Internal Fixation of Rib Fracture

Aetna considers internal fixation of rib fractures (e.g., MatrixRIB Fixation System, RibLoc Rib Fracture Plating System) medically necessary in cases of severe flail chest failing to wean from a ventilator or when thoracotomy is required for other reasons.

Aetna considers internal fixation of rib fractures experimental and investigational for all other indications.

Aetna considers the following interventions experimental and investigational for internal fixation of rib fractures because the effectiveness of these approaches has not been established:

- Bioabsorbable plate
- Minimally invasive plate osteosynthesis

See also CPB 0582 - Titanium Rib (../500_599/0582.html).

Background

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.*
Most injuries to the chest wall do not result in long-term respiratory dysfunction and operative indications for chest wall injuries are rare. Recent studies have explored the option of internal fixation of rib fracture for treatment of complex rib fractures, including flail chest, open fracture, symptomatic nonunion, and thoracotomy for other indications (Lafferty et al, 2011). Flail chest is diagnosed when multiple, consecutive ribs are fractured in two or more places, creating an incompetent region of the chest wall (Slater et al, 2001).

A number of small-scale studies have evaluated the use of internal fixation of rib fractures. Lardinois et al (2001) prospectively evaluated chest wall integrity and pulmonary function following operative stabilization of flail chest. They followed 66 patients with antero-lateral flail chest. Forty-seven percent of patients were able to be extubated immediately following the procedure and 85% within 7 days post-operatively. Pulmonary function testing and clinical assessment were performed 6 months post-operatively. The results showed that the 30-day mortality was at 11% and chest wall complains were noted in 6 of 57 patients, requiring removal of all plates and screws in 3 of those patients. Six-month follow-up results also showed a significant difference between predicted and recorded vital capacity ($p = 0.04$) and forced expiratory volume ($p = 0.001$). The investigators concluded that antero-lateral flail chest injuries accompanied by respiratory insufficiency, particularly when stabilized early, may be cost effective in that they reduce days on mechanical ventilation and restriction-related working incapacity.

Tanaka et al (2002) conducted a prospective randomized trial of 37 severe flail chest patients requiring mechanical ventilation, comparing the relative clinical efficacy of surgical stabilization (S group) and internal pneumatic stabilization (I group). The authors reported that “the S group showed a shorter ventilatory period (10.8 +/- 3.4 days) than the I group (18.3 +/- 7.4 days) ($p < 0.05$), shorter intensive care unit stay (S group, 16.5 +/- 7.4 days; I group, 26.8 +/- 13.2 days; $p < 0.05$), and lower incidence of pneumonia (S group, 24%; I group, 77%; $p < 0.05$). Percent forced vital capacity was higher in the S group at 1 month and thereafter ($p < 0.05$).” Although the findings of this study are encouraging, the relatively small sample size and the specificity of the inclusion criteria must be taken into account when attempting to generalize these findings.
Granetzny et al (2005) randomly assigned 40 patients with flail chest to surgical fixation or an external adhesive plaster. The operative group demonstrated significantly fewer patients requiring mechanical ventilation, fewer days in the intensive care unit, shorter hospital stay, and a lower incidence of pneumonia compared with the conservatively managed group.

Nirula et al (2006) conducted a matched case-control study to evaluate the impact of operative stabilization of rib fractures due to trauma. Thirty patients undergoing rib stabilization were matched with 30 controls and followed for length of intensive care unit stay (controls, 14.1 +/- 2.7 vs cases, 12.1 +/- 1.2, p = 0.51), total hospital stay (controls, 21.1 +/- 3.9 vs cases, 18.8 +/- 1.8, p = 0.59), total ventilator days (cases, 6.5 +/- 1.3 days versus controls, 11.2 +/- 2.6 days, p = 0.12), and ventilator days post-stabilization (cases, 2.9 +/- 0.6 days versus controls, 9.4 +/- 2.7 days, p = 0.02). The investigators concluded that rib fracture fixation may reduce ventilator requirements in trauma patients with severe thoracic injuries, but long-term functional outcomes need to be assessed to ascertain the impact of this procedure.

Richardson et al (2007) performed open reduction and internal fixation on 7 patients using titanium plates and screws. The investigators reported that "there was one death in the sternal fracture group in a patient who was ventilator-dependent preoperatively and extubated himself in the early postoperative period. Otherwise, the results were excellent, with no complications occurring in this group.". However, there are limitations to the degree to which findings can be extrapolated given the sample size of 7 patients.

Campbell et al (2009) reported on open reduction and internal fixation using Inion OTPS wraps for treatment of rib fractures for 32 Parkinson's disease patients with osteoporotic thoracolumbar compression fracture. Would infection have occurred in 19 % of patients, chest wall stiffness in 60 %, dyspnea at rest in 20 %, and nonunion of fracture occurred in 1 patient. The authors reported patient satisfaction with the procedure was at 100 % and that the procedure allowed for excellent stabilization of the ribs in both ambulatory and ventilated patients. However, it should be noted that there was a small sample size and relatively high complication rate, although this patient population was one with significant co-morbidity.

Mayberry et al (2009) conducted a survey of members of the Eastern Association for the Surgery of Trauma, the Orthopedic Trauma Association, and thoracic surgeons affiliated with teaching hospitals in the United States and received
surveys from 238 trauma surgeons (TRS), 97 orthopedic trauma surgeons (OTS) and 70 thoracic surgeons (THS). Although 82% of TRS, 66% of OTS, and 71% of THS thought that rib fracture repair was indicated in selected patients, only 26% of surgeons reported that they had performed or assisted on a chest wall fracture repair, whereas 22% of surgeons were familiar with published randomized trials of the surgical repair of flail chest. Mayberry et al (2009) concluded that “the published literature on surgical repair is sparse and unfamiliar to most surgeons. Barriers to surgical repair of rib and sternal fracture include a lack of expertise among TRS, lack of research of optimal techniques, and a dearth of randomized trials.”

Marasco et al (2009) had conducted a pilot study of operative fixation of fractured ribs in 13 flail chest patients, requiring on average 4 ribs fixed. Positive results were achieved in all patients with the flail chest stabilized and paradoxical chest wall movement eliminated. Based on the findings of this pilot study, a prospective randomized trial is currently underway. Marasco et al (2010) explored the operative stabilization of rib fracture in 13 patients who had 58 ribs fixed with absorbable prostheses, of which 10 rib fixations failed. The investigators observed that stresses on the plate differed between inspiration and expiration, with greater stress on the screws on the posterior part of the broken rib, and separation of the plate from the rib seemed more likely to occur at this site.

In September of 2008 the Food and Drug Administration granted 510K clearance to Synthes (West Chester, PA) for the Synthes MatrixRIB Fixation System for the fixation and stabilization of rib fractures, fusions and osteotomies of normal and osteoporotic bone (FDA, 2008). The Synthes MatrixRIB Fixation System is indicated for the fixation and stabilization of rib fractures, fusions and osteotomies of normal and osteoporotic bone. The system consists of bone plates, intramedullary (IM) splints and screws. All plates, IM splints and screws are manufactured from titanium alloy.

Marasco and colleagues (2016) noted that surgical management of fractured ribs with internal fixation is an increasingly accepted therapy. Concurrently, specific rib fixation prostheses are being developed which should improve results and minimize hardware and rib/splint construct failures. The Synthes titanium intramedullary splint lends itself to difficult-to-access areas such as posterior rib fractures and fractures under the scapula. In a retrospective case-series study, these researchers analyzed the findings of patients in whom this rib fixation prosthesis...
has been used. A total of 15 patients received 35 intramedullary splints. Follow-up at 3 and 6 months was performed with 3-D computed tomography (CT) scanning to assess for bone alignment, callus formation and healing, residual deformity, hardware failure or cut through. Computerized finite element analysis (FEA) was used to model forces acting on a posterior fracture with and without an intramedullary fixation splint in-situ. Complete healing (bony union) was noted in only 3 (9%) of the fractures fixed with splints by 3 months. Partial healing (cartilaginous union) was noted in 28 of the 33 fractures (85%), and non-healing was noted in only 2 (6%). In both those 2 patients, failure at the rib/splint interface was noted after both patients reported sneezing. No hardware failures were noted. By 6 months the fractures which had shown partial healing, had all completely healed. There were no late failures (between 3 and 6 months) of either hardware or rib/splint interfaces. FEA modelling identified sites of increased stress in the rib at the rib/splint interface and in a modelled intramedullary splint where it spanned the fracture. The authors concluded that further analysis of outcomes with intramedullary splints is needed as well as further development of similar rib fixation prostheses. This study was a retrospective descriptive review of a clinical case series and thus the findings should only be considered hypothesis-generating.

The current practice management guideline for pulmonary contusion - flail chest, issued by the Eastern Association for the Surgery of Trauma, states that surgical fixation may be considered in severe unilateral flail chest or in patients requiring mechanical ventilation when thoracotomy is otherwise required (Simon et al, 2012). However, this guideline is listed as a Level 3 recommendation, indicating that “the recommendation is supported by available data, but adequate scientific evidence is lacking … This type of recommendation is useful for educational purposes and in guiding future clinical research”. The EAST Trauma practice guidelines recognize surgical fixation as a Level III recommendation for management of flail chest given the small numbers of patients randomized and a lack of generalizability due to strict exclusion criteria, and the absence of trials comparing operative repair with “modern” nonoperative treatments, such as epidural anesthesia and chest physiotherapy. The guidelines state (grade III recommendation): “Although improvement has not been definitively shown in any outcome parameter after surgical fixation of FC, this modality may be considered in cases of severe FC failing to wean from the ventilator or when thoracotomy is required for other reasons. The patient subgroup that would benefit from early ‘prophylactic’ fracture fixation has not been identified.” The guidelines also state (grade III recommendation): “There is insufficient clinical evidence to recommend
any type of proprietary implant for surgical fixation of rib fractures. However, in vitro studies indicate that rib plating or wrapping devices are likely superior to intramedullary wires and these should be used as the preferred fixation device."
The guidelines noted that "significant quantitative and qualitative gaps exist in the body of knowledge regarding PC-FC." The guidelines identified indications and techniques of surgical fixation among areas in need of further investigation.

Bottlang et al (2013) stated that surgical stabilization of flail chest injury with generic osteosynthesis implants remains challenging. A novel implant system comprising anatomic rib plates and intramedullary splints may improve surgical stabilization of flail chest injuries. In an observational study, these investigators evaluated the early clinical experience with this novel implant system to document if it can simplify the surgical procedure while providing reliable stabilization. A total of 20 consecutive patients who underwent stabilization of flail chest injury with anatomic plates and intramedullary splints were prospectively enrolled at 2 Level I trauma centers. Data collection included patient demographics, injury characterization, surgical procedure details and post-operative recovery. Follow-up was performed at 3 and 6 months to assess pulmonary function, durability of implants and fixation and patient health. Patients had an Injury Severity Score of 28 ± 10, a chest Abbreviated Injury Score of 4.2 ± 0.4 and 8.5 ± 2.9 fractured ribs. Surgical stabilization was achieved on average with 5 plates and 1 splint. Intra-operative contouring was required in 14 % of plates. Post-operative duration of ventilation was 6.4 ± 8.6 days. Total hospitalization was 15 ± 10 days. At 3 months, patients had regained 84 % of their expected forced vital capacity (% functional vital capacity [FVC]). At 6 months, 7 of 15 patients who completed follow-up had returned to work; there was no mortality. Among the 91 rib plates, 15 splints and 605 screws in this study there was no hardware failure and no loss of initial fixation. There was one incidence of wound infection; implants were removed in 1 patient after fractures had healed. The authors concluded that anatomic plates eliminated the need for extensive intra-operative plate contouring. Intramedullary rib splints provided a less-invasive fixation alternative for single, non-comminuted fractures. These early clinical results indicated that the novel implant system provided reliable fixation and accommodated the wide range of fractures encountered in flail chest injury. These early findings from a small observational study need to be validated by well-designed studies.
The RibLoc Rib Fracture Plating System (ACUTE Innovations, LLC; Hillsboro, OR) was cleared by the FDA through the 510 (k) process in January 2012; it is indicated to stabilize and provide fixation for fractures, fusions, and osteotomies of the ribs, and for reconstructions of the chest wall and sternum. The RibLoc Rib Fracture Plating System consists of plates and screws for fractures, fusions, and osteotomies. The plates are pre-contoured to minimize bending that is done intraoperatively. Instrumentation is supplied with the implants to aid in the insertion of the plates and screws. All plates and screws are manufactured from titanium or titanium alloy. Large-scale, well-designed studies of this system need to be completed to evaluate the evidence-base for use of this system.

Messing et al (2014) presented a review on the role of open reduction and internal fixation of flail chest injuries. A 37-year old woman involved in a motorcycle crash sustained comminuted rib fractures on her right 3rd through 12th ribs. On post-injury day 2, the patient's 5th through 9th ribs were surgically reduced and plated. Later that same day, the patient was successfully weaned from mechanical ventilation and experienced a rapid improvement in incentive spirometry volumes. The authors concluded that further studies are needed to definitively determine the benefits of rib plating versus conventional treatment.

Fabricant et al (2014) performed a prospective clinical trial of resection with or without plate fixation for symptomatic rib fracture nonunion 3 or more months post-injury with 6-month post-operative follow-up. The McGill Pain Questionnaire (MPQ) and RAND 36 Health Survey were administered and activity level (sedentary, ambulatory, moderately active, vigorous), functional status (disabled, non-physical labor, physical labor), and work status (employed, unemployed, retired, student) were queried pre- and post-operatively. A total of 24 patients 4 to 197 months (median of 16 months) post-injury underwent surgical intervention for 1 to 4 rib fracture nonunions (median of 2 nonunions). Evidence of intercostal nerve entrapment was present in 9 patients (38%). MPQ Present Pain Intensity and Pain Rating Index and RAND 36 Physical Functioning, Role Physical, Social Functioning, Role Social, Bodily Pain, Vitality, Mental Health, and General Health were significantly improved at 6 months compared with study entry (p < 0.05). Activity levels significantly improved (p < 0.0001) but functional and work status did not change; 24-hour morphine equivalent dosage of opioids at study entry was 20.3 ± 30.8 (mean ± standard deviation) and at study completion was 9.4 ± 17.5 (p = 0.054). Complications included 1 wound infection, 2 partial screw back-outs, and 1 chest wall hernia at 1 year after resection of adjacent nonunions with significant
gaps repaired with absorbable plates. The authors concluded that surgical intervention for rib fracture nonunion may improve chronic pain and disability but without change in functional or work status. Resection of adjacent nonunions with significant gaps may lead to chest wall hernia.

Majercik et al (2014) noted that there has been increased interest in surgical stabilization of rib fractures (SSRF). It is difficult to define long-term benefits of the procedure. This is a descriptive study of patient outcomes after SSRF. Patients who had undergone SSRF between April 2010 and August 2012 at a Level I trauma center were identified. Data were collected from the medical records. A telephone survey asking about pain, satisfaction, and employment was administered to patients after hospital discharge. A total of 101 patients met inclusion criteria; 50 % patients completed the survey. Indications for SSRF included flail chest, displaced fractures, pain, and inability to wean from mechanical ventilation. Pain was gone at 5.4 ± 1.1 weeks post-discharge. Satisfaction with SSRF on a scale of 1 to 10 was 9.2 ± .2; and 90 % of employed patients returned to the same work at 8.5 ± 1.2 weeks. The authors concluded that SSRF patients were satisfied and were able to return to normal activity with few limitations. Moreover, they stated that a prospective study using modern rib fixation technology is needed to further define benefits. A drawback of this study was that only 50 % of patients completed the survey; thus, the findings may have been skewed.

An UpToDate review on “Inpatient management of traumatic rib fractures” (Bulger, 2014) states that “Rib fracture stabilization -- Rib fracture fixation has traditionally required an open thoracotomy for adequate exposure. Several plate types and plate fixation methods have been used, but the search for the optimal material and fixation method continues. Rib fracture fixation is complicated by the anatomy of the human rib. Rib thickness ranges from 8 to 12 mm with a very thin cortex. As a result, it does not hold cortical screws well. In addition, the rib tends to fracture in a spiral pattern or in many small fragments (i.e., comminuted), which complicate repair. Entrapment of the intercostal nerve either as a result of the injury or due to repair can lead to chronic postoperative rib pain. One approach to rib fracture fixation uses malleable plates attached to the anterior surface of the rib (image 1). However, fixation of these plates can be problematic. Another method of fixation uses wire cerclage (i.e., wrapped around the rib) but this can be complicated by wire breakage and plate dislodgement. In addition, circumferential fixation of the rib with a permanent material can potentially impinge the intercostal nerve, causing chronic pain which may require removal of the plates. For this reason, when
cerclage is necessary (i.e., comminuted fracture), absorbable sutures should be used. As an alternative, screws can be used to hold the plates in place, but their use is often limited by cortical thickness. Novel techniques for rib fracture fixation include the use of contoured rib plates, absorbable plates, intramedullary rods, U-plates fixed with screws placed over the top of the rib minimizing the risk to the intercostal nerve, and application of osteogenic protein at the fracture site”.

Wiese et al (2015) reported the experience with the Stratos system in 2 surgical centers for the management of 2 types of rib fractures: (i) flail chest and (ii) multiple dislocated rib fractures with significant chest wall deformity. From January 2009 to May 2012, a total of 94 consecutive patients were included. Selected indications were extended antero-lateral flail chest (n = 68) and dislocated painful rib fractures (n = 26). The open reduction internal fixation (ORIF) system consists of flexible titanium rib clamps and connecting plates. The post-operative course was assessed. Clinical and functional outcomes were evaluated at 6 months.

Functional assessment consisted of measurement of the FVC and magnetic resonance imaging (MRI) examination with determination of the radiological vital capacity (rVC) in patients with a flail chest. The median operation time and length of hospital stay were 122 mins and 19 days, respectively, in patients with a flail chest, and 67 mins and 11 days, respectively, in patients with dislocated painful rib fractures. The morbidity rate was 6.4 % and the overall 30-day mortality rate was 1.1 %. Clinical evaluation and pulmonary function testing at 6 months revealed no deformity of the chest wall, symmetrical shoulder girdle mobility in 88 % and a feeling of stiffness on the operated side in 19 % of the patients operated for a flail chest. Median ratio of FVC was 88 %, not suggesting any restriction after stabilization. Magnetic resonance imaging was performed in 53 % (36 of 68) of the patients with a flail chest. The analysis of the rVC showed, on average, no clinically relevant restriction related to the operation, with a mean rVC of the operated relative to the non-operated side of 92 % (95 % confidence interval [CI]: 83 to 100). Stabilization of more than 4 ribs was associated with a lower median rVC than stabilization of 4 or less ribs. The authors concluded that these findings suggested that stabilization of the chest wall with this screwless rib fixation device can be performed with a low morbidity and lead to early restoration of chest wall integrity and respiratory pump function, without clinically relevant functional restriction.

Owing to the simplicity of the fixation technique, indications for stabilization can be safely enlarged to selected patients with dislocated and painful rib fractures. The findings of this small study (only 26 patients with rib fractures) need to be validated by well-designed studies.
Girsowicz et al (2012) examined if surgical stabilization is effective in improving the outcomes of patients with isolated multiple distracted and painful non-flail rib fractures. Of the 356 papers found using a report search, 9 presented the best evidence to answer the clinical question. The authors, journal, date and country of publication, study type, group studied, relevant outcomes and results of these papers were given. These researchers concluded that, on the whole, the 9 retrieved studies clearly support the use of surgical stabilization in the management of isolated multiple non-flail and painful rib fractures for improving patient outcomes. The interest and benefit were shown not only in terms of pain (McGill pain questionnaire) and respiratory function (forced vital capacity, forced expiratory volume in 1 second and carbon monoxide diffusing capacity), but also in improved quality of life (RAND 36-Item Health Survey) and reduced socio-professional disability. Indeed, most of the authors justified surgical management based on the fact that the results of surgical stabilization showed improvement in short- and long-term patient outcomes, with fast reduction in pain and disability, as well as lower average wait before recommencing normal activities. Hence, the current evidence showed surgical stabilization to be safe and effective in alleviating post-operative pain and in improving patient recovery, thus enhancing the outcome after isolated multiple rib fractures. However, the authors concluded that given the little published evidence, prospective trials are needed to confirm these encouraging results.

Leinicke et al (2013) performed a systematic review and meta-analysis of studies comparing operative to non-operative therapy in adult patients with flail chest. Outcomes were duration of mechanical ventilation (DMV), intensive care unit length of stay (ICULOS), hospital length of stay (HLOS), mortality, incidence of pneumonia, and tracheostomy. A comprehensive search of 5 electronic databases was performed to identify randomized controlled trials (RCTs) and observational studies (cohort or case-control). Pooled effect size (ES) or relative risk (RR) was calculated using a fixed or random effects model, as appropriate. A total of 9 studies (538 patients) met inclusion criteria. Compared with control treatment, operative management of flail chest was associated with shorter DMV [pooled ES: -4.52 days; 95 % CI: -5.54 to -3.50], ICULOS (-3.40 days; 95 % CI: -6.01 to -0.79), HLOS (-3.82 days; 95 % CI: -7.12 to -0.54), and decreased mortality (pooled RR: 0.44; 95 % CI: 0.28 to 0.69), pneumonia (0.45; 95 % CI: 0.30 to 0.69), and tracheostomy (0.25; 95 % CI: 0.13 to 0.47). The authors concluded that as compared with non-operative therapy, operative fixation of flail chest was
associated with reductions in DMV, LOS, mortality, and complications associated with prolonged MV. They stated that these findings supported the need for an adequately powered clinical study to further define the role of this intervention.

Slobogean et al (2013) compared the results of surgical fixation and non-operative management for flail chest injuries. These investigators performed a systematic review of previously published comparative studies using operative and non-operative management of flail chest. Medline, Embase, and the Cochrane databases were searched for relevant studies with no language or date restrictions. Quantitative pooling was performed using a random effects model for relevant critical care outcomes. Sensitivity analysis was performed for all outcomes. A total of 11 manuscripts with 753 patients met inclusion criteria. Only 2 studies were randomized controlled designs. Surgical fixation resulted in better outcomes for all pooled analyses including substantial decreases in ventilator days (mean 8 days, 95 % CI: 5 to 10 days) and the odds of developing pneumonia (odds ratio [OR] 0.2, 95 % CI 0.11 to 0.32). Additional benefits included decreased ICU days (mean of 5 days, 95 % CI: 2 to 8 days), mortality (OR 0.31, 95 % CI: 0.20 to 0.48), septicemia (OR 0.36, 95 % CI: 0.19 to 0.71), tracheostomy (OR 0.06, 95 % CI: 0.02 to 0.20), and chest deformity (OR 0.11, 95 % CI: 0.02 to 0.60). All results were stable to basic sensitivity analysis. The authors concluded that the findings of this meta-analysis suggested surgical fixation of flail chest injuries may have substantial critical care benefits; however, the analyses were based on the pooling of primarily small retrospective studies. They stated that additional prospective RCTs are still needed.

Doben et al (2014) examined the impact of surgical rib fixation (SRF) in a treatment protocol for severe blunt chest trauma. Patients with flail chest admitted between September 2009 and June 2010 to the authors' level I trauma center who failed traditional management and underwent SRF were matched with an historical group. Outcome variables evaluated include age, injury severity score, intensive care unit length of stay (LOS), hospital LOS, ventilator days, total number of rib fractures, and total number of segmental rib fractures. The 2 groups were similar in age, injury severity score, intensive care unit LOS, hospital LOS, total number of rib fractures, and total segmental rib fractures. The operative group demonstrated a significant reduction in total ventilator days as compared with the non-surgical group (4.5 [0 to 30] versus 16.0 [4 to 40]; p = 0.040). Patients with SRF were permanently liberated from the ventilator within a median of 1.5 days (0 to 8 days). The authors concluded that surgical rib fixation resulted in a significant decrease in
ventilator days and may represent a novel approach to decreasing morbidity in flail chest patients when used as a rescue therapy in patients with declining pulmonary status. They stated that larger studies are needed to further identify these benefits.

Zhang et al (2015) compared the clinical efficacy of surgical fixation and nonsurgical management of flail chest and pulmonary contusion (FC-PC). Data on 39 patients diagnosed with FC-PC from July 2010 to December 2013 from the intensive care unit of Shanghai First People's Hospital and analyzed retrospectively. The patients required ventilator support and were divided into a surgical group and a nonsurgical group, according to the treatment method. Clinical data on mortality, the duration of mechanical ventilation (DMV), intensive care unit length of stay, hospital length of stay, days of antibiotic use, transfusion volume, medical expense and incidence of tracheotomy, pleural effusion, and incidence of ventilator associated pneumonia, were collected for all subjects. The surgical group was further divided into 2 groups according to the surgery timing. Surgery within 7 days of admission was defined as early surgery, and all other times were defined as late surgery. The clinical data and incidence of incision infection were collected and compared. The patients in the surgical group had a slightly shorter hospital length of stay. No differences were noted in mortality and the other clinical data between the groups. The early surgical group had a shorter duration of mechanical ventilation and less incidence of tracheotomy. The other parameters had no differences. The investigators concluded that surgery for FC-PC could reduce the HLOS, and early surgery could decrease the DMV and the need for tracheotomy.

Xu et al (2015) reported on a retrospective study comparing surgical and conservative treatments for flail chest. In this study, 32 patients with severe flail chest were treated in the Fujian Provincial Hospital (China) between July 2007 and July 2012 with surgical internal rib fixation (n = 17) or conservative treatments (n = 15). Mechanical ventilation time, intensive care unit (ICU) stay time, pulmonary infection, antibiotic treatment duration, acute physiology and chronic health evaluation II (APACHE II) scores 7 and 14 days after trauma, rate of tracheostomy, and rate of endotracheal re-intubation were compared. One patient died in the conservative treatment group. Better short-term outcomes were observed in the surgery group, such as total mechanical ventilation time (10.5 ± 3.7 versus 13.7 ± 4.4 days, p = 0.03), ICU stay (15.9 ± 5.0 versus 19.6 ± 5.0 days, p = 0.05), pulmonary infection rate (58.8 % versus 93.3 %, p = 0.02), and APACHE II scores on the 14th day (6.5 ± 3.8 versus 10.1 ± 4.7, p = 0.02). No difference was
observed in the therapeutic time of antibiotics, rate of tracheostomy, and the rate of endotracheal re-intubation between the 2 groups. The authors concluded that internal fixation surgery resulted in better outcomes in the management of severe flail chest compared with conservative treatments.

Vana et al (2014) stated that thoracic injury is currently the second leading cause of trauma-related death and rib fractures are the most common of these injuries. Flail chest, as defined by fracture of 3 or more ribs in 2 or more places, continues to be a clinically challenging problem. The underlying pulmonary contusion with subsequent inflammatory reaction and right-to-left shunting leading to hypoxia continues to result in high mortality for these patients. Surgical stabilization of the fractured ribs remains controversial. These investigators reviewed the history of management for flail chest alone and when combined with pulmonary contusion; they proposed an algorithm for non-operative and surgical management.

De Jong et al (2014) noted that rib fractures can cause significant problems in trauma patients, often resulting in pain and difficulty with respiration. To prevent pulmonary complications and decrease the morbidity and mortality rates of patients with rib fractures, currently there is a trend to provide surgical management of patients with flail chest. However, the indications for rib fracture fixation require further specification. Past and current strategies were described according to a review of the medical literature. These researchers performed a systematic review including current indications for rib fracture fixation. Medline (2000 to 2013) was searched, as well as Embase (2000 to 2013) and Cochrane Databases, using the keywords rib, fracture, fixation, plate, repair, and surgery. A total of 3 retrospective studies were found that described different techniques for rib fracture fixation. The results demonstrated a reduced number of ventilation days, decreased long-term morbidity and pain, and satisfactory rehabilitation after surgical treatment. In addition to flail chest, age, Injury Severity Score, and the number of rib fractures were important predictive factors for morbidity and mortality. The authors concluded that surgical rib fracture fixation might be indicated in a broader range of cases than is currently performed. Moreover, they stated that prospective RCTs are needed for further confirmation.

Cataneo et al (2015) conducted a Cochrane review to evaluate the effectiveness and safety of surgical stabilization compared with clinical management for people with flail chest (FC). The authors searched the Cochrane Injuries Group's Specialised Register, the Cochrane Central Register of Controlled Trials
CENTRAL, The Cochrane Library), MEDLINE (OvidSP), EMBASE Classic and EMBASE (OvidSP), CINAHL Plus (EBSCO), ISI WOS (SCI-EXPANDED, SSCI, CPCI-S, and CPSI-SSH), and clinical trials registers. The authors also screened reference lists and contacted experts. The review included randomized controlled trials of surgical versus non-surgical treatment for people diagnosed with FC. Two review authors selected relevant trials, assessed their risk of bias, and extracted data. The authors included three studies that involved 123 people. The methods used for blinding the participants and researchers to the treatment group were not reported, but as the comparison is surgical treatment with medical treatment this bias is hard to avoid. There was no description of concealment of the randomization sequence in two studies. All 3 studies reported on mortality, and deaths occurred in 2 studies. There was no clear evidence of a difference in mortality between treatment groups (risk ratio (RR) 0.56, 95 % confidence interval (CI): 0.13 to 2.42); however, the analysis was underpowered to detect a difference between groups. Out of the 123 people randomized and treated, 6 people died; the causes of death were pneumonia, pulmonary embolism, mediastinitis, and septic shock. Among people randomized to surgery, there were reductions in pneumonia (RR 0.36, 95 % CI: 0.15 to 0.85; 3 studies, 123 participants), chest deformity (RR 0.13, 95 % CI: 0.03 to 0.67; 2 studies, 86 participants), and tracheostomy (RR 0.38, 95 % CI: 0.14 to 1.02; 2 studies, 83 participants). Duration of mechanical ventilation, length of ICU, and length of hospital stay were measured in the 3 studies. Due to differences in reporting, the authors could not combine the results and have listed them separately. Chest pain, chest tightness, bodily pain, and adverse effects were each measured in 1 study. The Cochrane review concluded that there was some evidence from 3 small studies that showed surgical treatment was preferable to non-surgical management in reducing pneumonia, chest deformity, tracheostomy, duration of mechanical ventilation, and length of ICU stay. The review concluded that further well-designed studies with a sufficient sample size are required to confirm these results and to detect possible surgical effects on mortality.

Given the limitations of the literature, rib fracture fixation is rarely performed in North America (Slobogean and Stockton, 2015). In a review of outcomes and treatment practices from the American College of Surgeon's National Trauma Data Bank (NTDB), out of 3,467 patients with a flail chest injury, 0.7 percent were treated with surgical fixation (Dehghan et al, 2014).
Results of a pilot study conducted in Canada enrolled 14 participants, and did not specify a primary outcome; the results of this study have not been published. Multicenter randomized controlled clinical trials of surgical stabilization of acute, unstable chest wall injuries is currently ongoing (McKee et al, 2015; Granhed, 2014).

Slobogean and Stockton (2015) commented; "Several issues remain to be resolved before operative fixation of unstable chest wall injuries is accepted as standard practice with appropriate guidelines for its implementation. Very little evidence exists regarding the long-term outcomes of operatively fixing rib fractures. A minority of studies discussed complications encountered with operative intervention. As with any surgical procedure, rib fixation is associated with the risk of complications like wound infection, hardware failure, malunion or nonunion, and symptomatic hardware requiring subsequent operations. Considering the thin layer of soft tissue covering any proposed implant, these complications must be further elucidated prior to widespread implementation. As with much trauma literature, evidence so far has been hampered by small sample sizes and uncontrolled study designs . . . The current state of the modern literature suggests potential benefits for operative treatment compared with non-operative treatment of flail chest injuries. Recommendations regarding fixation of rib fractures for other indications such as intractable acute pain are primarily anecdotal at this time. Though initial results are encouraging, several important questions remain to be addressed. Cooperative efforts between centers and across the surgical specialties will be instrumental in addressing the limitations of the literature and improving the care of these critically injured trauma patients".

Bioabsorbable Plate

Oyamatsu and colleagues (2016) noted that a new technique for fixing rib fracture (bioabsorbable plate made of poly-L-lactide and hydroxyapatite) has received attention. These researchers adopted this new technique for a rib fracture by bending the plate into a U-shape and fixing it with suture through the holes in the mesh of the plate and holes that were drilled in the edge of the fractured rib. The suture was also wound around the plate. The clinical value of bioabsorbable plate for fixation of rib fracture needs to be ascertained in well-designed studies.
An UpToDate review on “Initial evaluation and management of rib fractures” (Karlson, 2016) does not mention bioabsorbable plate as a management tool.

An UpToDate review on “Inpatient management of traumatic rib fractures” (Bulger, 2016) states that “Rib fracture fixation has traditionally required an open thoracotomy for adequate exposure; however, minimally invasive approaches are now being developed. Several plate types and plate fixation methods have been used, but the search for the optimal material and fixation method continues”.

Minimally Invasive Plate Osteosynthesis

Bemelman and associates (2016) stated that since the introduction of plate fixation for fractures, several plates and screws have been developed, all with their own characteristics. To accomplish more fracture stability, it was thought the bigger the plate, the better. The counter side was a compromised blood supply of the bone, often resulting in bone necrosis and ultimately delayed or non-union. With the search and development of new materials and techniques for fracture fixation, less invasive procedures have become increasingly popular. This resulted in the minimally invasive plate osteosynthesis (MIPO) technique for fracture fixation. With the MIPO technique, procedures could be performed with smaller incisions and thus with less soft tissue damage and a better-preserved blood supply. In the previous 5 years, rib fixation has become increasingly popular, rising evidence has become available suggesting that surgical rib fixation improves outcome of patients with a flail chest or isolated rib fractures. Many surgical approaches for rib fixation have been described in the old literature, however, most of these techniques are obscure nowadays. Currently mostly large incisions with considerable surgical insult are used to stabilize rib fractures. The authors think that MIPO deserves a place in the surgical treatment of rib fractures. They presented the aspects of diagnosis, pre-operative planning and operative techniques in regard to MIPO rib fixation. The authors stated that no scientific reports have so far described the use of MIPO for rib fixation. This reflects the fact that MIPO for rib fixation is a new and developing technique. The clinical value of MIPO for fixation of rib fracture needs to be ascertained in well-designed studies.

An UpToDate review on “Inpatient management of traumatic rib fractures” (Bulger, 2016) states that “Rib fracture fixation has traditionally required an open thoracotomy for adequate exposure; however, minimally invasive approaches are
now being developed. Several plate types and plate fixation methods have been used, but the search for the optimal material and fixation method continues”.

CPT Codes / HCPCS Codes / ICD-10 Codes

Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "+":

<table>
<thead>
<tr>
<th>Code</th>
<th>Code Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT codes covered is selection criteria are met:</td>
<td></td>
</tr>
<tr>
<td>21811 - 21813</td>
<td>Open treatment of rib fracture(s) with internal fixation, includes thoracoscopic visualization when performed, unilateral</td>
</tr>
<tr>
<td>HCPCS codes not covered for indications listed in the CPB:</td>
<td></td>
</tr>
<tr>
<td>Internal fixation systems [e.g. RibLoc Rib Fracture Plating System, bioabsorbable plate, minimally invasive plate osteosynthesis] - no specific code:</td>
<td></td>
</tr>
<tr>
<td>ICD-10 codes covered if selection criteria are met:</td>
<td></td>
</tr>
<tr>
<td>S22.5xx+</td>
<td>Flail chest</td>
</tr>
<tr>
<td>ICD-10 codes not covered for indications listed in the CPB (not all-inclusive):</td>
<td></td>
</tr>
<tr>
<td>S22.31x+</td>
<td>Fracture of rib(s)</td>
</tr>
<tr>
<td>S22.49x+</td>
<td></td>
</tr>
</tbody>
</table>

The above policy is based on the following references:


43. Karlson KA. Initial evaluation and management of rib fractures. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2016.
44. Bulger EM. Inpatient management of traumatic rib fractures. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2016.


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Amendment to
Aetna Clinical Policy Bulletin Number: 0822 Internal Fixation of Rib Fracture

There are no amendments for Medicaid.

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