

Temporary Scaphotrapezoidal Joint Fixation for Adolescent Kienböck's Disease

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Purpose There are few therapeutic guidelines for adolescent Kienböck's disease. The purpose of our study was to investigate the clinical and radiographic outcomes of temporary scaphotrapezoidal (ST) joint fixation for adolescent Kienböck's disease.

Methods This was a retrospective review of 6 adolescent patients with Kienböck's disease treated by temporary ST joint fixation. All patients had pain with rest and activity before surgery. The mean patient age at the time of surgery was 14 years, and final follow-up examination was at a mean of 23 months. Under general anesthesia, 2 or 3 K-wires were inserted from the dorsal trapezoid to the scaphoid. The wires were removed at 3 to 6 months.

Results Mean postoperative wrist extension and flexion were increased from 46° and 48° to 68° and 77°, respectively. These improvements were statistically significant compared with preoperative wrist extension and flexion. Grip strength significantly increased from 52% to 86% of the unaffected side. None of the 6 patients had postoperative pain either at rest or with activity. On final follow-up wrist x-ray films, none of the patients had sclerotic change or fragmentation of the lunate, although decreased lunate height remained in all patients. Magnetic resonance imaging revealed improvement to nearly normal intensity of the lunate on T1- and T2-weighted images in all patients.

Conclusions Both clinical and radiographic outcomes of temporary ST joint fixation for adolescent Kienböck's disease were excellent. We therefore recommend this procedure for the surgical treatment of adolescent Kienböck's disease. (*J Hand Surg* 2009;34A:14–19. Copyright © 2009 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Therapeutic IV.

Key words Kienböck's disease, adolescent, temporary scaphotrapezoidal fixation.

THE ETIOLOGY AND natural history of Kienböck's disease are controversial. The disease is typically found in patients ranging in age from 20 to 40 years and is rare in adolescence. There are corre-

spondingly few therapeutic guidelines for adolescent Kienböck's disease. Rasmussen et al.¹ reported conservative treatment with immobilization in an 8-year-old girl who became pain-free with normal wrist function after 2 years of treatment. Ferlic et al.² reviewed 32 patients younger than 20 years of age with the disease and reported that radial shortening was the most commonly used surgical treatment. On the other hand, some investigators have reported treatment by limited wrist fixation. Yasuda et al.³ reported a 12-year-old girl successfully treated with temporary scaphotrapezoidal joint (ST) joint fixation. Shigematsu et al.⁴ obtained similarly good results in an 11-year-old girl with temporary scaphotrapeziotrapezoidal (STT) joint fixation. Kazuki et al.⁵ successfully treated a 15-year-old girl with temporary ST fixation and evaluated the postoperative re-

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TABLE 1. Patient Characteristics

Case	Age at Surgery (y) Gender	Affected Dominant Side	Stage	Ulnar Variance (mm)	Epiphyseal Plate	Postoperative Immobilization	Wire Removal	Postoperative Follow-Up
1	12/F	L/R	IIIB	-0.5	O	4 mo	4 mo	39 mo
2	14/F	L/R	IIIA	-1	O	2 mo	5 mo	17 mo
3	15/F	R/R	IIIA	0	C	1 mo	6 mo	48 mo
4	16/M	L/R	IIIA	0	O	3 mo	3 mo	7 mo
5	9/F	R/R	IIIB	-2	O	3 wk	3 mo	7 mo
6	17/M	L/R	IIIB	1	C	4 wk	6 mo	20 mo

Stage, Lichtman stage; O, open; C, closed.

vascularization within the lunate using serial magnetic resonance imaging (MRI) examinations. Temporary ST joint fixation is less invasive than radial shortening.

We have therefore treated adolescent Kienböck's disease with temporary ST joint fixation since 1996. The purpose of this study was to investigate both clinical and radiographic outcomes of temporary ST joint fixation for adolescent Kienböck's disease.

MATERIALS AND METHODS

Since 1996, we have treated 6 adolescent patients with Kienböck's disease using temporary ST joint fixation. Four patients were girls and 2 were boys. Their ages at surgery ranged from 9 to 17 years, with a mean of 14 years. The right hand was involved in 2 cases and the left in 4. None of the patients had a history of major trauma. Two patients were treated with splint conservatively for 2 months (case 1) or 8 months (case 3) before surgery. The other 4 patients had no conservative treatment. All patients had pain with rest and activity before surgery.⁷ The mean length of postoperative follow-up examination was 23 months (range, 7 to 48 months). Two patients (cases 5 and 6) were unable to keep appointments at 7 months. According to Lichtman's classification,⁶ 3 patients were stage IIIA and 3 were stage IIIB. There were 3 cases of ulnar minus variance, 2 of neutral variance, and 1 of plus variance. Four patients still had an open epiphyseal plate of the distal radius (Table 1).

Surgical technique

Surgery was performed under general anesthesia. Two or 3 K-wires were inserted from the dorsal trapezoid to the scaphoid under fluoroscopic control in the maximally ulnar-deviated position of the wrist. A cast or splint was then applied for 3 weeks to 4 months. Wires were removed 3 to 6 months after surgery (Table 1).

The timing of wire removal was decided by the findings of diminishing the avascular change on x-ray or MRI.

Clinical findings

We measured postoperative wrist motion (extension and flexion) and grip strength and compared them with preoperative values and with those on the unaffected side. We also evaluated subjective relief of pain at final follow-up using the method of Kuschner et al.⁷ No pain at rest or with activity was excellent, some pain with hard labor alone was good, some discomfort at rest or sufficient pain with work was fair, and pain with rest and activity was poor.

Radiographic findings

Radiographic evaluation was based on the presence of sclerotic change, fragmentation of the lunate, and decrease of lunate height. We also measured carpal height ratio (CHR), the ratio of carpal height to the length of the third metacarpal.⁸ MRI was performed before and after surgery in all 6 patients. The first author measured the CHR and assessed the MRI.

Statistical methods

Differences were examined for significance using paired *t*-tests, with $p < .05$ considered significant.

RESULTS

Clinical findings (Table 2)

Wrist range of motion: The mean postoperative wrist extension and flexion on the affected side increased significantly compared with the preoperative motion. But between the affected and unaffected side after surgery, there was significant difference in wrist flexion.

Grip strength: Although the mean postoperative grip strength had significant difference between the affected and unaffected sides, grip strength on the affected side

TABLE 2. Clinical Results

Case	Extension (degree)		Flexion (degree)		Grip Strength (kg)	
	Pre	Post	Pre	Post	Pre	Post
	Aff / Un	Aff / Un	Aff / Un	Aff / Un	Aff / Un	Aff / Un
1	40/95	80/80	40/90	85/90	9/17	26/26
2	40/60	70/60	30/95	85/95	20/28	28.5/30
3	85/95	85/95	90/95	80/95	17/29	20/28
4	40/70	60/70	35/65	60/65	7/19	13/19
5	30/90	70/90	60/90	90/90	6/16	17/19
6	40/45	45/45	35/65	60/65	14/32.5	24.5/28.5
Average	46/76	68*/73	48/83	77*†/83	12/24 (52%)	22†/25 (86%)*

Pre, preoperative; Post, postoperative; Aff, affected side; Un, unaffected side.

*Significant difference between preoperative and postoperative data on the affected side ($p < .05$).

†Significant difference between the affected and unaffected side after surgery ($p < .05$).

TABLE 3. Radiographic Results*

Case	Sclerosis	Fragmentation	Decrease of the Height	CHR*	MRI T1	MRI T2
1	P/N	P/N	P/P	0.46/0.44/0.50	low/improved	low†/improved
2	P/N	P/N	P/P	0.46/0.48/-	low†/improved	low†/improved
3	P/N	N/N	P/P	0.51/0.51/0.53	low/improved	low/improved
4	P/N	P/N	P/P	0.52/0.52/0.53	low/improved	low†/improved
5	P/N	N/N	P/P	0.46/0.50/0.52	low†/improved	low†/improved
6	P/N	P/N	P/P	0.56/0.54/0.60	low/improved	low†/improved

Preoperative/ Postoperative/ Unaffected Side.*

P, present; N, not present.

*Measuring only CHR.

†Low intensity with partial high intensity.

compared with the unaffected side significantly increased, from 52% to 86%.

Complications: In 1 patient, pins for ST joint fixation migrated to the volar side, and temporary ST joint fixation was performed again. Pin track infection occurred in 1 patient, but it was cured with antibiotics. There were no postoperative complications other than in these 2 patients.

Pain: As evaluated by the pain relief scale of Kuschner et al., all 6 patients had excellent results.

Radiographic findings (Table 3, Figs. 1–3)

Before surgery, on radiographic examination, all 6 patients had sclerotic change and evidence of collapse, and 4 patients had fragmentation of the lunate (Fig. 1A). On final follow-up wrist x-ray, no patients had sclerotic change or fragmentation of the lunate, although decreased lunate height remained in all patients (Fig. 3A).

Mean preoperative CHR was 0.49 (range, 0.46 to 0.56), and mean postoperative CHR was 0.50 (range, 0.46 to 0.54).

Preoperative MRI revealed low signal intensity in the lunate on T1- (Fig. 1B) and T2-weighted images in all 6 patients, including 3 patients with partial high-intensity areas on T2-weighted MRIs and 2 patients with partial high-intensity areas on T1- and T2-weighted MRIs. The postoperative signal intensity of the lunate was improved to nearly normal intensity on T1- and T2-weighted MRIs in all patients. The improvement suggested that the avascular changes had resolved (Fig. 3B).

DISCUSSION

Treatment of adolescent Kienböck's disease has been reported in a few cases, and the methods proposed have varied from conservative to surgical treatment. Rasmus-



FIGURE 1: A 17-year-old boy with Kienböck's disease (case 6) was treated by temporary ST joint fixation. **A** Preoperative x-ray shows sclerosis, fragmentation of the lunate, and decrease of the lunate height. **B** Preoperative MRI shows low signal intensity on T1-weighted images.



FIGURE 2: Postoperative x-ray shows temporary ST joint fixation using 3 titanium wires.

sen et al.,¹ Hosking,⁹ Greene,¹⁰ Smet,¹¹ and Herzberg et al.¹² reported conservative treatments with or without immobilization and good clinical results. On the other

hand, Foster et al.¹³ reported an 8-year-old girl with ulnar minus variance treated conservatively. However, because recurrence of wrist pain was noted after treatment of the hand for stiffness of the wrist due to immobilization, the patient had radial shortening osteotomy following 8 months of nonsurgical treatment. According to a review by Ferlic et al.,² conservative therapy with immobilization required long-term treatment for 15 weeks to 6 months. Iwasaki et al.¹⁴ noted that patients with successful nonsurgical treatment may have had bone marrow edema of the lunate because MRI examination had been inadequate. Ferlic et al.² reported that radial shortening was the most commonly used surgical treatment. For patients with ulnar minus variance, radial shortening is useful for decompressing the lunate. However, for patients with ulnar neutral or plus variance, this method involves the risk of ulnocarpal abutment syndrome. Because of this, Iwasaki et al.¹⁴ reported lateral closing wedge osteotomy for 2 patients with ulnar neutral or plus variance, 1 of whom had unsatisfactory results. Kazuki et al.⁵ suggested the risk of induction of hyperplasia of the radius following radial osteotomy. Herdem et al.¹⁵ reported radial overgrowth after radial shortening for Kienböck's disease in a 15-year-old boy. The ulnar variance in this patient changed from negative 1 mm in the surgical period to



FIGURE 3: **A** Final follow-up x-ray shows no sclerosis and fragmentation of the lunate, although decrease of the lunate height remained. **B** Magnetic resonance imaging shows improvement to nearly normal intensity on T1-weighted images.

negative 9 mm at the last follow-up evaluation 80 months after surgery due to radial overgrowth.

Watson et al.^{16,17} reported successful permanent STT joint arthrodesis for adult Kienböck's disease. This procedure provides a pain-free mechanism for load transfer through the wrist via the capitoscapoid and radioscapoid joints and decompression of the lunate. However, restriction of wrist motion is an important problem with it. Although Yajima et al.¹⁸ suggested temporary STT joint fixation for adult patients with Kienböck's disease, this procedure is combined with vascular bundle of the second or third metacarpal artery and vein, vascularized bone grafting, and interposition of a tendon roll. In 1998, Yasuda et al.³ reported initial temporary ST joint fixation alone for Kienböck's disease in a 12-year-old girl. Wrist pain disappeared and wrist motion was improved. Shigematsu et al.⁴ and Kazuki et al.⁵ obtained similarly good clinical results with adolescent Kienböck's disease with temporary ST (or STT) fixation. All of the present 6 patients became pain-free. Postoperative wrist extension and flexion improved significantly compared with preoperative wrist motion. These improvements solved the problem of restriction of wrist motion for permanent STT joint fixation. At follow-up, none of the patients had sclerotic change or fragmentation of the lunate, although evidence of collapse remained on x-ray films, with improvement to nearly normal intensity of the lunate on T1- and T2-weighted MRI studies (Fig. 3). These radiographic

findings were similar to findings in the 3 previous cases reported by Yasuda et al., Shigematsu et al., and Kazuki et al.

In our patients, wires were removed 3 to 6 months after surgery. To determine the optimal timing of wire removal, Kazuki et al.⁵ performed serial MRIs for Kienböck's disease in a 15-year-old and followed the time course of change in intensity of the lunate. They reported that 6 months after surgery, the intensity had normalized throughout the entire lunate, and the wires were removed then. MRI is useful for determining the optimal timing of wire removal when titanium wires are used for joint fixation.

Carpal height ratio can be calculated as the ratio of carpal height to the length of the third metacarpal. Youm et al.⁸ reported that the mean ratio for 100 normal wrists (young women) was 0.54, with a standard deviation of ± 0.03 , and that the degree of carpal collapse could be quantified by measuring CHR. In our cases, mean CHR was 0.49 before surgery and 0.50 after surgery. Carpal height ratio decreased in 2 of 6 patients and increased in 2 others. In 2 patients, postoperative CHR was unchanged compared with preoperative CHR. However, these results do feature the possibility of observer error due to the small lengths of the metacarpal and carpal bone compared with those in adults, or gender-, age-, and patient-associated differences in bone growth. Canovas et al.¹⁹ reported that the

maximum variation in carpal bone volume between the 2 wrists determined by quantitative computed tomography in patients aged 5 to 14 years was in the capitae. The ratio, computed as maximum volume – minimum volume/maximum volume of the capitae, ranged from 0.03 to 0.12. Measurement of the CHR of adolescents may be inappropriate for evaluation of the degree of carpal collapse. We therefore believe that assessment of vascularity using MRI is more important than the assessment of carpal height for determining the outcome of Kienböck's disease in adolescents.

There are some limitations of this study that must be considered. One is the relatively small number of patients in it. A further limitation lies in our lack of postoperative CHR data for the unaffected side.

However, both clinical and radiographic outcomes of temporary ST joint fixation for adolescent Kienböck's disease were excellent. This procedure is simple and less invasive than radial shortening, and it avoids long-term immobilization compared with conservative treatment. We therefore recommend temporary ST joint fixation for surgical treatment of adolescent Kienböck's disease.

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