

Research Article

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Modified Sauve-Kapandji procedure for patients with old fractures of the distal radius

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Abstract: Objective. To evaluate the clinical and radiographic outcomes of a modified Sauve-Kapandji procedure for patients with old fractures in the distal radius.

Methods. Fifteen patients (10 male and 5 female patients with an average age of 40 years old) were treated by the modified Sauve-Kapandji procedure from January 2014 to April 2016. All patients had undergone at least one previous operation on the involved wrist, and they were still suffering from pain and functional limitations at the time of admission. The postoperative follow-up period was 12-26 months and the average was 20 months. Functional assessment was made at the last follow-up. All patients were evaluated according a Modified Mayo Wrist Score system.

Results. Of the fifteen patients with posttraumatic arthritis, thirteen had excellent results, two had good results, and one had fair results. There were no major complications.

Conclusions. The modified Sauve-Kapandji procedure is a safe and effective surgical alternative for intractable disorders of the distal radioulnar joint and can be recommended as a salvage procedure when previous treatments fail.

Keywords: Distal radius fracture; Distal radioulnar Joint; Modified Sauve-Kapandji procedure

1 Introduction

Distal radius fractures (DRFs) are common injuries in clinical practice, accounting for one sixth to one fourth of all fractures treated in clinical emergency [1, 2], accounting for 75% of all forearm fractures [3]. The most common treatment options used to manage DRF include non-operative and reduction [4, 5]. Although surgical techniques continue to improve, distal radioulnar joint (DRUJ) disorders is a common consequence of DRF [6].

Injuries to the DRUJ with a DRF can result in pain of the wrist, decreased forearm rotation, instability of the ulna, and loss of function [6]. In recent years, much controversy has surrounded the treatment of this disorder. Various surgical techniques have been developed to treat instability of the DRUJ, including distal ulna resection, partial-resection with interposition arthroplasty, and the Sauve-Kapandji procedure [7].

Though the above procedures achieve satisfactory outcomes, there are some limitations including diminished grip strength, instability of the wrist, rupture of the extensor tendons, and ulnar carpal abutment. In this paper we address the modified Sauve-Kapandji procedure for the treatment of DRUJ derangement after DRFs. All patients had had at least one previous operation on the involved wrist, they were still having pain and functional limitations 7 months to one year later after the operation. The modified Sauve-Kapandji procedure is now an established treatment option in the setting of postoperative disorders of the DRUJ.

In this study we review our clinical experience with the modified Sauve-Kapandji procedure for chronic disorders of the DRUJ in patients with old fractures of the distal radius.

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2 Patients and methods

2.1 Patients

We prospectively selected and followed 15 consecutive patients with post-operation derangement of the DRUJ between January 5th 2014 and April 30th 2016. Although all patients had had at least one previous operation on the involved wrist, they were still having pain and functional limitations 7 months to one year later after the operation (Table 2).

Statistical analysis was performed using SPSS 16.0 software.

Ethical approval: Our research has been approved by the ethical committee of Tianjin Xiqing Hospital. Informed consent prior being included into the study was obtained from all patients and any data has been anonymised and has no patient identifiers.

2.2 Surgical Technique and Postoperative Management

The modified Sauve-Kapandji procedure is performed with the patient in the supine position and the extremity abducted with the hand on a hand table under local anesthetic and tourniquet control. Starting 5 to 6 cm proximal to the prominence of the ulnar head and ending at the level of the pisiform, make a longitudinal skin incision over the subcutaneous border of the ulna between the flexor carpi ulnaris (FCU) and extensor carpi ulnaris (ECU) tendons. Carefully identify and protect the dorsal sensory branch of the ulnar nerve. One alignment hole of the DRUJ is drilled by an electric drill to connect the ulnar and radius in advance. The hole we modified serves as a marker to simplify the operation and shorten the operation time. After a thorough DRUJ synovectomy, the ulnar notch of the radius and the ulnar head were decorticated. The resulting space between the head of the ulna and the distal radius is measured. A segment of bone of equivalent length is resected from the distal ulna to use as an intercalary graft. The resected portion of the ulna was rotated 90°, inserted into the DRUJ to bridge the gap between the ulnar head and the ulnar notch of the radius, and fixed at that site using with a tenaculum forceps. Kirschner wire was drilled into the hole and to fix the bone segment and the distal end of the radius. The second kirschner wire was drilled into the distal radioulnar joint at about 0.5cm from the proximal ulna to stabilize the DRUJ. Pay atten-

tion to the second needle gap to prevent the needle from hitting. The distal ulnar proximal stump can be stabilized with gliding of the ulnar carpal flexor and the extensor carpi ulnaris. Postoperatively the limb is immobilized in a long arm cast for 4 weeks with the forearm supinated about 45 degrees. A short arm splint is applied until the fusion site has healed. To avoid joint stiffness, the patients were instructed to perform functional exercise of wrist joint early in the postoperative period, and were encouraged to gradually exercise independently 4–6 weeks postoperatively. The postoperative rehabilitation training was under the guidance of a professional physician.

3 Results

The modified Sauve-Kapandji procedure was performed in 15 patients with post-operation derangement of the DRUJ between January 5th 2014 and April 30th 2016. All presented with pain in the distal radio-ulnar joint and impaired rotation of the forearm. There were 15 wrist in 15 patients (10 men and 5 women), with a mean age of 40 years (range, 28 to 67 years) at the time of the operation. All patients' outcomes included a follow-up of at least 20 months (12 to 26). 6 cases of left and right side in 9 cases. In 15 patients, DRFs with dislocation of the distal radio-ulnar joint, 6 cases of left and right 9 cases, 7 cases are complicated with malunion of comminuted fractures, 4 cases are complicated with DRUJ dislocation, and 3 cases are ulnar styloid fracture. There are varying degrees of shortening and deformity on distal radius. All patients experience varying degrees of wrist symptoms: decreased grip strength, painful limitation of forearm rotation with functional deficits, chronic volar DRUJ instability and loss of function etc. One of the patients, male, 55 years old, and images results in Fig 1. Preoperative x-ray film showed separation of DRUJ (Fig. 1a). Magnetic resonance imaging shows slight osteoarthritis of the DRUJ (Fig. 1b). All patients underwent radiographic, magnetic resonance imaging and clinical examination before the operation and at the final follow-up. Preoperative data were obtained from hospital records and confirmed with each patient. A functional evaluation was conducted based on the Modified Mayo Wrist Score (Table 1) after the operation.

At the final follow-up, 80% patients (15 patients, 12 excellent, 2 good results, 1 fair) have achieved excellent (Table 3). Preoperatively, all patients had moderate to severe pain facing the DRUJ. At the latest follow-up, fourteen patients had no pain in the region of the DRUJ and only one patient had mild pain. With regard to range of

motion (ROM), pronation improved from a preoperative mean of 48° to a postoperative mean of 88°, supination progressed from a preoperative mean of 51° to a postoperative mean of 86°. Grip strength improved significantly from a preoperative mean of 51% to a postoperative mean of 88% on the ipsilateral side compared with the contralateral side. The same patient, X-ray film one day and 4 months after the procedure showed that the pseudoarthrosis gap of the ulna was well preserved and that the stability of the proximal ulnar stump also was preserved (Fig. 1c and Fig. 1d).

4 Discussion

DRFs are primary portion of the orthopedic fractures. DRFs usually resulting from various traumas, and the occurrence of them is inclined to rise [8, 9]. This rise may be attributable to an increase in sports activities or better access to care and detection. DRFs often accompanied by instability of the DRUJ. The DRUJ is a diarthrodial trochoid synovial joint between the ulnar head and the ulnar notch on the lower extremity of the radius that ensures pronation-supination and load transmission across the wrist. Post-traumatic and degenerative joint disease of DRUJ

Table 1: Mayo Modified Wrist Score.

Definition	Points
Pain	
No pain	25
Mild, occasional	20
Moderate, tolerable	15
Severe to intolerable	0
Functional status	
Return to regular employment	25
Restricted employment	20
Able to work, but unemployed	15
Unable to work because of pain	0
Range of motion	
≥120°	25
100 to 119°	20
90 to 99°	15
60 to 89°	10
30 to 59°	5
0 to 29°	0
Grip strength (% of normal)	
90 to 100	25
75 to 89	15
50 to 74	10
25 to 49	5
0 to 24	0
Total point scores	
90-100	excellent
80 - 89	good
65 - 79	fair
<65	poor



Figure 1: Patient, male, 55 years old (a) Preoperative X-ray. Widened distal radioulnar joint space and uneven articular surface. (b) Preoperative nuclear magnetic resonance. Articular capsule have high signal area. (c) Radiological result one day after the modified Sauve-Kapandji procedure. The joint surface is smooth and the joints are stable. (d) Radiological result 4 months after the modified Sauve-Kapandji procedure. The joint surface is smooth and the joints are stable.

Table 2: The clinical characteristics of 15 patients (15 wrist).

Characteristics	Number (%)
Age, mean (SD)	40 (10.6)
Sex, no (%)	
Female	5 (33)
Male	10 (67)
Side, no (%)	
Left	6 (40)
Right	9 (60)
Pain (%)	
Moderate	3 (20)
Severe	12 (80)
Associated injuries (%)	
Distal radius malunion	7 (47)
Distal radioulnar joint dislocation	5 (33)
Ulnar styloid fracture	3 (20)

may lead to pain and deformity. DRFs are common injuries that cause pain and disability of DRUJ [10]. Although many advances have been made in the management of DRFs, immobilization is still the only alternative for most of our history. Treatment options include closed reduction and immobilization, closed reduction and percutaneous pinning, external fixation, internal fixation with plates and screws. Although treatment options available are more, the lessons have been learned from [11].

The Sauve-Kapandji procedure is usually useful for treating various pathologic conditions that alter normal function of the DRUJ [12]. In 1936, Sauve and Kapandji presented the procedure, an arthrodesis across the DRUJ and created a pseudarthrosis of the ulna, proximal to the fusion, to restore pronation and supination [13]. This technique preserves the head of the ulna and minimizes the potential for some of the complications that can follow its excision. Surgical indications include post-traumatic DRUJ arthritis, rheumatoid arthritis, and osteoarthritis. The most commonly discussed complication to the Sauve-

Table 3: The details of pre-operative evaluations and final follow-up outcomes in the fifteen patients.

Patient No.	Sex/age (years)	Side	Associated Injuries	Pain		Preoperative ROM (°)		Postoperative ROM (°)		Grip strength (% of normal)		MMW Score		Follow-up Period (months)	Final outcome
				Pre-operative	Post-operative	Extension/flexion	Pronation/supination	Extension/flexion	Pronation/supination	Pre-operative	Post-operative	Pre-operative	Post-operative		
1	m/67y	left	1	Moderate	None	45/50	20/60	60/65	90/90	40	65	35	75	24	Fair
2	m/28y	right	2	Severe	None	50/60	60/60	60/80	90/90	60	90	30	95	20	Excellent
3	f/45y	left	1	Severe	None	50/55	45/45	55/70	90/80	50	88	30	90	15	Excellent
4	m/55y	right	2	Severe	Mild	20/60	30/60	30/90	90/70	55	70	25	80	26	Good
5	m/38y	left	1	Severe	None	40/40	40/60	60/70	90/90	40	92	15	95	12	Excellent
6	f/41y	right	3	Moderate	None	45/60	45/45	45/60	90/75	40	94	40	95	22	Excellent
7	f/51y	right	2	Severe	None	50/60	60/60	60/75	90/80	55	92	30	95	18	Excellent
8	m/33y	right	2	Severe	None	40/30	70/30	65/60	80/90	60	95	20	95	20	Excellent
9	f/30y	right	1	Moderate	None	50/60	60/40	70/60	80/90	50	95	45	95	20	Excellent
10	m/38y	right	1	Severe	None	30/40	70/60	60/65	90/90	40	98	15	95	22	Excellent
11	m/44y	left	3	Severe	None	65/60	30/45	65/60	90/80	45	75	30	85	24	Good
12	m/36y	left	1	Severe	None	40/40	45/60	55/75	90/90	60	96	20	95	24	Excellent
13	m/30y	right	2	Severe	None	40/45	40/45	45/60	80/90	55	93	40	95	18	Excellent
14	f/30y	right	1	Severe	None	60/45	45/60	65/85	90/90	60	90	45	95	18	Excellent
15	m/34y	left	3	Severe	None	40/30	60/40	65/60	90/90	55	90	40	95	16	Excellent

Table 4: Paired samples t test for MMW Score of pre- operative to post- operative.

	Pre- operative	Post- operative	t value	P value
mean±standard deviation	30.67±10.15	91.67±6.56	19.72	0.00

Kapandji procedure is instability of the proximal stump. Different methods of stabilization have been proposed using the pronator quadratus, a slip of the extensor carpi ulnaris tendon (distally based or proximally based), a slip of the flexor carpi ulnaris tendon, or imbrication of the adjacent tissues. More recently some surgeons have tried to control stump instability by using an ulnar head prosthesis seated in a cavity created in the remnant of the ulnar head. Consequently, various modifications have been presented to address these complications. In our current study, we followed 15 wrists in for a mean postoperative follow-up time of 20 months and obtain successful clinical results. In our modified Sauve-Kapandji procedure, DRUJ was stabilized with a single fixed with cancellous bone screw. The ulnar flexor carpi ulnaris and extensor carpi ulnaris can be used to stabilize the proximal stump of the distal ulna in the surgery. Difficulties in surgery, Resection of the synovium of the ulnar radioulnar joint, according to the anatomical position of the distal radioulnar joint to the distal ulna ulnar notch and reset. The surgery is simplified, not into the wrist, saving time and is conducive to DRUJ joint fusion. we believe that our modified Sauve-Kapandji procedure, offers distinct advantages over conventional techniques.

The modification of Sauve-Kapandji procedure is a reliable salvage operation for young active patients with chronic post-traumatic derangement. Mohamed et al [14] reported that eighteen patients with chronic post-traumatic derangement of DRUJ were treated by a modified Sauve-Kapandji operation. The age of patients was 22-45 years. All patients disturbed by pain in DRUJ, limitation of forearm rotation, and diminished grip strength. After the modified operation (with extensor carpi ulnaris tenodesis), 12 patients had satisfactory outcome and four patients presented a fair outcome by using the modified Mayo wrist scoring system.

Stabilization of the proximal ulnar stump associated with Sauve-Kapandji procedure is a useful procedure to prevent an unstable ulnar stump in the treatment of osteoarthritis of the DRUJ. Modifications were performed in order to control stump instability. Surgical interventions, resection arthroplasties, such as the Sauve-Kapandji procedure is one of the selection of operative procedures [15]. Akio Minami et al [16] reported thirteen osteoar-

thritic wrists (8 primary and 5 traumatic) in 8 men and 5 women with an average age of 50 years were treated by the method of stabilizing the proximal stump of the ulna during the Sauve-Kapandji procedure by using a half-slip of the extensor carpi ulnaris.

The Sauve-Kapandji procedure is a common treatment for rheumatoid wrist. Since the Sauve-Kapandji procedure does not fuse the carpal with the forearm bone, it is reasonable to believe, that this procedure alone could not completely to prevent postsurgical progression of carpal translocation. However, the Sauve-Kapandji procedure has an advantage over wrist fusion since this procedure can preserve wrist motion after surgery. We believe that the modified Sauve-Kapandji procedure is still a good option among the currently available surgical treatments for the rheumatoid arthritis (RA) wrist. Satoru Fujita et al [17, 18] reported that the modified procedure, consistent with our surgical approaches, was performed on 56 patients with rheumatoid arthritis. All patients achieved osseous union, wrist pain resolved or decreased, and means total range of forearm rotation increased by 23°. Ota N et al [19] concluded modified Sauve-Kapandji procedure was a useful reconstruction procedure in patients with severe RA with poor bone quality. 29 wrists of 23 patients were performed operation that involves rotating the resected ulnar segment 90 degrees and using it to bridge the gap between the sigmoid notch and the ulnar head. 21 patients had severe RA, 2 had malunited radius fractures. After the 43 months of follow-up, the distal ulna was maintained in the proper position and sufficient ulnar support for the carpus was provided. Kawabata A et al [20] performed a modified Sauve-Kapandji procedure for treating disorders of DRUJ in 32 wrists of 27 RA patients. After operation, the mean follow-up was 93.1 months. The wrist pain reduced and ROM increased significantly regarding pronation and supination but decreased significantly regarding flexion in all cases.. They think this procedure could be applied for DRUJ disorders in RA patients with promising clinical as well as radiographic outcomes over a long period. Yu Sakuma et al [21] retrospectively reviewed radiographs of 40 RA patients who underwent the Sauve-Kapandji procedure or modification-1 (part of the removed ulnar shaft was inserted between the sigmoid notch and ulnar head in order to restore the width of “bony support”) or modi-

fication-2 (ulna head was rotated 90 degrees and its proximal stump was inserted into the distal radius and fixed as previously described). The study indicated that good concordance between the reconstruction of the smoothly curved distal radioulnar head complex and the carpus may be effective in reducing postsurgical carpus translocation after the Sauve–Kapandji procedure.

The modified Sauve–Kapandji procedure is an alternative salvage procedure to restore forearm rotation of revascularized hands. Wang W *et al* [22] evaluated the clinical outcomes in patients with forearm rotation limitation after successful wrist-level revascularization who underwent a modified Sauve–Kapandji procedure. 9 Patients have undergone successful revascularization at the wrist or hand level. The Surgery disturbed the stability of the DRUJ and gave rise to forearm rotational loss. The mean interval from the time of revascularization to reconstruction was 2.5years. A stable DRUJ was achieved by the construction of a quadrilateral frame by performing fusion of the DRUJ and the distal ulna and radius using a bone graft. They reviewed the results of a modified Sauve–Kapandji procedure for patients with forearm rotation limitation and found that good results were achieved.

W. Zhang *et al* [23] performed a wrist arthrodesis reconstruction combining with a modified Sauve–Kapandji procedure for patients with a giant cell tumour of the distal radius. Eight patients underwent en bloc resection and reconstruction. The patients were followed for a mean of 36 months. All patients were recovery of elbow joint function. The mean wrist ROM of the supination and pronation respectively was 75° and 70°. Grip strength reached a mean of 71% of the preoperative grip strength. One patient recurred and was treated by amputation. Radiological union was achieved in the other seven patients in about 8 months. Radiological union was achieved in 7 patients (70%) within a mean of 7.8 months. This operative procedure is an efficient and reasonably straight-forward technique for the treatment of a distal radius giant cell tumor.

The Sauve–Kapandji procedure and modification are excellent options for DRF treatment [24]. The Sauve–Kapandji procedure can be performed for disorders of the DRUJ after all fracture are healed and nonoperative treatment has failed. The main complication of this procedure, if not properly done, is instability of the proximal ulna stump, which is again quite difficult to treat. The two most difficult complications of the Sauve–Kapandji procedure are reossification of the pseudarthrosis site in the ulna and instability of the proximal ulnar stump. To prevent the latter complication, an additional palmar

tenodesis with a distally based tendon strip of the flexor carpi ulnaris was used to stabilize the proximal stump [16]. Specific clinical and radiographic indications for a modified Sauve–Kapandji procedure are post-traumatic osteoarthritis of the joint, chronic irreducible dislocation of the ulnar head with extensive limitation of forearm rotation, posttraumatic synostosis of the distal part of the forearm, simultaneous arthritic or post-traumatic destruction of the sigmoid notch and lunate fossa, and the need for salvage after a failed hemiresection arthroplasty. The modified Sauve–Kapandji procedure involves resection of the distal ulna with reinsertion of the bone into the distal radius after a 90-degree rotation. This provides improved bone stock and allows the procedure to be performed in the setting of destruction of the ulnar head, while potentially reducing the rate of nonunion.

Old fractures of the distal radius are the most important cause that leads to osteoarthritis of DRUJ. Osteoarthritis is a disease of the joints that causes joint pain, stiffness and swelling [25]. Osteoarthritis of DRUJ after post-traumatic is a major cause of pain and disability in the wrist [26]. The appropriate management of DRUJ problems has no consensus. Our experience shows that the modification of Sauve–Kapandji procedure can be successfully used for the treatment of any pathology involving the DRUJ for patients with old fractures of the distal radius.

5 Conclusion

Despite its limitations of the modified Sauve–Kapandji procedure under current medical conditions, 15 wrists of 15 patients in the present study demonstrated marked pain reduction, an improvement in forearm rotation. The modified procedure maintains the ulnocarpal buttress, preserves the triangular fibrocartilage complex and ulnocarpal ligaments, provides a more physiology pattern of force transmission from the hand to the forearm, and maintains the extensor carpi ulnaris tendon in its compartment. The addition of the modified Sauve–Kapandji procedure for osteoarticular reconstruction of the distal radius could improve functional outcomes and decrease the severity of degenerative changes of the wrist. The modified Sauve–Kapandji procedure is now an established treatment option for symptomatic DRUJ dysfunction.

Conflicts of Interest: The authors declare no conflicts of interest.

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