Clinical Ultrasound in Neoplastic Disease
—Echography for Tumor Diagnosis—

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Abstract: Ultrasonic echography has been recently highlighted for the clinical diagnosis of malignant neoplasm and other benign tumors because it is a noninvasive method and has no physical hazard as is the case with the radiological technique. It is a useful technique because it will offer considerable diagnostic information on the visualization of soft tissue pathology. Such information was rather difficult to obtain by the radiological method, and especially difficult was the visualization of malignant or benign tumors of soft tissue origin. Currently used techniques for ultrasonic echography are classified as compound contact scanning, arc-scanning through water-immersion, radial scanning (PPI), and recently developed high-speed real time electronic linear or sector scanning. These techniques can be applied to the clinical diagnosis of brain tumors, tumors of the orbit and eye, ENT tumors, thyroid tumors, abdominal tumors including pelvic tumors, breast tumors, urogenital tumors or soft tissue tumors of the extremities. Clinical usefulness of echography by the sensitivity graded method for breast cancer and gray scale image was highly appraised because of its diagnostic accuracy rates: T1 81%, T2 93%, and T3 100% according to the tumor size of TNM classification, and 97% for scirrhou cancer, 87% for medullary carcinoma, and 78% for papillary carcinoma. These rates may be considered to be better than those achieved by mammography. For echographic diagnosis of abdominal tumors, the technique can be used for neoplastic lesions in soft tissue organs such as the liver, gallbladder, pancreas, spleen, kidney, uterus, ovary and retroperitoneal space. It is especially useful in determining whether such lesions are cystic or a solid mass, for visualization of the tumor mass in anatomical relation to various intraabdominal organs, the preoperative determination of the tumor size, and it may also offer some important diagnostic information on whether the mass is malignant or benign in some instances. Those diagnostic information can be also obtained for the soft tissue tumors in the extremities. The technique may be a useful clinical auxiliary aid for differential diagnosis of neoplastic lesions, especially cancer detection in various organs. Therefore, this review focused on the viewpoint of cancer and medical ultrasonics, especially the current status of clinical echography in demonstrating the typical echograms of various neoplasms.

Key words: ultrasonography, benign tumor, malignant tumor.

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tical hazard as in the case of radiological techniques, and which has a high diagnostic accuracy rate. Because of these clinical benefits, many clinicians are entering various fields of organ diagnosis of soft tissue structures for noncancer patients and for cancer patients as the one of clinical modalities for the total body imaging systems recently blooming. Furthermore, its significant technical progress for refining the image quality and the ease of its clinical application has been widely accepted by many clinicians for the past ten years, in spite of its short history background as compared with radiological techniques.

Ultrasonic examination for neoplastic disease has wide clinical applications for many organs such as the brain, eyes, thyroid gland, parotid gland, parathyroid gland, mammary gland, overall abdominal region, gynecological organs, urinary tract, including the prostate and seminal vesicle, and other soft tissue in the extremities and trunk (Kobayashi & Kimura, 1975) (Table 1).

The diseases which can be diagnosed by ultrasonic examination include brain tumor, tumors of the eye ball and orbit, tumors of the parotid, thyroid, and parathyroid glands, tumor of the neck, breast cancer and benign tumors, primary or secondary liver tumors, of the gallbladder and biliary trees, pancreatic tumor, splenic, renal and adrenal tumors, aortic aneurysm, retroperitoneal tumor, tumors of the uterus and ovary, abdominal tumor of undetermined origin, tumors of the prostate and urinary bladder, and ascites. The organs related to these diseases have in common a soft tissue structure. Those organs containing air, such as the lungs, trachea, and part of the digestive tract, are difficult to be diagnosed by currently available ultrasonic apparatus.

It is a widely accepted fact that those diseases or tumors that are most easily

| Table 1. Organ and diseases to which ultrasonic tumor diagnosis is applicable |
|-----------------|-----------------|-----------------|
| **Organ**       | **Noncancerous** | **Cancerous**   |
|                 | **disease**     | **disease**     |
| Liver           | Cirrhosis; hepatic cyst | Hepatic cancer (primary or secondary) |
| Gallbladder     | Cholelithiasis; cholecystitis | Cancer of the gallbladder |
| Bile duct      | Stone; dilatation of common bile duct | Bile duct cancer |
| Pancreas        | Pancreatitis; pancreatic cyst | Pancreatic cancer |
| Spleen          | Splenic tumor; splenic cyst | Splenic tumor (hemopathy) |
| Kidney          | Renal cyst | Renal tumor; Wilms’ tumor |
| Suprarenal gland| Adrenal tumor (benign) | Adrenal tumor |
| Aorta           | Abdominal aortic aneurysm | — |
| Retroperitoneum | Retroperitoneal cyst | Metastasis of cancer; malignant lymphoma |
| Uterus          | Measurement of uterus fetus, placenta, embryo head; hydatidiform mole; uterine myoma | Malignant tumor of uterus |
| Ovary           | Ovarian cyst | Ovarian cancer |
| Abdominal wall  | Hematoma; cyst | Abdominal tumor (malignant) |
| Abdominal cavity| Hematoma; cyst | Ascites |
diagnosed by the ultrasonic pulse echo method are cysts and solid mass tumors. However, it is difficult to determine whether solid mass tumors, except breast carcinoma, are malignant or benign using the findings from ultrasonotomographic images alone.

The historical background of ultrasonic echography is reviewed in Table 2.

The Curie brothers (1880) first discovered the piezoelectrical effect, then Chilowsky & Langevin (1916) used this principle for detecting enemy submarines during World War I. A few years later this echo technique was introduced into industry by Sokolow (1937) to detect flaws in metals. Dussik (1942) first introduced this technique into clinical medicine in 1942, using it especially to detect brain tumors. Since this decade, research investigations on the echo technique were actively carried out throughout the world, especially in the United States (Holmes et al., 1955; Howry & Bliss, 1952), England (Donald, 1958, 1969, 1974), and Japan (Kikuchi et al., 1957). As for ultrasonic diagnosis in neoplastic disease, Wild (1950) and Howry & Bliss (1952) described its application to the diagnosis of breast cancer, and later Holmes et al. (1955) introduced the compound scanning technique in a water tank for the investigation of liver, kidney, spleen and urinary bladder pathologies. Donald et al. (1958) also introduced the contact scanning technique in the field of OB-GYN as more applicable for routine use. In Japan, Kikuchi (1975) independently introduced the water-coupling technique for the sensitivity graded tomography in the diagnosis of breast cancer.

Kossoff et al. (1968) introduced gray-scale echography which can be used in many fields of clinical oncology in refined image quality. Since this introduction, many clinicians suddenly began to use this technique. As a result, many papers have been published as to diagnostic criteria, accuracy rate, and amendment in technique for obtaining good image quality, for many important organs such as the breast (Kobayashi et al.,

<table>
<thead>
<tr>
<th>Year</th>
<th>Investigator</th>
<th>Contribution</th>
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</thead>
<tbody>
<tr>
<td>1880</td>
<td>Curie brothers</td>
<td>Introduction of ultrasound by piezoelectrical effect</td>
</tr>
<tr>
<td>1916</td>
<td>Langevin</td>
<td>Ultrasound to detect enemy submarine during World War I</td>
</tr>
<tr>
<td>1937</td>
<td>Sokolov</td>
<td>Discovery of ultrasound flaw detector</td>
</tr>
<tr>
<td>1942</td>
<td>Dussik</td>
<td>Introduction of ultrasonic technique into medicine, detection of brain tumor</td>
</tr>
<tr>
<td>1949</td>
<td>Ludwig</td>
<td>Introduction of pulse-echo technique for the detection of gallstone and other foreign bodies</td>
</tr>
<tr>
<td>1950</td>
<td>Wild</td>
<td>Diagnosis of brain and breast tumors (A scope and B scope)</td>
</tr>
<tr>
<td>1950</td>
<td>Howry</td>
<td>Ultrasonic diagnosis of soft tissue pathology</td>
</tr>
<tr>
<td>1954</td>
<td>Holmes</td>
<td>Introduction of compound scanning technique in water-tank (Liver, kidney, spleen and urinary bladder, etc.)</td>
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<tr>
<td>1957</td>
<td>Donald</td>
<td>Introduction of contact scanning technique in the field of OB-GYN</td>
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<tr>
<td>1957</td>
<td>Kikuchi &amp; Wagai</td>
<td>Introduction of water-coupling technique and sensitivity graded tomography</td>
</tr>
<tr>
<td>1972</td>
<td>Kossoff</td>
<td>Introduction of gray-scale echography</td>
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</table>

The ultrasonic diagnostic technique is very advantageous as compared with other diagnostic methods and has recently been attracting great attention in the field of tumor diagnosis. It allows for a noninvasive examination and since no syringing is necessary, there is no pain for the patient. There is no exposure to x-rays, thus there is no anxiety about the effect of the x-ray on the patient. Further, the ultrasonic diagnostic apparatus is easy to operate, and a short period of time is required for examination. Use of Polaroid camera with an ultrasonotomograph allows for an instant diagnosis. Diagnostic information which is difficult to obtain with roentgenography is simply to obtain with the ultrasonic technique without the need of any contrast medium (Table 3).

Tumor diagnostic information that can be read from the echogram (ultrasonotomographic image) is listed in Table 4 (Kobayashi, 1977).

Considerably improved ultrasonotomographic apparatus are currently available. These

<table>
<thead>
<tr>
<th>Table 3. Advantages of ultrasonic diagnosis</th>
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<tr>
<td>(1) Noninvasive examination</td>
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<td>(2) No pain for the patient</td>
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<td>(3) No radiation hazard as is the case with roentgenography</td>
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<td>(4) No lengthy examination time</td>
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<td>(5) Instant diagnosis</td>
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<td>(6) Repeated image recording</td>
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<tr>
<td>(7) Can obtain information that cannot be obtained by roentgenography (image of disease in soft tissue structures)</td>
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<td>(8) Can determine regression effect of antineoplastic treatment (chemical, radiation or surgical treatment)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4. Diagnostic information available from ultrasonotographic image</th>
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<tbody>
<tr>
<td>(1) Information for determining the organ where tumor or other disease exists</td>
</tr>
<tr>
<td>(2) Information for determining the position of tumor or disease in relation to surrounding organs</td>
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<tr>
<td>(3) Information for determining the size and spread of tumor or disease</td>
</tr>
<tr>
<td>(4) Information for determining whether it is a cyst or solid mass tumor</td>
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<tr>
<td>(5) Information for determining the tumor regression effect</td>
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</tbody>
</table>
updated apparatus offer the gray-scale ultrasonotomographic images that may compete with x-ray and CT images. The high performance real time ultrasonotomograph in which many transducer elements are arranged in array for electronic scanning has already been introduced and is being used effectively in the field of clinical diagnosis.

Currently, two ultrasonotomographic methods are used for the diagnosis of tumors. One is the manual contact scanning method in which the transducer is moved across the surface of the patient's body by hand. The other is the water-immersed scanning method in which the transducer is mechanically moved in a water bath placed on the patient's body surface as shown in Fig. 1 (Kobayashi, 1978).

The water-immersed scanning method is used for diagnosing tumors of the breast, the parathyroid, parotid, and thyroid glands and in the soft part of the limbs for orthopedic surgery (Kobayashi, 1978). The manual contact scanning method is employed mainly for diagnosing abdominal tumors in general and tumors in the female reproductive organs.

The ultrasonic tumor diagnoses of individual organs are described below:

1. **Breast Cancer**

Echogram is effective for the diagnosis of determining whether a breast tumor is malignant or benign. Since echography is a noninvasive, safe method with no exposure to x-rays, it is now attracting attention as a method for a mass screening examination to detect early breast cancer. Its diagnostic criteria are shown in Fig. 2.

The diseases which can be differentiated by this criteria include among others, breast carcinoma, fibroadenoma, benign cyst, chronic mastitis, and cystosarcoma phylloides. The echographic diagnosis for breast cancer is based on three criteria, the irregularity in shape of boundary echo, inhomogeneity of internal echoes and acoustic shadowing of posterior echo (Kobayashi, 1977).
The smallest early breast carcinoma which is identifiable by the ultrasonic examination is about 0.5 cm in size. The diagnostic accuracy rate is as high as 75% for tumors of less than 2.0 cm in size (T 1 by TNM classification by the UICC; International Union Against Cancer), 85% for those of 2.0 to 5.0 cm (T 2), and 92% for those larger than

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**Table 5.** Comparison of successful diagnosis percentage between echograph and mammography

(According to tumor size)

<table>
<thead>
<tr>
<th>TNM</th>
<th>Ultrasound</th>
<th>%</th>
<th>X-ray</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>T 1</td>
<td>31/40</td>
<td>78</td>
<td>28/37</td>
<td>76</td>
</tr>
<tr>
<td>T 2</td>
<td>52/58</td>
<td>90</td>
<td>49/56</td>
<td>88</td>
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<tr>
<td>T 3</td>
<td>13/14</td>
<td>93</td>
<td>12/14</td>
<td>86</td>
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<tr>
<td>Total</td>
<td>112 cases</td>
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<td>107 cases</td>
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</tbody>
</table>

(According to histological type)

<table>
<thead>
<tr>
<th>Histological type</th>
<th>Ultrasound</th>
<th>%</th>
<th>X-ray</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scirrhous carcinoma</td>
<td>32/35</td>
<td>91</td>
<td>30/33</td>
<td>91</td>
</tr>
<tr>
<td>Medullary carcinoma</td>
<td>33/42</td>
<td>79</td>
<td>26/40</td>
<td>65</td>
</tr>
<tr>
<td>Papillary carcinoma</td>
<td>26/31</td>
<td>84</td>
<td>25/32</td>
<td>78</td>
</tr>
<tr>
<td>Total</td>
<td>108 cases</td>
<td></td>
<td>105 cases</td>
<td></td>
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</tbody>
</table>

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5.0 cm (T3), as shown in Table 5 (Kobayashi & Kimura, 1975).

By introducing magnified echography (see Fig. 3) and various other techniques, efforts are being made to improve the diagnostic accuracy rate for breast cancer of less than 1.0 cm in size.

The echograms of typical breast cancer, fibroadenoma and benign cyst due to gray-scale ultrasonotomography are shown in Figs. 4, 5 and 6 respectively.

2. Thyroid Tumor

The gray-scale echographic image taken by using a logarithmic amplifier is sharp and clear, offers a wide variety of diagnostic information, and is useful for the differential diagnosis of thyroid tumor (Fig. 7). It is especially high in diagnostic quality for differentiation of cysts and solid mass tumors. Since both breast and thyroid tumors are near the body surface, their diagnostic accuracy rates have been reported to be higher than those of tumors in deeply situated organs or structures (Figs. 8 and 9). Figs. 10 and 11 show typical echograms of thyroid cyst and cancer (Kobayashi et al, 1976).

3. Hepatic Tumor

For ultrasonic diagnoses of abdominal organs, especially regarding the solid mass and parenchymatous tumors derived from the soft tissue structures, the manual contact scanning method and electronic sector (Fig. 12) or linear scanning (Fig. 13) method are used. Quality images and successful diagnostic results have been reported by many clinicians using this method.

As for hepatic and biliary tree diseases, it is reasonable to consider that the smallest

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Fig. 3. Magnifying ultrasonography for improvement in detection of early breast cancer. Magnified echogram at bottom right offers more detailed diagnostic information. (Kobayashi, 1977)
tumor in hepatic cancer that can be detected using the echographic apparatus currently available is 2.0 to 3.0 cm in diameter. Typical echograms of the normal liver, hepatic cyst, solitary hepatic tumor and multiple hepatic metastases are shown in Figs. 14 to 17.

By using the electronic scanning methods, clear depiction of the liver to include the hepatic luminal structure is possible. In addition, cholelithiasis, chlodocholith and dilatation of common bile duct and intrahepatic bile ducts can be simply depicted (Figs. 18 to 25).

Fig. 4. Echograms of benign cyst.
Top: Normal gray scale sectional image
Bottom: Magnified gray scale sectional image

Fig. 5. Echograms of fibroadenoma.

Fig. 6. Echograms of early breast cancer.
Top: By arc scanning
Bottom: Linear scanning

Fig. 7. Actual view of thyroid scanning using water-immersion technique.
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Fig. 8. Echogram of normal thyroid gland and its adjacent structures.

Fig. 9. Echogram (zooming) of normal thyroid gland.
LL: Left lobe  RL: Right lobe  A: Carotid artery  TR: Anterior wall of trachea
Fig. 10. Echogram of small thyroid cyst. A small cyst is visualized in the upper portion of the right carotid artery. (Bottom: Magnified echogram)

Fig. 11. Giant thyroid cancer. A huge carcinoma in the right lobe, forcing the trachea out to the left; the right carotid artery is not clearly visualized because the ultrasound beam is attenuated through the cancerous tissue.

Fig. 12. Electronic sector scanning transducer. Many small transducer elements are arranged in array for electronic scanning.

Fig. 13. Electronic linear scanning transducer.
Fig. 14. Echograms of the normal liver and its luminal structures, Gray scale echograms by contact compound scanning technique.

Fig. 15. Multiple cysts in the liver.

Fig. 16. Solitary metastatic lesion in the liver.

Fig. 17. Multiple metastatic lesions in the liver.
Top: Transverse sectional image
Bottom: Longitudinal sectional image
A: Aorta
IVC: Inferior vena cava
DS: Duodenal shadow
M: Metastatic lesions
VB: Vertebra
Fig. 18. Normal liver and hepatic luminal structure by electronic linear scanning. Hepatic vessels and diaphragm.

Fig. 19. Normal gallbladder by electronic linear scanning.

Fig. 20. Normal gallbladder (various echograms recorded in different scanning directions by electronic sector scanning).
Thus the ultrasonic examination is highly evaluated as the first-choice method for hepatic and bile-duct diseases.

4. *Pancreatic Tumor*

Of abdominal tumors, pancreatic cancer and pseudocyst are quite difficult to correctly diagnose using various auxiliary tests. For these tumors, good diagnostic results are obtainable by clearly depicting the surrounding blood vessels and luminal structures. An echogram of the normal pancreas and the ultrasonotomographic images clearly depicting the superior mesenteric artery and other adjacent parts of the pancreas are shown in Figs. 26 to 30 (Pancreas).

5. *Ultrasonographically Guided Biopsy Puncture*

It is now possible for a transcutaneous pancreatic biopsy to be applied under ultrasonic image guide by means of biopsy needle as fine as 0.6 mm, using a transducer with which the biopsy needle can be inserted in the center of the probe. This biopsy is being applied to many other important organs as listed in Table 6 (Kobayashi, 1976).
6. *Renal Tumor*

The ultrasonic apparatus is also used widely for examining renal tumors and related diseases, as shown in Table 7.

By applying scanning from the back of the patient who is in a prone position, the renal parenchym, pelvis of the kidney, inside of the kidney and tumor-diseased regions can be clearly depicted as, shown in Figs. 31 to 32.

7. *Malignant Lymphoma and Retroperitoneal Tumor*

The ultrasonic examination is excellent for detecting primary and metastatic tumors derived from the retroperitoneal lymphatic tissue. Typical echograms of two postoper
Ultrasound in Tumor Diagnosis

Fig. 25. Dilatation of common bile duct and intrahepatic bile ducts.
CBD: Dilated common bile duct  IVC: Inferior vena cava
PV: Portal vein  L: Liver parenchym

Fig. 26. Echogram of normal pancreas. Top: Transverse sectional image
Bottom: Longitudinal sectional image  PA: Pancreas  A: Aorta  IVC: Inferior vena cava
SMA: Superior mesenteric artery  SMV: Superior mesenteric vein  VB: Vertebral body
Fig. 27. Superior mesenteric artery.
SMA: Superior mesenteric artery
A: Aorta  L: Liver parenchym
ILL: Interlobar ligament
IVC: Inferior vena cava
P: Pancreas  RK: Right kidney
VB: Vertebral body

Fig. 28. Superior mesenteric artery
(Longitudinal sectional image).

Fig. 29. Cancer in the head of pancreas (Transverse sectional image).
M: Tumor mass  A: Aorta
IVC: Inferior vena cava
VB: Vertebral body
Ultrasound in Tumor Diagnosis

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Year published</th>
<th>Researcher</th>
<th>Organs and diseases</th>
<th>Ultrasonic apparatus Frequency</th>
<th>Scope</th>
<th>Probe characteristics and clinical information</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1961</td>
<td>Berlyne</td>
<td>Renal biopsy (20 cases) (6 uremia cases)</td>
<td>2 MHz</td>
<td>A</td>
<td>Industrial ultrasonic reflectoscope; cadaver used; time-distance relation setting; first applied to biopsy</td>
</tr>
<tr>
<td>2</td>
<td>1967</td>
<td>Joyner et al.</td>
<td>Thoracocentesis</td>
<td>2 MHz</td>
<td>A, M</td>
<td>Drainage of hydrothorax pocketed and difficult to drain by ordinary thoracocentesis</td>
</tr>
<tr>
<td>3</td>
<td>1972</td>
<td>Holm et al.</td>
<td>Development of biopsy probe; objective organs discussed in 1973 publication (Item 10)</td>
<td>2 MHz</td>
<td>A, B</td>
<td>Biopsy transducer developed for first time. Investigation of probe resolution and accuracy; probe focal distance set to 10 cm; relation between exploring needle and sound flux; relation between exploring position and needle (investigation of axis deviation); investigation of needle deflection; center aperture, 25 mm; probe diameter, 20 mm</td>
</tr>
<tr>
<td>4</td>
<td>1972</td>
<td>Rasmussen et al.</td>
<td>13 cases of hepatic metastasis</td>
<td>2 MHz</td>
<td>A, B</td>
<td>Biopsy of 13 hepatic metastasis focus cases; comparative investigation with Menghini method (blank); effective sampling percentage (Menghini method, 23%; ultrasonic biopsy, 85%)</td>
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<tr>
<td>5</td>
<td>1972</td>
<td>Bang et al.</td>
<td>Amniotic cavity puncture</td>
<td>2 MHz</td>
<td>A, B</td>
<td>Amniotic cavity puncture, 64/68 cases; no complication due to ultrasonic guide</td>
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<td>6</td>
<td>1972</td>
<td>Goldberg et al.</td>
<td>Kidney, hydrothorax and hydroperitoneum</td>
<td>2.25 MHz</td>
<td>B, M</td>
<td>Development of biopsy transducer; probe diameter, 1/2 inch; needle-passing center aperture, 1/8 inch</td>
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<tr>
<td>7</td>
<td>1972</td>
<td>Bahlmann et al.</td>
<td>50 nephropathy cases; biopsy applied to 64 cases</td>
<td>2 MHz</td>
<td>A, B</td>
<td>Biopsy effective sampling percentage, 97% (62/64 cases)</td>
</tr>
<tr>
<td>8</td>
<td>1972</td>
<td>Kristensen et al.</td>
<td>78 nephropathy cases</td>
<td>2 MHz</td>
<td>A, B</td>
<td>Biopsy effective sampling percentage, 96%; renal cancer, 82%; renal cyst drainage, 90%</td>
</tr>
<tr>
<td>No.</td>
<td>Year</td>
<td>Authors</td>
<td>Description</td>
<td>Technique</td>
<td>Remarks</td>
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<td>9</td>
<td>1972</td>
<td>Bartels et al.</td>
<td>473 nephropathy cases; biopsy applied to 609 cases</td>
<td>2 MHz</td>
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<td></td>
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<td>Investigation of biopsy effective sampling percentage (blank; for x guide and ultrasonic guide separately)</td>
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<td>10</td>
<td>1973</td>
<td>Holm et al.</td>
<td>Pericardial effusion hydrothorax, thyroid gland, liver, kidney, intra-abdominal abscess, tumor in abdominal cavity, hematoma, urinary bladder and amniotic cavity</td>
<td>2 MHz</td>
<td>A, B</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Check of clinical usefulness by applications to various diseases</td>
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<tr>
<td>11</td>
<td>1973</td>
<td>Pedersen et al.</td>
<td>Renal carbuncle</td>
<td>2 MHz</td>
<td>A, B</td>
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<td></td>
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<td></td>
<td>Renal carbuncle puncture; drainage; local injection of antibiotics</td>
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<tr>
<td>12</td>
<td>1973</td>
<td>Gammelgaard et al.</td>
<td>49 renal bioptic cases</td>
<td>2 MHz</td>
<td>A, B</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Biopit effective sampling percentage; renal cancer (43/49); 61 cyst drainage cases</td>
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<tr>
<td>13</td>
<td>1973</td>
<td>Goldberg et al.</td>
<td>16 renal cyst cases</td>
<td>2.25 MHz 2 MHz</td>
<td>A, B</td>
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<tr>
<td></td>
<td></td>
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<td>Cyst drainage; cyst size, 3 to 10 cm</td>
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<tr>
<td>14</td>
<td>1974</td>
<td>Pedersen</td>
<td>Uremia and pyelectasia</td>
<td>2 MHz</td>
<td>A, B</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Cannulization into pelvis of kidney expanded by ultrasonic guide; simplification of transcutaneous nephrotomy</td>
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<tr>
<td>15</td>
<td>1974</td>
<td>Burchart et al.</td>
<td>32 cases of hepatic portal vein imaging</td>
<td>2 MHz</td>
<td>A, B</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Method of transcutaneous and transhepatic portal vein imaging by means of ultrasonic guide, 31/32 cases successful</td>
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<td>16</td>
<td>1974</td>
<td>Yokoi et al.</td>
<td>Breast tumor, thyroid tumor, hydrocele and transcutaneous bile-duct imaging</td>
<td>2.25 MHz 2 MHz</td>
<td>A, B</td>
<td></td>
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<td></td>
<td></td>
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<td>Biopsy applied for first time in Japan</td>
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<td>17</td>
<td>1975</td>
<td>Hancke et al.</td>
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<td>Transcutaneous pancreatic biopsy and pancreatic cyst drainage (Follow-up of Hancke method)</td>
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Fig. 31. Echogram of the normal kidney. Prone transverse sectional image.

Fig. 32. Echogram of renal cyst (C). VB: Vertbral body

Fig. 33. Recurrence of postoperative gastric cancer.
Left: Echogram taken manually contact scanning method
Right: Echogram taken by electronic linear scanning method
A: Aorta
M: Mass of conglomerated metastatic lymph nodes
H: Direction of head
F: Direction of foot

Fig. 34. Recurrence of postoperative colon cancer (Retroperitoneal lymph node metastases). Transverse sectional image in the right decubitus position (Top). Transverse sectional image in supine position (Bottom).
M: Metastasis tumor (Wrapping SMA in center)
SMA: Superior mesenteric artery
SMV: Superior mesenteric vein
A: Aorta
RK: Right kidney
LK: Left kidney
VB: Vertebal body
Table 7. Ultrasonic diagnoses of nephropathy

(1) Renal tumors
(2) Infantile nephroma (Wilms' tumor, etc.)
(3) Renal cyst (cyst-single or polycystic)
(4) Hydronephrosis
(5) Adrenal tumor
(6) Determination of renal volume
(7) Perinephritic hematoma
(8) Perinephritic tumor
(9) Renal cyst fluid drainage by means of ultrasonic guide
(10) Renal biopsy by means of ultrasonic guide
(11) Follow-up (rejection, lymphocele) after renal transplantation
(12) Nonfunctioning kidney (nonexcretory)
(13) Diagnosis and therapy of renal carbuncle (drainage)
(14) Judgment of tumor regression effect no renal tumor
(15) Congenital renal abnormality (Horse-shoe kidney, etc.)

ative cases of tumors formed by retroperitoneal lymphatic tissue metastases with scirrhoustype gastric cancer and colon cancer are shown in Figs. 33 and 34.

The ultrasonotomographic images are also very helpful for diagnosing the retroperitoneal involvement of malignant lymphoma. It is considered that ultrasonotomography should precede lymphangiography and isotope scanning. In cases where a tumor has been found, ultrasonotomography can also be used before and after chemotherapy or radiation therapy to judge its tumor regression effect (Fig. 35).

8. Gynecological Tumor
In the field of gynecology, the ultrasonic technique is effectively utilized for diagnoses of uterine cancer, ovarian cancer, uterine myoma, ovarian cyst and other tumors (Fig. 36).

Fig. 35. Application of echography before and after chemotherapy in Hodgkins disease to observe tumor regression effect.
Left: Before chemotherapy (control).
Middle: After two chemotherapy treatments
Right: After three chemotherapy treatments
Fig. 36. Uterine myoma.
Left: Longitudinal sectional image  Right: Transverse sectional image
M: Myoma  UB: Dilated urinary bladder  UT: Uterus  CX: Uterine cervix

Fig. 37. Ganglion.
Left: Transverse sectional image  Right: Longitudinal sectional image

Fig. 38. Rhabdomyosarcoma Longitudinal sectional image.
9. Other Tumors

With regard to urinary tract diseases, the ultrasonic examination is used for diagnosing renal tumors, prostatic cancer and cancer in the seminal vesicle. In particular the transrectal ultrasonic examination developed in Japan is highly evaluated as be useful for detecting prostatic cancer.

The ultrasonic examination is also employed for examining orthopedic tumors, such as those of the limbs and trunk. Preoperative information which can be obtained includes whether it is a cystic or parenchymal massive tumor, what the positon of the tumor is in reference to bones, peristomeum, and tendon, whether the tumor is encapsulated or infiltrative into the subcutaneous tissue, what is the size of the tumor, how widespread it is (Figs. 37 to 39).

![Fig. 39. Synovial sarcoma.](image)

Left: Transverse sectional image    Right: Longitudinal sectional image

10. Present and Future of Ultrasonic Tumor Diagnosis

Basic and clinical research on ultrasonic tissue characterization for cancer are being actively carried out throughout the world, as summarized in Fig. 40. Accumulation of these data such as ultrasonic velocity measurement, attenuation measurement and reflection coefficient of various cancerous tissues can further contribute to the improvement and refinement of echographic apparatus in cancer diagnosis.

Reference


Ultrasound in Tumor Diagnosis

Wild, J.J. (1950): The use of ultrasonic pulses for the measurement of biologic tissue and the detec-
Ultrasound in Tumor Diagnosis


臨床腫瘍の超音波診断

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要 旨：悪性新生物および各種の良性腫瘍の臨床診断には種々の検査法が施行されているが、近年、レ線診断と異なり生体に何らの傷害も及ぼす懸念のない非観血的手段である超音波診断法が開拓をあびている。比較的歴史の新しい本検査法はレ線検査で把握することが困難とされている生体各部の被験組織病変の描写にその診断情報取得の威力を発揮し得るため病疾患、良性腫瘍の診断にその有用性が認められつつある。検査対象として眼科領域腫瘍、耳鼻科領域腫瘍、甲状腺腫瘍、乳腺腫瘍、腹部腫瘍、婦人科腫瘍、前立腺および膀胱腫瘍、整形外科領域の軟部腫瘍など多岐にわたる。
本検査法は観血的、非侵襲的、かつレ線被曝の危険性もないため癌疾患の補助的診断法として有用である。腫瘍疾患の超音波診断という立場のもとに現行の臨床超音波診断、特に癌疾患の超音波断層像を中心に概説した。

産業医大誌，1（2）：167-193（1979）