Modified Murray Technique for Carpal Navicular Nonunion

PASQUALE FARSETTI, MD; ROBERTO CATERINI, MD; VITO POTENZA, MD; MASSIMILIANO DRAGONI, MD; ERNESTO IPPOLITO, MD

abstract

The authors report the results of long-term follow-up in 29 patients treated for nonunion of the carpal navicular with a modified Murray technique performed through a lateral approach. Mean patient age at surgery was 22.5 years. Average time from injury to surgery for nonunion was 18 months. In 5 cases, mild signs of osteoarthritis of the radioscapoid joint (scaphoid nonunion advanced collapse [SNAC] stage I) were present before surgery, and in 2 cases, radiographic signs of avascular necrosis of the proximal nonunion fragment were evident. In all cases, a corticocancellous nonvascularized bone graft taken from the distal part of the ipsilateral radius was used. Mean follow-up was 11.2 years. Nonunion had healed in 93.1% of cases. At follow-up, the 2 patients in whom nonunion had not healed had severe painful osteoarthritis of the wrist (SNAC stage IV). Twenty patients were asymptomatic, and 5 had occasional pain in the wrist. Wrist range of motion was restricted in all patients compared with the contralateral side. Mild osteoarthritis was observed in 6 patients (SNAC stage I). The average Disabilities of the Arm, Shoulder and Hand score was 8.7 of 100. The modified Murray technique is reliable for treating nonunion of the carpal navicular. The union rate is high, and the incidence of wrist osteoarthritis is low compared with other studies. Early diagnosis and treatment of nonunion (a short interval between fracture and surgery) can minimize the risk of degenerative joint disease. Avascular necrosis of the proximal fragment is not an absolute contraindication to surgery. [Orthopedics. 2015; 38(9):e766-e772.]
Healing of carpal navicular nonunion is mandatory to avoid progressive osteoarthritis of the wrist. Various surgical techniques have been proposed to treat carpal navicular nonunion, with controversial results. A few long-term follow-up studies investigated the prevalence of wrist osteoarthritis in patients treated successfully for carpal navicular nonunion. However, most of these studies reported patients with scaphoid nonunion treated according to the Matti-Russe technique using the volar approach. To the best of the authors’ knowledge, very few long-term follow-up studies have been reported in patients with scaphoid nonunion treated by other surgical techniques. The current study reported long-term follow-up results in 29 patients treated for carpal navicular nonunion with a modified Murray technique, with emphasis on the incidence of wrist osteoarthritis. Because this surgical technique is based on limited surgical exposure of the articular surfaces of the carpal navicular, it should result in less wrist osteoarthritis.

**Materials and Methods**

From 1991 to 2007, at the authors’ institution, 54 patients were treated with a modified Murray technique for post-traumatic nonunion of the carpal navicular. Fourteen patients were lost to follow-up because they had moved and could not be contacted. The authors located the other 40 patients, but only 29 agreed to return for a follow-up evaluation. Eleven patients declined to return because they lived far away from the hospital, but they reported that they were doing well, without pain or limitation of hand function.

All 29 patients who returned for follow-up were men. In 19 cases, the right side was involved, and the left side was involved in the remaining 10. Mean age at trauma was 21 years (range, 18-28 years). In 14 cases, the navicular fracture had not been diagnosed and thus was not treated at the time of trauma. In 15 cases, the initial treatment was conservative. Nonunion was located in the proximal third of the bone in 13 cases and in the middle third in 16 cases. In 21 cases, nonunion appeared stable either without displacement or with only mild displacement. In 8 cases, displacement was marked and nonunion was considered unstable. In 2 cases, radiographic signs of avascular necrosis of the proximal nonunion fragment were observed. In 5 cases, mild signs of degenerative osteoarthritis of the radioscapophoid joint (scaphoid nonunion advanced collapse [SNAC] stage I) were present, and in all of these cases, the fracture had been misdiagnosed. Mean age at surgery was 22.5 years (range, 20-30 years). Average time from injury to surgery for nonunion was 18 months (range, 12-42 months). Mean follow-up was 11.2 years (range, 7-21 years).

All patients were operated on according to the Murray technique as modified by the authors. A lateral incision was made, extending from the anatomic snuffbox to the metadiaphyseal margin of the lateral distal radius. In 14 patients, the radial styloid was partially excised, the distal nonarticular portion of the scaphoid was exposed, and a tunnel was drilled with a cannulated drill (4-mm diameter) into the bone across the nonunion line under the image intensifier. The length of the tunnel was measured, and a corticocancellous bone graft of the proper size was harvested from the distal radius with the same incision and then inserted into the tunnel. The nonunion tissue was never excised, except for the portion crossed by the tunnel. In 13 patients treated before 1998, the nonunion was further stabilized by a Kirschner wire. In patients treated later, it was stabilized with a noncannulated (4 patients) or cannulated (12 patients) Herbert screw passed through parallel to the graft (Figure 1).

After surgery, in the patients stabilized with a Kirschner wire, the wrist was immobilized in a short arm cast with the first ray included for a mean of 12 weeks. In the patients stabilized with a Herbert screw, the cast was maintained for only 4 weeks. The wrist was further immobilized with a brace for another 4 weeks in only the patients treated with a Herbert screw.

At follow-up, all patients were examined both clinically and radiographically. Clinical examination included evaluation of pain (at rest and after prolonged use of the hand in either work or sport activity), range of motion of the wrist, and grip strength. The Disabilities of the Arm, Shoulder and Hand (DASH) scale was also used. Radiographic examination focused on healing of the nonunion and the presence of osteoarthritis of the wrist, classified according to Watson and Ballet. The 2 senior authors (P.F., E.I.) analyzed the radiographs at follow-up to evaluate the stage of SNAC.

Statistical analysis was performed with Student’s *t* test, and *P*<.05 was considered statistically significant.

**Results**

At follow-up, nonunion had healed in 27 cases (93.1%) at an average time span of 3.8 months (range, 3-6.5 months) and was still present in 2 cases (6.9%).

Twenty patients were asymptomatic and were able to use their operated on hands even for heavy manual activities (hobbies and work). In these 20 patients, no statistically significant difference was present between wrist range of motion preoperatively and at follow-up. However, on average, range of motion was restricted compared with the contralateral side (flexion-extension, -14°; radial-ulnar deviation, -4°). Pronation and supination of the affected forearm were equal compared with the contralateral side. Grip strength of the affected hand was normal compared with the opposite side. Radiographic examination of these 20 patients showed healing of the nonunion without osteoarthritis.

Five patients had occasional pain in the wrist after heavy manual activity. These 5 patients did not have a statistically signifi-
cant difference between range of motion of the wrist before surgery and at follow-up. However, in both cases, range of motion was restricted compared with the contralateral side (flexion-extension, -23°; radial-ulnar deviation, -7°). Pronation and supination of the affected forearm were equal compared with the contralateral side. Grip strength on the affected side was statistically reduced compared with the nonoperated wrist. Radiographic examination showed that mild osteoarthritis of the radioscaphoid joint (SNAC stage I), present before surgery, had not worsened at follow-up (Figure 1).

Two patients had avascular necrosis of the proximal fragment. In 1 of them, avascular necrosis appeared 2 months after surgery, but spontaneously disappeared in the subsequent months, with complete healing of nonunion. At follow-up 21 years after surgery, mild osteoarthritis of the wrist (SNAC stage I) was present, but the patient was pain free and wrist range of motion showed only a slight restriction of extension (Figure 2). In the other case, avascular necrosis of the proximal fragment was present before surgery, but disappeared after treatment, with nonunion healing. At follow-up 11 years after surgery, no osteoarthritis of the wrist was present, the patient was pain free, and wrist range of motion was normal compared with the contralateral side.

Two patients had nonunion at follow-up, associated with severe osteoarthritis of the radiocarpal and carpal joints (SNAC stage IV). Both patients had severe pain in the wrist, with deficit of grip strength and severe restriction of overall range of motion of 65° in 1 patient (flexion, -45°; extension, -20°) and 70° in the other patient (flexion, -40°; extension, -30°).

For all patients, the average DASH score was 8.7 of 100 (range, 0-58.5).

No statistically significant difference in clinical and radiographic results was noted between nonunion stabilized by a Kirschner wire and nonunion stabilized by a Herbert screw.

**Discussion**

There is general agreement that post-traumatic nonunion of the carpal navicular should be treated surgically, even in asymptomatic cases, because degenera-
tive osteoarthritis of the wrist is likely to occur.\textsuperscript{1,2,4,28,36-40} However, it is unknown whether treating asymptomatic nonunion prevents or slows the progression of degenerative wrist osteoarthritis, even when union is achieved.\textsuperscript{7,41}

Several authors investigated degenerative osteoarthritis of the wrist after surgical treatment of carpal navicular nonunion performed according to the Matti-Russe technique (volar approach). Stark et al\textsuperscript{28} reported radiographic degenerative osteoarthritis in 18 of 27 cases (66.6\%) at an average follow-up of 12 years; the union rate was 81\%, and average time from injury to surgery was 40 months. In a long-term review of 77 cases followed for 22 to 34.8 years after surgery, Hooning van Duyvenbode et al\textsuperscript{29} reported an incidence of 64\% for mild osteoarthritis and 20\% for severe osteoarthritis of the radiocarpal joint. In this study, the union rate was 80\% and average time from injury to surgery was 33 months. In a series of 25 patients followed for an average of 11 years after surgery, Jiranek et al\textsuperscript{30} reported a slight progression of wrist osteoarthritis in 56\% of cases; the union rate was 81\%, and average time from injury to surgery was 38 months. Martini and Otto\textsuperscript{31} reported a 69\% incidence of degenerative osteoarthritis in 55 patients at a mean follow-up of 10.7 years. In a 12-year follow-up study, Daecke et al\textsuperscript{32} observed radiographic signs of osteoarthritis in 8 of 35 patients (23\%) treated by bone graft and a Herbert screw. A volar approach was used in most cases. These patients had no preoperative degenerative changes. Moreover, in 15 other patients who had osteoarthritis at the time of surgery, the osteoarthritis remained unchanged in 9 patients and increased in severity in 6. The union rate was 84\%, and average time from injury to surgery was 50 months. In a 10-year follow-up review of 39 cases, Finsen et al\textsuperscript{33} reported an incidence of osteoarthritis of 20\%. In this study, the union rate was 89.7\% and average time from injury to surgery was 18 months. In a 12.2-year follow-up study in 50 patients treated with different surgical procedures (palmar, dorsoradial, or dorsal approach), Reigstad et al\textsuperscript{34} reported degenerative changes of the wrists in 39\% of patients. The union rate was 90\%, and average time from injury to surgery was 31 months.

In the current 11-year follow-up study, in which all patients were treated according to a modified Murray surgical technique, at follow-up, only 6 patients (20.6\%) showed mild signs of degenerative osteoarthritis at the radioscaphoid joint (SNAC stage I). In 5 cases, these signs were present before surgery and did not worsen after treatment. These results might be related to the limited surgical exposure of the articular surfaces of the carpal navicular compared with the Matti-Russe surgical technique, which requires
extensive exposure of these surfaces to create a slot for the bone graft. The Matti-Russe surgical technique seems to be more invasive and could jeopardize the articular surfaces of the carpal navicular, predisposing the patient to degenerative osteoarthritis.

In a long-term follow-up study, Cooney et al\textsuperscript{14} compared the results obtained in 90 nonunions of the carpal navicular treated with 4 different surgical techniques, reporting only a 50\% union rate in 18 nonunions treated according to the Murray technique. A possible cause of this discouraging result is that the authors did not stabilize the nonunion site during the surgical procedure in most cases (78\%). On the other hand, the current series, in which all cases were stabilized with a Kirschner wire or a Herbert screw, achieved a 93.1\% union rate.

No statistically significant difference was observed in range of motion measured before surgery and at follow-up; however, similar clinical results have been reported.\textsuperscript{32}

Grip strength of the operated on hand was normal in asymptomatic patients, whereas it was reduced compared with the contralateral side in patients with pain and SNAC. There may be a correlation between pain or osteoarthritis and grip strength. However, other authors did not report a correlation.\textsuperscript{34}

In the current study, the union rate was 93.1\%, similar to that reported in other long-term follow-up series. In the current study as well as in other studies, the worst results were observed in all cases in which union failed.\textsuperscript{32-34} In the current study, severe wrist degenerative osteoarthritis (SNAC stage IV) occurred in the only 2 patients with persistent nonunion at follow-up.

In the current study, average time between fracture and surgery for nonunion was 18 months. Other long-term follow-up studies reported a longer average interval between fracture and surgery, ranging from 18 to 50 months, with an average of 35 months.\textsuperscript{28-30,32-34} In the current study and in other studies, the incidence of wrist osteoarthritis increased at follow-up with increasing interval between fracture of the carpal navicular and surgery for nonunion.\textsuperscript{31,34} Therefore, a possible reason for the current satisfactory results may be the short interval between fracture and surgical treatment of nonunion.

Avascular necrosis of the proximal fragment, if associated with nonunion, is not an absolute contraindication to surgery. In 2 patients in the current study, avascular necrosis disappeared after surgery.\textsuperscript{37,42-47} On the other hand, severe degenerative osteoarthritis of the wrist rules out surgical treatment of nonunion.\textsuperscript{9,37,48} and different surgical techniques are indicated, such as proximal row carpectomy\textsuperscript{49} or scaphoid excision and 4-corner fusion.\textsuperscript{50} However, recently, Kent et al\textsuperscript{51} studied 13 patients with arthritis of the wrist associated with scaphoid nonunion who were treated by internal fixation and bone graft. Of the 13 patients, 10 achieved bone union, and 9 of them showed improvement on DASH score. The authors concluded that surgery for nonunion may be considered before salvage surgical procedures. Reigstad et al\textsuperscript{14} agreed with this indication and concluded that an old nonunion with mild radiographic signs of arthritis could be surgically treated as a recent nonunion, with internal stabilization and bone graft.

The iliac crest is the most common donor site to obtain a free bone graft for treatment of scaphoid nonunion. However, this surgical technique is often complicated by hematoma, persistent pain at the donor site, a scar, and paresthesia.\textsuperscript{52-54} All of the current patients had a corticocancellous bone graft taken from the distal part of the radius, without significant complications. Moreover, in a prospective randomized study in patients treated surgically for scaphoid nonunion, Garg et al\textsuperscript{27} compared 2 series of 50 patients, both stabilized by internal fixation. The first series of patients underwent distal radius bone graft, and the second underwent iliac crest bone graft. At follow-up, the authors observed no statistically significant differences between the 2 series in functional scores and union rate. They found no advantage of the use of the iliac crest over the distal radius graft to justify its greater morbidity. However, in short-term follow-up studies, some authors recently reported good results with vascularized bone graft and recommended this surgical option in patients with old nonunion or proximal pole nonunion.\textsuperscript{6,25,55,56}

In the current series, nonunion was stabilized with a Kirschner wire in all patients treated until 1998, and a Herbert screw was used in patients treated more recently. Although no statistically significant difference was observed between the 2 groups in the final result, in accordance with several reports,\textsuperscript{32,57-60} the current authors believe that the cannulated Herbert screw may be considered the best device for internal fixation to stabilize nonunion because it reduces the time of postoperative cast immobilization and better stabilizes the nonunion site. In the current series, the time of cast immobilization was reduced from 12 weeks to 4 weeks. The importance of stabilization of the nonunion site was recently emphasized by authors who used 2 small headless screws in addition to bone grafting.\textsuperscript{61} However, recently, Reigstad et al\textsuperscript{13} reported good results with Kirschner wires and bone grafting, demonstrating that their method is reliable and inexpensive.

**Conclusion**

This long-term follow-up study investigated the occurrence of osteoarthritis of the wrist after a modified Murray surgical procedure. Although the study was retrospective, it showed encouraging results. Although the operation may be technically demanding, especially when the proximal fragment is small, it seems to reduce the risk of osteoarthritis of the wrist compared with other surgical techniques. The union rate is high, comparable with other studies. Early diagnosis and treatment of
nonunion (a short interval between fracture and surgery) can minimize the risk of degenerative joint disease.

REFERENCES


