Thoracoscopy in the diagnosis and treatment of thoracoabdominal stab injuries

Delici ve kesici alete bağlı torakoabdominal yaralanmaların tanı ve tedavisinde torakoskopi

Salih PEKMEZCİ,[1] Kamil KAYNAK,[2] Kaya SARIBEYOĞLU,[1] Kemal MEMİŞOĞLU,[3] Taner KURDAL,[2] Ece KOL,[1] İlknur ERENLER KILIÇ,[1] Bilgi BACA,[1] Erhun EYÜBOĞLU,[1] Feridun ŞİRİN[1]

BACKGROUND

Occult diaphragmatic injuries are associated with significant mortality, if the diagnosis is delayed. We report our experience in diagnostic and therapeutic thoracoscopy in a selected group of patients with stab wounds of thoracoabdominal region.

METHODS

The patients who underwent thoracoscopic management of thoracoabdominal stab injuries between June 2001-December 2005 were included into the study. The data were retrospectively analyzed.

RESULTS

Ninety-three patients with abdominal and thoracoabdominal stab wounds underwent videoendoscopic management. Among them, eleven selected patients with thoracoabdominal stab injuries were managed by thoracoscopy. The procedures were performed under general (n=10) or local anesthesia (n=1). Diaphragmatic injuries were repaired by intracorporeal sutures in three cases and bleeding was controlled in another two cases by electrocautery coagulation. The procedures were simply diagnostic in six patients. The mean operating time and hospital stay were 35 minutes and 3.5 days respectively. There was neither intraoperative or early postoperative complication, nor mortality.

CONCLUSION

Thoracoscopy is a safe and efficient tool in the diagnosis and treatment of diaphragmatic stab injuries.

Key Words: Penetrating thoracoabdominal injury; diaphragm; thoracoabdominal wound; thoracoscopy; stab.

AMAÇ

Okült diyafragma yaralanmaları tanıda gecikildiği takdirde yüksek mortaliteye neden olurlar. Bu yazıda, torakoabdominal bölgenin delici ve kesici alet yaralanmalarında tanısal ve terapötik torakoskopi uygulanan hasta grubuna ait deneyimler sunuldu.

GEREÇ VE YÖNTEM

Haziran 2001-Aralık 2005 tarihleri arasında kliniğimizde torakoabdominal bölgenin delici ve kesici alet yaralanması nedeniyle torakoskopik yaklaşım uygulanan hastalar bu çalışmaya alındı. Veriler geriye dönük olarak analiz edildi.

BULGULAR

Abdominal ve torakoabdominal delici, kesici alet yaralanması nedeniyle 93 hastaya videoendoskopik girişim uygulandı. Bunların içinde torakoabdominal bölgenin delici ve kesici alet yaralanması nedeniyle seçilmiş 11 hastaya tanısal ve terapötik torakoskopi uygulandı. Ameliyatlar genel (n=10) ve lokal (n=1) anestezi altında uygulandı. Diyafragma yaralanması üç hastada saptandı ve intrakorporeal dikişlerle onarıldı. İki hastada kanama kontrolü elektrokoterle sağlandı. Geriye kalan altı hastada torakoskopi yalnızca tanısal bir işlem olarak gerçekleşti ve sonlandı. Ortalama ameliyat süresi ve hastanede yatış süresi sırasıyla 35 dakika ve 3.5 gün idi. Perioperatif veya erken postoperatif dönemde komplikasyonla ya da mortaliteyle karşılaşılmadı.

SONUÇ

Torakoskopi diyafragma yaralanmalarının tanı ve tedavisinde etkili ve güvenilir bir yöntemdir.

Anahtar Sözcükler: Delici ve kesici yaralanma; diyafragma; torakoabdominal yaralanma; torakoskopi; bıçaklanma.

Departments of [1]General Surgery, [2]Thoracic Surgery, Istanbul University Cerrahpaşa Medical Faculty, Istanbul; [3]Department of General Surgery, Fatih Sultan Mehmet Training and Research Hospital, Istanbul, Turkey.

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İstanbul Üniversitesi Cerrahpaşa Tıp Fakültesi, [1]Genel Cerrahi Anabilim Dalı, [2]Göğüs Cerrahisi Anabilim Dalı, İstanbul; [3]Fatih Sultan Mehmet Eğitim ve Araştırma Hastanesi Genel Cerrahi Kliniği, İstanbul.

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Correspondence *(İletişim)*: Salih Pekmezci, M.D. İ.Ü. Cerrahpaşa Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, 34065 İstanbul, Turkey.
Tel: +90 - 212 - 414 30 00 / 21381 Fax *(Faks)*: +90 - 212 - 633 48 41 e-mail *(e-posta)*: pekmezcisalih@gmail.com

Thoracoabdominal stab injuries (TSI) have unique features regarding physiological and anatomical aspects of the region. Thoracoabdominal area (TA) includes two distinct body cavities and the diaphragm between. Moreover TSI was shown to be associated with unacceptably high mortality rates if the diagnosis of diaphragmatic injury (DI) is delayed.[1-4] Thus, surgical exploration of the diaphragm for an occult DI is particularly important since conventional diagnostic methods, such as chest X-ray, computerized tomography (CT) etc. are unreliable in this group of patients.[5,6]

Thoracoscopy has been practiced for almost three decades in TSI[7] but videoendoscopic surgery undoubtedly enhanced the exploration of thoracic and abdominal cavities. So far, numerous studies on thoracoscopic management of thoracic trauma have been reported before and after videoendoscopic surgery era.[7-15] Minimally invasive techniques are not only helpful for the diagnosis of diaphragmatic, intraabdominal or intrathoracic injuries, they may also allow to surgical treatment. Therapeutic thoracoscopy was seldom reported in DI[13,16] and surgeons -not always but generally- prefer to limit the operation for the diagnosis. In the presence of a diaphragmatic injury, many surgeons convert to open procedures or laparoscopy.[8-11,14] In this study we report our experience in diagnostic and therapeutic thoracoscopy, on selected patients with thoracoabdominal stab wounds. Thoracoscopy was the mainstay of diagnosis and treatment in the study group.

MATERIALS AND METHODS

From June 2001 through December 2005, ninety-three patients with stab wounds of the abdominal and thoracoabdominal region were admitted to the Emergency Unit of Cerrahpasa Medical Faculty - Istanbul University. They all underwent videoendoscopic management and among them, eleven selected patients with thoracoabdominal stab wounds who fulfilled the below criteriae underwent thoracoscopic management. Patients' data were retrospectively analyzed.

Those who underwent laparoscopy and open procedures were kept out of the study and hemodynamic instability was considered as a contraindication for thoracoscopy. Hemodynamic stability was defined by systolic and diastolic blood pressures greater than 100 mmHg and 60 mmHg respectively, heart rate lower than 110 per minute and a requirement of crystalloids resuscitation lower than 2 lt. Laparoscopy was preferred in patients who had thoracoabdominal and abdominal wounds simultaneously or presented with abdominal signs.

In the absence of signs and symptoms that were suggesting an intraabdominal pathology (abdominal tenderness and /or guarding), the patients were followed closely for at least for 12 hours, and evaluated by the same surgical team during this period. At the end of the observation period, the following algorithm that was previously suggested by Ascensio et al.[17] was applied:

For left sided TSI, thoracoscopy was performed in all cases, regardless the results of diagnostic investigation. For right-sided lesions, if the clinical examination and radiological studies suggested an intrathoracic or diaphragmatic injury (pneumothorax, hemothorax, liver hematoma etc., regardless of its size and extent) thoracoscopy was performed; if these signs were lacking, patients were closely observed for at least 12 hours more. For both sides, if a DI or intrathoracic pathology was diagnosed, surgical therapy was carried out by thoracoscopy.

The thoracoabdominal area was defined as the anatomical region that was limited by a horizontal plane at the level of nipples for the upper level; the arcus costarum at both sides formed the lower border of the region and it was further divided into left and right by sternum in the front and columna vertebralis at the back.

Operative technique

All the stab wounds were closed with interrupted 3/0 polypropylene suture prior to the operation; stab wounds were not used as trocar sites. The procedures were performed under general or local anesthesia by Lidocaine 2% (Biosel, Turkey). General anesthesia was performed by unilateral lung ventilation, by double - lumen endotracheal tube (Carlens tube).

Patients were placed in lateral decubitus position. Specifically designed trocars were used for thoracoscopy (Thoracoport®, U.S. Surgical, Norwalk, CT, USA). The first 10 mm trocar was placed on the midaxillary line, for the camera, if the skin wound is not very close; otherwise the first trocar was inserted away enough from the wound. Then, one or two additional trocars were inserted according to the

operative findings. There was no standard trocar localization and the site of the injury was the only landmark in selecting trocar sites. A 30-degree camera was used during operations.

The fluids and adhesions were eliminated in the pleural cavity and then the affected hemi-thorax was explored. After completion of the procedure, a 32F chest tube was placed within the camera trocar site. Thereafter, lung expansion was achieved subsequent to whole lung ventilation. Trocar incisions were closed with 3/0 polypropylene sutures.

RESULTS

Eleven patients (ten male and one female) underwent thoracoscopic management of TSI during the study period. Six other patients who underwent laparoscopic management of diaphragmatic injuries were kept out of the study. The basis for favoring laparoscopy was multi-site (abdominal and thoracoabdominal together) injuries in four and the presence of abdominal signs in two patients. The patients' characteristics are shown in the Table 1. The mean age was 34 (range 20-65). The wounds were in the left hemi-thorax in six and right hemi-thorax in five cases. All the patients were stabbed within 24 hours prior to admission. Preoperative diagnostic studies revealed pathological results in all cases (pleural effusion in six, pneumothorax in three patients and hemopneumothorax and right diaphragm elevation in one patient each). Computerized tomography (CT) was performed in four cases and revealed pleural effusion in three cases and pneumothorax in one.

Thoracoscopic procedures were carried out under local anesthesia in one, and general anesthesia in ten

Table 1. Patients' data

No	Age / Gender	Side	Imaging findings		Operative diagnosis	Treatment	Op. time (min)	Drainage time (d)	Hospital stay (d)
			Chest X-ray	CT					
1	34 / M	R	Minimal rise in the right hemidiaphragm	Subcapsular liver hematoma, right pleural effusion	Diaphragmatic rupture + hemothorax	Thoracoscopic repair and drainage	70	3	3
2	38 / M	L	Left pleural effusion	–	Hemothorax	Drainage	20	1	4
3	35 / M	R	Left pleural effusion	Minimal hemothorax	Hemothorax	Drainage	25	1	3
4	65 / M	R	Right pleural effusion	–	Intercostal artery bleeding	Bleeding control by electrocautery and drainage	45	1	6
5	26 / M	R	Right pneumothorax	–	No pathology	Drainage	35	2	3
6	44 / M	L	Left pleural effusion	Left pleural effusion + no abdominal pathology	Hemothorax	Drainage	30	1	3
7	25 / M	L	Left pleural effusion	–	Diaphragmatic rupture + hemothorax	Thoracoscopic repair and drainage	50	2	4
8*	28 / M	L	Pneumothorax	–	No pathology	Drainage	15	2	3
9	20 / M	L	Hemopneumothorax	–	Hemothorax	Drainage	30	2	3
10	36 / F	L	Left pleural effusion	–	Intercostal artery bleeding	Bleeding control by electrocautery and drainage	40	1	4
11	23 / M	R	Normal	Right pneumothorax	Diaphragmatic rupture	Thoracoscopic repair and drainage	25	2	3

*Performed under local anesthesia; R: Right; L: Left; M: Male; F: Female; CT: Computerized tomography; min: Minutes; d: Days.

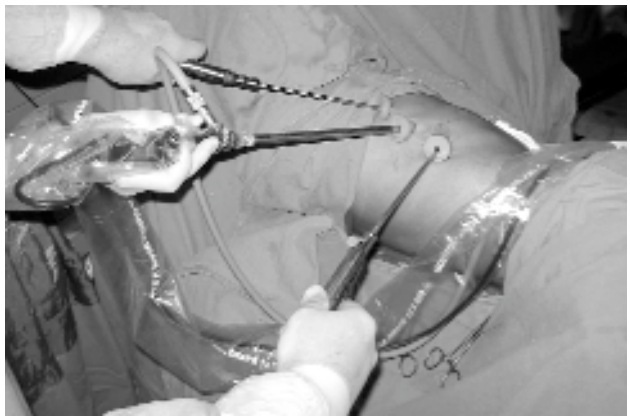

Fig. 1. Trocar localizations in a patient with right-sided diaphragmatic injury.

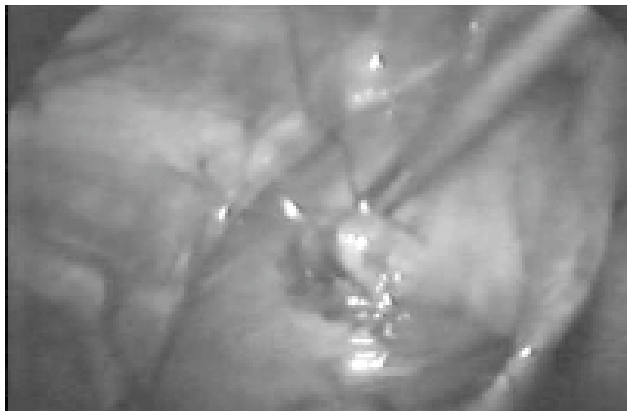

Fig. 2. Thoracoscopic view of hand-sewn suturing of diaphragmatic injury (Case no: 1 in the Table 1).

cases. A diaphragmatic rupture was diagnosed in three cases and repairs were performed thoracoscopically with #0 silk sutures using endo-needle holders (Fig. 1, 2 and 3). Three trocars were used in those who underwent diaphragmatic repairs and the trocar sites were decided according to the position of the injury.

A patient presented a liver hematoma and this has confirmed a diagnosis of diaphragmatic rupture. He has been followed for 24 hours by serial CT scans and after verifying the lack of hematoma enlargement and abdominal signs, this patient was taken to the operation room for thoracoscopic management. In the remaining two patients with diaphragmatic rupture, the preoperative imaging findings were left pleural effusion in chest X-ray and right pneumothorax in chest CT. Clinical follow-up was uneventful in those patients who underwent thoracoscopic repair. In another two patients, intercostal artery bleeding was present and hemostasis was achieved by electrocautery coagulation. In the remaining six patients the procedure was non-therapeutic: hemothorax was present in four patients and no pathology was found in two.

The mean operating time was 35 minutes (15-70 minutes). Chest tubes were left for a mean period of 1.6 days (1-3 days) and mean hospital stay was 3.5 days (3-6 days). The mortality was zero and no early or late complication, related to the procedure or study design was encountered for a mean follow-up time of 21.9 months.

DISCUSSION

The results of this study pointed out the convenience of thoracoscopy in the management of TSI. This technique was associated with effective diagnosis and treatment while providing well-known advantages of minimally invasive surgery.

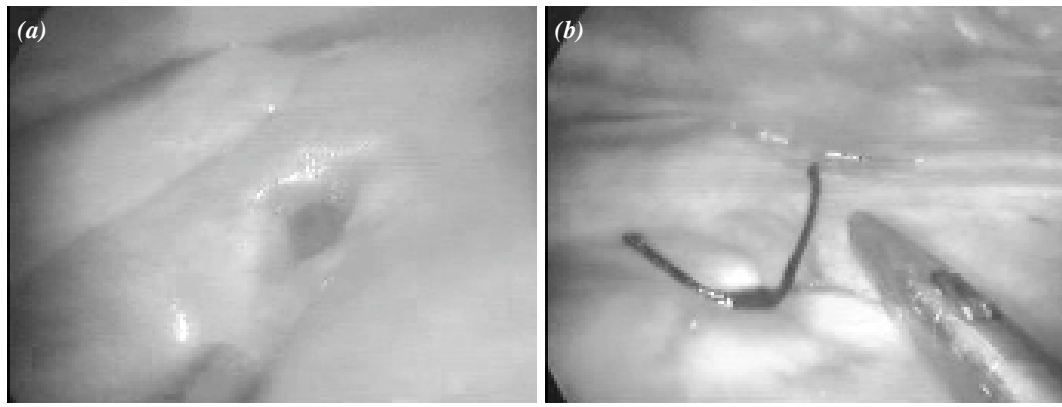

Fig. 3. **(a)** Thoracoscopic view of a diaphragmatic injury (Case no: 11 in the Table 1). **(b)** The lesion after the repair.

The best management strategy is still a controversial issue in TSI. The debates rise from the importance of DI diagnosis, and the extent of diagnostic work was not completely established. The overall mortality of TSI may reach 4.3%[18] and in the case of an occult DI this rate may be even higher since delayed diagnosis of DI is usually associated with strangulated hernia. There are clinical studies justifying the concerns of overlooking an occult DI. Demetriades et al. analyzed penetrating DI and reported that the mortality was 7.1% and 30% in patients with early and delayed diagnosis respectively.[4] In addition, Degiannis et al. reported comparable results on same subject and found that the mortality increased from 3% to 25% if the diagnosis of DI was delayed.[2] In another retrospective study on long term outcome of missed diaphragmatic trauma (blunt or penetrating) the mortality was 10%.[1] In contrast to these clinical series, some experimental studies in a porcine model revealed that penetrating diaphragmatic lesions can heal spontaneously without repair.[19,20] Zierold et al. encountered confusing results where all left sided lesions healed spontaneously and all right sided lesions were associated with strangulation.[19] Although spontaneous healing of DI can be a notable end result of this study, right-sided strangulation is even more interesting. In light of these data, the theory on protective effect of the liver in right-sided TSI may be questioned and more aggressive diagnostic strategies on right-sided TSI can be suggested. Nevertheless, there is not a clinical proof yet on spontaneous healing of DI, even though protective effect of the liver is usually mentioned for right-sided lesions.[1] The diagnosis of an occult DI continues to be a vital point in TSI.

The thoracoabdominal area has particular physiologic and anatomic aspects in penetrating trauma. It includes thoracic and abdominal cavities and has different pressure values. During exhalation, the diaphragm ascends to the level of the fourth intercostal space on the left, and fifth on the right anteriorly; both hemi-diaphragms reach the eighth intercostal space posteriorly.[17] Thus in TSI, localization of the wound is rarely diagnostic for DI. Occult DI was reported to be 7-24%[21,22] and clinical and radiological findings are not usually helpful in considerable number of patients. Chest X-ray (CXR) is one of the most practical diagnostic tools in thoracic trauma but has limited value in the diagnosis of DI and was reported to be useful in a minor group of patients.[5,6,13,23] This diagnostic dilemma led physicians to use diverse methods. Digital exploration[24] and contrast agent infusion[25] were reported to be beneficial (the latter was an experimental study). None of these methods gained widespread agreement and currently minimally invasive techniques seem to be the most accurate approach for the diagnosis of occult DI. Either laparoscopy or thoracoscopy was reported to be excellent tools for the diagnosis and treatment of DI. The sensitivity and specificity of the laparoscopy was reported to be high in the diagnosis of DI according to the results of several clinical studies.[26-29] Thoracoscopy has noteworthy value in the diagnosis of DI as well. Several studies reported excellent results regarding the ability of thoracoscopy on DI diagnosis.[7-11,13,14] Although some of these series did not include uniform groups of patients (penetrating and blunt traumas together) and some were performed before videoendoscopy era, the diagnostic sensitivity of thoracoscopy was reported to be nearly 100% in DI. Laparoscopy can also provide surgical management and several studies reported remarkable results regarding the therapeutic value of laparoscopy in patients with DI due to TSI.[30-32] In our experience thoracoscopy was a useful tool in making the diagnosis of DI.

Thoracoscopy has some notable features in the evaluation of TSI. It is a minimally invasive technique and can evaluate intrathoracic organs, besides diaphragm. Thoracoscopy does not require insufflation and there is no organ to retract in thoracal cavity if the procedure is carried out under general anesthesia; so the exploration is easy and quick. Moreover, there is no risk of tension pneumuothorax, in contrast to laparoscopy. Thoracoscopy allows also to eliminate pleural collections that may increase intrapleural sepsis risk.[8,33] Surgical management of intrathoracic pathologies may be done by thoracoscopy as well. Thoracoscopic repair of diaphragmatic injuries was reported to be a safe and efficient technique.[13] Hand-sewn suturing seems to be more comfortable then laparoscopic approach in DI according to our experience. Moreover, significant bleeding can be controlled by thoracoscopy, as we performed in two patients with intercostal artery bleeding. Regarding the advantages of thoracoscopy, we preferred this approach in a selected group of the patients who had no evidence of an abdominal injury and also did not present abdominal signs for a pre-

cise period of follow-up. However the technique has some disadvantages too. It evaluates just one hemidiaphragm and no abdominal exploration is feasible by this way. Moreover it requires double lumen anesthesia with Carlens tube and an anesthesiologist who is familiar with this technique. Thoracoscopic management of penetrating wounds under local anesthesia was previously reported by Nel et al.[8] The authors pointed out that the operation in unanaesthetized patients might has been responsible of three false-positive results in their series. In our study group, we performed thoracoscopic exploration under local anesthesia in just one patient but the surgical comfort, both for the patient and the surgeon, was not optimal. Local anesthesia should be reserved for patients who bear significant risks of general anesthesia.

Thoracoscopy may be criticized by the lack of abdominal exploration but laparoscopy can be added to the procedure if any abdominal injury is suspected.[16] Nevertheless, the choice between laparoscopy and thoracoscopy or the timing of these procedures is still a matter of question in the evaluation of DI. Laparoscopy ensures the exploration of intraabdominal injuries but significant intrathoracic injuries can be missed and may lead to further operations.[34] On the other hand thoracoscopy can miss an abdominal pathology too. We prefer laparoscopy in patients with multiple injuries localized on thoracoabdominal area and anterior abdominal wall, even if no sign of intraabdominal injury was present. Undoubtedly, a careful abdominal examination and close preoperative follow-up should be done considering the limits of the thoracoscopy which explores only the thoracic cavity.

In brief, thoracoscopy seems to be a safe, quick and efficient method in the diagnosis and treatment of DI in TSI. In an era when non-operative management is gradually more used in abdominal stab injuries, surgeons can resort to thoracoscopy as a diagnostic and therapeutic tool. Trauma surgeons should be aware of the potentials of thoracoscopy and must have sufficient skills to carry out this technique.

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