CASE REPORT – OPEN ACCESS

International Journal of Surgery Case Reports 77 (2020) 116–121

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.casereports.com

Autologous tendon graft for non-union distal clavicle fracture in a patient with chronic kidney disease

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ARTICLE INFO

Article history:
Received 10 September 2020
Received in revised form 19 October 2020
Accepted 22 October 2020
Available online 28 October 2020

Keywords:
Nonunion fracture
Distal clavicle fracture
Autologous tendon graft
Biological healing

ABSTRACT

BACKGROUND: Fracture of distal-end accounts for 20% of all clavicle fracture. In the situation of impaired bone healing environment such as chronic kidney disease (CKD), nonunion rates after surgery might increase. In the case where bone healing is unexpected, biological healing with tendon graft could be an alternative method to maintain bone reduction.

PRESENTATION OF CASE: A 62-year old male with a history of end-stage CKD presented to the hospital with pain, wound, and deformity on the right shoulder. The patient have had surgery in the past 4 months and resulted in a non-union fracture of the distal third right clavicle. The patient underwent implant removal and continued with coracoclavicular ligament reconstruction with autologous tendon grafts of semitendinosus tendon and mini-plate augmentation.

DISCUSSION: The Distal clavicle has a high rate of delayed and nonunion even without the presence of comorbidity. A compromised bone quality frequently leads to failed osteosynthesis in patients with end-stage renal failure. In the advanced stages of kidney disease, problems with a renal clearance of phosphate and low 1α-hydroxylase levels resulting in increased serum phosphate levels and low serum calcium levels. Given these circumstances, we considered the idea to maintain fracture reduction by biologic soft tissue healing of the graft to replace the coracoclavicular ligaments as we can not rely on normal bone strength and healing capacity.

CONCLUSION: In the situation where bone healing is unexpected, biological healing with tendon graft may be necessary. The use of autologous tendon graft and mini-plate suture augmentation could help to maintain bone reduction in such environment.

1. Introduction

Fracture of distal-end accounts for 20% of all clavicle fracture [1]. In Neer's type II fracture, nonunion complication is often inevitable. Nonsurgical treatment of this type of fracture resulted in more than 30% of nonunions and surgical treatment resulted in 6% nonunion rates [2]. Known risk factors for nonunion include increasing age, female sex, fracture displacement, comminution, and smoking [4]. However, in patients with impaired bone healing such as in chronic kidney disease(CKD), nonunion rates after surgical treatment might be higher. Patients on dialysis showed significant mineralized bone loss characterized by generalized thinning of cortical bone. Some studies revealed that the bone/implant contact ratio and strength of bone-implant integration were significantly lower in CKD patients and negatively impact the healing of bone fractures [3,5]. As declined renal function was associated with impaired bone regeneration, the presence of CKD could alter the fracture healing process [6].

Without the presence of CKD, surgical treatment, using hardware fixation to maintain the bone reduction, is expected to achieve a bone union. But in the case where bone healing is hard to be obtained, biological healing with autologous tendon graft reconstruction could be an alternative method to maintain the bone reduction until we achieve soft tissue and bone healing. Anatomical reconstruction of the coracoclavicular ligaments using autologous tendon graft has shown superior results compared to more conventional methods [3]. In our case, we had a relatively unforeseen presentation of nonunion fracture where conventional methods have failed to achieve bone union and successfully managed by

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https://doi.org/10.1016/j.ijscr.2020.10.106

Fig. 1. Preoperative Initial radiograph showed a distal clavicle fracture with coracoclavicular joint separation.

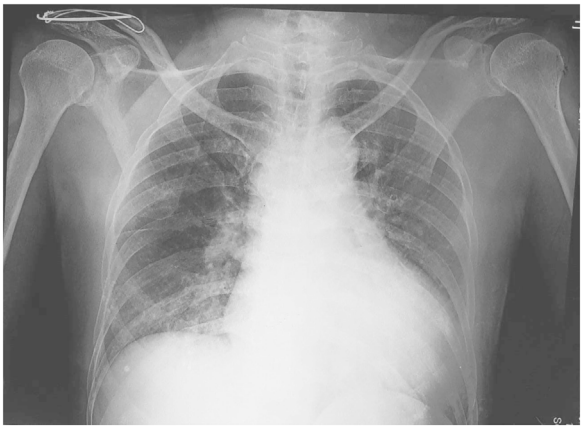

Fig. 2. Postoperative radiograph after intra-articular tension band wiring.

autologous tendon graft reconstruction to maintain distal clavicle fracture reduction.

2. Presentation of case

A 62-year old male presented to hospital outpatient department with pain, wound and deformity on the right shoulder. Seven months before admission, he slipped in the bathroom with his body weight resting on the right shoulder. After the incident, he complained about pain and deformity. X-ray examination was performed (Fig. 1) and internal fixation with intra-articular tension band wire surgery was carried out (Fig. 2). At four months follow up, he got the fracture non-union and implant failure and he complained a palpable and protruded implant (Fig. 3) The patient has a history of CKD and currently on hemodialysis.

On examination, there was a marked deformity on the right shoulder and tenderness. The range of motion was limited due to pain. Neurovascular examination was normal. The Patient then was advised to receive further treatment and diagnosed with non-union fracture of the distal third right clavicle. Implant removal was carried out and we continued with coracoclavicular ligament reconstruction with autologous tendon graft.

2.1. Surgical technique

The surgery was performed by the the authors.The beach chair position was used and the ipsilateral knee is also prepared for hamstring graft harvest, and a tourniquet then placed on the proximal

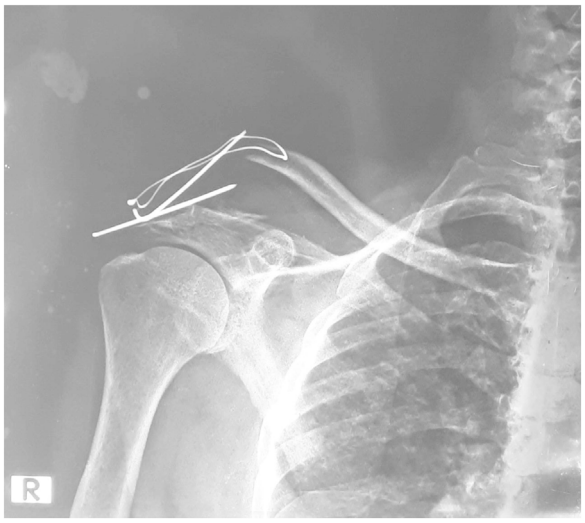

Fig. 3. Implant failure after 4 months post-operative.

Fig. 4. An incision was made on the superior surface of the clavicle closer to its anterior border. Soft tissues were debrided to help in distal clavicle fracture reduction and prevents graft passage obstruction.

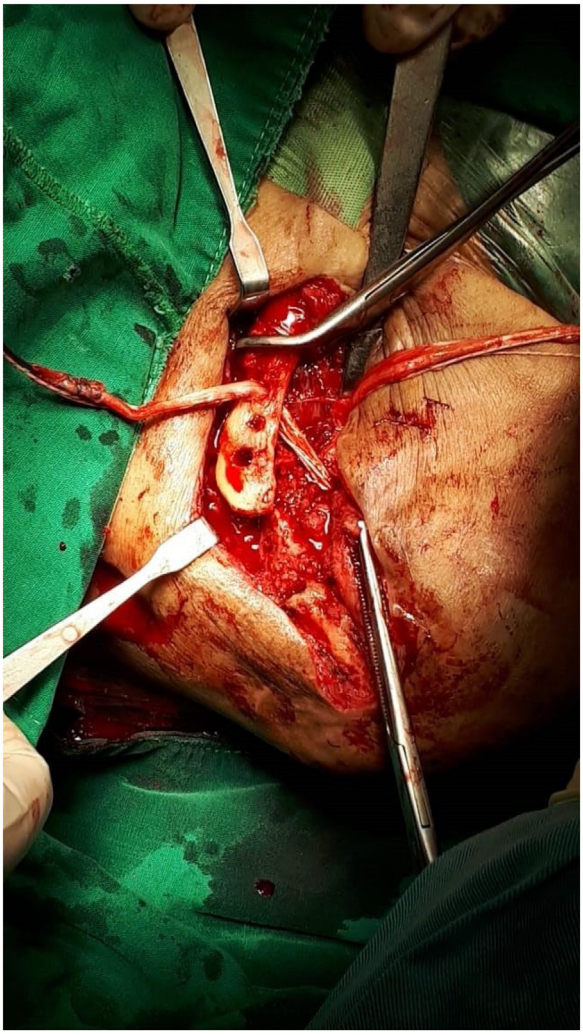

Fig. 5. The semitendinosus autograft was pulled out under the coracoid process.

Fig. 6. The graft was crossed, and the medial end is pulled through the lateral tunnel and vice versa.

thigh. C-arm was adequately positioned to ensure optimal reduction. Skin incision was created over the pes anserine and the soft tissue was dissected. Upper part of the fascia was identified and a reverse L-fashioned release was performed subperiosteally. The semitendinosus tendons were visualized and bluntly dissected. The graft and tendons are then released from the distal muscle-tendon junctions using a tendon stripper. Pre-tensioning was applied on a traction device with clamps. The proximal ends of the graft were then whip-stitched with another no. 2 Polyester suture (Ethibond, Ethicon Inc., Somerville, NJ, USA). Graft length and diameter are approximately 290 mm and 4.5–5.5 mm, respectively.

For the distal clavicle non-union fracture management, an incision was made from the anterior border of the clavicle extending laterally 1 cm beyond the AC joint. Soft tissue was cleaned from the anterior, lateral and posterior border of the clavicle for better mobilization and help in graft passage and distal clavicle fracture reduction (Fig. 4). A trial reduction is performed by pushing up on the elbow to elevate the scapulohumeral complex and pushing down the clavicle using a blunt and wide- ended device like a tunnel dilator positioned medial to the lateral end holes. After successful distal clavicle fracture reduction was achieved, temporary fixation was performed using a Kirschner (K) wire.

Then, we prepared the coracoid process for graft sling passage. The bony undersurface of the coracoid process was exposed and a roughened surface was created. The graft was looped around the base of the coracoid process and at the same time a no. 5 Polyester suture (Ethibond, Ethicon Inc., Somerville, NJ, USA) was then passed under the coracoid process. The suture loop then was placed under the coracoid process. The semitendinosus graft was pulled under the coracoid process (Fig. 5). To fixate the graft, a polydioxanone (PDS) suture act as a shuttle relay, the graft was crossed and the medial end was pulled through the lateral tunnel (Fig. 6). The length of graft, passing the most lateral tunnel (trapezoid tunnel). An ultra-high-molecular-weight polyethylene suture (Ultrabraid no. 2, Andover, MA, USA) and 4-hole 1.5-mm titanium mini-plate (Changzhou Kanghui Medical Innovation Co., Ltd) were used to provide fixation augmentation and to avoid tissue cut- through. The mini-plate should be firmly positioned on the clavicle using the forceps during knot tying to maintain reduction (Fig. 7), then the K-wire was removed.

This procedure reconstructs the coracoclavicular ligaments (Fig. 8, Figure Illustration 1).

2.2. Outcome and follow-up

On 3 months follow up, the patient was pain-free and post-op radiograph (Fig. 9) showed intact fixation (Fig. 9). On 6 months follow up, the patient had regained functional ROM (Fig. 10).

This work has been reported in line with the SCARE 2018 criteria [8].

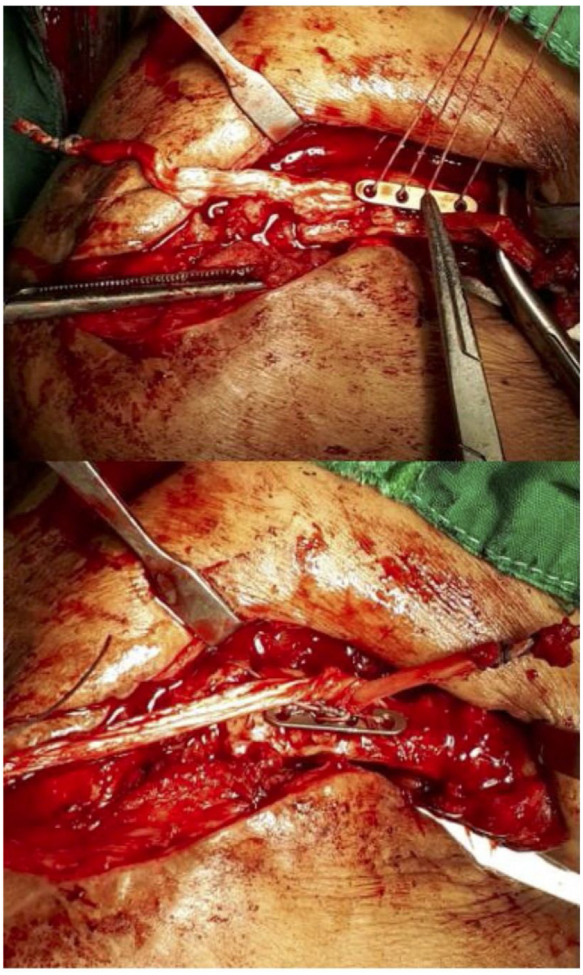

Fig. 7. UHMWPE suture (Ultrabraid no.2, Andover, MA, USA) and 4-hole 1.5-mm titanium mini-plate (Changzhou Kanghui Medical Innovation Co., Ltd) were used during knot tying to maintain reduction.

Fig. 8. After both graft end limbs were tied to create square knot, the graft was stitched upon itself using UHMWPE suture.

3. Discussion

Neer type 2 fracture of the distal clavicle has a high rate of delayed and nonunion even without the presence of comorbidity [3]. The rotational movement that occurs at the acromioclavicular joint is transferred to the fracture site, resulting in increased mobility of the lateral end causing nonunion. Conventional methods with various techniques of fixation have been advocated to prevent nonunion such as fixation by hook plate, K-wires, metal wire tension-band, bone suture, acromioclavicular ligament reconstruction performed under open or arthroscopic surgery [7]. Nonetheless, with the presence of impaired bone healing and increased fragility as in CKD, achieving bone union becomes a challenge.

As reported by Kalra et al., a compromised bone quality frequently leads to failed osteosynthesis in patients with end-stage renal failure [9]. In the advanced stages of kidney disease, problems with a renal clearance of phosphate and low 1α-hydroxylase levels resulting in increased serum phosphate levels and low serum calcium levels. Parathyroid glands are stimulated to increase hormone production in an attempt to raise serum calcium levels. Secondary hyperparathyroidism and osteomalacia developed, leading to increased risk of fragility fractures [10].

In order to achieve fracture healing, it may be necessary to provide mechanical stability or biological support depending on the nature of the nonunion. In a case study reported by Ding et al.,

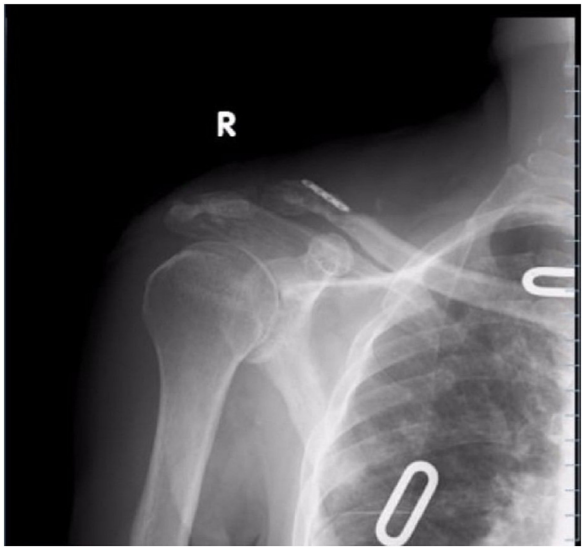

Fig. 9. 3 month post-operative radiograph showed intact fixation.

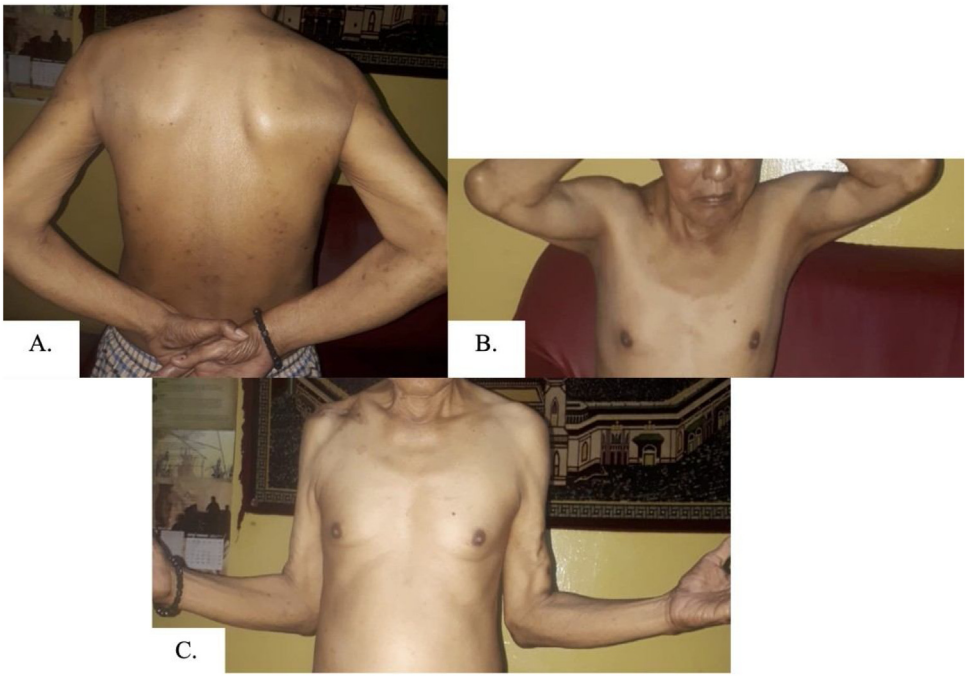

Fig. 10. Clinical picture of patient's shoulder ROM: A) Internal Rotation; B) External rotation in abduction; C) External Rotation in adduction; after 6 months follow up showed regained normal ROM.

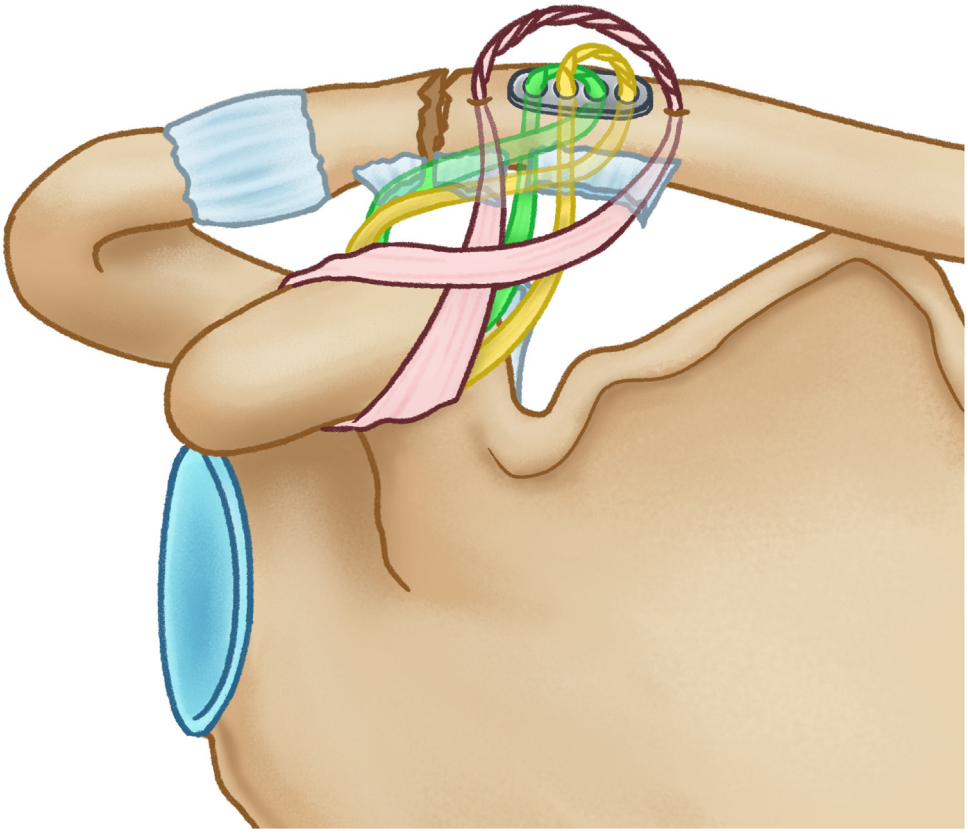

Illustration 1. Illustration of the surgical technique for maintaining distal clavicle fracture reduction using tendon autograft and mini-plate-suture.

a peri-implant fracture following fixation by hook plate is a rare complication, possibly due to the excessive rigidity of the plate implanted on an osteopenic bone [11]. A Similar case reported by Santolini et al. where the patient has symptomatic nonunion caused by disuse osteopenia and successfully treated with changing the type of implant and provide biological support using bone graft [12]. However, in our case it is redundant to use bone graft because of the poor bone quality and ability to heal due to the presence of CKD.

To address this problem, we decided to use an autologous semitendinosus tendon graft, which is able to provide adequate stability and maintain reduction until we achieved biological soft and hard tissue healing. In a biomechanical study by Lee et al., found that only the semitendinosus tendon survived two loading cycles and concluded that clinically it can be used as a strong and stable biologic option [13]. Another advantages of this procedure are avoidance of implant removal and possible complications such as hardware migration, peri-implant fracture, infection and foreign body reaction.

Given these circumstances, we considered the idea to maintain fracture reduction by biologic soft tissue healing of the graft to replace the coracoclavicular ligaments as we can't rely on normal bone healing. We chose an autologous tendon graft because of its advantageous biologic properties.

4. Conclusion

Using autologous tendon grafting in distal clavicle nonunion fracture can be an option of treatment. In a poor environment with impaired bone healing, maintaining fracture reduction by biologic soft tissue healing of the graft to replace the coracoclavicular ligaments in distal end clavicle nonunion fracture could be an option. The use of autologous tendon graft and mini-plate-suture augmentation could help to maintain bone reduction in such environment.

Declaration of Competing Interest

The authors declare there is no conflict of interests regarding the publication of this paper.

Funding

The authors declare that there is no sponsors involved in this paper.

Ethical approval

The patient received explanation of the procedures and possible risks of surgery and gave written informed consent.

Ethical approval has been granted in this study.

Consent

The patient received an explanation of the procedures and possible risks of the surgery and gave written informed consent.

Author's contribution

Renaldi Prasetia: Surgeon, Conceptualization, Visualization, Methodology. Supervision.

Rio Aditya: Writing.

Priscilla: Writing.

Ghuna A. Utoyo: Surgeon.

Hermawan Nagar Rasyid: Surgeon, Conceptualization, and Supervision.

Registration of research studies

1. Name of the registry: Research Registry.
2. Unique identifying number or registration ID: researchregistry6130.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/browse-the-registry#home/registrationdetails/5f8c00dea40aed00178160b9/.

Guarantor

Guarantor in this study is Renaldi Prasetia.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Acknowledgment

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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