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Real-Time Ultrasonography – An Efficient Screening Method for Abdominal and Pelvic Lymphadenopathy

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Summary

Real-time ultrasonography of the abdomen and pelvis was performed in 129 patients with malignant lymphoma and malignant tumors in the course of clinical and pathological staging.

The results of real-time ultrasonography were compared with the findings of computed tomography, lymphography and staging laparotomy.

Analysis of the data indicated a sensitivity of 72,6% a specificity of 88,8% and an overall accuracy of 78.3%.

Real-time ultrasonography, thus, proved to be an efficient screening method for abdominal and pelvic lymphadenopathy. It can reduce the number of lymphographies as well as abdominal CT examinations.

Sonographic anatomy of the lymph system and the varying features of lymphomatous involvement in the peritoneal cavity and retroperitoneal space are described, diagnostic pitfalls and the clinical importance of real-time ultrasonography in the diagnostic work-up in patients with adenopathy are detailed.

Introduction

Since retroperitoneal lymph nodes are frequent sites for spread of a wide variety of malignancies, the detection of the presence and extent of lymph node involvement is of critical importance when evaluating patients with suspected malignant diseases. The question of lymph node enlargement arises most commonly in patients with malignant lymphoma, although the need to identify enlarged lymph nodes in addition to other space-occupying lesions exists in other neoplastic diseases as well.

Accurate anatomical staging is not only important for therapeutical decisions, but often for follow-up studies after chemotherapy (1, 5, 13, 18).

Ultrasonography of the retroperitoneal space and the lymphatic system has been used for many years mainly with compound technique. The now available improved real-time machines give a good spatial resolution and, thus, allow a rather quick and exact overview of intra- and retroperitoneal structures.

Consequently real-time ultrasonography has become a routine part of the diagnostic work-up in patients with suspected adenopathy and might be able to replace lymphography and intravenous urography in a large number of patients. There are four major indications for imaging intra- and retroperitoneal lymph nodes by ultrasonography (Table 1)

Table 1 Indications for imaging intra- and retroperitoneal lymph nodes

1.	Evaluation of presence and extent of disease
2.	Staging
3.	Guide to therapy planning
3.1	Prior to fine-needle biopsy
3.2	Determination of radiation portals
4.	Follow-up examination
4.1	Evaluation of completeness of response to therapy
4.2	Detection of recurrence of disease

This report summarizes the findings with real-time ultrasonography in patients with suspected intra- and retroperitoneal lymphadenopathy, compared with the findings of CT, lymphography and histology.

Dedicated to Prof. Dr. *Michael Földi* on the occasion of his 60th birthday

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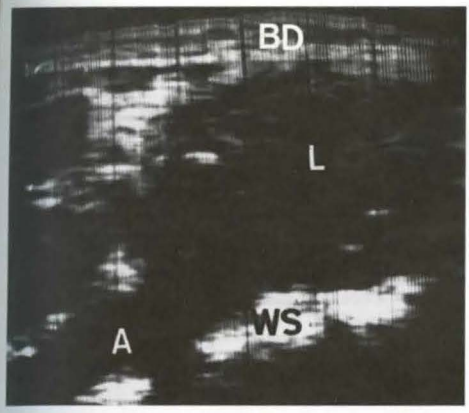

Fig. 1a 30-year-old patient with testicular teratoma. Longitudinal section at the level through the mid-abdomen demonstrates a huge, lobulated, echo-poor mass of lymphoma (L) adjacent to the anterior margin of the aorta (A)

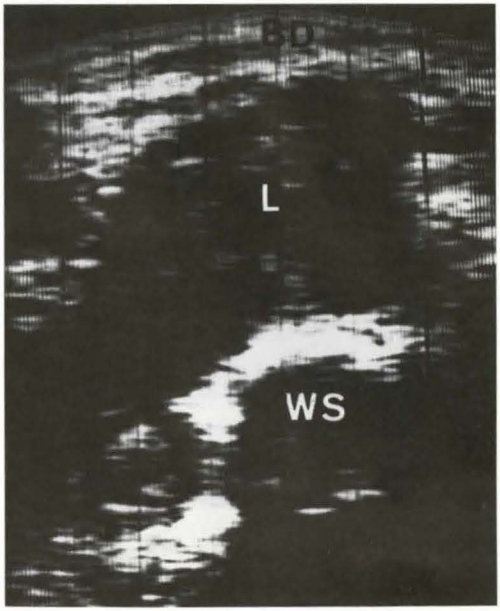

Fig. 1b Transverse scan at the level of the midportion of the kidneys demonstrates lack of distinct separation between the aorta and vena cava, indicating para- and prearotic adenopathy (L). The prevertebral vessels are totally encased and obscured by the mass ("echo-silhouette sign"). (WS = spine, BD = abdominal wall)

Examination Technique

The study of lymph node bearing areas of the abdomen, retroperitoneum and pelvis does not vary from a routine abdominal real-time study, which is always performed in a systematic fashion. Transverse and sagittal scans of the abdomen are performed in combination with subcostal and lateral views of liver and spleen to assess size and echogenicity as a sign of infiltration or lymphomatous involvement of these organs. Secondary effects such as biliary obstruction from enlarged porta hepatica lymph nodes may be visible as well.

For the pelvic portion of the examination a full urinary bladder is required to permit sufficient visualisation of the pelvic walls.

At the present we scan with a 3.0 MHz mechanical real-time scanner with a rotating transducer and parabolic mirror in a water bath (rectangular parallel line scan-Vidoson 735 SM - Siemens). We also used a computer controlled, automatic real-time scanner with compound-scan properties (RA 1 - Siemens).

Ultrasonographic Characteristics

Normal sonographic anatomy

In the middle and upper abdomen the inferior vena cava (IVC) and the aorta with its branches and the psoas muscle are the most important retroperitoneal structures to be visualized. On the right parasagittal scan the head of the pancreas lying in front of the IVC must be differentiated from enlarged lymph nodes while lymphoid tissue is sonolucent because of its acoustical homogenous texture. Superficially, lymph nodes often resemble fluid-filled space-occupying lesions, but do not show increased through transmission. In the study of *Hillman* and *Haber* (14) sonolucent masses were observed in 83% of the lymphoma cases and in 53% of patients with soft-tissue tumors. A correlation between sonographic pattern and histologic diagnosis could not be made.

If lucent masses change in form and show moving internal echoes from peristalsis, they represent bowel loops, which can only be differentiated in real-time mode, one of the major advantages of real-time ultrasonography over compound technique.

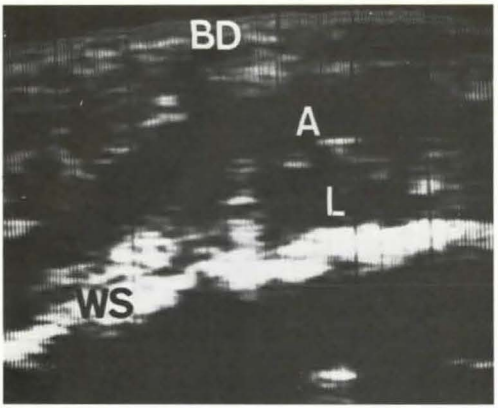

Fig. 2 21-year-old patient with testicular teratoma. Longitudinal scan of the lower lumbar region involved with lymphoma (L). The enlarged lymph nodes separate and elevate the aorta from the spine (WS) ("floating aorta").

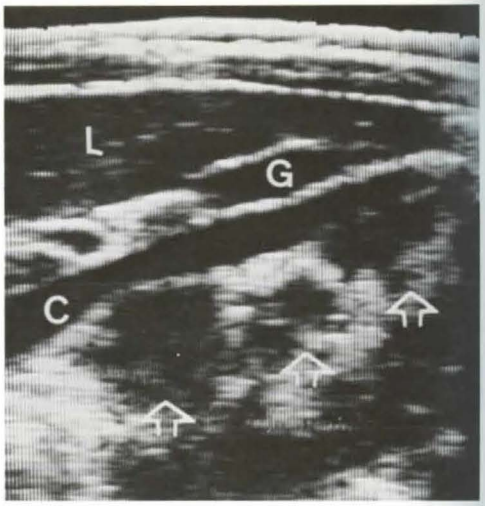

Fig. 3a 23-year-old patient with Hogdkin's disease. Longitudinal scan demonstrates retrocaval lymphoma (white arrows) compressing the inferior vena cava and displacing it anteriorly from the spine

3.2 Pathological Anatomy

Enlarged lymph nodes greater than 2–3 cm in size (3, 21, 22) present as one or more sonolucent masses adjacent to the anterior margin of the aorta and IVC and can appear in certain rather classical manifestations, which include:

- a single, lobulated or confluent mass related to the aorta, IVC, porta hepatis or mesentery, sausage shaped on corresponding parasagittal scans (Fig. 1a/b)
- a preaortic, mantle shaped plate encasing the aorta or IVC, sometimes elevating

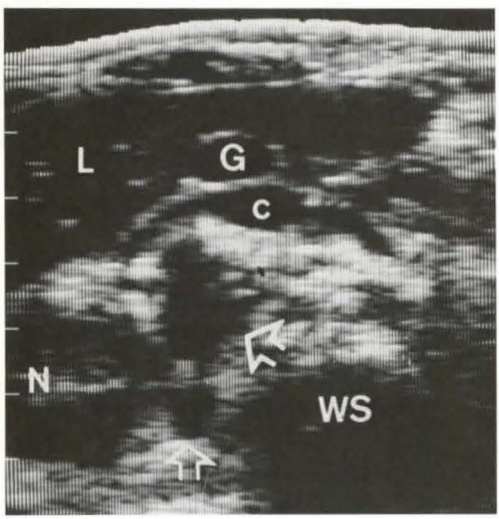

Fig. 3b Transverse scan at the level of the renal veins showing retrocaval lymphoma and enlarged nodes at the hilum of the right kidney (white arrows)

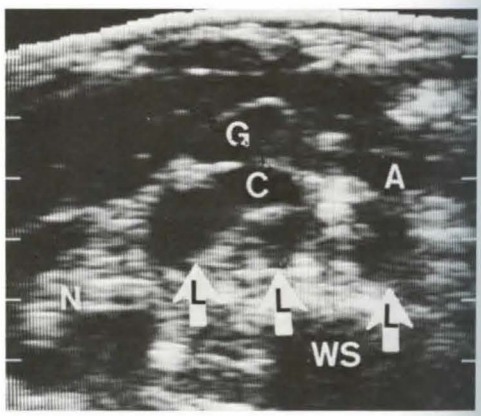

Fig. 3c Transverse scan caudally to the renal hilum demonstrates enlarged lymph nodes (L in white arrows) situated dorsally of the inferior vena cava and aorta

(A = aorta, C = inferior vena cava, G = gallbladder, L = lymphoma, N = kidney, WS = spine)

these structures from the lumbar spine (Fig. 2)
- bilateral, symmetrical, preaortic and precaval masses (dumb-bell appearance) (Fig. 3a/b) and multiple spindle-shaped masses (2, 3, 5, 8, 9, 10, 16, 17, 18, 19).

Nodes that involve the root of the mesentery which is fairly common in patients with malignant lymphoma, will show sonolucent, oval shaped masses with a layered or stratified appearance with plates of echogenic tissue (portions of mesentery) between them, representing lymphoma infiltrating the mesenteric leaves and encasing the superior mesenteric vessels (SMA and SMV) and perivascular fat ("sandwhich sign") (9, 10, 16, 17). The specificity of this "sandwich-sign" (17) in lymphomatous mesenteric adenopathy is unclear, but no instances of metastatic carcinoma have yet been observed to give this appearance.

Sometimes aorta and IVC are difficult to recognize when they are surrounded by enlarged lymph nodes (Fig. 1a, b and 3a). This "echo-silhouette sign" (9, 10) is caused by the similar density of nodal tissue and the elastic wall of the great vessels most frequently seen in young patients and less commonly in elderly where the aortic wall is of harder consistency (16). Occasionally smaller lymph nodes can be identified by the apparently irregular anterior margin they impose on the aorta.

For identification of these lesions, certain additional features are helpful. An enlarged spleen or liver, occasionally revealing coarse parenchymal texture indicating diffuse or nodular infiltration is much more common in malignant lymphoma than in other malignancies (10, 12). Metastatic disease of the liver can be demonstrated as well.

It is usually more difficult to identify lymph node enlargement on the pelvic sidewalls than para-aortic adenopathy. With more experience and improved equipment we are now able to identify lymph nodes larger than 3 cm along the iliac chains anterior to the iliopsoas muscle compartment, but gas in the pelvic colon often prevents adequate evaluation of pelvic lymph nodes.

4. Results

During a 12-month period at the University Hospital of Cologne, 160 patients with malignant lymphoma and malignant tumors were studied by real-time ultrasonography as part of their clinical staging. Of these 160 patients, 129 went on to have CT and/or lymphography and staging laparotomy. These 129 patients comprise the case material for this study (Table 2).

Table 2 Real-time utlrasonography of the lymphatic system.
Results (129 patients with malignant lymphoma and metastatic disease)

correct positive	61/84
correct negative	40/45
false negative	23/45
iliac chains	18
paraaortic nodes	5
false positive	5/45
sensitivity of ultrasonography	72.6%
specificity of ultrasonography	88.8%
overall accuracy of ultrasonography	78.3%

The presence or absence of adenopathy was then determined for each of these anatomic regions: porta hepatis, splenic hilus, retropancreatic, celiac and superior mesenteric, right and left paraaortic, right and left renal pedicles and right and left iliac lymph nodes.

Lymph nodes were interpreted as being involved when we were able to demonstrate echo-free or echo-poor masses in a lymph node group, which could not be accounted for by normal anatomic structures. Also splenic and hepatic size and the echopattern of these organs were evaluated.

The sensitivity of a diagnostic procedure is defined as the percentage of tests read as abnormal in diseased patients, the specificity as the percentage of tests read as normal in patients without disease. For our group the sensitivity of real-time ultrasonography was 72.6% for abdominal involvement, the specificity was 88.8% (Table 2).

The overall accuracy, defined as the sum of all correct positive and correct negative results related to the number of all patients

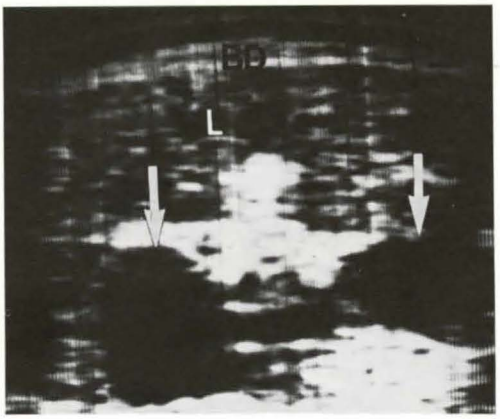

Fig. 4a 35-year-old patient with non-Hodgkin's lymphoma. Transverse scan shows bilateral, symmetrical, echo-poor preaortic and precaval masses obscuring these vessels (white arrow) (dumb-bell appearance). L = liver, BD = abdominal wall

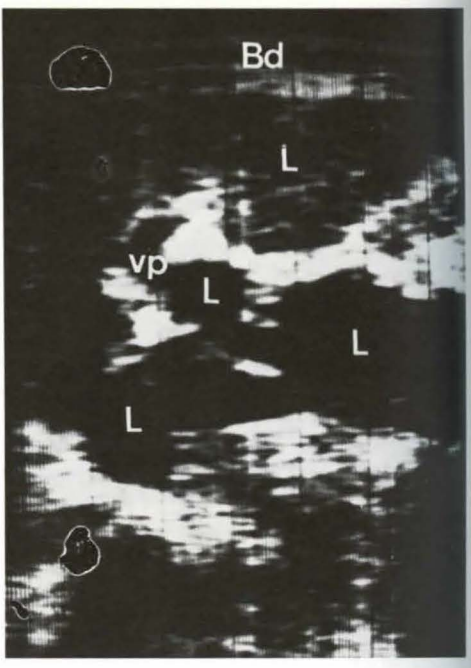

Fig. 4b Same patient with multiple echo-poor masses (L) representing lymphoma in the porta hepatis surrounding the portal vein (vp)

studied, was 78.3%. The sensitivity in cases with enlarged lymph nodes above the pelvis was 91% and the overall accuracy 90.2%.

Evaluation of the spleen revealed only little correlation between splenic involvement and splenic size, furthermore there were no characteristic changes of the echopattern as a result of involvement with lymphoma.

The results of our study demonstrate the ability of real-time ultrasonography to display lymphomatous involvement of many lymph node groups not delineated by lymphography. The demonstration of nodal involvement in these sites merits considerable attention because of revisions in therapy and prognosis which follow.

The main weakness of the method was that in 5 patients involved and enlarged iliac nodes were missed and that 17 patients had tumor growth in lymph nodes of normal size – demonstrated by lymphography – and consequently were not detectable by ultrasonography. phy.

5. *Discussion*

With current instrumentation real-time ultrasonography is of considerable value to those involved in the care of patients with malignant disease searching for neoplastic lymph node involvement. Unfortunately, the appearance of enlarged lymph nodes in ultrasonography is non-specific. Since not every enlarged node contains tumor and controversely all tumor bearing nodes are not enlarged, lymphography is still superior in this regard and may still be required after "normal" ultrasound and CT results (1, 15). Lymphography is able to determine the size of lymph nodes, demonstrates their internal structure, detects tumor growth in lymph nodes of normal size and is able to distinguish the large, but normal reactive lymph node from the larger, tumor containing node (6). Lymphoid hyperplasia and noncaseating granuloma can give false positive ultrasound scans (3).

Contrary to lymphography ultrasonography is capable of showing nodal masses in locations such as the hilus of the liver, in the peripancreatic or retrogastric area or in the mesentery, which are usually not visualized with conventional pedal lymphography (16), but,

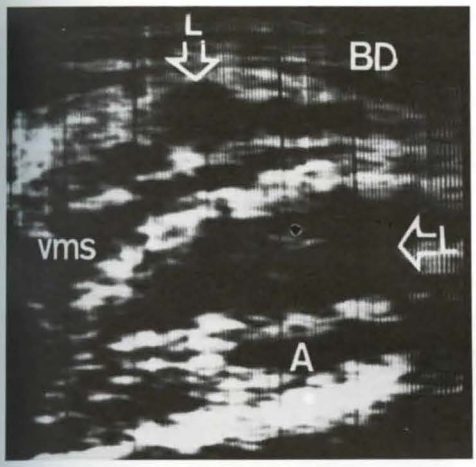

Fig. 5a 30-year-old patient with non-Hodgkin's lymphoma. Longitudinal scan demonstrates large, sonolucent masses (L - white arrows) anterior and posterior to the superior mesenteric vein (vms) surrounding central linear areas of increased echogenicity representing fat in the mesentery ("sandwich-sign"). Behind the masses the aorta (A) is discernible and separate

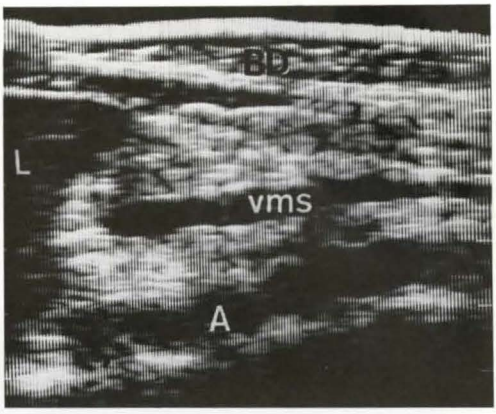

Fig. 5b Same patient 6 weeks later after cytostatic therapy. Lymphoma is no longer demonstrable

importantly, a negative ultrasound examination of these regions does not exclude malignant involvement of lymph nodes there. In addition ultrasonography often reveals more extensive disease than lymphography (7).

The resolution of modern CT scanners is generally superior to ultrasonography (4, 15), but patients with thin or normal body habitus are better evaluated by ultrasonography, because the paucity of retroperitoneal fat makes CT sometimes very difficult to evaluate. However, intestinal gas and obesity are major impediments for ultrasonography, markedly limiting the ability of this imaging technique to demonstrate mesenteric adenopathy unless they are large enough to displace surrounding air-containing bowel loops. This set of circumstances clearly indicates the complementary nature of these two non-invasive imaging modalities. Real-time ultrasonography is a highly operator dependant imaging technique; the quality of images and therefore diagnostic information of an examination is closely related to skill and interest of the operator, while CT requires mainly good interpretation of standard images. Lymphatic cannulation and interpretation of lymphangiograms requires high technical skills and advanced training as well. Ultrasonography is the ideal imaging technique since it is non-invasive and has no known harmful side effects. Both CT and lymphography require radiation, a fact, which seems of minor importance in the evaluation of patients with malignant disease, which will subsequently undergo radiation or cytostatic therapy. Beyond that lymphography is always invasive and carries a small, but definite risk. CT is oftentimes performed with infusion of water-soluble contrast medium with a well-known risk of adverse reactions (6).

7. Conclusion

The evaluation of lymphatic diseases has been remarkedly improved by ultrasonography, which posesses advantages as well as disadvantages. The most apparent disadvantage is, that it only provides information about lymph node size and echographic features whereas lymphography also demonstrates internal lymph node architecture, and, thus, has the potential of displaying abnormalities within normal size lymph nodes.

The obvious advantage of ultrasonography is its ability to demonstrate groups of lymph nodes not opacified by lymphography, and in the same setting the size and internal structure of liver and spleen (1, 15, 18).

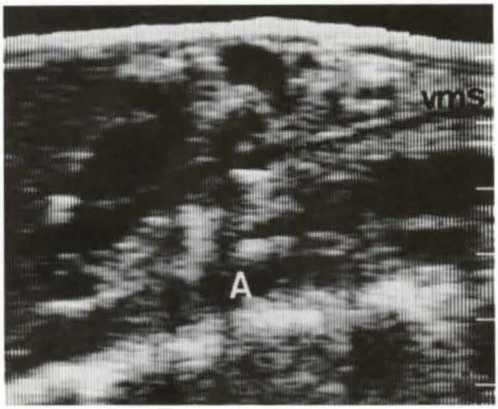

Fig. 6a 20-year-old patient with malignant lymphoma. "Sandwich sign" representing involvement of the mesenteric lymph nodes.
(vms = superior mesenteric vein, A = aorta)

Though the interpretation of CT is more reproducible, its resolution is better and there are no limitations by gas-filled bowel, the relative accuracy of ultrasonography indicates, that a patient with suspected lymphadenopathy should have initial evaluation with the quicker and cheaper technique of real-time ultrasonography as a *baseline study*, especially as liver and spleen can be evaluated simultaneously.

If ultrasonography reveals negative findings one should proceed to CT, because our results show still a significant number of false negative reports, especially in the pelvis. If CT is normal, too, and there is still a high level of clinical suspicion of disease, lymphography should be carried out.

If the ultrasonographic study is definitely abnormal in most instances no further investigation is necessary. In small or equivocal lesions the patient should have CT and both examinations should be interpreted by the same radiologist. If the tests are in agreement, it is likely that this reflexts the true pathological state and obliviates the need for pedal lymphography.

Contradictory findings of both techniques indicate an equivocal result and lymphography must be considered.

Fig. 6b Lymphadenogram 48 hrs. after pedal lymphography reveals enlarged lymph nodes with grossly disturbed storage pattern, more marked on the right than on the left side. There is remaining contrast medium in the lymph vessels indicating blockage of the lymphatic pathway at the level of L2-3. No lymphographic visualization of the sonographically demonstrated involvement of the mesenteric and retropancreatic lymph nodes.

Follow-up studies in patients with known disease under therapy should be obtained by ultrasonography non-invasively and at reasonable costs. Evaluation to substantiate eradication of metastatic nodes as well as prior to node dissection should be done with both modalities (ultrasonography and CT).

The routine use of lymphography is unnecessary in this patient population (5), but it seems unlikely that ultrasonography and CT will be able to replace lymphography totally, so that lymphography has not overlived its usefulness in the diagnostic work-up in lymphatic diseases. It is extended not replaced by ultrasonography.

By individualizing each case, the radiologist is able to select a proper examination sequence of ultrasonography, computed tomography and lymphography to provide a maximum of diagnostic accuracy and reliability at a minimum of radiation exposure, cost and annoyance to the patient.

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