

Elbow Arthrodesis after War Injuries

Guarantor: Ranko Bilic, MD PhD

Contributors: Ranko Bilic, MD PhD; Robert Kolundzic, MD; Goran Bicanic, MD; Kresimir Korzinek, MD PhD

Arthrodesis is a surgical procedure that results in fusion of the joint and bony ankylosis. With this operation, we can achieve satisfactory function of the limb in cases in which options for different treatments no longer exist. Severe joint destruction, joint infections, and nonunions, as well as complex war injuries (with large bone and soft tissue defects), are indications for arthrodesis. The elbow is the most susceptible joint of the upper limb to war injury. Between 1992 and 1995, we performed elbow arthrodesis for nine patients in our department after war injuries. As analysis of our results shows, elbow arthrodesis, although a rarely performed surgical procedure, is the best treatment for patients with complex war injuries of the elbow. For arthrodesis, we used external fixation in combination with internal fixation (cancellous bone screw) and additional autologous cancellous bone grafts.

Introduction

Elbow arthrodesis is a rare surgical procedure that results in bony ankylosis (bony overgrowth of the joint). Satisfactory upper limb function can be achieved for patients with painful and minimally mobile elbows or patients with large defects of the elbow joint.¹ Extra-articular and intra-articular techniques, as well as combinations of those techniques, have been described in the literature.¹⁻¹¹ Extra-articular techniques have been used only with large chronic elbow defects.^{1,9,10} The descriptions of earlier techniques included local and free bone transplants with only 50% bony ankylosis of the elbow.² Along with improvements in external and internal fixation, new techniques for intra-articular elbow arthrodesis were developed.^{4,6} Methods that are now used include external fixation alone or in combination with internal fixation (with cancellous bone screws or compression screws) or solely internal fixation with a plate (with or without compression screws).³ The results of these techniques proved to be much better (between 50% and 100% bony ankylosis) and healing times much shorter.^{4,5,12,13} Mueller et al.⁶ described an intra-articular technique for elbow arthrodesis with resection of all three elbow joint surfaces (humerus, ulna, and radius) and a combination of external and internal fixation (compressive osteosynthesis with external fixation and an axial cancellous bone screw with washer). The war in the Republic of Croatia caused an increase in the number of elbow injuries. We used the Mueller technique for elbow arthrodesis, combined with autologous cancellous bone grafts (from the iliac bone), when large bone defects were present. In this article, we present this modified procedure and the results after surgery.

Department of Orthopaedic Surgery, Clinical Hospital Centre Zagreb, School of Medicine, University of Zagreb, Salata 7, 10000 Zagreb, Croatia.

This manuscript was received for review in June 2003. The revised manuscript was accepted for publication in March 2004.

Reprint & Copyright © by Association of Military Surgeons of U.S., 2005.

Methods

Patients and Assessments

The study was a records review study, in which we analyzed the results after elbow arthrodesis for patients treated in the Department of Orthopaedic Surgery, School of Medicine, University of Zagreb. Patients were initially treated at the injury site (mostly first lines of fire), where primary wound treatment and temporary immobilization with a CMC external fixator¹⁴ were performed. All patients were treated for war-related elbow injuries. Indications for the operation were complex comminuted fractures and nonunions after primary immobilization. Postoperative X-rays were taken, and bone fusion was observed. After the records review, all patients were invited for a clinical examination. Control X-rays were taken during the examination, and patient satisfaction and functioning in everyday activities were evaluated. For patient satisfaction, the following gradation was used: very satisfied, satisfied, or unsatisfied. For functioning in everyday activities, the following gradation was used: no restriction, mild restriction, severe restriction, or incapable. No restriction or mild restriction was considered a good result, severe restriction was considered a satisfactory result, and incapable of everyday activities was considered a poor result. For pain evaluation, a visual analog scale was used (0 points, no pain; 10 points, worst pain ever).

Operative Technique

A tourniquet is used for the surgical procedure. We use a posterior approach for the elbow exposure. After exposure, resection of the distal humerus and olecranon is performed, followed by resection of the head of the radius just above the insertion of the biceps muscle. After remodeling of the resected surfaces, two Schanz screws are drilled into the humerus and two into the ulna. The proximal humeral Schanz screw is connected to the distal ulnar Schanz screw with one bar, and the distal humeral screw and the proximal ulnar screw are connected with another bar. The bars are then connected together, for better fixation of the whole construction (Fig. 1). After external fixation is completed, internal fixation with a cancellous bone screw and washer is applied (Fig. 2). Before final tightening of the screw and final compression between the Schanz screws, autologous cancellous bone from the iliac bone is inserted between and around the resected surfaces. Postoperative treatment is based on finger exercises, which start on the first day, and shoulder and wrist exercises, which start on the third postoperative day.

Results

A total of nine patients were surgically treated. There were eight men and one woman, with a mean age of 29.7 years (range, 22-40 years). Indications for the operation were complex com-

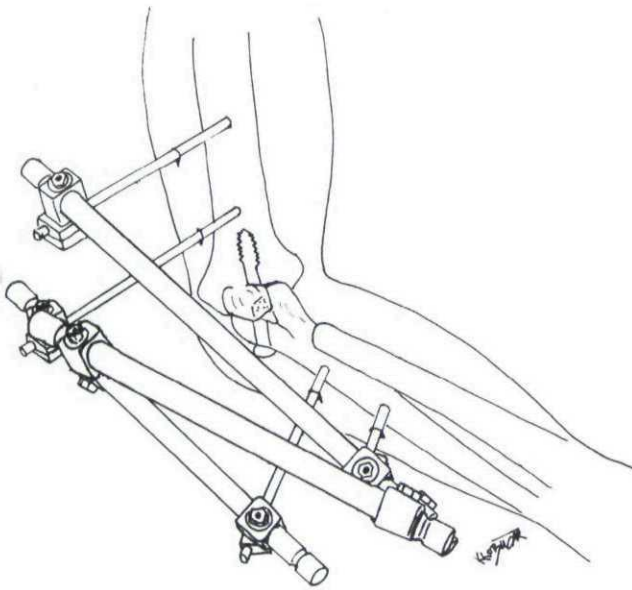


Fig. 1. External fixation device.

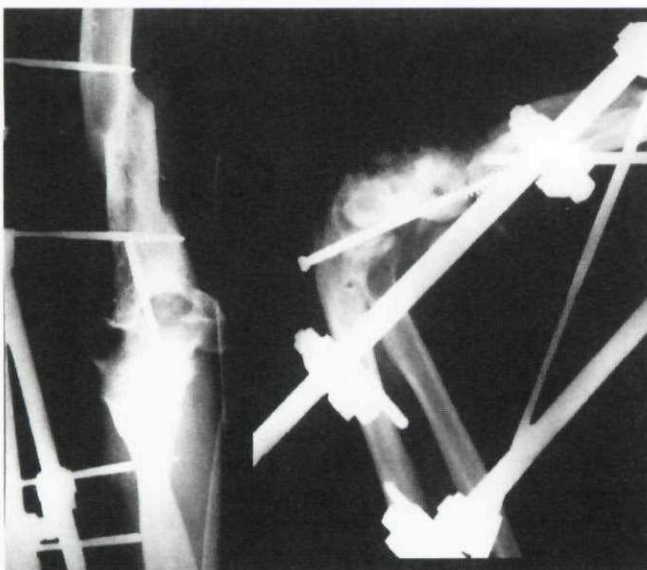


Fig. 2. X-rays obtained immediately after elbow arthrodesis, with combined external and internal fixation (left, anteroposterior projection; right, left lateral projection).

minuted fractures for four patients and nonunions for five patients. The operation was performed an average of 8.5 months after the primary war injury (range, 3 weeks to 37 months). Follow-up periods were 8 to 11 years.

The wounds were primarily infected for three patients (two patients with *Pseudomonas* and *Proteus* and one patient with *Acinetobacter* sp.), but infections were treated before the elbow arthrodesis. Temporary fixation with a CMC fixator was performed for six patients. External fixation in combination with cancellous bone screws was used in seven cases, and external fixation alone was used in two cases. The median elbow joint position was 90 degrees of flexion (average, 88 degrees; range, 60–100 degrees). X-ray analyses showed that the shortest period necessary for fusion of the elbow (bony ankylosis) was 5

months and the longest was 7.5 months. The average time necessary for fusion (bony ankylosis) after elbow arthrodesis was 6 months 10 days (Fig. 3). The external fixator was left in place an average of 12.5 months (range, 9–15 months). Revision operations were performed in two cases; we performed rearthrodesis in one case (because of nonunion after arthrodesis) and refixation with new Schanz screws in the other (because of loosening of the originally placed Schanz screws). In the second case, repositioning of the ulnar nerve was also performed because of the cubital tunnel syndrome (ulnar nerve compression was seen). Long-term follow-up monitoring (8–11 years) showed no complications (no loosening and no infections). All patients were very satisfied or satisfied with the results, and eight of nine patients had good results regarding everyday activities. For one patient, satisfactory results regarding everyday activities were achieved.

Discussion

War-related elbow injuries, because of their complexity (large bone defects, large soft tissue defects, and wound contaminations) and because mainly younger populations are affected, demand fast definitive treatment. For these large, open, intra-articular fractures (after trauma or wounding) associated with excessive bone and soft tissue loss, elbow arthrodesis is a method of choice (Fig. 4). During the decision-making process regarding elbow arthrodesis, one must take into account medical and occupational indications, the age of the patient, and the condition of nearby joints that will partially take over the function of the elbow. Candidates for elbow arthrodesis are younger patients with greater need for strength and stability of the arm.^{2,15} Arthrodesis is commonly used in cases in which the elbow is painful and minimally mobile or in which complications or failure of other surgical procedures⁴ is expected.

Elbow arthrodesis is also a method of choice for the treatment of complications of septic or tuberculous arthritis when extensive destruction of joint surfaces occurs.^{4,16} Post-traumatic el-



Fig. 3. X-rays obtained 2 years after elbow arthrodesis, showing total bony overgrowth in 90 degrees of flexion. The cancellous bone screw is not removed, because of possible extensive bone destruction during removal and weakening of the arthrodesis (left, anteroposterior projection; right, left lateral projection).



Fig. 4. X-rays for a 23-year-old, Croatian Army soldier, showing significant elbow destruction with a humeral diaphyseal fracture and soft tissue defect (wounded with a high-kinetic energy projectile) (left, anteroposterior projection; right, left lateral projection).

bow arthrosis and failed elbow arthroplasty are also indications for elbow arthrodesis.^{4,13} Every operative procedure, including elbow arthrodesis, has contraindications. Relative contraindications are reduced mobility of the ipsilateral shoulder, wrist, or cervical spine. For patients for whom both elbow joints are involved, alloarthroplasty or resection arthroplasty of at least one elbow is preferred.^{2,7,12,16} The optimal elbow joint position for arthrodesis varies; it depends mostly on specific functional demands, the patient's occupation, and compensatory arm and neck movement ability. Most authors suggest 90 degrees of flexion as the best position for elbow arthrodesis on the dominant side, with normal shoulder, wrist, and spine mobility. This is the best position for activities of everyday living (writing, eating, and personal hygiene) and allows maximal arm strength.^{1,2,6,8,15,17} Arthrodesis with 45 to 60 degrees of flexion is sometimes better (for some professions) and provides a better cosmetic appearance.^{4,15} The best position of the forearm for the arthrodesis, in cases in which rotation is not possible, is a neutral position, slight pronation (for better writing ability and better ability to use a computer), or slight supination (for better object-holding ability).^{4,17} For both-side elbow arthrodesis, 90 degrees of flexion on one side and 45 to 60 degrees of flexion on the other side is proposed.^{2,16} It is advisable to immobilize the patient's elbow in the desired position before the operation, for better evaluation of the patient's preferences.^{18,19}

Conclusions

Elbow arthrodesis is the definitive treatment for complex, open, intra-articular fractures with bone and soft tissue loss after wounding or large traumatic defects. The best position for elbow arthrodesis is 90 degrees of flexion, which ensures easy functioning in activities of everyday living and personal hygiene maintenance. Our results show that external fixation, along with internal fixation with cancellous bone screws and washers combined with autologous cancellous bone grafts, is an effective method for achieving arthrodesis of the war-injured elbow. Patients should be cautioned, however, that prolonged immobilization with an external fixator is required.

References

1. Rashkoff E, Burkhalter WE: Arthrodesis of the salvage elbow. *Orthopedics* 1986; 9: 733-8.
2. Beckenbaugh RD: Arthrodesis. In: *The Elbow and Its Disorders*, pp 696-703. Edited by Morrey BF. Philadelphia, WB Saunders, 1985.
3. Orozco R, Giros J, Sales JM, Videla M: A new technique of elbow arthrodesis: a case report. *Int Orthop* 1996; 20: 92-9.
4. McAuliffe JA, Burkhalter WE, Ouellette EA, Carneiro RS: Compression plate arthrodesis of the elbow. *J Bone Joint Surg Br* 1992; 74: 300-4.
5. Irvine GB, Gregg PJ: A method of elbow arthrodesis: brief report. *J Bone Joint Surg Br* 1989; 71: 145-6.
6. Mueller ME, Allgoewer M, Schneide R, Willenegger H: *Manual der Osteosynthese*, Ed 3. Berlin, Springer Verlag, 1991.
7. Hahn MP, Ostermann PA, Richter D, Muhr G: Elbow arthrodesis and its alternative. *Orthopaede* 1996; 25: 112-20.
8. Justi EI: Arthrodesis of shoulder, elbow, and wrist. In: *Cambell's Operative Orthopaedics*, pp 357-68. Edited by Crenshaw AH. St Louis, MO, Mosby, 1992.
9. Sakkers R, Lammens J, Reynaert P, Fabry G: Ilizarov reconstruction after a failed upper limb salvage procedure in oncology: a case report. *J Shoulder Elbow Surg* 2000; 9: 148-51.
10. Gunzburg R, Mokassa L, Wagner J: Arthrodesis of the elbow using Ilizarov's external fixator. *Acta Orthop Belg* 1989; 55: 593-7.
11. Pippow A, Krahenbuhl L, Michel MC, Witschger P: Combination of plate and external fixator for biological osteosynthesis of comminuted fractures. *Swiss Surg* 2002; 8: 230-6.
12. Morrey BF: Distraction arthroplasty: clinical applications. *Clin Orthop* 1993; 293: 46-54.
13. Wolfe SW, Figgie MP, Inglis AE, Bohn WW, Renawat CS: Management of infection about total elbow prostheses. *J Bone Joint Surg Am* 1990; 72: 198-212.
14. Koržinek K, Delimar D, Kolundžić R: Der CMC-Außenfixator. *Med Orth Tech* 1997; 117: 213-6.
15. Snider WJ, DeWitt HJ: Functional study for optimal position for elbow arthrodesis or ankylosis. *J Bone Joint Surg Am* 1973; 55: 1300-8.
16. Arafles RP: A new technique of fusion for tuberculous arthritis of the elbow. *J Bone Joint Surg Am* 1981; 63: 1396-1400.
17. Morrey BF, Askew LJ, Chao EY: A biomechanical study of normal functional elbow motion. *J Bone Joint Surg Am* 1981; 63: 872-7.
18. Nagy SM III, Szabo RM, Sharkey NA: Unilateral elbow arthrodesis: the preferred position. *J South Orthop Assoc* 1999; 8: 80-5.
19. Tang C, Roidis N, Itamura J, Vaishnau S, Shean C, Stevanovic M: The effect of simulated elbow arthrodesis on the ability to perform activities of daily living. *J Hand Surg Am* 2001; 26: 1146-50.