

# Midshaft clavicular non-unions treated with the Herbert cannulated bone screw

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## ABSTRACT

**Purpose.** To assess an alternative technique for the treatment of midshaft non-unions of the clavicle.

**Methods.** Five patients with symptomatic non-unions of the clavicle were treated with open reduction and intramedullary fixation by using a Herbert cannulated bone screw. Autogenous bone grafting was applied in one case and decortication in the other 4 cases.

**Results.** Review of the clinical and radiological documentation at a mean time of 13 months (range, 9-26 months) postoperatively shows that union was achieved in all 5 cases. There were no complications related to the operation, and no patient needed removal of the implant for protrusion, loosening, or any other cause.

**Conclusion.** Midshaft non-unions of the clavicle can be treated successfully using the Herbert cannulated bone screw, which avoids the need for a second operation to remove the implant after bone union.

**Key words:** bone screws; clavicle; fracture fixation, intramedullary; fractures, ununited

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## INTRODUCTION

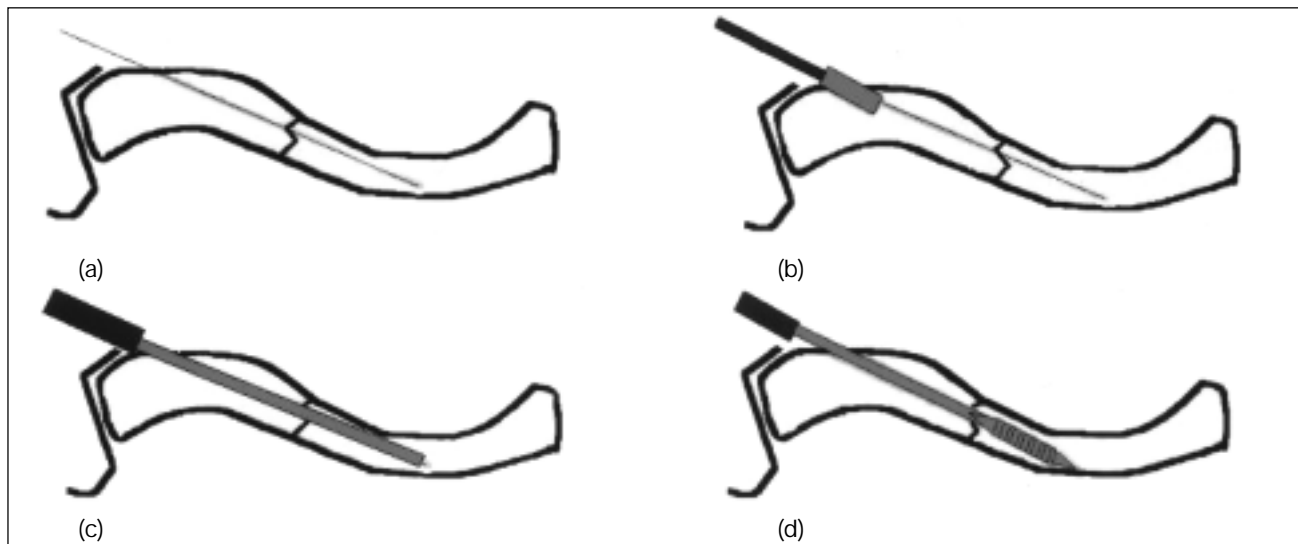
The incidence of non-union of the clavicle is reported to be between 0.1% and 15%.<sup>1-5</sup> Various surgical procedures have been proposed for the treatment of this potentially disabling condition, including interfragmentary screws or wire sutures,<sup>6,7</sup> intramedullary pinning with Kirschner wires,<sup>7-9</sup> Knowles pins,<sup>10</sup> Steinmann pins,<sup>11</sup> modified Hagie pins,<sup>12</sup> external fixation,<sup>13</sup> and compression plate with or without bone grafting.<sup>4,14-29</sup>

We assessed an alternative technique for the treatment of midshaft non-union of the clavicle by using a Herbert cannulated bone screw to achieve open intramedullary fixation.

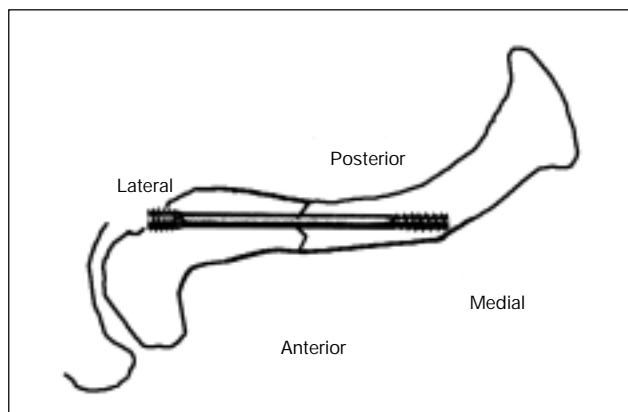
## MATERIALS AND METHODS

Five consecutive patients with midshaft non-unions of the clavicle were treated from 1999 to 2000. There were 3 men and 2 women with a median age of 33 years (range, 18-46 years). All the cases were right-sided.

In 4 patients, the original mechanism of injury was a fall from a height, and the remaining one a high-



**Figure 1** Operative technique: (a) the intramedullary canal of the clavicle is drilled with the Herbert cannulated guide pin by means of an anterograde or retrograde form; (b) insertion of the proximal drill bit over the guide pin to drill the cortex until the built-in stop contacting the cortex of the bone; (c) insertion of the distal drill bit over the guide pin to drill the intramedullary canal of the medial fragment until the end of the guide pin; (d) preparation of the canal with the cannulated tap for the leading screw threads of the implant.

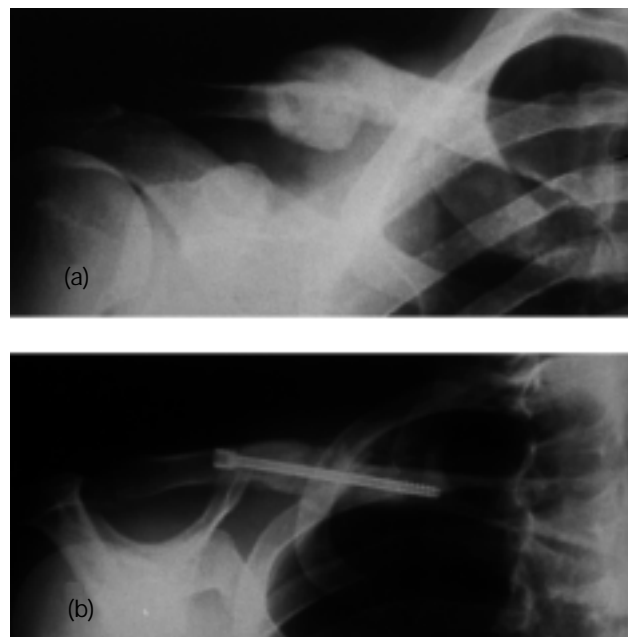


**Figure 2** Scheme of the implant in place.

energy traffic accident. All injuries were classified as group 1 (midshaft) clavicular fractures according to Allman<sup>30</sup> and Neer.<sup>31</sup> All fractures were initially treated conservatively with a figure-of-eight bandage for a mean period of 6.4 weeks (range, 6–9 weeks).

The mean time from the initial injury to the definitive operation was 14.8 months (range, 10–24 months). The type of non-union was hypertrophic in one case and atrophic in 4 cases. Pain at the site of non-union was the presenting symptom in all cases.

Open reduction and intramedullary fixation with the Herbert cannulated bone screw (Zimmer, Warsaw, US) was utilised in all cases. The patient was placed



**Figure 3** Atrophic non-union of the midshaft of the clavicle treated with Herbert cannulated bone screw: (a) preoperative radiograph; and (b) postoperative radiograph.

in the beach-chair position. A straight-line incision was made parallel to the long axis of the clavicle. After careful dissection of both ends of the clavicular fragments, the interposed fibrous tissue was removed and the medullary canal was opened on both sides.

In the case of hypertrophic non-union, the superficial part of the excessive bone was removed. The fracture was then reduced and fixed with an intramedullary Herbert cannulated bone screw. Internal fixation was performed by drilling the intramedullary canal of the lateral fragment with the Herbert cannulated guide pin to exit from the posterior cortex of the clavicle in the attachment zone of the conoid ligament, thereby avoiding the acromioclavicular joint (Fig. 1). After reducing the fracture, the guide pin was drilled across the fracture site and into the medial fragment, without perforating the anterior cortex. After insertion of the proximal drill bit over the guide pin, the posterolateral cortex of the clavicle was drilled until the built-in stop contacted the cortex of the bone. The distal drill bit over the guide pin was then penetrated at the end of the guide pin. A Herbert cannulated bone screw of proper diameter (4.5 or 6.5 mm) and length was selected and, after threading the canal created by both drill bits with the cannulated tap, the intramedullary implant was introduced from the posterolateral aspect of the lateral fragment to the anteromedial aspect of the medial fragment of the clavicle. In all cases the diameter of the implant was 4.5 mm (Fig. 2). Only one case (atrophic non-union) required autologous corticocancellous bone graft from the anterior iliac crest to pack the gap created in the non-union area, whereas in the other cases, this procedure was not required since good compression force was obtained with the Herbert screw (Fig. 3). However, these cases still required a decortication of both fragments at the non-union zone.

Finally, the trapezius and deltoid fascia were carefully repaired and the skin was closed after meticulous haemostasis. No drains were required in all cases. An arm sling was used for postoperative immobilisation for 3 weeks. Only passive motion of the shoulder not exceeding 90° of elevation was allowed during the next 3 weeks, and active motions were permitted after the bone union.

Review of the clinical and radiological documentation of all patients was undertaken at a mean time of 13 months (range, 9–26 months) after the surgical procedure. Restoration of clavicular anatomy and time to union were assessed by analysis of anteroposterior radiographs at 30° cephalic tilt. Union was considered to have occurred when the fracture zone or graft/host junctions had been obliterated by callus or when a complete periosteal bridging callus was present.

## RESULTS

Union was achieved in all 5 cases with no intra-

operative or postoperative complications. Union occurred within 4 months in 4 patients. The remaining case had segmentary bone loss after resection of the sclerotic ends of the clavicle. It required corticocancellous bone graft from the iliac crest, and union was achieved at 6 weeks. Restoration of clavicular length was achieved in all cases. All patients were asymptomatic after 10 weeks, and had a normal mobility of the shoulder with an acceptable cosmetic result.

## DISCUSSION

Non-union of the midshaft of the clavicle can be successfully treated by a variety of surgical techniques, including open reduction, and internal fixation with compression plates and intramedullary devices.<sup>32</sup> Of these, rigid internal fixation using Arbeitsgemeinschaft für Osteosynthesefragen (AO) plates with or without bone grafting seems to be the treatment of choice for this kind of fracture. Overall advantages of plate and screw osteosynthesis over other methods of fixation include excellent control of rotation and ability to restore the normal length of the clavicle. According to Jupiter and Leffert,<sup>33</sup> the apex of deformity in a clavicular non-union is superior; and a plate applied to the superior surface can act as a tension band, which enhances compression across the fracture. The high rate of success with plate fixation in various series lends support to these theoretical advantages. Another advantage of secure skeletal fixation with plates and screws is that immediate postoperative motion can be instituted.

Another method of treatment employed in the clavicular non-union is open intramedullary fixation with various devices, including smooth or threaded Steinmann pins,<sup>11</sup> Kirschner wires,<sup>7–9</sup> modified Hagie pins,<sup>12</sup> and Knowles pins.<sup>10</sup> Advantages of intramedullary pinning over other forms of fixation, particularly plate and screw osteosynthesis, include the limited extent of the incision with less dissection and stripping of the soft tissues, and the use of the intramedullary pin to serve as a load-sharing device. In this aspect, osteoporosis (which occurs under a plate as a result of stress shielding) is less severe. With an intramedullary pin, the likelihood of recurrent fracture through osteoporotic bone after hardware removal is also minimised.

These methods of treatment, however, have disadvantages. Disadvantages of plate fixation include the need for wider exposure and increased periosteal stripping, which can disturb the blood supply to the healing fragments. Furthermore, a larger exposure is

required for hardware removal, necessitating another surgical procedure, thereby increasing the risk of recurrent fracture after plate removal because of the osteoporosis below the plate and stress risers at the empty screw holes.

Disadvantages of intramedullary pinning include the difficulty to insert the device because of the curvature of the clavicle and the lack of control of rotational forces at the mid-third of the bone. The utilisation of such devices often requires external plaster support and this interferes with the rehabilitation regimen, particularly if stiffness of the glenohumeral joint exists. Therefore when a smooth rod is used, the stability is poor and severe complication of migration is not uncommon.

The method suggested in this report, which is similar to the technique described by Boehme et al.<sup>12</sup>—utilising a modified Hagie intramedullary pin—gives the advantage of producing a better compression of the non-union zone over the other intramedullary devices. In addition, since the implant can be completely embedded into the bone, there is no consequence of its protruding from the skin, thereby avoiding the production of lesions in the acromioclavicular joint. It also has the merit of permitting the collocation of bone grafts around the total perimeter of the bone, and hence avoiding the necessity of removing the implant after bone

union. The postoperative outcomes of the mobility of shoulders are similar for the cases treated with plate and those with screws. Olsen et al.<sup>24</sup> maintained the immobilisation with an arm sling during the first 3 postoperative weeks and allowed only passive motion of the shoulder not exceeding 90° of elevation for the first 6 weeks. Likewise Boyer and Axelrod<sup>14</sup> utilised a shoulder splint for patients' comfort for the first few weeks, and started active movement of the shoulder only when there was early evidence of radiographic union, which usually occurred at 6 weeks. Other authors,<sup>20,25-28</sup> who also employed plates and screws, limited passive forward elevation after surgery to prevent rotational torque on the clavicle and hardware.

## CONCLUSION

Both the plate and Herbert cannulated bone screw have their own merits, and neither one is absolutely better than the other in all aspects. In spite of the small number of patients in this study, our experience with the fixation technique using an intramedullary Herbert cannulated bone screw shows that successful treatment for midshaft non-unions of the clavicle can be achieved. This technique also avoids the necessity of removing the implant after bone union.

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