



## Plate fixation of middle-third fractures of the clavicle in the semi-professional athlete

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**From 1995 to 2003, 39 semi-professional athletes (34 men and 5 women) aged 17-34 years (mountain bike racers, soccer players, swimmers and cyclists) with a displaced fracture of the middle-third of the clavicle were treated operatively using rigid plate fixation within one week after the initial trauma. In 90% of the athletes, radiographic union was achieved after 12 weeks. At 6 weeks post-operatively the mean Constant score was 88 points, the mean visual analogue pain score was 3 out of 10 and the average time for return to sports was 45 days. Seventy-five percent of the patients were very satisfied with the end-result and 95% would chose to have the same operation again. In 5% of the cases the end-result was unsatisfactory. The most frequent postoperative complication was wound infection (18% of the cases). Nevertheless, this did not affect the outcome. Other postoperative complications in our athletic population included refracture (5%), transient neurological complications (7%) and non-union (5%), which were equally low in the literature. These data suggest that rigid plate fixation of middle-third clavicle fractures gives good results in the semi-professional athlete and may result in early return to sports activity, at the expense of a significant risk for complications, which would not be considered acceptable in patients with lower functional demands.**

### INTRODUCTION

Middle-third clavicle fractures are commonly encountered in the athletic population. Unless a neurovascular compromise or significant displace-

ment exists, the acute treatment is conservative (2, 3, 26, 27, 30, 36). Although non-union is uncommon and is reported in only 4% of these fractures (9, 13, 18, 25), a pseudarthrosis of the clavicle as well as its operative treatment can be very invalidating. Intractable pain, neurological complications and loss of shoulder function have been reported (7, 9, 13, 18, 33, 35). Especially sportsmen and women with a high activity level will not accept prolonged recovery and impaired shoulder function and therefore may require a more aggressive acute treatment of a middle-third clavicle fracture. In this study, we report the surgical outcome after open reduction

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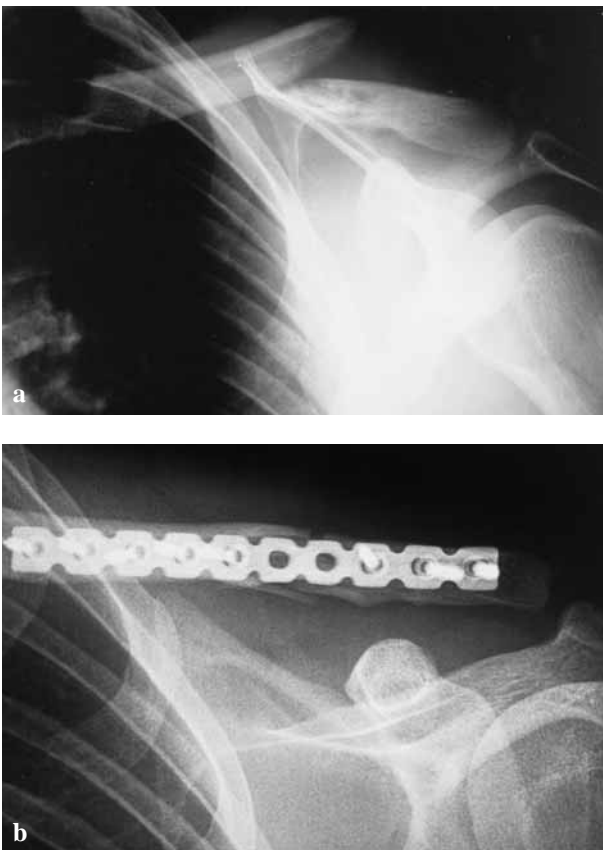
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and plate fixation of middle-third fractures of the clavicle in 39 semi-professional athletes.

### PATIENTS AND METHODS

Thirty-nine athletes (involved in soccer, motorcross, mountainbike, swimming and cycling) with a displaced middle-third fracture of the clavicle were treated operatively between 1995 and 2003. Thirty four athletes were men and 5 were women. Mean age was 28 years (range : 17 to 43) and in 16 patients the dominant side was involved.

Preoperatively all athletes had a 15° cephalad tilt AP radiograph to confirm the diagnosis of a displaced middle-third clavicle fracture. All patients were treated within one week after the initial trauma with rigid plate fixation, using either an AO reconstruction plate or a



**Fig. 1.** — a) Pre-operative radiograph of a middle-third clavicle fracture in a 21-year-old mountain bike racer ; b) Post-operative radiograph 6 weeks after open reduction and internal fixation with an anterior-inferior reconstruction plate. This patient returned to mountain bike racing 10 days after surgery.

Table I. — Surgical outcome of middle-third clavicle fractures after open reduction and plate fixation

	Surgical outcome (n = 39)
Constant score (max. 100 points, mean)	88
Pain (0 = no pain, 10 = severe pain) (mean)	3
Return to sports (mean)	45 days
Satisfaction rate	92%
Union rate (at 18 weeks)	90%
Complications	
Wound Infection	18%
Refracture	5%
Nonunion	5%
Neurologic symptoms	7%

3.5 mm low-contact dynamic compression (LCDC) plate that was modelled and fitted to the anterior surface of the clavicle. Postoperatively, all patients were immobilised in a sling but immediate passive and active mobilisation was started as tolerated. Clinical and radiographic follow-up was done postoperatively at 1 week, 6 weeks and 12 weeks. The average length of follow-up was 64 months (range : 12 to 99).

At clinical review the functional outcome was assessed by the Constant Murley score, a visual analogue pain score (0 = no pain, 10 = severe pain) (31, 32), return to sports status and by the patient's subjective satisfaction rating.

### RESULTS

At 6 weeks postoperatively the average post-operative Constant score was 88 (range : 50 to 98). The mean pain score on visual analogue scale was 3 out of 10. Patient satisfaction scores were 75% very satisfied, 20% satisfied and 5% unsatisfied. Ninety-five percent of the patients would have the same operation again. All patients returned to their original sports activity level. The average time to regain full sports activity was 45 days (range : 2 to 210) (table I).

Ninety percent of the athletes showed union of the fracture on radiographs at 12 weeks. Five percent of the patients sustained a refracture after a new trauma with the hardware in place (all were patients treated with 3.5 mm LCDC plate) and were successfully revised by open reduction and

internal fixation with bone grafts. Seven patients (18% of the cases) developed a wound infection, 4 of these were treated with antibiotics and 3 were deep infections that required surgical debridement and IV antibiotics. Two patients developed a non-union (1 patient treated with a 3.5 mm LCDC plate, 1 with a reconstruction plate); both healed uneventfully after revision surgery. Three patients showed transient, mild neurological symptoms which resolved spontaneously after 6 weeks.

## DISCUSSION

This study shows excellent results of operative treatment of middle-third clavicle fractures in semi-professional athletes. Patients treated with early, rigid fixation of their clavicle fractures showed a high postoperative Constant score, early pain resolution, early return to sports activity and high patient satisfaction rating.

Middle-third clavicle fractures are considered as benign injuries with a satisfactory outcome if treated conservatively (26, 34, 36). However, several reports challenge this view (1, 10, 15, 19, 28, 29), and there has been a resurgence of interest in operative treatment for fractures of the clavicle that display significant shortening, which may result in shoulder pain and weakness (7, 8, 10, 17, 24). Possible complications resulting from conservatively treated clavicle fractures are cosmetically displeasing end-results, delayed union, persisting non-union, chronic shoulder pain and impaired shoulder function (7, 10, 20). This may lead to low patient satisfaction rates and late return to sports activities (10, 35). The advantage of internal fixation of clavicle fractures, which includes early pain resolution, early return of shoulder function and potentially early return to sports, make it an appealing option for the treatment of displaced fractures in active individuals. Especially semi-professional athletes will not accept even mild loss of shoulder function, will desire early return to sports activities and are often interested in this treatment option.

Many different methods of operative fixation of midshaft clavicle fractures have been described: intramedullary pinning (Steinmann pins, Knowles pins or elastic nails, Kirschner wires) and the use of

screws and different plates (6, 11, 12, 21, 22, 28, 29, 35). Intramedullary pinning techniques have been associated with a high number of complications, such as pin migration and rotational instability (1, 4, 5, 16) and fixation with interfragmentary screws or wire sutures show insufficient immobilisation (5, 13). As a result, many authors prefer rigid fixation with a plate (1, 4, 13, 15, 19, 28, 29, 35). Both AO reconstruction plates and 3.5 mm limited contact dynamic compression plates (LCDC) have been shown to provide superior fracture stability and excellent clinical results in the treatment of acute fractures and non-unions (7, 11, 19, 35). We prefer to use an anterior position of the plate in order to decrease the risk of screw pull-out, and to reduce the risk of postoperative wound complications by avoiding subcutaneous bulky hardware. Such a plate position also allows for a better and easier contouring of the clavicle (15). Further research is needed to investigate whether a low profile, precontoured, antero-posterior clavicular plate may be easier to implant and also may provide a more rigid fixation.

In our study, the majority of the complications were postoperative wound disorders (18% of the cases). Ten percent were deep infections which needed operative debridement and IV antibiotics. Böstman *et al* (4) reported previously an infection rate of only 7.8% in their series of operatively treated clavicle fractures. The rather high rate of wound infections in our series can be explained by the quick pain relief afforded by the rigid fixation and almost immediate return to sports activity for some athletes, even before complete wound healing occurred. Other postoperative complications in our athletic population included refracture (5%); transient neurological complications (7%) and non-union (5%), which were equally frequent in the literature (1, 4, 14, 15, 28, 29, 36). Taking these percentages into account, we believe that operative treatment of acute middle-third clavicle fractures should be reserved to the semi-professional athlete who wishes to return early to his sports activity and who is therefore accepting to take the risk for potential complications. Especially wound disorders and infection may lead to disasters and the patient should be duly informed before deciding to have the operation.

The acute treatment of middle-third clavicle fractures remains a subject of controversy. These data demonstrate early pain relief in combination with good shoulder function after acute operative treatment resulting in quick return to sports activities and a high patient satisfaction rate in the semi-professional athlete. Therefore, we believe that open reduction and rigid internal fixation can be a valuable option in the acute treatment of middle-third clavicle fractures in the semi-professional athlete, despite a significant risk for complications which is typically well accepted by those patients with high functional demands, but would not be considered acceptable in a general population with lesser functional demands.

## REFERENCES

1. **Ali Khan MA, Lucas HK.** Plating of fractures of the middle third of the clavicle. *Injury* 1989 ; 4 : 263-267.
2. **Andersen K, Jensen PO, Lauritzen J.** Treatment of clavicular fractures. Figure-of-eight bandage versus a simple sling. *Acta Orthop Scand* 1987 ; 58 : 71-74.
3. **Barbier O, Malghem J, Delaere O et al.** Injury to the brachial plexus by a fragment of bone after fracture of the clavicle. *J Bone Joint Surg* 1997 ; 79-B : 534-536.
4. **Böstman O, Manninen M, Pihlajamäki H.** Complications of plate fixation in fresh displaced midclavicular fractures. *J Trauma* 1997 ; 43 : 778-783.
5. **Boehme D, Curtis RJ, DeHaan JT et al.** Non-unions of the mid-shaft of the clavicle. Treatment with a modified Hagie intramedullary pin and autogenous bone-grafting. *J Bone Joint Surg* 1991 ; 73-A : 1219-1226.
6. **Chu CM, Wang SJ, Lin LC.** Fixation of mid-third clavicular fractures with Knowles pins : 78 patients followed for 2-7 years. *Acta Orthop Scand* 2002 ; 73 : 134-139.
7. **Der Tavitian J, Davison JN, Dias JJ.** Clavicular fracture non-union : surgical outcome and complications. *Injury* 2002 ; 33 : 135-143.
8. **Edelson JG.** The bony anatomy of clavicular malunions. *J Shoulder Elbow Surg* 2003 ; 12 : 173-178.
9. **Edvardsen P, Odegard O.** Treatment of posttraumatic clavicular pseudarthrosis. *Acta Orthop Scand* 1977 ; 48 : 456-457.
10. **Hill JM, McGuire MH, Crosby LA.** Closed treatment of displaced middle-third fractures of the clavicle gives poor results. *J Bone Joint Surg* 1997 ; 79-B : 537-539.
11. **Iannotti MR, Crosby LA, Stafford P et al.** Effects of plate location and selection on the stability of midshaft clavicle osteotomies : a biomechanical study. *J Shoulder Elbow Surg* 2002 ; 5 : 457-462.
12. **Jubel A, Andemahr J, Bergmann H et al.** Elastic stable intramedullary nailing of midclavicular fractures in athletes. *Br J Sports Med* 2003 ; 37 : 480-484.
13. **Jupiter JB, Leffert RD.** Non-union of the clavicle. Associated complications and surgical management. *J Bone Joint Surg* 1987 ; 69-A : 753-760.
14. **Kitsis CK, Marino AJ, Krikler SJ, Birch R.** Late complications following clavicular fractures and their operative management. *Injury* 2003 ; 34 : 69-74.
15. **Kloen P, Sorkin AT, Rubel IF, Helfet DL.** Anteroinferior plating of midshaft clavicular nonunions. *J Orthop Trauma* 2002 ; 16 : 425-430.
16. **Loncan LI, Sempere DF, Ajuria JE.** Brown-Sequard syndrome caused by a Kirschner wire as a complication of clavicular osteosynthesis. *Spinal Cord* 1998 ; 36 : 797-799.
17. **McKee MD, Pedersen E, Wild L, Schemitsch EH.** Objective measured strength deficits following conservative treatment of clavicle fractures. *71<sup>st</sup> Ann Meet AAOS* 2004 ; San Francisco : pp 285.
18. **Manske DJ, Szabo RM.** The operative treatment of mid-shaft clavicular non-unions. *J Bone Joint Surg* 1985 ; 67-A : 1367-1371.
19. **Mullaji AB, Jupiter JB.** Low-contact dynamic compression plating of the clavicle. *Injury* 1994 ; 25 : 41-45.
20. **Naert PA, Chipchase LS, Krishnan J.** Clavicular malunion with consequent impingement syndrome. *J Shoulder Elbow Surg* 1998 ; 7 : 548-550.
21. **Neviaser RJ, Neviaser JS, Neviaser TJ.** A simple technique for internal fixation of the clavicle. A long term evaluation. *Clin Orthop* 1975 ; 109 : 103-107.
22. **Ngarmukos C, Parkpian V, Patradul A.** Fixation of fractures of the midshaft of the clavicle with Kirschner wires. Results in 108 patients. *J Bone Joint Surg* 1998 80-B : 106-108.
23. **Nordqvist A, Petersson CJ, Redlund-Johnell I.** Mid-clavicle fractures in adults : end result study after conservative treatment. *J Orthop Trauma* 1998 ; 12 : 572-576.
24. **Nordqvist A, Redlund-Johnell I, von Scheele A, Petersson CJ.** Shortening of clavicle after fracture. Incidence and clinical significance, a 5-year follow-up of 85 patients. *Acta Orthop Scand* 1997 ; 68 : 349-351.
25. **Nowak J, Mallmin H, Larsson S.** The aetiology and epidemiology of clavicular fractures. A prospective study during a two-year period in Uppsala, Sweden. *Injury* 2000 ; 31 : 353-358.
26. **O'Rourke IC, Middleton RW.** The place and efficacy of operative management of fractured clavicle. *Injury* 1975 ; 6 : 236-240.
27. **Orljanski W, Millesi H, Schabus R.** Late lesion of the brachial plexus after clavicular fracture. *Unfallchirurg* 1998 ; 101 : 66-68.
28. **Poigenfurst J, Rappold G, Fischer W.** Plating of fresh clavicular fractures : Results of 122 operations. *Injury* 1992 ; 23 : 237-241.

29. **Poigenfurst J, Reiler T, Fischer W.** Plating of fresh clavicular fractures. Experience with 60 operations. *Unfallchirurg* 1988 ; 14 : 26-37.
30. **Post M.** Current concepts in the treatment of fractures of the clavicle. *Clin Orthop* 1989 ; 245 : 89-101.
31. **Price DD, McGrath PA, Raffi A, Buckingham B.** The validation of VAS as ratio scale measures and chronic experimental pain. *Pain* 1983 ; 17 : 145-156.
32. **Scott PJ, Huskisson EC.** Graphic representation of pain. *Pain* 1976 ; 2 : 175-184.
33. **Simpson NS, Jupiter JB.** Clavicular nonunion and malunion : evaluation and surgical management. *J Am Acad Orthop Surg* 1996 ; 4 : 1-8.
34. **Stanley D, Norris SH.** Recovery following fractures of the clavicle treated conservatively. *Injury* 1988 ; 19 : 162-164.
35. **Wentz S, Eberhardt C, Leonhard T.** Reconstruction plate fixation with bone graft for mid-shaft clavicular nonunion in semi-professional athletes. *J Orthop Sci* 1999 4 : 269-272.
36. **Zenni EJ, Krieg JK, Rosen MJ.** Open reduction and internal fixation of clavicular fractures. *J Bone Joint Surg* 1981 ; 63-A : 147-151.