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Imaging of Traumatic Diaphragmatic Rupture: Evaluation of Diagnostic Accuracy at a Level 1 Trauma Centre

Vincent A. Leung, MD[a], Michael N. Patlas, MD, FRCPC[a,*], Susan Reid, MD, FRCSC[b], Angela Coates, MEd[b], Savvas Nicolaou, MD, FRCPC[c]

[a]*Division of Emergency/Trauma Radiology, Department of Radiology, Michael DeGroote School of Medicine, McMaster University, Hamilton, Ontario, Canada*

[b]*Department of Surgery, Michael DeGroote School of Medicine, McMaster University, Hamilton, Ontario, Canada*

[c]*Division of Emergency/Trauma Radiology, Department of Radiology, University of British Columbia, Vancouver, British Columbia, Canada*

Abstract

Purpose: Traumatic diaphragmatic rupture (TDR) is an uncommon injury that can be associated with significant morbidity if not detected and treated in a timely manner. The purpose of our study was to evaluate the diagnostic accuracy of 64-slice multidetector computed tomography (64-MDCT) for the detection of TDR in patients at our level 1 trauma centre.

Methods: We used our hospital's trauma registry to identify patients with a diagnosis of TDR from January 1, 2008, to December 31, 2012. Only patients with a 64-MDCT scan at presentation who subsequently underwent laparotomy/laparoscopy were included in the study cohort. Using surgical findings as the gold standard, the accuracy of the prospective radiology reports was analyzed.

Results: Of the 3225 trauma patients who presented to our institution, 38 (1.2%) had a TDR. Fourteen of the 38 were excluded as they did not have MDCT before surgery. The study cohort consisted of 20 males and 4 females with a median age of 34.5 years and a median Injury Severity Score (ISS90) of 26. Fifteen had blunt trauma while 9 had a penetrating injury. The overall sensitivity of the radiology reports was 66.7% (95% confidence interval [CI]: 46.7%-82.0%), specificity was 100% (95% CI: 94.1%-100%), positive predictive value was 100% (95% CI: 80.6%-100%), negative predictive value was 88.4% (95% CI: 78.8%-94.0%), and accuracy was 90.6% (95% CI: 82.5%-95.2%). However, only 3 of 9 patients with penetrating injury had a correct preoperative diagnosis. Two of the 6 missed penetrating trauma cases had only indirect signs of injury.

Conclusions: The detection of TDR in trauma patients on 64-MDCT can be improved, especially in patients presenting with penetrating injury. A careful search for subtle diaphragmatic defects and indirect evidence of injury is important to avoid missing the diagnosis.

Résumé

Objectif : La rupture traumatique du diaphragme (RTD) est une blessure peu courante associée à un taux élevé de morbidité si elle n'est pas détectée et traitée à temps. La présente étude visait à évaluer l'exactitude du diagnostic obtenu par tomodensitométrie multibarrettes (TDM 64 barrettes) chez les patients souffrant d'une RTD à notre centre de traumatologie de niveau 1.

Méthodes : Le registre des traumatismes de l'hôpital a été utilisé pour identifier les patients ayant reçu un diagnostic de (RTD) entre le 1er janvier 2008 et le 31 décembre 2012. Seuls les patients qui ont subi initialement une TDM 64 barrettes pour ensuite être soumis à une laparotomie/laparoscopie ont été inclus dans la cohorte de l'étude. L'exactitude des rapports radiologiques prospectifs a été analysée à partir des résultats de chirurgie.

Résultats : Parmi les 3 225 patients victimes d'un traumatisme qui se sont présentés à l'hôpital, 38 (1,2 %) souffraient d'une RTD. De ce nombre, 14 ont été exclus parce qu'ils n'avaient pas subi de TDM multibarrettes avant la chirurgie. La cohorte de l'étude consistait donc en 20 hommes et 4 femmes dont l'âge médian était de 34,5 ans et dont l'indice de la gravité de la blessure (ISS90) médian se chiffrait à 26. Quinze présentaient un traumatisme contondant, et 9, une plaie perforante. Le niveau de sensibilité global des rapports radiologiques était de 66,7 % (intervalle de confiance [IC] de 95 %: de 46,7 % à 82,0 %), la spécificité était de 100 % (IC de 95 %: de 94,1 % à 100 %), la valeur prédictive positive était de 100 % (IC de 95 %: de 80,6 % à 100 %), la valeur prédictive négative était de 88,4 % (IC de 95 %: de 78,8 % à

* Address correspondence to: Michael N. Patlas, MD, FRCPC, Department of Radiology, Hamilton General Hospital, 237 Barton St E, Hamilton, Ontario L8L 2X2, Canada.

E-mail address: patlas@hhsc.ca (M. N. Patlas).

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94,0 %) et l'exactitude était de 90,6 % (IC de 95 % : 82,5 % à 95,2 %). Cependant, seuls trois des neuf patients souffrant d'une plaie perforante avaient un reçu un diagnostic préopératoire juste. Deux des six cas avec plaie perforante pour lesquels le diagnostic n'indiquait pas de rupture traumatique du diaphragme, présentaient uniquement des signes indirects de blessure.

Conclusions : La détection des RTD par TDM 64 barres chez les patients victimes d'un traumatisme peut être améliorée, en particulier chez ceux souffrant d'une plaie perforante. Il importe d'effectuer un examen minutieux à la recherche de défauts subtils dans le diaphragme et de signes indirects de blessure afin de ne pas faire d'erreur de diagnostic.

Key Words: Diaphragmatic rupture; Trauma; Multidetector computed tomography

Traumatic diaphragmatic rupture (TDR) is an uncommon entity estimated to have an incidence of 0.8%-8% in blunt abdominal trauma [1,2] and up to 10%-15% in penetrating injuries [3]. Although there is a growing body of literature on TDR, it remains a challenging diagnosis that is difficult to detect on cross-sectional imaging [4,5]. TDR in blunt trauma managed with a conservative approach is occult in 7%-66% of cases [1] while 7% of patients with penetrating trauma may have undetected diaphragmatic injury [6]. Unfortunately, a delay in making the diagnosis can be associated with significant morbidity. In the latent phase after a missed diagnosis, which may range from days to years, patients may experience nonspecific symptoms such as dyspnea, nausea, vomiting, or abdominal pain due to the intrathoracic herniation of stomach or bowel [7]. This can progress to an obstructive phase in which mass effect from the herniated abdominal contents causes cardiorespiratory impairment, bowel ischemia and/or perforation, and even death [7–12]. The diagnosis is difficult to make clinically and as larger numbers of trauma patients are being managed conservatively, it becomes increasingly important for the diagnosis to be made by imaging at the time of the initial traumatic insult.

Chest radiographs are insensitive in the detection of TDR. The sensitivity of radiographs in diagnosing or suspecting a diagnosis of TDR has been reported in the range of 27%-68% for left-sided rupture and 17%-33% for right-sided rupture [7,13–15]. Specific signs include herniation of stomach or bowel into the chest or a supradiaphragmatic position of the tip of a nasogastric tube [2]. Additional signs of TDR are nonspecific and include obscuration or elevation of a hemidiaphragm, pleural effusion, and contralateral mediastinal shift, findings, which are often attributed to other pathologies, both traumatic and nontraumatic [15].

Computed tomography (CT) has been shown to have better accuracy than chest radiographs in detecting TDR [2]. A wide range of sensitivites and specificities have been reported. When considering helical and multidetector CT (MDCT) only, estimates range from 71%-90% and 98%-100%, respectively [1]. Numerous direct and indirect signs of diaphragmatic rupture on CT have been described. Some of the more common signs found in the literature include visualization of a focal diaphragmatic defect, herniation of abdominal organs or fat into the thorax, the ''collar'' sign, active contrast extravasation at the site of the defect, and the ''dependent viscera'' sign [1,16–20]. False negatives may occur when there is poor visualization of the diaphragm due to contact with adjacent structures or when the diaphragm is parallel to the scan plane, although multiplanar reformats (MPRs) can be helpful [1]. Conversely, false positives may occur if diaphragmatic eventration or a longstanding congenital or acquired diaphragmatic defect is mistaken for an acute injury [21].

The purpose of our study was to evaluate the diagnostic accuracy of MDCT in the detection of diaphragmatic injury in trauma patients at our level 1 trauma centre, using surgical findings as the gold standard. We also aimed to draw insight from cases that were incorrectly interpreted.

Methods

Subjects

Research ethics board approval was obtained from our institution. We retrospectively searched our level 1 trauma centre registry for all patients with a final diagnosis of diaphragmatic injury from January 1, 2008, to December 31, 2012. Only patients who had a CT scan at presentation and who had subsequently documented confirmation of TDR via laparotomy or laparoscopy were included in our study cohort. Both blunt and pentrating mechanisms of injuries were included.

For a control cohort, we searched the trauma registry for all patients presenting to the trauma service during the same time period who had a CT scan at presentation and subsequently underwent laparotomy or laparoscopy that documented no evidence of TDR.

The Injury Severity Scores (ISS90) for each patient were retrieved from the trauma registry. Chart reviews were conducted to obtain additional relevant clinical data including the patient's age, sex, mechanism of injury, and location of injury. Injuries were classified as either blunt or penetrating. Blunt mechanisms included motor vehicle collisions, pedestrians struck by a motor vehicle, crush injuries, and falls from height. Gunshot and stab wounds were considered penetrating injuries.

Imaging

CT scans performed during our study period were done on a 64-slice MDCT scanner according to our departmental trauma protocol. Each patient received 125 mL of intravenous contrast (Omnipaque 300, GE Healthcare) at a rate of