

# Minimally Invasive Video-Assisted Parathyroidectomy: Lesson Learned from 137 Cases

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**Background:** Since February 1997, a technique of minimally invasive video-assisted parathyroidectomy (MIVAP) was developed at our institution for the treatment of sporadic primary hyperparathyroidism (sPHPT). In this study we analyzed the entire series of patients who underwent MIVAP during the last 3 years.

**Study Design:** One hundred thirty-seven patients with sPHPT were selected for MIVAP. Selection criteria were: diagnosis of single adenoma based on preoperative localization studies (ultrasonography, sestamibi scintigraphy, or both), and no previous neck surgery or concomitant large multinodular goiter. The procedure, already described, is performed by a gasless video-assisted technique through a single 1.5-cm central skin incision above the sternal notch. Quick, intraoperative parathyroid hormone assay was used in 134 cases (97.8%) to confirm the complete removal of all hyperfunctioning parathyroid tissue.

**Results:** Mean operative time was  $54.3 \pm 22.6$  minutes. The conversion rate was 8.8%. One laryngeal nerve palsy was registered (0.7%), as was one case of persistent hyperparathyroidism. In six patients (4.4%) a transient symptomatic postoperative hypocalcemia was observed. Two thyroid lobectomies were associated using the same minimally invasive access. At a mean followup of  $15.4 \pm 10.6$  months, all but two patients were normocalcemic. The cosmetic result was considered excellent by most of the patients (92.8%).

**Conclusions:** Although not all patients with sPHPT are eligible for MIVAP, this approach can now be proposed in a bigger proportion (67% of patients). As already demonstrated in a previous study, also in a large series of patients, after greater experience has been

achieved, the results and the operative time are the same as in traditional surgery, with better cosmetic result and a less painful course. (*J Am Coll Surg* 2000; 191:613–618. © 2000 by the American College of Surgeons)

After the first description of endoscopic subtotal parathyroidectomy by Gagner in 1996,<sup>1</sup> during the last 3 years several minimally invasive procedures have been proposed for the surgical treatment of primary hyperparathyroidism (PHPT). They range from the “pure” endoscopic approach,<sup>1,2</sup> with constant gas insufflation, to video-assisted gasless techniques,<sup>3,4</sup> to minimally invasive open parathyroidectomy, which can be guided<sup>5</sup> or not<sup>6</sup> by intraoperative scintigraphic scan.

The need for preoperative localization studies and quick intraoperative parathyroid hormone (PTH) assay, the length and costs of the procedures, the risk of missing a multiglandular disease, and the high success rate of conventional surgery in experienced hands, are the reasons why these approaches raised many criticisms.<sup>7-9</sup>

There is still a limited number of papers about these techniques; they are generally based on small series of patients and represent feasibility studies. This probably contributes to the skepticism still present among endocrine surgeons regarding these innovative procedures.

In 1997 we developed a technique of minimally invasive video-assisted parathyroidectomy (MIVAP).<sup>4,10</sup> In a recently published randomized prospective study<sup>11</sup> we compared the results of MIVAP and conventional surgery, with bilateral exploration, on a relatively small series of patients, demonstrating the superiority of MIVAP over bilateral open exploration in terms of operative time, cosmetic result, and postoperative pain and distress. In this article we analyze a large series of patients who underwent MIVAP at our department during

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the last 3 years, to evaluate merits and limits of this procedure.

## METHODS

From February 1997 to February 2000, 204 patients underwent parathyroidectomy for PHPT in our department. One hundred thirty-seven patients (67.1%) were considered eligible for MIVAP. Eligibility criteria, based on clinical history and preoperative imaging studies, were: sporadic form of PHPT (sPHPT), no previous neck surgery, absence of concomitant thyroid nodules, and preoperative localization studies suggestive for solitary parathyroid adenoma. After a learning period these eligibility criteria were less strictly followed and after the first 70 patients, patients with small thyroid nodules (less than 3 cm in largest diameter), contralateral previous neck surgery, or no precise localization on preoperative imaging studies were selected for MIVAP.

Complete biochemical evaluation (serum calcium, phosphorus, and PTH levels) was obtained before operation in all cases. Preoperative imaging studies included ultrasonography examination (US) and Tc-99m-sestamibi parathyroid scan; they were performed in all cases. Preoperative informed consent was obtained by all patients. Followup evaluation included serum calcium, phosphorus, and PTH measurements. Postoperative evaluation of vocal cord motility was performed by laryngoscopy in all cases. All patients who successfully underwent MIVAP were asked to evaluate the cosmetic result of the operation by a verbal response scale 1 to 6 months after operation. This scale had four options: poor, acceptable, good, and excellent.

### Operative procedure

Patients were operated on either under general endotracheal anesthesia or, in 20 cases (14.6%), under bilateral superficial cervical block in association with laryngeal mask and sevoflurane administration. The neck was not hyperextended. MIVAP was performed as previously described.<sup>4</sup> The surgeon was aided by two assistants. One of them, or an experienced nurse, handled the endoscope. Briefly, the procedure was carried out through a 15-mm incision at the notch level. The cervical midline was opened and a conventional 12-mm trocar inserted

between the strap muscles and the thyroid on the side of the lesion.

Under endoscopic vision, a 3 to 4-minute CO<sub>2</sub> insufflation (12 mmHg) allowed gentle and anatomic dissection of the thyrotacheal groove. The trocar was then removed and the operative space maintained with small external retractors. Complete dissection of the thyroid lobe can be obtained also by blunt dissection with small instruments under endoscopic vision, without any trocar insertion and any CO<sub>2</sub> insufflation. In this case small retractors were used to maintain the operative space as in the first step of the procedure, which is then completely gasless. A 30-degree, 5-mm endoscope was used for the procedure and permitted optimal visualization of the operative field. In fact, the magnification of the endoscope allowed easy visualization of the parathyroid glands, the recurrent laryngeal nerve, and the other neck structures. Small instruments, 2 mm in diameter, were used for the dissection. Small conventional clips were used to ligate the middle thyroid veins if present, and the adenoma vessels. No drainage was necessary, and the midline was closed with interrupted absorbable suture. The skin incision was closed with either skin sealant or nonabsorbable monofilament subcuticular suture.

Quick intraoperative intact parathyroid hormone assay (qPTHa) (Nichols Institute Diagnostics, San Juan Capistrano, CA) was used. The completeness of the surgical resection of all hyperfunctioning parathyroid tissue was confirmed by a decrease of more than 50% in intact PTH values with respect to the highest preexcision level. Measurements were obtained at the induction of anesthesia, at the visualization of the adenoma, and 5 and 10 minutes after removal of the adenoma. When qPTHa was not available, bilateral neck exploration to visualize all parathyroid glands was performed through the same access (three patients).

## RESULTS

There were 104 women (75.9%) and 33 men (24.1%), ranging in age from 22 to 86 years (mean  $\pm$  SD: 58.2  $\pm$  13.5 years). Preoperative laboratory findings are reported in Table 1.

MIVAP was successfully carried out in 125 of the 137 patients who had been selected for this approach (91.2%). Mean operative time ( $\pm$  SD),

**Table 1. Preoperative Findings in 137 Patients who Underwent Video-Assisted Parathyroidectomy for Primary Hyperparathyroidism**

Laboratory test	Normal range	Mean	Range
Serum total calcium (mg/dL)	8.0–10.5	11.1	10.1–13.4
Serum phosphorus (mg/dL)	2.5–5.0	2.5	2.0–3.3
Serum intact parathyroid hormone (pg/mL)	10–65	221	90–379
Maximum diameter* (mm)	—	17	10–41

\*Measured with ultrasonography.

from skin incision to skin closure, was 54.3 minutes ( $\pm 22.6$  minutes). Conversion to traditional cervicotomy was required in 12 patients (8.8%). Reasons for conversion are listed in Table 2.

In one patient a double ipsilateral adenoma was removed during the same video-assisted procedure. Video-assisted bilateral exploration with visualization of four glands was successfully performed in three patients, because qPTHa was not available. One homolateral and one contralateral thyroid lobectomy were performed through the same access for a small (diameter  $< 3$  cm) thyroid nodule with a cytologic diagnosis of microfollicular tumor (definitive histology of both: follicular adenoma).

Preoperative localization studies, both sestamibi scan and ultrasonography, missed a second enlarged parathyroid gland in four patients with multiglandular disease. Ultrasonography failed to reveal the intrathyroidal location of four adenomas. In three patients a false-positive localization was registered: in two patients no adenoma was found; in the last one an adenoma was found on the opposite side. In all other patients localization was correct regarding the side of the lesion and the relationships with anatomic landmarks in the neck.

The qPTHa was used in 134 patients (97.8%). The mean decrease at 5 minutes was 71.4% ( $\pm 16\%$ ) and 78.2% ( $\pm 13\%$ ) at 10 minutes. In two patients, after removal of the adenoma, PTH failed to decrease adequately; bilateral exploration, performed in one patient by an open approach and in the other one by a video-assisted procedure, was negative for a second adenoma. Both patients are normocalcemic 28 and 17 months after operation, respectively.

**Table 2. Reasons for Conversion to Traditional Cervicotomy in 12 of 137 Patients Who Underwent Video-Assisted Parathyroidectomy for Primary Hyperparathyroidism**

Reason for conversion	n
Multiglandular disease	3
Intrathyroid adenoma	4
Parathyroid carcinoma*	1
Negative bilateral exploration	1
Intrathyroid ectopic adenoma	1
Ultrasonography false-positive result	1
qPTHa <sup>†</sup> false-negative result	1

\*Synchronous homolateral en bloc thyroid lobectomy.

<sup>†</sup>qPTHa, quick intact PTH assay.

Patients generally had an overnight discharge after careful evaluation of any sign or symptom of hypocalcemia and of serum calcium measurement. Twenty-four patients (17.5%) were discharged during the second postoperative day (for symptomatic hypocalcemia or detained for ongoing studies).

Six cases (4.4%) of transient symptomatic postoperative hypocalcemia requiring treatment were registered. One recurrent laryngeal nerve palsy (0.7%) was confirmed at laryngoscopy 6 months after operation.

Mean ( $\pm$  SD) followup is 15.4 months ( $\pm 10.6$  months). All but two patients are normocalcemic. One patient, who showed adequate qPTHa decrease, has persistent disease. One patient has persistent slight hypercalcemia after unsuccessful exploration. In this case, after conversion to an open procedure, no abnormal parathyroid tissue was found and the diagnosis of sPHPT was questioned. The patient with parathyroid cancer had normal serum calcium and normal parathyroid hormone levels when discharged and at followup (8 months).

Cosmetic results were considered excellent by the majority (116 of 125) of patients (92.8%); 4 patients (3.2%) considered the cosmetic result as good, and the remaining 5 patients (4.0%) as acceptable.

## DISCUSSION

According to our series a high percentage of patients with PHPT (67.1%) is eligible for the minimally invasive approach. This percentage has increased over the past 3 years, going from 64% during the first 2 years of experience and reaching 74% in the last year. In fact in the early phase of our experience,

previously reported eligibility criteria were strictly followed.<sup>4</sup> Recently, the surgical team being more confident with this approach, and thanks also to better technical support in terms of instrumentation, some contraindications, such as the presence of a thyroid nodule or inaccurate preoperative imaging, have been more flexibly interpreted. Actually, preoperative localization studies are generally considered mandatory when performing a minimally invasive approach.<sup>4,11</sup> Nonetheless, after a learning period, in three patients we demonstrated the feasibility of a bilateral exploration through the single central skin incision, without increasing the operative time too much. In the case of lesions that are not well localized, a minimally invasive video-assisted approach may be proposed. It should be emphasized that a thyroid lobectomy through the same incision was associated to MIVAP in two patients in the present series and video-assisted thyroidectomy has been demonstrated feasible and safe.<sup>12,13</sup> In this series MIVAP was successfully performed in one patient with previous contralateral thyroid resection. Conversely, in case of suspicion of multiglandular disease (hyperplasia), we think that a conventional approach should still be proposed.

Preoperative localization should be obtained to perform a unilateral exploration, which can obviously reduce the operative time, especially at the beginning of the experience.

One could be concerned about the costs of preoperative localization studies (ultrasonography, MIBI scan).<sup>14,15</sup> In this regard, we must point out that today, preoperative imaging studies have generally already been performed by the time the patient is referred to the surgeon.<sup>15</sup> In our experience ultrasonography showed two important advantages over scintigraphy. It gives more details about the exact position and morphologic characteristics of the adenoma and measures its size with great accuracy. MIVAP is not indicated for lesions larger than 35 mm, so ultrasonography can be very useful. Moreover, in the experience of our institution, ultrasonography had a sensitivity equal to that of scintigraphy.<sup>16</sup>

Mean operative time was about 54 minutes in this series. It should be stressed that, whereas it was 110 minutes in the first seven patients, after this early phase of the learning curve, it quickly dropped

to less than 1 hour, in our<sup>11</sup> and in others' experience.<sup>17</sup> Today, MIVAP operative time rivals that of standard open procedure (bilateral exploration).<sup>11</sup>

The availability of qPTH assay is very important when performing MIVAP and other minimally invasive techniques. In fact it avoids the need for bilateral exploration and identification of all parathyroid glands. This results in reduced operating time, limiting the overall costs of the procedure. Moreover, frozen section is not useful and does not give additional information when using qPTH assay. That results in a further reduction of the overall costs. Indeed, as shown in a recently published preliminary experience comparing MIVAP with conventional bilateral exploration with frozen section examination, the overall cost of the video-assisted procedure was slightly lower (\$1,720) than that of the conventional approach (\$1,910).<sup>11</sup>

Relying only on parathyroid intraoperative measurement might result in missing some cases of multiglandular disease.<sup>18,19</sup> In our series this happened in only one out of five cases of multiglandular disease (20%). Indeed, we observed a patient with persistent PHPT, although intraoperative PTH measurement had shown a more than 50% decrease at 5 and 10 minutes after removal of the adenoma. Conversely, in two patients PTH failed to decrease during the operation but patients are normocalcemic after an adequate followup. The occurrence of false-positive and false-negative results was reported by other authors as well<sup>18,19</sup> with similar rate, and generally is responsible for unnecessary bilateral explorations. Searching for a second normal ipsilateral parathyroid gland is always possible and does not prolong operative time in a significant way; in this case the possibility of missing a parathyroid hyperplasia or even a second adenoma is greatly reduced.<sup>20</sup> Finally, bilateral endoscopic exploration proved feasible by the minimally invasive approach that we use, even though a certain degree of experience is required. Even if qPTH assay is not available, MIVAP may be safely performed. This is a decided advantage of the approach, which, with its central incision, is quite similar to the standard open procedure. We did not observe any case of recurrent disease, but any conclusion would be inappropriate because of the short followup.

We registered 12 conversions in this series (8.8%) (Table 2). In three patients at the beginning

of the experience, we decided to convert because the results of qPTH assay led us to suspect a second contralateral adenoma, and we were concerned about the lengthiness of a video-assisted bilateral exploration. Now, feeling more confident about using this access, we would certainly perform a bilateral exploration by the video-assisted approach in a similar situation. Four patients required conversion because the adenoma, in spite of clear preoperative imaging, was not found on endoscopic exploration. In these patients a conventional procedure was then performed, revealing an intrathyroid adenoma, which was removed successfully by thyroid lobectomy. So, conversion was probably unavoidable because of the presence of such ectopia. In one patient, endoscopic exploration revealed a lesion that had the appearance of a parathyroid carcinoma, because of its large size, irregular margins, and signs of local infiltration. After conversion, an adequate procedure was performed and the presence of a malignant lesion confirmed. In one patient, endoscopic exploration failed to unveil an intrathyroid ectopic adenoma. In one patient, after removal of the adenoma, PTH failed to decrease adequately, bilateral open exploration was negative for a second adenoma, but in spite of that the patient was normocalcemic. In another similar patient later in our experience, bilateral exploration was performed by a video-assisted approach. Finally, in two patients, conversion was decided on after unsuccessful exploration. In one patient, the diagnosis of PHPT was questioned because after conventional exploration, no abnormal parathyroid tissue was found. In the remaining patient, an enlarged gland was found on the opposite side of the exploration, caused by false-positive results of preoperative localization studies.

The only relevant complication we registered in our series was a case of recurrent laryngeal nerve palsy (0.7%), which occurred in the early phase of the experience. Since then, we systematically identify the nerve before starting dissection of the adenoma. This helped avoid any laryngeal nerve injury in the last 93 patients. No case of definitive hypoparathyroidism was observed. Transient symptomatic hypocalcemia was observed in six patients (4.4%). In a controlled prospective study comparing the standard procedure with the video-assisted approach, transient symptomatic hypocalcemia was slightly more frequent with the standard procedure,

but not significantly so.<sup>11</sup> Some authors<sup>17</sup> claim decidedly superior outcomes for MIVAP in terms of transient postoperative hypocalcemia, probably because there is no manipulation of the intact glands.

One of the supposed limits of the video-assisted procedure is that it cannot be performed under local anesthesia.<sup>9</sup> In 20 patients we used a cervical block in association with laryngeal mask and sevoflurane administration. In this technique of deep sedation the use of the laryngeal mask produces a mechanical elevation of the larynx, creating a better exposure of the thyroid gland.<sup>21</sup> Moreover, such anesthetic approaches avoiding tracheal intubation represent a considerable step towards a "less invasive" anesthesia, which certainly is of major importance if minimal access surgery is to successfully rival the traditional approach.

One could be concerned about the length of the postoperative hospital stay in this series, in spite of the minimally invasive approach. Indeed there are many reports about the possibility of performing parathyroid surgery on an outpatient basis.<sup>22</sup> In spite of that, in the Italian public health care system it is not economically advantageous to perform surgical procedures on a day surgery basis, so we are forced to discharge patients on the first postoperative day, although most of them would be perfectly able to leave the hospital on the same operative day.

In conclusion, in this study based on a large series of patients, we confirm the results obtained in a previous prospective trial based on a small series of patients:<sup>11</sup> MIVAP compared with traditional surgery can offer a better cosmetic result and less postoperative discomfort at similar costs. Clinical outcomes in more than 100 patients proved to be the same as in the conventional approach.<sup>18-20</sup> Nevertheless, MIVAP is still a very specialized approach, which certainly requires that a surgeon be well experienced in both endoscopic and endocrine surgery. It should not be defined, though, as a highly technology-dependent operation for two main reasons: (1) the required surgical equipment is the same as that commonly used in any general hospital, and no disposable instruments are to be used, reducing the general costs; and (2) preoperative localization studies and intraoperative PTH assays are by now widespread in all tertiary centers dealing with patients presenting with PHPT.

Finally, it is important to recall that not all pa-

tients can benefit from this approach, but in a large series of patients, such as the one presented in this study, more than two-thirds (67%) of the patients proved eligible for a minimally invasive approach, which, if not strictly necessary, can be considered a valid option in the treatment of PHPT.

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