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Association of Chest Wall Injury Fracture Patterns with Different Mechanisms of Injury

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Description

Rib fractures are a common injury secondary to blunt trauma and are associated with significant morbidity and mortality [1,2]. Early intervention *via* multidisciplinary clinical pathways has been shown to reduce days on the ventilator, length of hospital stay, infectious morbidity and mortality [3,4]. High volume institutions have chest wall injury and reconstructive centers in place to streamline these efforts.

Rib fractures are typically diagnosed on initial trauma work-up with chest X-rays and Computed Tomography (CT). Even with modern technology, however, rib fractures and significant concomitant injuries such as traumatic diaphragmatic injury are often missed on initial imaging, delaying diagnosis and treatment [1,5,6]. In fact, chest X-rays, historically the initial imaging of choice, may miss 50% of rib fractures [7]. The Mechanism of Injury (MOI) has been shown to be an important predictor of sustained traumatic injuries [1,8,9]. If the MOI could be integrated into the standard trauma assessment protocol, fewer injuries would be missed and patients could be quickly triaged for nonoperative management, loco regional anesthesia, or early Surgical Stabilization of Rib Fractures (SSRF), where earlier fixation has led to improved outcomes [10-12].

A recent study by Brewer et al., (2024) examined whether specific MOIs were associated with distinct rib fracture patterns, analyzing fracture patterns based on falls, Motor Vehicle Collisions (MVCs), Motorcycle Collisions (MCCs), automobile-pedestrian strikes and bicycle collisions [13]. The group performed a retrospective analysis of de-identified, prospectively collected data contained within the Chest Injury International Database (CIID), an international database of the Chest Wall Injury Society (CWIS) that contains both operative and nonoperative patients with fracture patterns and chest injury-specific outcomes. They discovered a statistically significant association between the MOI and rib fracture pattern, which had not been previously shown. While fractures were most commonly found in the lateral ribs, those from MVCs trended towards anterior while those from falls trended towards posterior, which makes sense clinically as MVCs usually involve a frontal impact and with falls patients often land on their backs or with tucked arms [13]. Mechanisms with comparable energy levels of impact also exhibited similar fracture patterns-MVCs and MCCs averaged 9 fractures per patient, bicycle collisions 8.5, automobile-pedestrian collision 10 and falls 7 [13]. These pattern correlations enable radiologists and surgeons to appropriately triage patients who present with blunt force trauma and suspected rib injuries, allowing them to identify rib fractures and associated injuries more quickly and with greater reliability. Predicting injuries based on the MOI streamlines the implementation of appropriate imaging modalities such as three-dimensional rendering and use of arterial phase CT scans. In patients who are too unstable for imaging and proceed directly to the operating room, the MOI could be used to predict rib fractures and injuries to surrounding structures in the neck, chest, or abdomen to guide operative decision-making.

Brewer et al., is the first study of its kind to analyze the relationship between MOI and fracture patterns in living patients [6,13,14]. Advantages to using the CIID as in their study include a large sample size, a standardized CWIS taxonomy for rib fractures and a specificity that allows for scalability to future findings [15,16]. Their results suggest that rib fracture patterns may be predicted based on the MOI, which can thus be used to guide appropriate radiographic studies, leading to fewer missed injuries, more accurate diagnoses and earlier targeted intervention(s) for improved patient outcomes. For example, one study showed that low-grade liver or spleen injuries with rib fractures are associated with a 20% rate of diaphragmic injury [17]. Another group performed thoracoscopy during SSRF and revealed diaphragmatic injuries at a rate of 16.5% [18]. In the same study, 77% of the diaphragmatic injuries were missed on CT when reviewed by a radiologist. Therefore, knowing this association between the MOI and rib fractures to diaphragmatic injuries could develop into a new algorithm for undergoing diagnostic laparoscopy in candidate patients.

The study by Brewer et al., is limited by its sample population, which is selected predominantly from chest wall injury centers and may therefore introduce a selection bias. The study is also limited by the variability in database entry criteria at each institution-while some institutions enter all patients with rib fractures, others only enter patients who undergo SSRF. Entries into the CIID is also only done by chest wall surgeons, so patients who are less injured and are not seen by a surgical consultant would not be included in the registry. As the CIID expands, CWIS hopes to standardize criteria for populating the database as it recruits more participating institutions.

It is clear that different MOAs generate unique rib fracture patterns that can be used to anticipate diagnostic modalities and potential interventions in patients presenting with acute thoracic trauma. Future studies clarifying the association among MOI and rib fracture patterns with age, the Blunt Pulmonary Contusion 18 (BPC18) score factor and SSRF are validated.

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