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# Palpability of Breast Tumors
## —Correlation with Ultrasonic Findings—

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**With the recent development of high-resolution real-time ultrasonic devices and their application to clinical examination and breast screening, small non-palpable breast lesions have frequently been detected and controversy has arisen concerning their diagnosis and treatment. In order to evaluate the relationship between ultrasonic B-mode images and palpability of breast tumors, 71 breast tumors including 21 cancers were analyzed. Five basic measurements on tumor size and location were performed followed by calculation of secondary parameters of palpability. Larger size (D and W), less distance from the skin surface (S-T), less embeddedness within or more protrusion from the mammary gland (G-T) and greater relative size of tumor with respect to whole breast thickness (D/(S-P)) were found to be significantly related to greater palpability of breast tumors. Among the qualitative diagnostic criteria for breast tumors, an irregular shape, rough border, thick boundary echoes, heterogeneous internal echoes and indirect signs were statistically more frequent in palpable than non-palpable tumors, and in malignant than in benign tumors. In cases of cancer, palpability was related significantly only to size and to heterogeneous internal echoes. For early detection of breast cancer, identification of breast cancer among small non-palpable breast lesions less than 1 cm in size in ultrasonic B-mode images is considered to be essential.**

**Key words : Palpability, Breast tumor, Ultrasonic diagnosis, Image analysis**

## INTRODUCTION

High-resolution hand-held real-time ultrasonic scanners have made it possible to visualize many small solid or cystic breast masses which may be impalpable [2, 3, 4, 5]. In our recent experience at Tokai University Hospital, more than 80 % of cysts, nearly 80 % of intraductal lesions, more than half of fibroadenoma-like lesions and about 20 % of cancers were non-palpable.

The larger the size of breast tumor, the more easily it will be palpated. Which additional factors influence the palpability of breast tumors? These factors were studied mainly by quantitative analysis of ultrasound images of breast tumors.

## METHODS AND MATERIALS

### Palpability of Breast Tumors

A breast tumor detected in ultrasonic examination was judged to be palpable if the mass had already been pointed out by palpation at the corresponding site of the breast when the patient was first seen in an outpatient clinic. If it could be palpated by repeated careful palpation in the ultrasound laboratory after its detection in an ultrasonic examination, it was considered palpable even if it had not been discovered clinically.

### Ultrasound Images of Breast Tumors

The breasts were examined using an ultrasonic device, Toshiba SSA 250A with a 7.5 MHz annular array transducer. One representative ultrasound image of each breast tumor was selected for analysis.

### Measurements of Size and Location of Breast Tumors (Fig. 1)

Five basic measurements of tumor size and location as follows were undertaken on

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the representative image of each breast tumor.

D: tumor depth on Y-axis
W: tumor width on X-axis
S-T: distance from skin surface to upper margin of tumor
G-T: distance from surface of mammary gland to upper margin of tumor Minus value means protrusion of the tumor from the mammary gland into the subcutaneous fatty layer.
S-P: distance from skin surface to the pectoral fascia This represents the whole thickness of the breast.

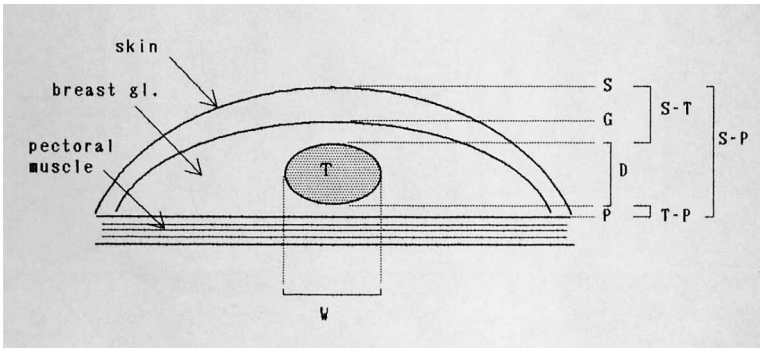



**Fig. 1** Measurement on Tumor Size and Location

**Table 1** Materials

| Pathological Diagnosis | Non-palpable | Palpable | Total |
|---|---|---|---|
| Cancer | 5* | 16 | 21 |
| Fibroadenoma | 9 | 6 | 15 |
| Fibrocystic Disease | 5 | 1 | 6 |
| Cyst | 21 | 4 | 25 |
| Intraductal Papilloma | 2 | 2 | 4 |
| Total | 42 | 29 | 71 |

*Two cases of intraductal carcinoma are included.

**Table 2** Ultrasonic Diagnosis

| Ultrasonic Diagnosis | Pathological Diagnosis | | | | | Total |
|---|---|---|---|---|---|---|
| | Ca | FA | FCD | Cy | IDP | |
| Cancer | 21 | 3 | 1 | 0 | 1 | 26 |
| Fibroadenoma | 0 | 11 | 2 | 1 | 0 | 14 |
| Tumor | 0 | 1 | 2 | 10 | 0 | 13 |
| Cyst | 0 | 0 | 0 | 10 | 0 | 10 |
| IDP | 0 | 0 | 1 | 4 | 3 | 8 |
| Total | 21 | 15 | 6 | 25 | 4 | 71 |

Ca: Cancer FA: Fibroadenoma FCD: Fibrocystic Disease Cy: yst IDP: Intraductal Papilloma

**Quantitative Parameters of Palpability**

In addition to the D/W ratio, which is used as a diagnostic criterion for breast tumors, several quantitative parameters concerning palpability of breast tumors were used as follows.

D/W: depth/width ratio
D/(S-P): size of tumor with respect to whole breast
W/(S-T): size with respect to tumor depth in the breast
Palpability Index (PI)

$$D/W * D/(S-P) * W/(S-T) = D\hat{}2/(S-P)(S-T)$$

If palpability of a breast tumor can be expressed in figures, it will facilitate studies of the relationship between palpability of breast tumors and other findings. Therefore the palpability index (PI) is proposed here and defined above using parameters expected to contribute to palpability.

**Qualitative Analysis of Ultrasound Image**

Images of breast tumors were evaluated using the diagnostic criteria proposed by the Japan Society for Ultrasonics in Medicine (JSUM) and other signs which are widely used in conventional ultrasonic diagnosis of breast tumors [1].

## MATERIALS

The materials were 71 tumors with pathological confirmation in 60 patients who were examined mainly by ultrasound-guided fine needle aspiration cytology at the Ultrasound Laboratory in Tokai University Hospital between October, 1992 and December, 1994 (Table 1). Age of the patients ranged from 24 to 81 (Median age: 46). Pathological diagnosis of the tumors was confirmed by excision of the tumors. Cysts were diagnosed when the size was reduced or the mass disappeared on puncture and aspiration and cytology indicated that they were benign. If aspirates resembled toothpaste or gruel, they were considered to be cyst concentrates. Among 71 tumors, 42 (59.2 %) were nonpalpable.

Preoperative ultrasonic diagnosis of these tumors is shown in Table 2.

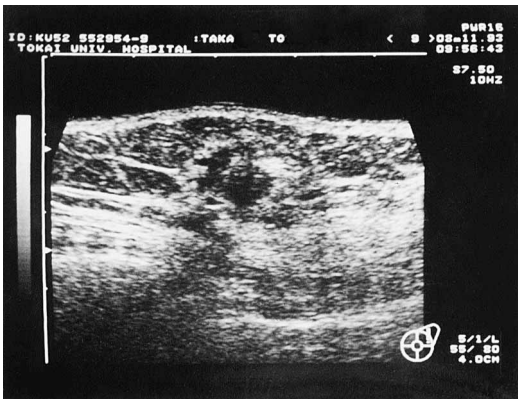
Ultrasonic images of breast tumors with size and quantitative parameters of palpability are shown in Fig. 2 (a - f).

## RESULTS

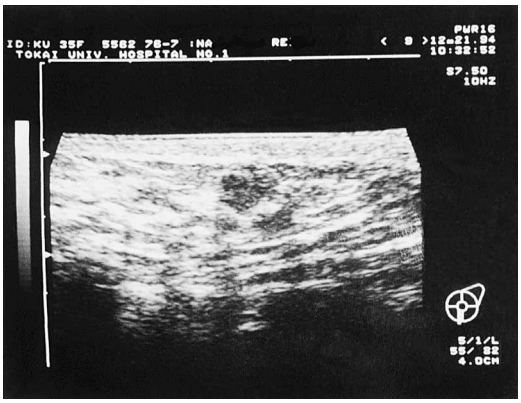
**(1) Measurement of Tumor Size and Location and Quantitative Parameters of Palpability**

Results of measurements of size and location of breast tumors and values of quanti-

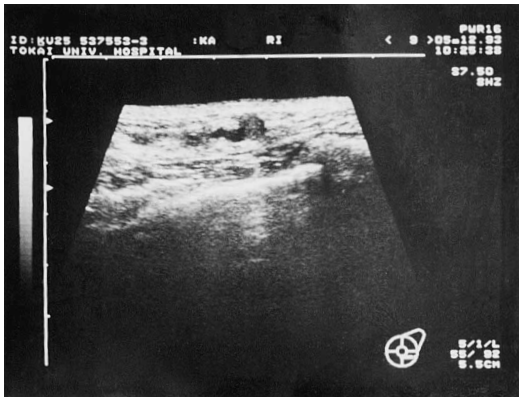
**Fig. 2 (a - f)** Ultrasonic Images of Breast Tumors
PI: palpability index = D^2/(S-T)*(S-P) D: depth W: width S-T: distance between skin surface and upper margin of tumor S-P: distance between skin surface and pectoral fascia



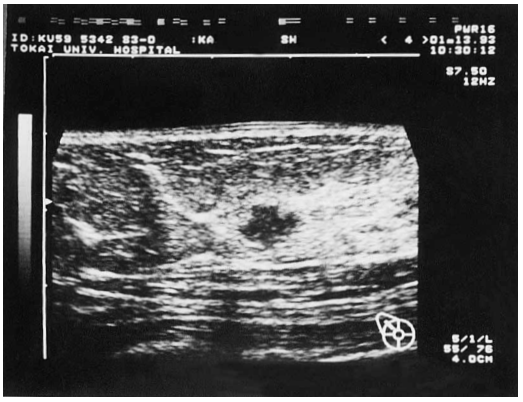

**a.** Palpable invasive ductal carcinoma
8.7 × 9.8 mm, PI: 0.33
Irregularly shaped tumor with thick boundary echoes protruding into subcutaneous layer.



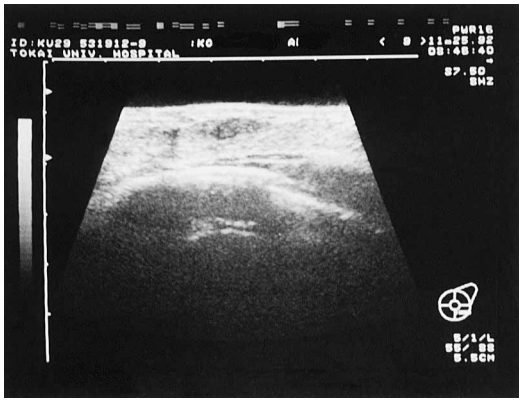

**b.** Palpable fibroadenoma
5.8 × 4.6 mm, PI: 0.53
Tumor with slightly irregular shape located beneath the skin.



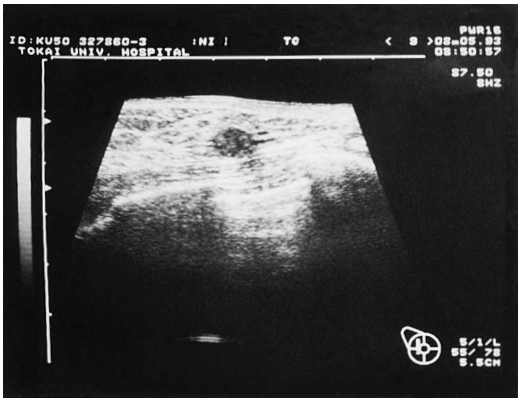

**c.** Palpable intraductal papilloma
5.2 × 4.8 mm, PI: 1.54
Round solid tumor connected to dilated duct located just beneath the skin.




**d.** Non-palpable invasive ductal carcinoma
5.4 × 4.8 mm, PI: 0.16
Irregularly shaped tumor located within mammary gland.




**e.** Non-palpable fibroadenoma
4.5 × 12.0 mm, PI: 0.52
Smooth bordered tumor with greater transverse length just beneath the skin.




**f.** Non-palpable intraductal papilloma
5.8 × 8.4 mm, PI: 0.60
Regularly shaped tumor within mammary gland.

tative parameters of palpability were compared between the two groups for six categories, i.e., palpable and non-palpable, malignant and benign, and palpable and non-palpable in patients with malignant tumors, benign tumors, fibroadenomas or cysts (Tables 3 and 4). Difference between mean values of the two groups were statistically analyzed with Student's t test.

With respect to tumor size (D and W), malignant tumors were larger than benign tumors and all palpable tumors were larger than non-palpable tumors except for fibroadenomas. These difference were statistically significant except for benign tumors.

In terms of location of the upper margin of the tumor with respect to the surface of the mammary gland (G-T), where positive values signify location of the tumor within the mammary gland and negative values protrusion of the tumor into the subcutaneous fatty layer, malignant tumors were smaller than benign tumors, and palpable tumors were smaller than non-palpable tumors except for cysts. The differences were statistically significant between malignant and benign tumors and between all palpable and non-palpable tumors and also fibroadenomas.

Concerning the distance between the skin surface and upper margin of the tumor (S-T), palpable tumors showed significantly

shorter values than non-palpable tumors in all cases and in benign cases. It was not different between malignant and benign tumors, and between palpable and non-palpable malignant tumors and cysts.

Distance between skin surface and pectoral fascia (S-P), i.e., whole breast thickness at the site of scanning, showed no significant differences between the two groups but in cysts where the value was larger in palpable tumors than in non-palpable tumors contrary to expectations.

The depth/width ration (D/W) was not statistically different between the two groups except for fibroadenomas, where palpable tumors showed higher values than non-palpable tumors.

The other three quantitative parameters of

**Table 3** Measurement of Tumor Size and Location

| | n | D | W | G-T | S-T | S-P |
|---|---|---|---|---|---|---|
| Cancer | 21 | 10.79 ± 5.82 | 15.50 ± 8.60 | -1.08 ± 5.07 | 6.53 ± 3.19 | 20.46 ± 7.21 |
| | | ** | * | * | NS | NS |
| Benign | 50 | 6.64 ± 2.71 | 11.33 ± 7.06 | 1.23 ± 2.84 | 7.41 ± 3.35 | 18.19 ± 4.62 |
| Non-Palpable | 42 | 6.00 ± 2.21 | 10.13 ± 5.92 | 1.50 ± 2.69 | 7.87 ± 3.17 | 18.03 ± 4.54 |
| | | ** | ** | * | * | NS |
| Palpable | 29 | 10.59 ± 5.14 | 16.07 ± 8.76 | -0.84 ± 4.64 | 6.11 ± 3.28 | 20.07 ± 6.68 |
| Cancer, N-P | 5 | 6.25 ± 1.81 | 8.73 ± 4.73 | 0.34 ± 0.87 | 6.58 ± 1.94 | 15.99 ± 4.20 |
| | | * | * | NS | NS | NS |
| Cancer, Palp | 16 | 12.21 ± 5.92 | 17.81 ± 8.44 | -1.52 ± 5.71 | 6.51 ± 3.49 | 21.85 ± 7.39 |
| Benign, N-P | 37 | 5.96 ± 2.25 | 10.32 ± 6.04 | 1.66 ± 2.81 | 8.04 ± 3.26 | 18.30 ± 4.52 |
| | | ** | NS | NS | * | NS |
| Benign,Palp | 13 | 8.59 ± 2.94 | 14.18 ± 8.77 | 0.00 ± 2.58 | 5.61 ± 2.93 | 17.87 ± 4.86 |
| Cyst, N-P | 21 | 4.84 ± 1.16 | 6.83 ± 2.09 | 1.76 ± 2.62 | 8.26 ± 3.14 | 17.57 ± 3.81 |
| | | ** | ** | NS | NS | * |
| Cyst, Palp | 4 | 10.18 ± 2.63 | 20.53 ± 9.74 | 3.04 ± 2.28 | 8.11 ± 3.67 | 22.36 ± 4.84 |
| FA, N-P | 9 | 7.41 ± 2.78 | 14.49 ± 5.08 | 1.80 ± 3.21 | 7.84 ± 3.52 | 20.15 ± 4.91 |
| | | NS | NS | * | NS | NS |
| FA, Palp | 6 | 8.37 ± 2.03 | 12.80 ± 6.35 | -1.54 ± 0.97 | 4.49 ± 1.22 | 16.46 ± 2.05 |

N-P: Non-Palpable Palp: Palpable FA: Fibroadenoma NS: not significant
*: significantly different with less than 5% risk **: significantly different with less than 1% risk

palpability, namely, D/(S-P), W/(S-T) and Palpability Index (PI), were larger in malignant palpable tumors than in benign non-palpable tumors, although the difference was not statistically significant between palpable and non-palpable malignant tumors for all three parameters and in fibroadenomas only for W/(S-T).

**(2) Qualitative Diagnostic Criteria (Tables 5, 6, 7, 8, 9, 10)**

Six categories: shape, border, boundary echoes, internal echoes, posterior echoes and indirect signs, among conventional diagnostic criteria were studied to compare four pairs: all malignant and benign tumors, all palpable and non-palpable tumors, and

**Table 4** Parameters of Tumor Palpability

| | n | D/W | D/(S - P) | W/(S-T) | PI |
|---|---|---|---|---|---|
| Cancer | 21 | 0.75 ± 0.25 | 0.51 ± 0.18 | 3.18 ± 2.78 | 1.36 ± 0.52 |
| | | NS | ** | * | ** |
| Benign | 50 | 0.69 ± 0.24 | 0.37 ± 0.14 | 1.91 ± 1.53 | 0.50 ± 0.53 |
| Non-Palpable | 42 | 0.68 ± 0.23 | 0.34 ± 0.11 | 1.57 ± 1.29 | 0.34 ± 0.29 |
| | | NS | ** | ** | ** |
| Palpable | 29 | 0.74 ± 0.26 | 0.52 ± 0.17 | 3.31 ± 2.49 | 1.35 ± 1.48 |
| Cancer, N-P | 5 | 0.79 ± 0.19 | 0.41 ± 0.13 | 1.39 ± 0.76 | 0.47 ± 0.31 |
| | | NS | NS | NS | NS |
| Cancer, Palpable | 16 | 0.74 ± 0.26 | 0.54 ± 0.18 | 3.73 ± 2.94 | 1.64 ± 1.84 |
| Benign, N-P | 37 | 0.67 ± 0.23 | 0.33 ± 0.11 | 1.59 ± 1.34 | 0.32 ± 0.28 |
| | | NS | ** | * | ** |
| Benign, Palpable | 13 | 0.74 ± 0.25 | 0.49 ± 0.14 | 2.80 ± 1.66 | 1.00 ± 0.70 |
| Cyst, N-P | 21 | 0.76 ± 0.22 | 0.28 ± 0.07 | 1.00 ± 0.64 | 0.20 ± 0.12 |
| | | NS | ** | ** | ** |
| Cyst, Palpable | 4 | 0.56 ± 0.16 | 0.47 ± 0.13 | 2.78 ± 1.16 | 0.86 ± 0.78 |
| FA, N-P | 9 | 0.51 ± 0.07 | 0.36 ± 0.08 | 2.19 ± 1.12 | 0.40 ± 0.23 |
| | | * | * | NS | * |
| FA, Palpable | 6 | 0.77 ± 0.27 | 0.51 ± 0.13 | 3.22 ± 2.04 | 1.14 ± 0.69 |

PI: Palpability Index N-P: Non-Palpable FA: Fibroadenoma NS: not significant
*: significantly different with less than 5% risk **: significantly different with less than 1% risk

**Table 5** Diagnostic Criteria - Shape -

| | Shape | | | |
|---|---|---|---|---|
| | n | Regular | Equivocal | Irregular |
| Cancer | 21 | 2 | 3 | 16 |
| ** | | | | |
| Benign | 50 | 25 | 14 | 11 |
| Non-Palpable | 42 | 20 | 12 | 10 |
| * | | | | |
| Palpable | 29 | 7 | 5 | 17 |
| Cancer, N-P | 5 | 1 | 1 | 3 |
| NS | | | | |
| Cancer, Palpable | 16 | 1 | 2 | 13 |
| Benign, N-P | 37 | 19 | 11 | 7 |
| NS | | | | |
| Benign, Palpable | 13 | 6 | 3 | 4 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

**Table 6** Diagnostic Criteria - Border -

| | Border | | | |
|---|---|---|---|---|
| | n | Smooth | Equivocal | Rough |
| Cancer | 21 | 1 | 7 | 13 |
| ** | | | | |
| Benign | 50 | 34 | 9 | 7 |
| Non-Palpable | 42 | 20 | 12 | 10 |
| ** | | | | |
| Palpable | 29 | 7 | 5 | 17 |
| Cancer, N-P | 5 | 1 | 1 | 3 |
| NS | | | | |
| Cancer, Palpable | 16 | 0 | 6 | 10 |
| Benign, N-P | 37 | 25 | 7 | 5 |
| NS | | | | |
| Benign, Palpable | 13 | 9 | 2 | 2 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

**Table 7** Diagnostic Criteria - Thick Boundary Echoes -

| | | Thick Boundary Echoes | | |
|---|---|---|---|---|
| | n | − | ± | + |
| Cancer | 21 | 12 | 1 | 8 |
| ** | | | | |
| Benign | 50 | 47 | 1 | 2 |
| Non-Palpable | 42 | 41 | 0 | 1 |
| ** | | | | |
| Palpable | 29 | 18 | 2 | 9 |
| Cancer, N-P | 5 | 5 | 0 | 0 |
| NS | | | | |
| Cancer, Palpable | 16 | 7 | 1 | 8 |
| Benign, N-P | 37 | 36 | 0 | 1 |
| NS | | | | |
| Benign, Palpable | 13 | 11 | 1 | 1 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

**Table 8** Diagnostic Criteria - Internal Echoes -

| | | | | Internal Echoes | | |
|---|---|---|---|---|---|---|
| | n | − | ± | Homogeneous | Equivocal | Heterogeneous |
| Cancer | 21 | 2 | 0 | 1 | 6 | 12 |
| * | | | | | | |
| Benign | 50 | 4 | 3 | 13 | 18 | 12 |
| Non-Palpable | 42 | 1 | 3 | 11 | 20 | 7 |
| ** | | | | | | |
| Palpable | 29 | 5 | 0 | 3 | 4 | 17 |
| Cancer, N-P | 5 | 0 | 0 | 0 | 5 | 0 |
| ** | | | | | | |
| Cancer, Palpable | 16 | 2 | 0 | 1 | 1 | 12 |
| Benign, N-P | 37 | 1 | 3 | 11 | 15 | 7 |
| NS | | | | | | |
| Benign, Palpable | 13 | 3 | 0 | 2 | 3 | 5 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

**Table 9** Diagnostic Criteria - Posterior Echoes -

| | Posterior Echoes | | | |
|---|---|---|---|---|
| | n | Enhanced | No change | Attenuated |
| Cancer | 21 | 4 | 10 | 7 |
| NS | | | | |
| Benign | 50 | 16 | 28 | 6 |
| Non-Palpable | 42 | 11 | 25 | 6 |
| NS | | | | |
| Palpable | 29 | 9 | 13 | 7 |
| Cancer, N-P | 5 | 1 | 3 | 1 |
| NS | | | | |
| Cancer, Palpable | 16 | 3 | 7 | 6 |
| Benign, N-P | 37 | 10 | 22 | 5 |
| NS | | | | |
| Benign, Palpable | 13 | 6 | 6 | 1 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

**Table 10** Diagnostic Criteria - Indirect Signs (Signs of Invasion) -

| | Indirect Signs (Signs of Invasion) | | |
|---|---|---|---|
| | n | − | + |
| Cancer | 21 | 8 | 13 |
| ** | | | |
| Benign | 50 | 43 | 7 |
| Non-Palpable | 42 | 37 | 5 |
| ** | | | |
| Palpable | 29 | 14 | 15 |
| Cancer, N-P | 5 | 3 | 2 |
| NS | | | |
| Cancer, Palpable | 16 | 5 | 11 |
| Benign, N-P | 37 | 34 | 3 |
| * | | | |
| Benign, Palpable | 13 | 9 | 4 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

malignant and benign palpable or non-palpable tumors. Differences between groups were examined statistically by the chi-square test. Indirect signs are usually signs of malignant invasion and include changes in the superficial fascia and Cooper's ligament, and interruption of the margins of the mammary gland.

An irregular shape, rough border, thick boundary echoes, heterogeneous internal echoes and positive indirect signs were significantly more common in malignant tumors than in benign tumors and in palpable tumors than in non-palpable tumors. No definite tendencies or differences were found for posterior echoes in any of the pairs. In patients with malignant tumors heterogeneous internal echoes were significantly more common in palpable tumors than in non-palpable tumors.

**(3) Fibrocystic Changes of the Breast (Table 11)**

In breast ultrasonography, fibrocystic change is thought to be present when the mammary gland is thick with a mottled pattern. The presence of fibrocystic change usually means thick induration of the gland on palpation, which makes it difficult to palpate a mass in the gland.

Fibrocystic changes were more prevalent in benign tumors than in malignant tumors.

## DISCUSSION

Incidence and mortality of breast cancer have rapidly increased in Japanese women. More than 7,000 women die of breast cancer every year. Early detection and treatment of breast cancer present an urgent problem. Mass screening by inspections and palpation have critical limitations in the early detection of breast cancer, because most of breast cancers form a palpable mass only after a certain degree of stromal invasion beyond the original intraductal or intra-acinar space. Mammography and ultrasound have been recommended for detection of early breast cancer and good results have been obtained.

High-resolution hand-held real-time ultrasonic scanners have become available for

**Table 11** Fibrocystic Change

| | | Fibrocystic Change | |
|---|---|---|---|
| | n | − | + |
| Cancer | 21 | 15 | 6 |
| * | | | |
| Benign | 50 | 22 | 28 |
| Non-Palpable | 42 | 11 | 31 |
| NS | | | |
| Palpable | 29 | 13 | 16 |
| Cancer, N-P | 5 | 4 | 1 |
| NS | | | |
| Cancer, Palpable | 16 | 11 | 5 |
| Benign, N-P | 37 | 20 | 17 |
| * | | | |
| Benign, Palpable | 13 | 2 | 11 |

NS: not significant *: significantly different with less than 5% risk
**: significantly different with less than 1% risk

breast examinations. Through screening and clinical examinations with ultrasound, small breast lesions have frequently been detected. Many of them cannot be palpated [2, 3, 4, 5].

Breast masses are presumably more easily palpated when they are large and superficially located in smaller breasts. Another important factor of palpability is the relationship between hardness or elasticity of the mass and surrounding tissue. Usually fatty tissue is soft and the mammary gland is hard, so that a mass protruding into the subcutaneous fatty layer is more readily palpable, while a mass embedded deeply in the mammary gland is more difficult to palpate. In the present study these factors related to tumor size and location were transformed into quantitative parameters measurable on ultrasonic images of breast tumors. A comparison was made between palpable and non-palpable tumors.

Hardness or elasticity of the breast tumor itself cannot be assessed directly on ultrasonic image. The depth/width ratio is used as a diagnostic criterion of breast tumors proposed by the JSUM. A high D/W ratio, namely a longitudinally long shape, is thought to suggest malignancy, especially in small breast tumors. Low D/W ratio, especially less than 0.5, means extremely rare malignancy. Many complex factors including the growth pattern of breast tumors influence the value of the D/W ratio. Hardness or elasticity of the tumor is thought to be one of these factors. On real-time B-mode images it is frequently observed that soft breast tumors are easily compressed by the transducer, i.e., the D/W ratio is reduced. The D/W ratio was adopted as one of the quantitative parameters of palpability in the present study. However, only in fibroadenomas was a higher D/W ratio significantly related to palpability of the breast tumor.

In patients with malignant tumors, quantitative parameters were not significantly related to palpability except for size. Among qualitative diagnostic criteria, only heterogeneous internal echoes were related to palpability of breast cancer. Invasive growth of breast cancer causing irregular patterns and signs of invasion in ultrasonic images is thought to be related to its palpability. In this study, however, this was not documented. Although the small number of cancer patients may affect these results, lower dependency of actual palpability of cancer on quantitative parameters of palpability may indirectly express a characteristic of cancer, i.e., its hardness. If this is true, it suggests greater malignancy when a tumor is palpated in spite of a low palpability index and other parameters. In such cases heterogeneous internal echoes may reinforce the possibility of malignancy.

The palpability of fibroadenomas was not influenced by size but by their location with respect to the surface of mammary gland (G-T), the D/W ratio and size relative to whole breast thickness. Longitudinally long shape of palpable fibroadenomas may mean that the fibrotic tendency influence their palpability. For cysts, the size and size relative to the whole breast thickness were the most important factors influencing palpability. Paradoxically, palpable cysts showed higher G-T and low D/W values than non-palpable cysts. One possible explanation for this phenomenon may be that small cysts include many concentrated cysts, which frequently have high D/W ratios and is not expansive to make outward pressure.

Coexistent fibrocystic change of the breast is thought to closely affect the palpability of breast tumors, but the presence of or absence of fibrocystic change did not clearly affect tumor palpability in our study.

The palpability index is the product of D/W ratio, size relative to the whole breast thickness (D/(S-P)) and the ratio of transverse size to depth (W/(S-T)). It was significantly higher in all palpable breast tumors except for cancer, although it also showed higher values in palpable cancer patients, suggesting its usefulness for expressing the palpability of breast tumors. W/(S-T) is also considered to be a simple palpability index. However, addition of D/W and D/(S-P) to it seemed to be more effective in expression of the palpability of breast tumors. Such studies on the palpability of breast tumors should be continued with statistical analysis including multivariate analysis of a larger number of cases.

## CONCLUSIONS

In this study, the usefulness of parameters including the palpability index in predicting palpability of breast tumors was suggested.

Except for size, these parameters did not show any significant correlation with palpability of cancers. Among qualitative diagnostic criteria, heterogeneous internal echoes appeared to be most closely related to palpability of cancer.

There are few reports concerning the relationship between palpability and findings in ultrasonic B-mode images of breast tumors. Yang and Metreweli reported a study of 529 Chinese women with palpable breast tumors, and found that palpability of breast tumors was significantly related to size and depth according to multivariate logistic regression, revealing the importance of breast self-examination [6]. One important and essential aim of breast ultrasonography is detection of breast cancer in its non-invasive or early invasive stage before it becomes palpable. This study again suggested the importance of diagnosis of small non-palpable deep-seated lesions in the mammary gland as benign or malignant in breast ultrasonography.

## ADDENDUM

Part of this study was presented at the 4th Congress of AFSUMB (Asian Federation of Societies of Ultrasound in Medicine and Biology) in Beijing in 1995.

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