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Robot-Assisted Transaxillary Thyroid Surgery: As Safe as Conventional-Access Thyroid Surgery?

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With the advent of minimally invasive techniques in thyroid surgery, conventional open-access surgery for bilateral multinodular goiter was extended to encompass total thyroidectomy. At the same time, the surgical approach to the thyroid gland was reduced to a minimum. Totally endoscopic and video-assisted procedures through a minimal neck incision were shown to be better tolerated by the patient, resulting in improved cosmesis with no increase in surgical morbidity [1]. In terms of perioperative and cosmetic benefit, minimally invasive procedures are superior to conventional open surgery when the surgical trauma inflicted to gain access to a fairly small target organ is substantial (e.g. in laparoscopic cholecystectomy or adrenalectomy). Owing to the short distance to the target organ, the thyroid and parathyroid glands stand least to gain from the use of minimally invasive surgery. Keeping the neck incision as short as possible was a first step towards achieving a better cosmetic result in the neck. Unfortunately, only some 15% of thyroid patients were suitable candidates for this type of surgery. Some other patients were dissatisfied because their expectations of having no visible neck scar were not met. Nowadays, more and more people from all walks of life, whatever their physical build or ethnic, geographic or cultural background, yearn for better surgical cosmesis after thyroidectomy – why should they not opt straightaway for a neck without a scar?

From a medical point of view, transaxillary thyroid surgery, the most popular approach in order to avoid scarring, needs not only to be feasible but also as safe as conventional-access thyroidectomy. From the patient perspective, the greater exposure of the thyroid facilitated by the transaxillary route is not as important as the potential of this new surgical approach for less damage in the short and long term. These considerations clinically trump the issue of cost and reimbursement policies [2–4] because most endoscopic procedures are less cost-effective than conventional open surgeries.

Is transaxillary, more specifically robot-assisted transaxillary surgery (RATS), as it stands today [5–7], as safe as conventional open-access thyroid surgery (CATS)? That is to say, is it safe enough for patients with uncomplicated, small, nonretrosternal goiter, or low-risk localized thyroid cancer to serve as an alternative to Miccoli's minimally invasive video-assisted technique [1, 8]? At present, this is not at all clear. Kang et al. [9], from the Yonsei University College of Medicine in Seoul (South Korea), were the first to describe RATS in 2009. Within a 5-year period, a total of 10,000 RATS procedures (without being able to avoid double counting of procedures reported by the same group in more than 1 publication) have been described in about 31 publications [4, 10–39]. Thirteen publications performed a head-to-head comparison of RATS and CATS [4, 9, 11, 12, 16, 18, 19, 23, 29,

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Table 1. Summary of RATS procedures, thyroid cancers and perioperative methods for surgical quality control

Number of retrospective studies	4
Total number of RATS	10,415
Total number of thyroid cancers (percentage of all RATS)	10,017 (96.2%)
Total number of ≥pT2 cancers (percentage of all thyroid cancers)[a]	3,273 (32.7%)
Studies with routine preoperative laryngoscopy, n	8 (26%)
Studies with routine vagus nerve monitoring, n	0
Studies with routine brachial plexus monitoring, n	1 (3%)
Studies with routine postoperative laryngoscopy, n	9 (29%)
Studies with routine postoperative brachial plexus control, n	0
Studies with routine postoperative calcium/parathyroid hormone control, n	7 (23%)

Review of RATS studies including >10 RATS procedures from 2009 to 2013 [4, 10–39] (see also table 2) with pertinent data on perioperative quality control, complications and thyroid cancer rates in the surgical specimens.
[a] Five studies were excluded because TNM categories were not given for cancer.

33, 40–42]. All 31 RATS studies, 22 of which were from South Korea and 9 from the USA, were retrospective by design (table 1). Systematically reviewed, they revealed three areas of concern regarding the safety of RATS: (1) perioperative surgical quality control, (2) surgical complications and (3) long-term oncological outcome in the setting of thyroid cancer.

Perioperative Surgical Quality Control

As a matter of fact, less than one third of the above-mentioned 31 RATS studies systematically looked for complications typical of thyroidectomy, notably recurrent laryngeal nerve and parathyroid function (table 1), as was outlined in the multicentric Scandinavian [43] and German [44] quality-evaluating studies and in the 'framework for new technology assessment and safe implementation' [45]. Only some of the above-mentioned RATS studies detailed the common, though often transient, complications of the transaxillary approach, such as wound hematoma, postoperative neck and anterior chest pain and paresthesia. There are two major complications that can result in serious long-term morbidity, which are not encountered with CATS: injury to the aerodigestive tract (especially the trachea) and the brachial plexus. Intraoperative monitoring of the brachial plexus [46, 47] was systematically performed in only 1 study [17], and postoperative evaluation of brachial plexus function was exceptional. Not a single study utilized intraoperative monitoring of the vagus nerve routinely, although this technology reliably permits prediction of recurrent laryngeal nerve function after the operation [48], and helps avoid bilateral vocal cord palsy by postponing completion of the other side in benign goiter and low-risk differentiated thyroid cancer [49]. Given the lack of outcome data regarding the function of the recurrent laryngeal nerves, the brachial plexus and the parathyroid glands, the published complication rates are likely underestimates of the surgical risk inherent in RATS.

Surgical Complications

When total thyroidectomy without or with the addition of central node dissection was performed (38% of all RATS patients reviewed), postoperative transient hypoparathyroidism was the most frequent complication of RATS (36%; table 2). The unusually low rate of permanent hypoparathyroidism, no more than 1/1,000 patients undergoing RATS, suggests that the majority were not systematically screened for this specific condition. Among the 29% of patients who underwent laryngoscopy after RATS on a routine basis, transient and permanent vocal cord palsies were noted in 3.9 and 0.5%, respectively. The actual rate of postoperative vocal cord dysfunction likewise seems to have been underdiagnosed, because the absence of hoarseness cannot exclude asymptomatic vocal cord palsy.

Brachial plexus neuropathy during RATS is probably due to positioning of the arm to gain sufficient access. Considering the absence of brachial plexus injury after CATS, this is at least believed to be a contributory cause. The neuropathy resolved in 0.2% of patients after RATS,

Table 2. Summary of intraoperative and postoperative complications after RATS

Hypoparathyroidism after total thyroidectomy[a]	
Transient	36.0
Permanent	0.1
Vocal cord palsy after surgery[b, c]	
Transient	3.9
Permanent	0.5
Brachial plexus neuropathy after surgery[c]	
Transient	0.2
Permanent	0.04
Tracheal injury during surgery[c]	0.2

These are the same studies as in table 1. All values are percentages. [a] Number of total thyroidectomies: 3,936. [b] Three studies did not report postoperative vocal cord function. [c] Per patient.

but was permanent in 0.04%. As the transaxillary approach usually requires elevation and flexion of the arm above the level of the head, brachial plexus neuropathy is thought to be a complication inherent in RATS. Although most of the time it is rare and transient, considerations of patient safety and possible medicolegal consequences warrant a great deal of attention to prevent this type of complication, more specifically, intraoperative electrophysiological monitoring and postoperative clinical controls of the brachial plexus. Tracheal injury, reported in 0.2% of patients undergoing RATS, seems to be another procedure-related surgical complication that may be more experience-dependent than inherent in RATS as brachial plexus neuropathy is considered to be. Although it can mostly be managed by closing the tracheal defect endoscopically, tracheal injury remains a serious complication of RATS that is not observed with CATS.

Even after 5 years of experience with RATS, it remains unclear whether the complication rates of RATS and CATS are comparable or not. As a matter of fact, the reported incidence of postoperative permanent hypoparathyroidism is, in all likelihood, a gross underestimate of the actual rate. As many as one third of RATS patients qualify for total thyroidectomy, so in the future, studies need to be designed such that postoperative hypoparathyroidism after RATS is rigorously ascertained after total thyroidectomy has been performed. Brachial plexus neuropathy and tracheal injury are grave procedure- and experience-related complications, virtually unheard of in conventional thyroidectomy, which will hopefully become rarer as surgeons progress on the learning curve.

Long-Term Oncological Risk

In stark contrast to the entire spectrum of thyroid diseases, 96% of RATS procedures were carried out for papillary thyroid cancer (PTC). Strikingly, one third of these patients revealed PTC with a T-category ≥T2, most of which fell into the T3 category for minimal extrathyroidal extension. Even if one were to concede that minimal tumor growth through the thyroid capsule does not entail a greater oncological risk [50, 51], it remains highly debatable whether a novel surgical technology should first be assessed in patients with higher-risk cancer. Owing to the fairly short follow-up period of less than 5 years, it is impossible to quantify the risk of neck recurrence after the possible seeding of cells from a pT3 thyroid cancer. A few retrospective studies used lymph node retrieval during node dissection and postoperative thyroglobulin levels as a surrogate for clinical outcome [11, 12, 16, 18, 23, 33, 42]. Based on these criteria, in some studies at least, RATS seemed to fare less well than CATS [12, 16].

In the quest for superior surgical cosmesis, RATS represents the culmination in the development of endoscopic thyroidectomy that is not minimally invasive in nature. The Korean surgeons are to be congratulated on having introduced the robot into thyroid surgery and having perfected its routine use. Robot thyroidectomy is now fit for clinical use if one is prepared to foot the bill for the incremental direct (i.e. robotic system including annual service fee and costs for single-use instruments) and indirect costs (i.e. prolonged anesthesia and operative time).

The incremental expenditure associated with the use of robot surgery raises important questions. Should we adopt a new technology solely because it affords a better cosmetic result? Should the use of this technology be governed by economic principles, such as a patient's or institution's willingness and ability to pay? Is it ethical to divert significant financial resources from the healthcare system merely for improved cosmesis, even though the novel technology has not yet been proven to be as safe as the former gold standard? As a matter of fact, most series published on RATS do not measure up to the usual requirements for surgical quality assessments. The surgical complication rates of robot thyroidectomy have still to be rigorously ascertained beyond the early postoperative period. Are we willing to accept serious complications over and above the usual spectrum of surgical complications, just for the use of a 'hip' technology? Are we willing to subject our patients to greater surgical morbidity until our learning curve has leveled off? After the introduction

of laparoscopic cholecystectomy in the early 1990s, longer operative times were observed but also more severe complications such as hilar and vascular damage than with the former standard of conventional open cholecystectomy. In the light of such experience, the surgical community agreed that learning curves involving longer operative times were acceptable, unlike learning curves associated with higher and more serious complication rates. The same should now apply to RATS. Should we really operate on higher-risk cancer patients in the first place before the safety of a novel technology has been established in benign thyroid disease?

Despite these reservations, RATS is a truly fascinating technology conferring superior cosmesis compared to CATS. Rather than abandoning RATS [52], national registries should be set up [53], flanked by rigorously conducted prospective, ideally randomized clinical trials to determine the benefit-risk profiles of RATS and CATS in a head-to-head comparison.

Disclosure Statement

The author declares not to have conflict of interest.

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