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ORIGINAL SCIENTIFIC REPORT

Robot-Assisted Transaxillary Thyroidectomy (RATT): A Series Appraisal of More than 250 Cases from Europe

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Abstract

Background Robot-assisted transaxillary thyroidectomy (RATT) is widely accepted in Asian countries. However, concerns regarding the balance between its real advantages and safety and cost have been raised by North American authorities. In Europe, assessments have been limited by small numbers since now. The purpose here is to report a large European experience with RATT.

Methods A retrospective analysis was conducted of 257 patients who underwent RATT for nodular disease between February 2012 and September 2016. Data collected included patient demographics, diagnosis, ultrasound-estimated mean thyroid volume and nodule size, type of resection, operative time, postoperative pain and morbidity, and the hospital length of stay. Pain was assessed by visual analog scale score 12 h postoperatively (on the first postoperative day, before discharge). Feasibility, effectiveness, and safety were the outcomes of interest. Follow-up of thyroid carcinoma patients was carried out measuring thyroglobulin levels and ultrasound examination (median follow-up 24 months (6–48 months)). First control after 12 months and successively once a year.

Results There were 253 women and 4 men, with a mean age of 37.3 years. Indications included benign disease in 116, papillary carcinoma in 56, and indeterminate nodule in 85. Mean thyroid volume was 16.8 mL, and nodule size was 25.3 mm. A hemithyroidectomy was performed in 138 patients and total thyroidectomy in 118. The mean operative time was 77.5 min for the former and 99.7 min for the latter. One conversion was required. Complications included transient hypoparathyroidism in 7/118 (total thyroidectomy) patients (5.9%), transient vocal fold palsy in 3/257 (1.1%), 1 delayed tracheal injury (0.4%), and 3 postoperative hematoma (1.1%). Mean visual analog scale score was 1.79, and the mean length of stay was 1.6 days for hemithyroidectomy and 1.9 days for total thyroidectomy.

Conclusion RATT is safe and effective and could serve as a viable treatment modality in selected cases.

Introduction

The concept of minimal access and cosmetic thyroid surgery is an appealing one because a large proportion of patients are young women who may be equally concerned with therapeutic and cosmetic outcomes. Among the multiple minimally invasive endoscopic and cosmetic procedures described in recent years [1–5] is robot-assisted transaxillary thyroidectomy (RATT), which was first introduced in South Korea in 2009 [6]. RATT is considered an appealing option not only to patients for whom it offers a thyroidectomy free of a neck scar, but also to surgeons for whom it offers improved ergonomics and dexterity compared with its videoscopic equivalents. Although RATT has become a widely accepted and used treatment

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modality for thyroid disease in Asian countries, and its feasibility, radicality, and safety have been demonstrated in published reports [7], the procedure has been losing popularity in North America [8–10], and large series reported from Europe are lacking. We here report our experience with RATT, which to our knowledge is the largest single-center experience published from Europe to date, as a contribution to the global assessment of this novel surgical procedure.

Materials and methods

From February 2012 to September 2016, 257 patients underwent RATT for nodular thyroid disease at the Endocrine Surgery Unit of the University Hospital of Pisa, Pisa, Italy. The da Vinci Si surgical robotic system (Intuitive Surgical, Sunnyvale, CA) was used to perform these operations.

The preoperative evaluation of patients included an ultrasound (US) examination of the neck, US-guided fine-needle aspiration cytology, and a thyroid function test. Selection criteria for RATT were a sonographically estimated mean thyroid volume <30 mL and a maximal sonographically determined nodule diameter of ≤50 mm for benign nodules and ≤20 mm for malignant nodules. Exclusion criteria included previous neck surgery, locally advanced cancer, thyroiditis, and Graves' disease. The choice of surgery (hemithyroidectomy vs. total thyroidectomy) was in concordance with the American Thyroid Association (ATA) guidelines at the time [11, 12].

Data collected included patient demographics, type of disease, sonographically estimated mean thyroid volume and nodule size, extent of resection, operative time, postoperative pain and morbidity, and the hospital length of stay. Pain was assessed by the visual analog scale (VAS) score 12 h postoperatively (on the first postoperative day, before discharge). Regarding follow-up of patients with final diagnosis of carcinoma, at 12 months, the patients underwent physical examination, neck ultrasound (US), recombinant human (rh) TSH (rhTSH) stimulation test for serum Tg (sTg) measurement, and in cases of detectable anti-Tg antibodies (TgAb), a diagnostic whole body scan (WBS). We considered the patients "free of disease" when sTg levels after rhTSH were <1 ng/ml, neck US was negative, and TgAb undetectable. The patients who did not undergo 131-I remnant ablation were considered "free of disease" when neck US was negative and sTg and TgAb were undetectable and/or stable during follow-up. Patients free of disease were followed up every 12 months.

Feasibility, effectiveness, and safety were the outcomes of interest.

Surgical technique

The procedure is performed under general endotracheal anesthesia. The patient is placed supine with the neck slightly extended. The arm on the side of the access is extended cephalad and flexed at the elbow, and the wrist is positioned over the forehead, in the modified Ikeda arm position [13]. The arm is well padded and fixed to a frame. An incision is made along the posterior border of the pectoralis major muscle well disguised in the axilla. The working space is then created by elevating a subcutaneous flap above the pectoralis major muscle all the way to the neck. A special retractor is introduced to maintain the working space throughout the entire procedure. Three arms of the da Vinci Si robot are introduced, and the fourth arm remains folded. A three-dimensional (3D) endoscope, a harmonic scalpel, and a Maryland dissector are placed at the center, upper corner, and lower corner of the incision, respectively.

The procedure is then performed from the console. An assistant provides countertraction and/or suction as required. The thyroid lobe is then resected and delivered in an endo-bag to protect against potential seeding along the surgical tract, which has been reported [14]. If a total thyroidectomy is intended, the contralateral lobe is then resected from the same access.

Results

There were 253 women and 4 men, with a mean age of 37.3 years (range: 16–73 years). Surgical indications included benign disease in 116, papillary carcinoma in 56, and indeterminate nodule in 85. The mean thyroid volume was 16.8 mL (range: 9–25 mL), and nodule size was 25.3 mm (range: 5–60 mm). A hemithyroidectomy was performed in 138 patients, and a total thyroidectomy was performed in 118 patients. The mean global (preparation of the access, docking time, console time, de-docking, and closure) procedure time was 77.5 min (range: 40–220 min) for hemithyroidectomy and 99.7 min (range: 55–180 min) for total thyroidectomy. Separately, the mean time for creating the access and the mean docking time were 17.7 min (range 10–53 min) and 5.7 min (range 2–25 min), respectively. Conversion to standard cervicotomy was required in only one procedure (0.4%) due to locally advanced cancer that escaped preoperative detection.

Complications included transient hypoparathyroidism in 7 of 118 (5.9%), transient vocal fold palsy in 3 of 257 (1.1%), tracheal injury (0.4%), and postoperative hematoma in 3 of 257 (1.1%), of which only one required

Table 1 Features of patients undergoing RATT

Variable	Mean (range) or no.
Age (years)	37.3 (16–73)
Sex	
Female	253
Male	4
Estimated thyroid volume (mL)	16.8 (9–30)
Nodule diameter (mm)	25.3 (5–50)
Diagnosis	
Nodular goiter	114
Papillary thyroid carcinoma	56
Undetermined nodule	85

Table 2 Outcomes of patients undergoing RATT

Outcome	Mean (range) or no. (%)
Post-op hospital stay (days)	
Hemithyroidectomy	1.6 (1–2)
Total thyroidectomy	1.9 (1–4)
VAS pain score at 12 h post-op	2.1 (0–5)
Conversions	1 (0.3)
Complications	
Transient laryngeal nerve palsy	3 (1.1)
Transient hypoparathyroidism	7 (5.9)
Hematoma	3 (1.1)
Tracheal leakage	1 (0.4)

TLNP transient laryngeal nerve palsy, *VAS* visual analog score

revision surgery via the same access. The tracheal injury/leak occurred 1 month postoperatively and was successfully managed conservatively. The mean VAS score was 1.79 (range: 0–8). The mean length of stay was 1.6 days for hemithyroidectomy and 1.9 days for total thyroidectomy (Tables 1, 2).

Regarding chest skin sequelae in the pectoralis area after the operation, nearly all patients were controlled 8 months after the operations (23 were lost at follow-up). In the remaining 234 patients, 65% did not experience any symptom (except fisiologic discomfort due to dissection and scar) after the operation, 25% of patients experienced transient numbness on the pectoralis area during the first month, fully recovered, 8% of patients experienced a complete resolution of these symptoms up to 6 months from the operation, and 2% of patients complained definitive anesthesia, paresthesia of the chest skin region.

Final histology showed carcinoma in 103 patients. Mean diameter of carcinoma was 12.9 ± 8.6 mm (range 1–35). In 56 cases (54%), diameter of carcinoma was ≤10 mm.

In all 103 cases, diagnosis was papillary carcinoma classical variant except papillary-follicular variant in 27 and follicular minimally invasive carcinoma in 2. According to the European consensus for thyroid cancer management, 26 patients were treated with low radioiodine (131-I) activities (1.1 GBq/30 mCi) for postsurgical thyroid remnant ablation.

After 4 years of follow-up, all patients with final diagnosis of carcinoma are free of disease and whose undergone total thyroidectomy showed a mean value of 0.8 ± 1.4 ng/ml TSH-suppressed serum Tg concentrations.

Discussion

The first striking finding that emerges from our experience is the outstanding discrepancy between the numbers of women and men who undergo RATT. This could be explained by both factors related to the desire of patients and others related to the technicalities of the procedure. The greater appeal for the robotic approach among women is related to its ability to offer a thyroid procedure free of a neck scar, therefore, an improved cosmetic outcome [15]. In addition, women tend to be more suitable candidates for the procedure because of their relatively smaller body habitus and the shorter distance between the access and the neck [16].

Although the ATA statement on remote access surgery does not recommend RATT for nodules sized >3 cm [17], this study demonstrates the feasibility of RATT for larger-sized nodules (up to 5 cm in this series) without compromising its safety. Nevertheless, it should be underscored that the patients selected for RATT in this study, even if some nodules were considered large in size, were carefully selected. Patients with active thyroiditis were excluded, and nodules situated on the upper pole of the thyroid were also considered not suitable for this access.

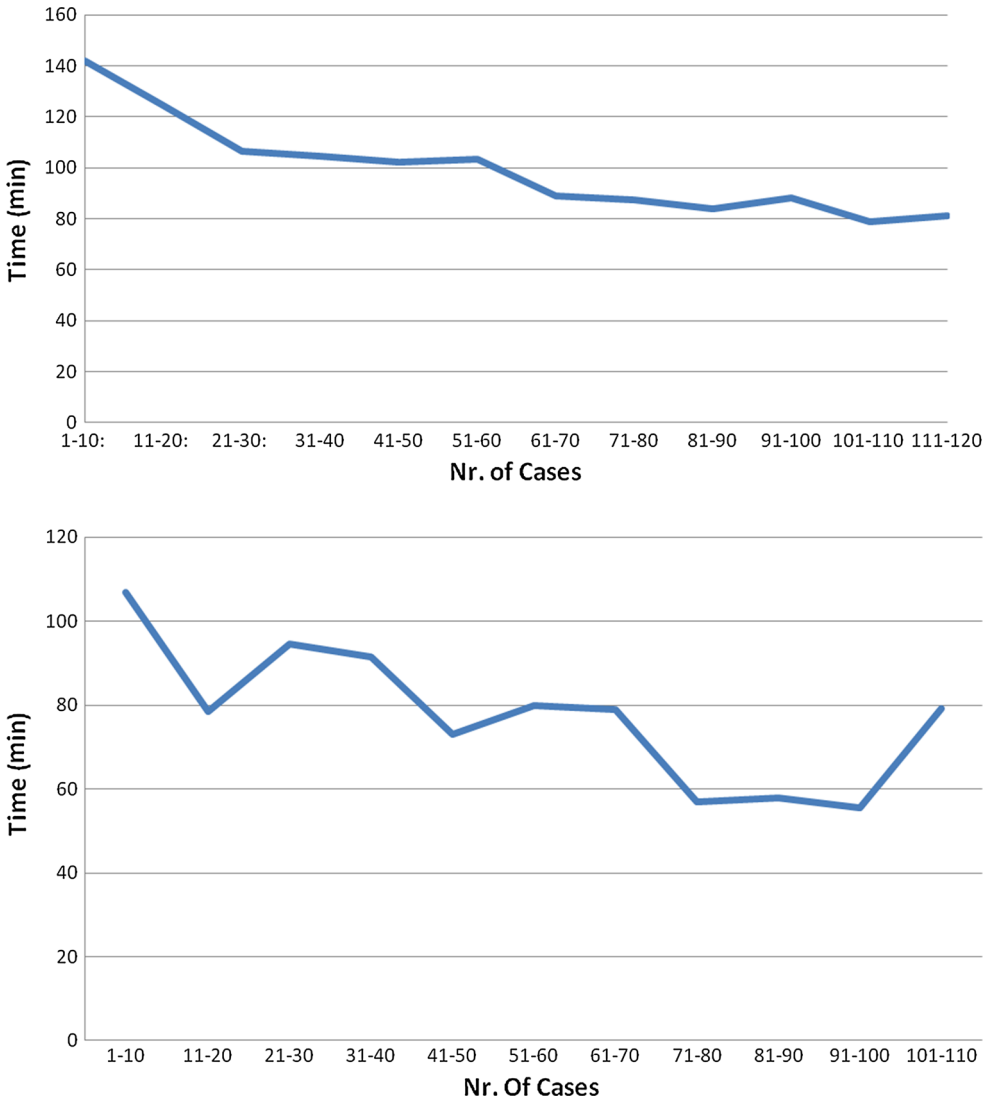
An accurate preoperative evaluation of patients with papillary carcinoma was performed, excluding patients with suspicious VI level metastases or T4 tumors. Only one patient in this series was misselected because features of advanced disease were not detected on the preoperative evaluation. The patient came to our unit with double fine-needle aspiration cytology showing benign disease (Thy 2) in both samples, and the 5-cm nodule was not suspicious under ultrasound examination. Conversion to standard cervicotomy was required in this case upon the intraoperative detection of local invasiveness, adhering to a fundamental oncologic principle: local control is a top priority, and a direct access is critical for that [18].

The mean operative time for RATT was significantly longer—almost double—than the mean operative time for conventional thyroidectomy at our center. This has considerable implications on cost and the number of thyroid procedures that could be offered by a high-volume referral

center. However, the learning curve should be taken into account (Fig. 1), with performance improving with experience in four phases. Accordingly, performance tends to improve with experience, and operative time is one of the measures used for its assessment. Operative time in turn is significantly influenced by the first part of the curve (the commencement of training). In this series, the first 20 cases constituted the first phase of the procedure's learning curve, after which the operative time started to decrease, from 80 to 45 min for lobectomy and from 100 to 80 min for total thyroidectomy.

It is worth mentioning here that the docking time at the commencement of the learning curve at our center was lower than that reported by American and Korean groups [19, 20]. This is probably attributed to the technique we use: we position only 3 arms and keep the fourth folded. Avoiding the use of the fourth arm also allows us to reduce costs in every single procedure. The cost of RATT was estimated as operative time plus anesthesia fees plus consumables plus the robotic system. Consumables for RATT were the robotic devices (each used 20 times) plus the trocar plus the robot drapes plus the special retractors plus the harmonic scalpels (disposable). The cost of the robotic system was calculated as the total robot cost divided by the total number of robot-assisted cases. However, we should consider that in our institution we share the robotic facilities with surgeons of other specialities (urology, gynecology, thoracic surgery, HPB surgery) for whom the da Vinci robot was initially purchased. The RATT procedure is usually a shorter time procedure compared with other robotic procedures, so it can find easily a place in the daily operating list, covering empty spaces. Then, it is correct to say that performing RATT, in our institution, is also a way to improve the efficiency of the robotic operating room, decreasing the costs of the robot itself. In our hospital, the global cost of standard thyroidectomy through cervicotomy

Fig. 1 Learning curve



is 2600 euros while RATT is about double. Patients are not required to self pay the operation because all costs are covered by the national health system.

Although a larger sample size is required to properly verify the safety of a procedure, the safety and reliability of RATT in this series were comparable to conventional thyroidectomy. This study also demonstrates the increased likelihood of untraditional complications for which remote access thyroid surgery has been incriminated [9]. Tracheal injury that went undetected intraoperatively occurred in 1 patient in this series and presented a month later as a diffuse asymptomatic neck swelling with subcutaneous emphysema. The patient was readmitted, and bronchoscopy revealed a 2-mm defect in the anterior surface of the trachea. This was probably attributed to injury from the active blade of the ultrasonic shears. Bronchoscopic curettage of the borders was performed, and the patient was given antibiotics. The patient's condition resolved completely within 8 days, and this was confirmed by repeat bronchoscopic examination [21].

A postoperative hematoma was developed in 3 patients in this series. Two were successfully managed by applying a compressive dressing along the surgical track, and 1 required revision surgery. Re-exploration was performed endoscopically via the axillary access, and the middle thyroid vein was identified as the source of bleeding and controlled by applying a clip. In an ironic twist, the large dissection that is required to create the working space in RATT and for which the procedure is often labeled as maximally invasive, plays a potentially protective role against life-threatening airway compromise in cases of postoperative bleeding as the hematoma finds a large space to evacuate.

The pain outcome of RATT seems to be similar to that of conventional thyroidectomy. A recent study demonstrated that pain in the immediate postoperative period was not worse after RATT, as might be suggested by the larger dissection it requires [22]. However, RATT patients had a greater tendency toward reporting a slight persistent pain. Nevertheless, this did not have any implications on the hospital length of stay or the amount of analgesia required. All RATT patients were discharged on postoperative day 2 as in conventional thyroidectomy.

In conclusion, our experience confirms the favorable results published by the Korean group who introduced this novel procedure, even when applied in a European population that may vary considerably from an Asian one, at least in body habitus. In carefully selected cases, RATT seems to be a viable treatment modality, especially in patients with concerns regarding a visible neck scar.

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