

Robotic Intrathoracic Fixation of Rib Acute Fractures (RIFRAF): First Institutional Experience Demonstrating Safety and Efficiency Compared to Open and Video Assisted Thoracoscopic Surgery Approaches

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Introduction

Surgical stabilization of rib fractures is an increasingly utilized intervention in trauma patients, particularly those with flail chest or multiple displaced fractures (Figure 1).

Rib fracture fixation has traditionally been performed using open or video-assisted thoracoscopic surgery (VATS) approaches. While effective, these techniques may be associated with significant soft tissue disruption, limited visualization of posterior fractures, and ergonomic challenges for the operating surgeon. Advances in minimally invasive and robotic surgical platforms offer the potential to overcome these limitations by enhancing visualization, precision, and instrument dexterity.

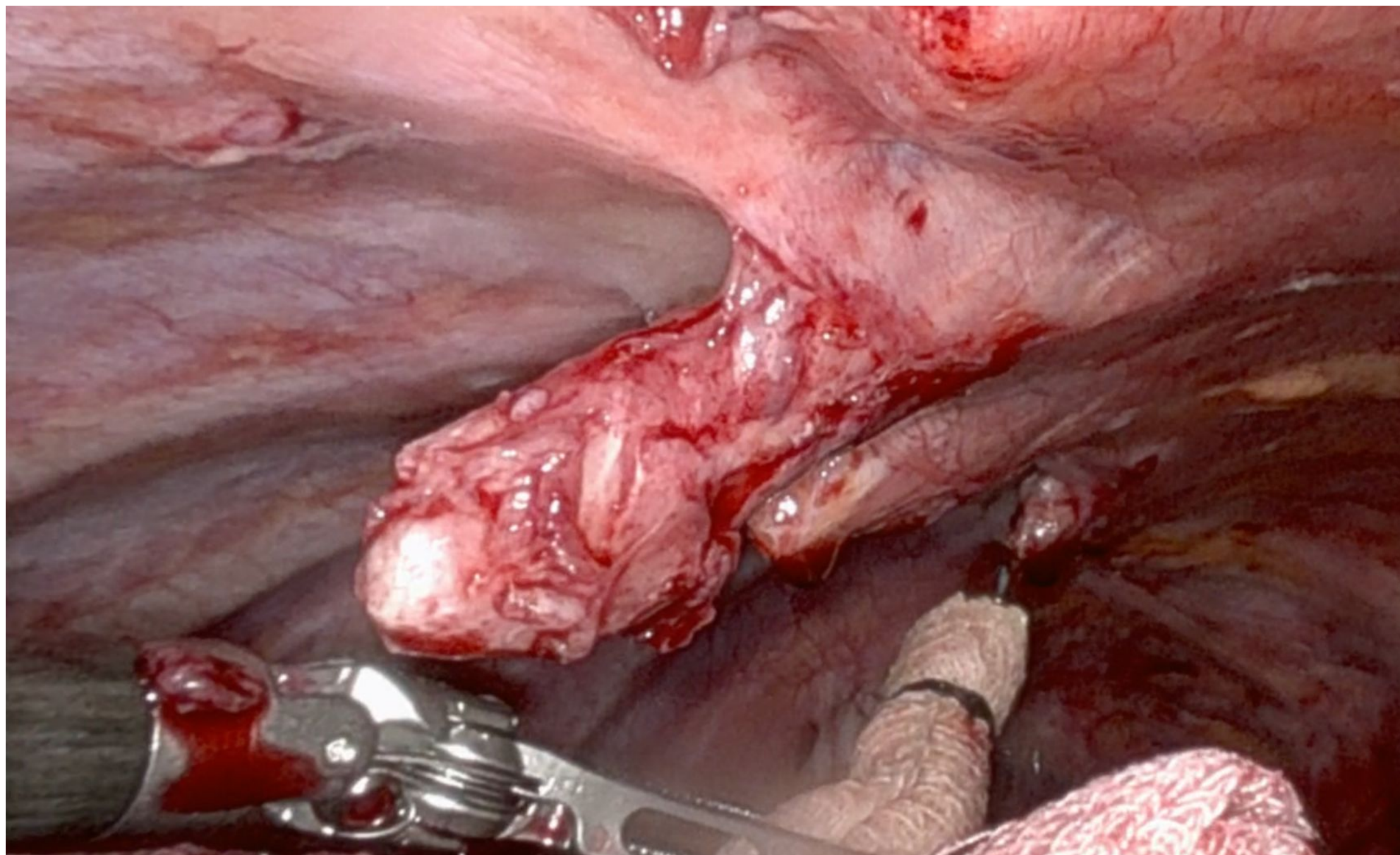


Figure 1: Intraoperative image showing multiple significantly displaced rib fractures

Purpose

To address these challenges, we developed a novel robotic-assisted technique - Robotic Intrathoracic Fixation of Rib Acute Fractures (RIFRAF) - and present our institution’s first experience evaluating its safety, efficiency, and outcomes compared to open and VATS rib fixation methods.

Methods

A retrospective review was conducted of 51 rib fixation cases performed at a single tertiary medical center between September 2022 and July 2025: robotic (n=25), open (n=13), and VATS (n=13).

Patient demographics, operative time, number of ribs plated, hospital length of stay (LOS) post operatively, intensive care unit (ICU) LOS post operatively, ventilator days post operatively, and mortality were analyzed.

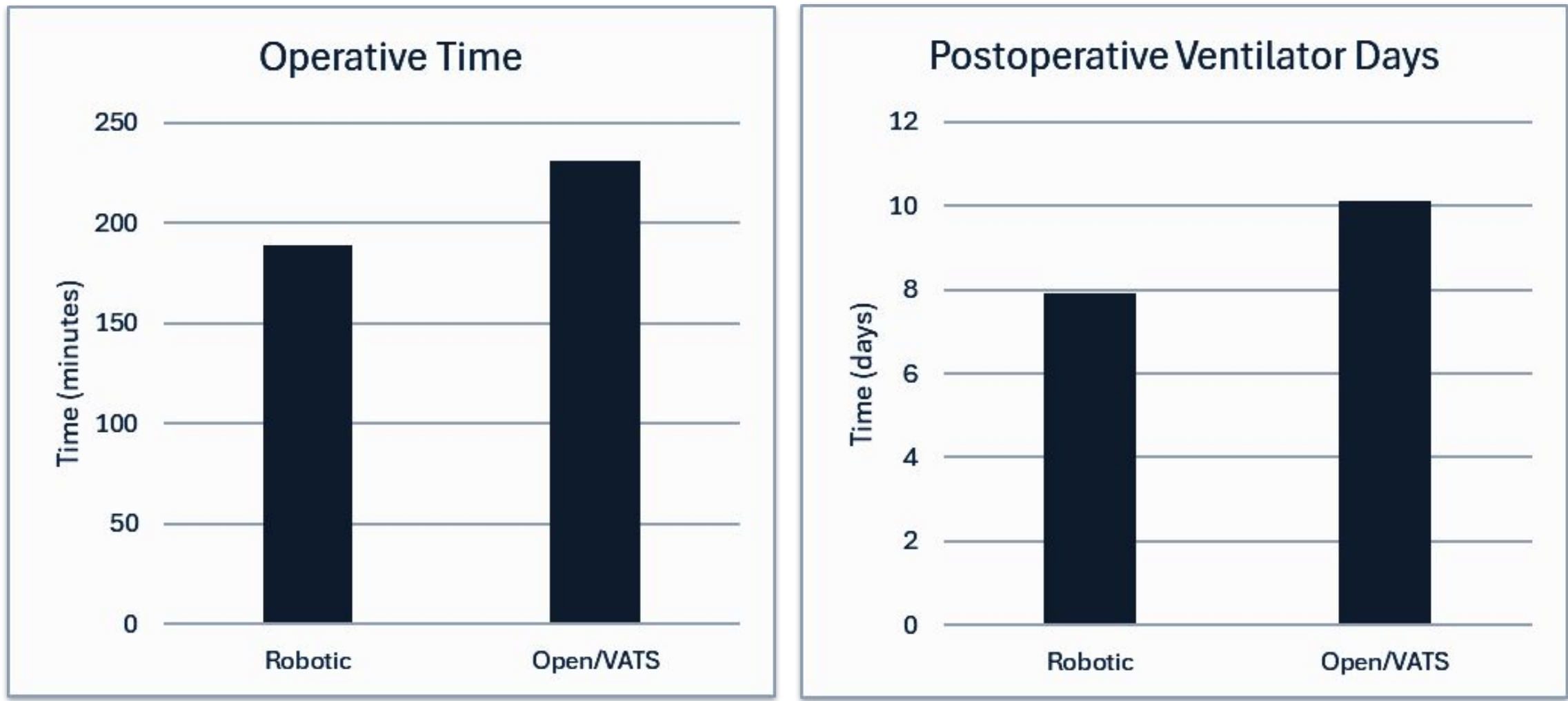


Figure 2: The RIFRAF technique was associated with shorter operative times and postoperative ventilator days compared to traditional open and video assisted thoracoscopic surgery

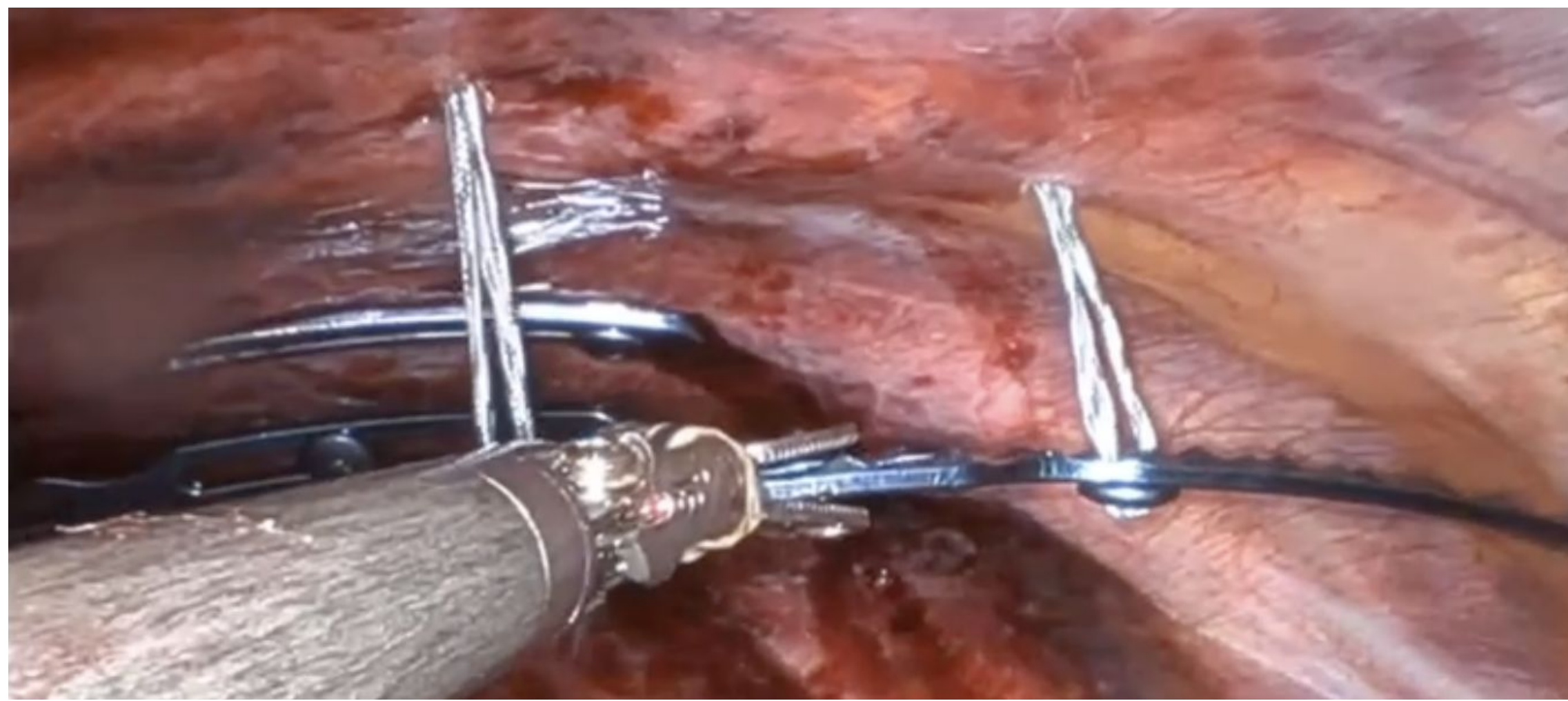


Figure 3: Intraoperative images of robotic internal fixation with the Zimmer Biomet RibFix TITAN Anchor Based Fixation

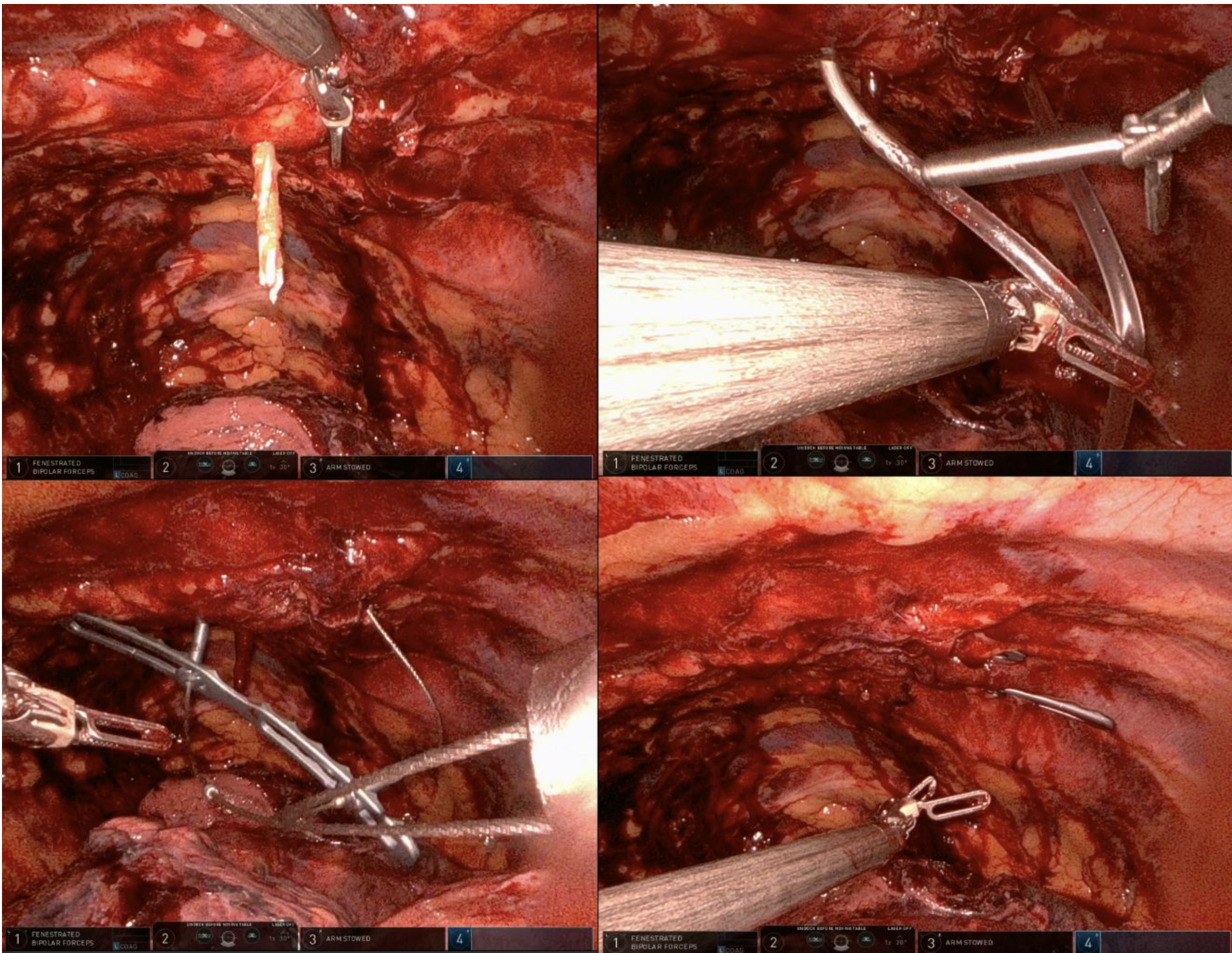


Figure 4: Series of intraoperative images demonstrating the process of robotic internal fixation utilizing the RibFix Advantage system by Zimmer Biomet

Results

This cohort included 17 females and 34 males, with an average age of 53 years (range 21-87).

Robotic fixation was found to be safe and effective when compared to traditional approaches (open and VATS), with equivalent ICU LOS (mean 7.3 days in both groups) and mortality (1 in robotic group, 2 in traditional group) across approaches.

Robotic cases demonstrated improved operative efficiency, with significantly shorter operative times (189.1 minutes vs 231.1 minutes, p=0.024). Patients undergoing robotic fixation also had fewer postoperative ventilator days (7.9 vs. 10.1 days, p=0.360).

	Robotic	Open/VATS	p value
Sample size	25	26	
ICU LOS	7.3 days	7.3 days	
Mortality	4.0% (n=1)	7.7% (n=2)	
Operative Time	189.1 minutes	231.1 minutes	0.024
Postoperative Ventilator Days	7.9 days	101.1 days	0.36

Table 1: Robotic fixation was noted to be equivalent in ICU LOS postoperatively and superior in operative time and postoperative ventilatory days.

Discussion and Conclusions

RIFRAF represents the first reported application of robotic-assisted surgery for rib fracture fixation and expands the role of robotics within minimally invasive thoracic and trauma surgery. Our early experience suggests that robotic fixation can be performed safely and achieve outcomes comparable to traditional open and VATS approaches, supporting the feasibility of this novel approach.

The robotic platform provides several technical advantages to facilitate precise fracture reduction and plate placement while minimizing chest wall dissection. These capabilities may contribute to the potential advantages in operative efficiency and postoperative ventilator duration. Larger-scale studies are needed to further explore the benefits and limitations of this technique.

Clinical Implications

As the first institution to develop and implement robotic rib fixation, we demonstrate the potential of robotics to advance the management of rib fractures. Broader adoption of the RIFRAF technique may enhance surgical performance and recovery without compromising patient safety.