Invited Commentary: Use of Electrical Impedance Spectroscopy for Intraoperative Tissue Differentiation During Thyroid and Parathyroid Surgery

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It is undisputed that, during thyroidectomy, a common problem is to identify the parathyroid glands so that their preservation in situ can be guaranteed. Indeed, hypoparathyroidism is the most common complication following thyroidectomy. For example, central lymph node clearance following thyroidectomy for malignancy carries a substantial risk of unintentional removal of healthy parathyroid glands. Furthermore, unnoticed damage of the vascular supply to the parathyroid glands increases the risk of hypoparathyroidism.

For this reason—to minimize the risk of permanent hypoparathyroidism—the search for tools that allow distinction between the different types of tissues involved in thyroid surgery and also identification of de-vascularized parathyroid glands have long been a field for the development of various technical aids for the surgeon. Almost 50 years ago, methylene blue was proposed as a tool for parathyroid identification [1]. Even the use of gamma probe identification of parathyroids during thyroidectomy has been proposed [2], and more recently, fluorescent techniques have been introduced [3, 4].

Now an entirely different technique for tissue identification during neck surgery has been proposed by a group in Sheffield, UK [5]. This relies on differing patterns of impedance in the tissues of concern, for example, thyroid and parathyroid tissue. This novel technique, electrical impedance spectroscopy (EIS), seems useful in the detection of early cervical cancer and aids in judging radicality in operations for this condition and probably also for

equivalents in the oral cavity. It seems easy to use, with no specific demands of technical knowledge for its use, and seems not to be too time-consuming. In this first pilot study, parathyroid tissue could be distinguished from thyroid tissue with a sensitivity of 76% and specificity of 60%.

Still, much more development is needed before EIS can be regarded as truly promising. Firstly, a software specific for neck surgery must be constructed, allowing for immediate feed-back of EIS patterns to the surgeon. Secondly, distinction between parathyroid tissue and (especially) lymph nodes should be proven possible with higher specificity and sensitivity than that between thyroid and parathyroid tissue; the latter is seldomly of major concern, although potentially useful. Lastly, EIS is not yet proven useful in identifying de-vascularized parathyroid glands, as the change in impedance of glands in vivo and ex vivo seems to depend on drop in temperature; as de-vascularized glands still in situ may keep the surrounding's temperature during the operation, EIS may not be able to detect the necessary differences.

The tools for aiding in surgical judgement of tissues in neck surgery are adding up, which is good news. Still, they must prove cost effective in all perspectives to justify introduction in everyday routine. It will be exciting to follow the development of EIS in this respect: although an experienced surgeon probably still has superior specificity and sensitivity in identifying parathyroid glands, the aim must be zero patients with permanent hypoparathyroidism following thyroid surgery. All thyroid surgeons long for a simple, quick and cheap tool to reach this goal.

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