

## KIENBÖCK DISEASE TREATED BY EXCISIONAL ARTHROPLASTY WITH A PALMARIS LONGUS TENDON BALL: A COMPARATIVE STUDY OF CASES WITH OR WITHOUT BONE CORE

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Received 30 October 2003; Accepted 27 April 2004

### ABSTRACT

We hypothesised that using a palmaris longus tendon ball (PLTB) with bone core (w bc) after excisional arthroplasty for Kienböck disease would maintain post-operative carpal height compared to a PLTB without bone core (w/o bc). Seventeen hands of 16 consecutive patients with Kienböck disease at Lichtman stage IIIA or IIIB were treated by replacement of the lunate with a PLTB w bc or w/o bc. We evaluated the clinical and radiological outcomes at one, three and 12 months after surgery. According to Dornan and Lichtman criteria respectively, there were no significant differences between the two groups. In the w bc group, the post-operative values of the carpal height ratio (CHR) were maintained at the same level as pre-operative values for one year, while the post-operative CHR values in the w/o bc group were significantly lower than those in the w bc group. Our results indicate that in Kienböck disease, arthroplasty using a PLTB w bc can maintain CHR at one year after surgery compared to arthroplasty using a PLTB w/o bc.

*Keywords:* Kienböck Disease; Palmaris Longus Tendon; Carpal Height Ratio; Arthroplasty.

### INTRODUCTION

Kienböck disease is characterised by flattening of the lunate and proximal migration of the capitate bone in the carpus. Carpal height gradually reduces as the lunate collapses. Simple excision of the collapsed lunate accelerates the reduction of carpal height and disrupts the carpal alignment. Autogenous soft tissue<sup>1–5</sup> or silicone implants<sup>1,6,7</sup> are commonly used for excisional arthroplasty, but the common replacement techniques do not prevent the reduction of carpal height. Several different techniques have been attempted to address this problem. These include temporal application of external fixation across the wrist<sup>5,8</sup> and temporary scaphoid-trapezium-trapezoid fusion with Kirschner wire.<sup>4</sup>

Since 1984, we have treated cases of Kienböck disease at Lichtman stage IIIA and IIIB<sup>6</sup> by replacing the lunate with a palmaris longus tendon ball (PLTB). From 1984 to 1997, consecutive patients were treated with a PLTB without bone core (w/o bc). In some of these cases, carpal height was rapidly reduced within one month post-operatively. We postulated that a PLTB w/o bc did not provide sufficient volume to fill the space of the excised lunate. For this reason, from 1997 to 2001, we treated consecutive patients with a PLTB with bone core (w bc).

We hypothesised that a PLTB w bc after excisional arthroplasty would maintain carpal height compared to a PLTB w/o bc. To test this hypothesis, we compared the carpal height of consecutive

patients with Kienböck disease treated by a PLTB w bc or by a PLTB w/o bc.

## PATIENTS AND METHODS

The subjects of this retrospective study were 17 hands of 16 consecutive patients with Kienböck disease at Lichtman stage IIIA and IIIB, treated by the same orthopaedic surgeon at our university hospital. The diagnosis of Kienböck disease was based on the characteristic radiographic features. The finding that the entire lunate had collapsed was judged as Lichtman stage III. IIIA indicated lunate collapse without fixed scaphoid rotation, and IIIB indicated lunate collapse with fixed scaphoid rotation and other secondary derangements. No patients had systemic disorders, such as rheumatoid arthritis or psoriatic arthritis, affecting the joint function or carpal bone alignment. We treated Kienböck disease at Lichtman stage IIIA or IIIB by replacing the lunate with a PLTB w bc or w/o bc. From 1984 to 1997, seven hands of six consecutive patients were treated w/o bc, and from 1997 to 2001, ten hands of ten consecutive patients were treated w bc. Follow-up period was an average of 46.4 months in the w/o bc group and 13.3 months in the w bc group. All cases were followed-up for more than 12 months.

We evaluated clinical scores according to the criteria of Dornan<sup>9</sup> of labour ability and that of Lichtman<sup>7</sup> of joint function, at 12 months after surgery. We measured the carpal height ratio (CHR) pre-operatively, and at one, three and 12 months post-operatively. CHR was calculated as carpal height divided by the length of the third metacarpal on the anteroposterior radiograph with the forearm in the supinated position.<sup>10</sup> We then compared the results between the w bc and w/o bc groups. There were no significant differences in patient background, including age, sex, Lichtman stage and pre-operative CHR, between the w bc and w/o bc groups (Table 1).

### Operative Procedure

The PLTB was performed through a palmar longitudinal lazy S-incision, and the flexor retinaculum was transected longitudinally. The palmar capsule was divided longitudinally between flexor tendons. The median nerve was carefully protected radially. The lunate was removed with great care to avoid injury to the dorsal capsule. The ipsilateral palmaris longus tendon strip of 12–15 cm in length was removed via a 2–3 cm transverse skin incision on the forearm. The tendon strip was rolled into a “rugby

**Table 1** Characteristic Features of Participating Patients.

	w/o bc	w bc	p Value
Age (Year)	42.7 ± 11.6	53.7 ± 11.6	NS
Sex (Male : Female)	5 : 2	6 : 4	NS
Lichtman Stage (IIIA : IIIB)	2 : 5	1 : 9	NS
Pre-operative CHR	0.537 ± 0.020	0.547 ± 0.038	NS

Data are mean ± SD. NS: No significant difference between the two groups by Mann-Whitney U-test for age and pre-operative CHR and by chi-square test for sex and Lichtman stage.

ball” and sutured to itself for the w/o bc cases. For the w bc cases, we created a round bone core of 7–8 mm diameter from the excised lunate, placed the bone core on the centre of the tendon strip, and rolled the tendon into a “rugby ball” around the bone core, before suturing the tendon strip to itself.<sup>4,11</sup> We inserted the rolled tendon w bc or w/o bc into the defect left by the excised lunate. The palmar capsule was closed securely. After surgery, the wrist was immobilised by a dorsal plaster splint for three weeks. After removal of the splint, active exercises commenced for range of motion (ROM) in the wrist joint and muscle exercises of the upper extremity. Patients commenced passive ROM exercises at six weeks, and returned to their previous activity level at nine weeks after surgery.

### Statistical Analysis

Data were expressed as the mean ± standard deviation (SD). At each time point, the difference between the value for the w/o bc and w bc groups was examined for statistical significance using Mann-Whitney U-test for patient age, CHR and %CHR, and examined using the chi-square test for sex and Lichtman stage. To compare the time-dependent changes of values at different time points after surgery, the Tukey-Kramer *posthoc* test after two-way analysis of variance (ANOVA) was used. A p value of less than 0.05 denoted the presence of a statistically significant difference.

## RESULTS

### Clinical Results

All 16 patients were able to return to their former occupation or activity within one year. One patient in the w/o bc group suffered

**Table 2 Clinical Results at One Year After Surgery.**

	w/o bc	w bc
<b>Dornan Criteria</b>		
Excellent	2(28.6)	5(50.0)
Good	4(57.1)	4(40.0)
Fair	1(14.3)	1(10.0)
<b>Lichtman Criteria</b>		
Satisfactory	4(57.1)	8(80.0)
Unsatisfactory	3(42.9)	2(20.0)

The numbers in the parentheses are the percentages of the cases in each group.

from post-operative complex regional pain syndrome type 1 (algodystrophy) of the hand, which was much improved by physical exercise and water baths within one year after surgery. According to the criteria of Dornan,<sup>9</sup> the clinical results were evaluated as excellent in two hands, good in four hands and fair in one hand in the w/o bc group. In the w bc group, the results were evaluated as excellent in five hands, good in four hands and fair in one hand (Table 2). According to the criteria of Lichtman,<sup>7</sup> clinical results were satisfactory in four hands and unsatisfactory in three hands in the w/o bc group, whereas in the w bc group the results were satisfactory in eight hands and unsatisfactory in two hands.

### Radiological Evaluation

Osteoarthritic change, characterised by narrowing of the radio-scaphoid joint, was found in two of seven hands in the w/o bc group, but not in the w bc group. The bone core completely disappeared in two cases (20%) and was reduced to less than 50% of the initial size in four cases (40%) in the w bc group within one year after surgery. In the w bc group, the post-operative CHR values were maintained at the same level as the pre-operative value for one year (Fig. 1). In contrast, the post-operative CHR values in the w/o bc group were significantly lower than those in the w bc group by the Tukey-Kramer test after two-way ANOVA. The CHR values of the w/o group at three and 12 months after surgery were significantly lower than those of the w bc group by Mann-Whitney U-test. Figure 2 shows the post-operative CHR values expressed as percentages of pre-operative CHR (%CHR). The post-operative %CHR values in the w/o bc group were significantly lower than those in the w bc group by the Tukey-Kramer test after two-way ANOVA. The %CHR value of the w/o bc group at 12 months post-operatively was significantly lower than

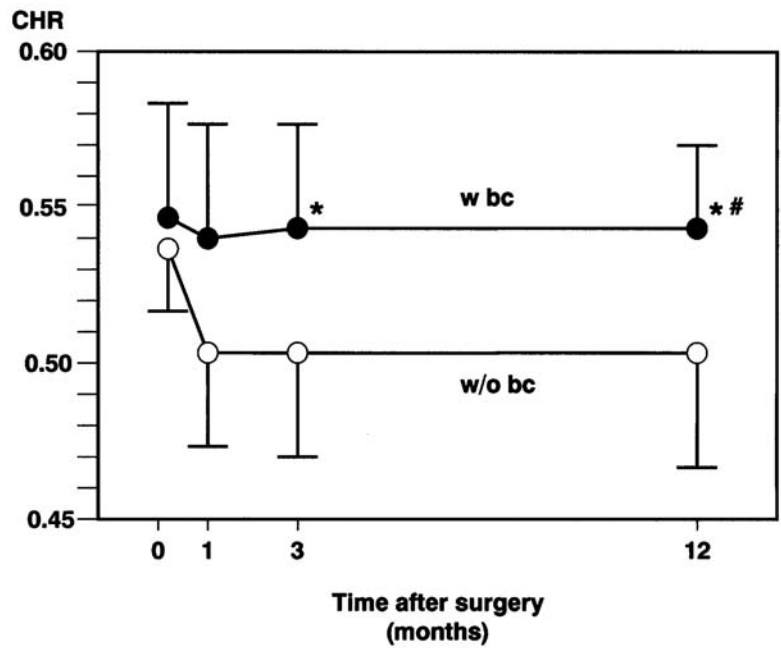
that of the w bc group by Mann-Whitney U-test. The %CHR value in the w/o bc group was gradually reduced to approximately 90% at one year after surgery.

### DISCUSSION

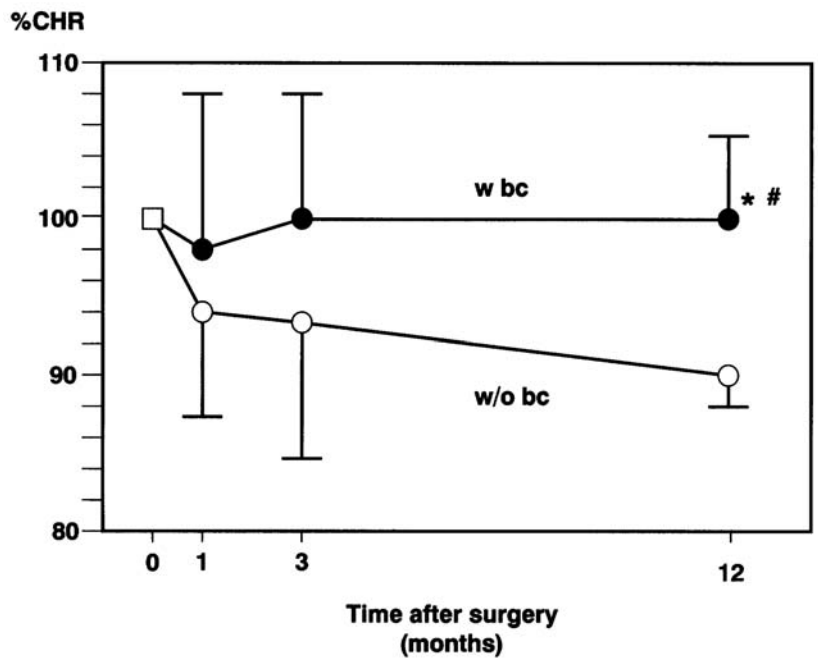
Our results demonstrated that a PLTB with bone core after excisional arthroplasty maintained the carpal height compared with a PLTB without bone core during a follow-up period of one year. The volume of the PLTB without bone core may not be good enough to fill up the space following total excision of the diseased lunate. One year post-operatively, there was no significant difference in the clinical outcome between the two groups, as judged by the criteria of Dornan<sup>9</sup> and that of Lichtman.<sup>7</sup> A longer follow-up period might be required to discriminate clinical outcomes reflecting architectural changes of the carpus after a PLTB with or without bone core.

A levelling operation, such as radial shortening or ulnar lengthening, or a vascularised bone graft is indicated for the early stage of Kienböck disease without lunate collapse. In general, two surgical procedures have been used for the treatment of advanced stage Kienböck disease. One is excisional arthroplasty using a prosthesis, such as a lunate silicone rubber implant<sup>1,6,7</sup> or soft tissue implantation like the palmaris longus tendon, a half slip of the flexor carpi radialis tendon or tensor fascia lata.<sup>1-5</sup> The other is partial carpal fusion, for example, scaphoid-trapezium-trapezoid fusion.<sup>2,3</sup> The former is advantageous for preserving the ROM in the wrist joint, but potentially is associated with more disease progression with respect to loss of carpal height. Controversy still exists concerning the validity of rolled tendon graft as spacer material in advanced stage of the disease.

Kato *et al.*<sup>1</sup> reported that two-thirds of the cases treated by silicone implant replacement were rated as unsatisfactory by the criteria of Lichtman,<sup>7</sup> when the preoperative carpal collapse was advanced. The decrease in carpal height led to unsatisfactory clinical outcomes. In their cases, most patients treated by a PLTB without bone core had progression of osteoarthritic changes accompanied by a marked loss in carpal height. Thus, we considered that maintenance of the carpal height might play a critical role in successful treatment of this condition. Recently, unique techniques for avoidance of post-operative reduction of the carpal height were reported. Temporal application of an external fixator<sup>5,8</sup> and temporary scaphoid-trapezium-trapezoid fusion with Kirschner wire<sup>4</sup> have been shown to be useful for maintaining carpal height after a coiled PLTB.



**Fig. 1** Changes in carpal height ratio after surgery. Data represent mean  $\pm$  SD. \* $p < 0.05$  versus the w/o bc group at each time point by Mann-Whitney U-test. # $p < 0.05$  versus the w/o bc group by Tukey-Kramer after two-way ANOVA.



**Fig. 2** Changes in %carpal height ratio (post-/pre-operative) after surgery. Data represent mean  $\pm$  SD. \* $p < 0.05$  versus the w/o bc group at each time point by Mann-Whitney U-test. # $p < 0.05$  versus the w/o bc group by Tukey-Kramer after two-way ANOVA.



**Fig. 3** Radiographs of one patient treated with palmaris longus tendon ball replacement with bone core. In this 59-year-old male mechanic, the bone core had disappeared within one year of surgery. (A) Pre-operative, CHR = 0.51; (B) three months after surgery, CHR = 0.49; and (C) 12 months after surgery, CHR = 0.49.

Joji *et al.*<sup>12</sup> reported that a grafted iliac bone core completely disappeared in 13% of cases and was reduced to less than half its volume in 33% of cases. In our series of patients treated with bone core (w bc group), the grafted bone core completely disappeared in 20% and was reduced to less than half its volume in 40% of cases. Thus, we consider that the reduction of bone core size does not reflect the source of the graft, that is, iliac bone or necrotic lunate. Although the grafted bone core was absorbed, carpal height was better maintained in the w bc group compared to the w/o bc group. A characteristic case is shown in Fig. 3. The bone core decalcified gradually and became undetectable on plain radiographs, but the tendon ball continued to fill the carpal space. Further investigation, such as animal studies to differentiate the histology of hyalinisation in the tendon graft over the long-term, would be needed to elucidate the difference in the effect upon the CHR between the two groups in our study.

In conclusion, in patients with Kienböck disease at Lichtman stage IIIA and IIIB, replacement of the lunate bone with a PLTB with a bone core maintained carpal height closer to pre-operative levels compared to a PLTB without bone core, at one year after excisional arthroplasty.

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