Chest Wall Injury Society

Title of Presentation

Hybrid Operating Room May Improve the Accuracy of Fracture Localization and Shorten Wound Size in Surgical Stabilization of Rib Fractures

Background

Rib fractures are among the most common thoracic injuries encountered in trauma patients. Surgical Stabilization of Rib Fractures (SSRF) has been shown to significantly improve clinical outcomes in selected cases, including reduced ventilator days, shorter hospital stays, and improved pain control. Previous studies have demonstrated that smaller incisions, achieved through minimally invasive SSRF techniques, are associated with shorter operation time, reduced blood loss, and shorter hospital stays. A critical factor in minimizing incision size is the accurate intraoperative localization of rib fracture sites. Traditional localization methods include clinical palpation, ultrasound, thoracoscopic identification, and preoperative imaging. However, these techniques all have limitations. Palpation may be unreliable in patients with flail chest or lateral rib fractures. Ultrasound can be challenging in obese patients or those with subcutaneous emphysema. Furthermore, fracture displacement can occur between the time of preoperative imaging and surgery, further complicating accurate localization. We hypothesized that the use of intraoperative imaging in a Hybrid Operating Room (HOR), specifically with robotic C-arm cone-beam computed tomography (CBCT) and laser-guided projection systems, could enhance the accuracy of fracture localization and allow for smaller, more precise incisions

Methods

This prospective study included 200 patients with multiple rib fractures who underwent SSRF at Kaohsiung Municipal Siaogang Hospital, Taiwan. All patients received preoperative chest CT for initial fracture assessment. Patients were assigned to either the HOR group or non-HOR group based on HOR availability. Intraoperatively, fractures were initially localized via palpation, and subsequently confirmed using CBCT and laser-guided targeting in the HOR group. The laser projection system was used to mark the fracture sites directly on the skin, enabling precise incision planning.
Collected variables included age, gender, body mass index (BMI), fracture location, incision length, operative time, estimated blood loss, chest tube duration, and hospital length of stay. The discrepancy between the palpated location and laser-guided location was also recorded.

Results

Results:
The average incision length in the HOR group was 4.0 cm, compared to 7.2 cm in the non-HOR group. Subgroup analysis showed significant decrease in wound length in obese and lateral rib fracture patients. Intraoperative imaging revealed that the discrepancy between palpation and laser-guided localization averaged 1.96 cm for posterior fractures, 2.4cm for anterior fractures and 4.0 cm for lateral fractures. This difference was more pronounced in obese patients and those with flail chest. Surgeons also noted increased accuracy and confidence in fracture localization with the use of laser guidance.
Discussion:
With increased surgical experience, the time required for laser localization decreased. Patients with higher BMI, lateral rib fractures, or flail segments appeared to benefit the most from image-guided localization, resulting in a more precise fracture localization and reduction in wound length. In selected cases, even non-displaced fractures were successfully managed using adjunctive platelet-rich plasma (PRP) injection to promote healing.

Conclusion

Hybrid OR technology using intraoperative CBCT and laser-guided localization enhances the accuracy of fracture site identification in SSRF. This approach allows for smaller incisions, minimizes tissue dissection, and may improve overall surgical efficiency and patient outcomes. These findings support the integration of HOR systems in managing complex rib fractures, especially in patients for whom traditional localization methods are suboptimal.