ORIGINAL

Intraoperative identification of parathyroid with 4K 3D ORBEYE® exoscope in thyroid surgery

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Abstract : Preservation of the parathyroid glands during thyroid surgery is important to preserve postoperative parathyroid function. However, macroscopic identification of the parathyroid glands in the surgical field is difficult because normal parathyroid glands are small and resemble lymph nodes or fat tissues. Recently, the detection of the parathyroids using near-infrared imaging has been reported. In this study, we applied ORBEYE, a three-dimensional surgical exoscope system, to four cases of thyroidectomy and examined whether the near-infrared mode of ORBEYE is useful for the intraoperative identification of the parathyroid glands. We demonstrated that the ORBEYE can be an effective surgical instrument in thyroid surgery, and it is necessary to accumulate more cases and examine the usefulness of this method in the future. J. Med. Invest. 73 : 208-211, February, 2026

Keywords **:** *near-infrared, ORBEYE®, parathyroid, thyroid surgery, exoscope*

INTRODUCTION

In thyroid surgery, the detection and preservation of the parathyroid glands are important for preserving postoperative parathyroid function. However, macroscopic identification of the parathyroid glands in the surgical field is difficult because normal parathyroid glands are small and resemble lymph nodes or fat tissues apparently (1-3). Previously, intraoperative identification of the parathyroid glands was performed using methylene blue, indocyanine green fluorescence, and rapid pathological diagnosis (4). Recently, parathyroid detection using near-infrared imaging was reported (1-3). This technique is based on the autofluorescence of parathyroids. Parathyroid glands exhibit intrinsic autofluorescence when excited at wavelengths around 785 nm, appearing with a higher autofluorescence intensity relative to the surrounding tissues (1-3).

ORBEYE® (OLYMPUS) is a 4 K-3D surgical exoscope that enables heads-up surgery and presents the fine structures of tissues and blood vessels using high-resolution digital images (5). Because ORBEYE® has the near-infrared mode, it can be used for intraoperative identification of parathyroids in thyroid surgery (6). In this study, we examined whether the near-infrared mode of ORBEYE is useful for intraoperative identification of parathyroid glands during thyroid surgery.

PATIENTS AND METHODS

This observational case series was conducted at the Department of Otorhinolaryngology-Head and Neck Surgery, Tokushima University Hospital, located in Tokushima, Japan, between January 2022 and December 2024. We operated the surgical field around parathyroids using normal mode with 4 K-3D ORBEYE® exoscope (Olympus, Tokyo, Japan) and observed autofluorescence of the parathyroids in the same view during dissection of the parathyroid area using near-infrared mode under high power field by simply switching modes (Fig 1). Albumin-corrected serum Ca and serum intact parathyroid hormone (PTH) levels were measured preoperatively and postoperatively using the LABOSPECT 008 α automatic chemistry analyzer and cobas® 8000 modular analyzer series. The patient characteristics, operative procedures, and pathologies are summarized in Table 1.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

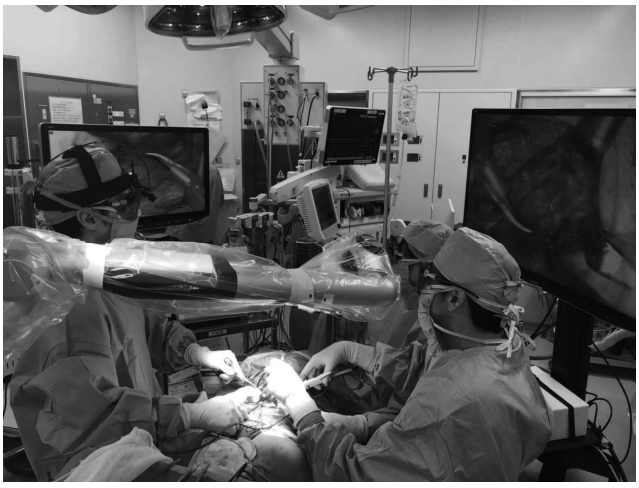

Fig 1. 4K-3D ORBEYE® exoscope.

Case 1 involved a 13-year-old woman.

She was underwent a right lobectomy. Autofluorescence of the right upper and lower parathyroids was detected intraoperatively using the near-infrared mode (Fig 2), preserving the parathyroids. Pathological examination confirmed the absence of parathyroids in the excised specimen. After surgery, serum

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Ca and intact parathyroid hormone (PTH) levels were within the normal range.

Case 2 involved a 46-year-old woman.

She was underwent total thyroidectomy with lymphadenectomy of the central compartment. Autofluorescence of the parathyroid glands was detected intraoperatively using the near-infrared mode (Fig 3), which allowed the right lower and left upper parathyroids to be preserved with blood flow because they were not proximal to the tumor. Immediately after surgery, the Ca level was low (7.4 mg/dL) and required Ca and vitamin D3 supplementation, which recovered to the normal range in approximately 1 month and remained within the normal range

Table 1.

Case	Age	Sex	BMI	Operation	Pathology	Ca (mg/dL)		
						Pre-operation	Post-operation	Three Months
1	13	Female	20.3	right lobectomy	Follicular adenoma	9.9	9.1	9.9
2	46	Female	19.0	total thyroidectomy lymphadenectomy	Adenomatous goiter	9.4	7.4	9.3
3	55	Female	23.9	left lobectomy	Adenomatous goiter	9.8	8.2	9.2
4	74	Male	22.2	right lobectomy lymphadenectomy	Papillary carcinoma	9.9	8.4	9.4

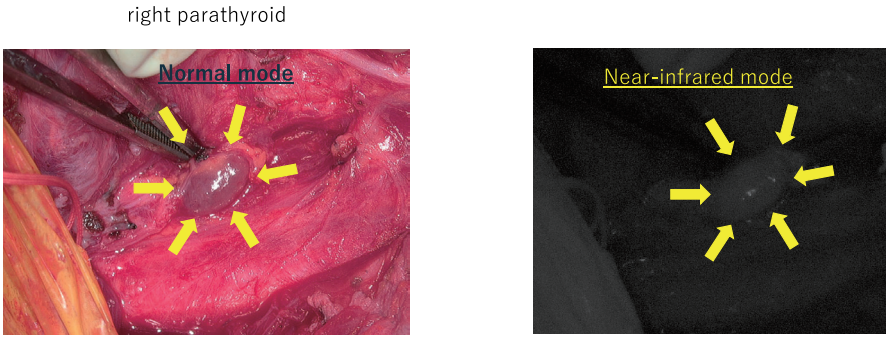

Fig 2. Autofluorescence of the right lower parathyroid can be detected intraoperatively using the near-infrared mode. The parathyroid glands are indicated by arrowheads in both the normal and near-infrared modes.

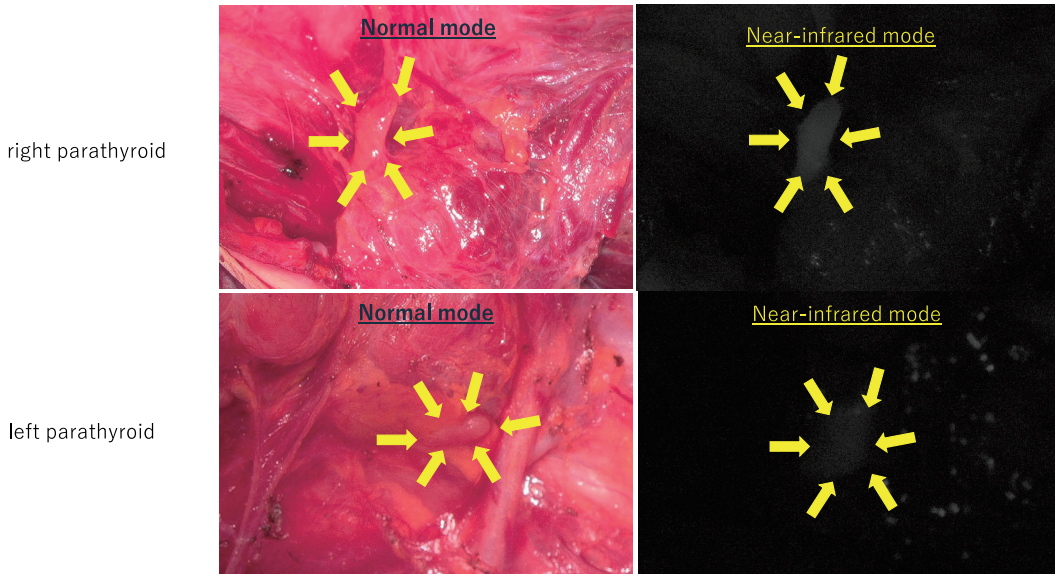

Fig 3. Autofluorescence of the parathyroids can be detected intraoperatively using the near-infrared mode. The parathyroid glands are indicated by arrowheads in both the normal and near-infrared modes.

after the supplementation was discontinued for 2 years.
Case 3 was a 55-year-old woman.

She was underwent a left lobectomy. Autofluorescence of the left upper and lower parathyroids was detected intraoperatively using the near-infrared mode, which was removed because they were close to the tumor (Fig 4). Pathological examination confirmed the presence of the parathyroids. Postoperatively, calcium and intact PTH levels were within the normal range.
Case 4 involved a 74-year-old man.

He was underwent a right lobectomy with lymphadenectomy of the central compartment. Autofluorescence of the right upper and lower parathyroids was detected intraoperatively using the near-infrared mode, which allowed the parathyroids to be preserved. Postoperatively, calcium and intact levels of PTH were within the normal range.

DISCUSSION

In this study, the parathyroids were detected in all four patients using the near-infrared mode with ORBEYE®. No false-positive or ambiguous autofluorescence originating from the surrounding tissue, such as fat tissues or thyroid capsule, were encountered. The parathyroids were distinguished based on their characteristic autofluorescence intensity, anatomical location, and intraoperative inspection of tissue morphology. Although previous reports have noted false-positive autofluorescence arising from fat tissues or thyroid capsule (7), such occurrences were not observed in this study. This discrepancy may be attributable to operatoer familiarity and immediate correlation with macroscopic appearance. Nonetheless, surgeons should interpret autofluorescence carefully and avoid relying solely on optical cues. Combining the near-infrared mode with ORBEYE® with anatomical knowledge remains essential for accurate identification. Ca and intact PTH levels were preserved in three of the four patients. Only patient 2 experienced transient hypoparathyroid function requiring the administration of calcium and vitamin D3. However, no symptoms were observed, and 1 month after the operation, the calcium level recovered to the normal range, and calcium and vitamin D3 were no longer necessary. These results suggest that the parathyroid detection intraoperatively using the near-infrared mode with ORBEYE® were effective.

The frequency of post-thyroid surgery hypoparathyroidism has been reported to be transient in 7%–50% and permanent in 0.8%–4.7% (8-12). Hypoparathyroidism causes hypocalcemia and hyperphosphatemia, including physical fatigue, muscle spasms, numbness, fuzziness, anxiety, and depression. The severity of symptoms correlates with lower health-related quality of life (12). Therefore, it is important to preserve parathyroid function during thyroid surgery. When at least one parathyroid gland is preserved in the surgical field with blood flow, parathyroid function is preserved in >95% of cases (13, 14). On the other hand, even in cases of thyroid lobectomy, it has been reported that the frequency of transient postoperative hypoparathyroidism was 1.9% (9).

It has been reported that parathyroid glands have near-infrared autofluorescence of 800–950 nm with a peak at 822 nm, and exhibit intrinsic autofluorescence when excited at wavelengths around 785 nm, appearing with a higher autofluorescence intensity relative to the surrounding tissues (1-3). parathyroid glands are identified by near-infrared imaging (1-3). Intraoperative identification of the parathyroid glands has been performed using methylene blue, indocyanine green fluorescence, and rapid pathological diagnosis, but all require additional procedures and time-consuming (4). In contrast, near-infrared imaging is simple and noninvasive and has been reported to be useful for the intraoperative identification of parathyroids (2, 4, 15). However, it does not provide information regarding their vascular perfusion status, which is essential for predicting postoperative hypocalcemia. Indocyanine green angiography has recently emerged as a complementary tool that allows real-time assessment of perfusion (16). Combining near-infrared imaging for anatomical identification with Indocyanine green angiography for perfusion evaluation may improve decision-making regarding autotransplantation and preservation strategies (17). Future studies integrating both modalities could lead to optimized intraoperative alhorithms. Near-infrared imaging has demonstrated 100% parathyroid detection accuracy in patients with toxic and nontoxic nodular goiters, Hashimoto's thyroiditis, thyroid adenoma, and Graves' disease (4). Previous studies have suggested that underlying thyroid pathology may influence the detectability of parathyroid autofluorescence (18). In this study, however, clear autofluorescence signals were observed regardless of underlying thyroid pathology. Further prospective studies with larger cohorts are warranted to evaluate the impact of disease-specific characteristics on imaging performance.

ORBEYE® is a 4 K-3D surgical exoscope that enables heads-up surgery, and presents the fine structures of tissues and blood vessels using high-resolution digital images (5). ORBEYE® has the near-infrared mode, which can be used for intraoperative identification of parathyroid autofluorescence in thyroid surgery. ORBEYE® can switch from normal to near-infrared modes simply by a button in a few seconds. Accordingly, we can operate the

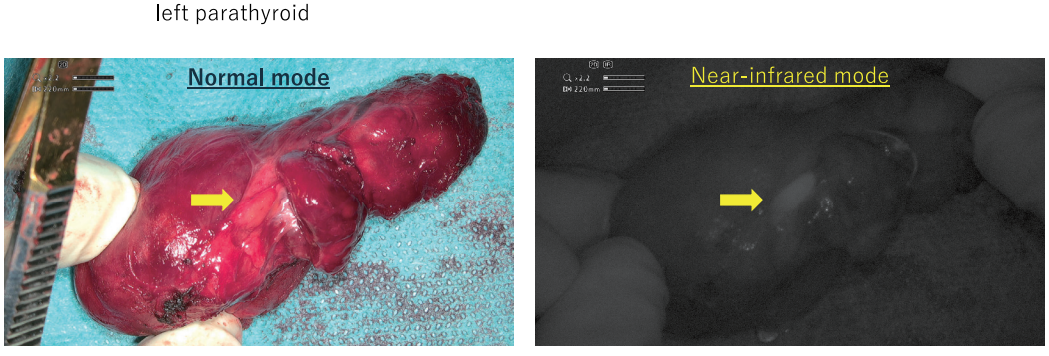

Fig 4. Autofluorescence of the left lower parathyroid can be detected intraoperatively using the near-infrared mode, which is removed because they are close to the tumor.

surgical field around the parathyroids using the normal mode with 4 K-3D and observe autofluorescence of the parathyroid glands in the same view using the near-infrared mode by simply switching modes. This is a great advantage because there is no need for separate dedicated equipment or additional procedures for the detection of parathyroids. In this study, autofluorescence of the parathyroid glands was detected intraoperatively in all cases using the near-infrared mode, which allowed the parathyroid to be preserved. These findings suggest that ORBEYE® is useful and easy to identify and preserve the parathyroid glands in thyroid surgery.

PDE-NEO (Hamamatsu Photonics) and FLUOBEAM (FLUOPTICS) have been reported to be useful for identifying the parathyroid (15). However, unlike ORBEYE®, both of these are handy camera units, so the units must be additionally prepared, draped, and operated by the surgeon or an assistant while they stop the surgery. It has been reported that there are differences in excitation wavelength and brightness depending on the device (15), and further comparative studies among devices, including ORBEYE®, are expected in the future.

The fluorophore in the parathyroid gland has been suggested to be a calcium-sensing or 25OHD receptor, although it is currently unknown (4). The intensity of the parathyroid autofluorescence was unaffected after removal or formalin fixation, suggesting that it was independent of blood flow or activity (1). In case 3, autofluorescence was detected after the removal of the parathyroid gland using the near-infrared mode of ORBEYE, which was pathologically confirmed (Fig 2). Parathyroid autofluorescence is attenuated by secondary hyperparathyroidism, obesity (body mass index [BMI] >25), hypercalcemia (>10.5 mg/dL), and low serum 25OHD(<30ng/mL) (4). In this study, all patients had a normal BMI, and their preoperative Ca levels were within the normal range, making them suitable for the observation of parathyroid autofluorescence (Table 1).

A limitation of this study is that preoperative 25OHD levels were not measured, a few patients were included at a single institution, and no statistical analysis was conducted. Further studies are required to improve and standardize its use.

FUNDING AND CONFLICT OF INTERESTS

None

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