

Rib Fracture Non-Union Treatment Guideline

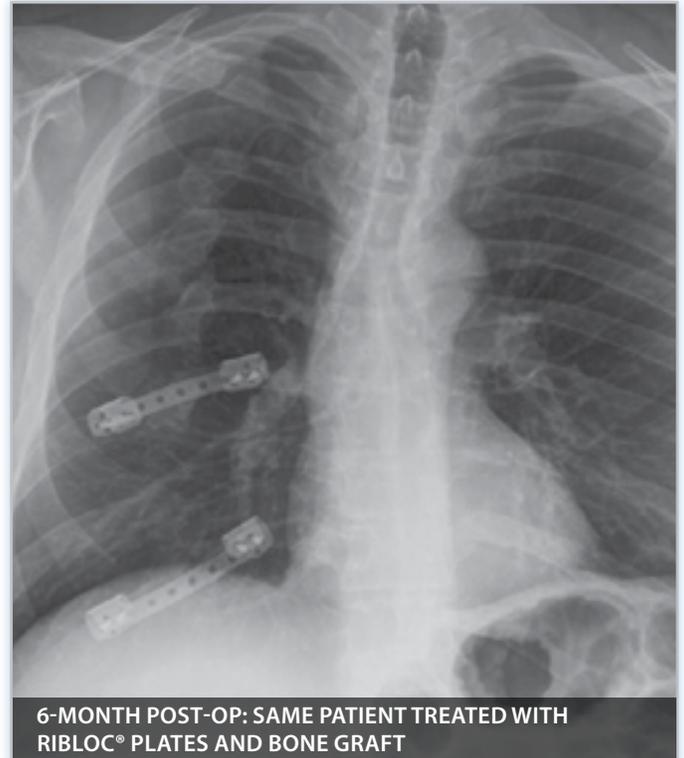
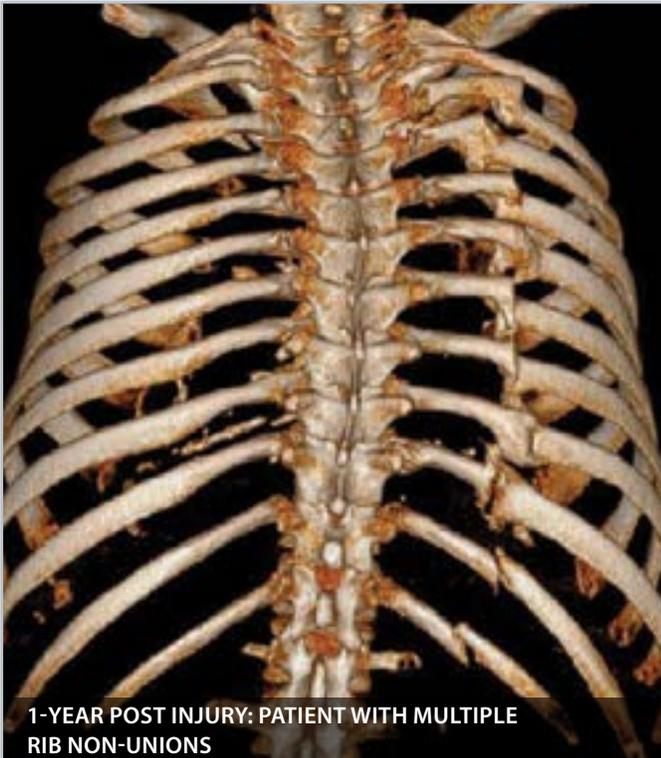
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The goal with surgical intervention for non-unions is for the body to provide long-term stability through bone healing or soft tissue scarring. Rib plates are designed to temporarily stabilize a rib fracture during healing and are not permanent prosthetics. Do not use a metal plate on a rib fracture or non-union that is not expected to heal. Make an intra-operative determination on whether the non-union is viable (capable of healing) or non-viable to determine what type of stabilization technique to use. This handout is intended for support and educational purposes only. All questions regarding surgical implantation of the product should be directed to a licensed medical professional familiar with ACUTE Innovations® products. In addition, consult the product 'Instructions for Use' for more detailed product information.



RibLoc® Rib Fracture Plating System or BioBridge® Resorbable Chest Wall Stabilization Plate can be used to address non-unions.



Patient Selection -

- Surgical treatment is recommended when the patient's symptoms, pain and/or movement of the fracture site, persist for 6 or more months post-injury.
- NOTE: Surgical intervention prior to 6 months post-injury may be indicated when time is unlikely to make a difference in healing, i.e. when there are severe displacements and/or distraction.

Pre-Op Imaging -

- If a non-union is suspected based on persistent pain or bone movement in a location of known rib fractures, then a plain radiograph rib series is used to screen for a non-union.
- If a non-union is found, then a CT scan is used to confirm and provide more specific morphology information in order to plan the surgical strategy.
- NOTE: If the plain radiographs do not suggest non-union but the patient's symptoms are suggestive enough, then a CT scan can be used to confirm or rule out completely.

Smoking -

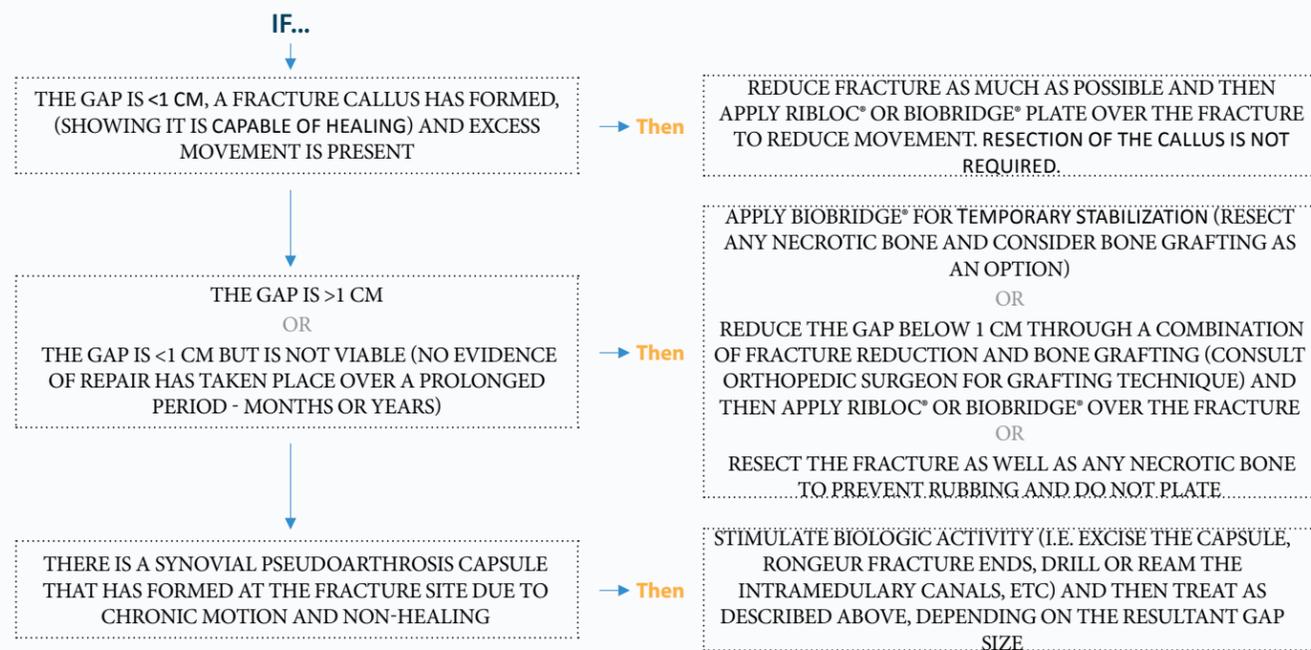
- Cigarette smoking impairs bone healing¹. Smoking cessation is recommended for 4 weeks prior to surgery and at least 6 months post-op.

Post-Op -

- Lifting restriction of 25 lbs. is recommended for 4 weeks after surgery.
- A bone stimulator 3 month trial may be useful in some instances.

The recommended treatment for non-unions depends on:

- The size of the fracture gap
- The amount of movement at the fracture site
- The viability (capability to heal) evident by the amount of biologic activity present



*Consult with an orthopedic surgeon if unfamiliar with bone repairing techniques. If active infection is present at the non-union, the infection must first be cleared before further intervention is attempted.

Severe Symptomatic Rib Fracture Non-Union Treated with RibLoc® Plates and Bone Graft

Product Used: RibLoc® Rib Fracture Plating System
Surgeon's Name: John Mayberry, MD
Facility Name/ Location: Oregon Health and Science University
 Portland, Oregon
Case Date: 2012-2013



CASE HISTORY:

45 year old male who suffered severe bilateral chest wall injuries in a rollover ATV crash in the fall of 2011. One year post injury the patient complained of persistent right chest wall pain associated with several rib fracture non-unions and mal-union deformities. The chronic pain interfered with the patient's ability to return to work. Surgical intervention for the right rib fracture non-unions was performed with the goal of improvement of chronic pain.

TREATMENT AND TECHNIQUE:

With the patient in the left lateral decubitus position, the right 7 – 9 rib fracture non-unions were exposed through an oblique incision. The 8th rib fracture non-unions was bulky and was partially attached to the 7th rib above and the 9th rib below. Tendrils of the intercostal nerve were found entrapped in the callous and malformed bone. Upon resection of the 8th rib non-unions, a 2 cm bony gap remained and it was decided not to attempt repair and plating. The 7th and 9th rib non-union were less bulky than the 8th and were amenable to resection of the callous and trimming of malformed bone. The RibLoc® plates were prepared and sized to ribs 7 and 9. Bone graft was obtained from the 8th rib resection, then was chipped into 3 mm pieces, and was mixed with commercially available demineralized bone matrix putty. Bone graft matrix was pressed into crevices of resected non-union callous to fill in the defect.

OUTCOME:

At 6 months post-operative his right chest wall pain had markedly improved. The patient's pre-op reported pain scale was 4 (1-10 scale) and taking on average 8 –10 opioid tablets per day and gabapentin 300 mg TID. At 6 months post non-union repair, the patient reported pain level of 2 (1–10 scale), taking 2 opioid tablets per day on average and able to perform moderately strenuous physical activity with minimal pain and no longer taking gabapentin.



BONE HEALING BACKGROUND

Bone Healing Terminology

The type of bone repair depends on the mechanical stability at the fracture site. These types include:

Direct (primary) Fracture Repair -

This method of bone healing occurs under a condition of rigid stabilization with bone matrix of one fragment opposed in direct contact with that of the other fragment (requires compression). This process can take months or years to fully complete and as there is almost always some small amount of motion at the fracture site, true direct fracture repair is not thought to be common in clinical fractures.

Indirect Fracture Repair -

When rigid stabilization is not present, bone repair proceeds by the formation of a callus which acts as a biological 'splint'. The healing process goes through the following steps (which typically takes 6-12 weeks).

- (1) Fracture and inflammation;
- (2) Granulation tissue is formed;
- (3) Callus is formed and hyaline cartilage is developed;
- (4) Hyaline cartilage is transformed into new bone.

Requirements for successful bone healing:

- Good blood supply
- Good bone to bone contact
- Relative stability at the fracture site (minimal movement)

If any of the three main requirements for healing are jeopardized, a non-union can occur.

The following factors may also contribute to poor bone healing: Infection, malnutrition and vitamin deficiencies, diabetes, corticosteroid use, nicotine use (including the persistent cough related to smoking), entrapped soft tissue that impedes bone healing, older age, inability to bear weight, burns, irradiation, obesity, alcohol abuse, metabolic bone disease.

Types of Non-Union

Viable (capable of biologic activity) -

Hypertrophic: Good vascularity and good bone contact but poor mechanical stability, leading to callus formation but no formation of new bone.

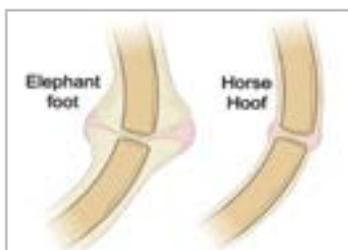
Oligotrophic: Adequate blood supply but no callus formation due to poor bone to bone contact (inadequate reduction, large gap >1 cm, or a highly displaced fracture).

Non-Viable (incapable of biologic activity) -

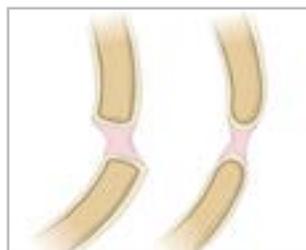
Atrophic: No callus formation or biologic activity due to inadequate vascularity. Fibrous tissue forms but it has no ability to further heal.

Synovial Psuedoarthrosis: Synovial fluid fills a pseudo-capsule due to excess motion at the fracture site. The capsule effectively seals off the medullary canal, which prevents any further healing.

- (1) Browner, Bruce D, and Neil E Green. Skeletal trauma. Edinburgh: Saunders, 2008.
- (2) Cowen, Stephen C. Bone Mechanics Handbook, 2nd ed. Boca Raton: CRC Press LLC, 2001.



Hypertrophic



Oligotrophic



Synovial Psuedoarthrosis



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