



Minimally Invasive Video-assisted Parathyroidectomy: Multiinstitutional Study

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Abstract. Unilateral and minimally invasive parathyroidectomies with endoscopic and video-assisted technique have been introduced. Most of these procedures utilize preoperative localization and intraoperative monitoring of parathyroid hormone. There are only a few reports on these procedures. The objective of this study was to evaluate video-assisted parathyroidectomy (MIVAP) for surgery in patients with primary hyperparathyroidism (pHPT). From February 1997 to June 1999 a series of 123 consecutive patients with pHPT at four surgical centers were evaluated. The patients' ages ranged from 18 to 77 years (median 50 years). Preoperatively, sestamibi scintigraphy and ultrasonography for localization were performed for all patients. Selection criteria for a MIVAP procedure excluded patients with negative localization, suspicion of multiglandular disease (MGD) or thyroid malignancy, a large thyroid mass, and prior surgery or irradiation to the neck. MIVAP was performed with a 1.5 cm suprasternal incision; the operation was then done through this incision with a 30 degree 5 mm endoscope and microsurgical instruments with brief CO₂ insufflation for adenoma identification. We then proceeded with an open technique through the small incision under video-assistance. Intraoperative monitoring of intact parathyroid hormone (iPTH) assays was used in all patients. Among the 123 patients in whom MIVAP was attempted, the procedure was accomplished in 109 (89%). Conversion to conventional cervicotomy was required in 14 (11%) patients because of failed localization, failure of the iPTH level to fall appropriately, or technical problems. There was no persistent or recurrent HPT during the 3 to 12-month follow-up. Oral calcium replacement for symptomatic hypocalcemia postoperatively was given in 7 (6%) cases. A unilateral transient laryngeal nerve palsy, resolving within 6 months postoperatively, occurred in two (2%) patients. The median hospital stay was 1.5 days (range 0.5–5.0 days). This study showed the feasibility of MIVAP as an alternative surgical treatment for pHPT in a selected group of patients. Further studies are necessary to evaluate the efficacy and rationale of MIVAP compared to other techniques for parathyroidectomy in pHPT patients.

roid glands. Improvement of preoperative localization measures with high-resolution ultrasonography (US) and increased sensitivity of ^{99m}Tc- or ¹³¹I-sestamibi scintigraphy encouraged further employment of unilateral and minimally invasive procedures [3, 4]. Use of rapid intraoperative parathyroid hormone assay (iPTH) was utilized to ensure adequacy of a unilateral exploration. This study presents early experiences of MIVAP from four surgical centers in Italy, Germany, the United States, and Turkey.

Patients and Methods

From February 1997 to June 1999 a total of 123 consecutive patients with a diagnosis of pHPT and satisfactory localization of hyperfunctional parathyroid glands using high-resolution US and sestamibi scan were investigated. There were 89 (72%) women and 34 (28%) men. All met the biochemical criteria for pHPT and had normal renal function. The median age was 50 years (range 18–86 years). Exclusion criteria involved unsatisfactory parathyroid localization, multinodular goiter, previous surgery or irradiation to the neck, and suspicion of multiglandular disease (MGD) or malignancy. With growing experience some of the exclusion criteria were changed. The operative procedure of MIVAP, as introduced by Miccoli in 1997, was performed in essentially the same fashion with only minor modifications by all four participating centers [5, 6] (Table 1). The procedure was performed under general anesthesia using a 1.5 cm transverse cervicotomy 1 cm above the sternal notch. After opening the midline fascia and dissecting and opening the paratracheal space, a 10 mm endoscopic trocar with a 30 degree magnifying telescope was inserted and the wound sealed with a purse-string suture. Only brief insufflation of CO₂ for 3 to 4 minutes at 12 mmHg was used to open the paratracheal plane bluntly. The remainder of the procedure was performed through the open incision with the magnifying telescope and microsurgical instruments. A bilateral exploration is feasible without extending the approach. Once before adenoma extirpation and 2, 5, and 10 minutes afterward peripheral blood samples were obtained and analyzed for iPTH values. The cutoff level for successful extirpation of all hyperfunctional parathyroid tissue was a decline in the iPTH level of at least 50%

The traditional surgical approach for primary hyperparathyroidism (pHPT) was bilateral exploration with visualization of all four parathyroid glands [1, 2]. Selective approaches were introduced by Pyrtek in 1983 with a unilateral exploration toward the parathy-

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Table 1. MIVAP: technique.

Technique	Center A	Center B	Center C	Center D
Preoperative localization	US, MIBI	US, MIBI	US, MIBI	US, MIBI
Intraoperative quick PTH assay	+	+	+	+
Approach	Transverse cervicotomy (1.5 cm), 1 trocar	Transverse cervicotomy (1.5 cm), 1 trocar	Transverse cervicotomy (1.5–2.5 cm), 1 trocar	Transverse cervicotomy (2 cm), 3 trocars
GA	+	+	+	+
Auxiliary techniques	—(LMA); two hemithy.	Nerve stimulation; two thyroid nodule extirpations	—(LMA)	—(Gamma probe)

US: ultrasonography; MIBI: sestamibi scintigraphy; PTH: parathyroid hormone; GA: general anesthesia; LMA: larynx mask; hemithy: MIVAP: minimally invasive video-assisted parathyroidectomy; hemithyroidectomy.

Table 2. MIVAP: results

Parameter	Center A	Center B	Center C	Center D
No.	89	19	12	3
MIVAP, PTX, pHPT (%)	59	35	?	6
Gender (M:F)	21:68	8:11	4:8	1:2
Corr US (%)	91	74	75	100
Localization MIBI (%)	57	53	92	67
Operating time (hr)	59	61	94	63
Hospital stay (days)	1.3	3	1.1	0.8
Histology	SGD 85 MGD 3 CA 1	SGD 17 MGD 2	SGD 12	SGD 3
Conversion	6	5	3	0
Emphysema	3	0	1	0
RLNP	1	1	0	0
pHPT/recurrence	0	0	0	0
Hypoparathyroidism	5	0	0	0
Ca subst	5	4	?	?

PTX: parathyroidectomy; pHPT: primary hyperparathyroidism; RLNP: recurrent laryngeal nerve palsy; SGD: single gland disease; MGD: multiple gland disease; CA: parathyroid carcinoma; Ca subst: oral calcium supplementation; Corr. US: correct ultrasonographic adenoma localization.

at 10 minutes after adenoma extirpation compared to the baseline value.

Results

Altogether, 123 MIVAP procedures were performed, accounting for 40% of all parathyroidectomies done for pHPT during the study's duration. Although selection criteria were not different, the percentage of patients chosen for MIVAP versus conventional parathyroidectomy differed considerably in the four participating centers (A 59%, B 35%, C 24%, D 6%) (Table 2). The preoperative PTH levels ranged from 60 to 140 pg/ml. Concomitant video-assisted hemithyroidectomy in two cases and thyroid nodule extirpation in one case were performed. In 14 (11%) cases conversion to conventional cervicotomy became necessary. The reasons for conversion were MGD in seven, unsatisfactory accessibility in three, and one for parathyroid carcinoma. The reasons for three conversions were obscured visibility due to bleeding, misplaced gas insufflation, and nonidentification of adenoma in three patients.

There were 75 adenomas on the left side of the neck and 45 on the right side; there were 76 adenomas in inferior position and 42

Table 3. MIVAP: collective results.

No.	123
Corr. localization	US 89%, MIBI 60%
Operating time	55 minutes
Hospital stay	1.5 days
Conversion	14 (11%)
Hypo/Ca substitution	5/9 (4%/7%)
RLNP	2 (2%)

in superior position. Ectopic adenoma localization was identified as intrathyroidal in two patients and dorsoesophageal in one patient. Histopathology confirmed 117 (95%) cases of single-gland disease, 4 (3%) cases of enlarged parathyroid glands, 1 (1%) case of four-gland disease, and 1 (1%) case of a parathyroid carcinoma. The median size of the adenomas was 150 mm (range 96–246 mm), and the median weight was 674 mg (83–2152 mg). The operating time ranged from 25 to 180 minutes (median: A 59 minutes, B 61 minutes, C 94 minutes, D 63 minutes) (Table 3).

Preoperative sestamibi scintigraphy correctly predicted adenoma localization in 75 (61%) cases and was false-positive or false-negative in 15 (12%) cases (correct: A 51; B 10; C 11; D 3). Preoperative localization by US was correct in 93 (76%) patients and false-positive or false-negative in 9 (7%) patients (correct: A 81; B 14, C 9, D 3).

The iPTH assessment was applied in all cases and correctly predicted nonaccomplished or incomplete extirpation of hyperfunctional parathyroid tissue in seven (6%) patients. Immediate conversion with further exploration and complete extirpation of all hyperfunctional parathyroid tissue with subsequent iPTH decrease according to the required criteria was performed in these seven patients.

All patients were cured in regard to the underlying disease up to the present time, a period of follow-up that ranged from 3 to 12 months. Symptomatic postoperative hypocalcemia that temporarily required oral calcium substitution was encountered in seven (6%) patients. Complications included two (2%) transient recurrent nerve palsies, which resolved within 6 months postoperatively, and four (3%) subcutaneous emphysemas, which did not require any treatment. There was no mortality in this series. The overall hospital stay ranged from the ambulatory setting to 5 days (median: A 1.3, B 3.0, C 1.1, D 0.8 days).

Discussion

This study looked at the feasibility of a minimally invasive video-assisted technique for pHPT in a series of 123 patients at four

surgical centers. The availability of preoperative localization with high-resolution US, sestamibi scintigraphy, and intraoperative iPTH monitoring produced confidence in a unilateral approach [2, 7–9]. A variety of unilateral explorations with minimal access as well as purely endoscopic and video-assisted approaches as described in this series have evolved [1, 3, 4, 9–26]. The possibility of missing MGD has been a concern with unilateral procedures [11, 18, 27].

This was found not to be true for the present series as the iPTH gave reliable results, and no persistence or early recurrence of HPT was encountered for the duration of the follow-up, although it was short at this point. An inadequate decrease in the iPTH level correctly predicted unsuspected MGD in seven (6%) patients. In these cases immediate conversion to cervicotomy with bilateral exploration and subsequent extirpation of further hyperfunctional parathyroid tissue was performed until an adequate iPTH decrease was accomplished.

A disadvantage of MIVAP was the need and additional expense incurred for (1) preoperative localization with sestamibi; (2) obtaining planar, oblique, and single photon emission computed tomography (SPECT) images; and (3) high-resolution US. The low accuracy of these measures in this series in contrast to reports from the United States was attributed to the high prevalence of concomitant thyroid diseases [2, 5, 6, 8, 10, 11, 14, 16, 21, 22, 26, 27]. The presence of concomitant thyroid disease was also believed to be responsible for the small total number of patients with HPT selected for MIVAP.

In the presented series general intubation anesthesia was used for all patients to investigate MIVAP and not disclose effects that were not attributable to the method. In this series all patients underwent general intubation anesthesia for the intervention, yet local anesthesia, as reported by some authors, may also be feasible for MIVAP, although it was not one of this study's interests. It was generally thought by the investigators that local anesthesia during MIVAP, as it is already applied for open unilateral approaches, was possible and would add to the method's advantages in outpatient settings, but it must be studied in another investigation.

Patient comfort postoperatively and scar size were thought to be superior to those seen with conventional procedures in patients who underwent MIVAP, but no objective evaluation was established to measure these parameters [1, 11, 13, 19, 28]. The overall hospital stay in Europe is generally longer than that in the United States owing to the different insurance systems, ranging from 5 to 7 days for patients undergoing conventional parathyroidectomy surgery for HPT. In this series the mean overall hospital stay was reduced to 1.5 days. It was thus expected to lower the total costs of surgery for pHPT with MIVAP. However, costs for sestamibi, US, iPTH, and endoscopic equipment for MIVAP presently exceed those for conventional procedures. Comparing MIVAP to other minimally invasive techniques (e.g., completely endoscopic parathyroidectomy), it exhibits a lower complication rate in regard to emphysema (3%) and a shorter operating time (median 94 minutes) [3, 24]. A learning curve was seen, and the operating time was continuously reduced over its course. The main difference was the briefer CO₂ insufflation and semi-open space. Postoperative symptomatic hypocalcemia was encountered in only 6% of the patients and was attributed to the lesser extent of preparation resulting in less compromise of the circulation to the remaining parathyroids when compared to conventional parathyroidectomy.

Conclusions

The presented data as a phase I study in regard to feasibility showed that MIVAP offered an alternative for surgical treatment of pHPT in a selected group of patients. The number of patients selected for this approach regionally depends on the incidence of concomitant thyroid disease. It may thus be expected that even with expansion of the selection criteria the number of patients appropriate for MIVAP will generally be smaller than for conventional parathyroid surgery procedures. Reported experiences with local anesthesia in thyroid and parathyroid surgery provide the possibility of performing MIVAP under local anesthesia in an outpatient setting. Patient selection and indications for MIVAP should be standardized to provide the necessary preconditions to evaluate the rationale and efficacy of the method's presently higher costs compared to conventional parathyroidectomy in view of the limited advantages demonstrated so far.

Résumé

Fond du problème. On a introduit récemment des techniques de parathyroidectomie unilatérale mini-invasive endoscopique et vidéo-assistée. La plupart de ces procédés font appel à une localisation préopératoire des parathyroïdes et un monitoring peropératoire de la parathormone. Il existe peu de publications sur ces procédés. Le but de cette étude a été d'évaluer la parathyroidectomie vidéo-assistée (PTVA) pour la chirurgie de l'hyperparathyroïdie primitive (pHPT). Matériels et méthodes: Entre février 1997 et juin 1999, on a évalué les résultats de 123 patients consécutifs ayant une pHPT provenant de quatre centres chirurgicaux. L'âge des patients allait de 18–77 ans (médiane 50 ans). Tous les patients ont eu une scintigraphie *sestamibi* et une échographie préopératoire pour la localisation. Les critères d'exclusion à une PTVA étaient les patients sans localisation préopératoire, une suspicion de maladie multiglandulaire, une pathologie maligne de la thyroïde, une tumeur volumineuse de la thyroïde, une chirurgie ou une radiothérapie au préalable. La PTVA a été réalisée par une incision sus-sternale de 1.5 cm, avec un scope 5 mm de 30° et des instruments microchirurgicaux en utilisant une insufflation brève de CO₂ pour l'identification de l'adénome, puis l'utilisation d'une technique ouverte à travers une petite incision sous vidéo-assistance. Un monitoring peropératoire de la parathormone intacte (iPTH) a été réalisé pour tous les patients. Résultats. On a réussi à faire la PTVA chez 109 des 123 patients (89%). Chez 14 (11%), une conversion à une cervicotomie classique a été nécessaire en raison de l'impossibilité de localiser la tumeur, de l'impossibilité d'obtenir une chute de la iPTH, ou des problèmes techniques. On n'a observé aucun cas d'HPT persistante ou récidivante pendant les 3 à 12 mois de suivi. On a donné du calcium par voie orale pour hypocalcémie postopératoire symptomatique dans sept cas (6%). On a observé une paralysie laryngée unilatérale, réversible spontanément en six mois chez deux (2%) patients. La durée médiane de séjour hospitalier a été de 1.5 jours (extrêmes 0.5–5 jours). Conclusion. Cette étude montre la faisabilité de la PHVA comme alternative à la chirurgie classique pour pHPT chez des patients sélectionnés. D'autres études sont nécessaires pour évaluer l'efficacité et la rationale de la PTVA comparée à d'autres techniques de parathyroidectomie pour pHPT.

Resumen

Antecedentes. La paratiroidectomía unilateral y mínimamente invasora mediante técnica endoscópica videoasistida ha sido recientemente introducida al armamentario quirúrgico. El procedimiento utiliza localización preoperatoria y monitoría intraoperatoria de niveles de parathormona. Existen pocos informes al respecto. El propósito del presente estudio fue evaluar la paratiroidectomía videoasistida mínimamente invasora (PTVAMI) en el tratamiento quirúrgico del hipoparatiroidismo primario (HPTp). **Material y Métodos:** En el periodo entre febrero de 1997 y junio de 1999 fueron evaluados 123 pacientes consecutivos con HPTp en cuatro centros quirúrgicos. Las edades fluctuaron entre 18 y 77 años (media 50 años). Se realizó localización preoperatoria por escintigrafía con sestamibi y ultrasonografía en la totalidad de los casos. Los criterios de selección para PTVAMI excluyeron pacientes con localización negativa, con sospecha de enfermedad multiglandular, con neoplasia maligna de la glándula tiroidea, con grandes masas tiroideas o con historia de cirugía o radioterapia previas. La PTVAMI fue practicada a través de una incisión supraesternal de 1.5 cm para operar con un endoscopio de 5 mm y 30 grados de visión e instrumentos de microcirugía y una breve insuflación de CO₂ para la identificación del adenoma, procediendo luego con técnica abierta a través de una pequeña incisión bajo asistencia de video. Se utilizó monitoría intraoperatoria de parathormona intacta en todos los casos. **Resultados.** Se intentó la PTVAMI en los 123 pacientes, habiéndose logrado en 109 (89%). En 14 (11%) se requirió conversión a cervicotomía convencional por falla en la localización, falla en el descenso de la parathormona o problemas técnicos. No se observó HPT persistente o recurrente en el seguimiento de 3–12 meses. Se administró calcio oral para hipocalcemia sintomática postoperatoria en 7 (6%) casos. Se presentó parálisis recurrencial unilateral, que se resolvió espontáneamente en los primeros 6 meses postoperatorios, en 2 (2%) pacientes. La estancia hospitalaria media fue de 1.5 días (rango 0.5–5 días). **Conclusión.** El presente estudio demuestra la factibilidad de la PTVAMI como una alternativa en el tratamiento quirúrgico del HPTp en un grupo selecto de pacientes. Se requieren estudios adicionales para evaluar la seguridad, eficacia y racionalidad de la PTVAMI frente a otras técnicas de paratiroides en el HPTp.

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