Kienböck Disease and Arthroscopy: Assessment, Classification, and Treatment

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Abstract

The assessment and management of Kienböck Disease (KD) has always been a conundrum. The Lichtman classification has traditionally been used to guide treatment based on imaging. Arthroscopy provides a direct visualization of the articular surface, allows probing of the surfaces, and enables minimally invasive techniques to be performed.

The Lichtman-Bain classification is a new classification that takes into account the osseous, vascular, and cartilage aspects of the lunate and the secondary effects on the wrist. It identifies the important prognostic factors including age, the status of the lunate, and the status of the wrist.

With arthroscopy, the articular surfaces of the lunate can be assessed to better understand the status of the lunate. The lunate can be defined as intact, compromised, or not reconstructable. If the lunate is intact then lunate decompression (forage) and arthroscopic assisted bone grafting can be performed. If the lunate facet and capitate are functional, then a proximal carpectomy can be performed. This can be performed as an arthroscopic procedure.

Keywords

- Kienböck disease
- avascular necrosis
- classification
- treatment
- wrist

Assessment of the wrist includes assessment of the adjacent articular surfaces of the central column articulations (radiocarpal and midcarpal articulations). Instability of the proximal carpal row can also be assessed. The radioscapoid articulation is often preserved except in late KD, which allows the scaphocapitate fusion to be a good surgical option. This can now be performed as an arthroscopic procedure. Once the radioscapoid articulation is degenerate, a salvage procedure is required.

Since its first description over a century ago, many theories have been postulated as to the cause and optimal treatment strategy for Kienböck disease (KD).¹ The Lichtman osseous classification has traditionally been used to guide treatment

based on imaging.² Arthroscopic assessment and treatment for KD was first described by Menth–Chiari in 1999 and has become an increasingly popular tool ever since.³ Our previous paper within this same edition, describes our current

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mechanical and biological model for the etiology and pathogenesis of the condition.⁴

Clinical presentation of KD may be vague and management is based upon careful history, clinical examination, and investigations. Newer imaging modalities such as four-dimensional computed tomography, magnetic resonance imaging with gadolinium, and single-photon emission computed tomography have furthered our understanding and allowed us to identify disease activity, morphological abnormalities, associated carpal pathology, and plan treatment. Precise arthroscopic assessment, however, remains the gold standard in assessment of the perilunate articular surfaces.^{5–7} It must be highlighted, however, that the newer modalities are providing an improved understanding of the articular surface, and for this reason we recommend that the articular surfaces be taken into account, when determining the best treatment options.

The treating surgeon should have both, the necessary arthroscopic skills and also an understanding of progression of the disease process as highlighted later.

The Normal and Kienböck Wrist

In the normal wrist, the radial, central, and ulnar columns maintain the height of the carpus and transmit the load of the carpus. The articular surfaces are the interfaces that allow motion and transmit the load from their column.

The proximal row is the intercalated segment between the forearm and distal carpal row, which links the three columns. It enables the three columns to change their orientation, and thereby change the direction of the hand, but at the same time, share the load across the three columns.

In KD, the secondary effects of the collapsing lunate are a “compromised” wrist, including:

- Deformity and collapse of the central column.
- Degeneration of the central column (perilunate) articulations.
- Proximal row instability, (i.e., between the central and radial columns).
- Degeneration of the radial column.

Reviewing each of these in turn, helps understand the total effect of KD on the wrist. Combining this understanding with arthroscopic assessment of the functional and nonfunctional surfaces, helps formulate the optimum management strategy for the patient.^{7,8}

Diagnostic Arthroscopy

A tourniquet is applied over the arm but not inflated unless bleeding obscures the visualization during the procedure. We recommend the standard working portals in the radiocarpal (3–4, 4–5, and sometimes 6U) and midcarpal joints (midcarpal radial [MCR] and midcarpal ulnar [MCU]). The lunate and adjacent articular surfaces are meticulously inspected for chondral integrity and fractures. The articular surfaces are probed to assess presence of softening, “floating” (unsupported) articular surfaces, and degenerative changes.⁶ At arthros-

copy, the wrist is suspended, including the carpus. With radiocarpal arthroscopy, it is common to identify a floating lunate articular surface, with an arthroscopic probe. This is because the collapsed lunate is now distracted, creating a potential space within the lunate.⁷

Debridement of loose bony fragments, chondral flaps, and synovitis is performed. This assists in understanding the extent of the lunate fragmentation and can provide symptomatic relief for the patient.

Bain reported a pattern of pathology identified at arthroscopy on patients with KD.⁷ He also reported the following:

- Synovitis was present in all cases, often correlating to the degree of articular damage.
- Plain radiographs underestimated the degree of articular damage
- The management strategy for the patient often changed based on the arthroscopic findings
- Cases occurred where despite collapse of the subchondral bone plate, the chondral envelope was intact.

The Bain and Begg classification focused on the ‘functional’ state of the articulating chondral surfaces and the number of surfaces involved.⁷ Functional surfaces are those determined to have a normal arthroscopic appearance; smooth and glistening. Non-functional articular surfaces are those with degeneration; fibrillation, fissuring, chondral detachment, or subchondral fracture.

New Kienböck Classification

Lichtman and Bain have developed a new classification for KD. (►Fig. 1, ►Video 1). This new classification respects the osseous, vascular, and cartilaginous aspects of KD. It takes into account the changes in the lunate and the secondary changes in the wrist.

Video 1

Assessment and classification of Kienböck Disease. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0036-1584546.

Arthroscopy can be used as a diagnostic tool to assess the status of the lunate and the status of the wrist. Arthroscopy can also be used as a therapeutic modality for the patient with KD.

From a diagnostic point of view, the concepts of the functional and non-functional articulations still remain.

B1—Lunate Intact

In this case, all of the articular surfaces are functional. From an arthroscopic surgery point of view, an arthroscopic debridement can be performed. This includes a synovectomy, debridement of any loose fragments, and chondral flaps. Often an extra-articular unloading procedure would be performed as

The Key Questions for Kienböck's Disease: A New Algorithm

<p>A. Patient's age?</p> <p>A1. <15 years: Nonoperative.</p> <p>A2. 16–20 years: Nonoperative first. Consider unloading procedure.</p> <p>A3. >70 years: Nonoperative first. Consider synovectomy and/or follow algorithm below.</p> <p>B. Stage of the lunate?</p> <p>B1. Lunate intact (Cortex and cartilage intact: Lichtman 0, I, II; Schmitt A; Bain 0) Protect/unload the lunate: Orthosis or cast first (trial for 2–3 months) Radial shortening osteotomy, capitate shortening for ulnar +ve (radial epiphysiodesis*) (Alternatives: Lunate decompression, vascularized bone graft*, radius forage*)</p> <p>B2. Lunate compromised (Localized lunate disease: Lichtman IIIA; Schmitt B; Bain 1) Lunate reconstruction: MFT*, lunate replacement*, PRC (RSL fusion, SC [or STT] fusion)</p> <p>B3. Lunate not reconstructable (Advanced lunate disease: Lichtman IIIC; Schmitt C; Bain 2b) Lunate salvage (excision): Lunate replacement*, capitate lengthening, PRC (SC fusion)</p> <p>C. State of the wrist?</p> <p>C1. Central column articulations compromised (Lichtman IIIB or C; Schmitt B; Bain 2a, 3, or 4)</p> <p>C1a. Radiolunate articulation compromised (Lichtman IIIA; Schmitt B; Bain 2a) Fuse or Bypass radiolunate joint: RSL fusion, SC fusion, Lunate Prosthesis, MFT graft</p> <p>C1b. Radiolunate and midcarpal articulations compromised (Lichtman IIIB or C; Schmitt B; Bain 3 or 4) Bypass central column: SC fusion</p> <p>C2. Carpal collapse with intact radioscapoid articulation (Lichtman IIIB or C; Schmitt B; Bain 2-4) Stabilize radial column: SC fusion</p> <p>C3. Wrist not reconstructable (Advanced wrist disease: Lichtman IV; Schmitt C; Bain 4) Wrist salvage: Total wrist arthrodesis, total wrist arthroplasty*</p>	
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Other options that can be considered have been placed in parentheses. STT fusion is an alternative to SC fusion.

*Alternate procedures, techniques that require specialized skills and therefore affect what the surgeon can offer.

The classification determines the recommended treatment based on the patient's age (A), status of the lunate (B) and the status of the wrist (C). What the surgeon can offer (D) and what the patient wants (E) ultimately determine what is performed.

Fig. 1 Lichtman, Pientka, and Bain classification for Kienböck disease.

part of the surgical procedure. If there is negative ulnar variance then radial shortening can be performed.

Forage (arthroscopic-assisted drilling of the lunate) has been used with satisfactory outcome in two patients with follow-up at 6 years (►Fig. 2). Arthroscopic-assisted bone grafting can also be used.⁹

If the lunate is intact, revascularization procedures can be performed, including pedicled grafts^{10–16} and free microvascular grafts.^{17–20}

B2—Lunate Compromised

This is usually due to nonfunctional proximal lunate articular surface. Ideally, a proximal lunate reconstruction would be performed. Alternatively, a proximal row carpectomy (PRC) can be considered, as the capitate head and lunate fossa of the radius are in good condition.²¹

B3—Lunate Not Reconstructable

In this case, the lunate is so diseased that a lunate salvage procedure is required. If the lunate facet and the capitate articulations are still intact, then a PRC can be performed.

C1a—Compromised Central Column Articulation; Radiocarpal Joint

(►Fig. 3). A radioscapolunate fusion can be utilized, but the prerequisite is that the midcarpal joint must be intact.²²

Rarely, the capitate articular surface remains functional, in which it is possible to perform a PRC with hemiarthroplasty.^{23–25}

C1b—Compromised Central Column Articulations; Radiocarpal and Midcarpal Joints

Once these articulations are involved, the surgical options become limited. Fortunately, the radioscapoid articulation is usually functional. The scaphocapitate fusion is often a good option in this group, as it stabilizes the radial column, and mobilizes the wrist through the intact radioscapoid articulation.

C2—Carpal Collapse-Intact Radioscapoid Articulation

Once there is carpal collapse, the wrist needs to have a stabilization procedure. In this case, the scaphocapitate fusion is again a good option.

Fig. 2 Forage of the lunate. Fluoroscopic image of the wrist, with the scope in the 6R portal and the drill within a sheath in the 3–4 portal. The drill is positioned under arthroscopic control, and confirmed to be satisfactory with fluoroscopy. Once positioned, the drill is advanced. Arthroscopic-directed drilling of the lunate in a patient with arthroscopic grade 0 Kienböck disease. Reprinted with permission from Bain GI, Durrant A. An articular-based approach to Kienböck avascular necrosis of the lunate. *Tech Hand Up Extrem Surg.* 2011 Mar;15(1):41–7.

C3—Wrist not Reconstructable

Once the wrist reaches this stage, only a salvage option can be utilized.^{17,26–28}

Specific Arthroscopic Procedures

Arthroscopy offers the advantage of being diagnostic and therapeutic. With new advanced arthroscopic techniques, many of the open surgeries can now be performed arthroscopically. Examples include arthroscopic limited wrist fusions and PRC (►Video 2).

Video 2

Arthroscopic therapeutic procedures. This video includes examples of arthroscopic debridement, lunate forage and bone grafting, proximal row carpectomy, and limited wrist fusions. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0036-1584546.

Arthroscopic-assisted fusion has many advantages. Surgical dissection is reduced and the extrinsic ligaments are left intact. This improves intercarpal stability and vascularity. With precise cartilage and osseous debridement, less bone is resected and carpal height is maintained, so bone graft is often not required. The carpal malalignment is corrected, and then percutaneous fixation is used to stabilize the carpus and therefore create a limited wrist fusion.

Fig. 3 Arthroscopic image of a nonfunctional proximal lunate articular surface, with sclerosis and ulceration of the proximal articular surface.

Arthroscopic Radioscapholunate Fusion

The prerequisite for a radioscapholunate (RSL) fusion is to have a functional midcarpal articulation. Therefore, it is limited to B1 or C1a. With the scope in the 4–5 portal, and the burr in the 1–2 and 3–4 portals, we commence debridement of the dependent radial styloid and fossae, and then debride the overhanging proximal scaphoid and lunate surfaces. Because of the significant shape mismatch between the scaphoid/lunate and the corresponding radial fossae, bone graft or substitute filler is often required. The graft is delivered via the 4.5 mm cannula through the 1–2 and 3–4 portals, with the Foley catheter in the 4–5 portal. The graft is then compacted tightly.

Under fluoroscopic control, a guide pin is advanced percutaneously through the central column of distal radius to the lunate (radiolunate [RL] pin) and another guide pin from the radial column to the scaphoid (radioscaphoid [RS] pin). The RL pin is introduced 1 cm proximal to the dorsal rim of the radius and aimed at the volar horn of the lunate, to maximize lunate purchase, but avoid penetration, which may damage the medial nerve. The RS pin is introduced into the radial column toward the proximal scaphoid at 45 degrees on the anteroposterior view. On the lateral view, the pin is aimed along the mid axis of radial styloid and proximal scaphoid. Cannulated compression screws are then advanced.

Arthroscopic Scaphocapitate Fusion

Scaphocapitate (SC) fusion was first described by Suto²⁹ for scaphoid nonunion using an open technique, and there have been several series since.^{30–32} Scaphotrapezium trapezium (STT) and SC fusion both transfer the load from the central column to the radial column, therefore unloading the necrotic fragmented lunate which may in turn relieve the pain and progression of KD.^{33,34} The SC fusion is indicated for advanced disease of the lunate (B3), or the compromised wrist, including central column degeneration (C1a and C1b) and proximal carpal row instability (C2). However, the radioscaphoid articulation must be functional.

Fig. 4 Arthroscopic resection of the proximal carpal row

When performing an arthroscopic assisted SC fusion, the opposing surfaces of the capitate and the waist and proximal scaphoid need to be resected. SC fusion is used in preference to STT fusion because the SC articulation is easier to arthroscopically access. Commence the resection at the inferior aspect, as the bleeding obscures the view of the dependent articulations. Progress upwards, removing the cartilage until there is punctate bleeding from the subchondral bone. The distal third of the scaphoid, trapezium, and trapezoid do not need to be debrided. If the lunate is very fragmented it should be resected.

When performing a SC fusion, we use fluoroscopic assessment and aim to maintain the normal alignment (SL and SC angle, 30–57 degrees; capitulunate angle, 0 ± 15 degrees).³⁵ Two guide pins are inserted across the SC interval. The position of scaphoid is controlled by thumbing the scaphoid tubercle from the volar aspect. The first guide pin is advanced through the 1–2 portal. The guide pin should enter the scaphoid between the proximal and middle thirds. It should be inserted at 60 degrees to the longitudinal axis of the wrist. In the lateral projection, aim at the middle of scaphoid and capitate. Another guide pin is inserted at least 5 mm distal and parallel to the first wire, aiming to enter the scaphoid between the middle and distal thirds. The cannulated depth gauge, drill, and screws are advanced over the guide wire, and assessed on fluoroscopy. For the SC fusion, bone graft is usually not required.

Arthroscopic Proximal Row Carpectomy

The prerequisite to perform a PRC is to have functional articular surface of the proximal capitate and lunate fossa (B2 or 3, C2). It is most suited to low demand patients >45 years of age.⁸ A standard arthroscopy, debridement, and articular assessment is performed as described previously. The central osseous portion of the lunate, scaphoid, and triquetrum are removed first. (→**Fig. 4**) The entire lunate and triquetrum are removed, but the distal one-third of scaphoid can be retained for the attachments of STT and the dorsal intercarpal ligaments.

Fig. 5 Arthroscopic removal of bone using pituitary rongeurs

Care is required to avoid the radial artery on the radial side of scaphoid and use meticulous hemostasis with radiofrequency. When using large burrs we maintain continuous irrigation to avoid overheating. The bipolar cautery can be used to release the capsular attachments to the bony fragments and the pituitary rongeur is useful to remove fragments within the joint (→**Fig. 5**).

Postoperative Care

Following these advanced arthroscopic procedures, a plaster slab is applied for 7 to 10 days. Then gentle active mobilization can be commenced with a wrist brace for protection. Gentle passive mobilization can commence after 4 weeks and strengthening exercises after 3 months. Radiological confirmation of fusion is required at 2–3 months.

Conclusion

KD usually affects a young, active, working population. With advanced imaging, the diagnosis and classification can be determined. Arthroscopic assessment can aid in fine-tuning the understanding of the pathoanatomy of the Kienböck lunate and how it secondarily affects the wrist. Arthroscopic procedures that can be performed include synovectomy and debridement, lunate forage, and bone grafting. Advanced arthroscopic reconstructive motion preserving procedures include PRC and limited wrist fusions.

Conflict of Interest

None.

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