Current Trends in Treatment of Kienböck Disease: A Survey of Hand Surgeons

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Abstract

Background: The cause and treatment of Kienböck disease is controversial. No treatment algorithm has been accepted. We surveyed US hand surgeons to determine trends and attitudes regarding the treatment of Kienböck disease. **Methods:** An online questionnaire was created focusing on specific treatments of Kienböck disease. The survey included 6 questions regarding the cause of disease, preferred vascularized bone grafting (VBG) procedure, and treatment of stages I, II, IIIA, and IIIB. Respondents were also asked to specify their geographic location of practice and the approximate number of years in practice. **Results:** A total of 338 of the 2781 surgeons contacted completed the survey for a response rate of 12%. The majority of respondents believe ulnar-negative variance alone contributes to the development of Kienböck disease. For treatment of a young ulnar-neutral male with stage I disease who had failed immobilization and nonsteroidal anti-inflammatory drugs, most hand surgeons chose distal radius core decompression. There was no preferred treatment among respondents for treatment of a young ulnar-neutral female with stage II disease. For treatment of a 40-year-old ulnar-negative male with stage IIIA disease, most hand surgeons chose a radial shortening osteotomy. The preferred treatment among respondents for treatment of stage IIIB disease is a proximal row carpectomy. **Conclusions:** Our study demonstrated that most hand surgeons believe ulnar-negative variance largely contributes to Kienböck disease and the most commonly preferred VBG technique utilizes the fourth and fifth extensor compartment arteries.

Keywords: bone grafting, distal radius, Kienböck disease, lunate, wrist

Introduction

Avascular necrosis (AVN) of the lunate was first described by Peste in 1843. In 1910, following the publication of Robert Kienböck's observations of the radiological changes associated with the condition, that Kienböck disease became more widely known.¹⁵ Kienböck, an Austrian radiologist, was the first to use the term *lunatomalacia*, and correctly hypothesized that the disease was precipitated by an interruption in the nutrition of the bone leading to AVN.

A few theories exist to explain the pathogenesis of Kienböck disease; however, no real consensus remains regarding the actual precipitating cause. The pattern of blood supply to the dorsal aspect of the lunate has been hypothesized to predispose patients to Kienböck disease. Lunate blood supply typically follows 1 of 3 patterns: "Y," "X," or "I," with the "I" pattern promoting the highest risk for AVN.⁶ The potential effect of biomechanics and anatomy in the progression of Kienböck disease has been investigated.^{9,18,23,25,26} Ulnar variance describes the anatomical position of the distal articular surface of the ulna in relation

to that of the radius. Ulnar-negative variance has been demonstrated to increase interosseous pressure of the lunate with wrist extension.¹⁸ Increased radial inclination from the ulnar aspect of the distal radius and the styloid tip of the radius may contribute added forces to the lunate increasing the risk for osteonecrosis.²⁶

Plain x-ray films may show typical signs of AVN, including increased bone density and sclerosis. In later stages, progressive loss of lunate height, proximal migration of the capitate bone, and degenerative joint disease can occur. Magnetic resonance imaging is the gold standard for diagnosis and a uniform T1 and T2 signal attenuation in the lunate is diagnostic. The Lichtman-modified Stahl's classification of Kienböck disease is based on the

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lunate appearance on imaging studies. It describes 4 stages of disease progression that surgeons may use to guide treatment. Surgical treatment is generally grouped into 3 categories: joint leveling, revascularization, or salvage. Joint-leveling procedures include radius or capitate shortening osteotomies with or without capitate-hamate arthrodesis and are intended to unload pressure on the lunate to promote vascularization. Revascularization of the lunate may be possible either directly with vascularized bone grafting (VBG) or indirectly with core decompression. Stage I is initially treated nonoperatively. Surgery is considered for refractory cases.^{11,12,21,22} More progressive stages (II, IIIA, IIIB, IV) are typically treated surgically to moderate pain. Several lunate-specific VBG procedures in the wrist have been described, whereas distal radius core decompression is believed to promote vascularization of the lunate by biomechanically unloading the radiocarpal joint.¹⁹ Joint-leveling techniques are applicable for stage I to IIIA disease with ulnar-negative variance or high radial inclination and may be supplemented with capitate-hamate fusion or VBG. For advanced disease (stages IIIB, IV), intercarpal fusion, proximal row carpectomy (PRC), total wrist arthroplasty, and total wrist fusion are available surgical options, and recently a lunate arthroplasty has become available.¹⁴

Given the uncertainty regarding the cause of the disease and the concurrent lack of “gold-standard” stage-appropriate treatments, we surveyed members of the American Society for Surgery of the Hand (ASSH) to determine current trends and attitudes toward treatment of Kienböck disease.

Materials and Methods

An online questionnaire was created focusing on specific treatments of Kienböck disease. The survey included 6 questions regarding the cause of disease, preferred VBG procedure and treatment of stages I, II, IIIA, and IIIB. Respondents were also asked to specify their geographic location of practice and the approximate number of years in practice. The survey was created using Google Docs survey template software (Google, Mountain View, California), and all questions were multiple choice.

Data Analysis

Responses to each question were recorded into a Google Docs spreadsheet, and proportions for each response were tabulated. We then used χ^2 analysis to test the statistical significance of the most common responses to each question. All χ^2 tests were performed using a Yates' continuity correction, and 2-tailed *P* values were calculated. Hypothesis testing was performed at an alpha score <.05.

Results

Questions and responses are shown in Table 1. A total of 338 of the 2781 surgeons contacted completed the survey for a response rate of rate of 12%. The highest percentage of respondents practice in the Northeast United States (23%), whereas those who practice in the Mountain West region of the United States had the smallest response rate (5%). Respondents who practice internationally comprised 8%. Moreover, most respondents have been in practice for 16 to 25 years (33%), whereas those just starting out in practice (<5 years) had the lowest response rate (17%). More than half of respondents have been in practice for more than 16 years (58%).

With regard to anatomic variants, the majority of respondents believe ulnar-negative variance alone contributes to the development of Kienböck disease (34%, *P* < .0001). Only 3 (1%) respondents believe high radial inclination alone or lunate shape alone predisposes a patient to the disease.

For treatment of a young ulnar-neutral male with stage I disease who has failed immobilization and nonsteroidal anti-inflammatory drug (NSAIDs), most hand surgeons chose distal radius core decompression (29%, *P* = .0012), whereas 11% would continue with conservative treatment involving further immobilization, NSAIDs, or observance. Thirty-one percent of respondents chose a radial shortening osteotomy (13%) or capitate shortening osteotomy with or without capitate-hamate fusion (13%), whereas 18% would perform a VBG for stage I Kienböck disease.

There was no preferred treatment among respondents for treatment of a young ulnar-neutral female with stage II disease. A VBG procedure for this patient was the most common response (25%); however, this response was not statistically different than performing a shortening osteotomy with or without VBG (*P* = .6523). Only 2% of respondents would continue with conservative treatment for stage II Kienböck disease.

Among the 67% of respondents who perform VBG procedures, the majority (70%, *P* = .0003) utilize the fourth and fifth extensor compartment arteries, whereas 7% prefer the dorsal metacarpal arcade to second or third metacarpal base, and 9% prefer a vascular bundle implantation using the second dorsal intermetacarpal artery.

For treatment of a 40-year-old ulnar-negative male with stage IIIA disease, most hand surgeons chose a radial shortening osteotomy (44%, *P* < .0001). Sixteen percent favored an intercarpal fusion, whereas 17% favored a radial shortening osteotomy or capitate shortening osteotomy with or without VBG for stage IIIA Kienböck disease.

The preferred treatment among respondents for treatment of stage IIIB disease is a PRC (62%, *P* < .0001). Nineteen percent favored an intercarpal fusion, whereas 13% favored a joint-leveling procedure. Two percent would perform a total wrist fusion, and only 1% would consider a lunate arthroplasty.

Table 1. Summary of ASSH Kienböck Disease Survey and Responses.

	Responses (total)	% Total responses
Question 1		
In your professional opinion, which of the following anatomic variants contributes to the development of Kienböck disease?	(338)	
1. Ulnar-negative variance	116	34%, $P < .05$
2. High radial inclination	1	0%
3. Lunate shape (type I lunate)	2	1%
4. Both 1 and 2	54	16%
5. Both 1 and 3	43	13%
6. All of the above	68	20%
7. None of the above	54	16%
Question 2		
What is your preferred method of treatment for a 30-year-old ulnar-neutral male with moderate to severe pain with an MRI demonstrating stage I Kienböck disease who has failed immobilization and NSAIDs?	(338)	
1. Continued immobilization and NSAIDs	37	11%
2. Distal radius core decompression	99	29%, $P < .05$
3. VBG procedure	60	18%
4. CSO with or without capitate-hamate fusion	43	13%
5. RSO	62	18%
6. VBG plus RSO or CSO	12	4%
7. Other	25	7%
Question 3		
What is your preferred method of treatment for a 35-year-old ulnar-neutral female with moderate to severe pain with an MRI demonstrating stage II Kienböck disease?	(338)	
1. Continued immobilization and NSAIDs	8	2%
2. Distal radius core decompression	46	14%
3. VBG procedure	84	25%, $P = .6523$
4. CSO with or without capitate-hamate fusion	56	17%
5. RSO	78	23%
6. VBG plus RSO or CSO	47	14%
7. Other	19	6%
Question 4		
If you use a VBG procedure, which technique do you most commonly use?	(338)	
1. VBG using fourth and fifth extensor compartment arteries	159	47%, $P < .05$
2. VBG using dorsal metacarpal arcade to second or third metacarpal base	25	7%
3. Vascular bundle implantation using the second dorsal intermetacarpal artery	30	9%
4. Other	12	4%
5. I do not use VBG techniques	112	33%
Question 5		
What is your preferred method of treatment for a 40-year-old ulnar-negative male with moderate to severe pain, motion loss, and an MRI demonstrating lunate fragmentation consistent with stage IIIA Kienböck disease?	(338)	
1. Intercarpal fusion (STT or SC fusion)	55	16%
2. CSO with or without capitate-hamate fusion	10	3%
3. Distal radius core decompression	4	1%
4. VBG procedure	19	6%
5. RSO	150	44%, $P < .05$
6. VBG plus RSO or CSO	57	17%
7. Other	43	13%

(continued)

Table 1. (continued)

	Responses (total)	% Total responses
Question 6		
What is your preferred method of treatment for a symptomatic 40-year-old female with stage IIIB Kienböck disease?	(338)	
1. Intercarpal fusion (STT or SC fusion)	64	19%
2. Joint-leveling procedure (RSO or CSO)	43	13%
3. Proximal row carpectomy	210	62%, $P < .05$
4. Total wrist fusion	6	2%
5. Implant arthroplasty of the lunate	5	1%
6. Other	10	3%
Question 7		
In what region of the United States do you primarily practice?	(338)	
1. Northeast	79	23%, $P = .8548$
2. Mid-Atlantic	23	7%
3. South	74	22%
4. Midwest	76	22%
5. Mountain West	16	5%
6. Pacific	43	13%
7. Outside the United States	27	8%
Question 8		
How long have you been in practice?	(338)	
1. Less than 5 years	59	17%
2. 6-15 years	82	24%
3. 16-25 years	111	33%, $P < .05$
4. More than 25 years	86	25%

Note. ASSH, American Society for Surgery of the Hand; VBG, vascularized bone grafting; CSO, capitate shortening osteotomy; RSO, radial shortening osteotomy; MRI, magnetic resonance imaging; NSAID, nonsteroidal anti-inflammatory drug; STT, scapho-trapezio-trapezoid; SC, scaphocapitate.

Discussion

Hulten,⁹ Gelberman et al,⁶ D'Hoore et al,⁵ and Tsuge and Nakamura²⁴ all studied the incidence of negative ulnar variance in patients with Kienböck disease versus a control group. Hulten⁹ and Gelberman et al⁶ found that negative ulnar variance correlated positively with Kienböck disease, whereas D'Hoore et al⁵ and Tsuge and Nakamura²⁴ found no significant relationship. D'Hoore et al studied patients in whom a Darrach procedure was indicated and found no increase in the incidence of Kienböck disease.⁵ Antuna Zapico characterized the risk of ulnar-negative variance by describing the risk of AVN as it related to the anatomy of the lunate bone and found that compared with ulnar-neutral and ulnar-positive variance, ulnar-negative variance showed the greatest propensity toward fatigue and stress fractures.² Schiltewolf et al compared the interosseous pressures between lunate and capitate during wrist motion and found a 40 mm Hg increase in interosseous pressure of lunate with wrist extension, indicating that wrist extension may predispose the lunate to osteonecrosis.¹⁸ Tsuge and Nakamura found a lower radial inclination in patients with Kienböck disease.²⁴ Other researchers have determined that there exists a relationship between the slope of the radius (on

anteroposterior [AP] x-ray projection) and the age of onset of Kienböck disease, as well as the forces transmitted on the lunate bone.^{8,29}

Trumble et al²³ performed radial lengthening and ulnar shortening procedures and determined that lunate strain reduction was maximized by 2 mm of length alteration, with a goal of 2 to 3 mm. After 4 mm of more of length alteration, no strain reduction over the lunate was seen. Horii et al⁸ showed that radial versus ulnar length alterations were mathematically equivalent in terms of the strain reduction, and consequent re-allocation of forces throughout the hand. Radial shortening osteotomy performed in 29 patients by Weiss et al²⁸ resulted in 87% of patients with decreased pain, increased range of motion, and no further lunate collapse, but no radiographic improvement was seen. The same procedure was performed by Rock et al¹⁷ in 16 patients, and subsequently 13 patients were pain free. A 20% to 30% increase in grip strength and an improvement of 15° in AP range of motion was noted. Linscheid^{3,16,20} performed an ulnar lengthening osteotomy from the distal third of the ulna to the interosseous membrane using a bone graft from the iliac crest to replace the lengthening defect. Postoperative grip strength improved by about 24%, and high patient satisfaction rates were reported.

Watanabe et al used a radial closing osteotomy to decrease the radial inclination of their patients, thereby redistributing axial loads from the radial lunate to the radial scaphoid without increasing ulnar carpal loads.²⁶ Almquist reported an 83% satisfaction rate with capitate shortening and capitate-hamate fusion. Patients achieved postoperative grip strength equal to 80% of the contralateral side.¹ Illarramendi et al performed distal radius core decompressions on 22 patients with Kienböck disease with ulnar-positive/neutral variance to simulate distal radius fractures. Sixteen of 22 patients improved following this procedure; only 4 had occasional pain.¹⁰

Watson et al performed STT fusions in 69 patients with stage IIIB disease. Of these patients, 46% and 32% reported excellent or good outcomes, respectively. Eighty-two percent of patients returned to their preinjury baseline levels of activity, but due to a high incidence of silastic particulate synovitis, this procedure was discontinued, and has been replaced by the scaphocapitate fusion technique.²⁷

For the treatment of stage IIIB/IV disease, Nakamura et al recommended PRC over STT fusion based on clinical experience.¹³ The results of one procedure of the other, however, have not been shown to be statistically different.¹³ De Smet et al also looked at patient outcomes following PRC; 13 of 21 patients experienced zero-mild postoperative pain, and 5 reported severe pain.⁴

Although most surgeons in our survey would prefer a joint-leveling procedure in an ulnar-negative wrist, 2 questions asked for a preferred treatment in an ulnar-neutral patient. Distal radius core decompression was preferred in stage I disease, but no favored treatment was noted in stage II. This lack of consensus may reflect our lack of understanding of the causation of Kienböck disease. VBG has the appeal of transferring new blood to the lunate; however, 33% of respondents do not use VBGs. Those performing VBGs preferred using the fourth and fifth extensor compartment arteries (47%).

In stage IIIA disease, where carpal height and alignment are maintained despite a fragmented and collapsed lunate, 44% of surgeons preferred a joint-leveling procedure (radial shortening osteotomy), which is consistent with studies showing pain relief without revascularization of the lunate.^{17,28} Stage IIIB disease involves capitate migration and scaphoid flexion and can be difficult to distinguish radiographically from stage IIIA disease.⁷ Surgeon treatment, however, favors a salvage procedure (PRC) by a wide margin (62%).

Our sample size of 338 respondents was certainly large enough to provide statistically significant differences; however, only 12% of the 2781 surgeons contacted completed our survey. This low response rate limits the internal validity of our findings among hand surgeons. The majority of respondents have been practicing for 16 to 25 years (33%), whereas only 17% of respondents are newly practicing surgeons (less than 5 years). This limits the external validity of

our findings across differing years of experience. Our survey responses were restricted to predetermined answers, as no open-ended responses were allowed. Furthermore, our study only polled active ASSH members, and therefore input from retired hand surgeons, non-ASSH members, and ASSH candidate members was not obtained.

In conclusion, our study demonstrated that most hand surgeons believe ulnar-negative variance largely contributes to Kienböck disease and the most commonly preferred VBG technique utilizes the fourth and fifth extensor compartment arteries. We also revealed a high acceptance (29%) of distal radius core decompression in the treatment of stage I. In addition, our study showed that most hand surgeons prefer to treat stage IIIA with a joint-leveling procedure and stage IIIB with a salvage procedure. Further research is required to determine the cause of Kienböck disease and to adequately model treatment trends and clinical outcomes. Utilization of various VBGs raises the question of which technique is most successful while further research on the success of distal radius core decompression is also needed.

Ethical Approval

Our study was exempt from approval by the Ohio State University Institutional Review Board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

This survey contained no identifying information and no statement of informed consent was required by our institution.

Declaration of Conflicting Interests

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