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Review

Breast-Conserving Surgery for Invasive Cancer: A Principle Based on Segmental Anatomy

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OHUCHI, N. *Breast-Conserving Surgery for Invasive Cancer: A Principle Based on Segmental Anatomy.* Tohoku J. Exp. Med., 1999, **188** (2), 103-118 —— As the incidence of breast cancer increases in Japan, breast-conserving surgery becomes an important issue in the light of quality of life. We have demonstrated by 3-D reconstruction studies that ductal carcinoma in situ (DCIS) originates from the terminal duct-lobular unit (TDLU). Normal mammary epithelium anatomically located in the TDLU was shown to be biologically associated with cancerous change, particularly in specimens from patients who subsequently developed invasive carcinoma. Atypical ductal hyperplasia as well as DCIS expressed breast cancer associated antigen, providing further biological evidence that the atypical lesion at the TDLU are premalignant. Intraductal spread of carcinoma was defined as "DCIS was present clearly extending beyond the TDLU, or present prominently within the large ducts," and was classified into 3 grades according to the distribution of carcinoma in the duct-lobular system. We have developed a breast-conserving surgery consisting of quadrantectomy and regional lymph node dissection and immediate volume replacement using lateral tissue-flap (LTF). The quadrantectomy was employed on the basis of segmental anatomy of the duct-lobular system in which breast carcinoma originates. Fairly good cosmetic outcome as well as local control were obtained in the patients who underwent the immediate volume replacement using LTF. It must be emphasized that the quadrantectomy is a radical procedure in the sense that it aims at removal of all the carcinoma cells of the primary tumor. ———— breast cancer; breast-conservative surgery; ductal carcinoma in situ; intraductal spread of carcinoma; quadrantectomy

Although Japan is one of the countries with low risk for female breast cancer, the incidence rate as well as the mortality rate are gradually increasing; the age-standardized incidence rate to the world population raised from 17.0 in 1975 to 29.3 in 1993 per 100 000 (The Reserch Group for Population-based Cancer Registries in Japan 1998), and 8391 women died of breast cancer in 1997 (Statis-

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Dr. N. Ohuchi is a recipient of the 1998 Gold Prize, Tohoku University School of Medicine.

tics and Information Department, Minister's Secretariat, Ministry of Health and Walfare, Japan 1997). Now, breast cancer becomes the most common neoplasm of women in Japan.

Since 1894 when Halsted (1894, 1907) reported a radical mastectomy procedure for breast cancer, total mastectomy has been employed as standard treatment over the century. However, the concept have shifted to limited surgery, because of the great change in the characteristics of the patient population that has occurred in the past decades. Better education, more extensive information, more refined diagnostic tools, and expanding screening campaigns all contribute to earlier detection of breast cancer. It would be unwise to perform the classic surgical procedures that were introduced at the beginning of the century to treat patients with tumors that were totally different in character and more often than not were locally advanced. Many patients bear breast tumors of very limited sizes, and sometimes these tumors are not even palpable. We have to consider that the feeling of women toward breast cancer and breast cancer treatment has also greatly changed.

Today, women are informed that if the primary tumors are small, most of the breasts may be spared with adequate surgical and radiotherapeutic procedures. This new optimistic view of breast cancer treatment has also stimulated women to participate more actively in screening programs, knowing that if a small cancer is found, treatment can preserve the breast rather than produce the scarring dissect prevailed in the previous eras.

TDLU as an origin of breast cancer

Terminal portion of mammary epithelial cells have been indicated as the site of carcinogenesis not only in animal model but also in human. Russo et al. (1982), who induced mammary cancer in rats by administering a chemical carcinogen, demonstrated that the terminal end buds (TEB) which are equivalent to the terminal duct-lobular unit (TDLU) of human breast are the site of origin of rat mammary carcinomas. Wellings et al. (1975), who carried out a study of 196 whole human breasts examined by a sub-gross procedure, concluded that the vast bulk of disease, much of which had been traditionally regarded as being ductal origin, is in fact of lobular and ductule origin.

We have conducted 3-D reconstruction analyses of breast tissues using sub-serial sections (Ohuchi et al. 1984a). The studies demonstrated that breast carcinoma and peripheral papilloma originated from the TDLU. The tissues were obtained by duct-lobular segmentectomy (DLS), or mastectomy. They were fixed in formalin, and embedded in paraffin after sequential slicing into 3 mm sections. The paraffin blocks were cut at 5 μm and stained following Heidenhain-Mallory method, which ensured fine discrimination among carcinoma, papilloma, benign epithelium, the ducts harboring tumors and the stromal tissues. Some sections were stained with hematoxylin-eosin for diagnostic histopathology. Sub-serial

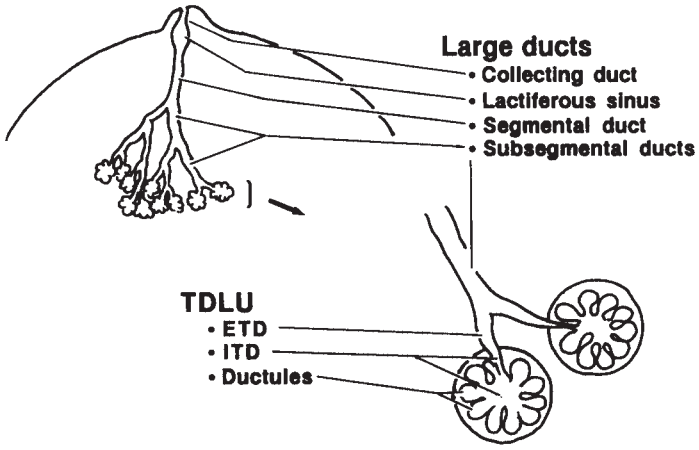

Fig. 1. A schematic diagram of mature duct-lobular system of female breast. Large ducts comprise collecting duct, lactiferous sinus, segmental duct and subsegmental ducts, whereas TDLU comprises extralobular terminal ducts (ETD), intralobular terminal ducts (ITD) and ductules. The ITD and ductules consist of a lobule.

Fig. 2. Ductal carcinoma in situ showing a monotonous arrangement of epithelial cells with hyperchromatic round nuclei, as well as a focal tendency to cribriform structure of the fronds. The bulbous fronds of hyperchromatic cells extend beyond the TDLU.

sections were submitted for 3-D reconstruction of tumors in relation to the duct-lobular system using a graphic reconstruction. Specimens obtained by mastectomy were also submitted to pathological investigation. The terminology of duct-lobular system, basically complied with the proposal of Wellings et al. (1975), was as follows: from the nipple opening, collecting duct, lactiferous sinus, segmental duct, subsegmental ducts and TDLU. The TDLU was so defined as to include extralobular terminal ducts, intralobular terminal ducts, and a cluster of ductules. Intralobular terminal ducts and ductules together constituted a lobule. In addition, we employed "large ducts" as a collective term for all portions of the duct-lobular system other than terminal duct-lobular units (Ohuchi et al. 1984b),

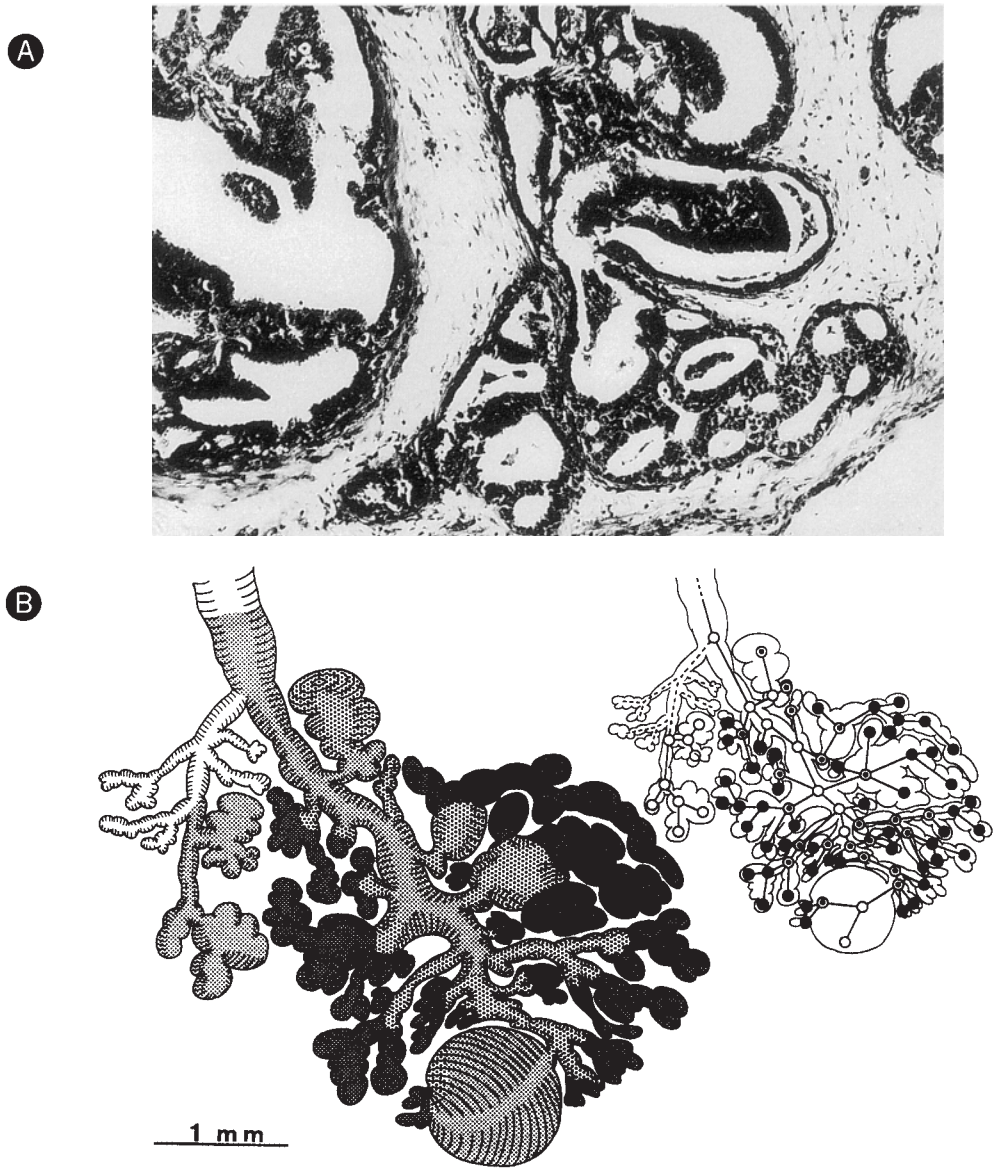

Fig. 3. (A) A lesion of ductal carcinoma in situ at right lower part of the microphotograph, featuring monotonous arrangement of nuclei with micropappilary, cribriform structure. (B) The 3-D reconstruction revealed that the focus of DCIS (arrow) was located at the distal site of multiple papillomas. ○, papilloma; ⊙, borderline (ADH); ●, carcinoma.

as illustrated in Fig. 1.

The reconstructions of microscopic foci of carcinomas suggest that the TDLU, especially the intralobular terminal ducts and ductules (Fig. 2), are the sites of origin of ductal carcinoma (Ohuchi et al. 1984a). The 3-D reconstructions revealed that carcinomas with multiple origins in TDLU were connected with peripheral papilloma (Fig. 3), suggesting that the peripheral papilloma was highly susceptible to cancerous change. In our study specially referred to possible cancerous lesions in the human breasts. We also demonstrated the 3-D atypical structure of carcinoma differentiating from benign papillary lesions of the breast (Ohuchi et al. 1985).

Biological significance of TDLU

Normal mammary epithelium anatomically located in the TDLU was shown to be biologically associated with cancerous change, particularly in specimens from the patients who subsequently developed invasive carcinoma (Ohuchi et al. 1986). Monoclonal antibody, RAP-5, directed against the *ras* gene product (a protein with a molecular weight of 21 000, p21) was used to evaluate *ras* p21 expression in malignant and benign mammary tissues as well as the normal epithelium (Thor et al. 1986). Normal mammary epithelial cells in the TDLU, from the patients who subsequently developed invasive ductal carcinoma, generally demonstrated higher levels of *ras* p21 than did epithelium in large ducts. This demonstration of enhanced *ras* p21 expression by the epithelium of peripheral lobular portion of the breast was consistent with the previous hypothesis that these areas preferentially undergo malignant transformation.

A breast cancer-associated antigen, DF3, has also been expressed in atypical ductal hyperplasia (ADH) as well as ductal carcinoma in situ (DCIS) (Ohuchi et al. 1987), providing further biological evidence that the atypical lesion at the TDLU are premalignant.

Intraductal spread of carcinoma as unfavorable pathologic factor for breast conserving surgery

Surgical management of DCIS has been a controversial issue in selection of breast conserving surgery. Definition of intraductal spread of carcinoma (ISC) becomes an important factor for the decision-making, but little is known how much intraductal extension influences the spreading of tumor in whole breast. To define any unfavorable pathologic factor exist in limited surgery for DCIS we investigated histopathologic characteristics using a sequential slicing of tissues. The ISC was defined as "DCIS was present clearly extending beyond the TDLU, or present prominently within the large ducts" (Table 1, Fig. 4). The predominancy of an invasive or an intraductal component was not considered

TABLE 1. *Definition of intraductal spread of carcinoma in comparison with that of extensive intraductal component*

Intraductal spread of carcinoma (ISC) ;
DCIS was present clearly extending beyond the terminal duct-lobular units (TDLU), or present prominently within the large ducts. The predominancy of an invasive or an intraductal component was not considered (Ohuchi et al 1994).
Extensive intraductal component (EIC) ;
DCIS was present prominently within the infiltrating tumor, and DCIS was present clearly extending beyond the infiltrating margin of tumor (Holland et al. 1990).
Combination of DCIS comprising 25% of more of the area encompassed by the infiltrating tumor and DCIS in the surrounding breast tissue (Schnitt et al. 1987).

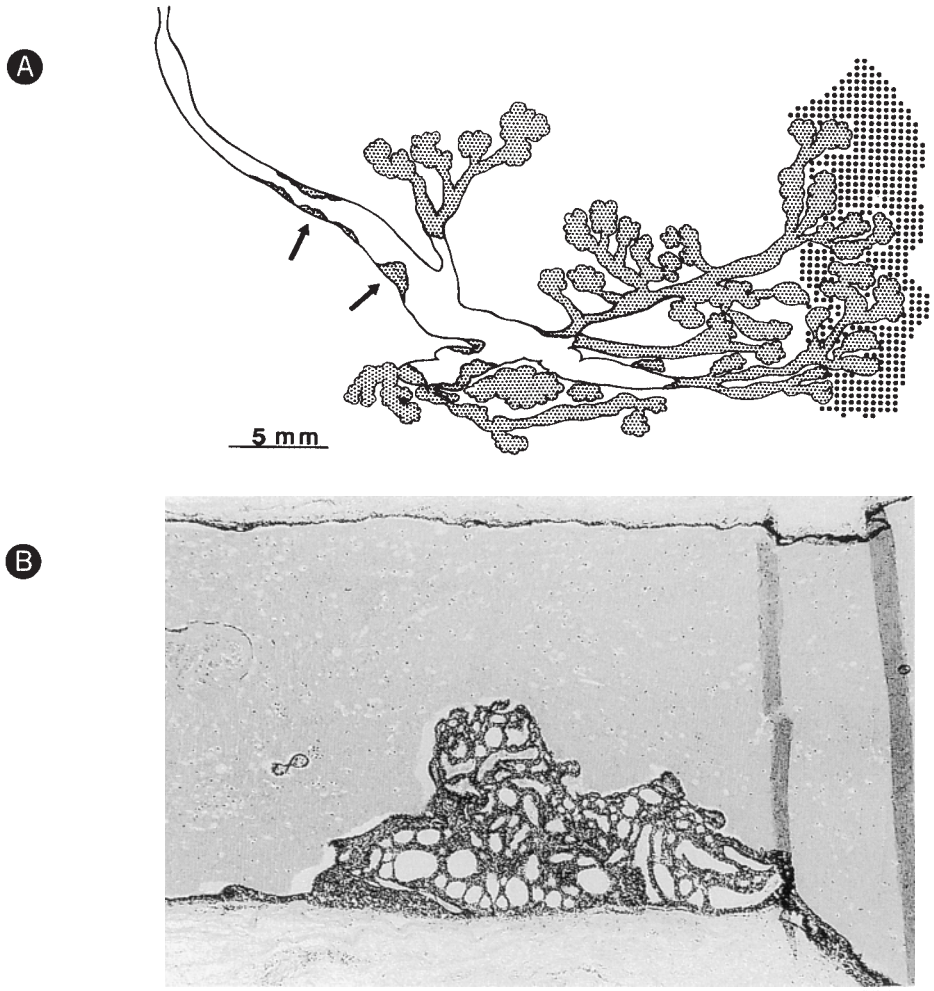

Fig. 4. Invasive ductal carcinoma predominant with intraductal component. (A) A schematic diagram of tumors together with the duct-lobular system. The larger dots at the right denote invasive components. (B) A photomicrograph around the area pointed by arrows in the diagram. A papillary frond of hyperchromatic carcinoma cells is clearly present on the basement membrane of segmental duct.

(Ohuchi et al. 1994).

DLS, a breast conserving surgery, was performed on 110 patients with bloody nipple discharge. The surgical procedure is a selective excision of a sector belonging to the duct-lobular system affected by intraductal proliferative disease, and is different from microdochectomy originally described by Babcock (1938). We do not use a microscope but macroscopically dissect the whole duct system from the nipple orifice to the TDLU. Six patients with invasive carcinoma and 17 patients with DCIS subsequently received total mastectomy. The specimens obtained by DLS and mastectomy were submitted to histopathological investigation. Using subserial sections we examined relationship between ISC in the DLS specimens and carcinoma residue in the mastectomy specimens.

Among 16 mastectomy specimens we found residual DCIS in 6, and ADH in 4 specimens. ISC was detected in 8 of 16 DLS specimens. Six of 8 patients with

ISC demonstrated residual DCIS. The other two patients demonstrated atypical hyperplasia in residual breasts. On the contrary, no residual DCIS was detected in the other 8 patients without ISC. Among 12 patients under observation without mastectomy 3 patients subsequently developed invasive carcinoma. Two of 3 patients demonstrated ISC in DLS specimens. Only 1 of 10 patients without ISC, however, developed carcinoma. The data indicate that ISC is unfavorable pathologic factor in breast conserving surgery for DCIS with nipple discharge.

Grading of intraductal spread of carcinoma

In breast conserving therapy, extensive intraductal component (EIC) of carcinoma has been recognized as a high risk factor for local treatment failure. This, however, has yet to be correlated with the distribution of tumors in the ductal tree. In a foregoing paper, we proposed the concept of ISC which was defined as DCIS extending beyond the TDLU and/or growing prominently in the large ducts, no matter whether invasive or intraductal component is the predominant feature. Thereafter, we intended a grading of ISC according to the extent of carcinoma in the ductal hierarchy based on computer-aided 3-D mapping, which allowed to visualize how invasive and intraductal tumors are distributed in and around the ductal tree (Fig. 5). Also, attention was paid to the frequency of multiple cancer development.

Forty DLS specimens with breast carcinoma were subjected to serial sectioning and 3-D reconstruction using a workstation. Based on the pattern and extent of tumor distribution, we introduced a grading of ISC from grade 0 without ISC, to grade 3 with widespread, diffuse ISC (Fig. 5). Adequacy or inadequacy of resection was evaluated in each case with the result of mapping and particularly, using this grading. Also, the presence or absence of multiple tumors was checked (Tables 2 and 3).

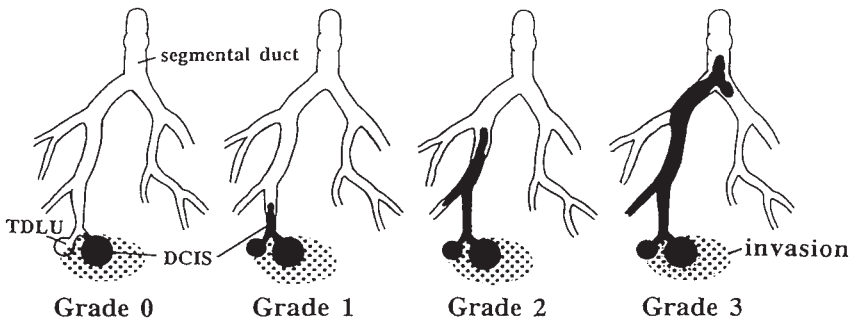

Fig. 5. A schematic diagram of intraductal spread of carcinoma. Grade 0: No intraductal spread of carcinoma. Carcinoma cells are confined within a TDLU. Grade 1: Carcinoma cells are extending beyond TDLU(s), but are confined within a single large duct or its peripheral site. Grade 2: More than two subsegmental ducts are involved by carcinoma cells. Grade 3: Carcinoma cells are extensively spreading into the large ducts.

TABLE 2. *Correlation of ISC grades with tumor diameter and positive surgical margin*

Grade	Number of specimens	Diameter of main tumor (cm) (Mean±S.D.)	Diameter of non invasive disease (cm) (Mean±S.D.)	Positive surgical margin (%)
0	5	2.0±0.7	0	0 (0%)
1	9	1.5±0.3	0.09±0.14	0 (0%)
2	13	1.9±0.6	1.70±1.19	0 (0%)
3	7	1.7±0.6	4.36±0.94	4 (56%)
Total	34	1.8±0.56	1.56±1.85	4 (12%)

TABLE 3. *Correlation of ISC grades with DCIS subtype, EIC and multiplicity*

Grade	Numeber of specimens	DCIS subtype		EIC	Multiplicity (%)
		Comedo	Non-comedo		
0	5	0	5	0	0
1	9	1	8	1 (11%)	1 (11%)
2	13	2	11	7 (54%)	7 (54%)
3	7	1	6	4 (57%)	7 (100%)

Thirty-four of 40 specimens were subjected to 3-D analysis. In all the cases carcinoma was confined in a single lobe. In those where ISC was grade 2 or lower, the surgical margin proved to be free from carcinoma. In grade 3 cases, however, the margin was positive in 4 of 7 (56%). Furthermore, the frequency of multiplicity tended to increase with advancing the grades; i.e., 11% in grade 1, 54% in grade 2 and 100% in grade 3. The 3-D mapping thus confirmed the clinical significance of ISC, and the grading of ISC was shown to faithfully reflect the risk of local recurrence.

A principle of breast-conserving surgery

Breast-conservation has recently been employed in the treatment of breast carcinoma in aims of the quality of life of the female patients. Randomized trials have established that breast-conserving therapy and mastectomy provide equivalent survival rates (Fisher et al. 1989; Jacobson et al. 1995; Veronesi et al. 1995; Mariani et al. 1998). The advent of treatment strategies for breast carcinoma that conserve the breast has generated several surgical approaches. These range from a comprehensive quadrantectomy to limited excisions of mass lesions (Holland et al. 1990; Veronesi et al. 1990, 1995; Touboul et al. 1999). The limited excisions have cosmetic benefits, but lack surgical radicality resulting in local treatment failure (Holland et al. 1990; Veronesi et al. 1990, 1995; Smitt et al. 1995; Mariani et al. 1998). On the contrary, the quadrantectomy has an advantage in surgical control of breast carcinoma, but reduces cosmetic outcome (Van Limbergen et al. 1989; Raja et al. 1997). Postoperative irradiation is generally applied to the

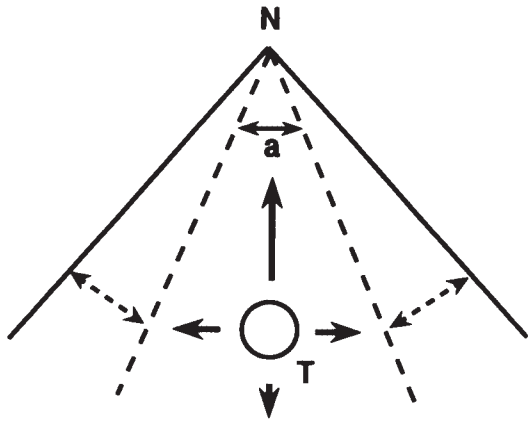

Fig. 6. Schematic diagram showing the rationale of quadrantectomy. *T* denotes tumor, *a* is the angle which covers the area where a duct-lobular system extends. The dotted arrows demonstrate the distances between the surgical stump and the duct-lobular system.

patients when the limited excisions are performed. However, surgical treatment should reduce the chance of local recurrence (Ghossein et al. 1992; Pittinger et al. 1994; Mariani et al. 1998).

Fig. 6 shows the rationale of quadrant resection based on segmental anatomy; breast carcinoma has been shown to originate from the TDLU and extends intraductally and/or extraductally (Ohuchi et al. 1984a, 1994) toward central, peripheral, or lateral directions. The duct-lobular system is generally defined within an average angle of 60° (*a* in Fig. 6). Therefore, a carcinoma-free margin could be obtained when the quadrant area was removed unless the breast had multicentricity.

Quadrantectomy with immediate volume replacement using lateral tissue-flap

The quadrantectomy has an advantage in surgical control of breast carcinoma, but may reduce cosmetic outcome. Based on the segmental anatomy of the breast in which duct carcinoma extends along the duct-lobular system, we have developed a novel breast-conserving surgery consisting of quadrantectomy and axillary dissection, followed by immediate volume replacement using a lateral tissue flap (LTF) for breast reconstruction (Ohuchi et al 1997). All patients who met the criteria (Table 4) were informed of their disease condition and possible treatment methods, either mastectomy or breast-conserving therapy.

For breast-conserving surgery, the S-shaped, lateral skin incision is performed from the apex of mid-axillary line to the infra-mammary fold, without removing the overlying skin (Fig. 7). The mammary gland is exposed by dividing the subcutaneous tissue from Cooper's ligament, creating a thin skin-flap. The upper lateral tissue along the pectoralis major muscle and the axilla are exposed, then the axillary fascia is cut to open the axillary lymph nodes. This early dissection makes it possible to define the status of lymph nodes whether or not carcinoma

TABLE 4. *Entry criteria for breast-conserving surgery*

1.	Tumor size ≤ 3 cm on clinical breast examination and mammography, without skin or chest wall fixation.
2.	Site of mass was not considered to be excluded even if the tumor was located under the nipple.
3.	Masses with multicentricity, or masses with diffuse micro-calcification are excluded.
4.	Postoperative radiation was performed when histopathology revealed either positive margin or axillar node metastasis.
5.	Adjuvant systemic therapy with Tamoxifen.
6.	Patients selected breast-conserving surgery based on informed consent at free will[a].

[a]All patients who met criteria 1–5 were informed of their disease condition and offered treatment options of either mastectomy or breast-conserving surgery.

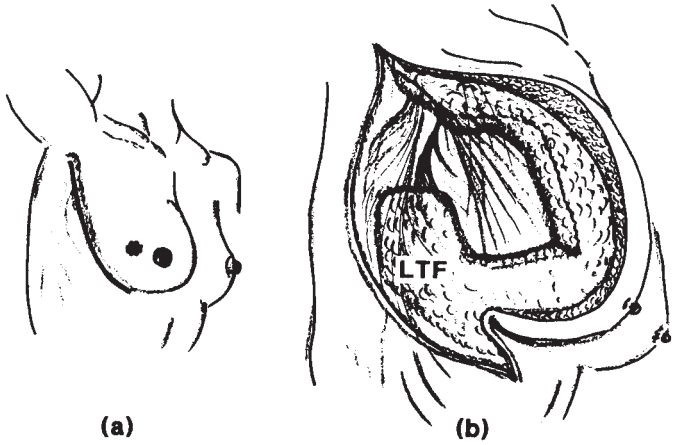

Fig. 7. (a) S-shaped skin incision from the apex of mid-axillar line to the inframammary skin fold. (b) Exposure of mammary gland after axillary dissection and quadrantectomy. LTF denotes lateral tissue-flap.

metastasis is present. While preserving the vessels and nerves (i.e., the thoracodorsal vessels and nerve, the inferior thoracic vessels and nerve, the thoracoepigastric vein and the intercostobrachial nerves) the axillary lymph nodes are dissected from levels 1 to 2. If the nodes are swollen, suggesting carcinoma metastasis, the dissection is extended to level 3. The LTF is effortlessly defined through the lateral aspect of the incision between the latissmus dorsi fascia and the costal margin beside the outer mammary gland. The LTF is then precisely removed from the latissmus dorsi fascia. To maintain the vascular supply of the LTF one should preserve the lateral thoracic vessels which run through axillar levels 1 and 2 to the costal margin below.

The quadrant area harboring the tumor is then resected with a surgical margin of 3 cm in all directions. The collecting duct and/or lactiferous sinus under the nipple is sharply separated and resected to prevent carcinoma residue in the duct-lobular system possessing the tumor. When the tumor is located near or under the nipple, the gland exceeding the nipple with a 3 cm margin apart from

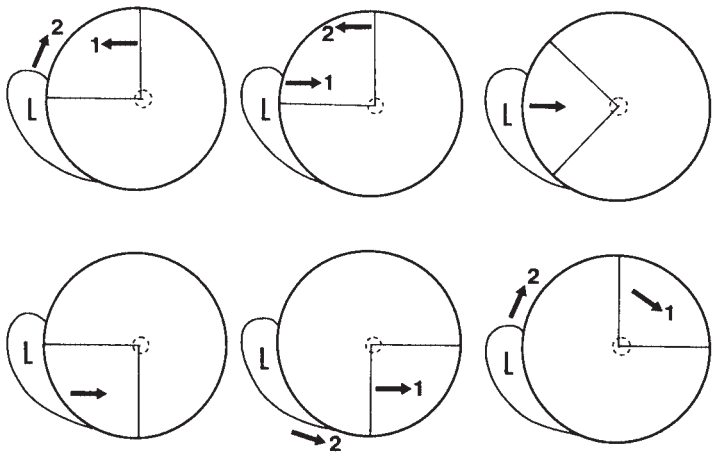

Fig. 8. Transposition using LTF (L) and residual galnd for immediate volume replacement. When tumor is located in the upper-outer area and the referral quadrant is resected, the inner part of the gland is shifted outside, then the LTF is transposed to the upper-outside (top left), or the LTF is moved inside the nipple, then the inner gland is rotated to the outside (top center). When the mid-outer quadrant is resected the LTF is transposed to replace the volume deficit (top right). The LTF is moved below and inside when quadrantectomy is performed at the lower-outer quadrant (bottom left). The residual gland in the lower-outer part is first shifted and the LTF is rotated inside when the tumor was present in the lower-inner quadrant (bottom center). The upper-outer gland is transposed, followed by shifting of the LTF when the upper-inner quadrant is resected (bottom right).

the tumor is resected. The angle less than 90°, however, can be applied when the tumor is small and the tumor-nipple distance is longer than 4 cm. The peripheral portion of the gland should also be resected at 3 cm away from the mass.

Breast reconstruction using LTF is performed as follows; first, the deficit portion of the gland and the volume demanded are investigated. An appropriate volume of LTF is harvested with or without dividing the tissue from the outer mammary gland. If the volume of LTF is not enough to supplement the defect, the residual mammary gland is rotated together with the LTF, as illustrated in Fig. 8. For instance, when the tumor is located in the upper-outer area and the referral quadrant is resected, the inner part of the gland is shifted outside, then the LTF is transposed to the upper-outside of the gland (Fig. 8, top left), or the LTF is moved inside the nipple, then the inner gland is rotated to the outside (Fig. 8, top center). There are some modifications of the methods according to the location of the tumor and the volume required to replace the deficit. Care is taken to avoid devascularization of the LTF as well as the residual mammary gland when they are transposed. Also, the overall volume of the flap should be adequate to allow for a small degree of postoperative atrophy, although this is not common compared to the breast-reconstruction using the latissmus dorsi flap (LDF). Two layered sutures are performed to model the tip of the flap under the nipple. This method helps to construct the breast mound for a better cosmetic

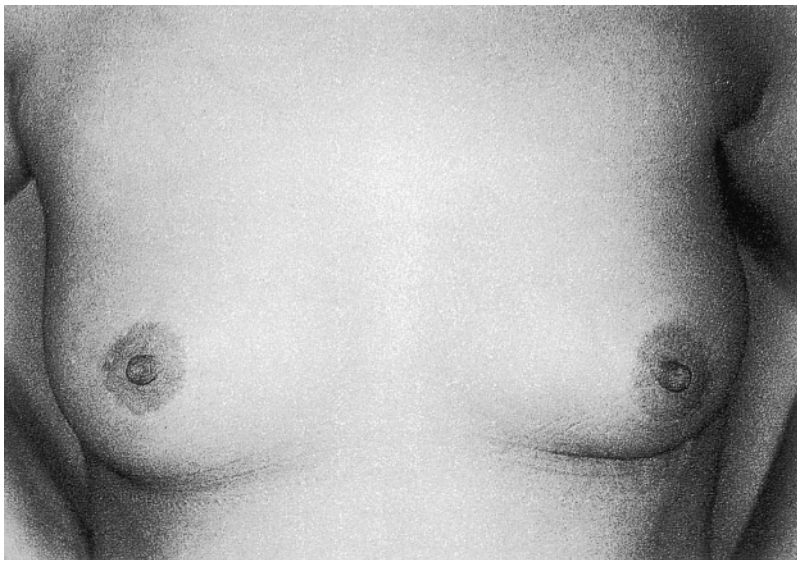

Fig. 9. A cosmetic outcome of a patient three years after breast conserving surgery using LTF volume replacement for her left breast cancer.

outcome. The breast cancer patients undergoing immediate volume replacement with the LTF showed better cosmetic outcome than patients who underwent breast reconstruction using the LDF (Fig. 9).

Discussion

It is essential for surgeons to understand the origin and the extending pattern of breast cancer, and make the surgical margin negative in breast-conserving surgery (Holland et al. 1998; Page and Simpson 1999). The quadrantic distribution of breast cancers influences the extent of excision and may predict the pattern of recurrence when tumor clearance is incomplete. Surgical treatment should reduce the chance of local recurrence.

A quadrantectomy is an operation which can remove a significant portion of the quadrant of the breast where the primary carcinoma is located. For small cancers, the classic concepts of oncological surgical practices, i.e., removal of an extensive portion of normal tissue around the primary, en-bloc removal of overlying skin and underlying muscular fascia, may be maintained without total mastectomy. This idea follows a similar evolution of thought in other fields of surgical oncology, e.g., partial gastrectomy instead of total gastrectomy, lung lobectomy or removal of a lung segment instead of pneumonectomy, when small cancers are found.

These ideas have developed essentially because of the remarkable change in the characteristics of the patient population that has occurred in the last decades. More extensive information, better education, more sophisticated diagnostic tools, and expansive screening campaigns all has contributed to earlier detection of breast cancer. Women today are aware that if the primary cancer is small, most of the breasts may be spared with adequate surgery with or without radiation

therapy. This innovative view of breast cancer treatment has also stimulated women to participate more actively in screening programs (Ohuchi et al. 1993, 1995; Shapiro et al. 1998), knowing that if a small cancer is found, treatment can preserve the breast.

Certainly, the quadrantectomy poses some cosmetic problems. In a breast of normal size, it produces acceptable results, but in small breasts, the cosmetic results may be unsatisfactory. Therefore in selected cases, the option of total mastectomy and immediate reconstruction may be considered. However, surgeons must be trained to reshape the breast after quadrantectomy. We described the immediate volume replacement using the LTF in breast-conserving surgery for primary breast cancer. Breast-conserving therapy must provide not only survival equivalent to mastectomy but also low rates of local recurrence, sufficient cosmetic results, and a low incidence of complications. Various factors have been identified that affect the rate of recurrence in the ipsilateral breast after breast-conserving surgery (Holland et al. 1990; Van Dongen et al. 1992; Johnson et al. 1995; Smitt et al. 1995; Gage et al. 1996). The use of radiotherapy after surgery was consistently associated with a crude reduction in the rate of local recurrence (Lijegren et al. 1994; Veronesi et al. 1995). However, whether or not radiotherapy is necessary following surgery for all subgroups of patients remains an unresolved issue. The quadrantic distribution of breast cancers influences the extent of excision and may predict the pattern of recurrence when tumor clearance is incomplete. Residual carcinomas were found in 42% of breasts 2 cm away from the referral carcinomas, whereas residues were found in only 10% of breasts 4 cm away from the tumors as described by Holland et al. (1985). We found residual carcinomas in 45%, 30% and 15% at distances of 1 cm, 2 cm and 3 cm, respectively from the primary lesion (data not shown). Other clinical data support these findings (Veronesi et al. 1995; Mariani et al. 1998), indicating extent of excision and margin involvement as strong precursors of local recurrence. Therefore, a significant reduction in both margin involvement and local recurrence could be obtained if patients were treated by quadrantectomy, an extensive local excision which could maximize local control (Gruenberger et al. 1998).

It must be emphasized that the quadrantectomy is a surgical procedure that may be defined as "radical" in the sense that it aims at removal of all the carcinoma cells of the primary tumor. Other procedures, such as lumpectomy, tylectomy, or tumorectomy, are just "debulking" operations whose objective is to reduce the mass of cancer tissue in order to improve the efficacy of post-surgical radiation therapy. The principle of the breast conserving surgery is to obtain negative surgical margins. Therefore, a tight quadrant resection is not always a concern if the stump is more than 3 cm away from the tumor. Quadrantectomy followed by radiotherapy has had excellent results, not only in overall survival but also in the incidence of local recurrences, with rates ranging from 3% to 5%, which is comparable to the rate of recurrence following the Halsted mastectomy

and probably lower than the rate of local recurrence after modified radical mastectomy. Our strategy is to identify patients in whom irradiation might be safely omitted after the breast-conserving surgery.

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