Translating Optical Imaging for Guiding Endocrine Neck Surgery

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Abstract
Thyroid and parathyroid diseases rely on surgery for definitive treatment. In these surgeries, parathyroid glands are difficult to distinguish from the thyroid and surrounding tissues in the neck, due to its small size and variability in position. Complications occur when the parathyroid or its blood supply is accidentally injured or removed during thyroidectomies. Since this is the only organ that can regulate calcium in the human body, there is a critical need for a sensitive tool that can identify the parathyroid glands and its perfusion state intraoperatively, regardless of disease state. We have successfully demonstrated that near infrared autofluorescence can be used for anatomical identification of the parathyroid gland regardless of its disease state with near 100% accuracy. The Food and Drug Administration has cleared an imaging as well as a probe-based device based on NIRAF as an adjunct tool for label-free intraoperative parathyroid gland identification.

In this talk, I will first present the journey in the development of NIRAF for parathyroid identification and show the results of a randomized multi-center clinical to determine the effect of using the fiber probe based NIRAF system in terms of surgical effectiveness, surgeon effectiveness as well as patient outcome. These results demonstrates that probe based NIRAF yields an accuracy of 94.3% and increases the confidence of all participating surgeons in correctly identifying the parathyroid gland regardless of surgeons' experience.

While surgeons like the use of the small form factor and the quantitative accuracy that the fiber probe based NIRAF provides, they also appreciate the spatial information that NIRAF imaging yields. Therefore, the next generation in the implementation of this and related technology is the development of a quantitative fluorescence imaging probe (QFIP) co-aligned with imaging modes for multi-modal imaging such as laser speckle contrast imaging to

visualize perfusion. I will present three alternative approaches for quantitative multi-modal imaging for intraoperative surgical guidance.