Topics in Diagnostic Medicine

Kienbock Disease: A Complicated Postsurgical Case Study Using Diagnostic Ultrasonography

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Abstract

Objective: The purpose of this case report is to describe a case of Kienbock disease (lunatomalacia) that was identified through diagnostic ultrasonography.

Clinical Features: A 27-year-old man presented to a chiropractic teaching clinic with a 3-year history of wrist pain. The history of chief concern consisted of lunatomalacia, diagnosed 2 years prior, with surgical intervention consisting of radial osteotomy and vascularized bone graft. Radiography and ultrasonography were performed upon presentation and at 2-year follow-up that demonstrated progressive collapse and fragmentation of his lunate with the development of progressive scapholunate advanced collapse of the wrist.

Intervention and Outcome: Conservative care included class IV cold laser and a splint worn during strenuous activity and while sleeping. The patient received minimal pain relief and continued to experience chronic left wrist pain. He is continuing conservative care and evaluating options for further surgical intervention.

Conclusion: This case demonstrates a patient with chronic wrist pain and progressive collapse of the lunate demonstrated on multiple imaging modalities after surgical intervention. To our knowledge, this is the first case demonstrating Kienbock disease using diagnostic ultrasonography.

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Introduction

Osteonecrosis of the lunate, also known as *lunatomalacia*, was described by Robert Kienbock in 1910 and thought to be caused by rupture of the ligaments and vessels around the lunate producing aseptic

necrosis, osseous softening, and collapse.¹ The eponym *Kienbock disease* was coined after his classic description. Kienbock disease typically affects adult men between 20 and 40 years old who present with wrist pain and weakness in the dominant hand.^{2,3} Accurate diagnosis can be challenging, as the differential diagnosis includes scapholunate sprain, lunate fracture, and dislocation.^{3,4} The etiology is not well understood and remains controversial, but is traditionally thought to be related to trauma or anatomical

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factors.^{5,6} Stahl et al⁵ reported no relationship between the development of Kienbock disease and trauma (although commonly reported), hand-arm vibration, heavy manual labor, and comorbidities. They did, however, report an association with the use of oral corticosteroids. This is consistent with findings of osteonecrosis in other areas of the skeleton, as prolonged use of corticosteroids is the most common nontraumatic etiology.⁵ Anatomical features may be a predisposing factor such as impaired blood supply and anatomical variation that results in increased shear force on the lunate such as negative ulnar variance.^{1,3,7} The association with negative ulnar variance is controversial and not consistent worldwide. Interestingly, it has been reported as a noncausative factor in Europe and Japan; yet a strong association has been reported in North America and China.⁶⁻⁹

The radiographic staging of Kienbock disease is classified according to Lichtman's system. It includes 4 stages that progress from normal radiographic appearance of the lunate (stage I) to collapse and rotation of the scaphoid with degenerative disease in the carpus (stage IV). Detailed discussion of the staging of Kienbock disease is beyond the scope of this case report. Operative procedures are targeted at realignment and restoration of vascularity, and good subjective outcomes are reported.^{10,11} Radial osteotomy may slow progression in patients with stage III disease (lunate collapse without scaphoid rotation [IIIA] or with scaphoid rotation [IIIB]) but has not been shown to prevent or reverse carpal collapse.^{9,12} Conservative management includes immobilization for up to 3 months and anti-inflammatory medication.^{8,13}

To our knowledge, there are no reported cases of Kienbock disease demonstrated on ultrasonography (US). Therefore, the purpose of this case report is to describe a case of Kienbock disease (lunatomalacia) that was identified through diagnostic US. This report highlights a case of a 27-year-old man diagnosed with Kienbock disease that was treated surgically and subsequently progressed to further osseous collapse at 4-year follow-up with the development of scapholunate advanced collapse (SLAC). Imaging evaluation included diagnostic US.

Case Report

A 27-year-old right-handed male chiropractic student presented to our clinic with a 3-year history of left wrist pain. Approximately 2 years prior, he presented to

Fig 1. Initial posteroanterior radiograph of the left wrist performed in the emergency department demonstrated irregularity, collapse, and deformity of the lunate along with osteosclerosis. There is negative ulnar variance of the ulna.

an emergency department (ED) with a chief concern of left wrist pain, 1 year in duration, exacerbated 5 days earlier while working at a landscaping company gardening and pulling roots. Physical examination revealed minimal swelling and evidence of extensor tendon tenosynovitis, without crepitus. His medical history consisted of a Meckel diverticulum with surgical resection and appendectomy. Radiography in the ED revealed flattening of the lunate with sclerosis, soft tissue swelling, negative ulnar variance, and a volar ossicle adjacent to the lunate (not pictured) (Fig 1). The radiologic findings within the lunate were overlooked, and the patient was diagnosed with tenosynovitis and discharged with a splint. No further treatment was provided.

The patient's left wrist pain was unabated, and he sought consultation with an orthopedic surgeon 17 days later. Upon examination, he had minimal swelling; and ranges of motion in flexion and extension were 45° in each direction. The radiographs obtained in the ED were reviewed, and avascular necrosis of the lunate was suspected. Magnetic resonance imaging (MRI) was requested that revealed flattening of the lunate and mixed signal intensity of the bone marrow consistent with edema and necrosis (Fig 2). The patient was then referred to an orthopedic hand surgeon.

Preoperative grip strength was 80 lb on the left and 190 lb on the right. Surgical intervention was performed 39 days after initial presentation to the ED. Procedures on the left wrist consisted of vascularized bone graft, corrective osteotomy of the radius with 3.0 mm of shortening, extensor tendon synovectomy (done on 9 tendons), and posterior interosseous nerve neurectomy to denervate the radiocarpal joint. Radiography was performed 10 days later and demonstrated

Fig 2. Magnetic resonance imaging coronal oblique T1-weighted image of the left wrist demonstrated collapse and fragmentation of the lunate with heterogeneous bone marrow signal intensity consistent with osteonecrosis.

radial osteotomy with intact surgical hardware (Fig 3). Normal ulnar variance was noted, and there was no change in the degree of lunatomalacia. Postoperative recovery was uneventful, and he returned to exercise activity without restrictions within 6 months. His left wrist pain improved minimally but did not resolve. The surgical hardware was removed approximately 1 year after surgery because of discomfort on palpation, swelling, and risk of tendon injury.

The patient then presented to our teaching clinic approximately 2 years after surgical intervention with chronic left wrist pain. The pain was described as a constant dull ache that rated 3 of 10 on the numerical pain scale and 7 at its worst with any strenuous activity.

Fig 3. Posteroanterior radiography of the left wrist performed after surgical intervention demonstrated radial osteotomy with intact surgical hardware. Normal ulnar variance is noted, and there is no change in the degree and extent of lunatomalacia.

Fig 4. Posteroanterior wrist radiograph approximately 2 years post-surgical intervention demonstrated interval removal of the surgical hardware with further collapse, sclerosis, and fragmentation of the lunate and proximal migration of the capitate resulting in a SLAC wrist.

Wrist flexion and extension were 26° and 37°, respectively. Pain was reported on resisted range of motion in extension and described as sharp and grinding. Radiographic series consisting of 4 views of the left wrist was performed and demonstrated evidence of radial osteotomy and collapse, fragmentation, and

Fig 5. Longitudinal US of the dorsal wrist demonstrated collapse and fragmentation of the lunate with migration of the capitate (a); normal for comparison (b).

sclerosis of the left lunate (Fig 4). Again, no ulnar variance was noted. A US of his left wrist was performed using a GE Logiq E9 (GE Healthcare, Milwaukee, WI) linear array transducer operating at 8 to 15 MHz. The US images of the dorsal and volar wrist revealed fragmentation and collapse of the lunate with proximal migration of the capitate (Figs 5-7). No hyperemia was present. These findings represented US evidence of chronic lunatomalacia.

Orthopedic consultation was obtained approximately 1 month after presentation to our clinic, and the patient was referred to his original surgeon for further evaluation. The patient decided not to pursue evaluation at that time and chose not to receive conservative care at our clinic until approximately 1 year later. Treatment consisted of class IV laser therapy and bracing when performing strenuous activity and at night, which provided minimal intermittent pain relief. Follow-up radiography was performed (4 years post-surgical) that revealed further collapse of his lunate and evidence of SLAC wrist (Fig 8).¹⁴ Currently, the patient's pain intensity has plateaued; and he experiences pain on a daily basis rated 3 of 10 on numerical rating scale. Left wrist flexion was 21° and extension is 27°. His grip strength on the left was 109 lb and his

Fig 7. Ultrasonography in the transverse plane on the dorsal surface of the left wrist demonstrated fragmentation of the lunate (a); normal for comparison (b).

Fig 6. Longitudinal US of the volar wrist demonstrating collapse of the lunate with osseous debris noted in the radius lunate joint (a); normal for comparison (b).

Fig 8. Posteroanterior wrist radiograph approximately 2 years later (4 years postsurgical) demonstrated interval progression of the osseous collapse and fragmentation as well as further narrowing of the radiocarpal joint with sclerosis.

right is 143 lb. He is continuing conservative care and evaluating options for further surgical intervention. Patient consent was provided for publication of deidentified clinical information and images.

Discussion

Kienbock disease is defined as osteonecrosis of the lunate progressing through advancing stages of avascular necrosis and joint destruction with arthrosis in 3 to 5 years if left untreated.^{4,11} The Litchman staging criteria are based on radiographic, computed tomography, and MRI findings that include degree of collapse, bone density, scaphoid rotation, and signal intensity abnormalities within the bone marrow.¹ Magnetic resonance imaging is the most sensitive imaging modality for detecting Kienbock disease. Staging ranges from normal radiographic appearance with bone marrow edema present on MRI to lunate collapse and fracture with degenerative changes within the wrist.¹ Stage IIIA is the most common at the time of diagnosis (lunate collapse without scaphoid rotation).⁴ Detailed discussion of the staging of Kienbock disease is complex and beyond the scope of this case study.¹

Treatment options have been established based on the Litchman staging in combination with the presence of ulnar variance.⁴ There is no definitive treatment option that has proven superior for lunatomalacia, but there are 3 main surgical interventions that include mechanical unloading (radial osteotomy or ulnar lengthening), revascularization, and salvage procedures.^{4,9,15} It should be noted that staging based on imaging does not always correlate with the severity of patient presentation; therefore, the final decision concerning surgical intervention should be driven by the patient's symptoms and functional deficits.³

Matsui et al¹⁰ reported long-lasting symptomatic relief on 10-year follow-up when evaluating the effect of radial shortening in the treatment of lunatomalacia. There was no progression of carpal collapse in any patient in his study, in contrast to our patient, who demonstrated further collapse on 4-year follow-up.¹⁰ Radial osteotomy is an accepted treatment for patients in stage I to IIIA but has shown poor results in stage IV patients.¹⁶ Revascularization of the lunate has been reported to accomplish improvement in range of motion and strength with excellent pain relief despite the possibility of further collapse of the lunate.¹¹ In our patient, the lunate demonstrated further collapse after bone grafting, which was reported in only 15% of

patients after revascularization.¹¹ Surgical interventions in patients with higher-grade Kienbock disease (stage IIIB or IV) include scaphotrapeziotrapezoid or scaphocapitate arthrodesis, proximal-row carpectomy, and wrist arthrodesis.¹³

Scapholunate advanced collapse of the wrist is the most common cause of osteoarthritis of the wrist and targets the radiocarpal joint.¹⁷ It most commonly occurs secondary to traumatic tearing of the scapholunate ligament allowing scapholunate dissociation and proximal migration of the capitate. Scapholunate advanced collapse of the wrist can occur with other entities such as calcium pyrophosphate deposition disorder, perilunate dislocation, midcarpal instability, or Kienbock disease.¹⁷ Kienbock disease with subsequent development of SLAC wrist is rare and considered a distinct entity from the classic features of SLAC wrist due to its unique etiology.¹⁸ Widening of the scapholunate joint space is not present in this case, but the other features of SLAC wrist (radiocarpal osteoarthritis and proximal migration of the capitate) are present.

There have been no cases of Kienbock disease using US reported as of the production of this case report.

Limitations

Case reports have inherent limitations. The variable training, experience, and skill sets of the participating clinicians, regarding both diagnosis and treatment outcomes, preclude their generalization to the public at large. The findings in this case may not necessarily be applicable in other patients or clinical settings.

Conclusion

This case report depicts the progression of Kienbock disease in a 27-year-old patient with surgical intervention, progressive collapse, and the development of SLAC wrist visualized on radiography and US. To our knowledge, this is the first case demonstrating Kienbock disease using diagnostic US.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

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