RadioGraphics

Cisterna Chyli at Routine Abdominal MR Imaging: A Normal Anatomic Structure in the Retrocrural Space[1]

Pedro S. Pinto, MD[2] • Claude B. Sirlin, MD • Olga A. Andrade-Barreto, MD • Michele A. Brown, MD • Robert E. Mindelzun, MD • Robert F. Mattrey, MD

The cisterna chyli, a dilated lymphatic sac in the retrocrural space, represents the origin of the thoracic duct. It is seen in approximately half of lymphangiographic studies and 20% of autopsies. Highly fluid-sensitive magnetic resonance (MR) imaging sequences such as single-shot rapid acquisition with refocused echoes, which are currently used in many abdominal MR imaging protocols, frequently result in the depiction of this structure. The cisterna chyli was evident on abdominal MR images acquired in 30 (15%) of 200 consecutive patients who underwent MR imaging at the authors' institution between February and June 2002. Its appearance varied from that of a thick tube to that of a thin tube, parallel or converging tubes, tortuous tubes, a sausage-shaped fluid collection, a focal collection, or a focal plexus. Radiologists who perform MR imaging should be familiar with the various possible appearances of this normal anatomic structure so as not to mistake it for a pathologic entity.

Abbreviations: HASTE = half-Fourier single-shot turbo spin-echo, MIP = maximum-intensity projection

Index terms: Abdomen, anatomy • Abdomen, CT, 995.12913 • Cisterna chyli, 995.92 • Lymphatic system, MR, 995.129419, 995.12943 • Magnetic resonance (MR), half-Fourier imaging, 995.129419 • Retroperitoneal space, 995.92

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[1]From the Department of Radiology, UCSD Medical Center, 200 W Arbor Dr, San Diego, CA 92103-8756 (P.S.P., C.B.S., O.A.A.B., M.A.B., R.F.M.); and Department of Radiology, Stanford University, Palo Alto, Calif (R.E.M.). Recipient of a Certificate of Merit award for an education exhibit at the 2002 RSNA scientific assembly. Received March 31, 2003; revision requested May 12 and received June 30; accepted July 1. **Address correspondence to** C.B.S. (e-mail: *csirlin@ucsd.edu*).

[2] **Current address:** Department of Radiology, Porto Medical School, Hospital S. João, Porto, Portugal.

Introduction

The cisterna chyli is a dilated lymphatic sac in the retrocrural space. It is located at the origin of the thoracic duct and is seen in approximately 50% of lymphangiographic studies (1) and 20% of autopsies (2). The appearance of the normal cisterna chyli at computed tomography (CT) has been described previously, but to the best of our knowledge, its appearance at magnetic resonance (MR) imaging has not. Highly fluid-sensitive sequences such as single-shot rapid acquisition with refocused echoes, which are currently employed in many abdominal MR imaging protocols, frequently result in the depiction of this structure. The article reviews variations in normal anatomy of the retrocrural space, with emphasis on the MR imaging appearance of the lymphatic system in this region and, particularly, the cisterna chyli.

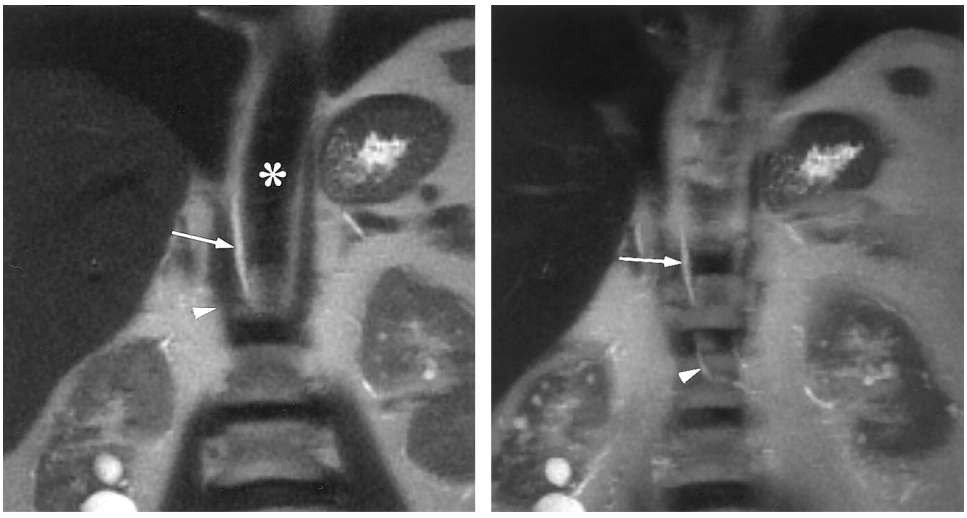
Anatomy and Function

The cisterna chyli is usually described in anatomic studies as a saccular area of dilatation in the lymphatic channels that originates at the level of the L1–2 vertebral body and extends 5–7 cm in the caudocephalic direction (Fig 1). It is located in the retrocrural space, usually to the immediate right of the abdominal aorta. This region is also the location of the azygos and hemiazygos veins and the retrocrural lymph nodes. The cisterna chyli is joined by two lumbar and intestinal lymphatic trunks, after which it continues in the cephalic direction as the thoracic duct (2). Despite this classic description, the cisterna chyli has a highly variable appearance. Complex anastomoses of lumbar lymphatics, which occur frequently, may result in a plexus rather than a single duct. Furthermore, multiple sacculations may be present in some of the convergent lymphatic channels (3). This wide variation in the origin of the thoracic duct has led some authors to prefer the descriptive phrase "abdominal confluence of the lymphatic trunks" to the term "cisterna chyli." The latter typically is reserved for cases in which a distinctly fusiform or saccular dilatation is present (2).

The cisterna chyli was identified in 14 (20%) of 70 subjects at autopsy (2) and in 204 (52%) of 390 patients evaluated with lymphangiography (1). The appearance of the cisterna chyli in the lymphangiographic study was variable. Among the most common shapes were an inverted letter Y or V, a string of pearls, and a comma-like configuration.

Figure 1. Photograph of a preserved cadaveric specimen shows a large cisterna chyli (arrow) anterior to the L1 vertebra and the proximal thoracic duct (arrowhead), afferent trunks that join with the inferior part of the cisterna, and intrathoracic tributaries of the thoracic duct. (Courtesy of Professor Roger Saban, Institut d'Anatomie des Saints Pères, Paris, France)

The appearance of the cisterna chyli at cross-sectional imaging seldom has been described (4–6). Gollub and Castellino described the cisterna chyli at CT in 18 patients (4), but no attempt was made to determine the prevalence of a visible cisterna chyli. In a more recent study, Smith and Grigoropoulos identified the cisterna chyli in only seven (1.7%) of 403 patients who underwent abdominal CT (5). In three patients, each of whom had an unusually large cisterna chyli (with a transverse diameter of 2 cm), Lee and Cassar-Pullicino observed enhancement of the cisterna chyli lumen on delayed CT and MR images obtained 10 minutes or more after intravenous administration of contrast material (7). These authors did not describe the appearance of smaller-caliber cisternae chyli.



a. b.

Figure 2. Single straight thin tube. **(a)** Coronal T2-weighted MR image acquired with a HASTE sequence shows a small cisterna chyli as a single straight thin tube (arrow) between the aorta (*) and the right hemidiaphragmatic crus (arrowhead). The thoracic duct is not seen. **(b)** MIP image, reconstructed by using several coronal sections from the same HASTE sequence, depicts the cisterna (arrow) and one of the lumbar or intestinal afferent trunks (arrowhead).

Table 1
Abdominal MR Imaging Parameters Typically Used with the HASTE Sequence

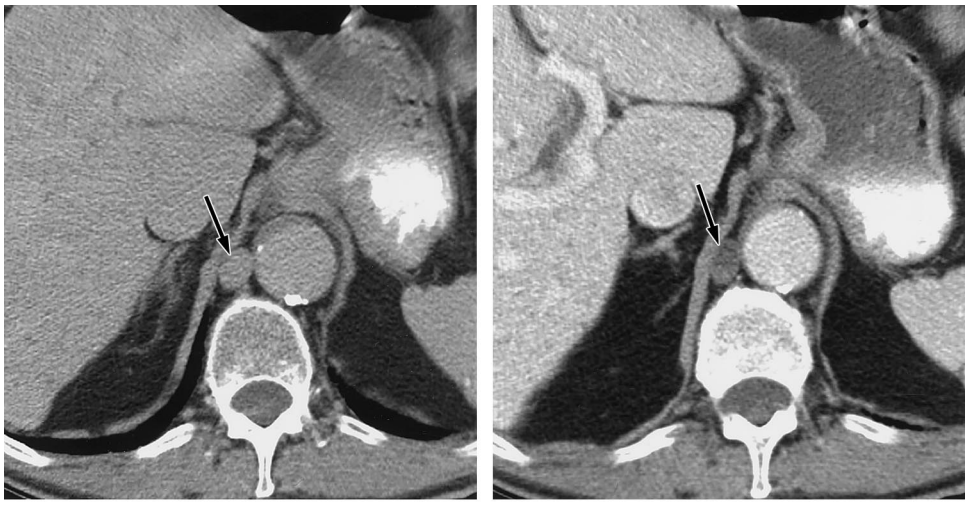
Repetition time	1,060 msec
Effective echo time	116 msec
Turbo factor (echo train length)	256
Section thickness	6 mm (0-mm gap)
Matrix	256 × 256
Field of view	30–40 cm

The main function of this ductal structure is the transport of ingested fat; approximately 100 mL of lymph per hour is transported through the channel (8). The caliber of the cisterna chyli may be altered by contraction waves, as has been demonstrated at fluoroscopy (1).

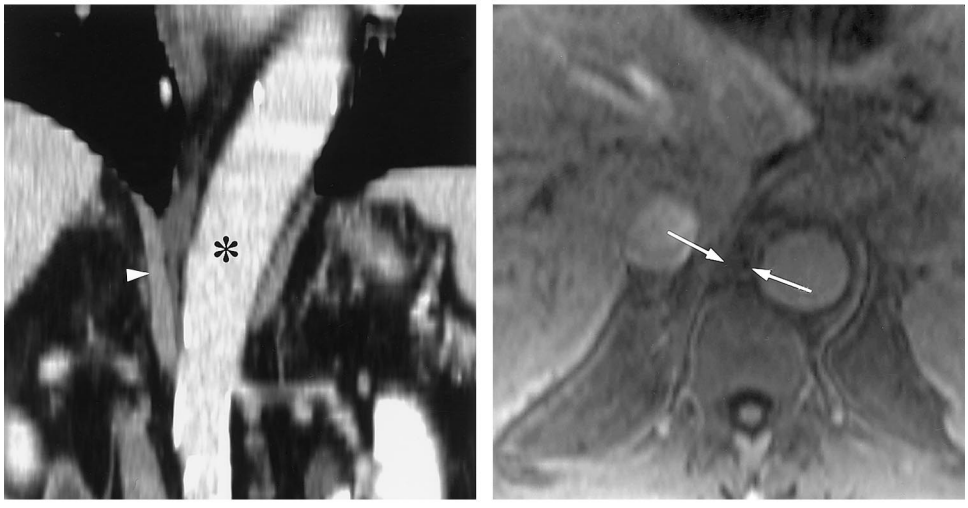
MR Imaging Appearance

We reviewed abdominal MR images obtained in 200 consecutive patients between February and June 2002 by using a 1.5-T system (Symphony; Siemens Medical Systems, Erlangen, Germany) with a torso phased-array coil. Each MR imaging examination included at least one half-Fourier single-shot turbo spin-echo (HASTE) sequence applied in the coronal plane through the retroperitoneum. This sequence is used in our standard abdominal MR imaging protocol (Table 1). Patients were asked to fast for at least 4 hours before the exam. Two radiologists in consensus reviewed the images at a workstation (Insight; Neo Imagery Technologies, City of Industry, Calif) by using a 1-Kb (1,024-bit) monitor. Maximum-intensity projection (MIP) reconstructions were performed at the workstation in all cases in which the cisterna chyli was visible on the source images.

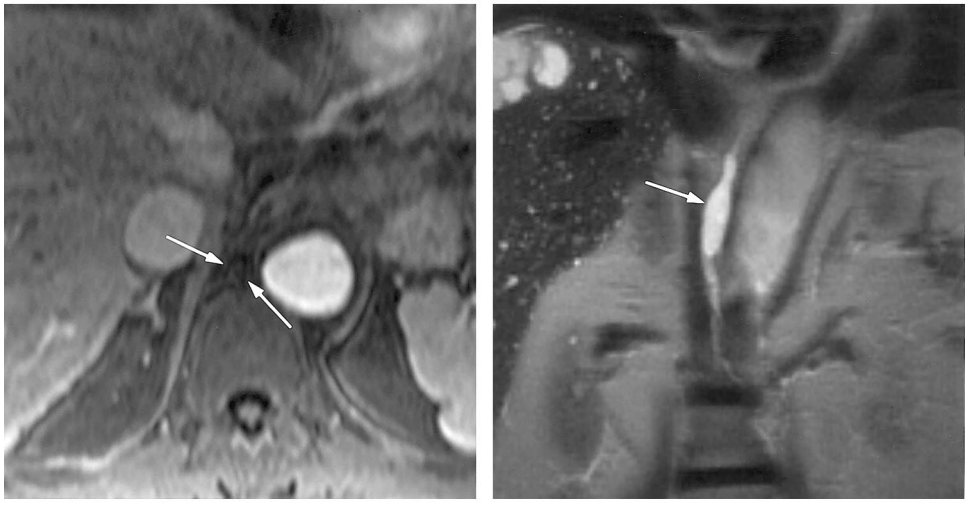
The cisterna chyli was considered present if a fluid collection with a diameter of 5 mm or more and a signal intensity similar to that of bile or cerebrospinal fluid was visualized in the retrocrural space. Smaller retrocrural collections were difficult to identify in the 6-mm-thick sections imaged with our standard protocol and, therefore, were not included in our definition of cisterna chyli. The cisterna chyli was identified in 30 (15%) of the 200 patients. The superior-inferior center of the cisterna chyli ranged from the level of the T12 to the L2 vertebra. Its maximum caliber was 23 mm. Shape was variable and included the following morphologic patterns: a single straight thin tube (Fig 2), single straight thick tube (Fig 3), and single sausage-shaped tube (Fig 4); multiple parallel or converging tubes (Fig 5) and tortuous



a. b.

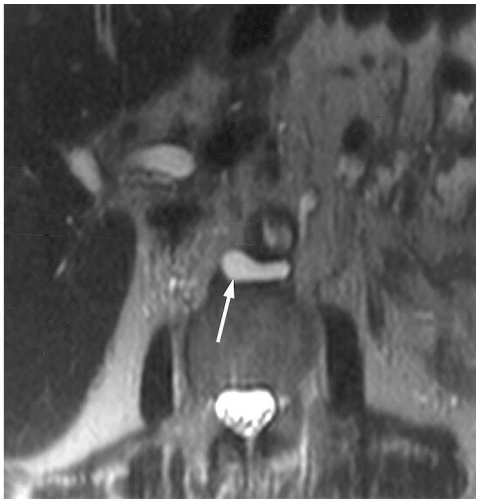


c. d.

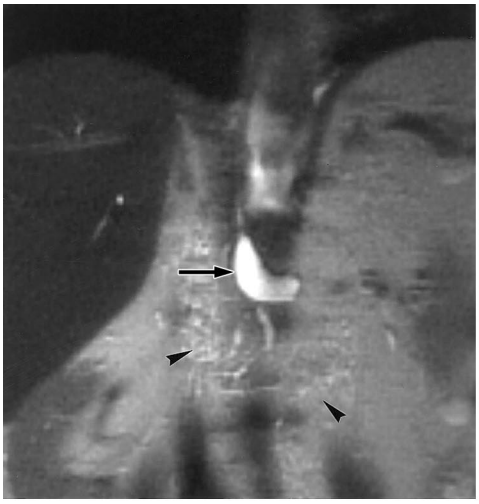


e. f.

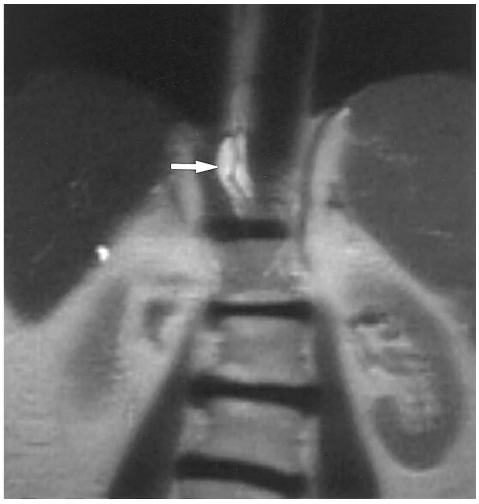
4a.



4b.



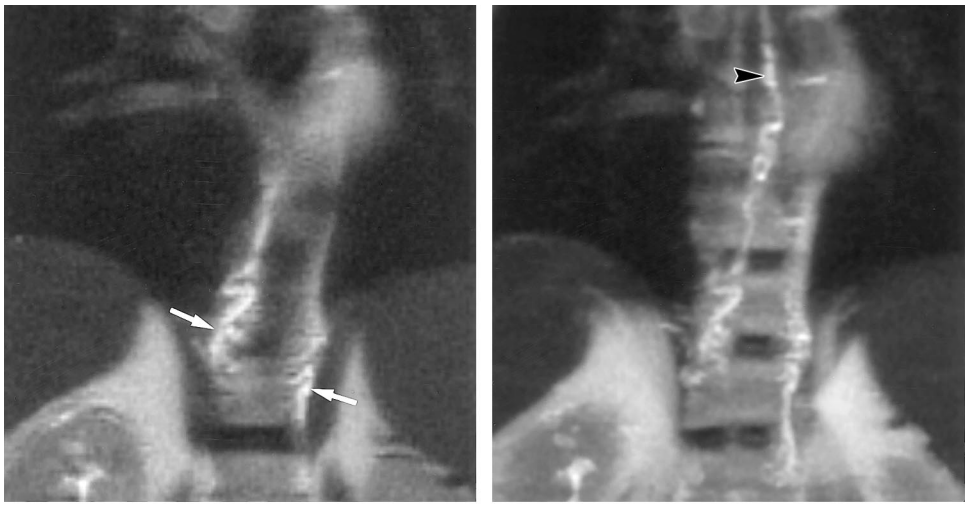
4c.



5.

Figures 4, 5. **(4)** Single sausage-shaped tube. **(a)** Axial nonenhanced CT image through the lower retrocrural space shows a structure with the attenuation of fluid posterior to the aorta (arrow). **(b, c)** Axial **(b)** and coronal **(c)** MR images obtained with a HASTE sequence show a sausage-shaped fluid-signal-intensity cisterna chyli (arrow). The meshwork of tiny lymphatic channels on both sides of the cisterna (arrowheads in **c**) represents the lumbar lymphatics. **(5)** Parallel tubes. Coronal HASTE image obtained in another patient depicts the cisterna chyli as two parallel sausage-shaped tubes (arrow).

Figure 3. Single straight thick tube. **(a, b)** Axial CT images of the retrocrural space, obtained before **(a)** and during **(b)** intravenous contrast material enhancement, show the cisterna chyli as a nonenhanced rounded structure (arrow) with the attenuation of fluid—an appearance that could result in its being mistaken for an enlarged retrocrural lymph node. **(c)** Coronal reformatted CT image shows the thick tubular cisterna between the right hemidiaphragmatic crus (arrowhead) and the aorta (*). **(d, e)** In the same patient, axial 2.5-mm-thick T1-weighted three-dimensional volume-interpolated breath-hold MR images obtained before **(d)** and approximately 60 seconds after **(e)** intravenous administration of a gadolinium compound show a low-signal-intensity structure (arrows), which did not enhance either in the arterial or the equilibrium phase (not shown). **(f)** Coronal HASTE image, obtained at the same MR imaging examination as **d** and **e**, depicts the cisterna chyli as a thick tubular structure (arrow). No size change was observed in this structure on 4- or 7-month follow-up images. Note the multiple hyperintense subcentimeter foci throughout the liver, which indicated von Meyenburg complex (bile duct hamartomas) in this patient.



a. **b.**

Figure 6. Tortuous tubes. **(a)** Coronal HASTE image through the retrocrural space shows two tortuous tubes, one on each side of the aorta (arrows), rather than a single cisterna chyli. **(b)** MIP image, reconstructed from several sections obtained with the same HASTE sequence, depicts the extent of the tubes and the continuation of the right tube as a tortuous thoracic duct (arrowhead).

Table 2
Morphologic Patterns of the Cisterna Chyli on MR Images Obtained in 30 Patients

Pattern	No. of Patients	Example
Single straight thin tube between 5 and 9 mm in transverse diameter	9 (30)	Figure 2
Single straight thick tube 10 mm or more in transverse diameter	1 (3)	Figure 3
Single sausage-shaped tube	2 (7)	Figure 4
Two or more parallel or converging tubes	3 (10)	Figure 5
Two or more tortuous tubes	2 (7)	Figure 6
Focal round or oval collection	8 (27)	Figure 7
Focal plexus	5 (17)	Figure 8

Note.—Numbers in parentheses are percentages and do not total 100 due to rounding.

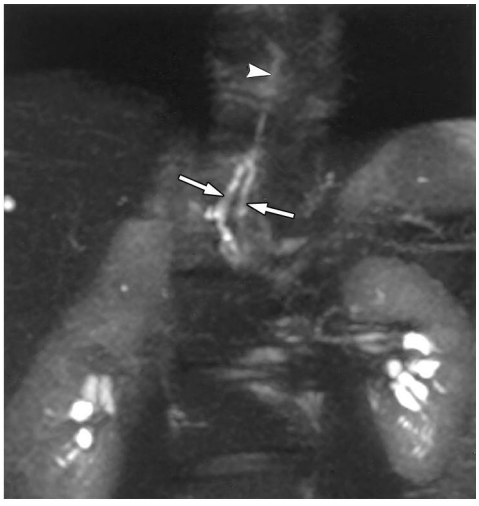
tubes (Fig 6); a focal round or oval fluid collection (Fig 7); and a focal plexus (Fig 8). The distribution of these shapes among the 30 patients is shown in Table 2.

In patients in whom the cisterna chyli was identified, the thoracic duct was commonly seen to arise from the cisterna and course upward (Fig 9). In five patients, a fine meshwork of lymphatics was clearly seen proximal and inferior to the cisterna chyli (Figs 10, 11). The conspicuity of the afferent lymphatics was consistently higher on MIP images than on source images.

7a.

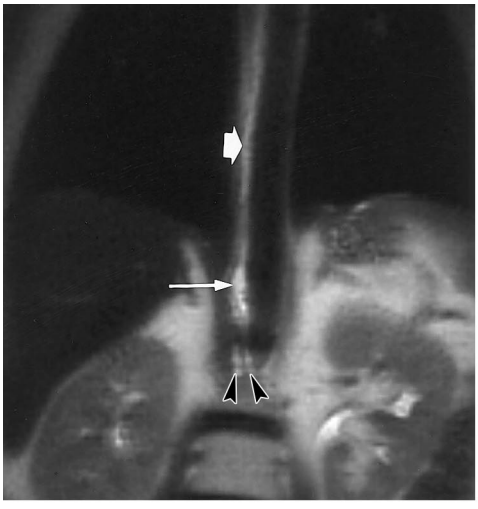
7b.

7c.

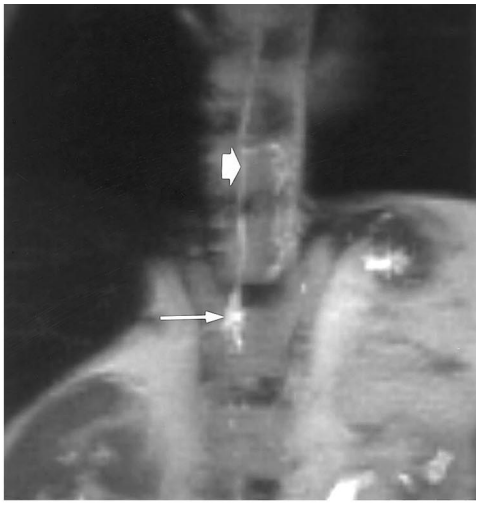


8.

Figures 7, 8. **(7)** Focal collection. **(a, b)** Axial CT images through the retrocrural space, obtained before **(a)** and during **(b)** intravenous contrast enhancement, show a low-attenuating nonenhanced oval structure (arrow) in the retrocrural space. **(c)** Coronal MR image obtained with a HASTE sequence in the same patient depicts the cisterna chyli (arrowhead) as a focal (not tubelike) collection with the signal intensity of fluid. **(8)** Focal plexus. Coronal MIP image reconstructed from image data obtained with a HASTE sequence depicts the confluence of the left and right lymphatic trunks (arrows) as a focal plexus that continues upward as the thoracic duct (arrowhead).

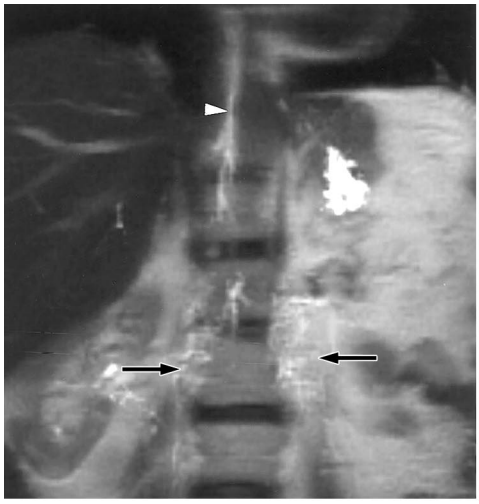


a.

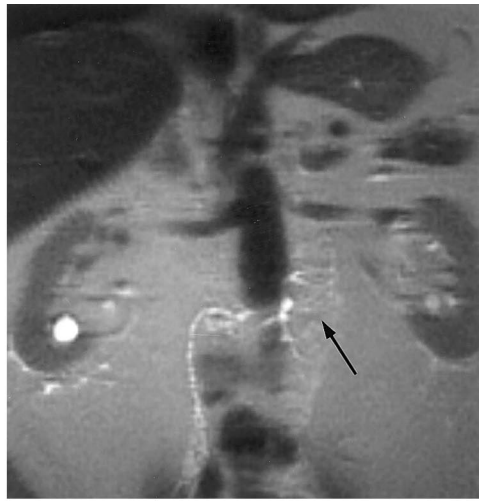


b.

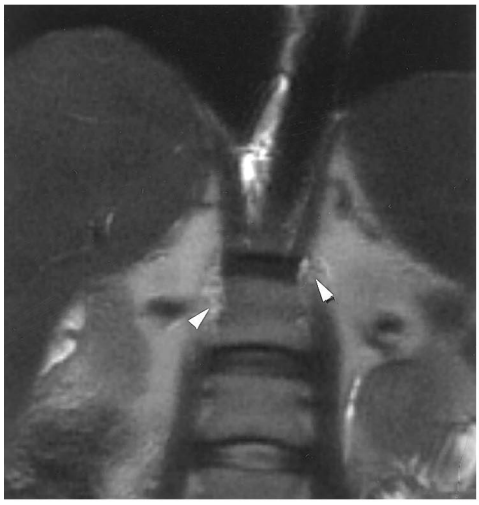
Figure 9. Coronal HASTE **(a)** and MIP **(b)** images show a thoracic duct (thick arrow) that courses up the right side of the aorta from its origin at the cisterna chyli, which appears as a focus of dilatation (thin arrow) in the retrocrural space. Two tubes adjacent to the lower aspect of the cisterna (arrowheads in **a**) represent two of the afferent trunks.



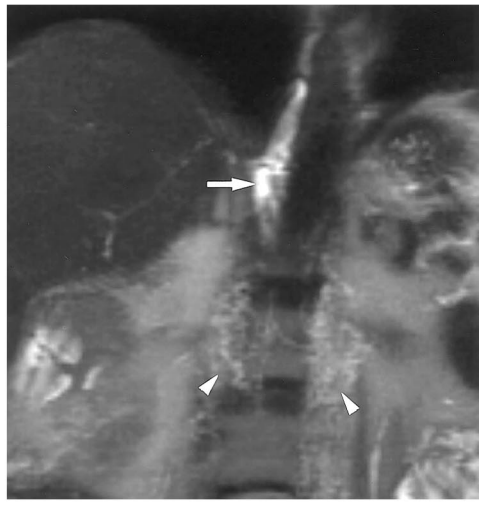
10a.



10b.



11a.



11b.

Figures 10, 11. **(10)** Coronal HASTE images obtained in two different patients show the meshwork of lumbar lymphatics (arrows). In **a,** the proximal thoracic duct is well depicted (arrowhead) and is seen to be supplied by several afferent trunks, rather than by a single distinct cisterna chyli. **(11)** Coronal HASTE image **(a)** and MIP image **(b)** show an irregularly shaped cisterna chyli (arrow in **b**), as well as a delicate meshwork of tiny lymphatics (arrowheads), in the lumbar region inferior to the cisterna, seen more clearly in **b**.

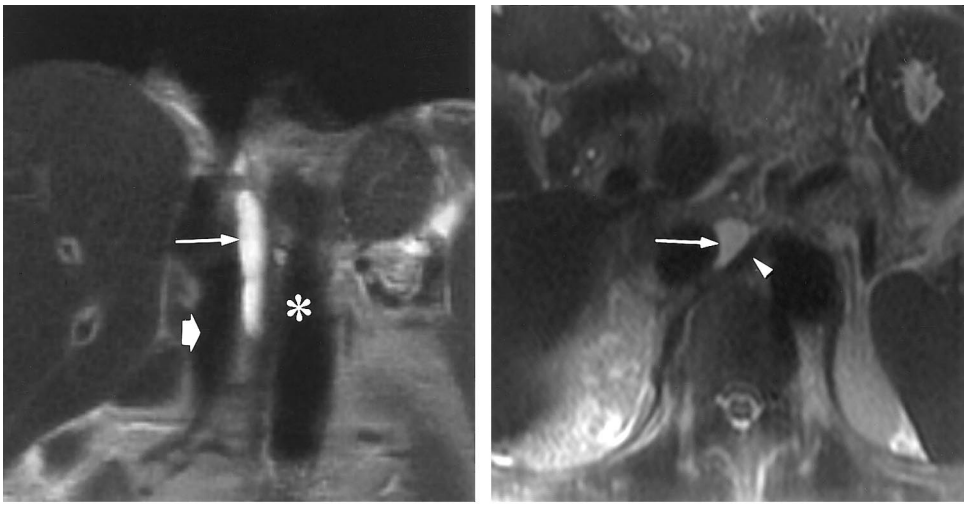
In one patient, the sausage-shaped cisterna chyli included a substantial component located directly posterior to the aorta, in addition to a right periaortic component (Fig 3). In another patient, two dominant lymphatic channels were present, one to the left and one to the right of the aorta, instead of a single dominant cisterna (Fig 6). In all other patients, the main component of the lymphatic confluence was located to the right of the aorta.

In all 30 patients, dynamic volume-interpolated breath-hold imaging through the cisterna chyli was performed during hepatic arterial, portal venous, and equilibrium phases after intravenous administration of gadoversetamide (Optimark; Mallinckrodt, St Louis, Mo). The cisterna chyli was not enhanced on dynamic images obtained in any of these 30 patients (Fig 2). The last imaging sequence was performed less than 5 minutes after contrast material injection in all patients. Seven of the 30 patients underwent a series of MR examinations separated by intervals of 3 to 10 months, and the appearance of the cisterna chyli was identical at each examination (Fig 2).

In one patient who had undergone recent liver transplantation, a small postsurgical fluid collection was observed that mimicked the cisterna chyli (Fig 12). The location of the postsurgical fluid collection, however—anterior to the diaphragmatic crus, instead of retrocrural—permitted its differentiation.

Conclusions

The cisterna chyli is seen in 15% of patients evaluated with routine abdominal MR protocols that include highly fluid-sensitive T2-weighted imaging sequences. This frequency of detection is higher than that reported for CT (5) but lower than that reported for lymphangiography (1). A dedicated MR protocol with thinner sections and fat suppression might enable clearer depiction of the cisterna chyli (9) and, thus, could be useful



a. b.

Figure 12. Coronal **(a)** and axial **(b)** HASTE images show a well-defined oblong postoperative fluid collection (thin arrow) in a patient 6 days after liver transplantation. In **a**, the fluid collection, because of its location between the aorta (*) and inferior vena cava (thick arrow), might be mistaken for the cisterna chyli. The axial image (**b**), however, clearly shows a location anterior to the right hemidiaphragmatic crus (arrowhead) and surrounding the vena cava, inconsistent with the location of the cisterna chyli.

for evaluating patients suspected of having lymphatic duct abnormalities, including chylothorax, traumatic chylous effusion, and congenital anomalies of the thoracic lymphatics. In addition, MIP reconstruction seems to improve visualization of the cisterna chyli and afferent channels, as well as the thoracic duct.

The cisterna chyli is observed at imaging as a variably shaped fluid-filled structure in the retrocrural space. In our experience, it does not appear substantially enhanced on dynamic images obtained within 5 minutes after intravenous injection of contrast material. It may, however, appear enhanced on delayed images obtained more than 5 minutes after contrast material injection, as has been reported (5).

On CT images, the cisterna chyli may be mistaken for a retrocrural lymph node; however, the depiction of the fluid content of the cisterna chyli on MR images permits its accurate identification. Tubular fluid collections in the retroperitoneum may mimic the cisterna chyli, but the typical retrocrural location of the cisterna chyli should allow differentiation. Fluid-sensitive MR pulse sequences applied in the axial plane may be necessary to confirm a retrocrural location.

Because contraction waves in the cisterna chyli are visible at fluoroscopy (1), we were surprised by the remarkably stable MR appearance of the cisterna chyli over time in the seven patients who underwent a series of MR examinations. One possible explanation for this stability is that our MR imaging protocol may not have had sufficient spatial or temporal resolution to document these physiologic contractions.

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