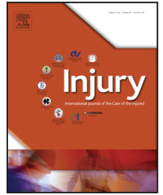




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Treatment of an atrophic clavicle non-union with the chamber induction technique: a case report

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KEY WORDS

Clavicle non union
Clavicle bone defect
Chamber Induction Technique
Masquelet Technique
Polytherapy

ABSTRACT

The gold standard technique for treating non-union of the clavicle is based on corticocancellous bone graft harvested from the iliac crest and fixation with a plate. In cases of large clavicular defects, this surgical procedure becomes ineffective and only a complex bone reconstruction can be considered. In the herein study we report on a clavicular non-union which was associated with a 4 cm bone defect that was managed successfully with optimum fixation and the Chamber Induction Technique (C.I.T)-formation of the masquelet membrane- and subsequent biological augmentation with a composite bone graft.

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Introduction

Clavicle fractures represent the 2.6–5.0% of all fractures in adults [1]. The annual incidence is 36.5 per 100,000 people while 70–80% of all fractures in adult occur in the middle-third of the shaft [1–3]. The annual incidence of midclavicular fracture in Europe is 64 per 100,000 population [1–5]. These fractures typically occur in young, male subjects as a result of high-energy trauma during a sports or motor vehicle accident [6]. Clavicle fractures are described by the Allman classification as midshaft, lateral third, and medial third fractures [7]. The midshaft is the thinnest segment of the clavicle and it's not stabilized by ligaments, whereas both the lateral side and the medial side are stabilized by strong ligamentous and muscular structures. Thus, the midshaft is comparatively more susceptible to fracture. The mechanism of injury is often a direct blow or a fall onto the shoulder [8]. These fractures show a high union rate of nearly 95% [9,10]. The majority of these fractures are characterised by displacement of fracture fragments. Historically, conservative treatment was recommended but the current trend is to provide internal fixation when the fracture is significantly displaced [10–15]. Overall, the non-union rate range has been reported to range between 0.1% and 24% [16,17]. An increased risk of symptomatic non-union for comminuted clavicle fractures following conservative as well as surgical treatment has been suggested [18,19]. In cases where revision surgery has failed, the atrophic and/or avascular bone segment requires resection that could

reach up to more than 5 cm. Every effort should be made to restore the length of the clavicle during revision surgery as shortening has been associated with a decrease in shoulder elevation, flexion and internal rotation movements, as well as an increase in coronal angulation of the clavicle at the sternoclavicular joint [20].

Significant risk factors that contribute to the development of the non-union or fixation failure include drug abuse, diabetes and previous surgery of the shoulder [21,22]. Surgical treatment is complex, technically challenging and may not be cost-effective [23]. In the herein case study we report the management of a clavicular non-union with bone loss that was managed with the chamber induction technique (CIT).

Clinical case

A 22-years old student with an atrophic non-union of the middle third of the shaft of the left clavicle presented to our institution for treatment. The history of his fracture started in 2009, after car accident, when he was treated at another hospital with a reduction of the fracture and osteosynthesis with k-wires. After one week from the surgery, he developed a local infection and the K wires were removed. Non operative treatment was suggested but the fracture failed to unite.

After two years' revision surgery was performed: the necrotic bone was removed, the bone defect was filled with homologous bone graft and a LCP plate was used to stabilise the bone. After one year as the fracture failed to unite the plate fail (broke). At the end of 2013 the patient was referred to our institution. Radiographs taken revealed an atrophic non-union with a critical bone size defect of 3 cm with the broken plate (Figure 1). There was pain on movement and residual instability. A CT scan was performed in order to complete the

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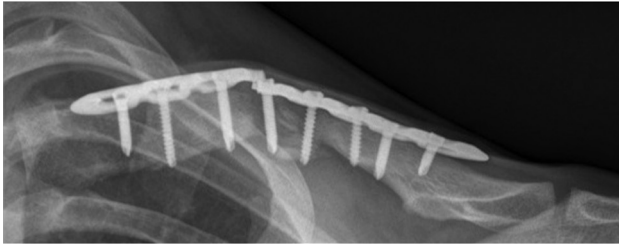
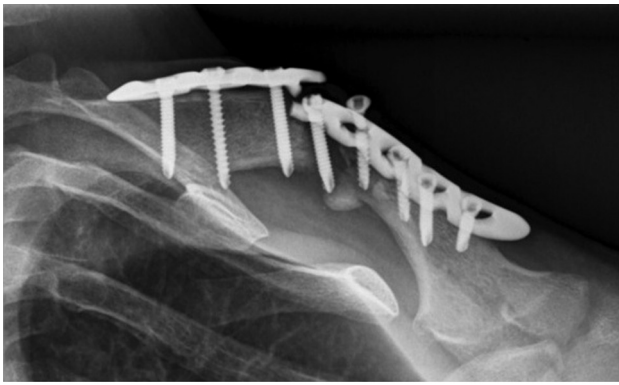


Fig. 1. Pre-operative X-rays showing the atrophic non union of the left clavicle with implant failure.

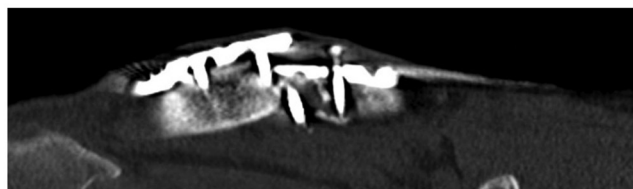
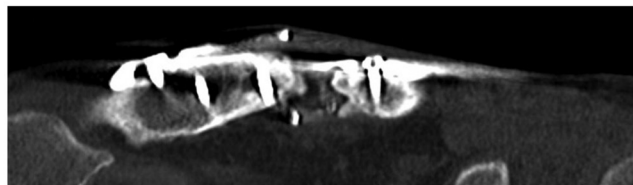
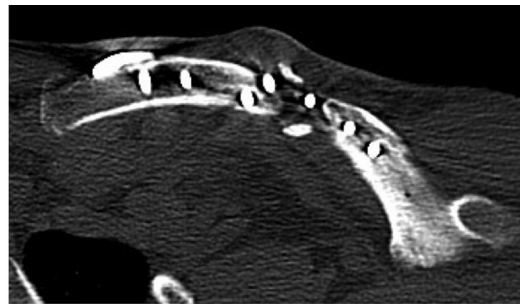
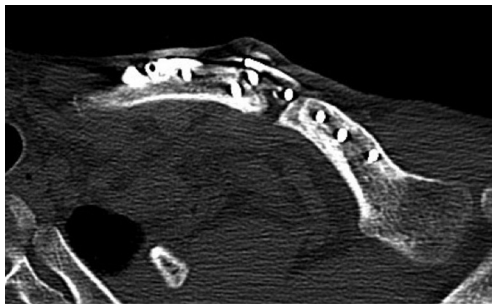


Fig. 2. Pre-operative CT scan demonstrating the left clavicular non-union.

preoperatively planning (Figure 2). The Non Union Scoring System (NUSS) [24,25] score was 52 points. We proposed to the patient a two stage reconstructive treatment (Chamber Induction Technique (C.I.T)) [26] taking into account the history of a previous septic condition, the high NUSS score and especially the necessity to correct the critical size bone defect. The first surgical step was characterised by the removal of the necrotic bone and of the broken plate. We calculated a bone defect of 4 cm, so we filled the gap with an antibiotic (clindamycin + gentamycin) cement spacer and the clavicle was stabilised with a locking plate (Figure 3). Tissue cultures taken during surgery revealed no bacteria growth.

After 3 months we performed the second surgical step and removed the cement spacer. The induced membrane that had formed was protected and the bone defect was filled with a composite autologous bone graft (RIA (left femur), mesenchymal stem cells MSCs (aspirated



Fig. 3. X-ray after the first step showing the new plate fixation and the antibiotic spacer.

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