Tc99m Sestamibi Scan in Parathyroid Surgery - Positive scan obviates routine intra-operative parathormone monitoring

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Background:
The gold standard for the treatment of primary hyperparathyroidism has long been four-gland exploration. The following technological advancements facilitated parathyroid surgery to move from traditional four gland exploration to targeted unilateral minimally invasive procedure.

1. Improved Imaging techniques for localisation of adenoma (Tc99m-Sestamibi scan & SPECT Scan).
2. Intra-operative PTH assay.
4. Different minimal access techniques (Small Incision, Endoscopic & Video-assisted).

Majority of primary hyperparathyroidism are due to solitary adenoma (>85%) with diffuse parathyroid hyperplasia or double adenoma (10 to 15%) and parathyroid carcinoma (1%) being rare. Hence targeted surgery is the standard of care in current practice with many adjuncts aiding for minimally invasive approach.

Aim of our Study:
1. To analyse the outcome of parathyroidectomy at our hospital
2. To correlate pre-operative Tc99m-Sestamibi localisation of adenoma with operative finding & ascertain the indications for intra-operative rapid PTH assay

Method:
1. Retrospective chart review of 40 patients who had parathyroid operations from 2009 to 2012.
2. The operative details (side and site of adenoma) are correlated with pre-operative image localisation (Sestamibi) and with laboratory results (normalising of serum PTH & calcium levels) and histo-pathological confirmation of adenoma.

Current protocol in our hospital is as follows:
1. Routine pre-operative work-up include Tc99m-Sestamibi scanning and base line PTH levels & bone profile in all patients.
2. All patients get PTH levels and bone profile checked at D1 post-op.
3. Intra-operative PTH assay is done only in selected patients (revision cases with previous failed exploration, ectopic adenoma etc).

Results:
- **Source of referral:** Majority of referrals (85%) came through general practitioners and seen at Joint Endocrine & ENT clinic but occasional referrals from renal, urology, orthopaedics and surgical admissions.
- **Presenting symptoms:**
  a. Majority (55%) of our patients presented with incidental hypercalcaemia on routine blood test by their family doctors
  b. The other 45% had varied clinical presentations - fatigue (10%), dehydration (10%), renal calculi (5%), renal failure (5%), fractures (5%), acute abdomen (5%), and acute medical admissions (5%).
- **Demographics:** Majority (75%) were females. Age ranged from 22 to 88 with mean of 58 (which correlate well with literature – primary hyperparathyroidism is seen mostly in peri-menopausal women)
- **Surgeal details:** Average operative time was 50 minutes. Majority (80%) had only targeted single gland removal, however 8/40 (15%) of patients needed more than 1 gland removal due to failed localisation on imaging. Re-exploration was done in 2 patients (5%)
- **Outcome:**
  - Postoperative PTH and calcium levels returned to normal in (95%) 38/40 patients. Mean Pre and post calcium and PTH levels are as in Table 1. Post op transient hypocalcaemia (hungry bone syndrome) in 3 (8%) patients. Persistent high PTH in 2 (5%) patients but symptomatically improved.
  - Imaging correlation: Of 40 patients only 36 had pre-operative sestamibi scan and localisation was positive in 24/36 patients (66.6%) and correlated 100% with surgical findings. Of remaining 16 patients with no scan or failed localisation, 10 had unilateral exploration & gland removal, 4 had bilateral exploration and 3 gland removal and 2 had re-explorations (1 had ectopic adenoma in superior mediasinum). Biopsy revealed 32 single gland adenoma, 6 double adenoma, 1 parathyroid carcinoma and 1 was fatty tissue.
  - **Intra-operative PTH monitoring:** is needed in only 2 (5%) patients who had re-exploration.
  - **Table 1 shows mean Pre and Post operative calcium and PTH levels.**
  - **Table 2 shows mean Pre-op PTH levels in patients with positive and negative Sestamibi scans**

Conclusion:
1. In our view, a preoperative Sestamibi scan is sufficient in majority of patients.
2. A gland explorations with intra-operative PTH assay are useful in selective patients with negative scan and failed initial explorations.

Discussion:
- **Advantages of usage of adjuncts for parathyroid surgery have been well established.**
- **Pre-operative Sestamibi scan, Intra-operative quick PTH assay and Intra-operative gamma probe have facilitated surgeons to move towards directed neck exploration for uniglandular parathyroid disease and guide the extent of resection in multi-glandular disease.**
- **Direct comparison of use of preoperative imaging and intra-operative PTH assay showed equivalent rates of successful surgery in recent literature.**
- **Sestamibi only approach is less expensive and has shorter operative times with an occasional need for reoperation, whereas the Intra-operative PTH assay more expensive and occasionally is unnecessary.**
- **Intra-operative PTH assays in conjunction with preoperative imaging does have a role in selected patients, however using them routinely is not cost-effective.**

### Pre-operative imaging modalities

<table>
<thead>
<tr>
<th>Imaging Modality</th>
<th>Sensitivity</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>High Resolution USG</td>
<td>30-90%</td>
<td>Results suboptimal with MNG, short thick neck &amp; ectopic glands</td>
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<tr>
<td>Sestamibi (planar imaging)</td>
<td>65 -93%</td>
<td>Sestamibi is concentrated in mitochondria rich hyper cellular parathyroid tissue with delayed washout</td>
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<tr>
<td>Sestamibi with SPECT scintigraphy</td>
<td>Up to 98%</td>
<td>Particularly for large multi-modular goiter, short thick neck &amp; ectopic glands</td>
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<tr>
<td>CT with Contrast</td>
<td>46-87%</td>
<td>Good for ectopic glands in chest</td>
</tr>
<tr>
<td>MRI</td>
<td>65-80%</td>
<td>Good for ectopic glands in neck</td>
</tr>
</tbody>
</table>

### Intra-operative PTH assay Facts
- Half-life of PTH in vivo is 2 to 5 minutes
- PTH should fall by 50% or more in 10 minutes after removal of adenoma
- Baseline PTH level is measured at pre-incision and post excision levels after 10-15 minutes

### Table 1: Pre and Post operative calcium and PTH levels

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>Post-op</th>
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<tbody>
<tr>
<td>Calcium</td>
<td>2.79</td>
<td>2.35</td>
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<tr>
<td>PTH</td>
<td>626.36</td>
<td>65.42</td>
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</tbody>
</table>

### Table 2: Mean PTH levels in positive and negative Tc99m-sestamibi scans

<table>
<thead>
<tr>
<th>PTH</th>
<th>Pre-op</th>
<th>Post-op</th>
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<tbody>
<tr>
<td>Pos</td>
<td>40</td>
<td>26</td>
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<tr>
<td>Neg</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
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### Table 2 – Targeted parathyroid adenoma removal

**Bibliography:**

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**Figure 1 - Tc99m Sestamibi with SPECT**

**Figure 2 & 3 – Targeted parathyroid adenoma removal**