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STERNAL FRACTURES

Evidence Based Medicine Guideline

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SUMMARY
Sternal fractures occur in approximately 3-8% of blunt trauma patients and up to 18% of polytrauma patients with thoracic injuries. The majority are caused by motor vehicle accidents (60-80%), followed by falls and direct trauma. While isolated sternal fractures generally have a favorable prognosis, those associated with other injuries require more careful evaluation and management. Key recommendations include the routine use of chest radiography and electrocardiography for initial evaluation, the selective use of echocardiography and cardiac enzyme testing, and conservative management for most isolated sternal fractures. Surgical fixation should be considered for specific indications, including severe displacement, instability, nonunion, and refractory pain.

RECOMMENDATIONS

- **Level 1**
  - None
- **Level 2**
  - Perform chest radiography and 12-lead ECG for all patients with suspected sternal fractures.
  - Obtain CT scan to confirm diagnosis and identify associated injuries in trauma patients.
  - Admit patients with abnormal ECG for continuous cardiac monitoring for at least 24 hours.
  - Measure troponin I in patients with normal ECG; if both are normal, significant blunt cardiac injury is effectively ruled out.
  - Patients with isolated sternal fractures, normal ECG, normal cardiac enzymes, and hemodynamic stability may be safely discharged with appropriate analgesia.
- **Level 3**
  - Obtain 3D CT reconstruction for pre-operative planning when surgical fixation is anticipated.
  - Routine echocardiography is unnecessary in stable patients with normal ECG and cardiac enzymes.
  - Consider surgical fixation for:
    - Severely displaced fractures (displacement greater than one sternal width)
    - Unstable fractures with mobility or crepitus
    - Symptomatic nonunion (persistent pain and fracture line after 3 months)
    - Sternal deformity causing functional impairment
    - Refractory pain despite adequate conservative management
    - Concomitant multiple rib fractures requiring surgical stabilization
    - Severe respiratory compromise related to the sternal fracture
  - When surgical fixation is indicated, use plate osteosynthesis with titanium plates and screws rather than wire cerclage.
  - For sternal nonunion with significant bone defects, consider bone grafting or bone morphogenetic proteins.
  - Manage infected sternal fractures with appropriate antibiotics, surgical debridement, and possible hardware removal.

INTRODUCTION
Sternal fractures are relatively uncommon injuries that account for less than 0.5% of all fractures but are found in approximately 3-8% of blunt chest trauma patients and up to 18% of polytrauma patients with thoracic injuries (1,2). The incidence has increased since the introduction of seat belt legislation due to the mechanism of sudden deceleration against the restraint (3). Motor vehicle accidents account for 60-80% of all sternal fractures, with falls from height and direct trauma accounting for most of the remainder (4).

The sternum can fracture in various patterns and locations, most commonly as transverse fractures of the sternal body (>50%), followed by fractures of the manubrium (25%) and fractures or dislocations of the manubriosternal joint (19%) (5). Displacement occurs in approximately 10% of fractures, which may increase the risk of associated injuries and complications (5).

The clinical significance of sternal fractures is primarily determined by associated injuries rather than the fracture itself. Isolated sternal fractures without associated injuries generally have a favorable prognosis with low morbidity and mortality rates (0.8%) (6). However, sternal fractures may be associated with other thoracic injuries, including rib fractures, pulmonary contusions, pneumothorax, and, rarely, blunt cardiac injury. Polytrauma patients with sternal fractures have significantly higher mortality rates (7.9%) compared to those with isolated sternal fractures (7).

LITERATURE REVIEW

Diagnosis and Imaging

The diagnosis of sternal fractures begins with clinical assessment. Patients typically present with localized pain, tenderness, and occasionally crepitus or visible deformity over the sternum. Pain is often exacerbated by deep breathing, coughing, or movement. Standard posteroanterior chest radiography has low sensitivity for detecting sternal fractures due to the overlapping densities of mediastinal structures. Lateral chest radiography has historically been the primary imaging modality but still misses many fractures (8). Computed tomography (CT) is now recognized as the gold standard for diagnosis, with superior sensitivity in detecting sternal fractures and associated injuries (9). In a large retrospective study, 94% of sternal fractures were visible only on chest CT and not on conventional radiography (9). Additionally, CT can detect associated thoracic injuries in over 80% of patients with sternal fractures. Ultrasonography has emerged as a valuable bedside tool for the initial diagnosis of sternal fractures with high sensitivity (83-97%) and specificity (>95%) (10,11). It is particularly useful in settings where CT is not readily available or when patient transport is risky.

Associated Injuries and Cardiac Evaluation

The association between sternal fractures and blunt cardiac injury (BCI) has been extensively studied. While early literature suggested a strong correlation, more recent evidence indicates that isolated sternal fractures are rarely associated with significant cardiac injuries (12,13). The Eastern Association for the Surgery of Trauma (EAST) practice management guideline for BCI recommends admission electrocardiography (ECG) for all patients with suspected BCI (14). If the ECG is abnormal, continuous cardiac monitoring is recommended. For patients with a normal ECG, troponin I measurement should be performed to rule out BCI. Multiple studies have shown that patients with both normal ECG and normal troponin levels have an extremely low risk of significant cardiac complications (14,15). Echocardiography can detect wall motion abnormalities or pericardial effusions not identified by ECG or cardiac enzyme testing. However, routine echocardiography in patients with sternal fractures has not been shown to change management in the absence of abnormal ECG, elevated cardiac enzymes, or hemodynamic instability (16,17).

Treatment Approaches

Conservative management is appropriate for the vast majority (>95%) of sternal fractures and consists of pain control with or without external support devices such as thoracic braces (18). Adequate analgesia is crucial to prevent respiratory complications from pain-limited breathing (19). Surgical fixation was historically rare but has gained popularity in recent years. A systematic review by Klei et al. identified 16 studies reporting outcomes of sternal fracture treatment in 191 patients and found 100% healing rates regardless of treatment approach (5). Surgical series report good outcomes with low complication rates (2-5%) (20,21). The most common surgical techniques involve plate osteosynthesis with titanium plates and screws, which provides superior biomechanical stability compared to wire cerclage (22). A large retrospective study by Zhao et al. reported decreased pain severity scores and healing in all 64 patients who underwent plate fixation for acute fractures or nonunion (21). Recent database analyses suggest potential mortality benefits associated with surgical stabilization in selected patients; however, these findings require prospective validation (23,24). These results are further noted by longer term data by Peek and Firmin (25).

Nonunion does remain a concern, and Wu et al. review different fixation strategies to treat persistent sternal instability (26). Among the discussed techniques, open reduction and rigid plate fixation with Sternalock plates resulted in no evidence of infection with appropriate bone healing. For cases of dislocation or combined injuries, Divisi suggests a role for demineralized bone matrix and plate techniques (27). In this study, Divisi found that usage

of titanium plates along with demineralized bone matrix resulted in more rapid recovery, decreased hospitalization, and appropriate aesthetic results.

Management Algorithm

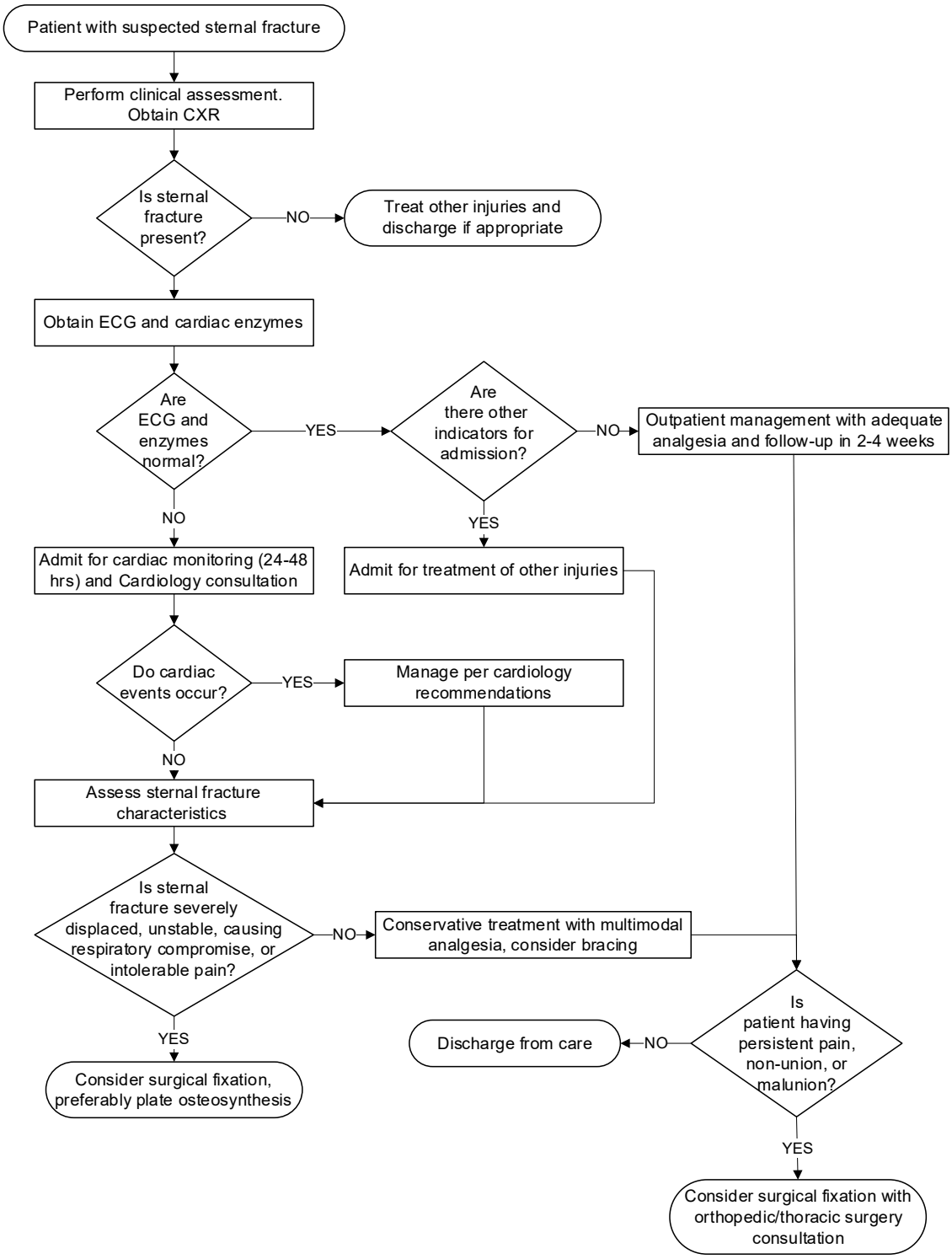

Table 1: Treatment Approaches for Sternal Fractures

Fracture Type	Clinical Presentation	Recommended Treatment
Isolated sternal fracture	• Minimal displacement • Normal ECG • Normal cardiac enzymes • No respiratory compromise	• Outpatient management • Adequate analgesia • Follow-up in 2-4 weeks
Isolated sternal fracture	• Minimal displacement • Abnormal ECG or elevated cardiac enzymes • Hemodynamically stable	• Inpatient monitoring for 24-48 hours • Cardiac consultation • Adequate analgesia
Displaced sternal fracture	• Displacement > one sternal width • Stable patient • No respiratory compromise	• Consider surgical fixation • Adequate analgesia • Close monitoring of respiratory status
Unstable sternal fracture	• Mobile fragments • Respiratory compromise • Pain limiting respiratory effort	• Surgical fixation (preferably plate osteosynthesis) • Pain management • Respiratory support as needed
Sternal fracture with nonunion	• Persistent fracture line >3 months • Ongoing pain • Mobility at fracture site	• Surgical fixation • Consider bone grafting for defects • Multimodal pain management
Sternovertebral fracture	• Concomitant thoracic spine fracture • Sternal fracture	• Treat according to spinal instability • Sternal fixation not routinely required unless criteria for fixation are met

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