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ORIGINAL STUDY

Clavicle non-union : autologous bone graft is not a necessary augment to internal fixation

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Most series of patients undergoing open reduction and internal fixation (ORIF) of clavicular non-union utilise distant autologous bone graft. We aimed to report the outcomes of a series of patients who had undergone ORIF for clavicular non-union without the use of distant bone graft.

All patients undergoing ORIF of a clavicular non-union were identified on the hospital database. Records were reviewed to determine basic demographics, operative findings, and radiological outcome. Patients were contacted and details about initial injury and treatment, and return to work and sport, were recorded. Disabilities of Arm, Shoulder and Hand (DASH) questionnaires for both operated and non-operated shoulders were completed.

Fifteen patients with at least 6 months follow-up (average 12.4) were identified. Their average age was 39 years. All patients were initially treated in a broad arm sling. All fractures were fixed with a pre-contoured locking plate and all went on to achieve clinical and radiological union. The average DASH score was 14.5 on the operated side and 4.2 on the contralateral side. All patients had returned to work and regular sport activities. One patient required plate removal due to local irritation.

The results of this small series suggest that use of distant bone graft is not necessary when performing ORIF for symptomatic non-union of the clavicle with appropriate preparation of fracture ends and adequate fixation.

Keywords : clavicle ; nonunion ; ORIF ; bone graft.

INTRODUCTION

Fractures of the clavicle are a common presentation to the orthopaedic service. The annual incidence of clavicular fracture has been variably reported, ranging from 29 to 64 per 100,000 persons per year. Fractures of the shaft account for the majority of clavicle fractures, with the incidence reported to be between 69% and 82% (*13,14,16*).

The accepted standard treatment for closed clavicular fractures is non-operative with immobilisation in a broad-arm sling or figure-of-eight bandage. While classically considered to be uncommon, non-union has been reported to occur in 6 to 15% (*4, 22*). It has been projected that in a female, over the age of 70 years old, and in whom the clavicle fracture is both displaced and comminuted, the risk of non-union is as high as 49% (*9*).

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A common approach to managing a symptomatic non-union of the clavicle midshaft is open reduction and internal fixation. A variety of plates are most commonly used for fracture fixation while fixation with Ilizarov or intramedullary devices is also reported (*2-4,6,8,11,17-20*). Bone graft harvested from a distant site is often used to augment the fixation although this can result in pain and varying degrees of patient morbidity (*1,5,15,21*). There is no consensus thus far as to which type of fixation is best and whether or not bone graft is even necessary.

In our institution we have used a titanium, precontoured locking plate (Clavicle Plate, I.T.S., Lassintzhöhe, Austria) for fixation of symptomatic fracture non-unions. We do not use autologous bone graft harvested from a distant site as a routine measure. We aimed to report the outcomes of a consecutive series of patients who had been treated with this approach for symptomatic fracture non-union of the middle-third of the clavicle.

PATIENTS AND METHODS

We identified all patients who had undergone open reduction and internal fixation of the clavicle for a symptomatic midshaft non-union. We define a non-union as failure to heal following 6-months standard treatment.

Basic demographics were obtained from medical records and clinical notes as were details of the initial injury and treatment, time to surgery, functional outcome, and complication including infection and secondary surgery. These details were confirmed with the patients by phone conversation. Details regarding return to work, leisure and sports and satisfaction about the cosmetic result were gathered.

Initial radiologic investigations were reviewed and non-unions classified as either hypertrophic or atrophic. Most recent radiographs were assessed to determine evidence of union.

Patients were invited to complete the Disabilities of Arm, Shoulder and Hand Score (DASH) (*7*). A DASH score of the contralateral upper limb in each patient was used for control purposes and history of contralateral upper limb injury was noted.

The surgical procedure

All procedures were performed under general anaesthetic. No regional block was used as an augment. The patient was positioned in the beachchair position. Intravenous antibiotics were given at induction and continued for 24 hours after surgery.

An incision was made along the clavicle anterosuperiorly, centered over the fracture site. Soft tissues were dissected and the incision developed straight down to bone without developing any superficial tissue plane. Once the fracture site was identified, it was cleared of any interposed fibrous tissue and reduced into position using bone holding forceps. Excess callus at the fracture site in the case of a hypetrophic non-union was morselized to use as local bone graft . In atrophic non-unions we paid attention to freshening the ends of the bone at the fracture site and used a 2 mm drill to open the medullary canal and encourage fresh bleeding from the bone ends. The plate (6- or 8-hole depending on patient size) was first secured medially with one screw. The first lateral screw was placed eccentrically through the plate hole to encourage fracture compression although the plate primarily functions by bridging the fracture. We aimed to engage six cortices either side of the fracture (fig 1).

Once fixation was completed, any anterior bony prominence resulting from imperfect reduction was debrided and this bone was also used as an augment. The wound was closed in layers and no drain was used. (fig 2 & 3 demonstrate pre-operative and post-operative images). The patient was initially kept in a shoulder immobiliser for comfort and passive range of movements were commenced after one week.

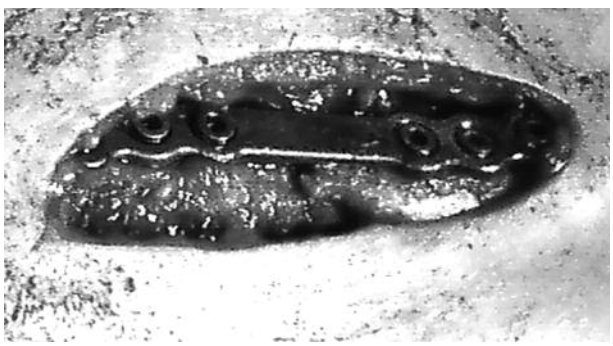

Fig. 1. — Three screws are used either side of the fracture site to engage six cortices on each side. Hypertrophic bone can be morselized and packed into the fracture site.

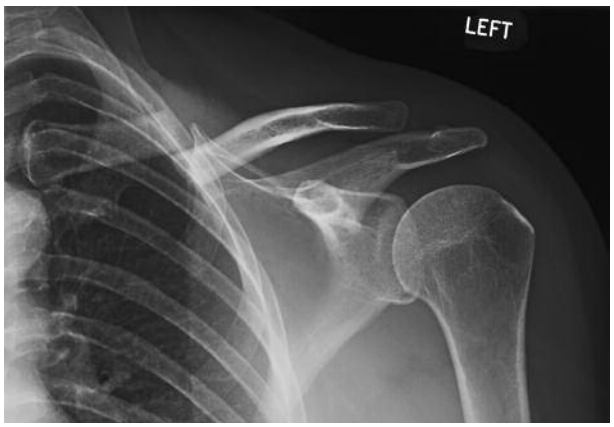

Fig. 2. — Pre-operative radiograph of a clavicle fracture non-union (atrophic) in a 50-year-old female. She sustained this fracture as a result of a fall from a bicycle.

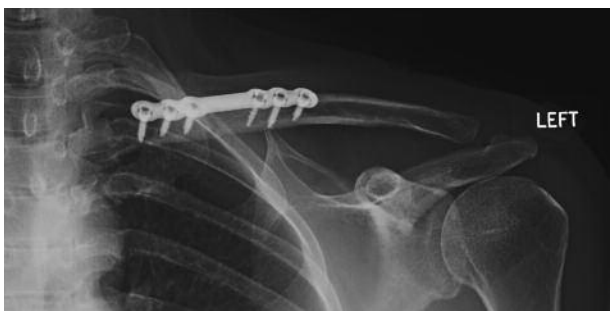

Fig. 3. — Immediate post-operative radiograph showing fixation with three screws either side of the fracture.

RESULTS

We identified 15 patients with an average age of 39 years (range 19-77)) who had undergone open reduction and internal fixation for a symptomatic clavicle non-union. At initial presentation with the clavicle fracture, all patients were treated in a broad arm sling at their original treating hospital. Details including original mechanism of injury can be seen in table I with further details.

At presentation to our service they chiefly complained of pain at the fracture site exacerbated by activity. All patients had the operative procedure performed as detailed above and none had bone graft harvested from a distant site. The average length of hospital stay was 1.1 nights (only one patient stayed two nights due to anaesthetic complications). There were no post-operative complications attributable to the clavicle fixation reported.

All patients were reviewed at least six months following surgery (average 12.4 months). All fractures united both clinically and radiologically. All patients had returned to normal work and regular sporting actvitiy at follow-up. No patient reported any restriction in sporting actvitiy. One patient involved in rowing complained of occasional hypersensitivity over the scar when carrying his canoe on the treated shoulder. The average DASH on the operated side was 14.5 and 4.2 on the contralateral side.

All patients were satisfied with the size and appearance of the scar following surgery. One individual required removal of the plate due to persistent discomfort over the medial end of the plate.

DISCUSSION

We performed a retrospective review of a series of patients undergoing open reduction and internal fixation of symptomatic clavicle fracture non-unions. Our patient outcomes using a precontoured locking plate without the use of distant bone graft appear acceptable.

The risk of non-union in displaced comminuted fractures of the clavicle is well established (*9*). Due to their ability to preserve blood supply it has been suggested that low-contact dynamic compression plates are the optimum fixation device (*12*). Our series here is a first to report outcomes following the use of a precontoured locking plate for the clavicle. Previous series have focussed on multi-purpose fixation devices or even pelvic plates (*2-4,10,12,18*). The results of this initial small series is supportive of a clavicle-specific plate as it appears to be effective without the use of distant bone graft.

A number of previous series have reported the outcomes following plate fixation of clavicle non-unions augmented with bone graft. Stufkens *et al*

reported a series of 52 patients with a majority having iliac crest graft used as an augment (*18*). About half this number again had some form of bone substitute while five did not have any bone graft. Wentz *et al* reported on a series of semi-professional athletes who had a clavicle non-union fixed with a plate and bone graft : all returned to sport, a finding consistent with our series (*19*).

Huang *et al* followed a similar approach to ours and used local callus from hypertrophic bone as a graft in appropriate cases and also finds satisfactory results. However, they used harvested iliac crest graft for atrophic non-unions that we have found to be unecessary (*6*). Our experience that bone graft harvest from the iliac crest has the potential to cause significant pain and complication is consistent with previous reports (*1,5,15,21*).

We place the pre-contoured plate antero-superiorly on the clavicle. One concern is that this can result in metalware prominence and necessitate plate removal. Collinge *et al* reported the follow-up fo 58 patients who had either acute fracture or non-union of the clavicle midshaft internally fixed with a 3.5 mm plate positioned antero-inferiorly. Despite this attempt to reduce the risk of metalware problems, two patients required plate removal due to bothersome metalware (mean follow-up 49 months) (*2*). It appears that despite best attempts some patients will complain of metalware irritation requiring late removal of the plate after the fracture has healed – only one patient in our series required this. We believe that careful attention to the approach allows a sufficient cover of soft tissue at the completion of the procedure and that this plays a role in miminising the need for subsequent removal.

We acknowledge that this is a small series and that a larger cohort would offer firmer evidence. However we believe that these results are promising and suggest an approach that can reduce patient morbidity by avoiding distant bone graft harvest.

In summary, we have found that a contoured locking plate applied to a suitably reduced midshaft clavicle fracture and used without distant autologous bone graft, results in a satisfactory patient outcome. Patient morbidity can be reduced by avoiding distant bone graft harvest.

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