Minimal access surgery – thyroid and parathyroid

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Abstract

The concept of surgical invasiveness cannot be limited to the length or to the site of the skin incision. It must be extended to all structures dissected during the procedure. Therefore, MIT or MIP should properly be defined as operations through a short and discrete incision that permits direct access to the thyroid or parathyroid gland, resulting in a focused dissection.

Parathyroid glands are particularly suitable for minimally invasive surgery as most parathyroid tumors are small and benign. MIP are performed through a limited or discrete incision when compared to classic open transverse cervical incision and are targeted on one specific parathyroid gland. The concept of these limited explorations is based on the fact that 85% of patients will have single-gland disease. MIP must be proposed only for patients with sporadic hyperparathyroidism in whom a single adenoma has been clearly localized by preoperative imaging studies.

The minimal access approaches to the thyroid gland may be broadly classified into three groups: the mini-open lateral approach via a small incision, minimally invasive video-assisted thyroidectomy via the midline and various endoscopic techniques. Endoscopic extracervical approaches have the main advantage of leaving no scar in the neck but cannot reasonably be described as minimally invasive as they require more dissection than conventional open surgery.

Initially the indications for MIT were a solitary thyroid nodule of less than 3 cm in diameter in an otherwise normal gland. Today, MIT are also proposed in patients with small nodular goiters, Graves's diseases and low risk papillary thyroid cancers. Some concern remains about the radicality of MIT in this latter group but preliminary results are comparable to those of conventional surgery both in terms of I-131 uptake and serum thyroglobuline levels.

Demonstrating the advantages of MIT and MIP over conventional surgery is not easy. Main complications, such as nerve injury, hypoparathyroidism, or hemorrhage, are the same as in conventional surgery. Several studies comparing conventional surgery with minimally invasive techniques using a cervical access have shown a diminution of postoperative pain, and better cosmetic results with minimally invasive techniques. MIP and MIT seem overall to be an advance but only randomized studies will demonstrate the real benefit.

Keywords. Minimally invasive surgery · thyroidectomy · parathyroidectomy

Introduction

Standard cervicotomy has remained for many years the preferred surgical approach in patients with thyroid and parathyroid diseases. The procedure can be performed under general or local anesthesia. There is no need to divide any muscle, except the platysma. This operation has enjoyed a high success rate with a concomitantly negligible operative mortality and morbidity rate. Most of the procedures can be carried out through cervical inci-

sions of 4 to 6 cm in length, in less than 90 min, with an excellent cosmetic result.

In recent years, challenging the traditional cervicotomy, several new minimally invasive parathyroidectomy (MIP) and thyroidectomy (MIT) techniques have been developed. The term of MIT or MIP covers a large spectrum of different types of operations and can be misleading. Whether all thyroid or parathyroid operations performed through cervical incisions of approximately 2–3 cm in length should be considered minimally invasive is questionable. Introducing an endoscope in the neck

does not mean automatically that you perform a minimally invasive procedure. The concept of surgical invasiveness cannot be limited to the length of the skin incision. It must be extended to the other structures dissected during the procedure. Methods using an extra-cervical approach have the advantage of leaving no scars in the neck but are not really minimally-invasive since more dissection is necessary than during the conventional open procedure.

Thyroid and parathyroid surgery must be considered minimally invasive not only in respect of the size of the skin incision but also, and above all, in respect of the accessibility of the operative field and the extent of dissection.

Therefore, MIT and MIP should properly be defined as operations through a short and discrete incision that permits direct access to the thyroid or parathyroid gland, resulting in a focused dissection. MIT and MIP access may be grossly divided in two groups: mini open approaches performed under direct vision via a small cervical incision, and various endoscopic approaches. The endoscope has the advantage to provide light and magnification resulting in an excellent view for the surgeon. By direct vision through mini-incisions, it is probably more difficult to obtain an adequate view of the key structures even if surgeons use head light and surgical loupes. However, mini open procedures can be performed under local or cervical block anesthesia and any effort to minimize invasiveness should also take into account the type of anesthesia. Local or regional anesthesia¹ and hypnosis² provide some advantages compared to general anesthesia. They avoid the nausea and vomiting frequently observed after general anesthesia. They also avoid any risk of vocal cord injury caused by the intubation process. Many patients requiring thyroid or parathyroid surgery are middle aged or elderly, and some of them are assigned to a class III or IV of anesthetic risk category. Even if the anesthetic mortality and morbidity rate is negligible, these patients will tolerate local anesthesia or hypnosis better than general anesthesia.

Minimally invasive parathyroid surgery

Parathyroid glands are particularly suitable for minimally invasive surgery as most parathyroid tumors are small and benign. In addition MIP is only an ablative procedure and therefore does not require elaborate surgical reconstruction. This explains that we have seen recently the appearance of several new minimally invasive techniques for parathyroidectomy: unilateral approach,^{3–5} radioguided surgery,^{6,7} open minimally invasive techniques⁸ (mini-incision with or without local anesthesia), and minimally invasive video-assisted or fully endoscopic.^{9–11}

The common thread amongst these techniques are: (1) They all have a limited incision when compared to classic open transverse cervical incision. (2) The surgery is targeted on one specific parathyroid gland. In most cases the

exploration of other glands is not performed. The concept of these limited explorations is based on the fact that 85% of patients will have single-gland disease. Today, these minimally invasive interventions can be successfully performed for three main reasons. Firstly, the available imaging techniques permit to localize with precision most adenoma to be excised. Secondly, the use of quick intra-operative PTH assay (QPTH) can confirm the successful extirpation of the diseased gland, obviating exploring others. Finally, new instrumentation and miniaturized cameras have been adapted for this kind of surgery.

Techniques of MIP

1. *Open minimally invasive parathyroidectomies (OMIP)*: OMIP is carried out through a 2–4 cm incision.⁸ The technique can involve the use of radioguidance.⁶ 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.

2. *Endoscopic minimally invasive parathyroidectomy (EMIP)*: Techniques using the endoscope can be divided into two groups: minimally invasive video-assisted parathyroidectomy (MIVAP)¹² and pure endoscopic minimally invasive parathyroidectomy (EMIP).^{13–15} MIVAP is a gasless procedure carried out 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 or a lateral access between the carotid sheath laterally and the strap muscles medially. Pure endoscopic techniques include constant gas insufflation and three or four trocars.

Mini-open techniques or endoscopic techniques?

The anterior access, or midline access between the strap muscles, is perfectly adapted for anteriorly located parathyroid glands. It is the access of choice when inferior parathyroid adenomas are located at the tip of the inferior pole of the thyroid, or along the thyro-thymic ligament or into the thymus. However, this anterior access is not always suitable for removal of parathyroid adenomas deeply located in the neck. It requires complete dissection of the strap muscles and anterior and medial retraction of the thyroid lobe. The lateral access, or back-door approach, using the plane between the strap muscles medially and the carotid sheath laterally is much more suitable for these posteriorly located parathyroid adeno-

mas. This emphasizes the role of preoperative imaging studies in MIP. Depending on the location of the adenoma in the neck, the surgeon can choose the most direct access to reduce the extent of the dissection. In addition, adenomas located at the posterolateral aspect of the thyroid lobe are intimate with the recurrent laryngeal nerve. The need to know preoperatively when the nerve is at risk reinforces the role of imaging studies to localize these deep-seated adenomas.¹⁵ Therefore, the success of these new limited techniques largely depends on accurate preoperative localization. Both ultrasonography and sestamibi scan are very 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 very important to differentiate deeply located adenoma from superficially located adenomas.

Indications for MIP

Not all patients presenting with primary hyperparathyroidism are candidate for MIP. Patients suspected of multiglandular disease on imaging studies or patients with familial hyperparathyroidism are not eligible for these limited procedures. MIP must be proposed only for patients with sporadic hyperparathyroidism in whom a single adenoma has been clearly localised by preoperative imaging studies. In addition evidence of associated goitre and history of previous neck operation in the parathyroid vicinity, may contraindicate MIP. According to different series 57–71% of the patients with primary hyperparathyroidism are eligible for MIP.

A survey from the International Association of Endocrine Surgeons showed that more than half the surgeons now perform MIP.¹⁶ 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.

Results of MIP

Depending on the type of access employed, conversion to conventional parathyroidectomy is necessary in 8–15% of cases. After MIP more than 95% of patients are normocalcemic^{6,8,17,18} but it should be kept in mind that these excellent results are obtained in a group of carefully selected patients. A longer follow-up is needed before one can evaluate the real risk of recurrent disease. Two prospective randomized controlled trial between unilat-

eral and bilateral neck exploration have demonstrated that unilateral exploration provides the same long-term results as bilateral neck exploration.^{19,20}

Demonstrating the advantages of minimally invasive techniques for parathyroid surgery is not easy. Whether MIP is actually less costly than conventional parathyroidectomy is difficult to quantify. Randomized trials have shown that MIP reduces operating time and early symptomatic hypocalcemia. It will be very difficult to challenge the results of both techniques as most advantages consist of subjective aspects, such as satisfaction with the scar and level of postoperative comfort. In addition, advantages in terms of comfort and cosmetic results are especially impressive on the first postoperative days.

Conclusion

In contrast to open surgery, the MIP surgeon depends on multiple technologies. The adenoma should be clearly localised before the operation. If the lesion is unique and confirmed by imaging studies, MIP can be proposed. One can choose a lateral or central approach depending on whether the lesion has a posterior or anterior location. The availability of the QPTH assay is of utmost importance. The overall accuracy of intraoperative QPTH monitoring is reported to be 97%.²¹ This test may be especially useful when localisation studies are less certain. MIP, and particularly endoscopic techniques, requires dedicated instruments.

MIP should not replace or be opposed to conventional parathyroidectomy. These operations will probably turn out to be complementary to each other in the future. A longer follow-up is needed before one can evaluate the real risk of recurrent primary hyperparathyroidism following minimally invasive techniques.

Minimally invasive thyroid surgery

The various approaches for MIT can be divided into cervical and extra-cervical approaches. Nevertheless, according to our definition of MIT, only cervical access should be considered minimally invasive. Considering the extent of the dissection required in some of extra-cervical endoscopic approaches the term of minimally invasive is not always appropriate.

Cervical approaches

1. *Central neck approach:* Central approach first described by Gagner et al. in 1996 opened avenue for new development. Central approach is performed with ports placed on anterior neck along a virtual line of a classic cervicotomy. When necessary, additional ports can be

installed along the medial border of the sternocleidomastoid muscle. Carbon dioxide is insufflated at 8 to 10 mm of Hg in the subplatysmal space. This technique allows access to both lobes and permits total thyroidectomy.^{9,22}

2. *Lateral Neck Approach*: The endoscopic lateral approach develops the plane between the carotid sheath laterally and the strap muscles medially. This unilateral access requires 3 ports (one 10 mm camera port and two lateral 2.5 mm working ports) placed along the medial border of sternocleidomastoid muscle. Carbon dioxide is insufflated at 8 mm of Hg. Unilateral thyroid lobectomy performed via this approach needs further evaluation.²³

3. *Minimally invasive video-assisted thyroidectomy (MIVAT)*: MIVAT is performed via a 15 to 20 mm central incision above the sternal notch without insufflation. Small conventional retractors maintain the operative space but require an additional assistant. Dissection is done under guidance of 0 degree 5 mm endoscope. This video-assisted technique has the advantage of using conventional instruments, and thus facilitates the 'conventional' surgeon to move progressively to endoscopic procedures. Hemostasis of superior thyroid pedicle is performed with ultrasonic scissors or clips.²⁴

4. *Minimal access thyroidectomy (MAT)*: MAT has evolved from MIP technique to incorporate thyroid lobectomy. MAT is performed by transverse 2 to 2.5 cm direct incision over the nodule. Thyroid is approached between strap muscles and sternocleidomastoid muscle. This approach is valid for unilateral thyroid lobectomy.²⁵

Extra cervical approaches

1. *Axillary approach (AA)*: AA or endoscopic transaxillary approach utilizes three equidistant apart 5 mm incisions placed below the anterior axillary line. The neck is slightly extended and ipsilateral arm abducted by 90 degrees. Using blunt dissection, an initial plane is developed on top of the pectoralis major muscle and then beneath the platysma maintained by carbon dioxide gas insufflations at 7 to 9 mmHg pressure. A 5-mm endoscope is used for direct visualization and ultrasonic scissors are used for dissection. The plane between the sternocleidomastoid muscle and the sternohyoid muscle is developed. After elevating the sternohyoid muscle the sternothyroid muscle is identified and retracted anteriorly exposing the ipsilateral thyroid gland. Further dissection and hemostasis is achieved by ultrasonic scissors and clips. This approach is valid for a unilateral access.²⁶

2. *Axillo-bilateral-breast approach (ABBA)*: ABBA is a combination of axillary and breast approaches, through

two incisions on the margin of the areola and an axillary incision, with carbon dioxide gas insufflations at 7–9 mmHg pressure or special skin lifting retractor with suction. A 5-mm endoscope is placed for direct visualization. This approach is valid for bilateral access.²⁷

3. *Bilateral axillo-breast approach (BABA)*: BABA is a modification of ABBA. It consists of a bilateral incision on the areola as well as axilla which enhances the visualization of the thyroid gland. This approach is valid for bilateral access.²⁸

4. *Postauricular and axillary approach (PAA)*: Many patients, especially young female patients, being reluctant to have their breast involved, this technique offers the advantage of avoiding the use of circumareolar incisions. Two axillary ports and two postauricular ports are used. Low pressure CO₂ insufflation generates operative space.²⁹

5. *Chest wall approach*: Three incisions, 3 cm, 0.7 cm and 0.7 cm are made bilaterally 2–3 cm below clavicles. Working space is created carefully to avoid injury to the anterior jugular vein. Space is maintained by skin lifting device and continuous suction for clear vision. Ultrasonic scissors are used for dissection and hemostasis.³⁰

Puntambekar technique is modification of chest wall approach with space developed from 3 cm incision lower down on sternum to hide the scar in clothing when upper chest is exposed. Carbon dioxide is used to maintain the space with 8 to 10 mm of Hg pressure. This approach is valid for bilateral access.³¹

6. *Other techniques*: Robotic thyroidectomy performed with da Vinci robotic system using AA and BABA approach has been described.³²

Experimental intra-oral approach to thyroid with instruments passing sublingually has been performed in human cadavers but requires further experimentation.^{33,34}

Indications for MIT and endoscopic techniques

Development of endoscopic techniques and MIT has lead to stratification of indications of thyroidectomy. Based on published international studies and in accordance to the level of evidence generated, relative indication for various endoscopic techniques could be established. The term relative suggest that conventional cervicotomy is comparable in most of the outcomes.

The indications for endoscopic techniques and MIT are technique specific and relative. None of these approaches are to replace conventional cervicotomy but to supplement in special situations. The part of upper body exposed in various societies could dictate the specific

approach. Techniques using cervical access are widely used in Western countries. Techniques using an extracervical access are developed in Asia as in these countries extracervical scars balance favourably with cervical scars. Therefore, according to geographical areas and culture these different procedures have specific indications.^{24,29–31}

The Indian scenario is very different from eastern or western populations. India patients are not thin and lean as western and eastern populations and most of them in fact have cervical skin fold which can hide the cervicotomy scar very easily. The chest wall approach is not suited for Indian patients as in Indian traditional clothing upper chest is exposed and Puntambekar modification may prove useful in achieving required cosmetic results.³¹

MIVAT is one of the most widely used techniques in Western countries. It has the attraction of using conventional instruments, does not require any gas insufflation and is relatively easy to learn. Only patients with <3 cm thyroid nodule and <20 ml thyroid lobe volume, without evidence of thyroiditis or past history of neck surgery or irradiation are eligible for MIVAT.^{24,34,35} Video-assisted technique probably could leave more visible scar due to lateral damage to the tissue during retraction and stretching in retrieving large size nodules. Size of the nodule should be taken into account before choosing the technique. In contrast extra cervical approaches allow resection of large thyroid tumors, up to 60 mm in size, and enlarged glands, up to 60 ml in volume.

MIVAT for pre-qualified, low to intermediate risk malignant nodules has shown comparable results in recent study with 5 year follow-up, generating level III evidence. An important extension of video assisted technique is in lateral neck dissection for thyroid cancers.^{37,38} Video assisted technique can achieve lateral neck dissection through cervicotomy incision of 5 to 6 cm without too much stretching of the incision.^{39,40}

Indication for endoscopic lateral neck approach are limited to benign unilateral <3 cm nodule with <20 ml thyroid lobe volume without past history of thyroiditis, surgery or neck irradiation restricting lateral neck space.²³ MAT by open lateral approach has similar indications.²⁵

Indications for pure endoscopic central neck approach are also limited to small nodules and small thyroid lobes but there is no limitation for bilateral thyroid pathology and total thyroidectomy. This procedure remains longer compared to video-assisted approaches, but with increasing

experience and progress in surgical instruments shorter operation times may be anticipated.^{9,22}

AA, ABBA, BABA and PAA could really put scars away from all exposed areas but could lead to extensive dissection and might prove invasive and add to morbidity. Reproducibility is also an issue. Large size benign thyroid nodule up to 5–6 cm size could be retrieved.^{26–28} Some concern remains about the radicality of these operations for malignant nodules but preliminary results are comparable to those of conventional surgery both in terms of I-131 uptake and serum thyroglobuline levels.^{41–43} Occasional reports of port site recurrences have been observed.⁴⁴

Conclusion

Endoscopic techniques and MIT is a debatable issue. Demonstrating the advantages of these techniques over conventional surgery is not easy. Whether these techniques are actually less costly than conventional surgery is difficult to quantify. Diminution of postoperative pain is especially impressive on the first postoperative days. At the level of the neck, no scar or reduction in the length of the scar to less than 2 cm is appealing to most patients. On the other hand, one must admit that a clean cut and short cervicotomy, pre operatively marked on a patient in sitting position, without too much intra-operative wound stretching can give an excellent cosmetic result, particularly when the scar is hidden in a cervical skin fold.^{45–48}

MIVAT with size criteria and bilateral access looks promising but neck scar is not avoided at expense of prolonged operative time and procedural difficulties.^{37,38} Extension of MIVAT might prove very useful in achieving lateral neck dissection without upward extension of conventional cervicotomy which gives bad cosmetic result.^{39,40} Lateral endoscopic or mini-open neck approaches could achieve hemithyroidectomy with excellent cosmetic results.^{23,25}

Chest wall approach and Puntambekar modification are techniques that can be proposed for demanding thin females without neck skin folds.^{30,31} AA, ABBA, BABA and PAA have the advantage of leaving no scars in the neck but are not really minimally-invasive.^{26–28,41–44} MIT and endoscopic techniques seem overall to be an advance but only randomised studies will demonstrate the real benefit.

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