

# Accuracy and Role of Surgeon-performed Intraoperative Ultrasound in Minimally Invasive Open Parathyroidectomy

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## Abstract

**Background:** Assessment of the accuracy and the role of surgeon-performed ultrasound in comparison to expert radiology-performed ultrasound, sestamibi scanning and histologic findings.

**Methods:** From January 2006 to December 2007 we prospectively evaluated forty-two consecutive patients undergoing parathyroidectomy for primary hyperparathyroidism. One surgeon who was unaware of the preoperative imaging studies did all ultrasound examinations just prior to skin incision. The correlations between surgeon-performed ultrasound, radiology-expert ultrasound, sestamibi scanning and histologic findings were assessed.

**Results:** There were thirty-eight females (mean age: 55.9 years, range: 13-83) and four males (mean age: 41 years, range: 42-77) with biochemical evidence of primary hyperparathyroidism. Single gland disease (SGD) was histologically confirmed in thirty-six cases (85.7%) and multigland disease (MGD) in six cases (14.3%). Concordant preoperative U/S and sestamibi findings were found in thirty-four cases in SGD patients: surgeon performed U/S and expert radiology U/S were equally correct in all of these cases. In the rest two discordant cases in SGD patients, radiologist U/S was wrong in both cases, whereas sestamibi and surgeon U/S had no false results. Multigland disease had been predicted by negative findings in preoperative U/S and sestamibi in four patients and by finding more than one enlarged parathyroid glands in two patients. Surgeon U/S gave one false result in the former subgroup of MGD patients, although correctly identified multiple gland enlargements in the latter subgroup.

**Conclusions:** This study shows that surgeon-performed ultrasound compares favourably and even exceeds radiology U/S. Since this positive predictive result applies especially in SGD, intraoperative U/S had been added in the standards of care of patients with primary hyperparathyroidism in our institution

**Keywords:** Ultrasound, parathyroid, primary hyperparathyroidism, sestamibi, adenoma.

## INTRODUCTION

Minimally invasive open parathyroidectomy in the form of unilateral or focused exploration appears to be an appealing concept in terms of better cosmesis, reduced operative time and reduced complication rates and it is further supported by a number of recent publications.<sup>1-5</sup>

Preoperative imaging modalities play a key role in this scenario since they allow accurate anatomic localization of the parathyroid adenoma. Average sensitivities of ultrasound imaging and sestamibi scans, though, vary greatly in the literature: 70-90% for the former,<sup>6-9</sup> 73-93% with positive predictive value 89-97% for the latter.<sup>10-12</sup>

Surgeon-performed ultrasound had gained an emerging role in this setting. "Real time information" and greater experience in anatomic relationships constitutes some theoretic advantages

of the surgeon-performed ultrasound compared to the other imaging modalities.

Under the light of these hypotheses, we prospectively evaluated forty-two consecutive patients undergoing minimally invasive parathyroidectomy for primary hyperparathyroidism. One surgeon was unaware of the preoperative imaging studies and did all ultrasound examinations just prior to skin incision.

The correlations between surgeon-performed ultrasound, radiology-expert ultrasound, sestamibi scanning and histologic findings were assessed to define the accuracy and the role of surgeon-performed ultrasound in the exciting field of minimally invasive parathyroid surgery.

## MATERIALS AND METHODS

**Patients:** From January 2006 to December 2007 forty-two consecutive patients that underwent parathyroidectomy for

primary hyperparathyroidism were prospectively evaluated. Their medical charts, preoperative ultrasound studies, sestamibi reports, laboratory investigative studies, operative notes and histologic reports were analyzed.

All patients met the biochemical criteria for primary hyperparathyroidism according to the workshop on asymptomatic primary hyperparathyroidism held at the NIH on April 2002. Patients with persistent or recurrent primary hyperparathyroidism were not included on the study. All patients gave informed consent to the minimally invasive parathyroidectomy and the intraoperative ultrasound procedure.

**Preoperative imaging studies:** All patients had preoperative ultrasounds and sestamibi scans performed and interpreted either within the associated departments of our hospital or elsewhere. The single-isotope dual-phase scan was the most widely scintigraphic technique used. Both early (10-15 minutes) and delayed (2-3 hours) images had been obtained.

**Surgeon:** Cervical ultrasound was performed by the first author. He had completed ultrasound postgraduate courses in Endocrine Surgery and had also, one year clinical experience in in-office and intraoperative ultrasound settings in thyroid and parathyroid surgery.

All high resolution ultrasound studies were performed with a 7.5 to 10 MHz linear transducer using transverse and longitudinal planes for the identification of the characteristic hypoechoic appearance of the parathyroid adenoma.

This author, who was totally unaware of the preoperative imaging studies, did all ultrasounds just prior to skin incision.

Given the results of this procedure, if there was concordance with the sestamibi the case was presumed as single gland disease and the skin incision was placed accordingly. In cases of obscure or indeterminate sestamibi results and/or discordance the case was classified as multigland disease.

**Surgery:** Most parathyroidectomies were done in a unilateral fashion using either a lateral-mini or a midline-mini approach with a 2.0-2.5 cm incision. In cases of multigland disease, a standard midline bilateral exploration was performed through a 3.0-3.5 cm, highly-placed transverse cervical incision. Success of adenoma resection and resolution of hyperparathyroidism were based on histologic confirmation of parathyroid tissue in frozen and permanent histology and on the same afternoon and next morning calcium measurements postoperatively. All patients were discharged on the first postoperative day with oral supplementation of calcium and vitamin D in a prophylactic basis.

**Statistical analysis:** The correlations between surgeon-performed ultrasound, radiology-expert ultrasound, sestamibi scanning and histologic findings were the primary outcome measures. Permanent histologic findings were used as the reference standard.

## RESULTS

From January 2006 to December 2007 we prospectively evaluated forty-two consecutive patients that undergone parathy-

roidectomy for primary hyperparathyroidism. There were thirty-eight females (mean age: 55.9 years, range: 13-83) and four males (mean age: 41 years, range: 42-77) with biochemical evidence of primary hyperparathyroidism (Table 1).

Mean preoperative calcium level was 11.1 mg/dl (SD: 0.46) and mean postoperative Ca (1st day) was 9.8 (SD: 0.63). Mean gland weight for the whole series was 846.2 mg (range 129-6270).

*Single gland disease (SGD)* was histologically confirmed in thirty-six cases (85.7%) whereas *multigland disease (MGD)* in six cases (14.3%) (Table 2). Concordant preoperative U/S and sestamibi findings were found in thirty-four cases in SGD patients: surgeon performed U/S and expert radiology U/S were equally correct in all of these cases. In the rest two discordant cases in SGD patients, radiologist U/S was wrong in both cases, whereas sestamibi and surgeon U/S had no false results (Figs 1 and 2). Mean gland weight for SGD was 1226.8 mg (range 210-6270).

*Multigland disease* had been predicted by negative findings in radiologist U/S and sestamibi in four patients. Two patients had preoperative findings of more than one enlarged parathyroid glands. Surgeon U/S gave one false result in the former subgroup of MGD patients, although correctly identified multiple gland enlargements in the latter subgroup. Radiologist U/S failed to identify one case of multiple gland enlargements. Mean gland weight for MGD was 465.7 mg (range 129-1896).

Concurrent thyroid disease was noted in 3 patients which undergone simultaneous total thyroidectomy and found to harbor incidental papillary carcinoma.

Minimally invasive parathyroidectomy was accomplished in all cases of SGD except in two cases of concurrent thyroid pathology. Total thyroidectomy for the other case of thyroid disease was performed along with the bilateral exploration for multigland parathyroid enlargement.

Sensitivity of radiologist U/S for the detection of SGD was 94.4%, whereas surgeon U/S did excellent. We could not find any relation of U/S sensitivity to the gland weight in SGD in this series.

In MGD, surgeon U/S sensitivity in the subgroup of MGD patients with negative findings in preoperative studies was 75%.

Radiologist U/S sensitivity for the subgroup of MGD patients with enlarged parathyroid glands was 50%, whereas surgeon U/S sensitivity for the same subgroup of MGD patients was 100%.

**Table 1:** Patient data and characteristics

Age (years)	56.1 (13-83)
Men n (%)	4 (9.5%)
Women n (%)	38 (90.5%)
Single-gland disease n (%)	36 (85.7%)
Multigland disease n (%)	6 (14.3)
Concurrent thyroid disease	Three incidental papillary carcinomas
Mean preoperative Ca	11.1 (SD: 0.46)
Mean postoperative Ca (1st day)	9.8 (SD: 0.63)

**Table 2:** SGD/MGD distribution and accuracy of imaging modalities in our series

SGD (n = 36)	Concordant sestamibi-R U/S: n = 34 (80.9%)	Sestamibi	true
		R U/S	true
		S U/S	true
	Discordant sestamibi-R U/S: n = 2 (4.8%)	Sestamibi	true
		R U/S	false = 2
		S U/S	true
MGD (n = 6)	Negative sestamibi-R U/S: n = 4 (9.5%)	S U/S	false = 1
	Multigland enlargement: n = 2 (4.8%)	Sestamibi	true
		R U/S	false = 1
		S U/S	true

SGD: Single gland disease, MGD: Multigland disease, R U/S: Radiologist U/S, S U/S: Surgeon U/S



**Fig. 1:** Left upper parathyroid adenoma (SGD-case1) missed by the radiologist U/S



**Fig. 2:** Right lower parathyroid adenoma (SGD-case 2) misinterpreted as thyroid nodule

We did not encounter double or ectopic adenomas in this series.

## DISCUSSION

Ultrasound examination of the cervical region is an easy, most convenient, noninvasive and virtually no-cost imaging modality. It can be easily learned through training courses, although it is mastered through practice as experience is gathered. The whole process takes no longer than 10-20 minutes to perform and involves no radiation or any invasive measures.

Surgeon-performed ultrasound is an emerging concept in minimally invasive parathyroid surgery. Interestingly enough, surgeon-performed U/S has been shown to be more sensitive

than radiologist-performed U/S in a number of recent publications,<sup>13-15</sup> a finding that was also confirmed in this series. Armed with a reasonable training, this author could do better than the radiologist U/S probably for two reasons: first due to strong motivation for parathyroid adenoma localization and subsequent performance of minimally invasive parathyroidectomy and second due to detailed knowledge of the anatomic structures and their relationships in the neck.

Intraoperative U/S as used in this study, gave also, another advantage to us: it provided real time visualization of the parathyroid adenoma and its relations to adjacent anatomic structures, affording the surgeon the opportunity to place the incision just where it was mostly needed.

Moreover, surgeon performed ultrasound proved to be superior compared to the radiologist ultrasound in the most critical part of minimally invasive parathyroid surgery: the identification of single gland disease.

Minimally invasive open parathyroidectomy, being developed as an alternative to the more complex video-assisted methods, has been centered on the focused (lateral) or the unilateral (midline-mini) approach. Successful outcome has been shown to be dependent on the appropriate patient selection and on the accuracy of the localization studies.<sup>2</sup> Correct identification of single gland disease is the most important parameter, a feature that was most complemented in this series. Actually, the sensitivity of radiologist U/S was 94.4% for SGD, whereas surgeon-performed ultrasound was correct in all cases of SGD. The radiologist U/S in this setting gave two failures: in one case the upper left adenoma was missed, whereas on the second case, the adenoma was misinterpreted as a thyroid nodule.

Multigland disease has been more difficult to correctly diagnose. There was a false positive result in the group of patients with negative findings from the other imaging studies for the surgeon U/S. Given the negative finding of the sestamibi, we started with midline-mini incision and proceeded to bilateral exploration when no single adenoma was found. In contrary, radiologist U/S missed the diffuse parathyroid enlargement in the other subgroup of MGD patients giving a result for a single adenoma: if we followed this path we should start with a lateral approach but eventually convert. Instead, we commenced the bilateral exploration with a mini-midline incision.

There is no doubt that in this small series the reported sensitivities are more satisfactory than often reported in the literature and the magnitude of superiority of surgeon vs radiologist U/S not dramatic. Nevertheless, the trend of the reasonably trained, dedicated endocrine surgeon to easily duplicate and even exceed the rates of radiologist performance is clearly depicted in this series. Do we have to abandon preoperative radiologist U/S? The answer is that we do not feel any comfortable at all if we do not perform our U/S examination before we proceed to minimally invasive parathyroidectomy in our patients.

## REFERENCES

1. Udelsman R, Donovan PI, Sokoll LJ. One hundred consecutive minimally invasive parathyroid explorations *Ann Surg* 2003;232:331-39.

2. Pang T, Stalberg P, Sidhu S, Sywak M, Wilkinson M, Reeve TS, Delbridge L. Minimally invasive parathyroidectomy using the lateral focused mini-incision technique without intraoperative parathyroid hormone monitoring *Br J Surg* 2007;94:315-19.
3. Grant CS, Thompson G, Farley D, van Heerden J. Primary hyperparathyroidism surgical management since the introduction of minimally invasive parathyroidectomy: Mayo Clinic experience *Arch Surg* 2005;140:472-78.
4. Clark OH. How should patients with primary hyperparathyroidism be treated? *J Clin Endocrin Metab* 2003;88:3011-14.
5. Norman J, Chheda H, Farrell C. Minimally invasive parathyroidectomy for primary hyperparathyroidism: Decreasing operative time and potential complications while improving cosmetic results *Am Surg* 1998;64:391-95.
6. Gilat H, Cohen M, Feinmesser R, Benzion J, Shvero J, Segal K, Ulanovsky D, Shpitzer T. Minimally invasive procedure for resection of a parathyroid adenoma: The role of high-resolution ultrasonography *J Clin Ultrasound* 2005;33:283-87.
7. Huppert BJ, Reading CC. Parathyroid sonography: Imaging and intervention *J Clin Ultrasound* 2007;35:144-55.
8. Gritzmann N, Koischwitz D, Rettenbacher T. Sonography of the thyroid and parathyroid glands. *Radiol Clin North Am* 2000;38:1131-45.
9. Mielstrup JW. Ultrasound examination of the parathyroid glands. *Otolaryngol Clin North Am* 2004;37:763-68.
10. Haber RS, Chun KK, Inabnet WB. Ultrasonography for preoperative localization of enlarged parathyroid glands in primary hyperparathyroidism: Comparison with 99m Tc sestamibi scintigraphy *Clin Endocrinol* 2002;57:241-49.
11. Chen CC, Holder LE, Scovill WA. Comparison of parathyroid imaging with technetium-99m-pertechnetate/sestamibi subtraction, double phase technetium-99m-sestamibi and technetium-99m-sestamibi SPECT *J Nucl Med* 1997;37:834-49.
12. Denham DW, Norman J. Cost-effectiveness of preoperative sestamibi scan for primary hyperparathyroidism is dependent solely on surgeon's choice of operative procedure *J Am Coll Surg* 1998;186:293-305.
13. Van Husen R, Kim LT. Accuracy of surgeon performed ultrasound in parathyroid localization *World J Surg* 2004;28:1122-26.
14. Prasannan S, Davies G, Bochner M, Kollias J, Malycha P. Minimally invasive parathyroidectomy using surgeon-performed ultrasound and sestamibi *ANZ J Surg* 2007;77:774-77.
15. Kairys JC, Daskalakis C, Weigel RJ. Surgeon-performed ultrasound for preoperative localization of abnormal parathyroid glands in patients with primary hyperparathyroidism *World J Surg* 2006;30:1658-63.