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Could the eZ-SCOPE AN Gamma Camera Replace Intraoperative Measurement of iPTH for PHPT?

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Intraoperative intact parathyroid hormone (iPTH) measurements have been proposed as an effective assay in surgery for primary hyperparathyroidism (PHPT). We have demonstrated the efficiency of the use of a hand-held gamma camera, eZ-SCOPE AN, with technetium-99m sestamibi (Tc-MIBI) scintigraphy for navigation surgery for PHPT. The aim of this preliminary study was to assess the possibility that the eZ-SCOPE AN can replace the measurement of intraoperative iPTH in surgery for PHPT. Sixteen consecutive patients with documented primary hyperparathyroidism underwent surgery using this compact camera. iPTH was routinely measured preoperatively and 10 minutes after the complete removal of adenoma. All patients had a well-defined parathyroid lesion identified on preoperative Tc-MIBI. The eZ-SCOPE revealed hyperfunctioning parathyroid glands in all cases. iPTH levels were decreased in all cases after the removal of adenomas. Our results suggest that this gamma camera is useful for confirming complete resection of endocrinologically active tissue in surgery for PHPT. In selective patients with scan-positive cases identified by preoperative Tc-MIBI, the eZ-SCOPE may replace the intraoperative iPTH assay in surgery for PHPT.

Key words: Primary hyperparathyroidism – Navigation surgery – Gamma camera – Sestamibi scintigraphy – Intact PTH

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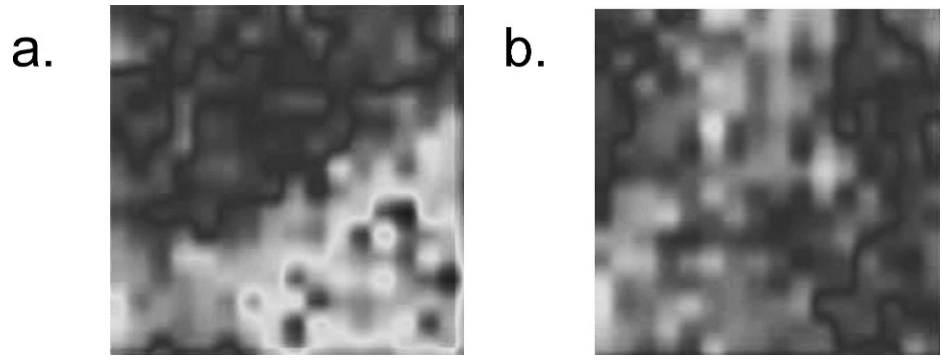

Fig. 1 Scintigraphy images of the neck by eZ-SCOPE (×1), (a) before skin incision and (b) after adenoma excision.

Surgery for primary hyperparathyroidism (PHPT) is moving from traditional bilateral neck exploration to directed unilateral neck exploration and minimally invasive parathyroidectomy.[1–3] Intraoperative intact parathyroid hormone (iPTH) measurements have been proposed as an effective assay in surgery for PHPT.[4–6] Circulating concentrations of iPTH decline dramatically within minutes following surgical excision of hyperfunctioning parathyroid glands. Thus, intraoperative iPTH monitoring is useful for confirming complete removal of hyperfunctioning parathyroid glands.[1,7,8]

On the other hand, technetium-99m sestamibi (Tc-MIBI) scintigraphy is a useful preoperative diagnostic tool in PHPT.[9,10] There have been some reports of radio-guided surgery for PHPT.[11–18] We have recently demonstrated that in scan-positive cases identified by preoperative Tc-MIBI, Tc-MIBI scintigraphy with the use of a hand-held gamma camera, the eZ-SCOPE AN, is useful for navigation surgery for PHPT and minimally invasive parathyroidectomy.[18] The eZ-SCOPE AN is designed to be used as a hand-held, regional diagnostic imaging device, which is a new compact-type semiconductor gamma camera based on the use of a cadmium-zinc-telluride (CdZnTe) detector.[18–20] In the current preliminary study, we assessed the possibility of using the eZ-SCOPE AN in surgery to replace the measurement of intraoperative iPTH for PHPT.

Patients and Methods

Sixteen consecutive patients with documented PHPT who underwent surgery by the same surgical team in the Department of General Surgical Science, Graduate School of Medicine, Gunma University, from May 2006 to April 2011, were enrolled in this study. The patients with clinical and laboratory findings of PHPT were evaluated by Tc-MIBI scintigraphy and neck ultrasound and computed tomography (CT). Suspected multigland disease or negative scintigraphy cases were excluded from this study. The diagnosis of PHPT was based on hypercalcemia documented on at least two occasions and an elevated iPTH level. All the patients included in this study gave their informed consent, and the research project was authorized by the Committee for Ethical Research of the Graduate School of Medicine, Gunma University.

The eZ-SCOPE is designed to be used as a hand-held, regional diagnostic imaging device.[18–20] This compact semiconductor gamma camera made of cadmium-zinc-telluride has 256 semiconductors representing the same number of pixels. Each semiconductor is a 2-mm square and is located in 16 lines and rows on the surface of the detector. The outer dimensions of the camera are 74 mm × 72 mm × 210 mm, and it weighs 820 g. The most significant differences between it and previous cameras include the spatial resolution, sensitivity, high count-rate characteristics, and energy resolution.[18–20]

On the day of the surgery, patients were injected with 370 MBq (10 mCi) 99mTc-MIBI shortly before the start of surgery. Scintigraphy images of the neck were acquired by eZ-SCOPE before skin incision, after adenoma location, and after adenoma excision, and *ex vivo* imaging of the specimen was also performed.[18] A 2.5- to 4.0-cm skin incision was made in a transverse direction above the sternal notch on the basis of hot spots identified by eZ-SCOPE. Measurements of iPTH were routinely taken preoperatively and 10 minutes after the complete removal of the adenoma. Total calcium (non–albumin-corrected levels) and iPTH levels were registered preoperatively and postoperatively. Special attention was given to correct baseline values and to the interpretation of intraoperative iPTH values. Only a decrease of 60% or more from

the preoperative iPTH level was considered to be a successful result.

Results

We analyzed the cases of 16 patients with documented primary hyperparathyroidism who underwent surgery. The average age was 55.4 ± 14.4 years, and 11 of the patients were women. All patients had a well-defined parathyroid lesion identified on previous Tc-MIBI. The eZ-SCOPE revealed hyperfunctioning parathyroid glands in all cases. Scintigraphy images of the neck were acquired by eZ-SCOPE before skin incision (Fig. 1a), after adenoma location, and after adenoma excision (Fig. 1b), and *ex vivo* imaging of the specimen was also performed. All patients had adenomas localized at the neck orthotopically, and there were no cases of ectopic location. Surgical findings confirmed the presence of a single parathyroid adenoma in all cases. The iPTH level decreased by more than 60% in all patients who underwent parathyroidectomy. The iPTH levels dropped by a mean of 82.7%. The average preoperative serum iPTH level was 377.8 ± 232.2 pg/mL, and the postoperative value of iPTH was 65.4 ± 73.3 pg/mL (Fig. 2). The average preoperative serum calcium level was 11.5 ± 0.7 mg/dL. The average postoperative calcium level was 9.6 ± 0.4 mg/dL. The histopathologic diagnosis was parathyroid adenoma in all cases, and the average adenoma size was 17.2 ± 10.3 mm. There were no complications in any of the cases. The mean follow-up was more than 6 months, and there was no patient with recurrent disease.

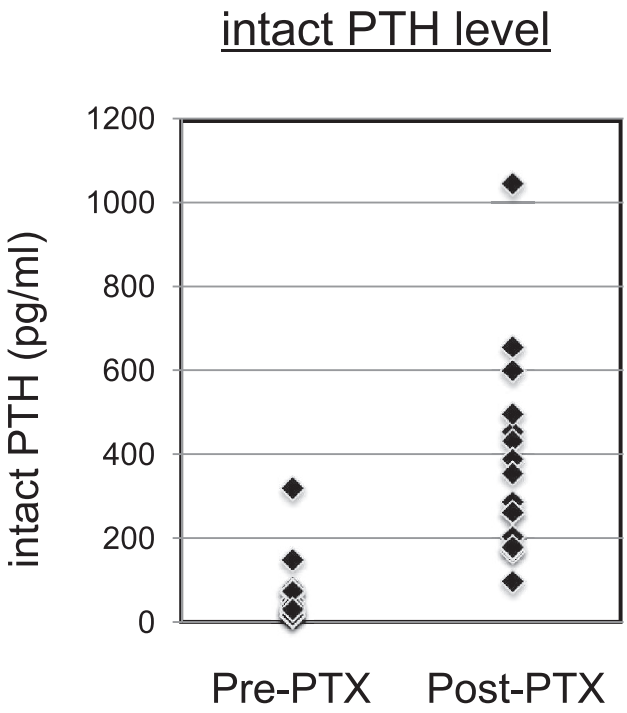

Fig. 2 The average preoperative serum iPTH level was 377.8 ± 232.2 pg/mL and postoperative value of iPTH was 65.4 ± 73.3 pg/mL. The iPTH level decreased more than 60% in all patients who underwent parathyroidectomy. The iPTH levels dropped by a mean of 82.7%.

Discussion

The recent remarkable development of hand-held gamma-ray detectors makes it easy to perform radio-guided surgery. We have demonstrated the efficiency of the use of a hand-held gamma camera, the eZ-SCOPE AN, with Tc-MIBI scintigraphy for navigation surgery for PHPT.[18] The key observations made in this study can be summarized as for cases with a positive Tc-MIBI scan. The iPTH levels were decreased in all cases after the removal of a single adenoma. These findings provide clear evidence that this gamma camera is useful for confirming the complete resection of endocrinologically active tissue during surgery to treat PHPT.

In patients with normal renal function, iPTH is cleared from the blood within minutes in an early rapid phase. The measurement of intraoperative iPTH during surgery for PHPT is useful for confirming complete resection of an abnormal parathyroid gland. However, randomized studies show that in patients with positive Tc-MIBI scintigraphy, there is no added value to support the use of intraoperative iPTH measurement.[1] In fact, our current study revealed that in all cases with a positive Tc-MIBI scan, iPTH levels are decreased after the removal of a single adenoma. These results are compatible with those of previous studies that report that even without iPTH measurements, radio-guided surgery results in an excellent cure rate, at least in selected cases of single adenomas.[9,13]

For single adenomas and cases with positive Tc-MIBI scans, radio-guided surgery is an effective tool in the surgical management of PHPT. However, in cases that are scan negative, radio-guided surgery is thought to be less useful, and intraoperative iPTH assay is recommended. Some studies also recommend the use of intraoperative iPTH assay for multigland disease.[1,21,22] The iPTH assay can reliably be used for patients with multigland disease with an accuracy similar to that shown for single-adenoma

cases.[21,22] The Tc-MIBI scan is not specific for parathyroid tissue, and thyroid nodules also accumulate Tc-MIBI.[23] In selected cases with a single adenoma and a positive scan and, if possible, without thyroid nodular disease, this new device may replace the intraoperative measurement of iPTH. However, in unselected cases, in conjunction with radio-guided surgery, the intraoperative iPTH assay is considered to be an important tool in surgery for PHPT.

This preliminary study has potential limitations, the major one being that the number of cases was relatively small. Additional research is needed to the assess possibility that radio-guided surgery is an acceptable replacement for intraoperative iPHT assay in treating PHPT.

In conclusion, we have demonstrated that navigation surgery for PHPT using the eZ-SCOPE permitted the intraoperative removal of parathyroid adenoma, and in cases with a positive Tc-MIBI scan, the iPTH levels were decreased in all cases after the removal of a single adenoma. In selective scan-positive cases identified by preoperative Tc-MIBI, Tc-MIBI scintigraphy with the eZ-SCOPE may replace the intraoperative iPTH assay during surgery for PHPT.

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