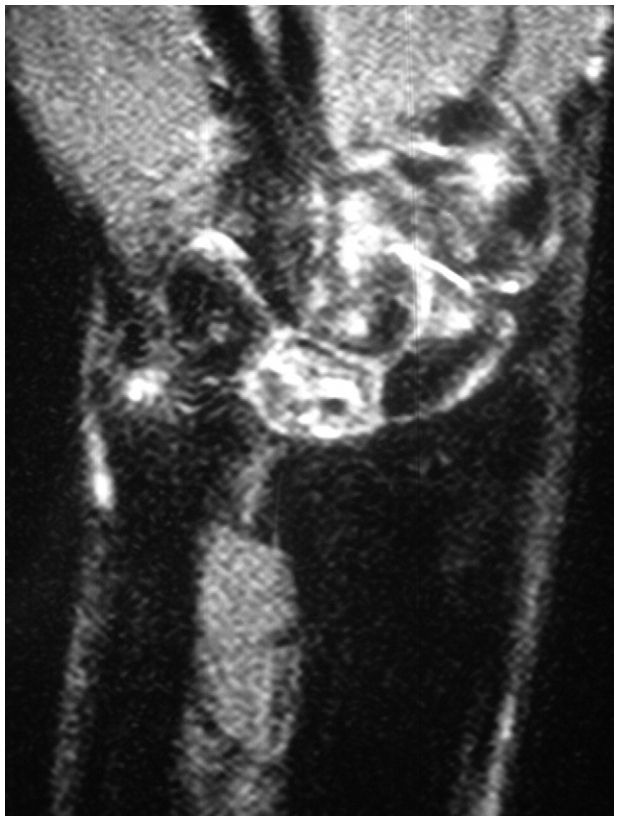

FIGURE 2: Increased signal intensity on magnetic resonance imaging fat suppression image indicates revascularization.

and after a relatively long period of time. A decrease in carpal height ratio and Stahl index and progression of Lichtman's stage indicate progression of the disease and failure of the revascularization process. Within the lunate, improvement of sclerosis, cystic changes, and fragmentation indicate revascularization of the bone.[7,8] Radiography is ineffective in detecting the revascularization process early.

The revascularization time might have a direct influence on the outcome of Kienböck's disease.[25,26] It seems that there is a time competition among different techniques to induce revascularization in the lunate. It would be appropriate to clarify the mean revascularization time in different studies and different techniques.[25,26]

In recent years, MRI has been used to detect and follow revascularization of the lunate.[9,16,20] Simmons et al. have described the technique of lunate revascularization with artery implantation and bone grafting and recommended detection of revascularization 3 months after surgery by MRI.[16] Moran et al. used a 4+5 extensor compartmental vascularized bone graft for the treatment of Kienböck's disease in 26 patients. Seventeen patients had follow-up MRI at a mean of 20 months after surgery; 12 patients showed evidence of revascularization. Revascularization was first noted 3 to 6 months after surgery on T2-weighted images.[20] Arora et al. treated 16 patients with stage III Kienböck's disease with free vascularized iliac bone graft. Postoperative MRI was obtained for 9 of 16 patients and showed evidence of revascularization at a mean of 19 months (range, 4–32 mo).[17]

Illarramendi et al. reported their experience of surgical treatment of Kienböck's disease by radius and ulna metaphyseal core decompression. Of 5 patients who had MRI before and after surgery, 4 showed signal improvement after surgery. The authors did not mention when the postoperative MRI was obtained.[18] Zelouf and Ruby reported their experience of external fixation and cancellous bone grafting in 17 patients. Of 10 patients who had obtained postoperative MRI at a mean of 23 months after surgery (range, 5–60 mo), 5 showed improvement in signal intensity.[27]

In the mentioned literature, the reported vascularization time of different techniques varies considerably and comparison between different authors' experiences is difficult if not impossible. Nevertheless, the mean detected revascularization time (4.7 mo) in the present

study might be considered a favorable finding. The partial vascularization might lead to full revascularization of the lunate; however, the entire process may continue for a long time.[8]

This study had several limitations. The investigation was retrospective, with a short follow-up period. Therefore, it is too early to evaluate the clinical outcomes, and so it was not the aim of the study. In addition, the number of subjects in the study was low. However, Kienböck's disease is uncommon and the patients usually have negative ulnar variance.[1] The incidence of patients with Kienböck's disease and ulnar neutral or positive variance is relatively low.[1] Also, the mean of 4.7 months to revascularization is likely an overestimation because the MRI interval was every 3 months. Finally, the revascularization process does not necessarily correlate with clinical outcome, and it is uncertain whether these findings correlate with clinical success.

Capitate shortening osteotomy has been the subject of only a few publications; however, it might be an efficient technique to induce the revascularization process in the early stages of Kienböck's disease.

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