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Complications of Marchetti locked nailing for humeral shaft fractures

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Abstract In this retrospective study 50 humeral fractures (36 acute, 6 pathological fractures and 8 non-unions) were treated by retrograde locked bundled Marchetti nailing. No intraoperative complications occurred. Postoperative complications included 7 non-unions (4/36 acute fractures and 3/8 delayed union), and 2 intraarticular penetrations of the secondary nails. However, at the subsequent removal of the implant 5 supracondylar fractures occurred.

Résumé Le but de ce travail est de déterminer les risques et les complications du clou fasciculé (Marchetti) dans le traitement des fractures de la diaphyse humérale. Cette série rétrospective de 50 cas comporte 36 fractures récentes, 8 pseudarthroses et 6 fractures pathologiques. Aucune complication per-opératoire n'est à déplorer. Parmi les complications post-opératoires 7 pseudarthroses (4 parmi les 36 fractures récentes, 3 parmi les 8 pseudarthroses opérées) et 2 effractions articulaires sans conséquences sont survenues. Cinq fractures supracondyliennes sont survenues à la suite de l'ablation de l'implant.

Introduction

Conservative treatment of humeral shaft fractures with hanging cast or Sarmiento brace provides union in about 95% of the cases [1, 15]. While conservative treatment is the best choice for most cases, surgical treatment is often required in polytraumatized patients, in displaced frac-

tures, or in cases with particular associated lesions. Open reduction with internal fixation is at high risk for radial nerve injury, with a rate between 2 and 5% [3] and in a prospective study even higher (3 to 29%) [11]. With the development of locking nails the use of intramedullary nailing has increased. All nails inserted proximal in the humerus may lead to damage of the rotator cuff, either at the insertion or during removal of the nail [5–7]. Nerve damage, tendinous entrapment or vascular injury caused by locking screws have been reported [5, 12] when using locked nails for the management of humeral fractures.

The Marchetti nail is a retrograde bundle locked nail. Reaming of the fracture site is not required and distal locking is automatically ensured by the secondary nails restrained under tension [8, 15].

Patients and methods

This retrospective study is based on our first 50 nailings performed between January 1995 and December 1998. All cases are listed in Table 1. There were 24 men and 26 women with a mean age of 55 (19–93) years. There were 36 acute fractures, 8 aseptic non-unions and 6 pathological fractures. All fractures were closed.

The patients were operated using X-ray imaging. All acute fractures were treated by closed intramedullary nailing, whereas a direct approach to the fracture site was used in non-unions where retrieval of material was needed. The entry point for the nailing was located at the tip of the olecranon fossa, prepared with a 3.2 mm drill and enlarged with a 4.5 mm drill. The flexible reamers were introduced progressing 0.5 by 0.5 mm, the first one 7 mm in diameter. They were used to prepare the first 4–5 cm of the medullary canal. For a nail with 4 secondary nails the last reamer was 8 mm. In case of a particularly narrow medullary canal, as seen in one case, reaming of the whole canal including the fracture site was done. The insertion of the nail is performed without the use of a guide-wire. Postoperatively a shoulder sling was used for 10 to 15 days.

All patients were checked by regular intervals including clinical and radiographic examinations. Two patients were lost to follow-up and three died before consolidation (2 patients suffering from pathologic fractures and one patient presenting a fatal pulmonary embolism). Functional results were evaluated according to a modified Stewart and Hundley scoring system (Table 2).

We proposed removal of the nail in the youngest patients, especially workers, in order to prevent problems in case of another trauma with the nail still in place.

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Table 1 Data of the patients

N°	Sex	Age	Indication	Type ^a	Site	Ass. Lesions	Outcome	Complications	Reoperation
1	M	48	Acute	B1	Midshaft	Median nerve palsy	Union		
2	M	39	Acute	A1	Midshaft		Union		
3	F	29	Nonunion	C1	Midshaft	Broken pins	Union		
4	M	39	Nonunion	A3	Distal third	Broken pins	Union		
5	F	81	Acute	B2	Proximal third		Union		
6	F	69	Pathological fr		Midshaft	Osteolysis		Death 2 mths	
7	F	67	Acute	A1	Distal third		Union		
8	F	45	Nonunion	B2	Proximal third		Union	Fracture removal nail	
9	F	81	Acute	B1	Proximal third		Non-union		Exchange nailing (N°35)
10	F	77	Pathological fr		Proximal third				
11	F	73	Acute	B1	Proximal third	Humeral neck fr	Union		
12	M	45	Acute	B1	Midshaft		Union		
13	F	16	Acute	A2	Midshaft		Union	Fracture removal nail	
14	F	61	Acute	B3	Proximal third		Union		
15	M	55	Acute	A1	Midshaft	Shoulder dislocation	Union		
16	F	36	Acute	C3	Proximal third	Pregnancy	Union		
17	F	21	Acute	A3	Midshaft		Non-union		Exchange nailing (N°23) Exchange nailing (N°31)
18	M	37	Acute	A3	Midshaft	Fr scapula	Non-union		
19	M	47	Acute	C2	Midshaft	polytraumatized	Union		
20	M	31	Acute	A3	Proximal third	Fr scapula	Union	Fracture removal nail	
21	F	56	Acute	B1	Proximal third		Union		
22	F	69	Acute	B1	Midshaft	Radial nerve palsy	Union		
23	F	21	Nonunion	A3	Midshaft		Non-union		Plate
24	F	41	Acute	A3	Midshaft		Union		
25	M	53	Acute	A3	Proximal third		Union		
26	M	27	Acute	B2	Midshaft		Union		
27	M	72	Acute	C1	Proximal third		Union		
28	M	36	Acute	C2	2 upper thirds		Union		
29	F	45	Acute	C1	Proximal third		Union	Fracture removal nail	
30	M	83	Acute	B1	Proximal third		Union		
31	M	37	Nonunion	A3	Midshaft		Union	Crack removal nail	
32	M	69	Pathological fr	A3	Proximal third		Union		
33	F	84	Acute	C1	Midshaft			Death 2 mths	
34	F	76	Acute	C3	Proximal third		Union		
35	F	81	Nonunion	B1	Proximal third		Non-union		Refused
36	M	51	Pathological fr	A3	Midshaft		Union		
37	F	93	Acute	B1	Proximal third		Union		
38	M	29	Nonunion	A3	Midshaft		Non-union	Fracture removal nail	Plate
39	F	63	Acute	B1	Proximal third		Union		
40	M	85	Acute	B1	Proximal third		Union		
41	F	84	Acute	A1	Proximal third	Humeral neck fr	Union		
42	F	45	Acute	B1	Midshaft		Union		
43	M	88	Acute	A1	Midshaft	Humeral neck fr	Union		
44	F	32	Nonunion	A1	Midshaft		Union		
45	F	74	Acute	A1	Proximal third		Union		
46	M	20	Acute	A1	Distal third		Union		
47	M	83	Acute	B1	Proximal third		Non-union		Plate
48	M	48	Pathological fr	A3	Distal third			Death 2 mths	
49	M	83	Pathological fr	A3	Midshaft		Union		
50	M	19	Acute	A3	Midshaft		Union		

^a Type according to the AO-system**Table 2** Evaluation of functional results

Results	Excellent	Good	Poor	Bad
Shoulder elevation	≥160°	<160°	<120°	<90°
Elbow flexion	≥140°	<140°	<130°	<110°
Loss of elbow extension	0°	<10°	<20°	≥20°

Results

The nailing procedure lasted in average 60 (35–100) min. No intraoperative complications were observed. A good reduction was obtained in all cases except 3 in which a gap between the main fracture fragments was maintained after the nailing. There were no infections and or neurological complications.

Fig. 1 **a** 42-year-old male with a proximal fracture of the left humerus (B1 type). **b** Conservative treatment led to a non union which was treated by reaming and Marchetti nailing. Union occurred in 3 months. **c** Extraction of the nail, 14 months later, created a crack at the entry hole of the nail. After a minor trauma a complete spiral fracture occurred

Fig. 2 **a** A comminuted fracture in a pregnant woman (9th month). **b** Union occurred with an excellent result in 10 weeks

32 patients suffering from an acute fracture achieved bony union within twelve weeks (range 45 days to 120). 4 non-unions occurred after 2 transverse fractures at the middle of the diaphysis, and after 2 proximal long spiral fractures with a third fragment. In 2 cases, a penetration of the articular surface of the humeral head by the secondary nails was observed. The penetration was minimal, and did not lead to premature removal of the nail. The 8 non-unions treated with reaming and Marchetti nailing resulted in 5 consolidations and 3 failures.

All patients recovered nearly the preoperative motion of their shoulder; the extension of the elbow was limited for about 10° in a few patients. All patients were pain free.

Removal of the Marchetti nail was performed twenty times and always appeared to be a difficult procedure. In one case the removal of the nail seemed to be impossible and the procedure was stopped; a second attempt a few weeks later was successful. In 2 cases a crack occurred without further problems. In 5 cases a supracondylar fracture occurred, peroperatively in 3 cases and postoperatively after a minor trauma in 2 cases. The 3 peroperative fractures were treated by pinning (1) or plating (2); the 2 postoperative fractures were treated conservatively. In these five cases the final result was good and the function of the elbow not altered.

Discussion

The advantages of the Marchetti bundle nail are an easy technique of insertion, lack of preliminary reaming of the medullary canal and automatic locking with the release of secondary preloaded nails [8, 16]. Contrary to the Halder device (personal communication), the secondary nails are fixed to the cylindrical part of the nail. Although the use of a guide wire is impossible with this nail, the mobilisation of the distal humerus with the nail handle facilitates reduction. The inherent elasticity of the secondary nails prevents iatrogenic comminution of the fracture as reported with both Seidel- [2, 13] and Russell Taylor-nails [14]. Fracture below the end of the nail as has been previously described [9] was not seen. A few cases of shortening at the fracture site was observed, and so was rotatory displacement, but only in 2 spiral fractures which did not unite. The penetration of the secondary nails in the humeral head was most often limited to 2 to 5 mm. So the recommended distance of 10 to 15 mm between the tip of the nails and the articular surface has to be respected.

The rate of non-union in the acute fractures in this series was relatively high. This might be due to faulty indications and bad reductions. In unstable long spiral fractures, an external sling for 4 to 6 weeks should be used, especially when contact between the main fragments is not obtained during surgery. In transverse midshaft fractures the Marchetti bundle nail is often too thin to provide stable fixation, even when 5 nails with a total diameter of 8 mm are implanted.

Although a few series reported a 100% union rate, the incidence of non union following locked humeral nailing ranges from 0 to 29% [5]. Chantelot [4] reported a union rate of 6% with the Marchetti nail. Our rate of consolidation in the non unions treated by this method was also disappointing. In these difficult situations with atrophic bone or persisting bone gap it is obvious that plating with bone grafting [10], or fixation with a rigid locked nail [11] are the methods of choice. Exchange nailing with a Marchetti nail should only be done in case of limited bone loss and good contact between the main fragments.

Fractures after removal of a nail is uncommon. Fracture following the removal of a humeral nail has to our knowledge not been described previously with other implants than the Marchetti nail. The main reason for this complication is the design of the nail. The distal cylindrical part of the nail which provides fixation of the secondary flexible nails is bent at 45 degrees, whereas most rigid nails are only bent 5 or 10 degrees. So the extraction of the Marchetti nail is very difficult and a crack or a complete fracture may easily occur. In our series the crack was in all cases produced by the cylinder part of the nail and not by the nail itself. A modification of this part of the nail is clearly needed. Furthermore the distal part of the nail is always found surrounded by dense cortical bone. Before extraction of the nail it is necessary to meticulously remove the bone around the nail with a small drill. When extraction of the nail is decided this should rather be done early, most often between the 4th and the 6th month.

The Marchetti retrograde bundle nail is however a useful device for the treatment of proximal or segmental humeral shaft fractures. It is not suited for transverse fractures in the middle or the distal third of the shaft. For non unions reaming and Marchetti nailing is rarely indicated. Removal of the nail is a major problem, which might be solved if the bending of the cylinder is modified.

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