14.1 Introduction

Some form of axillary surgery is an integral component in the locoregional management of early breast cancer. Surgical techniques have become progressively less extensive over the past 30 years in terms of both parenchymal and nodal resection of breast and axillary tissues, respectively. Despite the widespread introduction of breast conservation surgery (BCS), a formal axillary lymph node dissection (ALND) was, until recently, the standard procedure of choice for the management of the axilla in the majority of patients irrespective of primary tumour characteristics. Breast screening programmes and heightened public awareness have led to smaller tumour size at presentation and a lower proportion of patients with nodal involvement. Approximately 25–30% of patients now have nodal disease at the time of diagnosis compared with 50% two decades ago [1]. For those patients with positive nodes, removal of axillary nodes containing tumour foci minimises the chance of locoregional relapse and can provide crucial information for guiding systemic adjuvant treatments. Moreover, axillary nodal status remains the single most important prognostic factor in breast cancer and has yet to be superseded by newer molecular indices [1, 2]. Nonetheless, for node-negative patients with favourable primary tumour parameters, ALND represents over-treatment and can be associated with significant morbidity [3, 4]. Increased rates of node negativity have spurred the investigation of non-invasive methods for imaging the axillary nodes. However, these alone are questionable as a staging modality because of the limitations of resolution at the microscopic tumour level. Axillary ultrasound in combination with percutaneous node biopsy for tissue acquisition is yielding useful pre-operative staging information on regional nodes [5]. The optimum method for managing the axilla in breast cancer patients remains controversial, but there is compulsion to apply surgical methods for purposes of staging in all patients with invasive cancer. The aforementioned stage shift coupled with failure of ALND dissection to confer any clear survival benefit [6, 7] have prompted exploration of less intrusive methods for surgical staging of the axilla. These alternative methods involve either a blind or targeted form of sampling in which a variable, though restricted, number of nodes are removed (usually <4–5 nodes). Non-targeted sampling of the axillary nodes has been championed by a surgical minority for several years, but this technique has now evolved into a targeted form of sampling using blue dye alone, the so-called blue dye-assisted node sampling (BDANS) [8]. Sentinel lymph node biopsy (SLNB) has been embraced around the world as a standard of care for breast cancer patients and ideally incorporates dual localization techniques using both blue dye and radioisotopic localization. Though SLNB is now the dominant method for staging the axilla in clinically node-negative patients, technical aspects mandate standardisation and confirmation that long-term survival is not impaired as a consequence of either withholding systemic therapies or failing to remove non-sentinel nodes in the context of false negativity is awaited.

Breast cancer is a heterogeneous disease in terms of its pathobiology and this renders any blanket approach to the management of the axilla inappropriate. A selective policy based on thresholds of probability for nodal involvement could include not only ALND, but also SLNB, BDANS and observation alone. It should be noted that it is not the absolute incidence of nodal

---

J. R. Benson
Cambridge Breast Unit, Addenbrooke’s Hospital, Hills Road, Cambridge, CB2 0QQ, UK
e-mail: john.benson@addenbrookes.nhs.uk

---

Sentinel Node Concept
John R. Benson and Vassilis Pitsinis
involvement per se which is important, but rather the proportion of these metastases which develop into clinically relevant disease. The latter might manifest either as locoregional relapse or as distant metastases, which have arisen from axillary deposits acting as a source for tertiary spread.

This chapter will address nodal anatomy and patterns of lymphatic dissemination in breast cancer together with underlying biological paradigms. Some basic clinical issues will be discussed, including the indications for ALND, the optimum method for staging the axilla in patients who do not require ALND and whether a group of patients for whom axillary surgery can be safely omitted exist.

### 14.2 Anatomy of the Axillary Lymph Nodes

An understanding of nodal anatomy is important in the surgical management of breast cancer. There is often confusion in the designation of nodal groupings with classification based on clinical, anatomical or surgical criteria.

1. **Clinical groupings** – medial, lateral, anterior, posterior, apical
2. **Anatomical groupings** – lateral, anterior (pectoral), posterior (subscapular), central, subclavicular, interpectoral (Rotter’s)
3. **Surgical** – the axillary lymph nodes can be divided into three compartments, which are defined in terms of their relationship to the pectoralis minor muscle [9].

**LEVEL I** – nodes below and lateral to the pectoralis minor muscle

**LEVEL II** – nodes deep to the muscle and lying posterior to the medial and lateral borders of the pectoralis minor muscle

**LEVEL III** – nodes above and medial to pectoralis minor

A complete ALND refers to removal of axillary nodes at levels I, II and III, whilst a partial ALND implies a more limited clearance of nodes at levels I and II only. The term sampling describes a blind or targeted resection of a variable number of nodes, usually at level I; the number of nodes removed is generally inversely related to the degree of targeting (Fig. 14.1).

### 14.3 Lymphatic System of the Breast

Metastases to regional lymph nodes is a common pattern of dissemination for solid epithelial tumours, which commonly invade local structures and spread in a progressive and sequential manner from a primary tumour focus. The locoregional pathways of spread lie in anatomical continuity with lymphatic vessels, which act as a link between the index tumour and regional nodes. Metastatic dissemination of breast cancer occurs predominantly via the lymphatic system in accordance with the Halstedian paradigm, though it is acknowledged that a significant proportion of breast cancers are systemic at the outset as a result of tumour cells entering the bloodstream at an early stage of neoplastic development. Furthermore, such haematogenous dissemination is not conditional upon nodal involvement and access to the circulation can occur through both lymphatico-venous communications in regional nodes and the “leaky” endothelium of the tumour neovascularity.

The lymphatics of the breast form an extensive and complex network of periductal and perilobular vessels, which drain principally to the axillary nodes. The mammary gland is derived from ectoderm and develops from anterior thoracic wall structures. As noted by Haagensen [10], the lymphatics of the breast skin and parenchymal tissue are interconnected, and this accounts for preferential drainage of cutaneous malignancies to axillary nodes. Moreover, current practises in SLNB, whereby tracer agents are injected intradermally, are dependent upon the lymphatic system of the breast functioning as a single biological unit. Flow within this network of valveless vessels is passive, and this results in a degree of plasticity, which is relevant to malignant infiltration; the unidirectional flow of lymph may be diverted due to blockage at proximal sites by tumour emboli. The subepithelial lymphatics of the skin of the breast represent part of the superficial system of the neck, thorax and abdomen. These vessels are confluent over the surface of the body, and the subepithelial plexus of lymphatics communicates directly with subdermal vessels to form a cutaneous plexus. Within the region of the nipple-areolar complex, this cutaneous plexus is linked to the Sappey subareolar plexus, which receives lymphatics from the glandular tissue of the breast and has a key role in accommodating the dramatic surges of lymph flow occurring during