Cutting Edge in Thyroid Surgery: Autofluorescence of Parathyroid Glands

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BACKGROUND: Identification of parathyroid glands may be challenging during thyroid and parathyroid surgery. Accidental resection of the glands may increase the morbidity of the surgery. The aim of this study was to evaluate accuracy in identification of autofluorescent parathyroid glands with the use of near infrared light in real time.

STUDY DESIGN: Patients undergoing thyroid and parathyroid surgery between June and August 2015 were included in the study. During the procedure, the surgical field was exposed to near infrared laser light in order to analyze the intensity of the fluorescence of different tissues (parathyroid glands, thyroid glands, and background). Surgical images were recorded and analyzed.

RESULTS: Twenty-eight patients were included in the study. Nineteen patients were women and 9 were men. Seven patients had primary hyperparathyroidism, 4 had hyperthyroidism, 3 had goiters, and 11 had thyroid cancer. Three patients had mixed pathologies, including 2 patients with thyroid cancer and primary hyperparathyroidism and 1 patient with goiter and primary hyperparathyroidism. Identification of autofluorescent parathyroid glands was achieved in all patients with near infrared light.

The mean fluorescent intensity of parathyroid glands was 40.6 ($\pm$26.5), thyroid glands 31.8 ($\pm$22.3), and background 16.6 ($\pm$15.4). Parathyroid glands demonstrated statistically higher fluorescence intensity compared with the thyroid gland and background ($p < 0.0014$). No postoperative hypocalcemia or other complications related to the surgery were registered.

CONCLUSIONS: Visualization of autofluorescent parathyroid glands with the use of near infrared light allows high rates of parathyroid gland identification and could be a safe, feasible, and noninvasive method for intraoperative identification of parathyroid glands in real time. Further clinical studies must be performed to determine the cost-effectiveness and clinical application of this method. (J Am Coll Surg 2016;223:374–380. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Identification of parathyroid glands is one of the main concerns in endocrine surgery, either to preserve normal glands in thyroid surgery or to resect pathologic glands in parathyroid surgery.[1] It is usually very difficult to distinguish parathyroid glands from thyroid and surrounding tissues in the neck due to their small size and variable location.[2] The earlier the parathyroid glands are detected and correctly identified, the lower the risk is of hypocalcemia.[3]

In specialized endocrine centers, the number of incidental parathyroidectomies is about 16%.[4] The incidence of hypocalcemia can reach up to 4.5% in total thyroidectomies, rising to 11.5% in thyroidectomies with central node dissection.[5] These rates can increase to 50% for transient hypocalcemia and to 13.8% for permanent hypocalcemia in total thyroidectomies.[6] The clinical manifestation of hypocalcemia is more frequent after incidental parathyroidectomy.[7] There is a critical need for an improved intraoperative method for parathyroid identification in real time.[8] These frequent complications could be easily avoided with a safe and effective parathyroid identification method.

Disclosure Information: Equipment used in this study was provided by Fluoptics. The authors have nothing further to disclose.

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Parathyroid identification has always been a challenge, even for experienced surgeons.[9] Image guidance techniques include sestamibi scintigraphy, ultrasound (US), CT, and MRI.[10] However, these methods are limited by their inability to reliably localize normal parathyroid glands or provide real-time intraoperative information.[11] In the case of sestamibi scintigraphy, administration of a radiotracer requires an additional step and can be hindered by nonselective tissue uptake.[12] Actual methods used to achieve real-time visualization include fluorescence imaging with methylene blue (MB) or indocyanine green (ICG), but this technique requires injection of a dye.[13]

In the end, endocrine surgeons end up relying on their own expertise, frozen section, and fine needle aspiration for parathyroid identification.[14] But there are many disadvantages of these methods, including many false negatives, and the morbidity of biopsies in the vascularization of the gland.[15]

Fluorescence imaging is a groundbreaking technology that is exponentially growing and gaining acceptance in many surgical fields.[16] Real-time fluorescent cholangiography with ICG is an example of a quick, safe, and cost-effective way to visualize the biliary ducts, with outcomes comparable to those of conventional contrast cholangiography.[17] There is further research on tumor identification, sentinel lymph node identification, and lymphatic mapping, in addition to other uses.[18,19] Few studies have been published on autofluorescent parathyroid identification, and most use spectroscopy to identify parathyroid glands by measuring emission spectra of the different tissues.[20]

Visualization of parathyroid glands with fluorescence could open a broad spectrum of clinical uses such as visualization of normal parathyroid glands for preservation or identification of pathologic glands, especially in ectopic locations. The aim of this study was to evaluate the accuracy of the intraoperative autofluorescence guidance to identify the parathyroid glands.

METHODS

A total of 28 patients undergoing thyroid and parathyroid surgery for benign or malignant disease between June and August 2015 were recruited and included in the study. This study obtained institutional review board approval and followed institutional HIPAA guidelines. Informed consent was obtained from all individual participants included in the study. All procedures performed involving human participants were done in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Three experienced head and neck surgeons performed all the procedures and analyzed results. The preoperative workup included endocrine lab testing, head and neck US, fine needle aspiration, or a sestamibi study oriented to the preoperative diagnosis. Fluorescence intensities of parathyroid glands, thyroid glands, and background (brown fat, lymph nodes, and muscle) were evaluated during the surgery in real time with a Fluobeam (Fluoptics) (Fig. 1). Images were recorded and analyzed. Fluorescence intensities of parathyroid glands, thyroid glands, and background were compared. Evaluation of intensities in normal and pathologic glands (parathyroid adenomas) were investigated.

Technique

The thyroid and parathyroid glands were exposed, and the surgical field was explored with a Fluobeam (Fluoptics), which emits near infrared light with a laser system in order to visualize the intensity of fluorescence of different tissues. The class 1 laser provides an irradiance of 5 mW/cm^2 at 750 nm. Integration time was set at 333 ms/frame (3 frames/sec). The measurement was performed with surgical and room lights off. The white light provided by the Fluobeam (5,000 lux, 3,000 K, CRI 92) was on during the exploration, allowing the surgeon to

Figure 1. Fluobeam 800 equipment.