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Endoscopic Parathyroidectomy: Why and When?

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Abstract
Background In recent years, several new minimally invasive techniques for parathyroidectomy (MIP) have been developed. There was a rapid worldwide acceptance of mini-open procedures by most surgeons. However, the use of an endoscope remains debatable. This study was designed to determine the role of preoperative imaging studies in the decision-making for using an endoscope during MIP.
Methods All patients with sporadic primary hyperparathyroidism (PHPT) and candidate for MIP underwent localizing studies. MIP was proposed only for patients in whom a single adenoma was localized by both ultrasonography and sestamibi scanning. Three locations were described: (1) posterior to the two superior thirds of the thyroid lobe; (2) at the level of or below the inferior pole of the thyroid lobe but in a plane posterior to it; (3) at the level of or below the tip of the inferior pole of the thyroid lobe but in a superficial plane. In locations 1 and 2, the nerve was considered to be at risk and an endoscopic lateral approach was indicated. In location 3, a mini-open approach was indicated.
Results Of the 165 patients operated on for PHPT in 2006, 86 underwent MIP. According to the results of imaging studies, 39 patients presented an adenoma in location 1, 21 in location 2, and 26 in location 3. In locations 1 and 2, 59 patients (1 false-positive) had an adenoma that was located posteriorly, in close proximity to the nerve; all were cured. In location 3, 25 patients (1 false-positive) presented an inferior parathyroid adenoma superficially located; all were cured. There was no transient or permanent laryngeal nerve palsy.
Conclusions In patients who are candidates for MIP, we recommend the use of the endoscope for the resection of parathyroid adenomas that are located deeply in the neck.

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Introduction

Since the first parathyroidectomy performed by Mandl in 1925 [1], bilateral cervical exploration remained for many years the preferred surgical approach for primary hyperparathyroidism (PHPT). Identification of four parathyroid glands and resection of those that were enlarged formed the basis of a standard operative approach to PHPT.

Challenging the traditional exploration, limited parathyroid surgery has progressively emerged. The concept of limited parathyroid surgery is based on the fact that 85% of patients will have a single-gland disease, and therefore, systematic exploration of all four glands is not mandatory in all cases.

The first alternative procedure was a unilateral exploration based on finding an enlarged gland and an ipsilateral normal gland [2].The concept of unilateral exploration was reinforced with the development of improved localization studies and the introduction of intraoperative quick parathyroid hormone (Q-PTH) [3, 4]. In recent years, the wave of minimal access operative techniques has been applied to parathyroidectomy, and today the extent of the exploration can be bilateral, unilateral, or focused.

Minimally invasive parathyroidectomies (MIP) may be divided into two groups: mini-open approaches performed under direct vision via a small cervical incision, and techniques using the endoscope. These new minimally invasive techniques have two common threads: (1) they all have a limited incision compared with classic open transverse cervical incision; and (2) surgery is targeted on one specific parathyroid gland. In most cases, the exploration of other glands is not performed.

Open minimally invasive parathyroidectomies (OMIP) are performed through a 2–4 cm incision [5]. For upper adenomas, the incision is made on the anterior border of the sternocleidomastoid muscle and a posterolateral approach or "back-door" approach is used to reach the retrothyroid space. For anterior lower adenomas, the incision is made at the supra sternal notch level. The technique can involve the use of radioguidance [6].

Endoscopic minimally invasive parathyroidectomies (EMIP) can be divided into two groups: minimally invasive video-assisted parathyroidectomy (MIVAP) [7] and pure endoscopic techniques [8, 9]. MIVAP is a gasless procedure performed through a 15–20 mm skin incision made at the suprasternal notch. The operative space is maintained with small conventional retractors. The procedure is performed partially with the help of the endoscope. Pure endoscopic techniques are performed totally with the help of the endoscope, using a midline access between the strap muscles [8] or a lateral access on the anterior border of the sternocleidomastoid muscle, using the "back route" between the carotid sheath laterally and the strap muscles medially [9]. Pure endoscopic techniques include constant gas insufflation and three or four trocars.

Other endoscopic techniques use an extracervical approach: axillary approach [10]; anterior chest approach [11]. These operations, less commonly used in Europe, have the advantage of leaving no scar in the neck area. Nevertheless, they cannot reasonably be described as minimally invasive because they require more dissection than conventional open surgery.

MIP does not yet represent the "gold standard" for the treatment of PHPT, but a survey from the International Association of Endocrine Surgeons showed that more than half of the surgeons now perform MIP [12]. There was a rapid worldwide acceptance of OMIP by most surgeons. The dissemination of EMIP is hindered by the need for familiarity with the use of an endoscope in the neck. The learning curve can be long and mentoring by a surgeon who has experience with these techniques is recommended. This explains that for many parathyroid surgeons the use and the need of an endoscope during MIP remain debatable.

Surgeons using the endoscope in the neck consider that EMIP have the main advantage of offering a view and a light that permit a safe dissection. In their opinion, the use of the endoscope should be particularly recommended when the recurrent laryngeal nerve is at risk during MIP. Thus, the need for an endoscope during MIP may be determined by the location of the parathyroid adenoma. When the gland is located posteriorly and, therefore, is in close proximity to the recurrent laryngeal nerve, the use of the endoscope may be recommended.

This emphasizes the role of preoperative imaging studies when MIP is indicated in patients with PHPT. In this study, we evaluated the role of preoperative imaging studies in the decision-making for using an endoscope during MIP.

Patients and methods

In 2006, 165 patients were operated on for PHPT in our department. Fifty-six patients had contraindications to MIP and underwent conventional cervicotomy: large multinodular goiters that needed an associated thyroidectomy in 30 cases, previous cervical surgery in 11 cases, familial disease in 13 cases, 1 large (>40 mm) and palpable adenoma, and 1 adenoma located in a major ectopic site. All other patients with sporadic PHPT and candidate for MIP underwent both preoperative ultrasonography and sestamibi scanning.

Ultrasonography (US) was performed on patients installed in supine position with the neck hyperextented. A pillow was placed under the shoulders of patients with short necks. A high-frequency (7.5 MHz) linear transducer was used to obtain optimal depth penetration, between 3 and 4 cm. A bilateral and comparative scan was performed in transverse section, then in longitudinal section. First, in transverse section, the examination was proceeded on an area delimited by the longus colli muscles backwards, by the thyroid forwards, by the trachea internally, and by the carotid artery externally. Then, the scan was performed broadly without upward or downward limits. For the left parathyroid glands, an additional scan was performed with the head of the patient turned away to the right side and then during swallowing to optimize the latero-oesophageal images. The anterosuperior mediastinum was examined by inclining the transducer very deeply toward the retrosternal area. The three dimensions of the pathological parathyroid glands were measured. US appearance was analyzed with respect to echo texture, homogeneity of the interior structure, configuration, and location. Finally, a Color Doppler or a Power Doppler was performed to test the vascularization of the area and define the artery branches involved.

All patients underwent ^{99m}Tc-sestamibi parathyroid scintigraphy with static planar and SPECT images. Dual phase and subtraction protocols were used. Dual phase protocol was based on the differential tracer washout between thyroid and parathyroid tissue. Static images were performed at 15, 60, and at least 120 min postinjection (740 Mbq of ^{99m}Tc-sestamibi at T0). Image acquisition was started at T0, after ^{99m}Tc-sestamibi. A positive finding was defined as tracer retention on delayed images.

Subtraction protocol was based on persistence of parathyroid tissue after normalization and subtraction between ^{99m}Tc (parathyroid and thyroid uptake) and ^{123}I (thyroid uptake only) images. 12 MBq of ^{123}I was first administrated 2 hours before acquisitions. Two hours later, 740 MBq of ^{99m}Tc-sestamibi was injected. Interactive software was used for image normalization and subtraction. A positive finding was defined as a persistent image after image subtraction.

SPECT images were performed in both protocols at 45-minute postinjection using. The neck and the mediastinum (from the angle of the mandible to the heart) were studied. On SPECT images, a positive finding was defined as a focal uptake in a posterior or inferior position to the thyroid lobe or as focal tracer retention in a thyroid area, which contrasts with the remaining thyroid tissue.

Images that were located behind the thyroid gland were described as posterior. Images that were located at the tip of the inferior pole of the thyroid lobe or along the thyrothymic ligament were described as anterior.

MIP was considered only for patients in whom a single adenoma was clearly localised by both ultrasonography and sestamibi scanning [13]. Localizing studies were inconclusive in 23 patients. MIP was contraindicated and these patients had a conventional approach. Finally, 79 patients (47.9%) underwent a conventional parathyroidectomy and MIP was proposed in 86 patients (52.1%).

We introduced a classification system that is based on three different positions of enlarged parathyroid glands. Position 1 was posterior to the two superior thirds of the posterior surface of the thyroid lobe (Figs. 1 and 2). These adenomas were supposed to correspond to superior glands. Position 2 was at the level of or below the inferior pole of the thyroid lobe but in a plane posterior to it (Figs. 3 and 4). These adenomas may be a superior or an inferior gland that has fallen posteriorly and more or less inferiorly into the tracheoesophageal groove. Position 3 was at the level of or below the tip of the inferior pole of the thyroid lobe but in the same plane, that is in a superficial plane (Figs. 5–7).These adenomas, corresponding to inferior glands, can be found in close contact with the inferior pole of the thyroid lobe but also along the thyrothymic ligament or into the superior pole of the thymus.

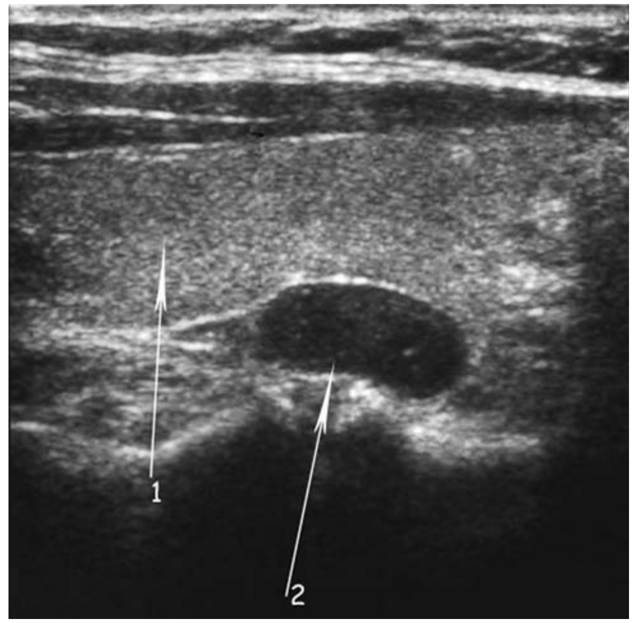

Fig. 1 Ultrasonography. Arrow 1: right thyroid lobe. Arrow 2: right superior parathyroid adenoma posterior to the two superior thirds of the thyroid lobe: position 1

Fig. 2 ^{99m}Tc-sestamibi scintigraphy (dual phase): left superior parathyroid adenoma in position 1

Adenomas in positions 1 or 2 were considered to be located in the vicinity of the recurrent laryngeal nerve. Adenomas in position 3 were considered to be at distance of the nerve, which runs more posteriorly.

Therefore, in positions 1 and 2, the nerve was considered to be at risk and its clear identification during the procedure was considered mandatory. The use of the endoscope was indicated and an endoscopic lateral approach,

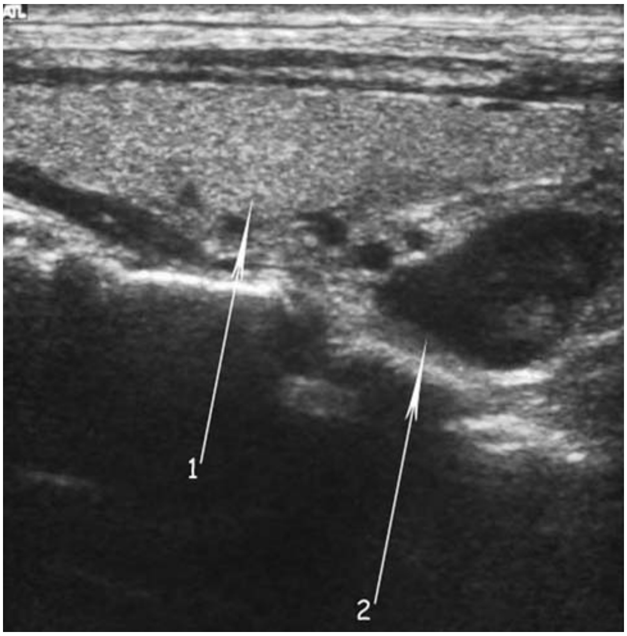

Fig. 3 Ultrasonography. Arrow 1: Right thyroid lobe. Arrow 2: parathyroid adenoma posterior to the inferior pole of the thyroid lobe: position 2

developing the plane between the carotid sheath laterally and the strap muscles medially was performed [9]. In location 3, identification of the nerve seemed not essential. An anterior mini-open approach (2 cm), without the help of the endoscope, was indicated.

Results

Of the 165 patients operated on for PHPT in our institution during 2006, 86 underwent MIP. Q-PTH assay was used during these procedures. Vocal cord mobility was assessed preoperatively and postoperatively. There were 15 men and 71 women with a mean age of 62 ± 11.3 years. Mean preoperative calcemia, phosphoremia, and PTH were respectively: 2.78 ± 0.23 (2.37–3.75) mmol/l; 0.83 ± 0.16 (0.48–1.26) mmol/l; 128 ± 116 pg/ml (*N*: 10–55).

According to the results of imaging studies, 39 patients presented an adenoma in position 1, 21 in position 2, and 26 in position 3. Patients with adenomas in locations 1 and 2 underwent an endoscopic lateral approach with systematic dissection of the recurrent laryngeal nerve. There was one false-positive result of imaging studies (position 2), and no adenoma was found after conversion to standard cervicotomy. Among the 59 other patients and according to the result of surgical exploration, 39 patients presented a superior adenoma in position 1, 4 patients a superior adenoma in position 2, and 4 patients an inferior adenoma in position 2. In the remaining 12 patients, with adenoma in position 2, it was not possible to determine which superior or inferior gland was involved as the ipsilateral gland was not identified. In all the 59 patients, the nerve and the trunk of the inferior thyroid artery were easily identified before starting the blunt dissection of the adenoma. In all cases, the adenoma was in the vicinity of the nerve or in close proximity to it. In 2 cases (2 adenomas in position 2), the nerve was adhered to the gland and it had to be freed by a meticulous dissection. One right inferior laryngeal nerve was not recurrent. The mean operative time was 41 (range,

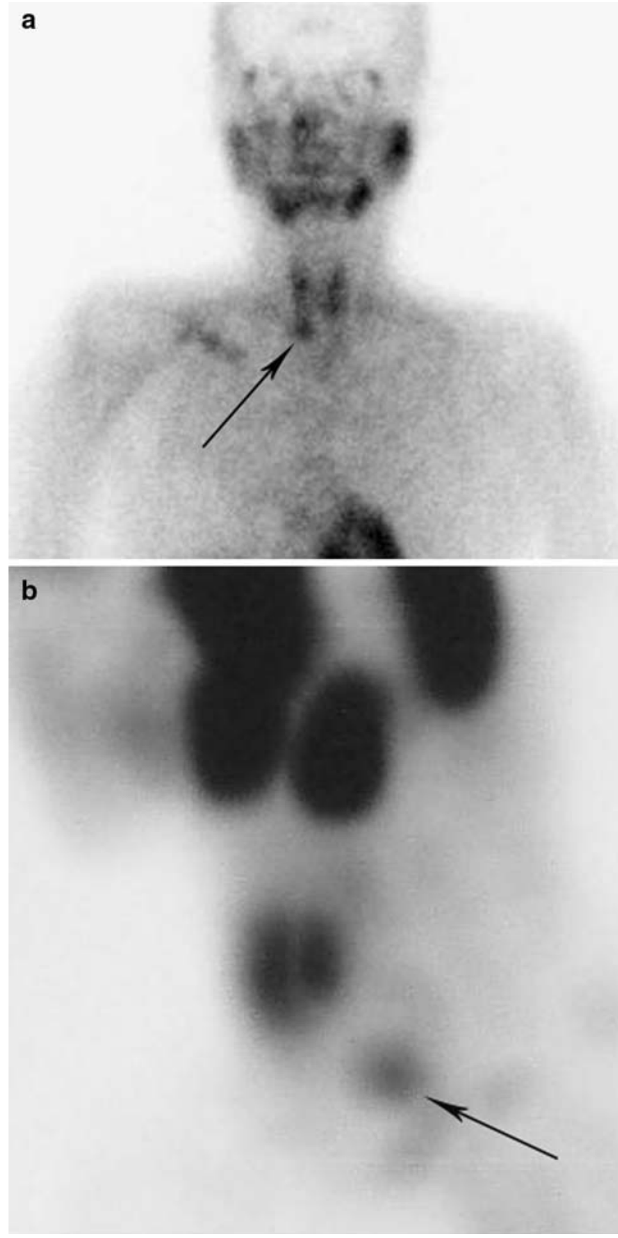

Fig. 4 (**a**) ^{99m}Tc-sestamibi scintigraphy (dual phase): right parathyroid adenoma at the level of the inferior pole of the thyroid lobe (*arrow*). (**b**) ^{99m}Tc-sestamibi scintigraphy (SPECT images, profile): same parathyroid adenoma posteriorly located: position 2 (*arrow*)

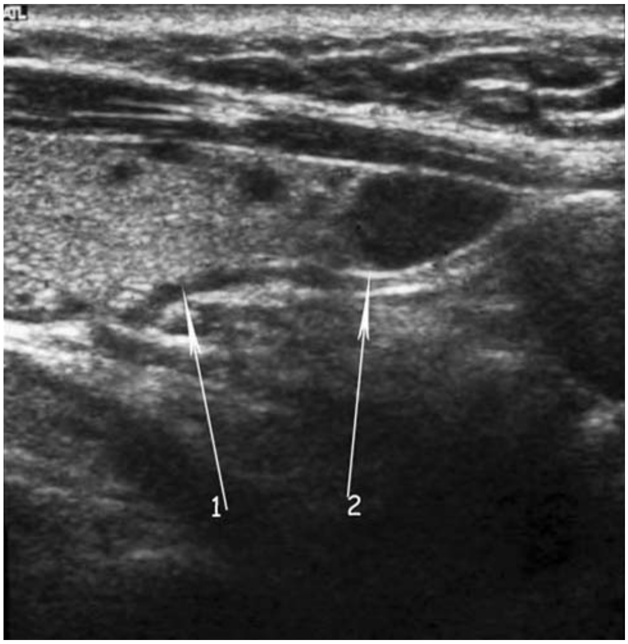

Fig. 5 Ultrasonography. Arrow 1: Right thyroid lobe. Arrow 2: right inferior parathyroid adenoma just below the tip of the inferior pole of thyroid lobe and in the superficial plane: position 3

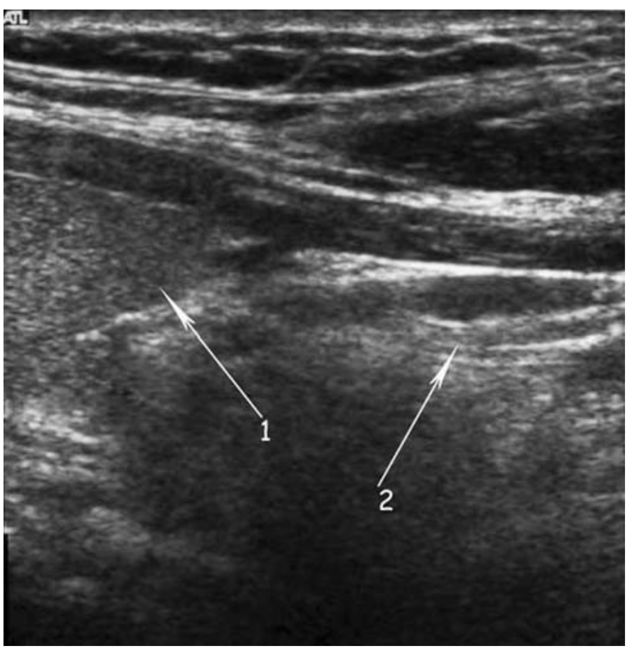

Fig. 6 Ultrasonography. Arrow 1: inferior pole of right thyroid lobe. Arrow 2: right inferior parathyroid adenoma along thyrothymic ligament: position 3

22–62) minutes. All 59 patients were cured. There was no transient or permanent laryngeal nerve palsy.

The 26 patients with adenomas in position 3 underwent a mini-open approach, without identification of the nerve. There was one false-positive result of imaging studies: one inferior adenoma found in contralateral location. All of the

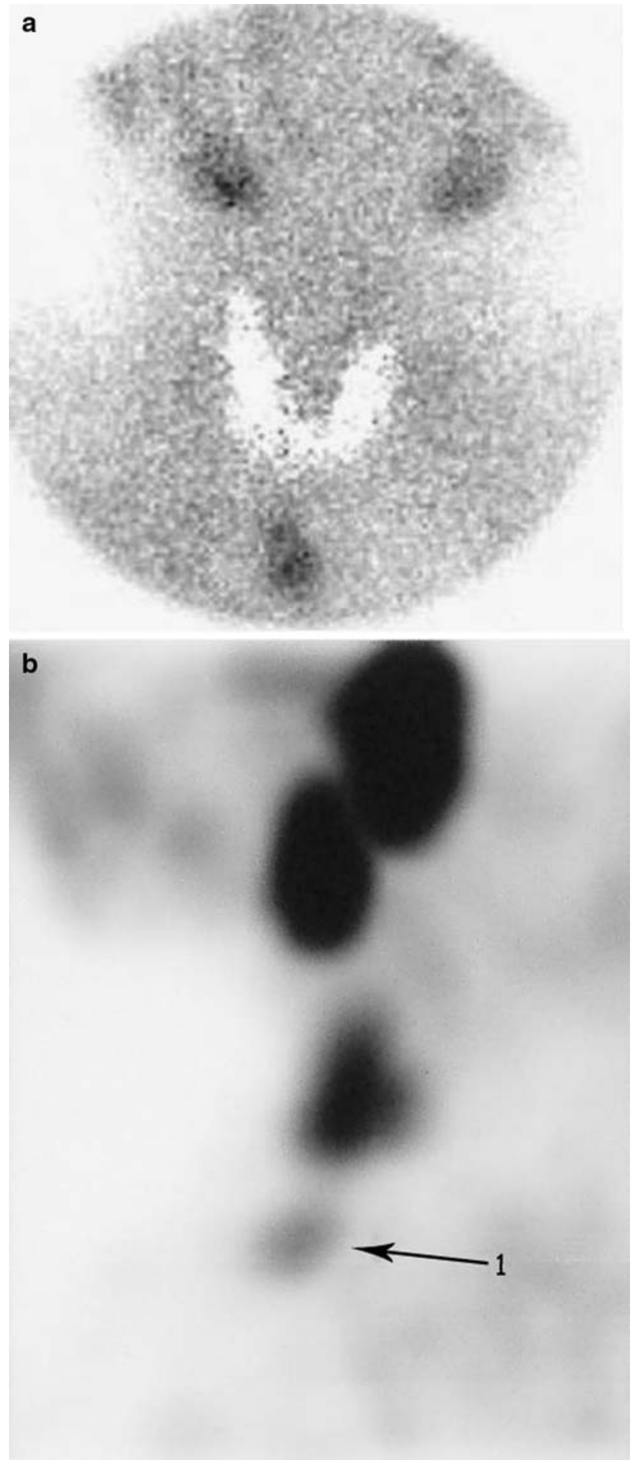

Fig. 7 (**a**) ^{99m}Tc-sestamibi scintigraphy (subtraction protocol): right parathyroid adenoma probably along thyrothymic ligament. (**b**) ^{99m}Tc-sestamibi scintigraphy (SPECT images, profile): same right inferior parathyroid adenoma along the thyrothymic ligament: position 3 (*arrow*)

25 other patients presented an inferior parathyroid adenoma that was superficially located in position 3: 12 in contact with the capsule of the inferior pole of the thyroid

lobe, 8 along the thyrothymic ligament, and 5 in the upper cervical portion of the thymus. The mean operative time was 24 (range, 14–42) minutes. All 26 patients were cured. There was no transient or permanent laryngeal nerve palsy.

In four cases a conversion to standard open cervicotomy was required: one negative exploration, difficulties of dissection in one case, one intrathyroid superior parathyroid adenoma, and one false-negative result of Q-PTH. There were two minimal capsular ruptures during dissection. The mean weight of the adenomas was 1111 ± 1097 (range, 100–4800) mg.

Discussion

The demonstration of meaningful advantages for EMIP compared with OMIP is not easy. Despite the increasing interest in MIP during the last few years, there are no published prospective, randomized series that compare the two techniques. It will be difficult to challenge the results of both techniques because most advantages consist of subjective aspects, such as satisfaction with the scar and level of postoperative comfort.

The potential advantage of EMIP is the greater and better surgical image provides with the endoscope. Whether the endoscope is better than a pair of 2.5x or 3.5x magnifying loops to identify anatomical structures is difficult to prove; however, EMIP offers not only a magnified view of anatomical details. EMIP also offers a perfect lighting of the area of dissection. The quality of the light provided by the endoscope is undoubtedly superior to the one obtained with frontal lamps. In OMIP surgical exploration is limited and hindered by the length of the skin incision: the shorter the skin incision, the more difficult the OMIP. This is particularly true for deep-seated parathyroid adenomas in patients with large and short necks. This explains in general skin incisions of OMIP are longer than skin incisions of EMIP. OMIP requires an incision of at least 2.5–3 cm long. In EMIP the length of the incision is determined by the size of the trocars only, that is 12–15 mm maximum for a 10 mm trocar or <10 mm for a 5 mm trocar. One can argue that pure EMIP, performed with gas insufflation, requires additional trocars but these trocars are 2.5–3 mm in section and do not leave any scar in the neck.

In our opinion, the main interest of using an endoscope is not that one can perform a parathyroidectomy through a small incision but that one can perform a safe parathyroidectomy through a small incision. We know that morbidity of conventional parathyroid surgery is minimal—close to zero [14]. MIP has to be as safe as conventional surgery.

Superior parathyroid glands are grouped at the posterior aspect of the thyroid lobe, and when they are enlarged they always tend to migrate posteriorly and in a downward direction. Consequently, the superior parathyroid adenomas themselves or their pedicles are always in close proximity to the nerve.

The territory of inferior parathyroid glands is much more extensive. In 61% of cases, they are situated at the level of the inferior pole of the thyroid lobes, on the posterior, lateral, or anterior aspects. In 26% of cases, they are situated in the thyrothymic ligament or in the upper, cervical portion of the thymus [15]. Adenomas located at the posterolateral part of the inferior pole of the thyroid lobe tend to descend posteriorly and in a downward direction to acquire a paratracheal or a paraesophageal position. It is in these cases that they become intimate with the recurrent laryngeal nerve. Other inferior parathyroid adenomas remain located superficially in the neck or in the superior mediastinum. During their dissection, the nerve is not at risk because it runs more posteriorly.

The need to know preoperatively when the nerve is at risk reinforces the role of imaging studies to localize deep-seated adenomas. Therefore, both ultrasonography and sestamibi scan are helpful. These two localization studies are complementary, particularly when adenomas are located at the level of the inferior pole of the thyroid lobe. At this level, it is important to differentiate deeply located adenoma from superficially located adenomas. Recently four-dimensional computed tomography has been proposed and the first results seem very promising [16].

In this series the exact location of the adenoma was correctly predicted in all cases except two. No transient or permanent recurrent nerve palsy was observed. This demonstrates the safety of EMIP when the adenoma is in the vicinity or becomes intimate with the nerve (position 1 and 2). The endoscope was particularly helpful in three cases: one nonrecurrent inferior laryngeal nerve and two nerves adherent to the adenoma.

By direct vision through mini-incisions, it is certainly more difficult to get an adequate view of structures, and particularly of the recurrent laryngeal nerve. In our opinion, optimal conditions for exploration are not met in all patients who undergo OMIP, even if surgeons use frontal lamps and magnifying loops. The potential advantage of EMIP may theoretically result in a decreased incidence of injuries. However, due to the low incidence of morbidity in both EMIP and OMIP, this hypothesis will be difficult to confirm.

On the other hand, when ultrasonography and sestamibi scan are both in favor of a superficially located adenoma (position 3), we do not think that systematic identification of the nerve is mandatory. In these latter cases, the endoscope seems to be a gadget to us. All 25 patients with adenomas in position 3 were cured in a mean operative time of 24 minutes without any morbidity.

Pure endoscopic techniques are more time consuming than OMIP. This is clearly demonstrated in this short series: 41 versus 24 minutes. However, in this series, one must consider that both procedures cannot be compared. In EMIP the nerve was searched for before any dissection of the adenoma, whereas in OMIP the dissection was limited to the adenoma only.

Among the different EMIP techniques, video-assisted techniques have the advantage of using conventional instruments and are relatively easier to learn than pure endoscopic techniques. However, we think that pure endoscopic techniques allow a wider exposure of cervical structures than video-assisted gasless techniques. In addition, insufflation with CO_2 creates a working space in which anatomical structures can be identified without distortion caused by mechanic retraction.

In our opinion, the endoscopic lateral approach [17] provides the best access to the posterior aspect of the thyroid lobe. It permits a complete exploration of all anatomical elements of the retro-thyroidal area from the superior pedicle to the postero-superior mediastinum. Therefore, it is applicable in all cases where the parathyroid adenoma is located posteriorly—i.e., in position 1 and 2.

Conclusions

Today the parathyroid surgeon is dependent on the quality and the adequate interpretation of preoperative imaging to make a judicious choice for different procedures of MIP. Once contraindications have been eliminated, all patients with sporadic primary HPT can be considered candidates for MIP. The use of the endoscope must be recommended when the parathyroid adenoma becomes intimate with the recurrent laryngeal nerve, i.e., when the adenoma is located in the retro-thyroidal area. In our opinion, mini-open approaches using a skin incision of <2.5–3 cm should be used only when there is no need to identify the nerve during the dissection, i.e., when the adenoma is superficially located in the neck.

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