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• Original Article •

Thoracoscopy in Management of Chest Trauma: Our Three-year Jeju Experience

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Purpose: The role for minimally invasive surgery in chest trauma is vague, one that recently is more frequently performed, and one attractive option to be considered. Thoracoscopic surgery may improve morbidity, mortality, hasten recovery and shorten hospital stay.

Methods: A total of 31 patients underwent video assisted thoracoscopic surgery for the treatment of blunt and penetrating chest trauma from June 9th, 2013 to March 21st, 2016 in Jeju, South Korea.

Results: Twenty-three patients were males and eight patients were females. Their ages ranged from 23 to 81 years. The cause of injury was due to traffic accident in 17 patients, fall down in 5 patients, bicycle accident in 2 patients, battery in 2 patients, crushing injury in 2 patients, and slip down, kicked by horse, and stab wound in one patient each. Video assisted thoracoscopic exploration was performed in the 18 patients with flail chest or greater than 3 displaced ribs. The thoracoscopic procedures done were hematoma evacuation in 13 patients, partial rib fragment excision in 9 patients, lung suture in 5 patients, bleeding control (ligation or electrocautery) in 3 patients with massive hemothorax, diaphragmatic repair in two patients, wedge resection in two patients and decortication in 1 patient. There was only one patient with conversion to open thoracotomy.

Conclusion: There is a broad range of procedures that can be done by thoracoscopic surgery and a painful thoracotomy incision can be avoided. Thoracoscopic surgery can be done safely and swiftly in the trauma patient. [J Trauma Inj 2017; 30: 33-40]

Key Words: Thoracic trauma, Trauma surgery, Video assisted thoracoscopic surgery

I. Introduction

The characteristics of the isolated nature of islands inevitably cause many limitations to very needed emergency medical services. Jeju of South Korea is not an exception. There are only two major hospitals on the island. Annually there are about 13,000 trauma patients seen at our hospital, Cheju Halla General Hospital, which is one of the two hospitals with over 600 beds. Trauma is the leading cause of all deaths in patients aged less than 45 years worldwide and 25% of the mortalities are due to chest injuries.(1,2) Urgent exploration is required in over 30% of these patients and has until recently been done by open thoracotomy.(3) Open thoracotomy is the most painful surgical incision with the highest

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complications causing prolonged recovery and unrelenting pain. Ever since the first thoracoscopic procedure done for trauma reported by Branco in 1946 and with the advent of video apparatus in the 1990s, there has been a growing trend in minimally invasive surgery, but only recently seen in trauma.(4) We report our retrospective clinical analysis of patients who have undergone minimally invasive surgery for the treatment of blunt and penetrating chest injuries to assess the usefulness of video assisted thoracoscopic surgery in the trauma patient from an environment where transfer may not be an option.

II. Materials and Methods

This study was performed at the Cheju Halla General Hospital, a 600 bed secondary care institution, and S-Jungang Hospital, a 350 bed operating secondary care hospital. Cheju Halla Hospital possesses one of the seven designated emergency centers in the nation and is a strong candidate for the establishment of the sole level I trauma center within the island. We retrospectively examined 31 patients who underwent thoracoscopic procedures for blunt and penetrating chest injuries done from June 9th, 2013 to March 21st, 2016. All procedures were performed by a single chest surgeon who specializes in trauma surgery. All procedures were performed under general anesthesia with double-lumen endotracheal intubation. The number of ports and surgical method varied, depending upon the procedure performed. Parameters evaluated were demographic data including name, sex, age, and other data including trauma type, Injury Severity Score (ISS), number of rib fractures, number of displaced rib fractures, time to operation, operative times, operative indications, procedure, ICU stay, complications, and length of hospital stay. All reports, before and after the operation were analyzed and postoperative outcomes recorded. All patients after March, 2015, were reviewed and treated with the help of the Acute Care Surgery team of Cheju Halla Hospital. Hemodynamic instability or shock, major hemorrhage or massive air leakage were not exclusion criteria in this study. However, cardiac tamponade or other major cardiovascular injuries were excluded. Exploratory thoracoscopy was performed routinely for patient's who had undergone rib fixations for flail chest or greater than or equal to three displaced fractures (including those from the 3rd to 10th ribs only). This was done to identify the area for incision, remove retained hemothoraces, and remove any penetrating rib fragments. Our indications for thoracoscopic removal of a sharp protruding rib fragment in the presence of lung/organ penetration was as follows: 1. Major air leak >3 days; 2. Increase of minimal pneumothorax or new development of pneumothorax >1 week after trauma; and 3. Potential vessel injury

This study was approved by the institutional review board of Cheju Halla Hospital.

III. Results

A total of 4,628 trauma patients were admitted to S-Jungang Hospital from June 9th, 2013 to February 28th, 2015 and a total of 2,168 trauma patients were admitted to Cheju Halla General Hospital from March 1st, 2015 to March 21st, 2016. Thirty-one patients underwent a thoracoscopic procedure and among them 23 patients were males (74%) and 8 patients were females (26%). Their ages ranged from 23 to 81 years with a mean of 56 years-of-age. The most common mechanism of injury was due to traffic accidents in 17 patients. There were 5 fall down patients, 2 bicycle accidents, 2 patients sustaining injuries due to battery, 2 crushing injury patients, and one patient with a slip down, one kicked by a horse and one stab wound patient (Table 1). The average ISS was classified as severely injured (>15) at 25.2.

The indications for surgery were flail chest in 9 patients, prolonged air leakage in 9 patients, greater than 3 displaced ribs in 9 patients, hematoma evacuation in 4 patients, massive hemothorax in 3 patients, empyema in 2 patients, diaphragmatic rupture in 2 patients, and penetrating wound and thoracic outlet syndrome in one patient each (Table 2). The average time to operation was 8.6 days (excluding the patient with thoracic outlet syndrome done more than 1 year after his trauma incident).

The average operation time was 139.7 minutes. The video assisted thoracoscopic exploration was performed in the 18 patients with flail chest or greater than 3 displaced ribs. The video assisted procedures done were hematoma evacuation in 13 patients, par-

tial rib fragment excision in 9 patients, endoscopic lung suture in 5 patients, bleeding control (ligation or electrocautery) in the 3 patients with massive hemothorax, diaphragmatic repair in two patients, wedge resection in two patients and decortication in 1 patient (Table 3). Among the operative findings, lung laceration in 14 patients, there were retained hemothorax in 13 patients, rib fragment penetration to the lung in 13 patients, active bleeding in 5 patients (including one patient with a minor tear in the aortic wall), ruptured diaphragm in two patients, empyema in two patients, traumatic bulla in two patients (one of whom a wedge resection was performed), focal aortic aneurysm in one patient, and a patient with a large pericardial tear with cardiac herniation (Table 4).

There was only one patient with inevitable conversion to open thoracotomy due to the extent of rib fractures and mutilation of his integrity of his chest wall. The mean period of ICU stay was 9.8 days. The average time for tube indwell was 5.8 days and the total mean hospital stay was 52 days. Complications seen were end-stage renal disease and status epilepticus in one patient, Bell's palsy and rib collapse in one patient each (unrelated to the thoracoscopic procedure), delayed extubation (5 days after the procedure), chest wall seroma, and one patient with deep vein thrombosis. There were three mortalities not related to the video assisted thoracoscopic procedure,

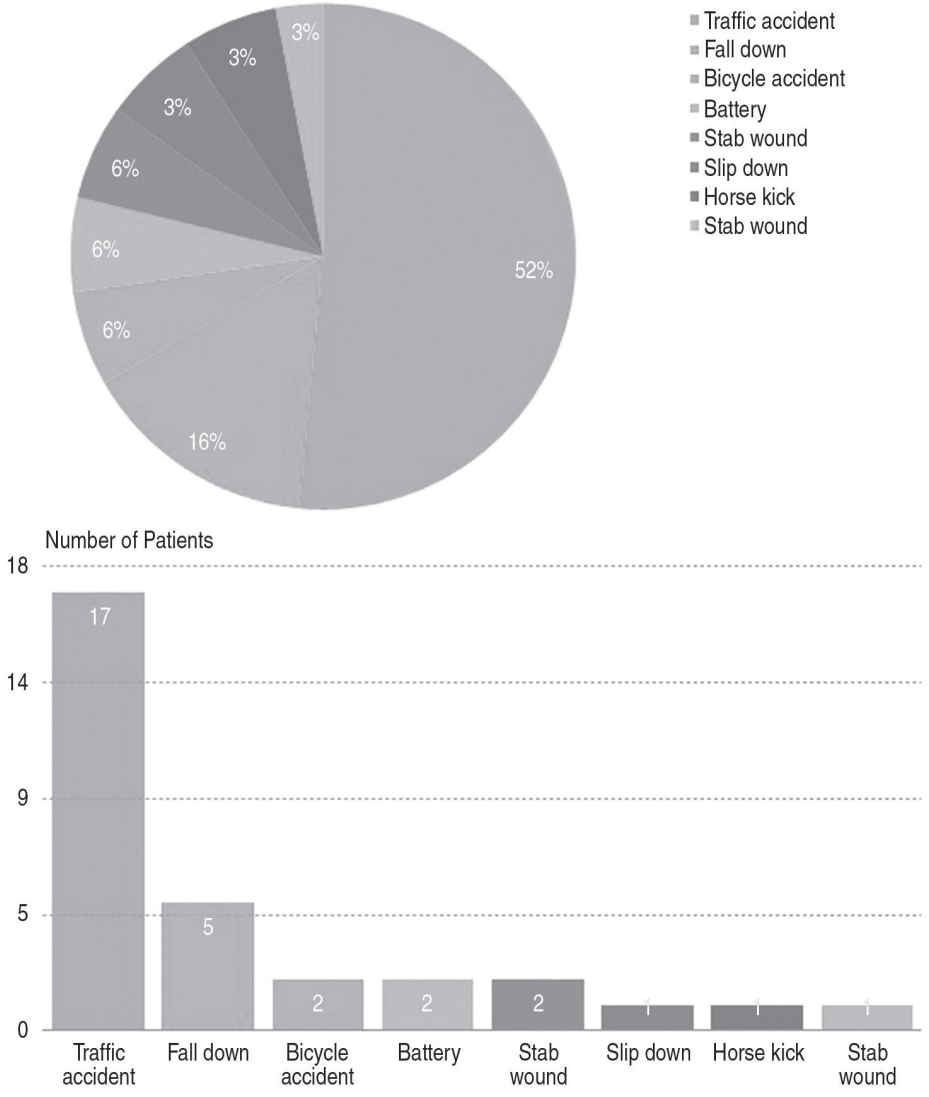

Table 1. Statistics for mechanism of injury: traffic accidents, fall down, bicycle accidents, battery, crushing injury, slip down, horse kick, and stab wound

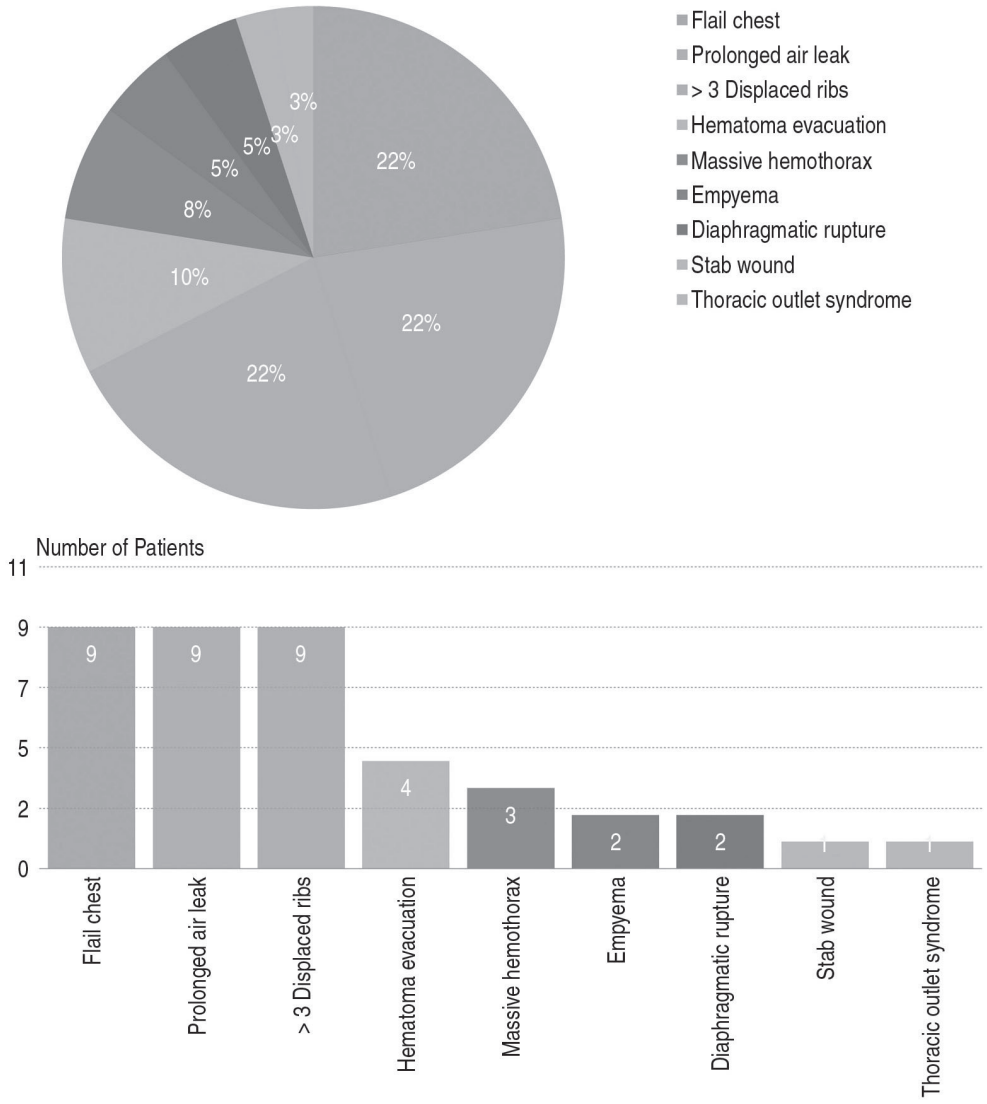

Table 2. Statistics for surgical indications: flail chest, prolonged air leak, hematoma evacuation, massive hemothorax, empyema, diaphragmatic rupture, stab wound, and thoracic outlet syndrome

two patients expired due to intracranial hemorrhaging and one due to gastric bleeding.

IV. Discussion

A majority 80 to 85% of patients with blunt thoracic trauma requiring intervention is resolved with a chest tube insertion alone. The other 15 to 20% require additional surgical intervention.(5) There are no definite standards for treatment of patients in need of surgical treatment in the chest trauma patient for various types of injury. This includes fracture of ribs, traumatic pneumothorax, and least but not least thoracoscopy. It was not until the advent of optics and equipment with video monitors has the era of thoracoscopic surgery really started. Thoracoscopic surgery in chest trauma is relatively new, with few clinical analyses. Video assisted thoracoscopic surgery (VATS) has made its major mark with evaluations in diaphragmatic injuries, then for retained hemothoraces, and then for persistent traumatic pneumothorax.(6-10)

Our most common indications for thoracoscopic surgery in trauma patients were for aiding patients with flail chest, patients with greater than or equal to 3 displaced ribs, and persistent posttraumatic pneumothorax. Video assisted thoracoscopic exploration was performed for flail chest and multiple rib fractures (1) to help identify the precise area of frac-

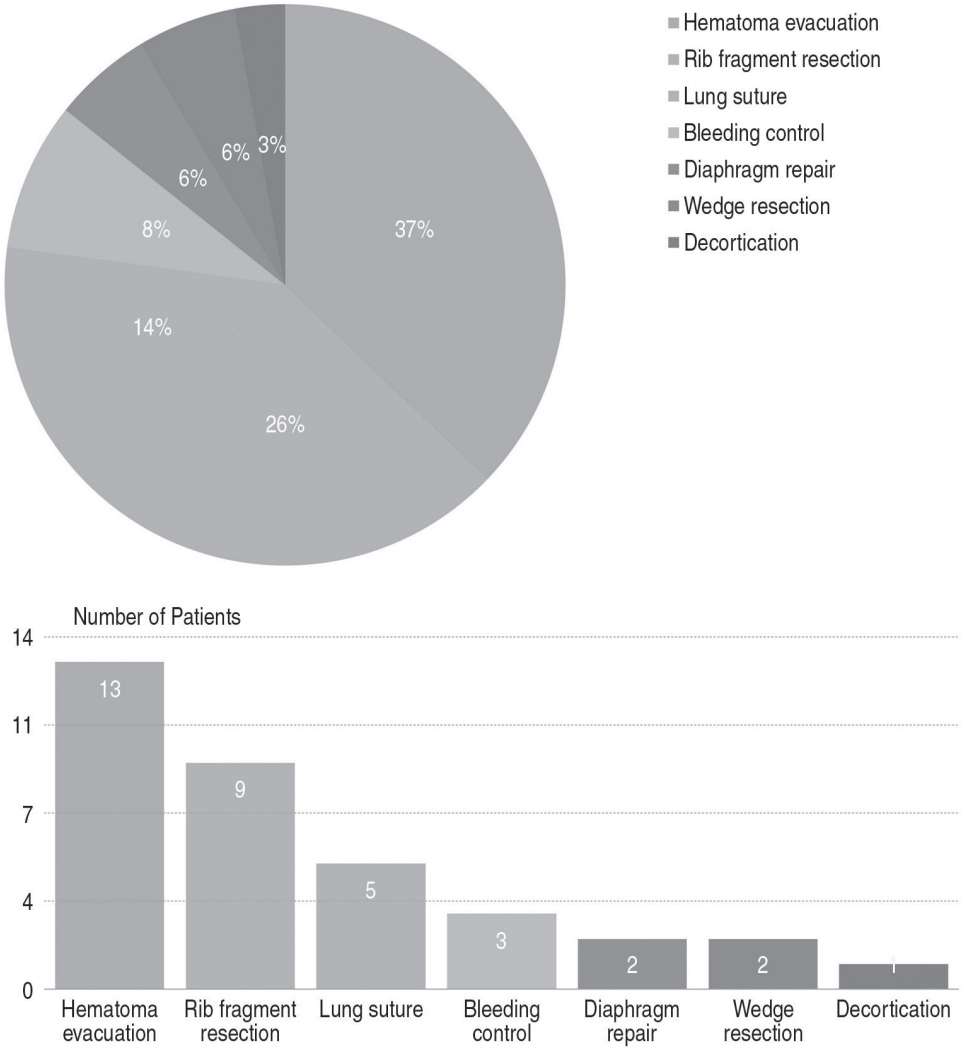

Table 3. Statistics for video assisted thoracoscopic procedure performed: hematoma evacuation, rib fragment resection, lung suture, bleeding control, diaphragmatic repair, wedge resection, and decortication

ture that needs fixation and thus, locating the area for the overlying incision, (2) evaluating the severity of chest wall cavity collapse, (3) checking for possible hematoma accumulation, (4) identifying lung penetrating rib fragments, (4) making sure screws do not penetrate the pleural cavity to the point that it may injure the lung, (5) and observing the results after rib fixation and expansion of the chest cavity. Hematoma evacuation and massive hemothorax were also relatively common indications for VATS in our series. Our indications for rib fixation were flail chest (defined as greater than or equal to 3 rib fractures at greater than or equal to two multiple sites), greater than or equal to 3 displaced fractures, collapsed chest wall, and unrelenting severe chest pain due to multiple rib fractures (greater than or equal to three fractured ribs). We have used thoracoscopy in rib fractures to identify the area with rib displacements for the external incision, to remove retained hemothoraces, and to remove any penetrating rib fragments. Our indications for thoracoscopic removal of sharp protruding rib fragments impaling the lung were as follows: 1. Major air leak >3 days; 2. Increase of minimal pneumothorax or new development of pneumothorax >1 week after trauma; 3. Potential vessel injury; and 4. Other indication requiring exploration. We found that, however, fixating ribs many times negated the need for resecting the penetrating fragments. Definition of retained hemothorax was residual hemothorax >500 ml, blood occupying greater than a third of the

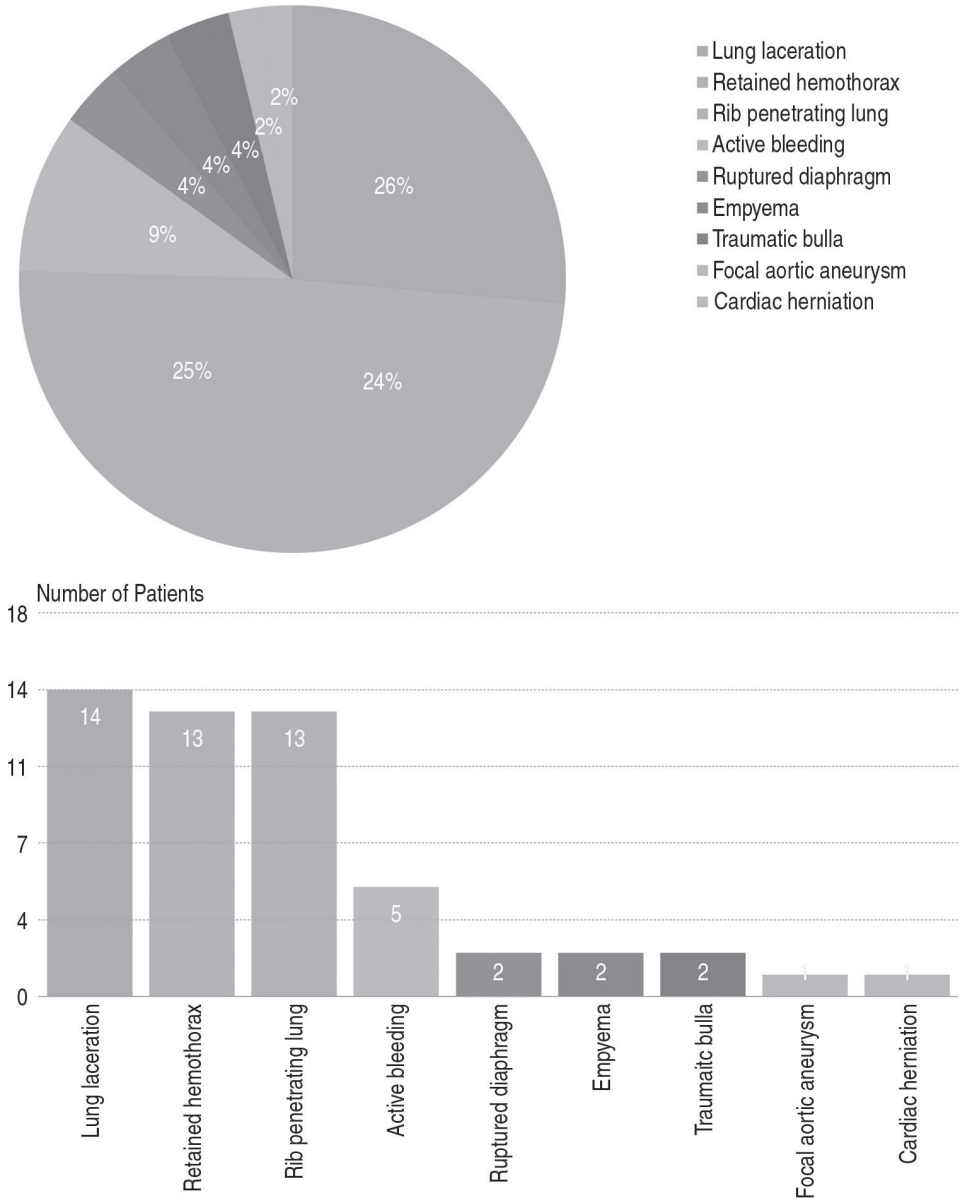

Table 4. Statistics for operative findings: lung laceration, retained hemothorax, rib penetrating lung, active bleeding, ruptured diaphragm, empyema, traumatic bulla, focal aortic aneurysm, and cardiac herniation

pleural cavity, or residual blood that cannot be drained despite tube insertion for more than 72 hours.(5) VATS evacuation has been recommended to be done within 10 days. The reasons for early intervention were that retained pleural collections usually occur 48 hours after trauma and infections often occur 72 hours after trauma.(11) If done thereafter, failure rates were reported to be high.(12) Conversion to open thoracotomy rates have been found to be from 13.8 to 31%.(13) Our conversion rate was 3.2% (1 patient). Timing of the operation can also be influenced by head injury, in that recovery of brain injury needs at least 4 days.(14) This would necessitate postponing a VATS operation in a trauma patient with significant head injury. In our study in 2 patients the operation was delayed due to major head injury. VATS has been found to reduce complications, chest tube drain, duration of tube indwell, duration of hospital stay, operation times, amount of bleeding and need for transfusion.(15) Our study showed a median ICU stay of 9.8 days, which seems to be quite long. However, the reason for the long ICU stays were because of the high injury sever-

ity scores with an average ISS of 25.2 and combined severe trauma such as injuries to the brain. Most patients were admitted to our ICU for reasons not only due to the chest injuries, but due to multiple injuries. This study was aimed at finding the feasibility of thoracoscopic surgery in trauma and did not include comparisons with open procedure controls.

The only contraindications for VATS in trauma includes severe fibrous adhesions, inability to tolerate single-lumen ventilation, severe hemodynamic instability, unresponsive shock, and life-threatening thoracic injuries.(15) Our study included patients with hemodynamic instability that did respond to inotropics or fluid replacement, but did not include patients with cardiac or significant aortic injury. Open thoracotomy can be done in 10 minutes on an emergent basis. Thoracoscopic surgery can start in less than 1 minute, however, if there is much bleeding, it may be safer by open thoracotomy due to clouding of the endoscopic camera.

V. Conclusion

There are options over a painful thoracotomy incision and VATS is an attractive option. Thoracoscopic surgery can be done safely and swiftly in the trauma patient and may improve outcomes in the severe trauma patient. Possible benefits of early thoracoscopic procedures in chest trauma may include a shorter hospital stay, rapid recovery, and improvement of the quality of life after the traumatic incident. From diagnostic to therapeutic, VATS will provide more diverse modes of minimally invasive treatment in the future.

VI. Authorship

This work represents the original efforts of the investigators. All listed authors contribute to study design, data collection, data interpretation, and manuscript development.

VII. Acknowledgements

All data are collections from two institutions in Jeju Island, South Korea: S-Jungang Hospital and Cheju Halla Hospital. The data were obtained with permission from both Superintendents and from the owners of both private institutions. The tables were created from software from the Apple Incorporate application, Numbers for iOS.

VIII. Disclosure

The authors declare no conflicts of interest

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