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Radiological comparison of conventional versus modified sauvé–kapandji procedure with stabilization of the proximal ulnar stump using the extensor carpi ulnaris tendon

A retrospective case–control study

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Abstract

The Sauvé–Kapandji procedure is a reliable option for patients with various disorders of the distal radioulnar joint (DRUJ). However, postoperative pain over the proximal ulnar stump frequently develops during forearm rotation or when lifting heavy objects, although many clinically satisfactory results have been reported. This stump pain has been suggested to result from dynamic instability of the proximal ulnar stump. Several types of tenodesis have recently been performed simultaneously with the Sauvé–Kapandji procedure to stabilize the proximal ulnar stump and thus relieve the associated pain. Although satisfactory outcomes of these stabilization procedures have been reported, correlations of the residual symptoms and radiographic findings between the conventional method and the modified method. Additionally, the mechanism of pain relief remains unclear.

To elucidate the cause of proximal ulnar stump pain, the clinical results and radiographic changes were compared between 2 treatment groups in which different Sauvé–Kapandji procedures had been performed. Twenty-four wrists with distal radioulnar disorders, all of which had undergone Sauvé–Kapandji procedures, were retrospectively classified into 2 groups according to the procedure. Group A (13 wrists) was treated by the conventional surgical procedure, in which the proximal ulnar stump is not stabilized. Group B (11 wrists) was treated by the modified method, in which the proximal ulnar stump is stabilized by tenodesis with the extensor carpi ulnaris tendon. Wrist pain, proximal ulnar stump pain, ranges of forearm pronation/supination, and grip strength were investigated. The ulnar distance, ulnar gap, interosseous distance, and dorsopalmar distance were measured on both resting and dynamic radiographs.

Stump pain was recognized in 6 wrists in group A and 0 in group B. However, no substantial differences in the other clinical findings or 4 radiographic parameters were found between the 2 groups.

These findings suggest that stabilization of the proximal ulnar stump cannot correct either dorsal ulnar deviation or dorsal displacement of the radius. Therefore, proximal ulnar stump pain may not be caused by either radial or dorsal deviation of the proximal ulnar stump but instead by other dynamic factors.

Abbreviations: DRUJ = distal radioulnar joint, ECU = extensor carpi ulnaris.

Keywords: extensor carpi ulnaris tendon, proximal ulnar stump, Sauvé–Kapandji procedures, stump pain, tenodesis

1. Introduction

The Sauvé–Kapandji procedure[1] is a reliable option for relieving wrist pain, obtaining a sufficient range of forearm rotation, and improving the grip strength in patients with various disorders of the distal radioulnar joint (DRUJ) such as rheumatoid arthritis, osteoarthritis, ulnocarpal abutment syndrome, and dislocation of the DRUJ. Although many clinically satisfactory results have been reported, postoperative pain over the proximal ulnar stump frequently develops during forearm rotation or when lifting heavy objects. This stump pain has been suggested to result from dynamic instability of the proximal ulnar stump.[2,3] Several types of tenodesis have recently been performed simultaneously with the Sauvé–Kapandji procedure to stabilize the proximal ulnar stump and relieve the associated pain.[4–7] Although satisfactory outcomes of these stabilization procedures have been reported in case series, no reports have described the correlations of the residual symptoms and radiographic findings between the original method (in which the proximal ulnar stump is not stabilized) and the modified method (in which the proximal ulnar stump is stabilized by tenodesis). Additionally, the mechanism of pain relief remains unclear. In the present study, we compared the clinical results and radiographic changes between 2 different Sauvé–Kapandji procedures: the conventional procedure without stabilization of the proximal ulnar stump[1,8] and the modified

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procedure with stabilization of the proximal ulnar stump using the extensor carpi ulnaris (ECU) tendon.[5] The cause of proximal ulnar stump pain is also herein discussed.

2. Methods

This retrospective case series was performed from February 1995 to January 2004 at Nippon Medical School Hospital. Patients' demographic characteristics, medical history, imaging findings, and follow-up data were extracted from their medical records. This was a retrospective human noninterventional study. According to public health law in Japan, approval from an institutional review board is not required for human non-interventional studies. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki. Informed consent was obtained from all patients in this study.

2.1. Surgical procedures

The patients' wrists were classified into 2 groups according to the treatment method used. Group A was treated by the conventional Sauvé–Kapandji procedure without stabilization of the proximal ulnar stump. In group B, the ECU tendon was split in the central sulcus to the ulnocarpal level from the musculotendinous junction, and the released radial half was passed through a hole drilled in the proximal ulnar stump and sutured to the remaining tendon.[8] In both groups, cancellous bone collected from the proximal ulnar shaft was grafted onto the decorticated DRUJ and fixed with a screw and pin. A part of the pronator quadratus muscle was interposed in the resultant pseudarthrosis, and its fascia was sutured to the surrounding soft tissue. In group B, tendon suturing was performed with the wrist in maximum volar flexion while tension was manually applied to the tendon (Fig. 1). All surgical procedures were performed by one of the authors (TS).

2.2. Patients

We performed the Sauvé–Kapandji procedure in 23 patients (24 wrists) with DRUJ disorders. All patients were followed up for ≥6 months after the operation. The causes of the DRUJ disorders were primary osteoarthritis, dorsal dislocation of the DRUJ, and secondary osteoarthritis caused by fracture malunion. Patients with rheumatoid arthritis were excluded from this study. One patient with a bilateral DRUJ disorder underwent the conventional procedure in both wrists. In total, group A comprised 13 wrists of 12 patients (4 male, 8 female), and group B comprised 11 wrists of 11 patients (4 male, 7 female). The details of the patients in both groups are shown in Table 1. No significant differences in age, sex, or follow-up period were observed between the 2 groups.

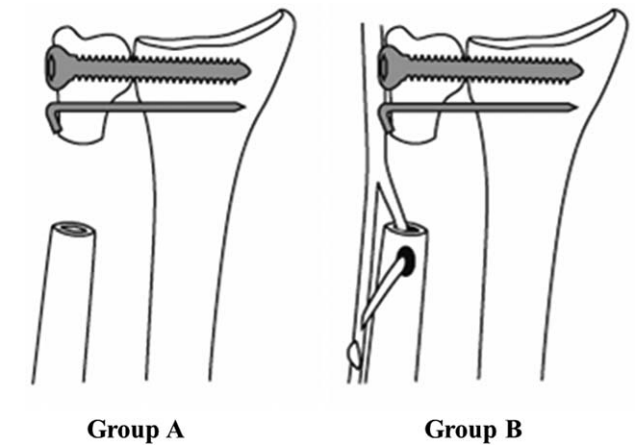

Figure 1. Two different operative procedures. (A) Group A: conventional surgical procedure without stabilization of the proximal ulnar stump. (B) Group B: the radial half of the split extensor carpi ulnaris tendon was passed through a bone hole made in the proximal ulnar stump and sutured to the remaining tendon in an interlacing fashion while the proximal ulnar stump was distally suspended. In each method, the fascia of the extensor carpi ulnaris tendon was sutured to the ulnar periosteum.

Table 1

Preoperative demographic data.

	Group A	Group B	*P*
n (Total)	12 (13 wrists)	11 (11 wrists)	
Male:female	4:8	4:7	1.00
Affected side (Lt:Rt)	6:7	4:7	.94
Age, y*	44.9 ± 14.3	46.3 ± 13.1	.70
Follow-up period, mo*	17.7 ± 8.0	17.5 ± 6.3	.07
Disorder			
Primary osteoarthritis	9	8	
Dorsal dislocation of DRUJ	1	0	1.00
Secondary osteoarthritis	3	3	

* Average ± standard deviation.

2.3. Postoperative evaluation

Six months after the operation, wrist pain, proximal ulnar stump pain, the ranges of forearm pronation/supination, and the ratio of the grip strength between the affected and unaffected sides as measured with a dynamometer (Jamar; Baran/Tec, Clifton, NJ) were investigated. Part of the clinical evaluation score described by Inoue et al,[9] who considered the range of forearm rotation to be important, was modified by the addition of stump pain to wrist pain among the pain items. Stump pain was classified as severe (presence of pain affecting daily activities), moderate (presence of pain not affecting daily activities), mild (absence of pain but presence of clicks), or absent (absence of pain and clicks) (Table 2).

Standard posteroanterior and lateral radiographs of each patient were taken at the final examination under 2 different conditions: the resting view (during rest with complete relaxation) and the dynamic view (during maximal gripping). The patients' forearms were always held in neutral rotation with the shoulders abducted and the elbows flexed to 90° while obtaining the radiographs. On the posteroanterior images, the remaining length of the ulnar head (ulnar distance, mm), the distance between the proximal ulnar stump and distal ulnar stump (ulnar gap, mm), and the minimum distance between the distal end of

Table 2

Modified Inoue's clinical evaluation score.

	0	1	2	3	4
Pain					
Wrist	Sever	Moderate	Mild	–	None
Ulnar stump	Sever	Moderate	Mild	–	None
Pro/sup	<100°	100°–120°	120°–140°	140°–160°	160°–180°
Grip strength	<25%	25%–40%	40%–65%	65%–80%	>80%

Excellent: 15 to 16, good: 12 to 14, fair: 9 to 11, poor: <9.

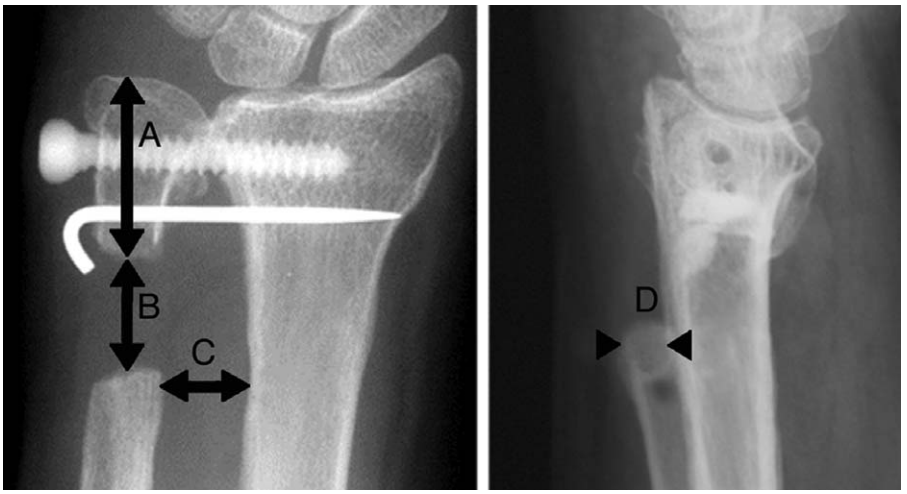

Figure 2. Measurement methods on plain X-ray films. (A) Ulnar distance (mm). (B) Ulnar gap (mm). (C) Interosseous distance (mm). (D) Dorsopalmar distance (mm).

the proximal ulnar stump and distal radius (interosseous distance, mm) were measured. On the lateral images, the minimum distance between the dorsal margin of the distal radius and the dorsal margin of the proximal ulnar stump (dorsopalmar distance, mm) was measured (Fig. 2).

During gripping, one of the authors (TS) determined whether incorrect rotation of the wrist or forearm was present. Two of the authors (TS and YT) performed all radiographic measurements. The occurrence of clinical and radiographic complications until the final evaluation was also investigated.

2.4. Statistical analysis

All data are presented as mean ± standard deviation. The *t* test was used to analyze continuous variables between the 2 groups. Categorical data were analyzed with Fisher exact test. All data were statistically analyzed with SPSS 19.0 software (IBM Corp. Armonk, NY). A *P* value of less than .05 was considered statistically significant.

3. Results

3.1. Treatment results

The range of rotation in the final examination was 158° ± 22° in group A and 159° ± 25° in group B ($P = .92$). The grip strength compared with that on the normal side was 85.7% ± 14.7% in group A and 83.3% ± 12.3% in group B ($P = .67$). A marked improvement was observed in both groups without a significant difference. Wrist pain at the final evaluation in group A was classified as absent in 10 wrists and mild in 3, and that in group B was classified as absent in 8 wrists and mild in 3; an improvement to mild or absent wrist pain was observed in both groups without a significant difference ($P = 1.00$). Stump pain in group A was classified as absent in 7 wrists, mild in 3, moderate in 2, and severe in 1, and that in group B was classified as absent in all wrists ($P < .01$). The treatment results in group A were excellent in 7 wrists, good in 3, and fair in 3, and those in group B were excellent in 7 wrists and good in 4. The differences between group A and group B were mainly due to stump pain.

3.2. Radiographic evaluation

No significant difference in the ulnar distance or ulnar gap was observed between the 2 groups. The interosseous distance and dorsopalmar distance were shorter during gripping than at rest in each group. The interosseous distance was slightly shorter in group A than B. However, these parameters did not significantly differ between the 2 groups (Table 3).

3.3. Complications

In 1 wrist in group A, limitations in forearm rotation developed 6 months after the operation, and plain X-ray examination showed recurrence of bone union of the ulnar pseudarthrosis. This bone union was resected again together with the remaining periosteum, and a tendon ball produced with the palmaris longus tendon was put in place. The limitations in forearm rotation rapidly disappeared. In group B, no complications occurred, including restriction of range of motion or recurrence of bone union of the ulnar pseudarthrosis.

4. Discussion

The Sauvé–Kapandji procedure has been widely performed not only to improve pain, range of motion, and grip strength in patients with DRUJ disorders but also as a salvage operation for DRUJ disorders or comminuted fractures of the distal end of the

Table 3

Radiographic evaluation.

Radiographical parameter	Group A*	Group B*	*P*
Ulnar distance, mm	19.9 ± 2.4	20.5 ± 2.2	.58
Ulnar gap, mm	13.7 ± 2.3	12.3 ± 1.8	.11
Interosseous distance			
At rest, mm	8.5 ± 4.0	8.9 ± 1.4	.76
At grip, mm	7.7 ± 2.8	8.0 ± 1.3	.73
Dorso-palmar distance			
At rest, mm	1.1 ± 3.6	1.1 ± 3.3	.99
At grip, mm	1.1 ± 1.6	0.9 ± 1.6	.80

* Mean ± standard deviation.

radius. Although clinically satisfactory outcomes have been reported,[10,11] this procedure is associated with the occurrence of pain around the artificially produced pseudarthrosis at the distal end of the ulnar shaft during motion. Several authors[2,3] have reported that pain at the proximal ulnar stump occurred within 3 months after the operation in a case series of patients treated by the Sauvé–Kapandji procedure without stabilization of the proximal ulnar stump. Inagaki et al[12] reported that the radioulnar distance after the Sauvé–Kapandji procedure was narrower than that before surgery and that it was related to tenderness over the distal ulnar stump and radioulnar instability of the proximal ulnar stump. To reduce the instability of the proximal ulnar stump, Kapandji[8] recommended shortening the pseudarthrosis distal to the ulnar shaft and placing it as distally as possible. In their consecutive series, however, Minami et al[5] stated that the site of the pseudarthrosis does not seem to enhance the stability of the ulnar stump. Additionally, an excessively short pseudarthrosis is associated with a risk of recurrence of bone union or impingement between the distal and proximal ulnar stumps. Minami et al[5] found radial deviation of the proximal ulnar stump on X-ray films and thus speculated that this radial deviation was the cause of proximal ulnar stump pain.[5] They reported that a stabilizing procedure with the ECU tendon in the proximal ulnar stump was needed to prevent persistence or recurrence of pain.[16] The use of the ECU tendon to stabilize the proximal ulnar stump has been frequently reported in recent years.[5,13–16] However, no relationship between stabilization of the proximal ulnar stump and the occurrence of stump pain has been described.

To evaluate the association between radial deviation and pain of the proximal ulnar stump, we compared changes in pain and radiographic findings between patients treated by the Sauvé–Kapandji procedure without stabilization of the proximal ulnar stump and those treated by this procedure with stabilization using the ECU tendon. McKee and Richards[17] reported that the proximal ulnar stump approached the distal end of the radius (dynamic radioulnar convergence) because of antebrachial muscle contraction during maximal grip in patients treated by Darrach procedure, resulting in direct contact (dynamic radioulnar impingement) in 5 of 23 patients. They suggested that this phenomenon was due to the lack of a sufficient supporting effect of the DRUJ resulting from resection of the ulnar head, but they did not describe the degree of convergence. We performed measurements using a similar method and observed radioulnar convergence (ie, a decrease in the interosseous distance) on posterolateral X-ray images during firm gripping in both groups. However, the degree of convergence was slight, and no wrists showed any dynamic radioulnar impingement in our series. Unlike Darrach procedure, the Sauvé–Kapandji procedure preserves the ulnar head, which may function as a roof, thereby avoiding direct force due to muscle contraction on the proximal ulnar stump.

In the present study, persistent proximal ulnar stump pain was observed a mean of 18 months postoperatively in 6 (46%) of the 13 wrists in group A (treated without stabilization of the proximal ulnar stump); this is consistent with the findings of previous reports. Conversely, persistent proximal ulnar stump pain was not observed a mean of 16 months postoperatively in group B (treated with stabilization of the proximal ulnar stump using the ECU tendon). Nonetheless, no significant differences in the deviation of the proximal ulnar stump were observed on X-ray films between groups A and B. These findings suggest that stabilization of the proximal ulnar stump can control its instability but cannot correct either dorsal ulnar deviation or dorsal displacement of the radius. In other words, proximal ulnar stump pain may be caused not by radial or dorsal deviation of the proximal ulnar stump but by other dynamic factors.

The study has some limitations. Because of the small number of cases, significant conclusions regarding the clinical or radiologic outcomes cannot be made. As in any retrospective study, the results are susceptible to inaccurate documentation. The main prognostic factors for choosing the most effective procedure for stabilization of the proximal stump remain unclear. Further studies are needed to help surgeons choose an appropriate technique for the stabilization of the proximal stump in the Sauvé–Kapandji procedure.

5. Conclusion

To evaluate the association between radial deviation and pain of the proximal ulnar stump, we compared changes in pain and radiographic findings between the conventional Sauvé–Kapandji procedure (without stabilization of the proximal ulnar stump) and modified Sauvé–Kapandji procedure (with stabilization using the ECU tendon). Stump pain was observed in 6 of the 13 wrists in group A but in 1 of the 12 wrists in group B; however, no significant differences in the deviation of the proximal ulnar stump were observed on X-ray films between the 2 groups. These findings suggest that stabilization of the proximal ulnar stump can control its instability but it cannot correct either the dorsal ulnar deviation or dorsal displacement of the radius. In other words, proximal ulnar stump pain may be caused not by radial or dorsal deviation of the proximal ulnar stump but by other dynamic factors.

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