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### RESEARCH ARTICLE

#### MDCT OF ABDOMINAL WALL LUMBAR HERNIAS

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#### Abstract

**Purpose:** To review the anatomical landmarks of the abdominal wall lumbar region and its normal appearance on multidetector computed tomography (MDCT) and to briefly describe the MDCT features of lumbar hernias. Diagnosis of traumatic diaphragmatic hernia due to blunt abdominal trauma requires a high index of suspicion. This study was conducted to assess the accuracy of multidetector computed tomogram (MDCT) in the diagnosis of traumatic diaphragmatic hernia. Diaphragmatic injuries remain a diagnostic challenge for both radiologists and surgeons. The detection of traumatic diaphragmatic rupture in the acute setting is problematic because specific clinical signs are usually not evident. Furthermore, the high frequency of associated injuries (52–100%) may distract from diaphragmatic injury. In conservatively managed patients, the rate of initially missed diaphragmatic injuries ranges from 12 to 66%, and they may even be overlooked at laparotomy. Diagnosis of a diaphragmatic injury requires a high index of suspicion, as delayed diagnosis increases the chance of visceral herniation and strangulation, which has mortality as high as 60%. Thus, the ability to detect diaphragmatic injuries with noninvasive techniques is increasingly important. Initial reports found CT to have sensitivity equal to that of chest radiography (i.e., 0–50%). Because of a dramatic reduction in motion and beam-hardening artifacts and significant improvement of spatial resolution, especially along the z-axis, helical CT and multisection CT allow better demonstration of most subtle signs of diaphragmatic herniation. In addition, these are also useful tools in the evaluation of patients with multiple traumatic injuries. Traumatic diaphragmatic hernias (TDHs) are sometimes difficult to identify at an early stage and can consequently result in diagnostic delays with life-threatening outcomes. It is the aim of this case study to highlight the difficulties encountered with the earlier detection of traumatic diaphragmatic hernias.

**Methods:** We performed a retrospective search of the imaging report database from November 2007 to October 2011. We retrieved the clinical data and MDCT studies of patients suffering from abdominal wall lumbar hernias. We reviewed the imaging features of abdominal lumbar hernias and compared those with the normal appearance of the lumbar region in asymptomatic individuals. We assessed variables such as age, gender, mechanism of trauma, methods of diagnosis, herniated organs and associated lesions, time of evolution, morbidity, and mortality. Anteroposterior supine chest radiograph, which was

performed in all patients, was also analyzed. Computed tomogram (CT) was performed on four-slice MDCT after an IV bolus of iodinated contrast agents. A slice thickness of 4 mm at a pitch of 1.5 was useful to evaluate thorax and abdomen with reconstruction at 1 mm reconstruction increment. An oral contrast agent was given whenever required. Multiplanar reconstruction was done in sagittal and coronal planes. Images were read in lung parenchyma, soft tissues, and bone windows. Findings were analyzed in a prospective manner to evaluate their use as a diagnostic modality as well as to determine their contribution to patient management.

**Results:** We classified lumbar wall hernias as diffuse, superior (or Grynfelt–Lesshaft) and inferior (or Petit) lumbar hernias. We briefly describe the imaging features of each subtype and review the anatomy and MDCT appearance of normal lumbar region. Currently available MDCT provides an excellent opportunity for reviewing the normal anatomy of the wall lumbar region and may be considered a useful modality for evaluating lumbar hernias. Regarding Diaphragmatic hernia following blunt trauma: MDCT is a highly accurate modality for diagnosing traumatic diaphragmatic hernia. In addition, it is fast and compatible with various life-support systems; hence, it can be used in acute trauma setting for making a diagnosis and helping in the management. Delayed traumatic diaphragmatic hernias are not common, but can lead to serious consequences once occurred. Early detection of diaphragmatic injuries is crucial to prevent the occurrence of dTDHs. Surgeons should maintain a high suspicion for injuries of the diaphragm in patients who had suffered abdominal or lower chest traumas, especially during the initial surgical explorations. The need for radiographical follow-ups is emphasized to detect diaphragmatic injuries at an earlier stage.

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### **Introduction:-**

Lumbar hernias (LH) are rare defects of the dorsolateral abdominal wall. They are defined as protrusions of extraperitoneal fat, with or without peritoneum and visceral contents. Specific sites of anatomical weakness within the lumbar region are particularly predisposed to the formation of LH. These are the superior (Grynfelt-Lesshaft) and inferior (Petit) lumbar triangles. According to their etiology, LH may be congenital or acquired. Congenital LH appear during infancy and associate with other malformations. Acquired LH may be spontaneous, posttraumatic or postoperative. According to their contents, LH may be extraperitoneal, paraperitoneal or intraperitoneal [10].

Lumbar hernias (LH) may remain asymptomatic or cause pain and palpable lump. Gastrointestinal symptoms and urinary obstruction may occur, posing a significant challenge on clinical diagnosis [7, 11]. In the past, computed tomography (CT) was found useful for depiction of LH [4, 5, 6, 9]. More recently, multidetector computed tomography (MDCT) has become the modality of choice for evaluating abdominal wall hernias [1, 2] and may be particularly helpful for assessing LH.

Consequently, our purpose is to review the anatomical landmarks of the lumbar region and its normal appearance on MDCT studies. We also review the MDCT features of LH and their differential diagnosis.

1. Materials and methods for lumbar hernia
2. We performed a retrospective search of our imaging report database from November 2007 to October 2011 and reviewed those MDCT studies of patients suffering abdominal wall lumbar hernias. All of our studies were performed in a 64-slice MDCT (Aquilion 64, Toshiba Medical Systems), using a conventional contrast-enhanced abdominal protocol. Acquisition was performed in a craniocaudal direction after IV administration of 90–120 ml of non-ionic contrast medium at flow rate of 3 ml/seg, using a power injector.

Volume data set were acquired with configuration of  $64 \times 0.5$  mm, and reconstructions were obtained with a slice thickness of 1 mm and reconstruction interval of 0.8 mm. Subsequently, thin-section multiplanar reformations, including orthogonal and oblique views, and volumen-rendered images were evaluated in a dedicated workstation.

The superior lumbar triangle is an inverted triangle (Fig. 1b). It is bordered superiorly by the 12th rib and the serratus posterior inferior muscle, posteromedially by the erector spinae and quadratus lumborum muscles and anterolaterally by the internal oblique muscle. Its floor is formed by the transversalis fascia and other fasciae. The superior lumbar triangle is superficially covered by the latissimus dorsi muscle and is pierced by the subcostal neurovascular pedicle.

The inferior lumbar triangle is upright, smaller, more lateral and less constant than its superior homologue (Fig. 1c). It is bordered inferiorly by the iliac crest, anterolaterally by the external oblique muscle and posteromedially by the latissimus dorsi muscle, which merges with the thoracolumbar fascia. Its floor is formed by the thoracolumbar fascia and other fasciae. The inferior lumbar triangle is not covered by muscles and is not pierced by any neurovascular structures.

The lumbar region shows great anatomical variability. A tall, thin person with angulated 12th ribs will have a narrow superior triangle. Conversely, a medial origin of the latissimus dorsi muscle will cause a wide inferior triangle [10]. Besides, the inferior triangle may reach a very anterior position in the vicinity of the mid-axillary line. Knowledge of the cross-sectional structure of the lumbar region (Fig. 2) and familiarity with its variability are required for understanding the MDCT appearance of the lumbar region.

#### **MDCT appearance of the lumbar region:**

On MDCT the muscles bellies of the lumbar region are found to diverge from each other, get slender or fade away. The small gap in between is filled up with normal fatty tissue. Posterior coronal (Fig. 3a) and oblique lateral (Fig. 3b) volume-rendered MDCT views provide a panoramic approach to the evaluation of the normal lumbar region. However, its anatomical landmarks are more easily characterized on standard axial views and multiplanar reconstructions. The MDCT appearance of the lumbar region is influenced by the age and body habitus of the patient. In young well-fit individuals close apposition of muscle bellies may difficult identification of the lumbar triangles, which are more evident in obese or elderly patients.

On axial MDCT images, the upper limits of the superior triangle, namely the 12th rib and the serratus posterior inferior muscle, are easily identified (Fig. 4a). At more caudal axial views (Fig. 4b), these structures are no longer seen, and the latissimus dorsi muscle gets slender and fuses with the thoracolumbar fascia. Also at distal axial views, the fascial floor, represented by a single laminar structure, becomes more evident. However, the inferior corner of the inverted triangle is hard to define. On sagittal MDCT views, the normally flat or anteriorly convex fascial floor is readily evaluated (Fig. 5). On coronal MDCT views, the inverted configuration of the superior triangle becomes evident and is found to contain mildly asymmetric amounts of normal fatty tissue (Fig. 6).

On axial MDCT images the inferior triangle should be searched for lateral to the most superior aspect of the iliac crest, and medial to the external oblique muscle (Fig. 7a). At this region, the latissimus dorsi muscle is very thin and merges with the thoracolumbar fascia. Consequently, both the internal margin and the fascial floor of the inferior triangle may be hard to identify on axial MDCT views. On sagittal MDCT views, the normally flat contour of the fascial floor is more easily evaluated (Fig. 7b). On coronal MDCT views, the open interval between the external oblique muscle and the iliac crest may falsely suggest abnormal muscle desinsertion (Fig. 7)

#### **Discussion:-**

##### **Discussion on diaphragmatic hernia following blunt trauma.**

The incidence of diaphragmatic rupture varies from 0.8 to 8% following major blunt trauma [9–11]. Sennertus was the first to describe a traumatic diaphragmatic hernia in 1541 [4, 12]. Bowditch made an antemortem diagnosis of a traumatic diaphragmatic rupture in 1853 [13]. Shanmuganathan et al. [9] has stated that more than 90% of blunt traumatic diaphragmatic ruptures occur following motor vehicle accident. There were 12 patients in our study (70.59%). The mechanism of injury is thought to be a lateral impact distorting the chest wall and shearing the diaphragm or a direct frontal impact causing a sudden increase in intra-abdominal pressure [5].

Carter et al. proposed three time phases for patients with diaphragmatic injury. The acute phase extends from the time of injury to 14 days afterward. If the patient survives the initial trauma and the hernia is not manifest within the first 14 days, the second or interval phase is entered. This interval phase extends until the third stage, which is the phase of obstruction or strangulation [6]. Seventeen of our patients presented in the acute phase, while two presented in the delayed phase. We did not pick up any patient in the interval phase.

Injuries to the left hemidiaphragm occur three times more frequently than to the right side following blunt trauma. On the left side, the left posterolateral aspect is the commonest site. This is structurally weak area as it originates from the pleuroperitoneal membrane [14]. The right hemidiaphragm is congenitally stronger and is partially protected by the liver, preventing the transmission of force through the abdominal viscera to the right hemidiaphragm. Bilateral hemidiaphragm injuries are uncommon and are seen in up to 4.5% of patients. There was no case in our study. The left-sided diaphragmatic rupture following blunt trauma is seen in 68.5–87% cases [9, 15]. Eleven patients (57.89%) had the left-sided diaphragmatic rupture in our study.

Although multiple imaging modalities are available to evaluate the diaphragm following major blunt trauma, chest radiographs are the initial and the most commonly performed imaging study. The initial radiographs are diagnostic in 27–60% of cases with the left-sided injury, but only 17% in the right-sided injury [9]. Attempts have been made to improve the sensitivity of plain chest radiographs by repeating films after nasogastric tube placement and contrast-enhanced gastrointestinal tract studies [16]. Chest radiographs were positive in 52.63% in our series and all of them were on the left side.

Diagnosing a diaphragmatic hernia as hydropneumothorax on radiographs is not an uncommon mistake that is made and is well identified in the literature [17]. In our series, one of the cases highlights this mistake (Fig. 1a and b).

Helical CT is valuable in the preoperative detection of diaphragmatic ruptures [5, 16]. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy reported by various authors [5, 11, 16, 18] are shown in Table 3. Findings are comparable with the findings of our study.

Of the two false-positive cases found in our study, one was a small tear seen in the left diaphragm found on CT scan, which was not confirmed by surgical intervention. Small defect seen in 6% of general population is a normal variant and is seen more commonly in older patients, in women, and in those with emphysema [18]. The second case was diagnosed on the basis of the thickened right hemidiaphragm. Nachimi et al. [18] also found a high degree of false-positivity in their study for this sign.

The most common viscera to herniate is the stomach and colon on the left side and the liver on the right side, as seen in our series [18].

Nachimi et al. [18] described 11 signs of blunt diaphragmatic rupture on CT scan. They found that any positive finding significantly increased the likelihood of blunt diaphragmatic rupture ( $p < 0.001$ ). Multivariate logistic regression found six signs to be isolated good predictors ( $p < 0.001$ ) of blunt diaphragmatic rupture: diaphragmatic discontinuity, segmental unrecognized diaphragm, intrathoracic herniation of abdominal content, elevated abdominal organs, thickened diaphragm, and presence of both hemothorax and hemoperitoneum. Murray et al. [5] evaluated 11 cases of diaphragmatic rupture and found that diaphragmatic discontinuity was seen in 8, visceral herniation was seen in 6, and the collar sign was seen in 4 patients.

Dependent viscera sign occurs when the herniated organs directly abut the posterior ribs due to absence of posterior support by the diaphragm, which ruptures in case of diaphragmatic hernia. It is described in the literature to be up to 100% sensitive [19]. Intrathoracic herniation has been found to be 32–64% sensitive. Diaphragmatic discontinuity is 71–80% sensitive and the “collar sign” up to 63% with helical CT [16]. The finding in our series is described in Table 2.

Other signs described in the literature are contrast medium extravasation at the level of the diaphragm described by Larici et al. [11] and hypoattenuation of the hemidiaphragm due to devascularization described by Nachimi et al. [18]. Nachimi et al. found 0% sensitivity for the first sign, as also seen in our series. To the best of our knowledge, no other author has reported the second sign. These signs were not observed in our series.

Both Killeen et al. [16] and Larici et al. [11] found that helical CT performed better for the left-sided injuries, while we found the sensitivity and specificity to be equal on both sides. Also, in contrast to Killeen et al. [16], Larici et al. [11] found that sagittal and coronal reformation added little to the ability to diagnose diaphragmatic injury. It was helpful only in three of our cases.

High incidence of associated injuries such as pelvic fractures, thoracic aortic injury, hepatic, and splenic injuries has been reported in up to 100% of patients with diaphragmatic injury [9]. Brasness et al. [20] have found that associated abdominal injuries are common with liver (38%), spleen (34%), and renal injuries in (30%) and splenic injuries were seen in 7%. Similar findings were seen in our series.

#### **MDCT features of LH:**

MDCT studies should be able to identify the LH, assess its size and anatomical relationships and characterize it as superior, inferior or diffuse. MDCT should be able to depict the internal contents and complications of the LH and occasionally suggest its etiology. MDCT may also be used for evaluating muscle atrophy or coexistent defects within the abdominal wall. Finally, MDCT may be helpful for surgical planning or postoperative follow-up [1, 4, 5, 9, 10].

The following MDCT criteria for diagnosing LH have been suggested: First, protrusion of extraperitoneal fat and/or viscera through the fascial floor plane should be seen on axial or sagittal views. Such protrusion typically modifies the normal contour of the extraperitoneal fat and may associate with a visible tear of the fascial floor [4]. Second, abnormal separation between muscle and fascial layers of the lumbar region is a predictable consequence of the protrusion. This is particularly useful for early detection of small fatty protrusions, because LH have a natural history of a gradual increase in size over time [14]. And third, the protrusion causes an abnormal bulge within the abdominal flank, usually in asymmetric fashion [4]. However, LH may be bilateral, and normal lumbar regions may also have slightly asymmetric contour.

LH of the superior lumbar triangle typically emerge right under the 12th rib and are commonly spontaneous. They usually impinge on the inner aspect of the latissimus dorsi muscle (Fig. 8) and may anteriorly reach subcutaneous planes (Fig. 9). LH of the inferior lumbar triangle are usually found right on top of the lateral iliac crest and are frequently traumatic [9]. Traumatic LH are commonly associated with flank hematomas, lumbar fracture, jejunal perforation or mesenteric laceration. They may be part of the seat-belt syndrome, and their occurrence should warn about the possibility of life-threatening internal damage (Fig. 10) [15]. Diffuse LH typically involve the superior and inferior lumbar triangles (Fig. 11). Diffuse LH are usually found after lumbotomy [12, 13]. However, incisional LH may also cause selective involvement of the superior triangle (Fig. 12) or involve an area contiguous to the inferior triangle after iliac crest harvesting (Fig. 13) [3, 16].

#### **Conclusion:-**

1. Radiologists should be able to recognize abdominal wall lumbar hernias, their types and anatomical details. Multiplanar capabilities of MDCT provide an excellent opportunity for studying the normal anatomy and herniations of the lumbar region. It also is useful for evaluating their complications and for differentiating them from other situations that mimic abdominal wall lumbar hernias.
2. MDCT is a highly accurate modality for diagnosing traumatic diaphragmatic hernia. In addition, it is fast and compatible with various life-support systems; hence, it can be used in acute trauma setting for making a diagnosis and helping in the management.

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