

Radio-guided Minimally Invasive Parathyroidectomy: A Descriptive Report of the Experience from Tertiary Center in Bangalore

Abstract

Overview: Minimally invasive parathyroidectomy (MIP) is an accepted surgical procedure for parathyroid adenomas. In the patients with parathyroid adenoma localized by dual phase ^{99m}Tc -Sestamibi scan, a focused approach utilizing the gamma probe intra-operatively helps in ensuring complete resection and avoiding exploration of the other parathyroid glands. **Objective:** The aim of the study was to evaluate the performance of radio-guided MIP for parathyroid adenomas detected by dual phase ^{99m}Tc -MIBI preoperatively, without intra-operative parathyroid hormone (ioPTH) monitoring for patients who had evidence of single-gland disease. **Patients and Methods:** A retrospective dataset of 30 patients diagnosed with solitary parathyroid adenoma operated between 2009 and 2014 were reviewed. All of the patients underwent radio-guided MIP and were followed up for at least 6 months post-operatively. The biochemical parameters (serum calcium and serum parathyroid hormone levels), imaging parameters (ultrasonography and ^{99m}Tc -MIBI), and operative times were analyzed. **Results:** Our study consisted of 30 patients with 50% females, with a mean age of 42.5 ± 12 years. The mean surgical duration was 20 ± 12 min. All of the patients achieved biochemical cure (normalization of serum calcium) and remained eucalcemic at follow-up. No major surgical complications were noted. **Conclusions:** Focused parathyroidectomy using the gamma probe localization could be a potential alternative for ioPTH assay in ensuring the completeness of surgical resection of parathyroid adenoma. It is also likely to shorten operative time.

Keywords: Adenoma, calcium, focused parathyroidectomy, gamma probe, parathyroid

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Introduction

Hypercalcemia is identifiable in approximately 0.5% of the general population, and primary hyperparathyroidism (PHPT) is the most common cause of hypercalcemia in nonhospitalized patients. The disease occurs at all ages, but it is most commonly seen in women in their seventh decade. PHPT results from single adenomas in 80% to 85% cases, double adenomas in 2% to 3%, multigland hyperplasia in 12% to 15%, and rarely from carcinoma.^[1] Traditionally for suspected parathyroid adenoma, the surgical procedure carried out was 4 gland exploration and excision of the suspected gland. The first parathyroidectomy for PHPT was performed by Felix Mandl in Vienna in 1925.^[2] But due to the advances in imaging modalities, more focused approaches have evolved. As the newer imaging modalities were developed, the accuracy of localization has improved. Henceforth, the surgical procedures became more refined in terms of extent of dissection

and smaller incision. These led to evolution of the term “minimally invasive.” The goal of the surgical procedure is to obtain biochemical cure by normalizing the calcium levels. Focused parathyroidectomy not only achieves this goal but also prevents hypocalcemia, because the normal parathyroid glands are not dissected. In general, there is a lot of controversy about the criteria to label the procedure as “minimally invasive.” James *et al.*,^[3] have reviewed the literature and found that 18 words were used in 75 different combinations to describe minimally invasive parathyroidectomy (MIP) with the mean incision length described in the literature is just over 2 cm.

Methods

MIP has been conducted at Narayana Health City since 2009. The data of the patients who underwent radio-guided MIP for hyperparathyroidism was collected from 2009 to 2014.

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Inclusion criteria

All of the patients with biochemically confirmed PHPT) with localizable adenoma on dual phase ^{99m}Tc -Sestamibi scan (^{99m}Tc -hexakis-2-methoxy isobutyl isonitrile - MIBI) were included.

Dual-phase ^{99m}Tc -Sestamibi protocol^[4]

Early (10-30 min after injection) and delayed (1.5-2.5 h after injection) high-count images of neck and thorax were obtained after intravenous injection of 15 to 20 mCi of ^{99m}Tc -Sestamibi [Figure 1a]. Delayed Single-photon emission computed tomography (SPECT CT) images [Figure 1b] were also acquired on most occasions to aid better localization. In some patients, ultrasound of the neck was also performed to localize the adenoma but surgical decisions were based on MIBI localization. All of the patients were operated within 30 days after the MIBI scan. All of the patients underwent pre- and post-operative videolaryngoscopy (VLS). Operative times were recorded as the time from the incision to the placement of the final sutures. All of the patients had post-operative estimation of calcium and PTH levels and were followed up for a minimum duration of 6 months.

Exclusion criteria

Patients with previous history of neck exploration for parathyroid surgery, family history of PHPT, tertiary hyperparathyroidism, and those who refused surgery were excluded. Patients with MIBI-negative adenoma were also excluded.

Surgical procedure

The procedure was started 90-120 min after the intravenous injection of 20 mCi ^{99m}Tc -MIBI. Skin marking of location of parathyroid adenoma was performed under the Gamma Camera [Figure 2]. Once the patient was intubated, he was positioned supine with neck extension (with a shoulder bag support); care was taken to avoid hyperextension of the neck. Patient was positioned similar to that during marking of adenoma, to increase accuracy [Figure 2].

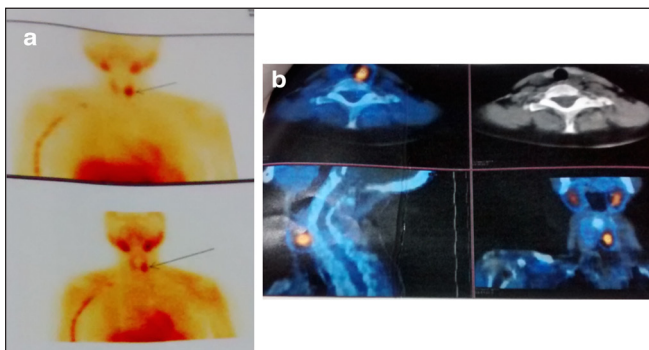


Figure 1: Dual-phase ^{99m}Tc -Sestamibi early and delayed high-count images of neck and thorax were obtained after intravenous injection of 15 to 20mCi of ^{99m}Tc -Sestamibi (a and b). Images (arrow) show a MIBI avid left inferior parathyroid adenoma

We use Europrobe 3 (100-230 V, 50/60 Hz, 150-65 mA) (EURORAD S.A., Strasbourg, France) gamma probe [Figure 3]. Before the incision, counts/s were obtained from the four quadrants of the neck every 10 s by the gamma probe (GP) device. The skin incision of 2 cm length was timed by taking into consideration the maximum upper skin counts and the marking. Incision was deepened, platysmal fibers cut horizontally and subplatysmal flaps were elevated. The strap muscles (Sternohyoid and Sternothyroid) identified. The lateral borders of the muscles were retracted medially. By gentle dissection, the adenoma was identified. The gamma count was again obtained and recorded. The adenoma was gently mobilized and excised en block [Figure 4a]. The gamma count reading was again recorded. The area where the maximum counts/s was observed indicated the location of parathyroid adenoma and where the lesion was excised. The counts, taken from ex-vivo parathyroid adenoma (a) and the background counts taken from the area where the lesion was excised (b) were measured. If (a) counts were 20% more than the (b) counts, the excised lesion was accepted as parathyroid adenoma and further neck exploration was not performed. The incision was closed in layers without a drain and timed.

Statistical analysis

Continuous variables were expressed as mean \pm standard deviation (SD).

Results

A total of 30 patients, 50% female gender and age 42.5 ± 12 (mean \pm SD) years with primary hyperparathyroidism were treated with radio-guided focused parathyroidectomy. The mean preoperative calcium and PTH values were 11.48 ± 1.08 mg/dl and 420.72 ± 388.18 pg/ml, respectively. The mean postoperative calcium and parathyroid hormone values were 8.27 ± 0.73 mg/dl and 14.4 ± 10.24 pg/ml. Table 1 shows the success of this technique with normal restoration of calcium-PTH axis in all patients on follow-up at 6 months. The mean weight of the excised adenoma was 2.05 ± 1.69 g. Histopathological features showed



Figure 2: Pre-operative marking of right inferior parathyroid adenoma



Figure 3: Use of intra-operative gamma probes

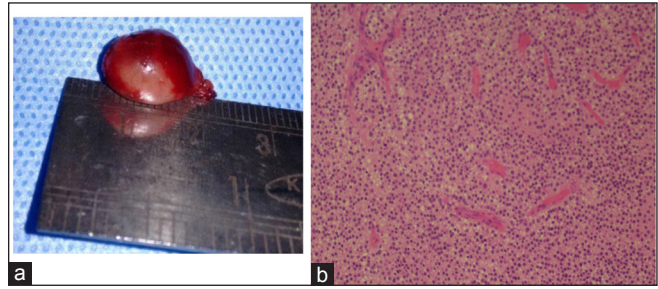


Figure 4: (a and b) Gross specimen showing resected parathyroid adenoma and H and E stain 4x magnification showing cellular sheets of fairly uniform eosinophilic to clear cells in a delicate vascular network

Table 1: Pre- and post-operative calcium and PTH profiles

Laboratory measure	Pre-operative	Post-operative (24 h)	Post-operative (6 months)	Biological reference interval
Serum calcium (mg/dl)	11.48 ± 1.08	8.27 ± 0.73	8.13 ± 0.54	8.5–10.1
Serum PTH (pg/ml)	420.72 ± 388.18	14.4 ± 10.24	12.5 ± 9.64	11.1–79.5

hypercellular parathyroid adenoma in all cases with typical features of adenoma including well circumscribed, cellular, homogeneous lesion with a thin fibrous capsule. The lesion was composed predominantly of chief cells and oxyphil cells in lobules and a microfollicular pattern. Few of the histopathology showed rich vascular network with areas of cells exhibiting mild to moderate degree of pleomorphism and hyperchromasia.

The mean duration of surgery was 20 + 12 min. The intra-operative location was concordant with the pre-operative MIBI location in 27 cases. In 3 cases although the lateralization of the adenoma was accurate, the position superior versus inferior was discrepant. In all these cases the MIBI called it an inferior adenoma while the intra-operative location was superior adenoma. Right inferior position (30%) was the most common location of the parathyroid adenoma in our series. None of our patients had any peri-operative complication. At follow-up in 6 months all patients were eucalcemic and were not on any calcium or vitamin D supplements.

Table 1: Pre- and post-operative calcium and PTH profiles

Limitations

By including MIBI-positive adenomas, we have studied a pre-selected cohort of PHPT patients and these results are not applicable to PHPT patients in the exclusion criteria. We did not compare operative times in those in whom radiotracer was not used and we also did not compare this technique with ultrasound or 4D CT localizable adenomas. A follow-up of 6 months is relatively short to pick up recurrence of PHPT; however, the cohort is being followed

up and long-term data are likely to be published in the future.

Discussion

When combined with use of intra-operative parathyroid hormone (ioPTH) monitoring, MIP techniques result in excellent outcomes that are comparable with a traditional bilateral cervical exploration.^[5] Localization results inform the surgeon where to start looking for the adenoma, and ioPTH results suggest to her/him when to stop looking. Completeness of surgical resection is usually confirmed by the significant fall in ioPTH levels. ioPTH test has been shown to have sensitivity of 93.2%, a specificity of 92.3%, and an accuracy of 93.1%.^[6]

In centers where ioPTH is not feasible or reliable assay cannot be carried out quickly, the signals of ^{99m}Tc-MIBI captured on the gamma probe can be used intra-operatively to decide the success of the surgical procedure. The probe converts the signal intensity into counts, which is audible and recorded. The use of gamma probe and the basis of radio-guided MIP was proposed by Norman and Chheda in 1997.^[7] The technique involves intravenous administration of ^{99m}Tc-labeled Sestamibi approximately 2 h preoperatively. Using Sestamibi uptake as an indirect measure of parathyroid gland hyperfunction, the surgeon uses a handheld gamma probe in conjunction with preoperative imaging results to focus the incision over the site of greatest radioactivity.^[8] Once the suspected offending gland or glands are removed, the gamma probe is also used to survey the surgical bed. An ex-vivo radioactivity count more than 20% above background is a possible threshold for completion of the exploration. Although there are concerns expressed in this radio-guided MIBI missing

multiglandular disease and false-positive uptake of MIBI in the thyroid gland resulting in unnecessary resection of healthy tissue.^[9] We have successfully implemented this technique in our institution.

Conclusion

Patients with pre-operatively MIBI-localizable parathyroid adenoma were all successfully treated with radio-guided MIP and in these pre-selected patients radio-guided technique can be seen as a potential alternative to ioPTH assay.

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Conflicts of interest

There are no conflicts of interest.

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