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ORIGINAL ARTICLE

The advantages of extended subplatysmal dissection in thyroid surgery—the "mobile window" technique

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Abstract
Purpose Minimal access thyroidectomy, using various techniques, is widely known, but respective data on thyroidectomy for thyroid cancer with lymphadenectomy is scarce. The present study aims to evaluate the feasability of extended subplatysmal dissection in combination with a small incision ("mobile window" technique).
Methods A retrospective study was performed analysing data from 93 patients. All patients suffered from thyroid carcinoma and underwent (total) thyroidectomy, bilateral cervico-central (levels VI and VII) and functional lateral neck dissection (levels II to V) on the side of the malignancy. In group A, consisting of 47 patients, the operation was performed by a traditional Kocher incision (minimal range 6–7 cm), in 46 patients (group B) a mini-incision (≤4 cm) was made. Intra- and postoperative morbidity as well as oncological accuracy were assessed.
Results There was no significant difference between the two groups comparing postoperative pathological diagnosis, intra- and postoperative complications and the number of removed lymph nodes. However, operating time was slightly longer in group A and thyroid weight was heavier in group B.
Conclusions Extended subplatymsal dissection allows thyroidectomy and even lateral lymphadenectomy for thyroid carcinoma via "mobile" mini-incision. The procedure is safe, of equivalent oncological accuracy compared to traditional incision and the cosmetic results are excellent.

Keywords Functional neck dissection · Cervical lymphadenectomy · Mini-incision · Thyroid cancer · Thyroid carcinoma

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Introduction

Surgical access to thyroidal disease has not substantially changed for almost 100 years after Kocher's pioneering works in this field. The last decade has brought important technical changes in approaches to thyroidectomy, particularly in terms of minimally invasive techniques [1]. Minimally invasive thyroid surgery can be grouped into two main categories based on whether, and to what extent, endoscopic devices are used to operate on the (peri-) thyroidal tissue and—if an incision is made on the neck or not [2].

Thyroidectomies without an incision on the neck are pure endoscopic procedures with access either below the clavicle or from the axilla with or without CO_2 insufflation. The main drawbacks of these procedures are worse exposure of the contralateral thyroid lobe and longer operating time compared to the traditional Kocher incision [3]. Furthermore, patients with extrathyroidal tumour invasion, cervical lymph node metastasis and lesions located in the dorsal area of the thyroid may not qualify for these techniques [4–8]. In highly experienced centres, however, complication rates for robotic procedures seem to be low even for extended procedures [9]. Furthermore, the cosmetic results after axillary thyroid resection are excellent

because the scars in the axilla are not visible when the arm is in the normal postural position.

Thyroidectomy with incision in the neck can be performed with a complete endoscopic approach with or without gas insufflation or with an anterior skin incision performing a non-endoscopic thyroidectomy. The anterior endoscopic approach to the neck is proven to be feasible in solitary benign nodules [4], while the endoscopic lateral access allows lobectomy of the ipsilateral side only [6]. Both endoscopic approaches with CO_2 cervical gas insufflation can cause serious complications such as considerable subcutaneous emphysema [5]. Video-assisted thyroidectomy without gas insufflation done by an anterior approach is limited to benign diseases and nodules less than 3.5 cm in maximum diameter [7]. The lateral approach without gas insufflation is applicable only for hemithyroidectomy [8].

Non-endoscopic minimal invasive thyroidectomy is generally defined as an incision of 4–6 cm [10, 11]. The Sofferman technique was introduced in 2005 and aimed to reduce incision length to <6 cm (from 8 to 12 cm before) by transection of the strap muscles [12]. In the last years, open total thyroidectomy was performed in experienced centres with incisions smaller than 4 cm; hemithyroidectomy even with smaller incisions [13].

This technique has been demonstrated to have several advantages compared to the traditional Kocher incision, including less tissue trauma and postoperative pain, as well as better cosmetic results [14]. While the feasibility and safety of this technique have been shown for goitres and small thyroid carcinomas limited to the thyroid gland and central compartment of the neck (levels VI, VII) [15, 16], data on cancer patients undergoing not only thyroidectomy but also lymphadenectomy in the lateral compartment (levels II–V) through a minimally invasive access have not yet been reported in the literature. Given the excellent long-term survival of patients with a well-differentiated thyroid carcinoma, the cosmetic pretence concerning the cicatrice is generally high, and an "ugly" scar may interfere with patients' quality of life [17]. At our institution, we basically approach any kind of thyroid and parathyroid surgery using an anterior neck incision with a measured maximum length of 4 cm since 2008. The purpose of the present study is to evaluate feasibility and safety of (total) thyroidectomy, cervico-central and functional (lateral) neck dissection through a minimally invasive 4-cm anterior neck incision combined with extended subplatysmal dissection, with respect to intra- and postoperative complications and oncological adequacy.

Methods

This trial was approved by the local ethics committee. A total of 680 (hemi-) thyroidectomies were performed during the study period between January 2005 and December 2010, of which 169 resections were performed for malignancy. We retrospectively reviewed the medical records of all 93 patients from our comprehensive institution's database in the study period undergoing total thyroidectomy, bilateral central neck dissection and functional (lateral) neck dissection on the affected side due to thyroid carcinoma. Central neck dissection is defined as the removal of the prelaryngeal, pretracheal and paratracheal lymph nodes along the recurrent laryngeal nerve of levels VI and VII [18] (C1a and C1b according to Dralle et al. [19]). Functional neck dissection is defined [20] as modified radical neck dissection type III [21] and consists of removal of lymph nodes of levels II–V (C2 and C3 according to Dralle et al. [19]) while sparing non-lymphatic "functional" structures (i.e. axillary nerve, internal jugular vein and sternocleidomastoid muscle).

Group A consisted of 47 patients who were operated between January 2005 and June 2008 with an incision between the two medial edges of the sternocleidomastoid muscles 2 fingers above the suprasternal notch, resulting in a minimal length of incision from 6 to 7 cm. They were compared to a group B of 46 patients, operated between July 2008 and December 2010, via a minimally invasive approach defined as a skin incision of 4 cm or smaller.

Patients' demographics including gender, age, body mass index (BMI), pathological diagnosis, operating time, thyroid weight, number of resected lymph nodes, as well as intra- and postoperative complications were recorded. There were no drop-outs, as in all patients starting from June 2008 and beyond a mini-incision with extended subplatysmal dissection was performed. All patients routinely received a pre- as well as a postoperative laryngoscopy by an otorhinolaryngologist.

Surgical technique

The surgical procedure was carried out under general anaesthesia with the patient being intubated and ventilated. Patient's position was supine, with the neck held in extension. Both the operator and the first assistance are equipped with a headlamp and surgical loupes. Apart from the incision size, surgical technique remained the same over the study period. The incision was made 2 cm above the suprasternal notch. After horizontal division of the platysma, the subplatysmal space is developed by blunt finger and sharp electro-cautery dissection until palpation of the cricoid cartilage, and both medial edges of the sternocleidomastoid muscle. The vessels encountered are divided between ligatures. Inferiorly, retrosternal dissection is continued until the posterior face of the manubrium sterni can be palpated. The sternocleidomastoid muscles are then bilaterally released from the subcutaneous tissue and the strap muscles, respectively, beyond the lateral margin of the sternocleidomastoid muscle. The flaps are retracted and the midline between the strap muscles is opened with an electro-

cautery to expose the thyroid gland. Its superior pole is exposed first, and the supporting vessels are divided between ligatures. The gland is completely freed laterally, and the function of the vagus—recurrent laryngeal nerve circuit is routinely assessed using the neurostimulator device. The inferior pole vessels are then divided, and the thyroid gland, including the isthmus, is meticulously separated from its bed and removed while maintaining the integrity of the recurrent laryngeal nerve. The parathyroid glands are identified and conserved. Routine assessment of the functionality of the recurrent laryngeal nerve is again performed via stimulation of the vagal nerve and documented using the neurostimulator after completion of the thyroidectomy. Instead of early luxation of the gland in the conventional technique, the gland is rotated and moved in the same position but subplatysmal only and the ≤4-cm incision is moved over the operative field as a "mobile window". The last step of the full mobilization of the lobe is the luxation of the specimen through the mini-incision.

Applying a radical concept, bilateral central neck dissection and functional (lateral) neck dissection on the affected side is performed as depicted above (Fig. 1). The intraoperative situs after thyroidectomy, bilateral central neck dissection and functional (lateral) neck dissection on the left side through the mini-incision for a PTC is shown in Fig. 2.

Statistical analyses

The Fisher's exact test was used to compare differences of categorical data. Numerical data were analysed using the Student's *t*-test. A p value <0.05 was considered to be statistically significant.

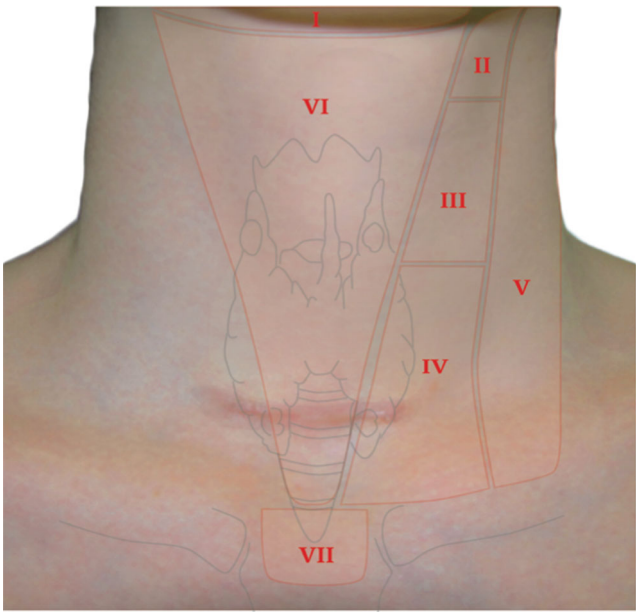

Fig. 1 The reachable lymph node compartments through the "mobile window" of ≤4 cm

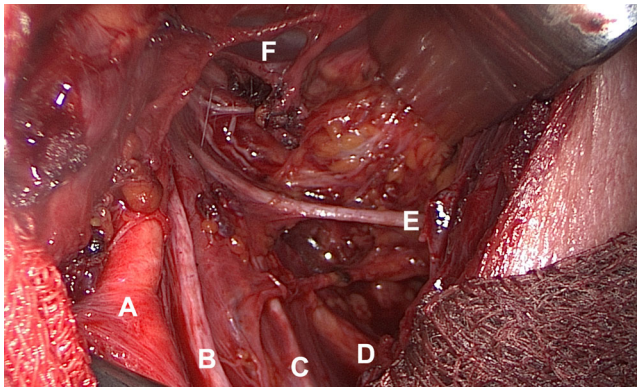

Fig. 2 Intraoperative situs after thyroidectomy, bilateral neck dissection and functional (lateral) neck dissection on the left side through the mini-incision. *A* carotid artery, *B* vagus nerve, *C* phrenic nerve, *D* plexus brachialis, *E* accessory nerve, *F* jugular vein

Results

Patients' demographics did not show any significant differences of age, gender and BMI between the two groups analysed, as depicted in Table 1. Almost two thirds of the patients of each group were female, and median age was young (47 years in group A, and 46.5 years in group B, respectively). The average patient of the analysis was non-obese, having a BMI of 27 kg/m^2. Papillary thyroid carcinoma (PTC) was by far the most common cancer type patients had to be operated for (n = 31 in group A, and n = 35 in group B, respectively). Three patients in group B, and none in group A, suffered from an anaplastic thyroid cancer (ATC). Furthermore, in one patient in group B, a PTC and FTC was found, while one patient in group A suffered from a mucoepidermoid carcinoma. The TNM stage between the two groups did not show a significant difference.

The operating time in group A showed to be slightly longer than in group B, with a median duration of 240 and 195 min, respectively (p = 0.004). Median size of the retrieved thyroid gland was considerably larger in group A compared to group B, weighing 29 versus 20.5 g, respectively (p = 0.003).

Table 1 Patients demographics

	Group A n = 47	Group B n = 46	p value
Age (year)	47 (16–77)	46.5 (15–83)	ns
Female	33	32	ns
Male	14	14	ns
BMI (kg/m^2)	27 (19.1–47.0)	27 (20.1–45.0)	ns

Group A operations 01/2005–06/2008, incisions ranging from 6 to 7 cm in minimum, *Group B* operations 07/2008–12/2010, incisions ≤4 cm and extended subplatysmal dissection

*Median

Neither the total number nor the number of infiltrated lymph nodes resected showed statistically significant difference between the groups. A median of 31 and 28 lymph nodes were harvested, of those a mean of 3.5 and 4.5 were tumour-positive in group A and B, respectively. There was no perioperative mortality.

Intra- and postoperative complications were rare in general, and did not differ significantly between the two groups. The incidence of accidental intraoperative removal of a parathyroid gland with subsequent autotransplantation into the sternocleidomastoid muscle contralateral to the cancer occurred in 4 (8.5%) and 9 (19.6%) patients in group A and B, respectively. Permanent hypoparathyroidism, however, defined as the need for calcium and vitamin D supplementation for more than 6 months was only seen in one (2.1%) patient in group A. All patients received calcium and vitamin D postoperatively on a routine basis. Therefore, the occurrence of transient hypoparathyroidism cannot be evaluated.

Permanent palsy (>6 months) of the recurrent laryngeal nerve was seen in two patients of either group, accounting for 2.2% of all nerves at risk (Table 2). In both patients, the nerve was resected due to extensive infiltration by the carcinoma.

Discussion

Thyroid carcinoma is the malignancy with the most rapidly increasing incidence worldwide [22], yet associated with a generally very good long-term outcome after radical treatment, including surgery. Hence, factors normally deemed secondary in association with cancer management, such as cosmetic results, may become important. Compared to other surgical fields, minimally invasive techniques have been adopted with a certain delay for thyroid operations. Possible reasons for this reluctance may be the tight working space and the vital structures in the operating field. However, in the last 10 years, several minimally invasive techniques have been developed in order to improve the cosmetic outcome in the often young patients [1]. Due to the convincing advantages, such as less tissue trauma and less postoperative pain, these techniques have been established and are accredited for well-defined indications. Indeed, endoscopic approaches with either subclavian or axillary access allow only restricted exposure of the opposite thyroid lobe. Moreover, endoscopic techniques with incision in the neck are limited to benign diseases with nodules less than 3.5 cm in diameter [7]. Consequently, both endoscopic approaches need conversion in case of carcinoma and lymphadenectomy which lead to longer operative time, a greater extent of scars and finally poorer cosmetic results. Additional to very high costs, the mentioned drawbacks also affect robotic thyroid operations [23].

In our unit, thyroid surgery is performed by mini-incision ≤4 cm since July 2008, irrespective of whether the patient undergoes a hemithyroidectomy for a benign disease or a carcinoma has been discovered intraoperatively followed by a lymphadenectomy. The incision remains identically small and the operative technique is standardized. This is possible due to extended subcutaneous dissection but without transection of the strap muscles. Particularly, the meticulous preparation of the access and the perithyroidal tissue allows to move the small incision over the operation field like a window giving facile insight to any part of the thyroid and all levels of the lymphatic tissue. The operation can therefore be performed to almost any extent, the sole limitation being the size of the specimen to be retrieved. As known from robotic thyroidectomy, even extensive subcutaneous dissection does not result in more postoperative pain [24]. Furthermore, a bilateral central (levels VI, VII) and functional lateral neck dissection (levels II–V) can be done via the same approach without enlarging the wound size when preoperative fine needle biopsy or intraoperative instantaneous sections indicate so. Given the relatively young age of the (predominantly female) patients, and the favourable long-term outcome of thyroid cancer, cosmetic issues are of importance.

The present study demonstrates that a 4-cm mini-incision combined with extended subplatysmal dissection is not only applicable for benign diseases of the thyroid but also for the treatment of carcinoma with lymphadenectomy. Whereas the optimal extent of lymph node dissection remains a matter of debate [25], the mean number of lymph nodes in the central and lateral compartment found by histopathological examination should be 10 (4–30) and 20, respectively [26, 27]. This shows that the average number of lymph nodes resected in our series meets the oncological standards for treatment of thyroid malignancies. Advantages of this technique are summarized in Table 3.

In the present study, the results of intra- and postoperative complications of patients undergoing traditional incision are comparable to those operated by mini-incision. While more than twice as many iatrogenic parathyroid gland resections and replantations were seen in patients with mini-incision than in patients with traditional access, this did not translate into a difference of postoperative hypoparathyroidism. Indeed, none of the patients undergoing a minimally invasive approach suffered from permanent hypoparathyroidism. The morbidity found in our series is comparable to other groups performing minimally invasive thyroid surgery. While some studies quote an incidence of hypoparathyroidism and laryngeal nerve injury after lymphadenectomy of 3–4% and 3–6%, respectively [28], other case series encompassing over 100 patients report rates of persistent parathyroid failure and laryngeal nerve palsy of less than 3 and 2%, respectively [22, 29, 30].

A possible weakness of the study may be the comparison of the mini-incision group to historical data. However, there was

Table 2 Results

	Group A $n = 47$	Group B $n = 46$	p value
Histological diagnosis			ns
PTC	31	35	
FTC	11	5	
MTC	4	2	
ATC	0	3	
PTC + FTC	0	1	
Other	1	0	
TNM stage			ns
T1	19	23	
T2	10	9	
T3	16	12	
T4	2	2	
N0	35	29	
N1	12	17	
M1	1 (Liver)	1 (Brain and bone)	
Operating time (min)	240 (120–420)	195 (115–450)	0.004
Thyroid weight (g)	29 (17–370)	20.5 (18–83)	0.003
Number of resected lymph nodes	31 (10–105)	28 (11–71)	ns
Number of lymph node metastases	3.5 **	4.5 **	ns
Intraoperative complications			ns
Lesion of the carotid artery	1	0	
Autotransplantation of one parathyroid gland	4	9	
Postoperative complications			ns
Neck lymph-fistula	1	0	
Chylothorax	0	1	
Permanent recurrent laryngeal nerve palsy	2	2	
Permanent hypoparathyroidism	1	0	

ATC anaplastic thyroid carcinoma, *FTC* follicular thyroid carcinoma, *MTC* medullary thyroid carcinoma, *PTC* papillary thyroid carcinoma, *Permanent recurrent laryngeal nerve palsy* decreased vocal cord mobility more 6 months after surgery, *Permanent hypoparathyroidism* need for calcium and vitamin D substitution for more than 6 months after surgery

*Median, **Mean

no significant difference between patients' demographics, histological diagnosis, number of resected lymph nodes, lymph node metastases and complication rate. On the other hand, a certain disparity of the distribution of the histological type of thyroid carcinoma between the two groups could be detected. However, none of these differences reached statistical significance. The only difference over the period of time in question was the incision; hence, the two groups are comparable. A possible reason for the difference in operation time may be a change in the composition of the operating team. Starting in 2008, one responsible senior consultant was nominated to lead and supervise thyroid operations. The presence of the same senior consultant in the operating theatre for each thyroid intervention led to higher operating efficiency and shorter intervention time, even though emphasis on teaching was maintained.

We did not find a plausible reason for the difference in weight of the specimens retrieved in groups A and B. However, whether weighing 30 or 20 g in average,

Table 3 Advantages of extended subplatysmal dissection

1) Small incision even for large goitres possible
2) No unnecessary tension by rotation of the specimen under the skin
3) "Mobile window" makes lateral lymph node dissection through mini-incision possible

preparation and retrieval of such a thyroid gland would, anyway, easily be possible through a minimally invasive access of 4 cm or less. In our experience, specimens of up to 100 g (50 g each lobe) can be harvested through this small incision. Having said this, the variability of weight found between the two groups has no impact on feasibility of (total) thyroidectomy and functional neck dissection through a mini-incision of 4 cm.

In conclusion, this study shows that total thyroidectomy and adequate lymphadenectomy (levels II to VII) are feasible and safe through a small incision with extended subplatysmal dissection, using it as a "mobile window" over the field of surgery.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This trial was approved by the local ethics committee.

Informed consent Informed consent was obtained from all individual participants included in the study.

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