OPERATIVE TREATMENT OF CLAVICULAR NONUNION

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Twelve patients treated for clavicular nonunion mainly with plate fixation and bone grafting were reviewed in order to evaluate the treatment. Follow-up was a median of 41 months (20-117). Nine out of 12 patients achieved a good end result, but the primary treatment failed in half of the cases, probably because of short (4-hole) semitubular plates and insufficient postoperative immobilization. We conclude that 4-hole semitubular plates cannot be recommended for treating clavicular nonunion because of a high risk of failure. Sufficient postoperative immobilization should follow plate fixation. If this is respected, plate fixation with bone grafting appears as a good method for treating clavicular nonunion.

Keywords : clavicula ; nonunion.
Mots-clés : clavicule ; pseudarthrose.

INTRODUCTION

Nonunion of a fracture of the clavicle is very uncommon.
Reviewing 2,235 cases of conservatively treated fractures, Neer (7) found the rate of nonunion to be 0.1%. Furthermore clavicular nonunion is often asymptomatic (11). When nonunion causes symptoms, plate fixation combined with bone grafting is recommended in most recent papers (2, 4, 5, 9, 10, 11).

The aim of this study was to evaluate the operative treatment of clavicular nonunion as performed in our department.

MATERIAL AND METHODS

From 1984 to 1992 twelve patients were operated for clavicular nonunion. All patient files and roentgenographs were reviewed. At follow-up all patients were scored according to Constant's functional score (1) (but without the strength score), and follow-up roentgenographs were taken. Patient characteristics are shown in table I.

All cases of nonunion resulted from fractures — 11 group 1 (middle third) and one group 2, type 2 (lateral third, dislocated) according to the Neer classification (8). There were 9 cases of atrophic and 3 cases of hypertrophic nonunion.

Table I. — Patient characteristics

Sex (male/female)	5 / 7
Age (median/range)	34 (19-60)
Fracture/operation (median/range)	11 months (4-84)
Follow-up (median/range)	41 months (20-117)

RESULTS

The results are presented in table II. Ten patients were operated with plate fixation and corticocancellous bone graft from the iliac crest. Eight plates were placed on the superior and 2 on the anterior edge of the clavicle.

Five cases failed to unite ; one of them was asymptomatic (F/52,table II), as the nonunion was retained by a firmly anchored 6-hole plate. In 3 cases the plate and screws loosened within the first 5 weeks and all were reoperated using

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Table II. — Results

1	2	3	4	5	6	7	8	9
M / 46	1	A	6 DCP + b	3W FS + 3W OS			yes	75 / 75
F / 52	1	A	6 DCP + b	3W OS			no	73 / 75
F / 60	1	A	4 STP + b	2W OS	loosening	4 STP + b	no	30 / 71
M / 19	1	A	4 STP + b	none	loosening	4 STP + b	yes	50 / 75
F / 41	1	H	5 DCP + b	3W FS + 3W OS			yes	75 / 75
M / 32	1	A	6 DCP + b	4W OS			yes	75 / 75
M / 33	1	A	5 STP + b	1W FS + 2W OS	loosening	5 STP + b	yes	73 / 75
M / 30	1	H	5 DCP + b	3W FS + 4W OS			yes	74 / 75
F / 59	2/2	A	coracoclav	3W OS			yes	74 / 75
F / 51	1	H	4 STP + b	4W FS + 2W OS			yes	75 / 75
F / 34	1	A	4 STP + b	3W FS + 3W OS	plate breakage	6 DCP + b	yes	56 / 73
F / 19	1	A	Herbert	none	loosening		yes	74 / 75

Vertical : Patients
Horizontal :
1 : Sex/age, M = male, F = female
2 : Fracture group ; 1 = group 1 and 2/2 = group 2, type 2 (Neer classification)
3 : Nonunion ; A = atrophic, H = hypertrophic
4 : Operation ; number of holes in plate, DCP = 3, 5-mm dynamic compression plate, STP = 4, 5-mm semitubular plate, coracoclav = coracoclavicular screw, + b = bone graft
5 : Immobilization postoperatively ; W = weeks, FS = fixed sling, OS = ordinary sling
6 : Complications postoperatively
7 : Reoperations
8 : Union
9 : CFS = constant functional score ; left = nonunion side, right = normal, maximum = 75 (without strength score)

the same plate and new screws. One of these did not heal ; the patient still has a nonunion, but declines any further treatment. In one case the plate broke after 11 months ; the patient was reoperated with a 6-hole plate, and the nonunion healed.

Two patients were operated using screws. An intramedullary screw (Herbert screw) was used in one case ; this operation failed, and the patient was successfully reoperated with a plate. The other was successfully operated with a coracoclavicular screw (3).

The time to union was estimated to be from 6 to 16 weeks, but in 3 cases it took 10 months before union could be confirmed. The plates and screws were removed in 6 cases ; the other 6 patients had no complaints from the material.

At follow-up 9 patients had a normal and 3 patients had a reduced Constant functional score. One, though, had primary damage to his shoulder that could explain the reduced score (M/19). One patient had normal shoulder function, but complained of pain and paresthesias for which there was no obvious explanation (F/34). The last patient with a reduced score was the one with nonunion, who wished no further treatment (F/60). All patients with a reduced score had undergone reoperation. A total of 10 nonunions healed, while 2 patients still had a nonunion (one asymptomatic).

DISCUSSION

At follow-up 9 out of 12 cases achieved a good end result, but almost half of the patients had been reoperated.

When one analyzes the 10 cases of primary plate fixation the following is found :

1 : There are 3 four-hole plates among the failed plate fixations (n = 5) versus only 1 four-hole plate among the successful ones (n = 5).
2 : There are 4 semitubular plates (STP) and only one dynamic compression plate (DCP) among the failed plate fixations (the one DCP still retains the nonunion, and the patient is asymptomatic) versus one STP and 4 DCPs among the successful ones.
3 : Postoperative immobilization for 3 weeks with a fixed sling followed by 3 weeks with a simple sling was used in only one case among the failed plate fixations versus 4 cases among the successful ones.

It thus seems that fixation with semitubular plate, followed by poor postoperative immobilization, has a high risk of failure.

Our primary results show an 80% success rate after plating 5 nonunions with DCP's (5-6 holes), but only a 20% success rate after plating 5 nonunions with STP's (4-5 holes). Reoperations show a 100% success rate after plating 2 nonunions with DCP's (6 holes) and a 63% success rate in plating 3 nonunions with STP's (4-5 holes). The overall success rate is thus 86% for DCP's but only 38% for STP's.

Karaharju *et al.* (5) reported a 100% success rate in plating 12 nonunions with STP's, but they used 5- and 6-hole plates and 3-6 weeks of immobilization postoperatively. Jupiter and Leffert (4) reported a 100% success rate in plating 11 nonunions with DCP's (5-8 holes) and 63% success in plating 3 nonunions with STP's (3-5 holes), and Rabenseifner (10) reported 100% success in plating 11 nonunions with DCP's.

The AO group (6) recommends that, because of the forces acting on the clavicle, one should use 3.5-mm DCP's or 3.5-mm reconstruction plates with 6 to 7 holes. Our results leads us to the conclusion that 4-hole semitubular plates cannot be recommended for treating clavicular nonunion, because of a high risk of failure (loosening/plate rupture). Sufficient postoperative immobilization has to be applied following plate fixation : we suggest 3 weeks in a fixed sling followed by 3 weeks in a simple sling. If this is respected, plate fixation and bone grafting appears as a good method for treating clavicular nonunion.

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SAMENVATTING

M. PEDERSEN, K. POULSEN, F. THOMSEN, B. KRISTIANEN. Chirurgische behandeling van pseudarthrose van de clavicula.

Twaalf patiënten, behandeld voor pseudarthrose van de clavicula, hoofdzakelijk met plaatfixatie en botenten, werden teruggezien voor evaluatie. De gemiddelde follow-up was 41 maanden (20-117). Negen van de 12 patiënten hadden een behoorlijk eindresultaat, maar voor de helft van de gevallen, mislukte de primaire behandeling, hoogstwaarschijnlijk omwille van een te korte (4 gaten) halfbuizige plaat en onvoldoende postoperatieve immobilisatie. Konkluderend : een immobilisatie met een 4 gaten, halfbuizige plaat is niet aangewezen bij de behandeling van pseudarthrose van de clavicula, rekening houdend met een hoog risico voor mislukking. Na de operatie blijft de immobilisatie geboden voor voldoende tijd. Wanneer hiermee rekening gehouden wordt, is de fixatie met plaat, aangevuld met botenten, een goede techniek voor de behandeling van pseudarthrosen van de clavicula.

RÉSUMÉ

M. PEDERSEN, K. POULSEN, F. THOMSEN, B. KRISTIANEN. Traitement chirurgical des pseudarthroses de la clavicule.

Douze blessés, chez qui une pseudarthrose de la clavicule fut traitée par plaque vissée et greffe osseuse, furent réexaminés en vue d'évaluation. Le recul moyen était de 41 mois (20-117). Un bon résultat fut noté chez 9 des 12 patients, mais le premier traitement échoua dans la moitié des cas, à cause de la brièveté de la plaque semi-tubulaire (4 trous) et d'une immobilisation post-opératoire insuffisante. Les auteurs concluent que la plaque à 4 trous ne peut être recommandée pour traiter les pseudarthroses de la clavicule, vu l'important risque d'échec. Une immobilisation post-opératoire pendant un temps suffisant est nécessaire après mise en place d'une plaque vissée. A condition de respecter cette précaution, la fixation par plaque, complétée par greffe osseuse, se revèle une méthode fiable pour le traitement des pseudarthroses de la clavicule.