



Analysis Of Near-infrared Fluorescence Imaging For Detection Of Inadvertently Resected Parathyroid Glands After Endoscopic Thyroidectomy



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Introduction: Preserving parathyroid function during thyroidectomy is crucial, but remains challenging. Real-time near-infrared autofluorescence (NIRAF) aids surgeons in intraoperative parathyroid gland (PTG) identification. However, its role in detecting PTGs unintentionally removed during surgery is unclear.

Materials and methods: This prospective study included adult patients undergoing endoscopic thyroidectomy. Surgeons identified and documented PTGs visually. Excised specimens underwent visual inspection and NIRAF imaging (PDE-Neo II). All fluorescent tissues were dissected and pathologically evaluated (reference standard). One scanned image per lobe was chosen to quantify autofluorescence (AF) intensity.

Results: Overall, 95 patients underwent endoscopic thyroidectomies, with NIRAF imaging applied to 152 excised lobes. Of these, 19 lobes displayed a total of 23 spots with increased intensity. 175 specimens were sent for pathological evaluation, and 7 were confirmed to be parathyroid tissue. NIRAF demonstrated 100.0% sensitivity and 90.5% specificity for predicting parathyroid tissue, with 30.4% positive predictive value, 100.0% negative predictive value of and 90.9% accuracy. Quantitatively normalized, the AF signal intensity was significantly higher in NIRAF-positive tissues than negative (4.3 vs 1.2 times, $p < 0.0001$). Additionally, the AF signal intensity in regions pathologically confirmed of parathyroid tissue was higher than non-parathyroid tissue (9.1 vs 2.1 times, $p < 0.0001$).

Discussion/Conclusion: This study suggests that NIRAF has high sensitivity and specificity for detecting inadvertently resected PTGs after endoscopic thyroidectomy, contributing to preservation efforts. However, NIRAF-positive tissues still require additional confirmation through multiple methods, emphasizing other examinations to verify that they are indeed parathyroid tissues. Further research is warranted to refine NIRAF imaging parameters.

Table 1. Baseline characteristics of the study cohort		
Characteristic	All (n= 95)	
Age, y, mean (SD) [range]	46.81 (12.48)	[45.78, 19.4-74.2]
Sex ratio, male:female (%)	16:79	(16.84:83.16)
BMI, kg/m ² , mean (SD) [range]	22.59 (4.15)	[21.28, 19.1-30.3]
Thyroid disease, n (%)		
Nodular goiter	47	(49.47)
Follicular adenoma	20	(21.05)
Thyroiditis	4	(2.29)
Non-invasive follicular thyroid neoplasm with papillary-like nuclear features	2	(1.14)
Papillary thyroid microcarcinoma	4	(2.29)
Papillary thyroid carcinoma	18	(10.29)
Type of operation, n (%)		
Hemithyroidectomy	38	(40.00)
Bilateral thyroidectomy	57	(60.00)

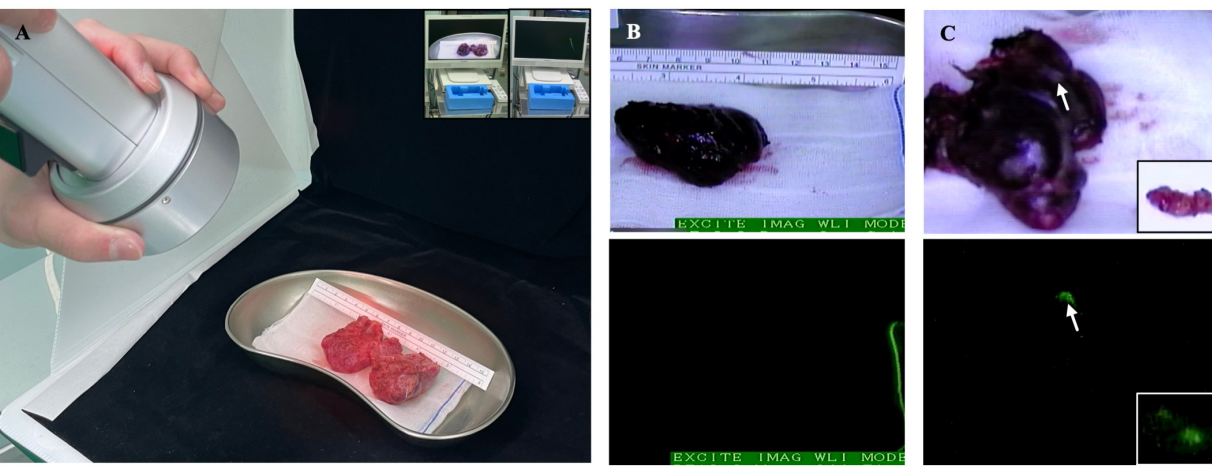
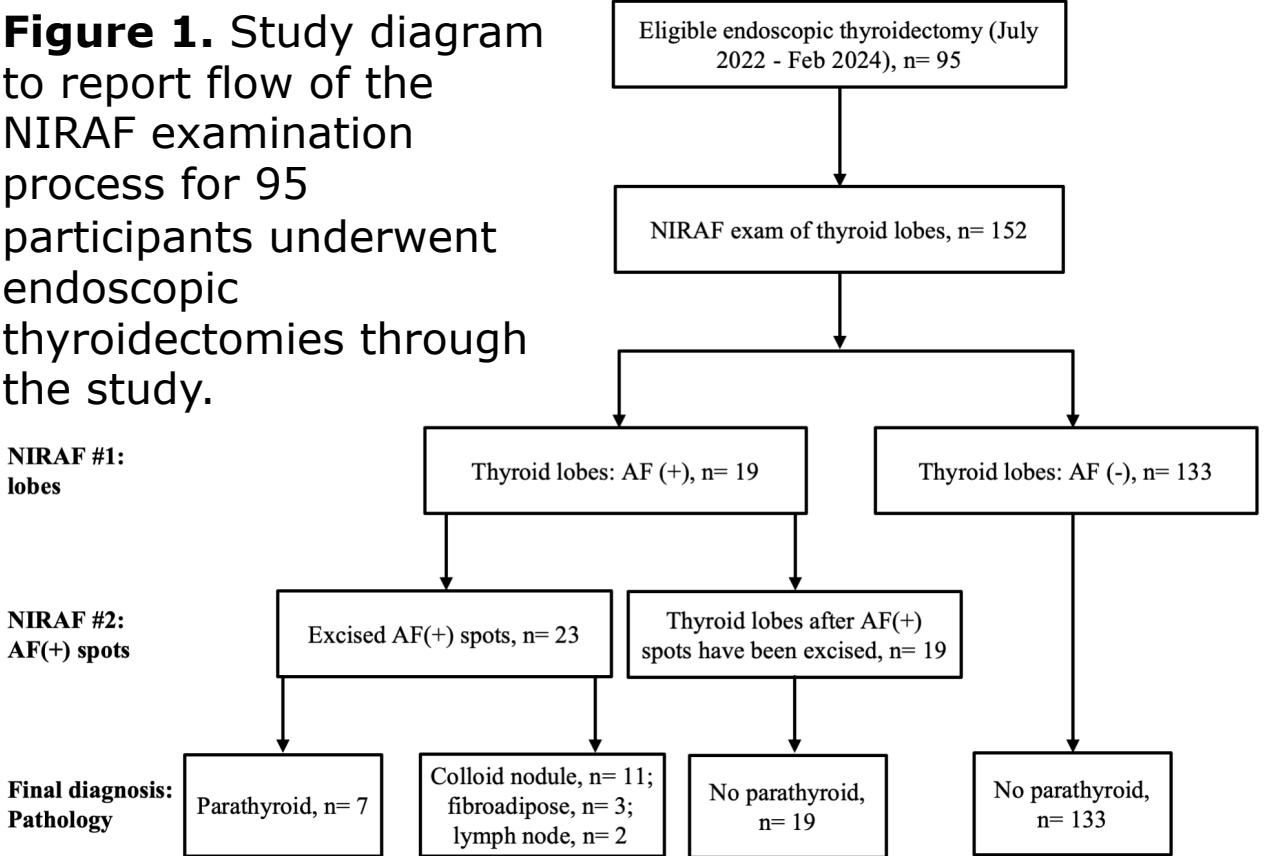


Figure 2. Evaluation of surgically excised thyroid lobes with NIRAF: schematic diagram, examination examples, and identification of potential PTGs.

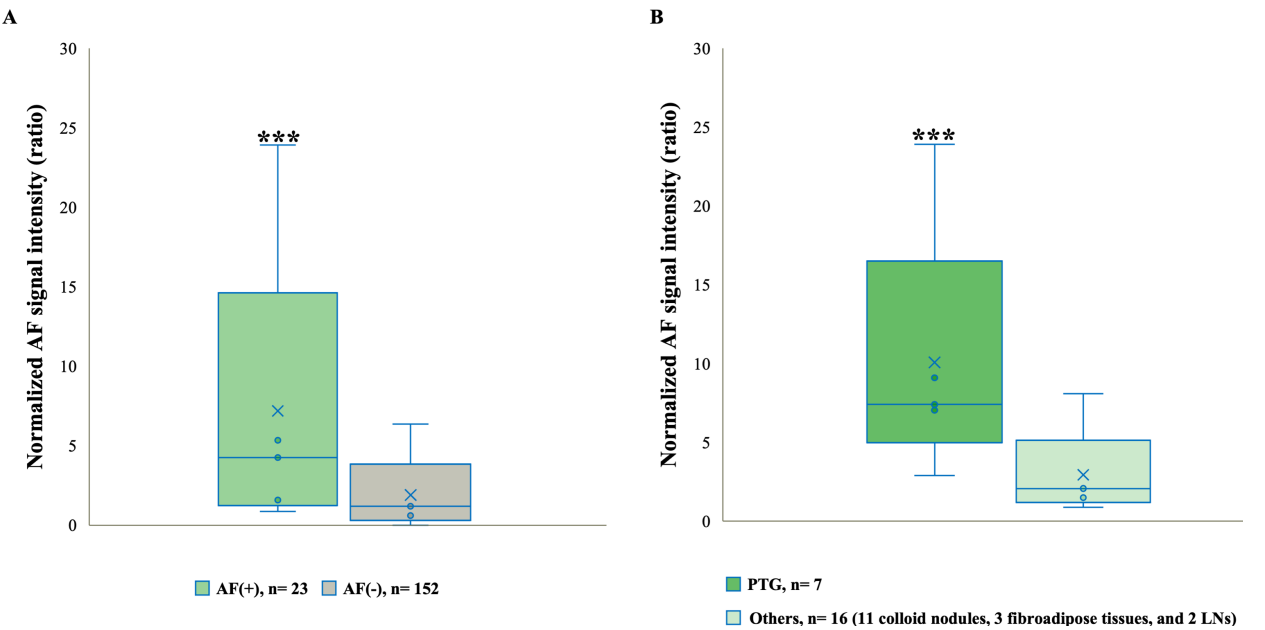


Figure 3. Illustrates the quantification of AF density.

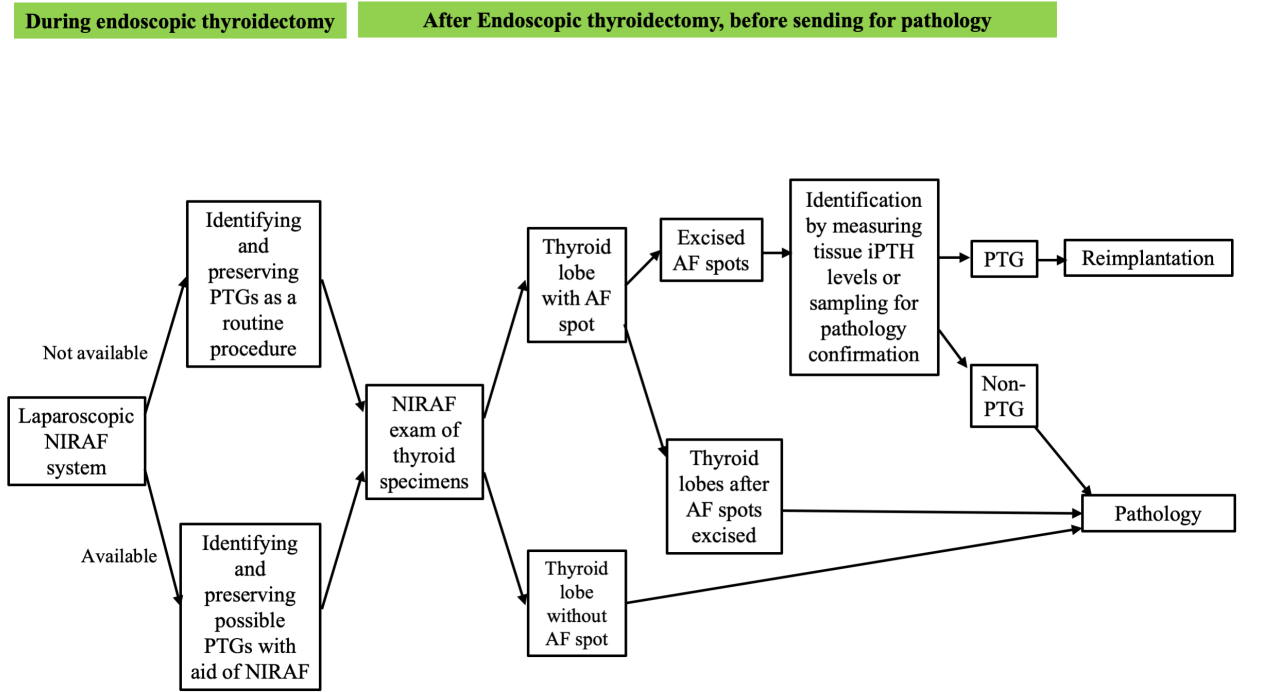


Figure 4. Proposed algorithm for application of NIRAF imaging for detection of inadvertently resected parathyroid glands after endoscopic thyroidectomy.

Table 2. Related Measurement Indices for Predicting Parathyroid Presence Assessed in 175 Surgico-pathological Specimens by NIRAF Imaging		
Index		
Sensitivity/TPR/Recall	1.000	(1.000 - 0.000)
Specificity/TNR	0.905	(0.860 - 0.949)
PPV/Precision	0.304	(0.116 - 0.492)
NPV	1.000	(0.000 - 0.000)
Accuracy	0.909	(0.866 - 0.951)