Erosion of the Coracoid Process After Distal Clavicle Fracture Plate Fixation. An Unreported Complication

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ABSTRACT

Background: Several surgical techniques have been developed to reduce nonunion rates and improve functional outcomes after displaced distal clavicle fractures, including the use of a tension band, the modified Weaver-Dunn procedure, coracoclavicular screw fixation, or locking plates. None of these techniques have been universally accepted, and each one has its own complications. To our knowledge, there are no previous publications describing osteolysis of the coracoid process caused by the tip of a cortical screw of a distal LCP plate. **Case summary:** We present the case of a 29-year-old male patient who had been treated with an anatomic pre-contoured plate for a distal clavicle fracture. Six months later, he presented to our institution with limiting shoulder pain and tenderness upon the right coracoid process. Standard radiographs of the shoulder showed that the tip of a cortical screw was eroding the coracoid process. Surgery with hardware removal was then performed. One month after surgery, the patient was painless and with a full active shoulder ROM. **Conclusion:** Erosion of the coracoid process with plate screw fixation has never been described before. We suggest that extreme precaution should be taken in drilling and measuring the length of screws to avoid potential complications.

Key words: Coracoid erosion; clavicle fracture; complications; reduction; osteosynthesis.

Level of Evidence: IV

Erosión de la apófisis coracoides secundaria a osteosíntesis de fractura de clavícula distal. Reporte de un caso

RESUMEN

Introducción: El 10-30% de las fracturas de clavícula ocurren en el tercio distal. El diagnóstico se realiza con radiografías de hombro (de frente y de perfil, y proyección de Zanca). La mayoría de estas fracturas se tratan de forma conservadora, pero aquellas con gran desplazamiento, patrones transversos o conminutos pueden requerir tratamiento quirúrgico debido a la alta tasa de seudoartrosis. Se ha descrito diversos tipos de fijación para este grupo de fracturas. Si bien la osteosíntesis con placas logra resultados clínico-funcionales y de consolidación satisfactorios, no está exenta de complicaciones y las más frecuentes son: intolerancia al material de osteosíntesis (hasta un 30%), infección, lesión neurovascular y seudoartrosis. Sin embargo, según nuestro conocimiento, no existen reportes sobre la osteólisis de la apófisis coracoides secundaria a la osteosíntesis con placa LCP en fracturas del tercio distal de la clavícula. **Conclusión**: La erosión de la apófisis coracoides debido a la fijación con placa y tornillos es una complicación que no ha sido publicada previamente. Debe tenerse extrema precaución al realizar el túnel óseo y al medir la longitud de los tornillos para evitar potenciales complicaciones.

Palabras clave: Erosión de coracoides; fractura de clavícula; complicaciones; reducción; osteosíntesis.

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INTRODUCTION

Clavicle fractures represent 10% of all fractures and are usually caused by direct lateral trauma to the shoulder.[1] 10-30% of clavicle fractures occur in the distal third.[1] They are diagnosed with standard anteroposterior and lateral shoulder radiographs and clavicle radiographs with 15° of cephalic deviation (Zanca view).[1] Most clavicle fractures are treated conservatively, but those with large displacement or transverse or comminuted patterns may require surgery due to their high nonunion rate.[2] Various types of fixation have been described for this group of fractures, such as pre-contoured dynamic compression plates, tubular, or reconstruction plates.[2] Although plate osteosynthesis achieves satisfactory clinical-functional and consolidation outcomes, it is not exempt from complications.[3] The most frequent are intolerance to the osteosynthesis material (up to 30%), infection, neurovascular injury, and nonunion.[3] Likewise, other complications have been described, such as implant migration, acromial osteolysis, mechanical failure, pneumothorax, and adhesive capsulitis.[2,3] However, to our knowledge, there are no reports on osteolysis of the coracoid process secondary to osteosynthesis with locking compression plates in fractures of the distal third of the clavicle.

CLINICAL CASE

In 2018, a 29-year-old man underwent surgery in another Center due to a fracture of the right distal clavicle, with two fragments, secondary to a fall from his bicycle (Table). He underwent reduction and osteosynthesis with plate and screws, using an anatomically pre-contoured superior clavicle locking compression plate with angular stability and lateral extension (Depuy Synthes, Johnson & Johnson, USA). The patient underwent a postoperative kinesiology rehabilitation protocol that consisted of the use of a broad arm sling for two weeks, continued with pendulum movements of the shoulder, and ended with active abduction and controlled flexion up to 90° between the third and sixth weeks. Full active range of motion was authorized after six weeks and return to sports activity after 12 weeks. Initially, the patient returned to cycling and, progressively, to a recreational contact sport (soccer). He also stated that, as of the third postoperative month, he had not undergone any more clinical or radiographic controls and that he had been discharged.

Table. Classification of the patient's clavicle fracture

Classification	Type
Allman	2
Robinson (Edinburgh)	3A.1
Neer	2A
Cho	2A

Six months after surgery, he began experiencing limiting and increasing pain in his right shoulder, for which he decided to consult, at that time, in our institution. Physical examination revealed hypersensitivity at the level of the coracoid process with functional impairment of the shoulder due to severe pain, 9/10 on the visual analog scale. Radiographs of the clavicle and shoulder were taken in the anteroposterior, lateral, and Zanca views, in which the erosion of the coracoid process caused by contact with the distal end of the cortical screw used in the locking compression plate was observed (Figure 1). We decided to perform a three-dimensional computed tomography to correctly assess the extent of the lesion (Figure 2).

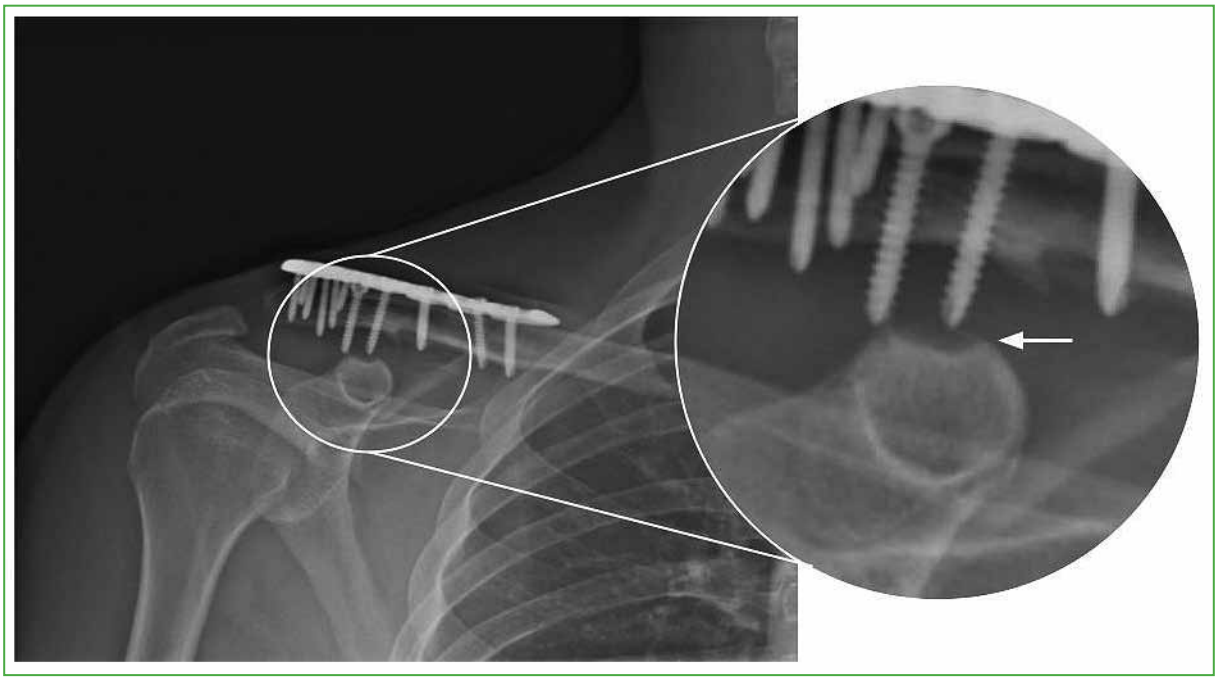

Figure 1. Anteroposterior radiograph of the right shoulder. The distal end of the cortical screw is seen eroding the coracoid process.

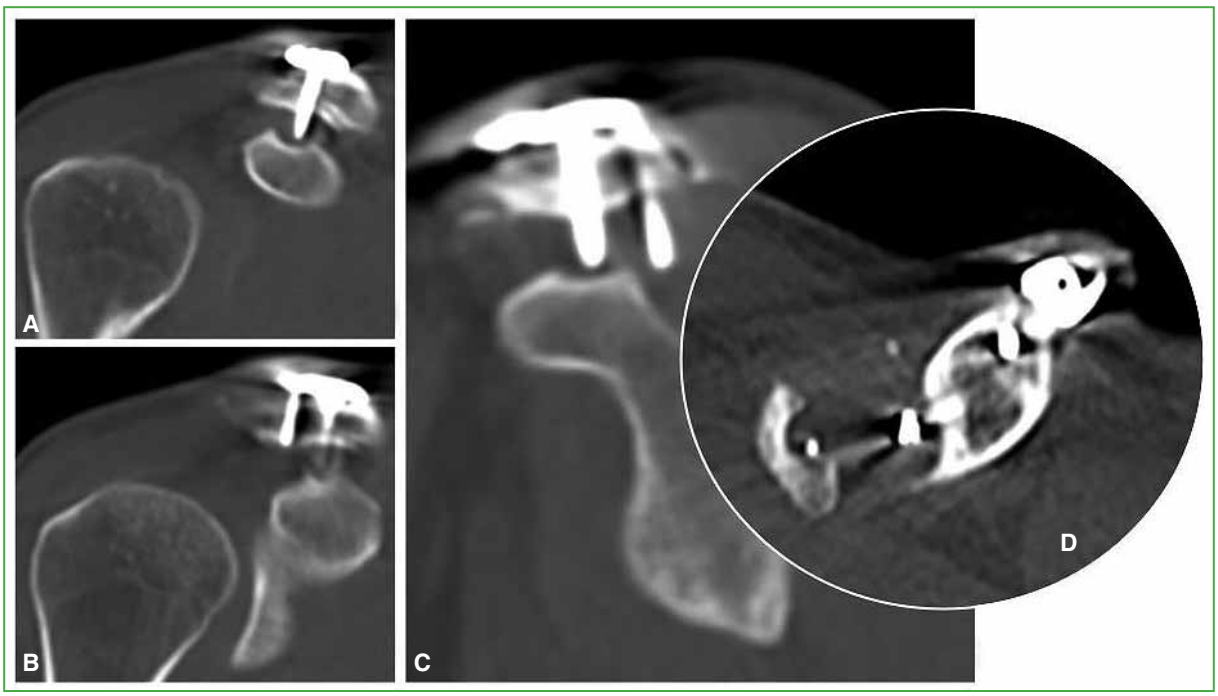

Figure 2. Preoperative 3D computed tomography of the right shoulder. **A and B.** Coronal sections. **C.** Sagittal section. **D.** Axial section showing >50% involvement of the coracoid process surface.

After the complementary studies, the osteosynthesis extraction surgery was scheduled 15 days after the initial consultation. To remove the plate and screw, the patient underwent sedation and a selective plexus block. The patient was placed in a beach chair position. The approach was performed over the previous incision and the osteosynthesis material was extracted under direct vision. The postoperative control radiographs were satisfactory (Figure 3). One month after surgery, the patient was pain-free and had full active range of motion, so he was able to resume activities of daily living and sports. He was discharged three months after surgery. The clinical-functional evaluation 12 months after the intervention included the Constant scale and the visual analog scale for pain. The results obtained were 96 and 1/10, respectively. No postoperative complications were detected.

Figure 3. Anteroposterior radiograph of a man after extraction of the osteosynthesis material.

DISCUSSION

Fractures of the distal third of the clavicle represent a challenge for the orthopedic surgeon.[4] The deforming forces caused by the weight of the upper limb, as well as the traction of the trapezius muscle, produce displacement of the fracture fragments.[4] In 1963, Neer classified distal clavicle fractures into five types.[5] Type II fractures occur medially or at the level of the coracoclavicular ligaments (type IIa and type IIb, respectively). Type V are comminuted fractures, with a free lower segment attached to the coracoclavicular ligaments, but not in continuity with the rest of the clavicle.[5] These two types of fractures are considered unstable and at high risk of nonunion, which is why Neer recommended surgical treatment for them.[5] Several studies have shown that the rate of consolidation with surgical treatment is greater than 90%, which is why most authors favor surgery.[6] However, others recommend conservative treatment based on the good clinical-functional outcomes achieved, despite the fact that the nonunion rate with this type of treatment is high.[6]

Different surgical treatment modalities have been described for distal clavicle fractures, including hook plates, intramedullary devices, subcoracoid suture, suture buttons (EndoButton®), harpoon fixation, coracoclavicular screws, locking T-plates and pre-contoured distal clavicle plates.[4] While there are multiple implant and surgical options, there is currently no consensus on which is best for treating Neer type II and type V clavicle fractures.[4,5] Anatomical (pre-contoured) locking distal clavicle plates have proven to be an acceptable surgical alternative with good clinical-functional outcomes.[2] However, such fixation is not exempt from complications, such as protrusion

or mechanical failure of the implant, infections, poor aesthetics, nonunion, neurovascular injuries, pneumothorax, and refracture after removal of osteosynthesis in cases of intolerance to the material.[7]

During plate and screw osteosynthesis, the subclavian neurovascular bundle may be injured,[5] it can be damaged by the drill bit during bone drilling, or by screw placement.[8] This injury can go unnoticed and have devastating consequences.[8] Shackford and Connolly reported a critical ischemia of the upper limb secondary to a pseudoaneurysm due to erosion of the subclavian artery caused by the distal end of one of the screws.[8] To avoid such damage, it is recommended to use blunt retractors placed on the lower edge of the clavicle when drilling with the drill bit. Additionally, control over direction and depth during plate fixation is of paramount importance. Qin et al. attempted to determine safe drilling angles and depth by dividing the clavicle into three segments, from medial to lateral.[9] They used magnetic resonance imaging to determine the spatial relationship between the clavicle and the subclavian neurovascular bundle. They determined that segment I, from the sternoclavicular joint to point "N" (where the subclavian bundle passes below the midpoint of the clavicle) was the one with the greatest risk of injury, and that the perforation should not exceed 17 mm deep. Because the neurovascular bundle was well below the level of the coracoid process (>40 mm), in segment III, they did not determine the angulations or perforation depths.[9]

It is clear, then, that the intimate relationship between the clavicle and the underlying neurovascular structures puts the latter at risk during surgery. Technical caution is essential during bicortical screw placement. In a biomechanical study, Zaidenberg et al. compared the strength of locking plate fixation with bicortical versus unicortical screws in displaced fractures of the middle third of the clavicle, which would prevent this potential neurovascular complication.[10] In this study, they found that bicortical screw locking plates were biomechanically superior in terms of resistance to axial load (compression) and torsional forces. However, the authors concluded that unicortical fixation with locking plates may be a valid option to treat such fractures. Aside from avoiding subclavian neurovascular damage, Looft et al. considered that the use of unicortical screws could have other benefits such as the ease of removing the implant in case of intolerance and the possibility of conversion to bicortical fixation if revision surgery is necessary.[11]

The coracoclavicular screw fixation technique, first described in 1941 by Bosworth, has been a widely used surgical method for treating fractures of the distal third of the clavicle. Fazal et al. used temporary fixation with a 6.5 mm partially threaded coracoclavicular screw with a washer in 30 patients who had a displaced fracture of the distal third of the clavicle.[12] Adequate bone consolidation was achieved in all cases and patients returned to their previous level of activity within a year.[12] Although this technique manages to achieve good clinical-functional outcomes, it causes potential complications, such as screw loosening, limitation of the range of shoulder joint motion, fracture of the coracoclavicular apophysis, implant breakage, screw retraction, and the appearance of ossifications between the clavicle and the coracoid.[12] Fazal et al. emphasized the need to strictly adhere to the postoperative rehabilitation regimen, avoiding early scapulothoracic mobilization, as this can produce rotation and tilting of the fractured fragment that causes retraction (pull-out) of the screw.[12] Coracoid osteolysis as a complication from fixation with a coracoclavicular screw has not yet been described in the literature.[12-14] Due to these complications, rigid screw fixation has been replaced by flexible or dynamic fixation, with sutures, suture harpoons, tapes, or button sutures.[14] The main advantage of this type of fixation is that it does not require a new intervention to remove the implant. Although most publications report excellent clinical-functional outcomes, these techniques are not exempt from complications. The most frequent are the loss of reduction (in up to 19% of cases) and the erosion of the bone tunnels with the consequent osteolysis.[14]

In multiple systematic reviews, it has been determined that pre-contoured locking plate osteosynthesis provides the best clinical-functional outcomes and poses lower risks of complications than other fixation methods.[15-17] However, to date, there is no consensus on which of these fixation methods is the best.[15-17]

Erosion of the coracoid process as a consequence of plate and screw fixation of fractures of the distal third of the clavicle is a complication that has not been reported to date. We believe that it can be avoided through proper preoperative planning and proper measurement of the length of the screws. Likewise, and if possible, we recommend the use of an image intensifier during the surgical process.

CONCLUSION

Erosion of the coracoid process due to plate and screw fixation is a previously unreported complication. Extreme caution must be used when making bone tunnels and when measuring screw length to avoid potential postoperative complications.

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