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A modified matti-russe technique for the treatment of scaphoid waist non-union and pseudarthrosis

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A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
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Summary

Background: The aim of this study was to analyze the long-term results of a modified Matti-Russe technique for the treatment of scaphoid non-union and pseudarthrosis. The modification was based on the use of bone graft taken from the ipsilateral distal radius, rather than from the iliac crest, as originally described.

Material/Methods: Between 1987 and 2000, 23 consequent male patients with scaphoid waist non-union or pseudarthrosis underwent surgery by a modified Matti-Russe technique. During the 5-year follow-up, patient evaluation was based on radiological findings and the Green & O'Brien scoring system.

Results: Anatomy was restored and healing of the non-union was achieved in 21 (91.3%) patients. The other 2 patients failed to achieve union and underwent the same operation a second time, which was successful. According to the Green & O'Brien scoring system, 82.6% (19/23) of patients showed excellent results and 17.4% (4/23) showed good results at 2-year follow-up. At 5-year follow-up, 73.9% of patients (19/23) had excellent results and 26.0% (4/23) had good results. No early postoperative complications developed. Two patients demonstrated mild radiological radio-scaphoid arthritis at 2.5 years postoperatively. All patients returned to previous levels of activity.

Conclusions: The standard Matti-Russe technique is an old but reliable and inexpensive method for the treatment of long-standing or neglected scaphoid non-unions or pseudarthroses. The modification of this established method, based on use of the distal radius as a donor site, reduces operative time, can be performed through a single approach, does not show donor site morbidity, and allows the use of regional anaesthesia.

key words: Matti-Russe technique • scaphoid non-union • surgical treatment

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Background

The scaphoid is the most frequently fractured carpal bone, accounting for up to 70% of all carpal bone fractures [1,2]. Almost 90% of these fractures heal after early and appropriate treatment [3]. However, a small but quite important percentage of the scaphoid fractures lead to non-union and pseudarthrosis, as well as radio-scaphoid osteoarthritis and functional deficiency of the wrist [4,5]. A wide variety of methods for treating scaphoid non-union have been described, including surgical techniques (drilling, bone grafting, internal fixation), non-invasive techniques (electrostimulation), or a combination of these methods [6–14]. In the past, the Matti-Russe technique was a widely applied method using iliac autologous bone graft [5,15–17]. However, more recent techniques alternatively use non-vascularised or vascularised bone grafts taken from the distal forearm bones, rather than the iliac crest, for either simple scaphoid non-unions or recalcitrant non-unions [18,19].

This study presents a modified Matti-Russe technique based on the use of bone graft taken from the distal radius, rather than from the iliac crest. The modified technique was applied to a series of patients suffering from scaphoid waist non-union or pseudarthrosis. The aim of this clinical study was to demonstrate the advantages of the modified Matti-Russe technique over the one originally described.

Material and Methods

During the period 1987–2000, 23 male patients with scaphoid waist non-union were treated with a modified Matti-Russe technique. The selection of only male patients was not intended. All patients had an average age at time of operation of 30 years (range 15.6 to 62 years). Scaphoid non-union involved the dominant hand in 78% (18/23) of the patients. The mechanism of the initial scaphoid fracture was sports injury in 9 cases, motor bike accident in 6 cases, work-related accident in 5 cases, and a non-specifically described mechanism in 3 patients. Nine patients were heavy smokers (consumption of more than 1 pack per day) and another 3 were light smokers (consumption of less than 1 pack per day). Twenty patients had been previously treated conservatively for a period of 6–12 weeks with a scaphoid spica, and the remaining 3 patients had a neglected scaphoid fracture that had been left untreated. The interval between the injury and the time of surgical treatment of the scaphoid non-union was on average of 24 months (range 6 months to 7 years). Ten patients were employed in heavy labor and 13 had sedentary office jobs.

Scaphoid non-union was both clinically and radiographically diagnosed. Patients complained of wrist pain and inability to perform any manual work. On physical examination, pain was reproduced during direct compression of the scaphoid or axial loading of the thumb. On plain radiographies, with anterior-posterior and oblique wrist views, as well as clenched fist views, scaphoid non-union was demonstrated with smooth round fracture edges, osteosclerosis and bone cyst formation. According to the Filan and Herbert classification, [20] 1 non-union was stage C (delayed union more than 6 weeks), 19 cases were stage D1 (fibrous healing), and 3 cases were stage D2 (sclerotic margins). We did not identify any cases with developed avascular necrosis of the proximal pole or severe humpback deformity.

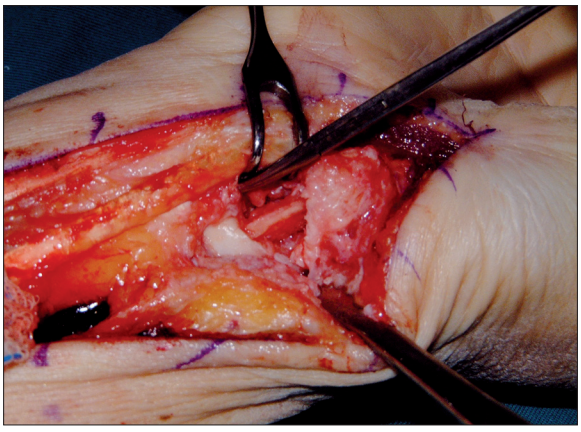

Figure 1. Palmar approach, debridement of the non-union area and rectangular bone peg insertion harvested from ipsilateral distal radius.

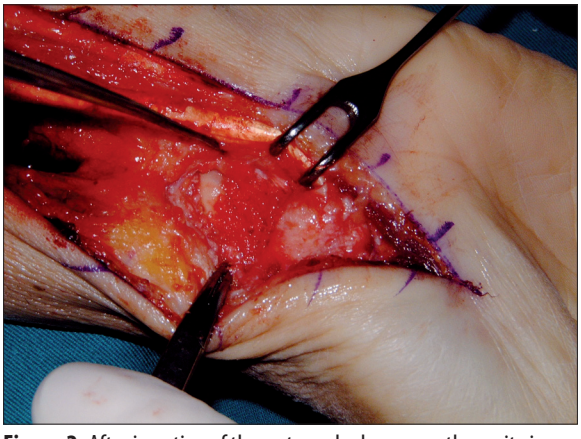

Figure 2. After insertion of the rectangular bone peg, the cavity is filled with autologous cancellous bone.

Technique

Patients were treated by a modified Matti-Russe technique. This modification of the originally described technique was based on bone graft harvesting from the distal radius instead of from the iliac bone. Under regional anaesthesia (interscalene or axillary block), a 4–5 cm incision was made along the radial edge of the flexor carpi radialis and over the tip of the styloid process of the radius. An approach through the flexor carpi radialis tendon and the radial artery was then performed. The palmar joint capsule was then longitudinally divided, and the deep palmar radio-carpal ligaments (radio-scapho-capitae and radio-lunate) were identified. The ligaments were either divided or retracted to gain access to the scaphoid non-union. The non-union was debrided, and an oval-shaped cavity was made with the use of fine osteotomes (Figure 1). In cases in which a satisfactory distraction of the 2 fragments was not possible, a window over the palmar aspect of the non-union was made. The fibrous and sclerotic tissue was removed with the use of a fine burr and rongeur until fresh hemorrhagic cancellous bone was revealed. After the preparation of the scaphoid cavity,

Table 1. Clinical and functional outcome according to Green and O'Brien scoring system modified by Cooney et al. [7].

Category	Findings	Score
Pain (25 points)	No	25
	Occasional	20
	Moderate, tolerable	10
	Severe non tolerable	0
Function (25 points)	Return to work	25
	Inability to work	20
	Able to work but unemployed	15
	Inability to work due to pain	0
Mobility (25 points)	% of the normal	
	100	25
	75–99	15
	50–74	10
	25–49	5
	0–24	0
	Palmar-dorsal arch	
	>120	25
	91–119	15
	61–90	10
	31–60	5
	<30	0
Grip strength (25 points)	% of the normal	
	100	25
	75–99	15
	50–74	10
	25–49	5
	0–24	0

Score		Pre-op	2 years post-op	5 years post-op
Excellent	90–100	0%	82.6% (19/23)	73.9% (17/23)
Good	80–89	0%	17.4% (4/23)	26.0% (6/23)
Moderate	65–79	0%	0%	0%
Poor	<65	100% (23/23)	0%	0%

cortical bone was harvested from the distal end of the radius. The rectangular bone graft was then inserted into the scaphoid cavity so as to keep the 2 scaphoid fragments in appropriate distraction and correct the scaphoid height. Intra-operative radiographs were obtained to check the position of the fracture and confirm that any mild humpback deformity was adequately corrected. The cavity and the initially opened window were also filled with impacted cancellous bone taken from the distal radius (Figure 2). In 4 cases, instability of the 2 scaphoid fragments remained after bone grafting, and osteosynthesis was performed with the use of 2 Kirschner wires (0.9 or 1.1 mm) inserted parallel to the longitudinal axis of the scaphoid [21]. The radio-carpal ligaments and the joint capsule were then repaired. The donor area was not filled with allograft or any synthetic graft. Postoperatively, the wrist was immobilized with plaster, involving the metacarpo-phalangeal joint of the thumb for a period based upon healing of the non-union (2–3 months).

Table 2. Functional evaluation of the wrist when compared to the opposite side (normal side =100%).

Movement (normal average)	Pre-op	2 years post-op	5 years post-op
Dorsal flexion (70°)	68%	61%	62%
Palmar flexion (75°)	75%	69%	68%
Radial deviation (20°)	65%	70%	72%
Ulnar deviation (35°)	76%	81%	84%
Grip strength	48%	82%	80%

Rehabilitation

All patients followed a specific physiotherapy protocol immediately after the operation. The program included finger, elbow and shoulder exercises during the immobilization period. After the clinical and radiological confirmation of bone healing (at 3 months), the cast was removed and the patients were instructed to perform active, passive and assisted active kinesiotherapy of the wrist and forearm. After regaining satisfactory range of movement, the patient followed a muscle strengthening protocol. All patients were allowed to return to heavy manual work and sports after a period of 6 months and by the completion of 3 months after bone healing.

Follow up

All patients were reviewed regularly at the outpatient clinic for a period of 5 years. Evaluation included: a) the functional outcome of the hand based on the Green and O'Brien scoring system modified by Cooney [7] (Table 1); b) the range of motion of the wrist with the use of a goniometer and compared with the range of motion of the other hand (Table 2); c) the grip strength of the hand using a dynamometer and compared with the grip strength of the other hand (Table 2); and d) radiographic criteria. Plain X-rays demonstrated the healing process and the potential development of post-traumatic osteoarthritis (Figure 3). Postoperative CT scans were not considered to be necessary for assessment of the healing. On plain X-rays, bone healing was confirmed

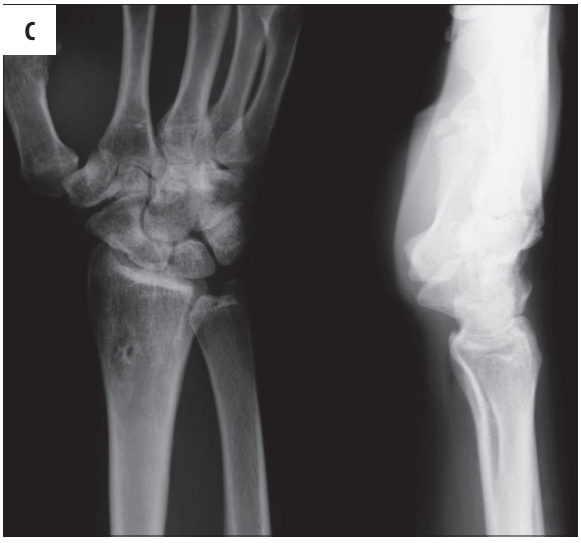

Figure 3. (**A**) Radiographic view of scaphoid non-union. (**B**) Two months post-operatively. (**C**) Four and half years post-operatively.

when fracture site disappeared and cancellous bone was remodeled. Radiographic appearance of osteoarthritis was classified into 3 stages according to its severity: no arthritis, mild arthritis and severe arthritis. A fragment gap or step more than 2 mm was considered as non-acceptable.

Results

Functional outcome

Functional outcome was based on the Green and O'Brien scoring system modified by Cooney [7] (Table1). Six months after surgery, all patients returned to work. Pain relief and limb function were satisfactory. Nineteen patients were asymptomatic, 4 had moderate pain, 8 were experiencing occasional mild pain during manual work, and 3 had sensitivity during forced radial movement of the wrist.

Functional evaluation of the wrist in terms of movement and strength was also evaluated at 2- and 5-year follow-up (Table 2). An overall decrease of dorsal and palmar flexion (or wrist extension/flexion) was noticed when compared to preoperative measurements. The mean dorsal-palmar arch of movement was 120° on average. An overall increase of radial and ulnar deviation was achieved when compared to preoperative measurements. Grip strength was improved at 2-year follow-up, but remained almost invariable at 5-year follow-up. No early complications such as infection, causalgia or donor site morbidity were noticed.

Radiographic evaluation

Twenty-one patients demonstrated radiographic healing (91.3%). In 2 patients (one stage D1-fibrous healing, and the other stage D2-sclerotic margins), the technique failed, and a second operation, following the same surgical principles, was successfully performed. There were no cases of malunion or height loss. Mild osteoarthritis of the radio-scaphoid joint developed in 2 patients at 2.5 years postoperatively, but did not progress significantly at 5-year follow-up (Figure 3).

Discussion

Bone grafting for scaphoid non-union is a widely accepted method, with a high percentage of healing, reaching 90% to 95% [6,9,18–22]. Historically, in 1928, Adams and Leonard [23] used cortical autograft placed between the 2 non-united fragments. In 1936, Matti [15] described a new technique for scaphoid non-union through a dorsal approach, a formation of a cavity between the 2 fragments, and filling of the cavity with cancellous autograft. In 1960, Russe [16] described a palmar approach for the formation of the bone cavity, and filled the cavity with cortical and cancellous autograft. The technique of filling the non-union area with cortical and cancellous autograft through a plantar approach is referred to as Matti-Russe technique [5,17].

With the use of Matti-Russe technique, hardware application is avoided. Thus, the risk of infection is minimized and there is no need for a second operation for hardware removal [24]. Additionally, the palmar approach offers a better view of the non-union area, prevents scaphoid blood supply injury, reduces the risk of avascular necrosis, and retains a greater range of flexion-extension movement. This last advantage of the Matti-Russe technique was also confirmed in our study, with postoperative increase of flexion-extension arch and ulnar-radial deviation.

In the classic Matti-Russe technique, bone autograft is harvested from the iliac crest. This has the increased risk of donor site morbidity such as postoperative pain, infection, scar tissue development [5,16]. In our series of patients, bone graft was harvested from the distal end of the radius through the extension of the initial incision.

A disadvantage of Matti-Russe technique is the long immobilization period of the wrist, which some patients could barely tolerate [5]. In contrast, most osteosynthesis techniques do not require long periods of immobilization [25]. Outdated fixation techniques have a greater percentage of scaphoid non-union, more extended approach for appropriate hardware placement, and long-term complications related to the articular cartilage and the scaphoid blood supply [6,12,25–27]. However, modern fixation techniques are often done percutaneously or arthroscopically, and none of the above mention problems are of major concern [28,29].

In this study, all patients had scaphoid waist fracture. This type of scaphoid fracture, as well as distal pole fractures, indicate the application of the Matti-Russe technique [17]. The long interval of more than 2 years between the injury time and the time of operation is a poor prognostic factor for fracture healing [30]. In our study, however, all patients underwent surgery for scaphoid non-union at an average of 2.5 years after the initial injury. This fact shows that the Matti-Russe method is indicated even for cases neglected for a very long time.

In previous studies, a postoperative mal-reduction and malposition (gap or step greater than 2 mm) led to osteoarthritis of the scapho-lunate and radio-scaphoid joints, despite the radiographic proof of healing [31]. In this study, the anatomic position of the 2 fragments and the restoration of the scaphoid height – as shown in the postoperative radiographs – led to good and excellent functional outcomes. However, we should mention that we had no patients with major humpback deformities, since one criticism of the Matti-Russe approach is that it is not as satisfactory when used in patients with humpback deformity [32].

Clinical evaluation of the patients showed that the postoperative range of movement of the wrist did not improve significantly when compared to the preoperative range of movement. The long period of postoperative immobilization of the wrist may contribute to the limitation of the range of movement. However, the patients were satisfied because they had pain relief, satisfactory function of the wrist, and were able to return to their jobs. Radiographic evaluation showed bone healing in 21 cases (91.3%). Only 2 cases underwent a second operation due to non-union, which was successful. Our results are in accordance with those of previous studies demonstrating that Matti-Russe technique has an 80% to 100% success rate [5,17]. Additionally, our results are comparable to those of other modern techniques that combine bone grafting and hardware fixation [33,34].

Finally, the modified Matti-Russe technique can be combined with the use of Kirschner wire fixation in cases in which bone grafting itself cannot achieve proper stabilization. Use of Kirschner wires for internal fixation has the advantages of lower cost, ease of insertion and accessibility when compared to alternative fixation techniques such as the AO cannulated screw or the Herbert screw. Therefore, our method could become the treatment of choice even in developing countries [18].

On radiographic examination, 2 patients had already developed mild radio-scaphoid osteoarthritis even before the operation. One might think that this fact justifies the application of Matti-Russe technique in cases of mild post-traumatic osteoarthritis. However, the observation that these 2 patients did well postoperatively does not mean that it can be extrapolated that the Matti-Russe technique is indicated in patients with mild arthritis preoperatively. According to other studies, in more severe cases the non-union healing technique could be applied in combination with radius styloid excision [5].

We should mention the 2 limitations of Matti-Russe technique according to previous reports. The first limitation is the use of the technique in patients with scaphoid humpback deformity, where the results were not satisfactory [32]. The second limitation is the use of Matti-Russe in patients with scaphoid-non-unions and avascular proximal pole fragments [35]. However, recently published studies conclude that even vascularized bone grafting did not improve the union rate for scaphoid fracture non-unions with avascular proximal pole fragments [36].

Conclusions

In conclusion, the Matti-Russe technique seems to be a well established method for the treatment of neglected scaphoid waist non-unions and pseudarthroses [37–39]. This technique may be applied even in cases with mild post-traumatic radio-carpal osteoarthritis, but this conclusion could hardly be supported in our study, due to the inclusion of only 2 patients with asymptomatic radiographic arthritis. The original Matti-Russe technique, and the modification described in this study, are both associated with a high percentage of fracture healing, restoration of scaphoid height and satisfactory early functional outcome. What makes the modified technique more attractive than the original one is that it requires only 1 surgical incision, has no donor site morbidity, has low cost and can be performed even under regional anaesthesia.

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