



Shoulder arthrodesis using combined internal and external fixation : A review of 9 cases

Michel VANCABEKE, Bruno BAILLON, Pascal RÉMY, Frédéric SCHUIND, Franz BURNY

From Université Libre de Bruxelles, Brussels, Belgium

A technique of shoulder arthrodesis is presented. Fixation of the arthrodesis combines scapulohumeral half-frame Hoffmann external fixation and internal fixation using a cancellous screw. Cancellous bone autografts are packed at the site of arthrodesis. The functional results of nine cases are presented.

Keywords : shoulder ; arthrodesis ; fixation ; results.

INTRODUCTION

The indications for shoulder arthrodesis have largely decreased owing to the development of shoulder arthroplasty (8,18). Some indications however remain, mainly contraindications to shoulder arthroplasty, including brachial plexus injuries, chronic infections, failed revision arthroplasties, severe refractory instabilities, or bone defects following resection of a tumour of the proximal humerus (16,19,20,26). Some surgeons prefer arthrodesis for young patients who perform heavy labour (3). Arthrodesis will not provide an acceptable functional result if the scapulothoracic muscles (trapezius, levator scapulae, serratus anterior, rhomboid) are paralysed, or if acceptable function of the elbow, forearm, hand and wrist is not preserved. Charcot arthropathy and contralateral arthrodesis have also been reported as contraindications to shoulder arthrodesis (3).

SURGICAL TECHNIQUE

The surgical approach is posterior, through the deltoid and the posterior muscles of the rotator cuff. An arthrotomy is performed, and the articular cartilage is removed. The position of the arthrodesis is determined during the surgical procedure. A scapulohumeral half-frame Hoffmann external fixator is inserted, with implantation of two or three 4mm or 5mm pins in the humerus, and three to five 4mm pins in the scapular spine. The external fixator is particularly useful to precisely determine the optimal position of the arthrodesis, which is usually with some scapulohumeral abduction. The

-
- Michel Vancabeke, MD, Orthopaedic surgeon.
 - Bruno Baillon, MD, Orthopaedic surgeon.
 - Frédéric Schuind, MD, PhD, Professor and chairman.
 - Franz Burny, MD, PhD, Honorary Professor.
- Department of Orthopaedics and Traumatology.*
- Pascal Rémy, Physiotherapist.

Department of Physiotherapy.
Université Libre de Bruxelles, Cliniques Universitaires de Bruxelles, Brussels, Belgium

Correspondence : Michel Vancabeke, Department of Orthopaedics and Traumatology, Clinique Universitaire de Bruxelles, Hôpital Erasme, Route de Lennik 808, B-1070 Brussels, Belgium. E-mail : michelvancabeke@hotmail.com

© 2007, Acta Orthopædica Belgica.



Fig. 1. — Radiograph immediately after operation



Fig. 2. — Radiograph after bone healing

patient must be able to reach his mouth with the hand, and to fully adduct the arm in contact with the chest wall. Cancellous bone autografts are procured from the iliac crest and inserted within the articular and subacromial space. The fixation is completed with one 6.5 mm cancellous screw, fixing the humerus to the scapular glenoid (fig 1).

PATIENTS AND METHODS

Nine shoulder arthrodeses with combined internal and external fixation were performed since 1970. Our indications for arthrodesis included four cases of Erb-Duchenne C5-C6 paralysis, two shoulders with post-traumatic sequelae in which arthroplasty was contraindicated (infection and/or rupture of rotator cuff), one scapulohumeral agenesis, one syringomyelia, and one villonodular synovitis. The patients were reviewed after a mean follow-up duration of 5.1 years (range : 0.6 to 15.4).

The results were evaluated clinically, using the functional score of Constant with 75 points (the 25 points evaluating power are not testable in the case of a shoulder arthrodesis). In addition, an isometric measurement of abduction/adduction and internal/external rotation power was performed in 5 patients using Cybex®. Each posture was maintained for 5 seconds and was performed three times by the patient.

RESULTS

Bone healing was obtained in 7 of the 9 patients (fig 2) after a mean time interval of 148 days (median : 138 days). One patient died from cardiac failure before healing was achieved. Non-union occurred in the case with syringomyelia. Two humeral fractures were treated with a humero-humeral external fixator. One of these fractures occurred in the patient with syringomyelia and, in the other, through a pin-hole of the external fixator. In total, 53 pins were implanted, 29 in the scapula and 24 in the humerus. Sixteen pins were radiologically and clinically loose (30%) : 20% of the humeral pins and 39% of the scapular pins. The final results were very good. All patients were satisfied. Four patients were pain-free and 3 complained of mild pain. Two patients occasionally used some pain medications.

Analysis of postoperative mobility showed a mean abduction of 56°, a mean forward flexion of 67.5° and rotations of 39° (table I). The range of movement permitted good functional results (table II). The average functional Constant score was 41/75 points (table III). Isometric power was tested in 5 patients : the weakness in abduction-adduction was more severe than in rotation (table IV). We

Table I. — Postoperative range of motion (7 cases)

	Mean (SD)
Abduction	57° (16°)
Forward flexion	68.5° (19°)
Rotation	39.5° (7°)

Table II. — Function (6 cases)

Hand to pocket	6 (100%)
Hand to mouth	6 (100%)
Hand to back	4 (66%)
Hand to neck	3 (50%)

Table III. — Functional Constant Score (6 cases)

	Mean (S.D.)
Subjective (35 points)	27.64 (3)
Objective (40 points)	13.6 (3)
Total	41/75 (5)

Table IV. — Study of isometric power by Cybex® (as compared to the normal contralateral side – 3 cases)

	Mean (SD)
Internal rotation	94% (20%)
External rotation	64% (25%)
Abduction	42% (16.5%)
Adduction	48% (21.5%)

also noted that one patient, operated 16 years previously, had more isometric power than those operated more recently.

DISCUSSION

Bone healing after shoulder arthrodesis is difficult to achieve because of the limited contact area between the humeral head and the scapula (1). Rybka *et al* (21) and Vastamäki (23) pull down the acromion in order to increase the contact area. With the same objective, Cofield and Briggs (4), Müller *et al* (12) and Richards *et al* (15) create a superior subluxation of the humeral head. The consensus for the ideal position of the arthrodesis appears to

favour less abduction (10-15°), less forward flexion (10-15°) and more internal rotation (45°) (3). Several techniques of fixation have been described in literature. Cofield and Briggs (4), Merle d'Aubigné (11), Beltran *et al* (1), Vastamäki (23), Hawkins and Neer (6) used isolated screws. Richards *et al* (15) and Riggins (17) reported the use of plates. Makin (10) and Valasco Polo and Monterrubio (24) recommended intramedullary nailing using Steinmann pins. Charnley (2), Johnson *et al* (7) and Nagano *et al* (13) fixed the arthrodesis with only external fixation. Patte (14), Vidal *et al* (25), Schröder and Frandsen (22) and Foucart and Burny (5) used a combination of internal and external fixation. These authors have reported varied results. Kostuik and Schatzker (9) had 15 painless shoulders in 18 arthrodeses with plate fixation, with complete fusion in all ; 87% of the patients were satisfied. In their series of 71 patients, Cofield and Briggs (4) had 68 solid fusions and pain relief in 75%. Hawkins and Neer (6) had only 4 patients who were free of pain out of 17 arthrodeses and 8 patients in their series were satisfied. Schröder and Frandsen (22), who used external fixation combined with internal fixation, had 11 fusions in 12 patients and all of them reported pain relief. Only two of our patients occasionally need medication. In our series of 9 patients, we had one non-union in a case of syringomyelia with severe bone loss, and we observed two diaphyseal fractures of the humerus. Proximal humeral fractures have been reported with all techniques (0-25%) ; they seem to be less frequent with screw fixation of the arthrodesis and to be more frequent with plate (13%) or external fixation. Screw holes or pin holes may act as stress risers or a fracture may occur due to stress concentration at the distal end of a plate.

We believe that the technique reported here, combining external and internal fixation, could be the best compromise : isolated external fixation is not sufficient, owing to poor anchorage of the pins in the scapular spine (18,25), but it avoids the need for an uncomfortable plaster cast during a prolonged postoperative period, and potential wound infections which may be related with a prominent plate.

CONCLUSIONS

The combination of external and internal fixation is a satisfactory technique for shoulder arthrodesis. Our single case of non-union was related to the underlying pathology, syringomyelia, rather than to the surgical technique. The use of Cybex® to evaluate the functional result of shoulder arthrodesis is promising. This technique will in the future permit a better comparison of the function of the shoulder after arthrodesis or arthroplasty.

REFERENCES

1. **Beltran JE, Trilla JC, Barjau R.** A simplified compression arthrodesis of the shoulder. *J Bone Joint Surg* 1975 ; 57-A : 538-541.
2. **Charnley J.** Compression arthrodesis of the ankle and shoulder. *J Bone Joint Surg* 1951 ; 33-B : 180-191.
3. **Clare DJ, Wirth MA, Groh GI, Rockwood CA.** Shoulder arthrodesis. *J Bone Joint Surg* 2001 ; 83-A : 593-600.
4. **Coffield RH, Briggs BT.** Gleno-humeral arthrodesis. Operative and long term functional results. *J Bone Joint Surg* 1979 ; 61-A : 668-677.
5. **Foucart M, Burny F.** Traitement kinésithérapique après une arthrodèse d'épaule par fixateur externe d'Hoffmann. Mémoire de fin d'études. ULB. 1970.
6. **Hawkins RJ, Neer CS.** A functional analysis of shoulder fusions. *Clin Orthop* 1987 ; 223 : 65-76.
7. **Johnson CA, Healy WL, Brooker AF, Krackow D.** External fixation shoulder arthrodesis. *Clin Orthop* 1986 ; 211 : 219-223.
8. **Jonsson E, Brattström M, Lidgren L.** Evaluation of the rheumatoid shoulder function after hemiarthroplasty and arthrodesis. *Scand J Rheumatol* 1988 ; 17 : 17-26.
9. **Kostuik JP, Schatzker J.** Shoulder arthrodesis-AO technique. In : Bateman JE, Welsh RP, Editors. *Surgery of the Shoulder*. CV Mosby, St. Louis ; 1984, pp 207-210.
10. **Makin M.** Early arthrodesis for a flail shoulder in young children. *J Bone Joint Surg* 1977 ; 59-A : 317-321.
11. **Merle d'Aubigné R.** [Technique of shoulder arthrodesis through a posterior approach.] (French). *Rev Chir Orthop* 1966 ; 52 : 155-161.
12. **Müller ME, Allgöwer M, Schneider R, Willenegger H.** *Manual of Internal Fixation. Techniques recommended by the AO group.* 2nd ed. Springer Verlag, New York 1979, p 384.
13. **Nagano A, Okinaga S, Ochiai N, Kurokawa T.** Shoulder arthrodesis by external fixation. *Clin Orthop* 1989 ; 247 : 97-100.
14. **Patte D.** [Shoulder arthrodesis.] (French). *Encycl Méd Chir*, Paris, France, Technique chirurgicales. Orthopédie 1988 ; 44298 ; 11-1988-10.
15. **Richards RR, Sherman RM, Wadell JP.** Shoulder arthrodesis using a pelvic reconstruction plate. A report of eleven cases. *J Bone Joint Surg* 1988 ; 70-A : 416-421.
16. **Richards RR, Wadell JP, Hudson AR.** Shoulder arthrodesis for the treatment of brachial plexus palsy. *Clin Orthop* 1985 ; 198 : 250-258.
17. **Riggins RS.** Shoulder fusion without external fixation. A preliminary report. *J Bone Joint Surg* 1976 ; 58-A : 1007-1008.
18. **Rockwood CA, Matsen FA.** *The Shoulder*, WB Saunders, Philadelphia 1990 ; Vol.2 : 705-711.
19. **Rowe CR.** Arthrodesis of the shoulder used in treating painful conditions. *Clin Orthop* 1983 ; 173 : 92-96.
20. **Rühmann O, Schmolke S, Bohnsack M et al.** Shoulder arthrodesis : indications, technique, results, and complications. *J Shoulder Elbow Surg* 2005 ; 14 : 38-55.
21. **Rybka V, Raunio P, Vanio K.** Arthrodesis of the shoulder in rheumatoid arthritis : a review of 41 cases. *J Bone Joint Surg* 1979 ; 61-B : 155-158.
22. **Schröder HA, Frandsen PA.** External compression arthrodesis of the shoulder joint. *Acta Orthop Scand* 1983 ; 54 : 592-595.
23. **Vastamäki M.** Shoulder arthrodesis for paralysis and arthrosis. *Acta Orthop Scand* 1987 ; 58 : 549-553.
24. **Velasco Polo G, Monterrubio C.** Arthrodesis of the shoulder. *Clin Orthop* 1973 ; 90 : 178-182.
25. **Vidal J, Nakach G, Robischong P, Micalles JP, Virenque P.** [Scapulohumeral arthrodesis by combined external and internal fixation. A biomechanical, technical and clinical study.] (French). *Rev Chir Orthop* 1987 ; 73 : 171-177.
26. **Wilde AH, Boumphrey FRS.** Arthrodesis of the shoulder, current indications and operative technique. *Orthop Clin North Am* 1987 ; 18 : 463-472.