SAJS
Trauma

Video-assisted thoracoscopic pericardial window for penetrating cardiac trauma

PRADEEP H. NAVSARIA, F.C.S. (S.A.), M.MED. (SURG.)
ANDREW J. NICOL, M.B. CH.B., F.C.S. (S.A.)

Trauma Unit, Groote Schuur Hospital and University of Cape Town

Summary

Objective. To report our experience with thoracoscopic pericardial window (TPW) for occult penetrating cardiac injury.

Patients and methods. During the study period (1 January - 31 December 2000), a small group of haemodynamically stable patients with anterior left-sided praecordial wounds were selected for TPW. All patients underwent general anaesthesia with double-lumen intubation and collapse of the left lung. A rigid laparoscope was inserted through a 2 cm incision in the 5th intercostal space in the anterior axillary line. Another 3 cm incision was made in the fourth intercostal space over the cardiac silhouette. Conventional instruments were used to grasp and open the pericardium. Any myocardial injury identified was an indication to proceed to sternotomy. In the absence of a myocardial injury and bleeding, the procedure was terminated and considered therapeutic.

Results. Seventy-one patients with suspected penetrating cardiac injuries were seen. TPW was successfully completed in 13 patients. All were men, with a mean age of 29.8 (range 19 - 38) years. Ten and 3 patients sustained stab and gunshot wounds, respectively. The mean revised trauma score was 7.84. Ultrasound was performed in 12 patients; the results were equivocal for 2 patients, and positive for an effusion in 4 patients. Haemopericardium was found in 3 patients, 2 of whom proceeded to sternotomy. No cardiac injury was found in 1, a left ventricular contusion was identified in the second, and the third patient had no further procedure after good video-thoracoscopic visualisation of the anterior myocardium revealed no injury. In another patient, pericardial bruising was evident without any haemopericardium. The mean operative time was 13.4 (range 10 - 15) minutes, with a mean hospital stay of 5.4 (range 3 - 8) days. There were no complications. The use of a double-lumen endotracheal tube increased the cost of TPW by 23% when compared with subxiphoid pericardial window (SPW).

Conclusion. TPW is a feasible, although in our setting not cost-effective, diagnostic option for occult penetrating cardiac injuries.

The application of video-assisted thoracic surgery (VATS) in trauma is limited to a highly select group of haemodynamically stable patients. Its role in the management of patients with penetrating cardiac injury is unclear. We report on a small series of patients with praecordial penetrating trauma undergoing thoracoscopic pericardial window (TPW) for suspected cardiac injury.

Patients and methods

During the 12-month period from 1 January to 31 December 2000, all patients with a suspected cardiac injury at our institution (Trauma Unit, Groote Schuur Hospital, Cape Town, South Africa) were managed according to an established penetrating cardiac injury protocol. A small group of haemodynamically stable patients with anterior left-sided praecordial wounds were selected for a diagnostic TPW. The technique employed was a slight variation on that described by Morales *et al.*[1] Patients were prepared and draped in the supine position for conversion to median sternotomy when indicated. All patients underwent general anaesthesia with double-lumen intubation and collapse of the left lung. A rigid laparoscope was inserted through a 2 cm incision in the 5th intercostal space in the anterior axillary line, anterior to the collapsed lung. Those with tube thoracostomies *in situ* had the tube removed and the scope inserted into the existing site. Another 3 cm incision was made in the 4th intercostal space over the cardiac silhouette. Under video-thoracoscopic vision, the phrenic nerve was identified and a haemostat used to grasp the pericardium. A scissor was used to open the pericardium and the pericardial fluid was evaluated for the presence of blood. In the presence of haemopericardium, an attempt was made to visualise the myocardium for an injury. Any myocardial injury identified was an absolute indication to proceed to sternotomy. In the absence of a myocardial injury and bleeding, the procedure was considered therapeutic and terminated. A tube thoracostomy was replaced at the site of camera insertion and the left lung was allowed to re-expand. A cost analysis is presented.

Results

During the 1-year study period, 71 patients with suspected penetrating cardiac injuries were treated. Twenty-four patients presented with clinical tamponade and underwent emergency surgery. Thirty-four stable patients underwent

TABLE I. CLINICAL SUMMARY OF PATIENTS UNDERGOING THORACOSCOPIC PERICARDIAL WINDOW (N = 13)

No.	Injury mechan sm	RTS	Neck ve ns	CVP (cm)	Heart sounds	ECG	Heart s ze	U trasound (mm)	T me de ay	Hosp ta stay (days)	Thoracoscop c w ndow f nd ngs	T me (m n)
1	SW-P	7.84	Distended	30	Soft,rub	ST	> CTR	30	2 wks	8	300 ml Proceed to sternotomy – no cardiac injury	15
2	SW-P	7.84	Normal	15	Rub	Normal	Normal	Equivocal	24 h	3	Normal	12
3	GSW-P	7.84	Normal	8	Normal	ST	Normal	Normal	24 h	7	Normal	10
4	SW-P	7.84	Normal	9	Normal	ST	Normal	5	48 h	6	Normal	15
5	SW-P	7.84	Normal	11	Normal	ST	SLHB	Equivocal	24 h	3	Normal	15
6	SW-P	7.84	Normal	8	Normal	ST RBBB	Normal	3	24 h	4	Normal	15
7	GSW-P	7.84	Normal	13	Rub	ST	Normal	Normal	24 h	4	Pericardial bruise	10
8	SW-P	7.84	Normal	8	Normal	ST J-wave	SLHB	Normal	72 h	6	No haemopericardium Normal	11
9	SW-P	7.84	Normal	12	Normal	ST	Pneumo-pericardium	Not done	24 h	5	Normal	15
10	SW-P	7.84	Normal	6	Normal	Normal	> CTR	Normal	72 h	7	Normal	15
11	SW-P	7.84	Normal	8	Normal	ST J-wave	Normal	13	72 h	10	100 ml Good thoracoscopic visualisation of anterior myocardium, nil further	15
12	GSW-P	7.84	Normal	10	Normal	ST	> CTR	Normal	24 h	5	50 ml Proceed to sternotomy – LV myocardial bruise	12
13	GSW-P	7.84	Normal	7	Normal	ST	SLHB	Normal	48 h	4	Normal	14

SW = stab wound; GSW = gunshot wound; P = praecordium; RTS = revised trauma score; CVP = central venous pressure; Rub = pericardial rub; ECG = electrocardiogram; ST = nonspecific ST segment changes; RBB = right bundle-branch block; > CTR = increased cardiothoracic ratio; SLHB = straight left heart border; mm = millimetre effusion; Time delay = time from injury to TPW; LV = left ventricle; min = minutes.

subxiphoid pericardial window (SPW). TPW was attempted in 15 stable patients. All patients were referred from surrounding hospitals for a suspected cardiac injury. In 2 patients the procedure was abandoned and converted to SPW. In 1, the pericardium could not be visualised adequately because of 'excess pericardial fat', and in the other because of adhesions preventing adequate left lung collapse, therefore obscuring thoracoscopic vision of the pericardium. The clinical presentation and management of the 13 patients who underwent successful TPW is outlined in Table I. All patients were men with a mean age of 29.8 (range 19 - 38) years. Ten and 3 patients sustained stab and gunshot wounds, respectively. The weighted revised trauma score was 7.840. Only 1 patient, with a 2-week delay in presentation, had a central venous pressure of greater than 15 cm of water with distended neck veins. Electrocardiography changes were seen in 11 patients. Ultrasound was performed in 12 patients; the results were equivocal for 2 patients and positive for an effusion in 4 patients. The mean time delay from injury to TPW, excluding the 1 patient with a 2-week delay, was 40 (24 - 72) hours.

Haemopericardium was found in 3 patients, 2 of whom proceeded to sternotomy. No cardiac injury was found in 1, and a left ventricular contusion was identified in the other. The third, with good thoracoscopic visualisation of the anterior myocardium revealing no injury, had no further procedure. In another patient, pericardial bruising was evident without any haemopericardium. The mean operative time for the TPW was 13.4 (range 10 - 15) minutes. Thoracoscopy was also useful in treating 3 patients with clotted or loculated haemothoraces, removing 800, 900 and 300 ml of clot, respectively. The mean hospital stay following the TPW was 5.4 (range 3 - 8) days. Associated injuries included an axillary artery transection (N = 1) and a stab wound of the abdomen (N = 1). There were no deaths. One patient developed a hospital-acquired pneumonia. A cost analysis, using the UPFS (Uniformed Patient Fee Schedule) tariffs for public health institutions is presented in Table II. The anaesthetic and surgical professional fees, and theatre facility fee, were the same for both procedures. The cost of a double-lumen tube was the only added major expense to the procedure.

Discussion

VATS has been shown to be both an effective diagnostic and therapeutic tool in

TABLE II. COST ANALYSIS COMPARING SUBXIPHOID PERICARDIAL WINDOW WITH THORACOSCOPIC PERICARDIAL WINDOW (UPFS TARIFFS)

Subxiphoid pericardial window	(R)	Thoracoscopic pericardial window	(R)
Tracheal tube:			
Single lumen	**7.69**	**Double lumen**	**528**
Professional surgeon's fee	**426**		**426**
Professional anaesthetist's fee	**245**		**245**
Theatre facility fee*	**1 555**		**1 555**
Total	**2 233.69**		**2 754**

UPFS – uniformed patient fee schedule for state hospitals.
*No disposable instruments used.

TABLE III. THORACOSCOPIC PERICARDIAL WINDOW FOR TRAUMA – REVIEW OF THE LITERATURE

Author	Year	No. of patients
Waller *et al*.[5]	**1996**	**2**
Morales *et al*.[1]	**1997**	**108**
Boyce *et al*.[6]	**1997**	**1**
Pons *et al*.[4]	**2002**	**13**
Caceres *et al*.[7]	**2004**	**1**
Total		**125**

the management of occult diaphragm injuries, retained post-traumatic haemothorax and empyema, persistent parenchymal air leaks and continuous bleeding through a thoracostomy tube.[2] However, the role of VATS in the management of mediastinal injuries is unclear, controversial and rarely reported. The management of patients with acute tamponade is immediate surgery. It is the stable patients with praecordial and transthoracic wounds who may either have clinical, electrocardiographic and/or radiological suspicion of cardiac injury. Diagnostic SPW is the gold standard management of stable patients with suspected haemopericardium with equivocal non-invasive tests, namely electrocard iogram, chest radiograph, ultrasound and echocardiography, none of which have 100% specificity, sensitivity or accuracy. Video-assisted TPW has been shown to be a safe, effective approach to draining pericardial effusions of both benign and malignant origin in general thoracic surgery.[3] There are few reports on the evaluation of cardiac injuries using minimally invasive techniques (Table III). This may be explained partly by the fact that patients with occult penetrating cardiac injuries are considered potentially unstable, are aggressively investigated, and undergo emergency surgery when diagnostic tests are equivocal. The 2 largest studies with 108 and 13 patients, respectively, each support the use of TPW. Morales *et al.*[1] found TPW to be 100%, 96% and 97% sensitive, specific, and accurate, respectively. They believe it to be less invasive and recommend it be the standard diagnostic approach for cardiac injuries. They also claim that it allows for evaluation of other thoracic injuries from the diaphragm, internal mammary artery and lungs, and the evacuation of clotted haemothorax. Pons *et al.*,[4] on the other hand, rely on transthoracic echocardiography for diagnosis of haemopericardium, performing TPW for equivocal studies. We agree with the prerequisite requirement that the surgical team performing TPW must be familiar with treating cardiac injuries, and be able to convert to open surgery at any time. The above studies[1,4] both failed to make a cost analysis.

Conclusion

Our experience, although limited to a small series of 13 stable patients with left-sided precordial wounds, revealed TPW to be a feasible diagnostic option. We have, however, abandoned performing TPW as we have found no technical advantage over SPW. Furthermore, it is 23% more expensive than performing a SPW, which in our current public health economic climate with severe budget constraints is simply not cost-effective. Therefore, in our unit, SPW remains the gold standard diagnostic tool for patients with equivocal non-invasive tests with occult cardiac injuries.

REFERENCES

1. Morales CH, Salinas CS, Henao CA, Patiño PA, Muñoz CM. Thoracoscopic pericardial window and penetrating cardiac trauma. *J Trauma* 1997; **42:** 273-275.
2. Lowdermilk GA, Naunheim KS. Thoracoscopic evaluation and treatment of thoracic trauma. *Surg Clin North Am* 2000; **80:** 1535-1542.
3. Yim APC, Lee TW, Izzat MB, Wan S. Place of video-thoracoscopy in thoracic surgical practice. *World J Surg* 2001; **25:** 157-161.
4. Pons F, Lang-Lazdunski L, de Kerangal X, Chapuis O, Bonnet PM, Jancovivc R. The role of videothoracoscopy in the management of precordial thoracic penetrating injuries. *Eur J Cardiothorac Surg* 2002; **22:** 7-12.
5. Waller DA, Bouboulis N, Forty J, Hasan J, Morritt GN. Video-assisted thoracoscopy in the evaluation of penetrating thoracic trauma. *Ann R Coll Surg Engl* 1996; **78:** 463-465.
6. Boyce KE, Edwards JG, Rajesh PB. Video-assisted thoracoscopy in the evaluation of penetrating thoracic trauma. *Ann R Coll Surg Engl* 1997; **79:** 233-234.
7. Caceres M, Buechter K, Rodriguez JA, Liu D. Delayed hempericardium after penetrating chest trauma: thoracoscopic pericardial window as a therapeutic option. *South Med J* 2004; **97:** 921-922.