Semi-automatic Ultrasonic Full-breast Scanner and Computer-assisted Detection System for Breast Cancer Mass Screening

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1. ABSTRACT

Breast cancer mass screening is widely performed by mammography but in some population with dense breast, ultrasonography is much effective for cancer detection. For this purpose it is necessary to develop special ultrasonic equipment and the system for breast mass screening. It is important to design scanner, image recorder, viewer with CAD (Computer-assisted detection) as a system. Authors developed automatic scanner which scans unilateral breast within 30 seconds. An electric linear probe visualizes width of 6cm, the probe moves 3 paths for unilateral breast. Ultrasonic images are recorded as movie files. These files are treated by microcomputer as volume data. Doctors can diagnose by digital rapid viewing with 3D function. It is possible to show unilateral or bilateral images on a screen. The viewer contains reporting function as well. This system is considered enough capability to perform ultrasonic breast cancer mass screening.

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2. INTRODUCTION

In Tochigi Prefecture, Japan, authors performed ultrasonic breast cancer mass screening since 1987. At the beginning of the series, portable ultrasonic equipment was carried to the screening fields and examined for candidates who had some findings by palpation at the site. The results depend on palpation by this method. From 1987 to 1996, breast cancer detection ratio was 0.06, but after adopting ultrasonography for all examinee, cancer detection ratio increased up to 0.1%. (Table 1) So, we changed to perform ultrasonic examination for all candidates from 1997.

Table 1. Results Comparing Palpation and Ultrasonic Screening

Year	1987-96	1997-98
No of applicants	174521	43210
Palpation positive	13442	516
US positive	7210	1643
Further exam. required	3224	1646
Took precise exam.	2860	1260
Cancer detected	112	45
Cancer detected (%)	0.06	0.1

The trial, evaluating diagnostic capability of three diagnostic methods, physical examination, ultrasonography and mammography, was performed in Tochigi from Oct. 1999 to March 2000. Total examinee was 3455. Among them 10 cancers (0.29%) were detected. (Fig. 1) According to the results, ultrasonography and mammography detect breast cancer compensating each weak point. The combination mammography and ultrasonography is the best method. We decided to adopt

ultrasonography for breast cancer mass screening in Tochigi Prefecture. Tochigi Public Health Service Association provides two types of screening. One is mammography with physical examination and the other is mammography with ultrasonography. Individual local governments select one of them. On the other hand, conventional ultrasonic examination for breast screening, sonographer move hand held probe manually.[1)2)] It is not adequate for large mass screening. We started to make special ultrasonic equipment for breast cancer mass screening, which automatically scans enough area for unilateral breast at a time.

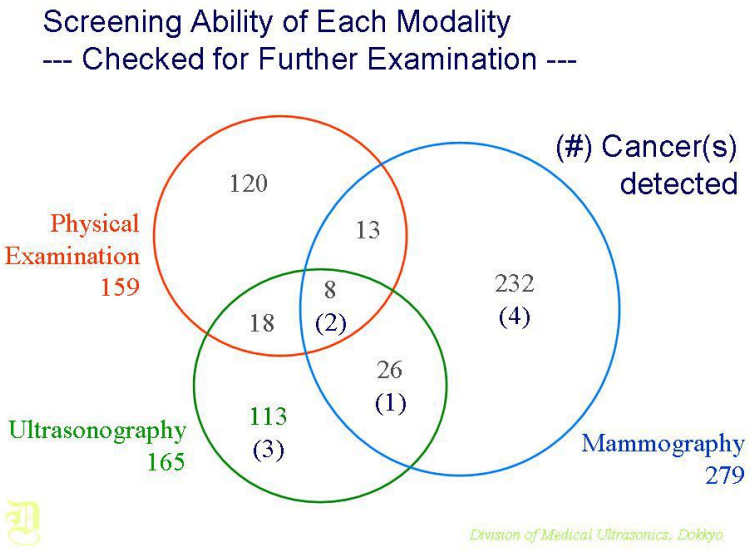

Fig.1 The result of a trial comparing physical examination, ultrasonography and mammography.

3. MATERIALS AND METHOD

Authors developed a semi-automatic full-breast scanner ASU-1004 (Fig.2) (Aloka, Tokyo, Japan) which scans unilateral whole breast in approx. 16 cm x 16 cm by 3 paths within 30sec. (Fig.3) A probe, which can visualize 6cm wide, is in water. Thin elastic membrane, located at top of a tank oppresses a breast loosely to reduce breast thickness. Examinee bent down over the tank. Full breast ultrasonic images are stored and processed by a microcomputer. The special viewer also developed by authors. Three dimensional display is feasible.[3)] The viewer contains reporting chart.

Fig. 2 ASU-1004 full breast scanner

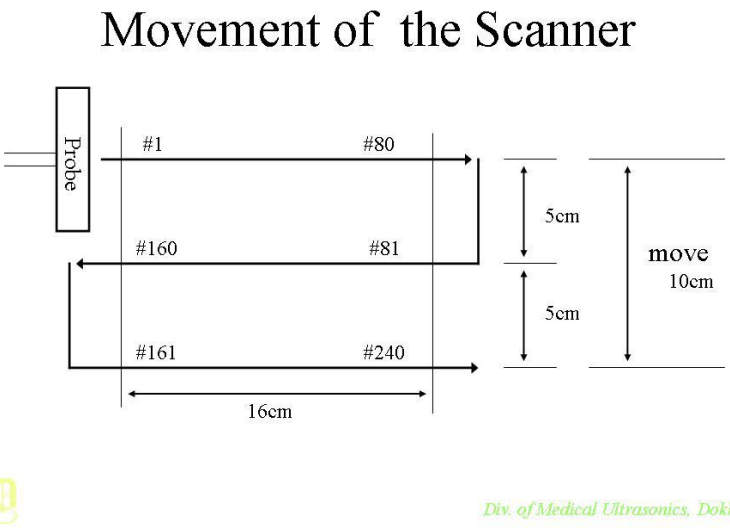

Fig. 3 Movement of transducer. It covers 16x16cm by 3 paths

4. RESULT

We already examined over than 200 cases by this system. Examination time for one examinee, bilateral breasts, is 3 to 4 min, which is similar to that for mammography. Three paths images are combined as one breast image and displayed as “rapid viewing”, so radiologist can easily diagnose tumor location with the relation to a nipple position. The authors developed special viewer can display transverse (Fig.4), longitudinal (Fig. 5), oblique and C-mode images (Fig. 6). Radiologists can view the images as a movie by digital rapid viewing to save diagnosing time. For dual display, marking each nipple position on the viewer, it can adjust the level of both breasts. It is possible to show the original images of each path as well. Diagnosed results are recorded on digital check sheet included in the viewer.

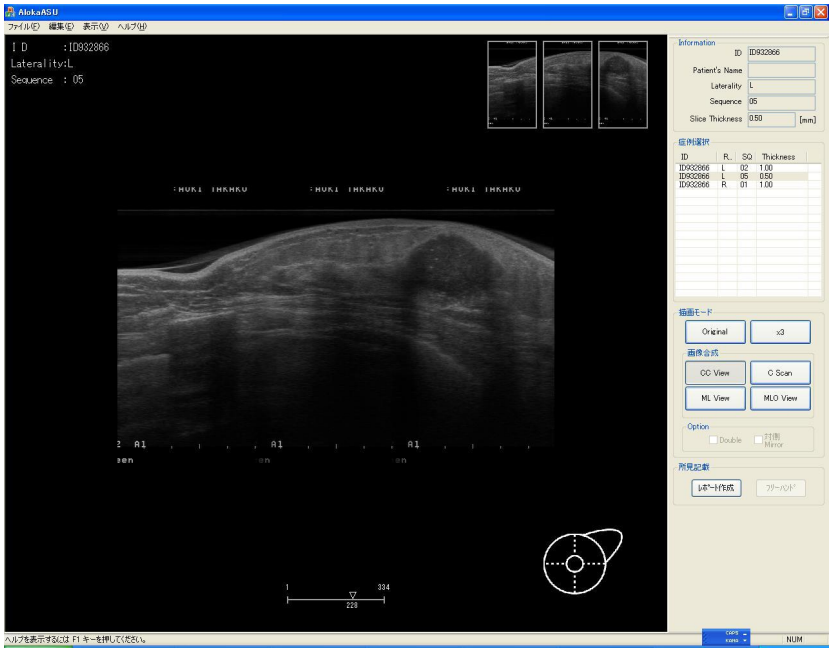

Fig. 4 Panoramic view – Horizontal view

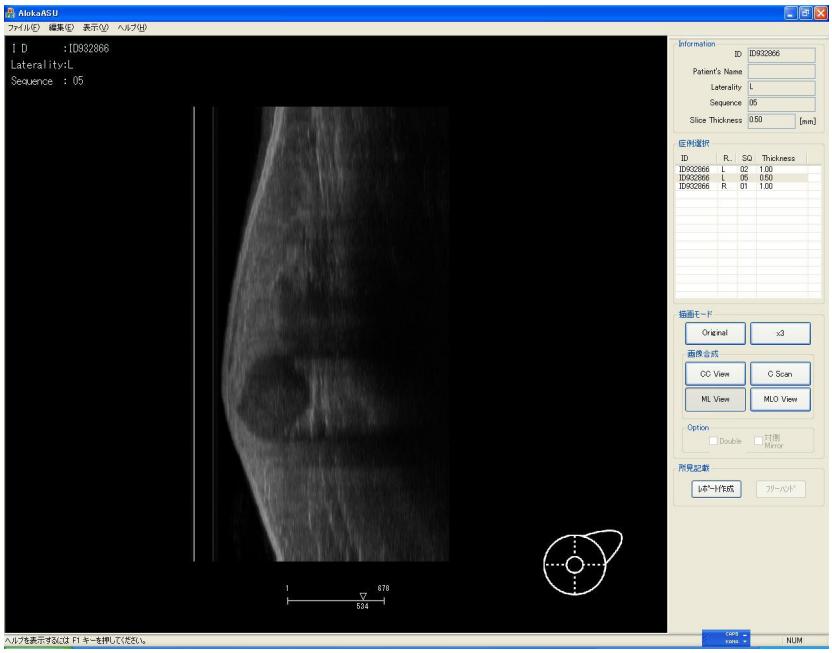

Fig. 5 Sagital view

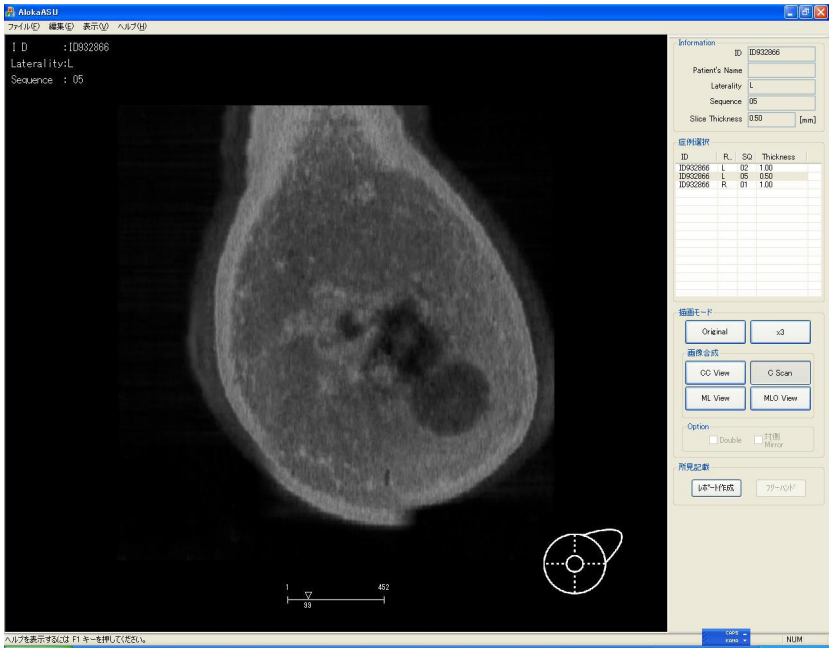

Fig. 6 C-mode image

5. CONCLUSION

Acquired ultrasonic image by this system is good for diagnosis. Not only transverse images, sagital or C-mode images have enough resolution for diagnosis.(Fig.4,5,6) Examination time for one examinee is almost the same as that of mammography. It is important to perform combined breast cancer mass screening by mammography and ultrasonography for 40s. To improve the image quality much more, the probe and scanning method may be changed in the near future. This system will contain computer aided tumor detection scheme being developed.[4)5)6)7)] Ultrasonic images are handled as volume data, if physician check the tumor location on some image, tumor location is checked automatically on digital mark sheet. This is helpful for both screening doctors and for those of further examination site. Dual display of bilateral breast ultrasonic images is also effective for comparative diagnosis of laterality. With all these functions, the system can be used for ultrasonic breast cancer mass screening.

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REFERENCES

1. R. F. Chang, K. C. Chang-Chien, H. J. Chen, D. R. Chen, E. Takada, and W. K. Moon, “Whole breast computer-aided screening using free-hand ultrasound,” in Computer Assisted Radiology and Surgery, H. U. Lemke, K. Inamrua, K. Doi, M. W. Vannier, and A. G. Farman, eds., Proc. of CARS 2005, pp. 1075.1080, 2005.

2. R. F. Chang, C. J. Chen, E. Takada, C. M. Kuo, and D. R. Chen, “Image stitching and computer-aided diagnosis for whole breast ultrasound image,” in International Journal of Computer Assisted Radiology and Surgery, H. U. Lemke, K. Inamrua, K. Doi, M. W. Vannier, and A. G. Farman, eds., Proc. of the 20th International Congress and Exhibition 1, pp. 340.343, 2006.

3. D. Fukuoka, T. Hara, H. Fujita, T. Endo, and Y. Kato, “Automated detection and classification of masses on breast ultrasonograms and its 3D imaging technique,” in 5th International Workshop on Digital Mammography, M. J. Yaffe, ed., Proc. of IWDM 2000, pp. 182.188, 2001.

4. Y. Ikedo, D. Fukuoka, T. Hara, H. Fujita, E. Takada, T. Endo, and T. Morita, “Computer-aided

detection system of breast masses on ultrasound images," in SPIE Medical Imaging 2006: Image Processing, J. M. Reinhardt and J. P. W. Pluim, eds., Proc. of SPIE 6144, pp. 61445L1.61445L8, 2006.
5. Y. Ikedo, D. Fukuoka, T. Hara, H. Fujita, E. Takada, T. Endo, and T. Morita, "Fully automatic detection system for breast masses on ultrasound images," in International Journal of Computer Assisted Radiology and Surgery, H. U. Lemke, K. Inamrua, K. Doi, M. W. Vannier, and A. G. Farman, eds., Proc. of the 20th International Congress and Exhibition 1, p. 519, 2006.
6. D. Fukuoka, Y. Ikedo, T. Hara, H. Fujita, E. Takada, T. Endo, and T. Morita, "Development of breast ultrasound cad system for screening," in Digital Mammography, S. M. Astley, M. Brady, C. Rose, and R. Zwiggelaar, eds., 8th International Workshop, IWDM 2006, Manchester, UK, June 2006, Proceedings, pp. 392.398, 2006.
7. Y. Ikedo, D. Fukuoka, T. Hara, H. Fujita, E. Takada, T. Endo, T. Morita, Computerized mass detection in whole breast ultrasound images: Reduction of false positives using bilateral subtraction technique, SPIE Medical Imaging 2007, in press, 2007.