A Modified Surgical Technique for Minimally Invasive Arthroscopic Total Wrist Fusion

Shahram Nazerani, MD¹ Tina Nazerani² Alireza Molayem, MD¹ Mohammad Reza Keramati, MD³

¹Department of Surgery, Mehr General Hospital, Tehran, Iran

²Faculty of Medicine, Karl Josef Medical University, Graz, Austria

³Department of Surgery, Tehran University of Medical Sciences, Tehran, Iran

Address for correspondence: Mohammad Reza Keramati, MD, Department of Surgery, Tehran University of Medical Sciences, Keshavarz Boulevard, Imam Khomeini Hospital Complex, Tehran, Iran (e-mail: dr_morezak@yahoo.com).

J Wrist Surg 2019;8:84–88.

Abstract

Background Arthroscopic total wrist arthrodesis is a procedure with minimal violation of extensor compartments and less scar formation, compared with open wrist arthrodesis. In this paper, we would like to present our experience with a modified surgical technique for arthroscopic total wrist arthrodesis.

Description of Technique After an arthroscopic cartilage removal through radio-carpal and midcarpal portals, the operation is continued under fluoroscopic control. In this technique, four wires are inserted separately in four various directions (as described in the paper), followed by insertion of self-tapping cannulated screw, under fluoroscopic control.

Patients and Methods In this prospective study, a total of four patients underwent arthroscopic total wrist arthrodesis using our surgical technique within a period of 2 years. All four patients were followed for a minimum of 3 months for possible complications and functional outcome.

Results The results were satisfactory, and no complication was observed. All the patients had complete union after 12 weeks, and the fusion was radiographically complete in all cases by 12 weeks. All patients were happy with their functional outcomes.

Conclusion Using the described modified arthroscopic technique, we did four total wrist arthrodeses with minimal scar, no complication and acceptable functional results.

Keywords

- wrist
- arthrodesis
- arthroscopy

Steindler in 1918 published the concept of wrist arthrodesis for stabilization in patients with polio and spastic hemiparesis.¹ The open total wrist arthrodesis has evolved to the current dorsal approach and different plating techniques and intramedullary pin fixation.^{2–5} In 2009, Terzis et al proposed total wrist arthrodesis in patients with brachial plexus palsy as a complementary procedure in brachial plexus injuries for improvement of overall upper limb function and appearance.⁶

Open total wrist arthrodesis can have negative effects on a functionally compromised hand by causing adhesion of the extensors. Sometimes, the hardware needs to be removed, and this also can add to the previous problems and possible

damage to tendons (►Fig. 1). Carpal tunnel syndrome is another late complication of open wrist arthrodesis and can be seen in nearly 10.5% of patients, and approximately 67% of them require carpal tunnel release.⁷

Arthroscopic total wrist arthrodesis is a procedure with minimal violation of extensor compartments compared with open wrist arthrodesis, in which a long incision from distal forearm to proximal hand; it can lead to a cosmetically more acceptable scar formation. In this study, we would like to present our experience and surgical technique for arthroscopic total wrist arthrodesis with very satisfying results. This technique presents our preferred method of wrist fixation.

received

April 30, 2018

accepted

July 30, 2018

published online

September 18, 2018

Copyright © 2019 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
Tel: +1(212) 584-4662.

DOI <https://doi.org/10.1055/s-0038-1669918>.
ISSN 2163-3916.

Fig. 1 Dorsal open approach resulted in a large scar, and inadvertent bone removal.

Surgical Technique

The cartilage of scaphoid and lunate fossa of the radius and also the cartilage of the scaphoid and lunate bone near the radius fossae are removed. The joints in the midcarpal space are then addressed. Afterward, the cartilages are removed from lunate, scaphoid, capitate and trapezoid, and part of the hamate (►Fig. 2). ►Fig. 3 presents arthroscopic views of radiocarpal and midcarpal joints, before and after cartilage ablation. Although, the arthroscopic cartilage ablation is a time-consuming procedure, preserving the Gilula's lines can be helpful during the fixation. Of the five articulations which need to be removed (i.e., radiolunate, radioscapoid, luno-capitate, scaphocapitate, and third carpometacarpal), the third carpometacarpal joint is inaccessible by arthroscopy, and this joint will be fixed by a screw.

We used four different methods of fixation in our patients, including a central pin and cannulated lag screws, headless

Fig. 3 Arthroscopic views of radiocarpal joint. (A) Normal cartilage; (B) cartilage is shaved and the bone is exposed; (C and D) cartilages of the midcarpal bones were removed.

screw fixation and cannulated screws; and in the fourth patient, we have devised a fixation method, which seems to have all the requirements of a complete five articulation fixation (►Fig. 4). To perform this fixation, we used a long 2.7 mm cannulated screws, as lag screws do not have enough performance in the spongy wrist bones. This type of screw, full threaded, can have the best results by fixing all five articulations needed for a total wrist arthrodesis.

After completion of arthroscopic cartilage removal through radiocarpal and midcarpal portals, using 2.5 and then 3.2 mm burrs, the operation is continued under fluoroscopic control. First, a guide wire is inserted from radius into the scaphoid and onward to the third metacarpal head; then, a self-tapping cannulated screw is inserted and fixed under fluoroscopic control (►Fig. 5A and B). The second guide wire is then inserted the same way as the first one. The pin will be passed from radius to lunate and capitate and the second self-tapping cannulated screw is inserted afterward (►Fig. 5C and D).

Fig. 2 Cartilages are removed under arthroscopic view (A and B).

Fig. 4 Different forms of screw fixation used for wrist arthrodesis in our patients, (A–D) Patients no.1–4; (E) Lateral view after arthroscopic wrist fusion.

In this stage, through a small incision near the second web space, a tunnel is created between the interosseal muscles. In a plane, deep enough to reach the space between the second and third metacarpals, the third guide wire is inserted from this point through the carpal bones and into the radius. The third cannulated screw is then inserted and fixed (► Fig. 5E and F). Finally, through the third web space, a new tunnel is created, and the fourth cannulated screw is inserted parallel to the previous one. These screws must be inserted as deep as possible, until they have passed the radiocarpal joint (► Fig. 5G and H).

Patients and Methods

In this prospective study, a total of four patients underwent arthroscopic total wrist arthrodesis, using our surgical technique within a period of 2 years. This study has been approved by the ethics committee of the university. All patients were informed, and written consent was taken. ► Table 1 shows demographic data, etiology, and final diagnosis in each patient.

The fourth patient in this series was operated with the same idea described above, but with a small difference. Due to

undesirable insertion of the first screw, we were unable to insert the second one from proximal to distal, and had to insert the last screw in a reverse manner, from distal to proximal. It is very important that the screws pass parallel and grip all the bones, from which the cartilage is removed (► Fig. 4D).

The wounds were closed with sterile adhesive tapes. A short forearm plaster cast was applied, which was removed after radiographic signs of complete fusion in 8 to 10 weeks. For the patient with cerebral palsy, we recommend a longer casting period, due to the spastic nature of the disease. We also recommended wrist support at night and in rest for 6 months.

Results

All four patients were followed for a minimum of 3 months. The results were satisfactory, and no complication was observed. All the patients had complete union after 12 weeks, and the fusion was radiographically complete in all cases by 12 weeks. The cosmetic appearance was far superior to open total wrist arthrodesis, because of less scar formation. In men, the small surgical scars can be hidden by the dorsal hand hair (► Fig. 6).

Fig. 5 A total of four pins followed by four long screws are inserted. (A) First pin; (B) first screw; (C) second pin; (D) second screw; (E) third pin; (F) third screw; (G) fourth pin; (H) fourth screw.

Discussion

In cerebral palsy and brachial plexus traction injuries, the wrist can be a “thief of the hand function.” In the absence of wrist flexors and extensors, all the forces from finger extensors and flexors are “robbed” by the wrist, and when the wrist is fixed in neutral position, the hand function is improved (► Fig. 7).

The indications of wrist arthrodesis are numerous, including cerebral palsy, arthrosis of the radiocarpal and midcarpal joints failed limited arthrodesis, and failed total joint or previous arthroplasty. It can also be done during other operations for brachial plexus injuries.⁸

Table 1 Demographic data, etiology, and final diagnosis of patients

Gender	Age (y)	Etiology	Diagnosis	Complete fusion (wk)
Male	25	Road traffic accident	Brachial plexus traction injury	8
Male	55	Road traffic accident	Brachial plexus traction injury	11
Female	23	Birth trauma	Cerebral palsy	12
Male	28	Road traffic accident	Brachial plexus traction injury	10

The greatest functional problem in total wrist arthrodesis will be lifting objects from a low table and using a screwdriver. Nelson et al used splints, mimicking arthrodesis, on normal subjects and demonstrated that 123 activities of daily life could be performed by minimal, 5 to 7 degrees, wrist joint motion.⁹

The open surgical technique with violation of dorsal compartments of the hand can have negative effects on a functionally compromised hand. A second procedure for hardware

Fig. 6 Incisions of arthroscopic wrist arthrodesis are minimal and may be hidden by dorsal hand hair in men.

Fig. 7 Cerebral palsy in an adult. The patient has no functional use of the hand due to an ineffective flexion and extension of the fingers. After wrist arthrodesis, the patient can flex the fingers and grasp objects.

removal and the possibility of carpal tunnel syndrome are some of the disadvantages of open total wrist arthrodesis, compared with arthroscopic technique. The incidence of carpal tunnel syndrome after AO plate fusion in open wrist arthrodesis is as high as 10.5%, with approximately 67% of the patients requiring carpal tunnel release.⁷ Therefore, in this paper, we described our experience of a modified arthroscopic technique for total wrist fusion.

Moreover, in the open surgical method, removing the cartilage and bone, especially by hand instruments, such as Chisel and Rongeurs can lead to excess bone removal, necessitating bone graft. As the contour of Gilula's lines is preserved in this technique, bone graft is not needed for fusion here.

Wrist arthrodesis is an accepted procedure in several upper extremity situations. We have done arthroscopic total wrist arthrodesis with a minimal scar and acceptable functional results. A fixation method for wrist arthrodesis was proposed in this paper, which can be added to the armamentarium of the hand surgeon.

Authors' Contributions

All authors have contributed equally in all parts of this research.

Note

This study was conducted in Mehr General Hospital, Tehran, Iran.

Funding

None.

Conflict of Interest

None.

References

- 1 Steindler A. Orthopaedic reconstruction work on hand and forearm. *New York Med J* 1918;108:1117–1119
- 2 Wagner ER, Elhassan BT, Kakar S. Long-term functional outcomes after bilateral total wrist arthrodesis. *J Hand Surg Am* 2015;40(02):224–228
- 3 Wei DH, Feldon P. Total wrist arthrodesis: indications and clinical outcomes. *J Am Acad Orthop Surg* 2017;25(01):3–11
- 4 Addosooki A, Doi K, Hattori Y, Wahegaonkar A. Wrist arthrodesis after double free-muscle transfer in traumatic total brachial plexus palsy. *Tech Hand Up Extrem Surg* 2007;11(01):29–36
- 5 Koman LA, Gelberman RH, Toby EB, Poehling GG. Cerebral palsy. management of the upper extremity. *Clin Orthop Relat Res* 1990; (253):62–74
- 6 Terzis JK, Barmptsioti A. Wrist fusion in posttraumatic brachial plexus palsy. *Plast Reconstr Surg* 2009;124(06):2027–2039
- 7 Hastings H II, Weiss AP, Quenzer D, Wiedeman GP, Hanington KR, Strickland JW. Arthrodesis of the wrist for post-traumatic disorders. *J Bone Joint Surg Am* 1996;78(06):897–902
- 8 Rizzo M, Ackerman DB, Rodrigues RL, Beckenbaugh RD. Wrist arthrodesis as a salvage procedure for failed implant arthroplasty. *J Hand Surg Eur Vol* 2011;36(01):29–33
- 9 Nelson DL. Functional wrist motion. *Hand Clin* 1997;13(01):83–92