Is radial shortening useful for Litchman stage 3B Kienböck's disease?

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Received: 16 April 2007 / Revised: 12 June 2007 / Accepted: 14 June 2007 / Published online: 28 August 2007
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Abstract Treatment of Litchman stage 3 Kienböck's disease is still controversial. In this study our aim was to evaluate the effectiveness of radial shortening on stage 3B Kienböck's disease in comparison with stage 3A cases. Radial shortening was performed for 23 patients who had stage 3A (group I, n=13) and 3B (group II, n=10) Kienböck's disease between 1994 and 2004. The radial osteotomy was performed 4.5 cm proximal to the distal articular surface. The mean shortening was 2.6 mm (range 2 to 4.5). The average follow-up period was 85 months (range 26–147). Based on the modified Nakamura system, the mean clinical points were 14.3 in group I and 13.3 in group II. There was no statistical difference between both groups with regard to clinical points ($P=0.483$). The extension-flexion arc showed significant improvement in both groups. Based on the results of this long-term follow-up study, we concluded that radial shortening osteotomy can be performed in the treatment of type 3B Kienböck's disease as reliably as type 3A, despite the lack of evident radiological improvement.

Résumé Le traitement de la maladie de Kienböck Stade III Litchman est toujours controversé. Le but de cette étude est d'évaluer l'efficacité du raccourcissement radial sur les stades 3-B de la maladie de Kienböck en comparaison avec

les stades 3-A. Un raccourcissement du radius a été réalisé pour 23 patients qui étaient au stade 3-A (Groupe I, n=13) et au stade 3-B (Groupe II, n=10) de la maladie de Kienböck entre 1994 et 2004. L'ostéotomie du radius a été réalisée à 4,5 cm de la surface articulaire distale. Le raccourcissement moyen était de 2,6 mm (de 2 à 4,5). Le suivi moyen était de 85 mois (de 26 à 147). Basé sur le système de Nakamura modifié, le score clinique moyen était de 14,3 dans le groupe I et de 13,3 dans le groupe II. Il n'y avait pas de différence statistiquement significative entre les deux groupes en ce qui concerne le score clinique ($p=0.483$). L'arc de mobilité en flexion extension montrait une amélioration significative dans les deux groupes. A partir des résultats de cette étude à long terme, nous avons conclu que l'ostéotomie de raccourcissement radial peut être réalisée comme traitement des maladies de Kienböck 3B de façon aussi efficace que pour les 3A et ce, en dépit de l'absence d'amélioration radiologique.

Introduction

Kienböck's disease arises from avascular necrosis of the os lunatum. The disease was recognised by various observers before 1910, but Kienböck was the first to carry out a study and to try to correlate the radiographic findings with the various clinical phases. The treatment of Kienböck's disease has been a challenging problem since its description. The treatment for Kienböck's disease ranges from conservative modalities such as immobilisation to operative options such as radial shortening [10, 11, 12, 16, 18], ulnar lengthening [24], excision [5] /silastic arthroplasty [13, 14], intercarpal fusions [22], and revascularisation procedures [9, 23].

Although the aetiology is unknown, it was believed that negative ulnar variance is the significant factor causing

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Kienböck's disease [19]. Therefore, radial shortening has been recommended to unload the diseased lunate without degenerative changes in the wrist [4, 7].

In the study, our aim was to evaluate the patients who had no evidence of arthritis clinically and radiologically and were treated via radial shortening in stage 3B Kienböck's disease in comparison with stage 3A cases.

Patients and methods

Between 1994 and 2004, 23 patients were treated as having Kienböck's disease on the basis of roentgenographic findings. There were 14 men and nine women in the study. At the time of diagnosis 13 had stage 3A (group I) and ten had stage 3B (group II) according to the Lichtman criteria [14]. Seventeen right wrists and six left wrists were affected, 16 being on the dominant side and seven on the non-dominant side. The mean duration of symptoms was six months (range 3–24). Seventeen patients sustained the disease from repeated manual work, and the other patients reported no trauma, and were classified as idiopathic. Twenty-one wrists were painful during active and passive flexion, extension, and as well as during grip strength testing. Only two patients had pain at rest. Twenty patients were heavy manual workers and three were housewives. None of the patients had received conservative treatment before. None had worker's compensation claims.

Preoperative preparation Ulnar variance and carpal collapse were measured. Ulnar variance was evaluated according to Palmer's technique [19]. The carpal height index was noted. In order to evaluate the palmar rotation of the scaphoid, the radio-scaphoid angle was measured [15].

Surgical technique All the operations were carried out under general anaesthesia using a pneumatic tourniquet. An 8- to 10-cm longitudinal incision was made over the volar aspect of the forearm (volar Henry incision) centred on the distal one fourth of the radius.

An average 2.6-mm radial shortening (2 mm to 4.5 mm) was performed in the diaphyseal area using an air-powered saw approximately 4.5 cm proximal to the distal articular surface of the radius.

The length of the bone segment equalled the amount of negative ulnar variance that was calculated on the radiographs taken preoperatively. Internal fixation was accomplished with a four- or five-hole dynamic compression plate. Mean operation time was 45 min (range 34 to 58 min). Single dose antibiotics (first generation cephalosporin) were used for prophylaxis preoperatively. Postoperative immobilisation was applied with a long arm cast for

first four weeks and with a short arm cast the following four weeks.

Active and passive exercises were encouraged after cast removal.

Based on the modified scoring system described by Nakamura et al. [17], patients were evaluated clinically (Table 1). The range of wrist flexion/extension and radial/ulnar deviation of both sides was measured both preoperatively and at the latest follow-up by a colleague who was not involved in the study using a manual goniometer. Grip strength of both wrists was recorded using a hand dynamometer. Using the technique described by Palmer et al. [19], we determined ulnar variance on radiographs. In addition, we measured other radiographic parameters including the radioscapoid angle and carpal height ratio preoperatively.

Statistical analyses were evaluated by using paired and unpaired t tests. $P < 0.05$ was accepted as significant.

Results

The ages of the patients ranged from 18 to 46 years (average 30.7). The mean follow-up period was 85 months (range 26–147). Bony union at the osteotomy site was achieved within 14 weeks (range 8–25). Mean hospitalisation time was three days (range 2–5). Mean interval from operation to return work for workers (17 cases) was 3.5 months (range 2.5–7.5). Thirteen of these patients were able to return to their previous occupations (76%); the others

Table 1 Scoring system for the assessment of results (modified Nakamura scoring system [17])

Clinical assessment	Points (21 points)
Pain in the wrist	
None	10
Mild with strenuous activity	7
Mild with light work	4
Grip strength (percentage of unaffected side)	
90%	5
80%	4
70%	3
60%	2
50%	1
Increase in range of flexion and extension	
>20°	6
10°–19°	5
5°–9°	3
Overall grade	Total points
Excellent	15–21
Good	9–14
Fair/poor	<8

Table 2 Comparison of clinical outcomes (mean±SD) of type 3A and type 3B

	At diagnosis	At follow-up
Type 3A		
Range of wrist extension/flexion arch of the wrist in degrees	92°±15.6	102.4°±18.5
Percentage grip strength of unaffected side	57.6±25.4	82.3±17.6
Clinical score		14.3±3
Type 3B		
Range of wrist extension/flexion arch of the wrist in degrees	84.4°±15.6	92.3°±11.1
Percentage grip strength of unaffected side	46.1±19.9	80.2±18.4
Clinical score		13.3±3.8

had to change to easier work (24%). There was no correlation between the jobs of the patients and their return to work.

Clinical examination At follow-up the range of passive motion of the wrists was measured. The preoperative

average extension-flexion arc was 92° (SD±15.6) and 84.4° (SD±10.9) in group I and II, respectively. The average extension-flexion arc was significantly improved to postoperatively 102.4° (SD±18.5) in group I and 92.3° (SD±11.1) in group II ($P=0.0001$). In addition there were no significant differences between the two groups with regard to the extension-flexion arc at the last examination ($P=0.144$).

The mean grip strengths of the affected side were 29.2 bars (range 10–68) preoperatively and 44.3 bars (range 25–71) postoperatively (Table 2).

At the last follow-up six patients had no pain (26%), 12 had pain with strenuous activity (52%), and five patients had minimal pain in daily living (22%).

Based on the modified Nakamura et al. [17] scoring system, the mean clinical score was 14.3±3 (range 9–19) in group I and 13.3±3.8 (8–19) in group II with no significant

Fig. 1 N.A. Preoperative radiogram of a 27-year-old female with Lichtman type 3A Kienböck's disease

Fig. 2 N.A., postoperatively 98 months later on anteroposterior radiogram, excellent result

Fig. 3 S.A., preoperative radiogram of a 30-year-old female with Lichtman type 3B Kienböck's disease

difference ($P=0.483$) (Table 2). There were six excellent and seven good results in group I and three excellent, six good, and one fair result in group II (Figs. 1, 2, 3 and 4). The early and late complications were as follows: two superficial infections, one delayed union, two pain on the ulnar side and two tenosynovitis. There was no pain at the osteotomy site.

Radiological examination Standard posteroanterior and lateral radiographs of all the wrists were obtained at the last follow-up. Preoperatively no patient had ulna plus. Seven cases were ulna neutral (30%) and 16 cases ulna minus (70%). The mean Stahl index [21] showing collapse of the lunate fossa was 34.2 (range 26–50) preoperatively and 34.9 (range 25–54) postoperatively. The mean inclination angle of the lunate fossa was 9.3° preoperatively and 9.8° postoperatively. The radial inclination angle was 23.4°

(range 18–30) preoperatively and 23.8° (range 17–28) postoperatively. The lunate coverage range was 73.7% preoperatively and increased to 82% postoperatively.

Discussion

Radial osteotomies have been well-accepted as effective extra-articular surgical procedures for patients with Kienböck's disease. However, the factors affecting the clinical procedures are controversial [12].

Since Kienböck described lunatomalacia, different types of treatment options have been proposed. Based on Hulten's [8] theory, which included ulna minus resulting in Kienböck's disease, osteotomy for the purpose of equalisation has been attempted, either by means of

Fig. 4 S.A., postoperatively 111 months later AP X-ray, excellent result

lengthening of the ulna or shortening of the radius. Hulten estimated that only 8% of the normal population had ulna minus; however, ten of his 19 cases had this feature. However, D'Hoore et al. [3] measured normal and diseased wrists and found no correlation between Kienböck's disease and negative ulnar variance. Similarly, Nakamura et al. [16] reported that ulnar variance is not an important predisposing factor in Kienböck's disease. In the meta-analysis reported by Chung et al. [1], there are insufficient data to support a significant association between negative ulnar variance and Kienböck's disease.

Nakamura et al. performed [16] radial shortening even in patients with ulnar zero or plus variance. Their results showed that radial shortening was effective even in these cases. Therefore, they recommended radial shortening not as a joint levelling procedure, but as one that distributes the axial load and allows decompression of the lunate. The McMurray effect of the para-articular osteotomy shows that the relief of symptoms has not been well understood [6].

This study displayed that radial shortening is effective in decreasing pain and in improving the range of wrist motion and grip strength with few intraoperative or postoperative complications. One issue considered by this study was that the amount of radial shortening must be equal to the preoperative negative ulnar variance, but this procedure may be useful for the patients having Kienböck's disease and neutral ulnar variance. In seven patients neutral ulnar variance was observed preoperatively, and they underwent radial shortening. The mean shortening was 2.4 mm (range 2–3). Of these seven cases, at the last follow-up four had satisfactory clinical results and three had unsatisfactory results. Therefore, the exact amount of radial shortening may not be as important as unloading of the lunate resulting from the shortening of the radius. For this reason this procedure may be useful for patients who have neutral ulnar variance. Weiss et al. recommended the amount of shortening needed to be effective should be slight (about 2 mm) [25].

Another important issue, the basis of this study, is whether radial shortening is suitable for patients who have stage 3A and 3B disease in which the lunate has collapsed. Weiss et al. reported four patients having stage 3B with excellent results. In these cases radiographic improvement in the appearance of the lunate cannot be expected [25].

Although there are many reports including the comparable results of radial osteotomy for Kienböck's disease, the choice of treatment in advanced stages is still controversial [10, 16, 20, 25]. As advanced stages, Lichtman 3A means collapse of the whole lunate and Lichtman 3B means fixed rotation of the scaphoid in addition to lunate collapse. Radial osteotomies were considered to be contraindicated because there would be no effect on scaphoid malrotation for stage 3B disease [5, 24]. Condit et al. reported unsatisfactory

results with osteotomies in Kienböck's disease of radio-scaphoid angles greater than 60° [2]. However, in this study we obtained satisfactory results in three patients who had radio-scaphoid angles greater than 60°. Iwasaki et al. reported excellent results in stage 3B patients, though there was no radiological healing. Similarly, no radiographic healing was observed in our stage 3B cases, although they had satisfactory clinical results.

Iwasaki et al. found excellent results in Kienböck's disease either with lateral closed wedge osteotomy or radial shortening osteotomy [11]. In our study we observed excellent results with respect to patient's satisfaction in type 3A and 3B Kienböck's diseases. We did not determine degenerative changes though up to a ten-year follow-up period.

Conclusion

Radial shortening osteotomy can be concluded to be a simple procedure with low complication rates and an easily applicable technique. In contrast to intraarticular procedures such as intercarpal fusion and proximal row excision, osteotomy seems to be more functional.

On the basis of our long-term follow-up study, we concluded that the radial osteotomy can be effective for patient satisfaction and functional improvement in the treatment of patients having stage 3B despite no obvious radiological healing.

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