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Indocyanine Green Fluorescence Imaging in Parathyroid Surgery for Primary Hyperparathyroidism in Cases of Uncertain, Discordant, or Atypical Preoperative Localization: Narrative Review and Case Series

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ABSTRACT

Background: Primary hyperparathyroidism (primary HPT) affects approximately 0.9% of the general population. The definitive treatment is surgical, and focused minimally invasive parathyroidectomy (MIP) is the current standard, conditional upon accurate preoperative localization. Technetium-99m sestamibi (MIBI) scintigraphy false-negative rates range from 8% (adenomas >1000 mg) to over 70% (adenomas <100 mg), and ectopic or atypical adenoma locations are reported in up to 22% of previously unexplored patients. Localization failure leads to extensive cervical exploration, prolonged operative time and an increased risk of recurrent laryngeal nerve (RLN) injury. Aim: To provide a narrative synthesis of the recent evidence (2017-2025) regarding the role of intraoperative indocyanine green (ICG) fluorescence imaging in parathyroid surgery and to describe our initial experience in an observational, single-centre series of 5 female patients, based on prospectively recorded clinical data, with defined clinical scenarios: imaging discordance, atypical localization, and extreme biochemical presentation.

Materials and methods: Observational, descriptive single-centre case series based on prospectively recorded clinical data, comprising 5 deliberately selected female patients with primary HPT, operated by the same surgeon between April and August 2024 using the Karl Storz IMAGE1 S™ Rubina® system. Standard ICG dose: 5 mg IV bolus (2.5 mg/mL). Outcomes assessed: time to onset of fluorescence, standardized qualitative fluorescence pattern of the target gland and of the normal parathyroid glands, early biochemical cure and complications.

Results: Patient ages 22-70 years (median 55), baseline parathyroid hormone (PTH) 100-192 pg/mL (mean 135.3), hypercalcaemia in 4 of 5 cases (Ca 11.0-14.86 mg/dL; the maximum value was recorded during the preceding endocrinology admission) and one case of normocalcaemic primary HPT (Ca 9.7 mg/dL). Two cases showed MIBI–intraoperative discordance, two presented technically demanding atypical localizations, and one was a 22-year-old patient with severe biochemical presentation. ICG identified the culprit hyperfunctioning gland in all 5 cases, with fluorescence onset at 22-38 seconds; in each case the target gland displayed rapid, intense and persistent hyperfluorescence, clearly distinguishable from the moderate, transient enhancement of normal glands. Histopathology showed a solitary parathyroid adenoma in four cases (300-1158 mg) and hypercellular parathyroid tissue with discrete hyperplasia in the normocalcaemic case. Early biochemical cure was achieved in all 5 cases; there were no RLN injuries and no ICG-related adverse reactions. Given the
deliberate selection of cases, these results are reported strictly descriptively and should not be interpreted as estimates of overall diagnostic performance.

Conclusions: In our experience, ICG fluorescence imaging provided useful intraoperative guidance in three clinical scenarios: discordance with preoperative imaging, technically demanding atypical

localizations, and severe presentations requiring support for the single-gland hypothesis. Reductions in operative time, extent of cervical exploration and RLN injury risk reported in comparative studies could not be assessed in this uncontrolled series and remain potential benefits. These hypothesis-generating observations support further evaluation of ICG as an adjunct within the MIP protocol.
Keywords: primary hyperparathyroidism, indocyanine green, focused parathyroidectomy, parathyroid adenoma localization, MIBI discordance, near-infrared fluorescence