

Case Report

Treatment of Recalcitrant Medial Clavicle Non-union with Novel Dual Plating Technique

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Abstract

Medial clavicle fracture are rare injuries associated with significant morbidity. Treated conservatively historically, operative management has been recommended to improve function and union rates. Optimal surgical fixation has not been described, particularly in revision cases following failed fixation. Previously described options include sternoclavicular fusion or partial claviculectomy. We describe a case of a 33-year-old female surgeon who had two failed surgeries treated with iliac crest tricortical grafting with dual plating using an anterior plate and an inverted distal clavicle plate. Postoperatively, she was instructed to use a bone stimulator and receive teriparatide treatment. At the 9 months follow up, patients pain and function improved, and she is back to working full time. Dual plating technique supplemented with bone stimulator use and teriparatide administration appears to be a good treatment option in the short-term.

Introduction

Medical clavicle fractures account for 2-3% of all clavicle fracture [1]. Historically, most have been treated conservatively. Displaced fractures have been shown to cause symptomatic non-unions in 8% of patients treated non-operatively [2]. Surgical management has been recommended, especially for young, active patients [3]. However, this is associated with high complication and failure rates, particularly hardware migration [1,4-8]. Different fixation techniques have been described such as K-wires, plates, and nails [1,4-8]. Various plate options have included standard clavicular plates, plating across the sternoclavicular joint, using hook plates [8], and even distal radius plates [9].

Revision treatment for failed surgical fixation with non-union has not been well described. Partial claviculectomy has been reported for recalcitrant non-union of the medial clavicle, but this procedure is generally reserved as a salvage option, primarily in pathologic cases [10]. Sternoclavicular joint fusion has also been described, but with risk of failure,

stiffness, hardware migration, and pneumothorax. This usually demands a second procedure to remove the fixation across the joint [11]. We present a case of a young, active patient who sustained a medial clavicle fracture and failed two previous surgeries that was treated with a novel dual plating technique.

Case Report

A 33-year-old healthy female patient sustained a bicycling injury at the age of 23. She was found to have a medial clavicle fracture treated with an open reduction internal fixation using a superior plate. Although she continued to have pain, she was able to proceed with her pursuit of becoming a physician. Towards the end of her surgical training, at the age of 32, she had gradual onset of worsening symptoms about the medial clavicle and was unable to operate or partake in physical activities. X-rays at that time showed a medial clavicle non-union with a broken plate, which was missed (Figure 1). This was eventually addressed with a revision open reduction internal fixation using superior plating and synthetic bone grafting with calcium triphosphate.



Figure 1: Radiograph during the symptomatic stage showing broken hardware.

Four months after her second surgery, the patient presented to us for an initial consultation. She was complaining of continued pain, poor function, decreased motion, inability to work, difficulty sleeping, and paresthesias about her ipsilateral upper extremity. X-rays at that time showed a non-union with an impending catastrophic hardware failure (Figure 2). Patient at the time was undergoing treatment with a bone stimulator without any improvement and came to us for a second opinion.



Figure 2: This image was taken three months after the patients first revision surgery. Clearly visible is a medial one- third clavicle non-union with lucencies about the three medial screws and the lateral most screw. The superior plate seems to have started to bend with an apex superior deformity and likely impending catastrophic hardware failure.

We performed a complete infectious and metabolic workup, which was fortunately negative. CT scan was obtained, which confirmed the non-union and further delineated the significant lucencies about the screws (Figures 3a and 3b). A 3-D model of her contralateral clavicle was made for operative planning for the patient's true length and rotation (Figures 4a-d). Surgery was performed with a direct approach to the medial clavicle. Her previous incision was excised. Vascular and hand surgeons helped with the exposure. The posterior clavicle was adhered to the subclavian artery and vein. This was carefully elevated off the clavicle. The brachial plexus was explored and a formal neurolysis

was achieved. Once the clavicle was exposed, fracture reduction was achieved and autologous tricortical iliac crest bone graft was compressed within the fracture site. Care was taken to recreate healthy bleeding beds on both sides for optimal osteointegration. Bone marrow aspirate was also used to help stimulate local healing. Our plating technique consisted of an anterior titanium LCP plate and an inverted ipsilateral titanium distal clavicle plate placed superiorly (AccuMed, Portland, Oregon) (Figures 5a-c). Appropriate bending of the plate was done as needed. Previous screw holes were filled with synthetic bone graft and an amnion membrane was placed underneath the clavicle to prevent scarring and adherence of the subclavian vascular bundle along with the brachial plexus. She was restarted on her bone stimulator for four months post- operatively and underwent a three-month treatment with teriparatide.

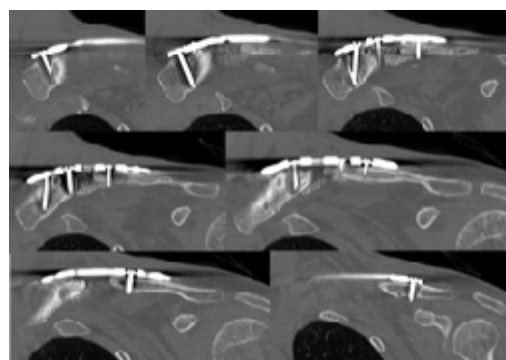


Figure 3a: Coronal CT images of the non-union and lucencies about the screws.

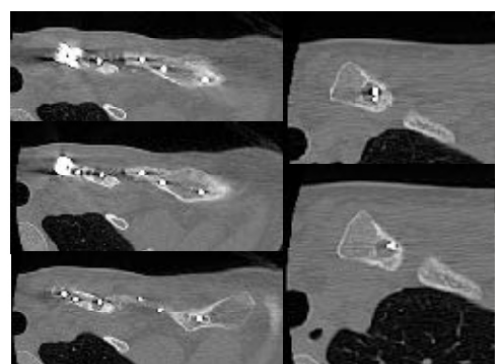
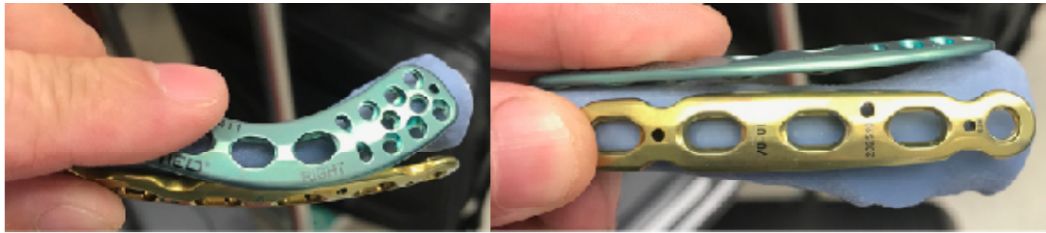


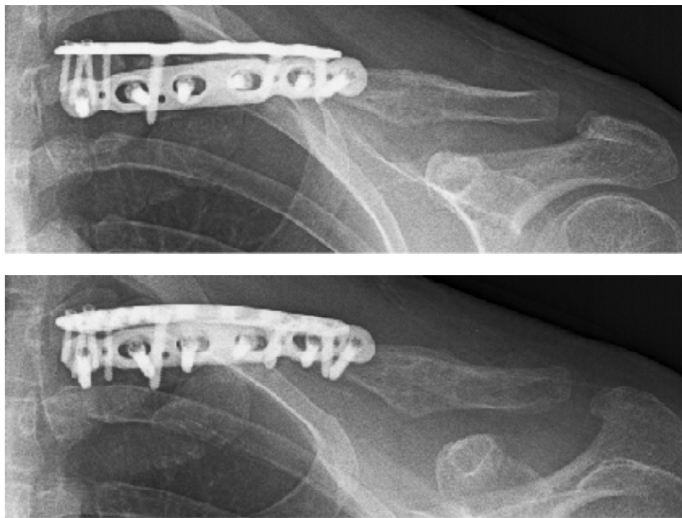
Figure 3b: Axial CT images showing the non-union and screw lucencies.



Figures 4a and 4b: This shows the dual plate construct for the contralateral unaffected size using a 3D model.



Figures 4c and 4d: Showing the same construct on a model of the ipsilateral side using a 3D model. The deformity and amount of correction is clearly shown.



Figures 5a and 5b: Dual plating construct showing anterior plating and inverted distal clavicle plating superiorly. Notice the multiple locking screws in the medial fragment possible by inverting the distal clavicle plate.



Figure 5c: Intra-operative picture of final construct. In this picture, the head is to the right side and the shoulder to the left.

Postoperatively, the patient's paresthesias have resolved. Her pain level is lower than it was preoperatively, and her range of motion is now full after 9 months. She is back to operating full time and complains of only mild discomfort with heavy overhead activities. She does not have difficulty sleeping and is very happy with her progress. Her SANE score improved from a 20 to 80. Clinically she has no tenderness or signs of a neuroma. Her strength improved from 3+ to 5- with respect to abduction, forward elevation, and rotation.

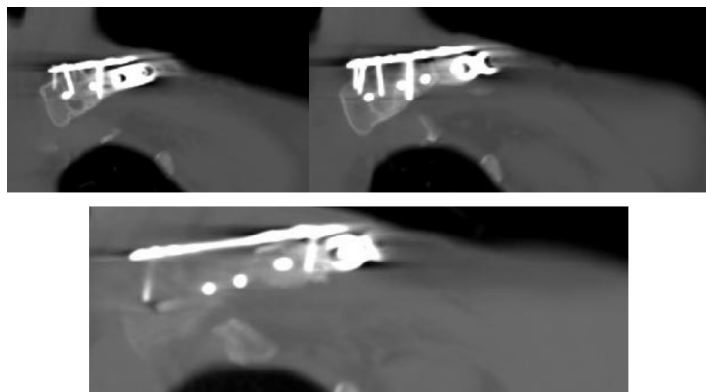
Discussion

Surgical treatment of displaced medial clavicle fractures have been recently recommended in order to improve function and decrease the chance of symptomatic non- unions. Since the medial fragment is usually small, optimal stabilization is difficult to achieve. Its location to vital neurovascular structures also makes this a difficult procedure with an increased chance of complications.

Various methods have been described, all with their own sets of complications. No gold standard has been established. In revision cases, fixation becomes even more difficult. K-wire fixation is not rigid enough and can fail [3,8]. Plating across the sternoclavicular joint limits motion and requires a second procedure to remove the temporary fusion [9].

Oe et al. in 2012 [1] treated ten patients using various plating options. The authors found that T-locking plates are preferred and recommended at least three locking screws in the medial fragment. Brunner et al. [12] reported a failure of medial clavicle fixation using 2.4 mm locking T-plates and hence advocated using a 3.5 mm locking plate for medial clavicle fractures.

In our case, we used dual locking plates. The anterior plate is a 3.5 mm LCP plate with the ability to tap threads in any screw hole to create options for angled locking screws. The superior plate used is a 180-degree inverted distal clavicle locking plate, which gives multiple 2.7mm locking screw options that provide additional fixation into the medial fragment. Inverted clavicle plates are always an option and may contour well to the medial clavicle in some cases [13,14]. Due to our patient's two previous failures, we augmented the rigid construct with the use of tricortical iliac crest autograft and BMAC. We also used post-operative bone stimulation and teriparatide, as we routinely do for our professional athletes. At the 9 months follow up, we have satisfactory clinical results. CT imaging shows fracture healing and filling of the previous screw lucencies (Figures 6 and 7).



Figures 6a-c: Coronal CT images showing fracture healing and filling of cysts left behind from previous fixation at two and a half months after surgery.



Figures 7a-c: Coronal CT images 7 months after surgery showing fracture union and no change in hardware position. Notice medial cyst still present but nearly fully filled.

Conclusion

Revision medial clavicle non-union fixation is a difficult problem. Dual plating appears to be a viable option. Bone stimulation and biologic anabolic may also be considered.

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