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Axilloscopy and endoscopic sentinel node detection in breast cancer patients

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Abstract
Background: Sentinel node biopsy is a promising technique that allows the axillary status of breast cancer patients to be predicted with high accuracy. Reducing false negative results remains a major challenge for the improvement of this procedure. Furthermore, new techniques are required to achieve axillary clearing with less morbidity in cases of unsuccessful mapping or multicentric carcinoma. We analyzed whether axilloscopy and endoscopic sentinel node biopsy is a feasible procedure for visualization of the axillary space and resection of the sentinel node using endoscopic techniques.
Methods: Following blue dye–guided lymphography and liposuction of the axillary fat, endoscopic axillary sentinel node biopsy was performed in 35 breast cancer patients. We then assessed the exposure of anatomical landmarks, the detection rate of the sentinel node, the false negative rate, and the accuracy of consecutive axillary clearing.
Results: In almost every case, an excellent anatomical orientation was achieved. The detection rate for the sentinel node was 83.3%. In one case, the sentinel node did not reflect the status of the residual axilla. A mean number of 17.1 lymph nodes was harvested at consecutive axillary clearing.
Conclusions: Axilloscopy and endoscopic sentinel node biopsy, following liposuction of the axillary fat, is a feasible procedure that allows identification and minimally invasive resection of the sentinel node with high accuracy. The endoscopic approach might help to minimize the pitfalls of sentinel node biopsy by visualizing the axillary space. In future, it may become a technique that enables minimally invasive axillary clearing when complete lymphadenectomy is required.

Key words: Breast cancer — Cancer — Endoscopy — Lymphadenectomy — Sentinel node

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Minimally invasive procedures for the evaluation of axillary status are becoming more and more important in breast cancer surgery for small tumors. An increasing number of studies have shown that sentinel node biopsy is a promising means of predicting axillary status by limited surgery [4, 6, 10, 16]. The false negative rate varies between 0% [1] and 25% [12], and the sensitivity varies between 75% [2] and 100% [12]. The pitfalls of this method are related to certain characteristics of the primary tumor (multicentric carcinoma, peritumoral vascular or lymphatic invasion) [16]; they may also arise in cases when the primary draining node has lost its functional lymphatic capacity due to tumor invasion and therefore cannot be detected [2, 11]. These problems limit the oncologic security of lymphatic mapping in breast cancer patients.

Two techniques for the identification of a sentinel node are currently being discussed. The method described by Giuliano et al. makes use of peritumoral blue dye injection in order to identify the first draining blue-stained lymph node [6]. This approach is simple and cost-effective. Another way to detect the sentinel node is by injection of radiolabeled colloids near the tumor site, with consecutive identification by a hand-held gamma probe [1, 2, 9]. This technique is more costly and requires interdisciplinary cooperation between the surgeon and the radiologist. For the blue dye technique, the detection rate for the sentinel node seems to be slightly lower than for the technique using radiolabeled tracers [7, 10, 12, 16]. Another disadvantage of the blue dye–guided lymphatic mapping procedure is that extensive preparation of the axillary soft tissue is required before identification of the sentinel node [2, 11].

Recently, Suzanne et al. introduced a technique in which endoscopic lymphadenectomy is performed following liposuction of the axillary fat [15]. In a pilot study of 30 patients, we were able to confirm that endoscopic axillary dissection is a reliable technique for removing the lymph nodes of breast cancer patients [11]. In this study, we examined whether endoscopic sentinel node dissection following lipoaspiration is a feasible procedure for combining visualization of the axillary space with minimally invasive sentinel node resection.

Materials and methods

Following a pilot study in which endoscopic axillary lymph node dissection proved to be a reliable procedure for axillary clearing in breast cancer patients, all women who presented at our department with suspicious lesions of <2 cm in diameter and clinically negative axillary status were free to choose either conventional or endoscopic axillary dissection in cases of proven carcinoma. In a series of 35 patients, endoscopic sentinel node detection was performed following blue dye–guided lymphography and aspiration of the axillary fat. After identification and resection of the sentinel node, axillary clearing was completed for levels I and II using endoscopic techniques. All patients signed a written consent.

Surgical technique

Histology was obtained either by preoperative jet-needle biopsy or excisional biopsy with intraoperative frozen section. Then 1.5 ml of isosulfan blue (Lymphazurin, Hirsch Industries, Richmond, VA, USA) was rejected at three sites cranial, lateral, and caudal to the tumor. After a mean time of 20 min, the tumorectomy was performed.

Axilloscopy was prepared by lipoaspiration of the axillary fat. Prior to performing liposuction, 200–340 cc of a tumescent solution containing 200 cc of aqua bidest, 200 cc NaCl 0.9% solution, 1 ml Adrenalin 1:1,000, and 40 cc Xylocaine 1% were injected into the axilla. The axillary space was then dilated with carbon dioxide gas using a pressure of 7 mmHg and a gas flow of 1 L/min.

A 10-mm trocar was inserted into the apex of the axilla. Two 5-mm trocars were inserted at the lateral border of the pectoralis major muscle and the latissimus dorsi muscle. The blue-stained sentinel node was identified and resected using a 5-mm grasping forceps and a pair of monopolar scissors. The sentinel node was sent separately for histologic examination. Axillary lymph node dissection was completed for levels I and II using the endoscopic technique described above (Figs. 1–5).

Histologic examination

The histopathologic examination of all resectioned lymph nodes was completed using the standard procedure. The removed lymph nodes were fixed in 4% formaldehyde solution, freed from the surrounding fatty tissue, and treated as follows: Lymph nodes <5 mm were halved, and the two halves were embedded in paraffin. Larger lymph nodes were lamellated and likewise completely embedded. All blocks of specimens were cut into at least four sections. All specimens were dyed conventionally using hematoxylin/eosin (H/E). For those lymph nodes designated as “sentinel node” that had not indicated tumor cells in the H/E coloring, an additional immune histochemical examination was carried out.

Results

The mean age of the patients was 52:4 years. Between 9 and 64 g (mean, 44.3) of axillary fat were aspirated by liposuction. Visualization of the axillary space and identification of anatomical landmarks was excellent in all but two patients, who presented with extreme obesity. Liposuction was insufficient in these cases to allow adequate anatomical orientation. In one case, the operation was converted to open axillary dissection for oncologic safety reasons. In this patient, several suspicious lymph nodes >1 cm in diameter were detected endoscopically and later confirmed as positive on frozen section.

The sentinel node was identified in 30 of 35 cases. The detection rate was 83.3%. A mean number of 1.4 stained nodes (min, one; max, three) were identified. In eight of 35 patients, axillary status was positive on histologic examination; in 27 of 35 cases, no axillary metastases were found. In one patient, the negative sentinel node did not reflect the status of the residual axilla. In this case, intramammary lymphatic tissue invaded by tumor cells was found in the definitive histopathologic evaluation. The blue-stained sentinel node was negative, whereas two other axillary nodes were positive at microscopic examination. In every case, sentinel node biopsy was followed by complete endoscopic axillary clearing in levels I and II. A mean number of 17.1 lymph nodes (min, 12; max, 28) were resected.

Intraoperative blood loss was minimal. No operation had to be converted to an open procedure because of uncontrolled bleeding. A suction system was used in only three cases.

Discussion

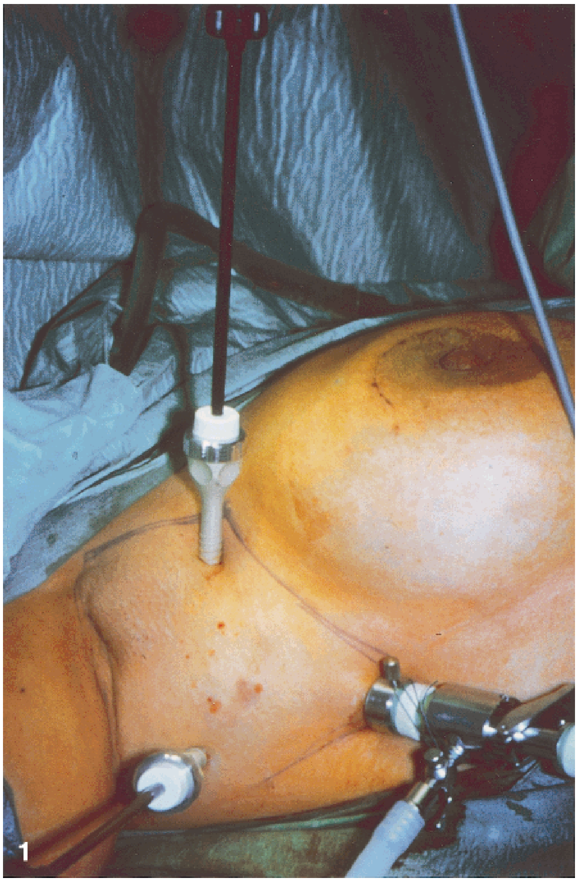
Axillary status is the most important predictor for disease-free survival and overall survival in breast cancer patients [14]. Therefore, thorough exploration of axillary lymph nodes is indispensable in ensuring local tumor control and adequate adjuvant therapy. Although imaging techniques have shown insufficient sensitivity and specificity, new minimally invasive techniques that are expected to allow exact histologic determination of axillary status with reduced shoulder-arm morbidity are now at the stage of clinical evaluation.

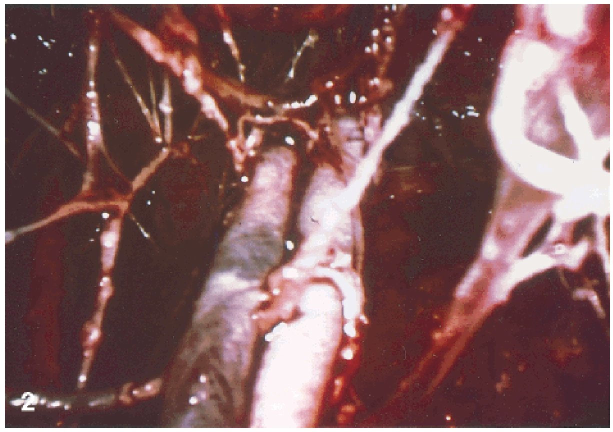
Suzanne et al. were the first to publish a new approach to axillary clearing [15]. They described an endoscopic lymph node dissection following lipoaspiration of the axillary fat. The feasibility of endoscopic axillary dissection was proven by several other authors [3, 8, 11, 13]. Our own data confirm the fact that axilloscopy permits good visualization of the axillary space and that the number of lymph nodes resected endoscopically is comparable to the number of nodes harvested with open techniques. Complete endoscopic axillary clearing of levels I and II, however, is a time-consuming technique that requires considerable surgical skill and experience.

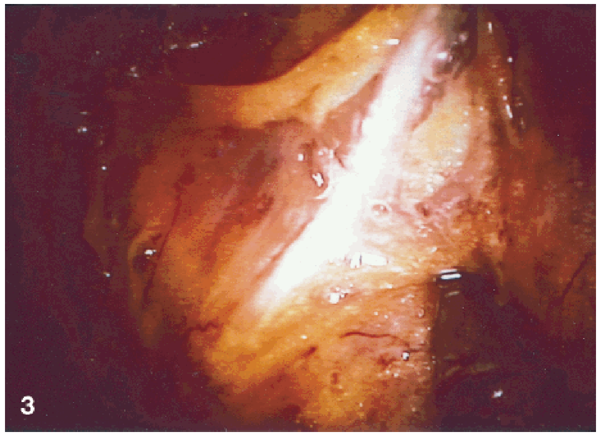
Sentinel node biopsy seems to be another promising means of achieving the goal of reduced shoulder-arm morbidity by limited axillary dissection. In contrast to complete axillary clearing, this technique entails two risks: (a) that the sentinel node may not be detected, (b) that the results may actually be false negative.

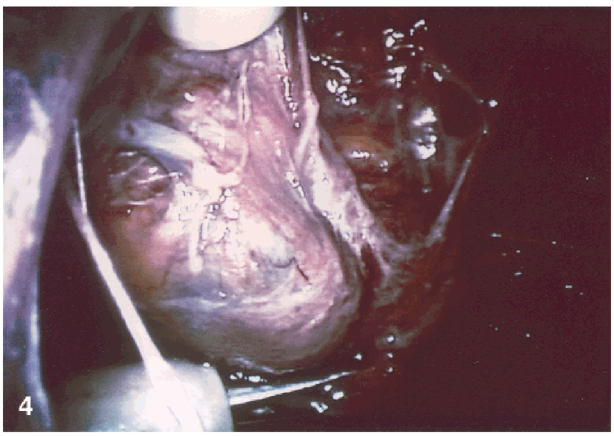
Although lymphatic mapping techniques using blue dye–guided lymphography seem to provide lower rates of sentinel node detection in comparison to techniques using radiolabeled tracers, the predictive value, seems identical (Table 1). In our series of endoscopic sentinel node biopsies, the rate of identification was slightly higher than that described by many authors for the blue dye technique using an open approach. Giuliano et al. reported a detection rate of 93.5%; however, this high rate has so far not been achieved by others.

The time between blue dye injection and axillary surgery may be a factor that influences the detection rate for the sentinel node using the blue dye technique. For traditional reasons, in our series tumorectomy was performed









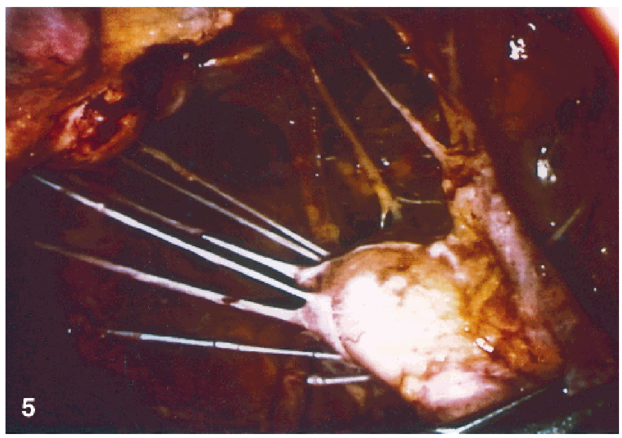


Fig. 1. Trocar placement for endoscopic lymphodenectomy.

Fig. 2. Thoracodorsal vessel.

Fig. 3. Long thoracic nerve.

Fig. 4. Blue-stained sentinel node with afferent lymphatic vessel.

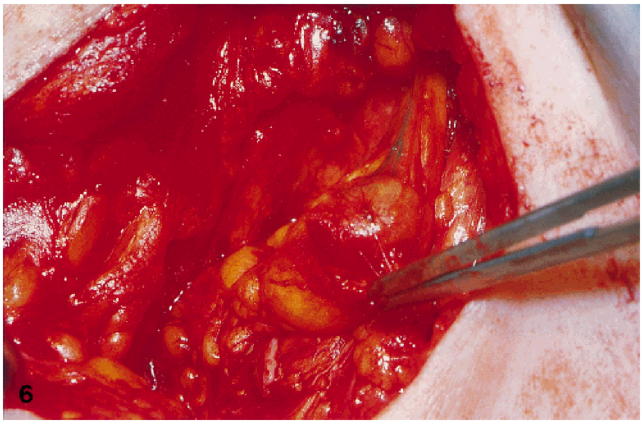
Fig. 5. Enlarged nonstained node with lymphatic vessels.

prior to axillary dissection. Further studies are necessary to show whether the detection rate obtained can be improved by performing axillary dissection prior to tumorectomy, thus shortening the interval between blue dye injection and axilloscopy.

The main objective for the development of new techniques for examining axillary status is the reliable histologic evaluation of the lymphatic basin of the breast combined with reduction of shoulder-arm morbidity. A major disadvantage of the blue dye technique is the fact that identification of the sentinel node may be associated with extensive preparation of the axillary space (Fig. 6) [2, 11]. The existence of several sentinel nodes is excluded only after thorough exploration of axillary soft tissue. The use of a hand-held gamma probe may reduce the surgical trauma of sentinel node detection in comparison to the blue dye–guided technique. However, in some cases, the technique may require a procedure that is not exactly “minimally invasive”—in cases, for example, of limited tracer uptake in the first draining node as a result of reduced functional capacity (e.g., fatty degeneration, tumor invasion) (Fig. 7), or in patients who have eccentric tumors in the upper outer quadrant

Table 1. Sentinel node biopsy in breast cancer: results of international trials

First author (year)	*n*	Technique	Rate of detection (%)	Sensitivity (%)
Albertini (1996)	62	Blau + Tc	91.9	100
Günther (1997)	145	Blau	71.0	90.3
Veronesi (1997)	163	Tc	98.2	95.3
Giuliano (1997)	107	Blau	93.5	100
Roumen (1997)	83	TC	68.7	95.7
Flett (1998)	68	Blau	82.4	83.3
O'Hea (1998)	59	Blau	74.6	88.9
	59	Tc	88.1	75.0
	59	Blau + Tc	93.2	87.0
Krag (1998)	443	Tc	91.4	88.6
Cox (1998)	466	Blau + Tc	94.4	98.0
Borgstein (1998)	104	Tc	93.8	97.7
Kühn (1999)	92	Blau	73.9	87.0



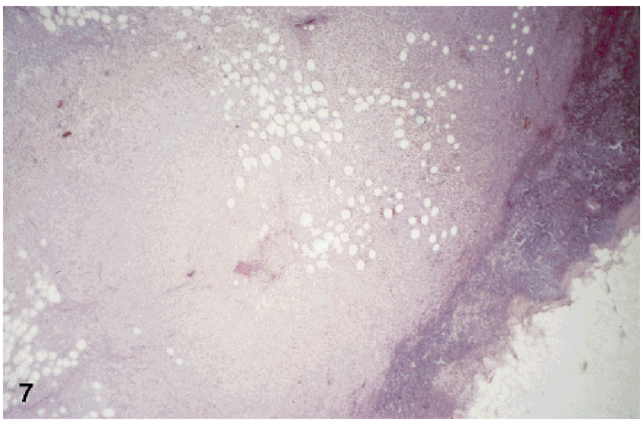


Fig. 6. Sentinel node detection (conventional technique).

Fig. 7. Sentinel node with little functional capacity due to tumor invasion.

with background radioactivity that interferes with sentinel node detection. The endoscopic approach following lipoaspiration of the axillary fat may be a method of minimizing surgical trauma in the detection of blue-stained sentinel nodes.

The rate of false negative sentinel nodes represents the oncologic risk of the technique, leading to possible local recurrence or inadequate adjuvant therapy. Incorrect prediction of axillary status is described in 0–17% of cases in the literature. These errors are mainly due to characteristics of the primary tumor (e.g., multicentricity, peritumoral vascular or lymphatic invasion) or complete tumor invasion of the first draining node, leading to uptake of the lymphatic agent in nodes other than the "true" sentinel node [2, 11]. The risk of finding false negative results due to complete tumor invasion exists for both techniques of lymphatic mapping.

While the analysis of such pitfalls and the improvement of patient selection are the objectives of clinical research, further techniques need to be developed to exclude complete tumor invasion of nondetected nodes. Imaging techniques may be one way to solve this problem. Our study shows that endoscopy may be another solution for detecting sentinel nodes with a high rate of accuracy and for identifying enlarged lymph nodes as a possible source of false sentinel node biopsy. Furthermore, this technique also provides the opportunity for complete minimally invasive lymphadenectomy when total clearing is required.

Conclusions

Improving the sensitivity of sentinel node biopsy and minimizing surgical trauma remain major challenges for the development of minimally invasive techniques in the reliable evaluation of axillary status in breast cancer patients. Axilloscopy and endoscopic sentinel node biopsy is a feasible technique that allows a high rate of sentinel node identification and provides a high predictive value for the determination of nodal status. The low number of patients with positive axillary lymph nodes in our series does not yet permit a conclusion concerning the sensitivity of the technique described, although a low false negative rate may be expected. Our finding of mean number of 17 lymph nodes during endoscopic axillary clearing indicates that endoscopy may in future be used not only to resect the sentinel node but also to complete axillary node dissection in cases of multicentric carcinoma, unsuccessful lymphatic mapping, and perhaps even in patients with positive axillary status.

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