

Role of uniportal video-assisted thoracoscopic surgery in the management of penetrating thoracic injuries



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Kardiochirurgia i Torakochirurgia Polska 2022; 19 (3): 155-157

Chest-related injuries account for 25% of trauma-related mortality. Penetrating chest trauma is less common than blunt trauma; however, it is more deadly, accounting for a mortality rate of about 1.5% [1]. The vast majority of penetrating chest trauma can be safely managed by thoracostomy tube drainage. However, approximately 14% of patients with stab wounds may require early operative intervention to control bleeding or repair damaged internal organs [2].

Current guidelines for the management of penetrating chest injuries advocate for urgent thoracotomy if an acute evacuation of blood on tube placement exceeds 1500 ml or there is persistent bleeding of 200 ml per hour for 2 to 4 hours [2]. Open thoracotomy incision contributes to the morbidity, mortality and prolonged painful recovery of the patient mainly due to the extent of the incision. This provided the incentive to develop less invasive methods to manage thoracic trauma.

With the recent advances in minimal access thoracic procedures, video-assisted thoracoscopic surgery (VATS) provided an alternative method to diagnose and simultaneously treat any thoracic injury. Papers showed that VATS compared to open thoracotomy in hemodynamically stable patients with chest trauma had a favorable post-operative period, superior long-term outcome and greater patient satisfaction [3]. The first progress was in uniportal VATS conducted by Prof. Rocco in which uniportal VATS was performed for pleural effusion, pleurodesis, pleural and mediastinal biopsies, and lung wedge resections [4]. A breakthrough in uniportal VATS was first reported by Dr. Gozalez Rivas when he performed major lung resection with radical lymphadenectomy for non-small cell lung cancer (NSCLC) [1].

This study evaluates the feasibility and safety of uniportal VATS for the management of penetrating stab wounds of the chest in the emergency setting.

This a retrospective review of all uniportal VATS performed for the management of penetrating stab wounds of the chest. Between September 2016 and December 2019

a total of 21 patients underwent emergent thoracic surgery due to penetrating injury, 19 of the operations performed using uniportal VATS. The inclusion criteria were: uniportal VATS approach for the management of hemodynamically stable patients with active bleeding after penetrating stab injuries to the chest outside the cardiac box and with a chest drain output of more than 1500 ml of blood on chest tube insertion. The exclusion criteria were: suspicion of cardiac or great vessel injury, hemodynamic instability of the patient, and stab wounds within the cardiac box of the chest. Initial assessment, resuscitation and stabilization were carried out in the Emergency Department by a multidisciplinary team. All patients had a baseline chest X-ray (CXR) done.

Patients were either intubated with a double-lumen tube and ventilated using single-lumen ventilation or intubated with a single-lumen tube with intermittent apneic ventilation. The patients were positioned in the left lateral or right lateral position according to the side of the injury.

The approach utilized the chest tube incision (1.5–2 cm) to access the pleural cavity in all the patients. A wound protector was always placed. A 30-degree thoracoscope was used and instruments with proximal and distal articulation utilized. Intraoperatively, blood and blood clots were evacuated and the source of bleeding identified and controlled, which usually arises from the intercostal vessels or lung lacerations. Intercostal bleeding was stopped using electrocautery. Lung lacerations were managed by wedging of the affected tissue using an endoscopic stapler. At the end of the operation, a 24–28 Fr. chest tube was placed through the same incision and a local anesthetic (bupivacaine – Marcaine) was infiltrated in 3–4 intercostal levels around the incision site. Discharged patients were followed up in the outpatient department with a CXR on the day of the appointment.

From the 19 eligible patients, 16 (84.2%) patients were male and 3 (15.7%) were female. The mean age was 23.5 (15–46) years. The indications were active bleeding

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Received: 25.06.2022, **accepted:** 10.07.2022.

hemothorax from iatrogenic injury ($n = 1$) and stab injury ($n = 18$). Six patients had left side hemothorax and thirteen had right sided hemothorax. Nine patients had a bleeding intercostal artery alone. Five patients had lung laceration alone. Three patients had a bleeding intercostal artery with an associated lung laceration. One patient had a bleeding intercostal artery with an associated diaphragm injury and 1 patient had bleeding from an adhesion with an associated lung injury.

Double lung intubation was used in 2 patients. The rest of the patients had single lumen intubation and intermittent apnea ventilation was used.

The initial chest tube site was utilized as the working port and also used for placement of the chest tube at the end of the surgery. The chest tube was removed between the first and fifth post-operative day. In 52.6% of the patients, the chest tube was removed by post-operative day 3. By post-operative day 4, 84% of the patients had the chest tube removed. The mean post-operative hospital stay was 4 days, ranging from 2 to 8 days. Results are summarized in Table 1.

All patients were extubated in the operation theater and transferred to a high-dependency unit post-operatively. There was no conversion to thoracotomy. All the patients were exclusively managed by uniportal VATS. There was no need for revision surgery. All patients were followed up in the outpatient department for a period of 90 days post-operatively with no complications reported.

Thoracoscopy was originally used in the trauma setting by Branco in 1946 when he reported his experience with hemothorax after penetrating chest trauma [5]. Ochsner *et al.* were the first to report the use of multiport VATS for

trauma. They found VATS to be safe, accurate and less invasive for diagnosing diaphragmatic injury [6]. VATS successfully allowed for the development of minor and major thoracic procedures to be done through small incisions instead of the traditional large thoracotomy incision. These less destructive small incisions are associated with less acute and chronic pain, shorter hospital stay, early recovery and less deformity of the thorax. Kaseda *et al.* report that VATS lobectomy leads to only 15% loss of vital capacity (VC) and forced expiratory volume in 1 second (FEV_1), while open thoracotomy lobectomy leads to 23% loss of VC and 29% loss of FEV_1 [7].

The conventional 3–4 port VATS rapidly evolved to uniportal VATS. Major and complex thoracic procedures including lobectomies, pneumonectomies, bronchoplasty and vascular reconstruction have been done with good outcomes. The uniportal VATS is associated with fewer incisions and potentially less injury to fewer intercostal nerves. The uniportal VATS approach is a safe procedure with a lower complication rate compared to the conventional VATS approach [4]. In a meta-analysis of uniportal VATS compared to multi-portal VATS, Harris *et al.* found a significant reduction in the overall rate of complications, length of hospital stay and duration of postoperative drainage for patients who underwent uniportal VATS [8]. In the literature, the use of uniportal VATS in the emergency setting is scarcely reported. Swierzy *et al.* found that uniportal VATS is safe and feasible for the diagnosis and management of emergency cases [9]. In our study we confirm this statement in the setting of hemodynamically stable patients and injury outside the cardiac box. However, a randomized controlled trial comparing

Table 1. Indications, diagnosis, intraoperative findings, days on ICT, hospital stay, and intubation

Sex	Age	Diagnosis	Intraoperative findings	Days on chest tube	Chest tube size	Hospital stay	Intubation
Male	46	Left hemothorax	Lung laceration	1	28 Fr	2	Single
Male	33	Left hemothorax	Intercostal artery bleeding	3	28 Fr	4	Single
Female	28	Right hemothorax	Lung laceration	2	28 Fr	5	Single
Female	18	Right hemothorax	Intercostal artery bleeding	3	24 Fr	3	Single
Male	16	Right hemothorax	Intercostal artery bleeding	4	24 Fr	5	Single
Male	20	Left hemothorax	Intercostal artery bleeding	1	28 Fr	2	Single
Male	19	Right hemothorax	Intercostal artery bleeding	2	28 Fr	2	Single
Male	19	Right hemothorax	Intercostal artery bleeding + lung laceration	3	28 Fr	4	Single
Male	15	Left hemothorax	Lung laceration	2	24 Fr	4	Single
Male	21	Right hemothorax	Intercostal artery bleeding + lung laceration	2	24 Fr	3	Single
Male	25	Right hemothorax	Lung laceration	3	28 Fr	5	Single
Male	23	Right hemothorax	Lung laceration	2	28 Fr	4	Single
Female	21	Right hemothorax	Intercostal artery bleeding	1	28 Fr	3	Single
Male	32	Right hemothorax	Intercostal artery bleeding + lung laceration	3	28 Fr	5	Single
Male	17	Right hemothorax	Intercostal artery bleeding	2	24 Fr	4	Single
Male	18	Left hemothorax	Lung laceration	3	28 Fr	4	Double
Male	20	Left hemothorax	Intercostal artery bleeding	4	28 Fr	6	Single
Male	35	Right hemothorax	Intercostal artery bleeding	5	28 Fr	8	Double
Female	21	Right hemothorax	Lung laceration	2	24 Fr	3	Single

uniportal versus multi-portal access for thoracic emergency surgery need to be done to provide enough evidence for an algorithm in the management of thoracic trauma.

Uniportal VATS is an accurate and effective modality in the evaluation and management of thoracic trauma. We propose that uniportal VATS, in the hands of an experienced surgeon, can be successfully and safely applied to hemodynamically stable patients with penetrating stab injuries to the chest outside the cardiac box. Nevertheless, the superiority of uniportal VATS over multiportal VATS need to be further investigated in a randomized controlled trial.

Disclosure

The authors report no conflict of interest.

References

1. Inci I, Özçelik C, Taçyıldız I, Nizam O, Eren N, Ozgen G. Penetrating chest injuries: unusually high incidence of high-velocity gunshot wounds in civilian practice. *World J Surg* 1998; 22: 438-422.
2. Ludwig C, Koryllos A. Management of chest trauma. *J Thorac Dis* 2017; 9 (Suppl 3): S172-S177.
3. Ben-Nun A, Orlovsky M, Best LA. Video-assisted thoracoscopic surgery in the treatment of chest trauma: long-term benefit. *Ann Thorac Surg* 2007; 83: 383-387.
4. Rocco G, Martin-Ucar A, Passera E. Uniportal VATS wedge pulmonary resections. *Ann Thorac Surg* 2004; 77: 726-728.
5. Branco JMC. Thoracoscopy as a method of exploration in penetrating injuries of the thorax: (preliminary report). *Chest* 1946; 12: 330-335.
6. Ochsner MG, Rozycki GS, Lucente F, Wherry DC, Champion HR. Prospective evaluation of thoracoscopy for diagnosing diaphragmatic injury in thoracoabdominal trauma: a preliminary report. *J Trauma* 1993; 34: 704-709.
7. Kaseda S, Aoki T, Hangai N, Shimizu K. Better pulmonary function and prognosis with video-assisted thoracic surgery than with thoracotomy. *Ann Thorac Surg* 2000; 70: 1644-1646.
8. Harris CG, James RS, Tian DH, Yan TD, Doyle MP, Gonzalez-Rivas D, Cao C. Systematic review and meta-analysis of uniportal versus multiportal video-assisted thoracoscopic lobectomy for lung cancer. *Ann Cardiothor Surg* 2016; 5: 76-84.
9. Swierzy M, Faber S, Nachira D, Günsberg A, Rückert JC, Ismail M. Uniportal video-assisted thoracoscopic surgery for the treatment of thoracic emergencies. *J Thorac Dis* 2018; 10 Suppl 31: S3720-S3725.