Effectiveness of Surgeon Interpretation of Technetium Tc 99m Sestamibi Scans in Localizing Parathyroid Adenomas

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Objectives: To evaluate the ability of surgeons to predict the laterality of parathyroid adenomas from technetium Tc 99m sestamibi scans and compare their results with the radiologic interpretations.

Design: Retrospective medical record review with single-blinded review of sestamibi scans.

Setting: Tertiary care academic medical center

Patients: The study population included 110 consecutive parathyroidectomy cases from January 2001 to June 2004. Inclusion criteria were biochemically proven primary hyperparathyroidism, with documented serum hypocalcemia and elevated parathyroid hormone levels. Only cases due to a single adenoma that were cured with a single surgical procedure were included.

Intervention: All patients underwent resection of a parathyroid adenoma following a preoperative sestamibi localization study and serum calcium and parathyroid hormone level analysis.

Main Outcome Measure: Adenoma location was determined from a review of operative and pathological reports. Two head and neck surgeons performed a blinded review of all scans, and their findings were compared with the radiology reports.

Results: Of 82 adenomas, 51 (62%) were correctly lateralized in the radiology report, while the other 31 were interpreted as normal scans. The sensitivity and specificity of the radiologic interpretations for parathyroid adenomas in all patients with primary hyperparathyroidism were 62% and 83%, respectively. The scan interpretation of the 2 surgeons produced accurate lateralization of 91% and 91% of these single adenomas. Of the 31 single adenoma scans read as normal by the radiologist, the surgeons correctly lateralized 22 of 29 (76%) and 21 of 28 (75%) of the adenomas.

Conclusion: The review of sestamibi scans by surgeons allows accurate localization of parathyroid adenomas that may not be identified by standard radiologic interpretations.

Table. Findings for Single Parathyroid Adenomas

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age, mean (range), y</td>
<td>58 (33-91)</td>
</tr>
<tr>
<td>Patient sex, female, No./total No. (%)</td>
<td>69/82 (84)</td>
</tr>
<tr>
<td>Scan sensitivity, %</td>
<td>62</td>
</tr>
<tr>
<td>Scan specificity, %</td>
<td>83</td>
</tr>
<tr>
<td>False-negative findings, No./total No. (%)</td>
<td>31/82 (37)</td>
</tr>
<tr>
<td>Adenomas lateralized by 2 surgeons’ scan interpretations, No./total No. (%)</td>
<td>22/29 (76) and 21/28 (75)</td>
</tr>
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</table>

Each surgeon retrospectively reviewed all scans independently, blinded to the patients’ identifying data. The films were presented to the surgeons in a random fashion by the primary author (S.R.A.), with patient names obscured from view. Patient diagnosis was not available during the film reviews. After the surgeons’ radiologic interpretations were rendered and recorded, the pathologic diagnoses were then determined. Then the scan interpretations were compared with the true adenoma location. Radiologists’ interpretations of all scans were also examined, which included some scans that were unavailable for blinded study surgeon review.

Sestamibi scan interpretations were classified as true positive when the report correctly identified the side of the neck containing the adenoma and as true negative when normally functioning glands were not visualized. False-positive reports incorrectly designated a focus of scintigraphic activity as a hyperfunctioning parathyroid gland, and false-negative reports did not identify a hyperfunctioning gland. Sensitivity was determined as the standard ratio of true positives to the sum of true positives and false negatives. Specificity was calculated as the ratio of true negatives to the sum of false positives and true negatives.

RESULTS

Of the 110 parathyroidectomy patients, 2 were excluded for tertiary hyperparathyroidism, 12 were excluded for secondary hyperparathyroidism, and 2 cases were unresolved with initial surgery. Of the 94 patients with primary hyperparathyroidism who were cured with a single procedure, 93 had the full study data available for review. Of these 93 patients, 82 (88%) were found to have a single adenoma, which was the focus of this study. The patient ages ranged from 33 to 91 years, with a mean of 58.4 years (Table).

Of these 82 adenomas, 51 (62%) were correctly lateralized in the radiology report, while the other 31 were interpreted as normal scans. There were 10 true-negative and 2 false-positive readings. The sensitivity and specificity of the radiology interpretations for parathyroid adenomas in all primary hyperparathyroidism patients scans were 62% and 83%, respectively. One radiology interpretation scored both a false negative and a false positive because it reported an adenoma on the left, but the adenoma was actually located on the right side.

The scans for 76 of the 82 patients with single adenomas were available for retrospective blinded surgeon review. Despite being unavailable for blinded review, some scans had their preoperative surgeon interpretation recorded on the history review and physical examination and were therefore included in this study. The scan interpretations of the 2 surgeons produced accurate lateralization of 71 of 78 (91%) and 70 of 77 (91%) of these single adenomas. Of the 31 single adenoma scans read as normal by the radiologist (false negatives), surgeon review and/or interpretations were performed by 2 head and neck surgeons for 29 and 28. From these films, the 2 surgeons correctly lateralized 22 of 29 (76%) and 21 of 28 (75%) of the adenomas (Figure 1 and Figure 2).

COMMENT

The advantages of the focused parathyroidectomy over the traditional bilateral neck exploration have been well supported. Sestamibi scan accuracy is the fact that the studies typically compare clinical findings with the radiologists’ interpretation of the parathyroid scan.

This study focuses on independent surgeon interpretation of sestamibi scans, with the goal of predicting adenoma laterality. By augmenting the radiologist’s reading of the scan, we hypothesize that the localization and/or laterality accuracy for single adenomas will improve.
described and include decreased operative time and length of hospital stay, smaller incision, decreased incidence of postoperative hypocalcemia, lower cost, and the option of avoiding general anesthesia.\textsuperscript{12-17} Even when a focused parathyroidectomy case develops into a unilateral neck exploration, most of these advantages over bilateral exploration still apply.\textsuperscript{9}

Preoperative sestamibi scintigraphy has emerged as the optimal evaluation of hyperfunctioning parathyroid tissue. The study’s ability to direct a surgeon to a single adenoma currently averages 85% to 90%. Our study measured the radiology lateralization accuracy at 61%, which is lower than that quoted in most recent reports. This finding could be because our review includes scans per-

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**Figure 1.** Early (A) and delayed (B) planar sestamibi scan images read as nonlocalizing. Focused parathyroidectomy based on a surgeon’s reading revealed a single left inferior parathyroid adenoma.

**Figure 2.** Planar sestamibi scan (A, early; B, delayed) and select single-photon emission computed tomographic images (C and D) read as nonlocalizing. Focused parathyroidectomy based on a surgeon’s reading revealed a single right inferior parathyroid adenoma.
formed several years ago and refinements in scan performance and interpretation have improved localization accuracy. In addition, our scans were performed and interpreted at 10 different facilities, including some that perform this examination infrequently and lack the interaction with endocrine surgeons from which larger facilities benefit. The radiology departments used differing scan protocols, as described previously, and occasionally included SPECT scanning. Some of the scan protocols included in this study, such as allowing 3 to 5 hours for tracer washout, have been found to be suboptimal. These scans were included in this study because this is a review of consecutive surgery patients. We have since altered our protocol to have all patients undergo sestamibi scanning at our institution to establish uniformity in scintigraphy results. All reviewed scans were hard copies. This resulted in the surgeons reviewing a variety of film sizes, image number, and orientation, which allows for a broad applicability of our results. With the advent and widespread installment of digital radiographic systems, which allow infinite adjustment of the digital images, the current scan localization accuracy may be even higher.

Sestamibi parathyroid scanning is a relatively new technology and continues to improve with time. The single isotope, double-phase (washout) technique, initially reported in 1992, is the standard technique. Single-photon emission computed tomography improves sensitivity and localization accuracy, and SPECT–computed tomography fusion promises to further improve localization. Dual radionuclide subtraction imaging has been found to benefit localization in patients with thyroid abnormalities. Although its sensitivity for multinodular disease is notably lower, misdiagnosis can be avoided with supplemental preoperative imaging and/or intraoperative rapid PTH measurements.

Although the accuracy of the sestamibi scan regularly approaches 90% in the literature, we propose that surgeons can improve the localization accuracy. They have a more thorough understanding of developmental and clinical anatomy and are not bound to strict radiologic interpretation criteria. This study validates the concept that the surgeons’ lateralization accuracy of 91% exceeds published radiology values. Our surgeons based their scan interpretations on scintigraphic asymmetry. For scans that did not have an obvious adenoma radiotracer collection, the surgeons used minute differences in radiotracer retention to correctly lateralize the adenoma. Some authors advocate supplemental imaging, such as ultrasound, for nonlocalizing sestamibi scans. Our study shows that surgeon review of the sestamibi scan will considerably improve study accuracy: our surgeons were able to correctly lateralize 75% of the adenomas in “nonlocalizing scans.” This occurs without any additional cost or patient involvement.

The quoted accuracy of sestamibi scans in published studies is based on radiologists’ scan interpretations, and some authors even suggest that the surgical approach and operative success depend on the skill of an institution’s radiology staff. Some studies have specifically examined the role that the nuclear medicine radiologist plays in parathyroid adenoma localization, finding better results with experienced scintigraphers and when the scans are read by the surgeon and nuclear medicine physician together. Our study appears to be the first to measure the surgeon’s ability to localize parathyroid adenomas through independent sestamibi scan interpretation.

One obvious potential bias in this study is the fact that the radiologists reviewed all sestamibi scans, while the surgeons retrospectively reviewed the scans for this study, knowing that it includes only patients with single adenomas. However, this “bias” exists in reality, as radiologists interpret the scans according to radiologic criteria, including the absence or presence of an adenoma. Surgeons, meanwhile, review the scans in preparation for opening the neck. They are responsible for deciding which side to explore first and where to focus the search. Therefore, they should approach scan interpretation as the surgeons did in the present study—by using any scintigraphic asymmetry to predict adenoma laterality, whether or not there is an obvious adenoma. We propose that surgeons scrutinize all scans preoperatively, especially nonlocalizing scans, to increase the chance of a successful adenoma localization and unilateral exploration.

We conclude that the sestamibi scan is a proven, reliable method for preoperative localization of parathyroid adenomas and that the review of sestamibi scans by surgeons allows accurate localization of parathyroid adenomas that may not be identified by standard radiologic interpretations.

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Author Contributions: Dr Anderson had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Anderson and Karakla. Acquisition of data: Anderson and Vaughn. Analysis and interpretation of data: Anderson, Karakla, and Wadsworth. Drafting of the manuscript: Anderson and Vaughn. Critical revision of the manuscript for important intellectual content: Anderson, Karakla, and Wadsworth. Statistical analysis: Anderson. Administrative, technical, and material support: Anderson and Vaughn. Study supervision: Karakla and Wadsworth.

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REFERENCES


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