Transaxillary Robotic Thyroid Surgery: A Preliminary European Experience

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Key Words

Robotic surgery · Thyroidectomy · Transaxillary robotic thyroidectomy · Thyroid

Abstract

Background: Robot-assisted endoscopic transaxillary thyroidectomy is an emerging surgical technique that needs to be evaluated in European patients. We evaluate the feasibility and preliminary results of our experience of this technique in a cohort of patients from within a single European university hospital (Nîmes, France). **Methods:** We performed a retrospective review of the first 23 patients, treated consecutively between September 2010 and June 2012. **Results:** Nine patients underwent total thyroidectomy and 14 patients lobectomies. All procedures were completed successfully with a mean total operative time of 134 min. We observed a single case of internal jugular vein injury during the console time. No instances of persistent complications were observed; however, minor postoperative events occurred in 5 patients. Pathological diagnoses included benign follicular adenoma in 18 patients, benign adenoma with lymphoid thyroiditis in 1 patient, and benign adenoma with Graves' disease in 4 patients. **Conclusions:** Robotic thyroid surgery

is feasible in European patients and can be safely performed on selected patients. This technique has infrequent minor complications and provides a high level of satisfaction.

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Introduction

Robot-assisted endoscopic thyroidectomy is an emerging surgical technique first described by Kang et al. [1] via a transaxillary approach. This innovative procedure is based on the use of the daVinci[®] Surgical System (Intuitive Surgical, Inc., Mountain View, Calif., USA) that provides the surgeon with three-dimensional, high-definition, magnified visualisation of the operative field, and allows control of various instruments with increased precision, tremor filtration, and more degrees of freedom. Since its introduction in 2007, the use of this robotic system for thyroidectomy has been seducing more and more surgeons and patients worldwide. We first used the daVinci system for robotic thyroidectomy through an infraclavicular approach in 2010 and then decided to use the transaxillary approach. This change in practice was as a result of the various technical limitations presented by the

infraclavicular approach and a patient-driven demand for a robotic procedure which totally avoided a visible scar on the neck and chest [2–4]. As this technique has become increasingly popular among patients, European surgeons have introduced it to their clinical practice resulting in several practical issues. Firstly, apart from the impressive Korean experience, the reproducibility and validity of this technique has been poorly documented in Western countries. Secondly, an adequate training of surgeons is necessary to obviate ethical and safety reasons; however, such training is currently not properly organized in Europe.

In this paper, we present the experience of our 23 first cases of transaxillary thyroid robotic surgery by the da Vinci system using the surgical technique described by Kang et al. [1]. We report one of the first European experiences in the field, and in doing so provide essential steps to guide other surgical teams in their initial experience with this emerging technique. The future and perspectives of this procedure in Europe are also discussed.

Methods

This study was carried out with the agreement of the institutional review board of the University Hospital of Nîmes where the work was conducted. Patients within a single institution were operated upon by a single, experienced thyroid-head and neck surgeon (B.L.) and assistant (G.C.). Prior to commencement of the study, our team had already developed significant experience in robotic surgery, having carried out 21 robotic thyroidectomies using an infraclavicular approach in addition to a further 45 transoral robotic surgeries for the treatment of pharyngeal or laryngeal cancers [5]. The primary surgeon (B.L.) undertook two cadaveric dissections before enrolling the first live case, to ensure familiarisation with the new surgical technique.

Candidate patients were informed of the innovative features of the technique and of the subsequent risks before gaining informed consent from them. The following data were collected prospectively for each patient: age, gender, thyroid lobe size (largest dimension), largest nodule size, presence of thyroiditis, extent of surgery, total time for patient in theatre, surgeon console time, working space creation time, use of drain, pathologic findings, complications (such as hypocalcaemia, inferior laryngeal nerve palsy, haemorrhage, seroma or infection), incidence of pain requiring additional medication, and hospital length of stay. Our inclusion criteria were follicular adenoma or benign thyroid nodule <5 cm with a thyroid lobe size <7 cm or Graves' disease with a thyroid lobe size <7 cm and an associated normal thyroid-stimulating hormone level at the time of inclusion. We excluded patients with a preoperative diagnosis of carcinoma or abnormal cervical lymph nodes on ultrasonography, a previous history of neck surgery (apart from previous thyroid lobectomy), and surgical breast augmentation or radiotherapy. Postoperative voice abnormalities we re-evaluated using the Voice Handicap Index-10 (VHI-10), a validated tool that measures patient self-assessment of voice quality and the effect of voice on quality of life. The VHI-10 consists of 10 questions, with re-

Fig. 1. Position of the patient and placement of the incisions.

sponses to each scaled from a minimum of 0 (no voice alteration) to a maximum of 40 (highest voice impairment) [6, 7]. Postoperative swallowing difficulties were assessed using the Swallowing Impairment Index (SIS-6), a validated 6-item self-assessment of symptoms related to dysphagia. The scoring of each item on the SIS-6 ranges from a minimum of 0 (no swallowing alteration) to a maximum of 24 (highest swallowing impairment) [8, 9]. Cosmetic satisfaction and global satisfaction were individually assessed by patients on a 5-point scale including the following fields: very unsatisfied, unsatisfied, indifferent, satisfied or very satisfied.

Surgical Technique

The patients were operated with the da Vinci S-HD robotic system (Intuitive Surgical, Inc.) following the technique described by Kang et al. [1], modified by the inclusion of a fourth arm of the robot. Briefly, the surgery was carried out under general anaesthesia in a supine position. The neck was maintained slightly extended by a small shoulder roll and the patient's arm on the operative side raised and flexed at the elbow by 90° thus ensuring the shortest distance between the axilla and the anterior neck (fig. 1). After the patient was prepped and draped, a 6- to 8-cm vertical skin incision was made in the axilla. A working space was then created by dissecting between the subcutaneous tissue and the pectoralis muscle to reach the space between the sternal and clavicular heads of the sternocleidomastoid muscle. This space was opened to reach the strap muscles and omohyoid which were subsequently dissected free from the internal jugular vein and elevated off the thyroid. This dissection creates sufficient working space from the sternal notch to the superior pole of the thyroid. A lifting device (Chung's retractor) was then inserted through the incision and attached to the operative bed to maintain the working space. The technique was further modified by inserting the lower 8-mm trocar through an incision carried out on the inferior mammary fold instead of the presternal area (fig. 1). We used a unilateral approach for both lobectomy and total thyroidectomy. Once the working space was created, the da Vinci system cart was positioned and docked. Four robotic arms were used for the surgery. Three arms were inserted through the axillary incision: one supporting a 30° dual-channel endoscope used in a downward-facing orientation, one supporting

Table 1. Clinical data of 23 consecutive patients treated by robotic transaxillary thyroidectomy

Patient	Sex	Age	Post-operative stay	Disease	Type of surgery	Console time	Working space creation time	Total time	Complication	VHI 10	SIS 6	Scar satisfaction	Dysaesthesia
1	f	39	2	adenoma	TT	MD	MD	147	none	1	0	indifferent	6 months
2	m	42	2	adenoma	LL	MD	MD	124	none	0	0	very satisfied	yes
3	f	64	2	adenoma	RL	54	64	138	none	0	0	very satisfied	yes
4	f	30	3	Graves'	TT	122	58	213	seroma	0	0	satisfied	yes
5	f	56	2	adenoma	TT	112	72	218	Hypo-Ca	8	0	very satisfied	no
6	f	33	3	adenoma	TT	110	57	174	Hypo-Ca	MD	MD	MD	MD
7	f	41	2	thyroiditis	TT	134	46	189	none	0	4	satisfied	yes
8	f	41	3	adenoma	CT	36	55	100	hematoma	0	0	satisfied	no
9	f	40	2	adenoma	RL	38	38	95	none	0	0	indifferent	no
10	f	48	2	adenoma	RL	43	36	96	none	0	0	very satisfied	no
11	f	43	2	adenoma	LL	18	77	107	none	0	0	satisfied	6 months
12	f	43	2	Graves'	TT	MD	39	188	none	MD	MD	MD	MD
13	f	39	3	Graves'	TT	121	56	192	Hypo-Ca	0	0	satisfied	2 months
14	m	57	2	adenoma	LL	MD	35	62	none	0	1	satisfied	no
15	f	34	2	Graves'	TT	82	49	229	Conv	3	0	satisfied	no
16	f	36	1	adenoma	LL	35	31	81	none	0	0	very satisfied	1 month
17	f	31	1	adenoma	RL	45	34	96	none	0	0	satisfied	6 months
18	f	32	2	adenoma	RL	42	32	84	none	MD	MD	MD	MD
19	f	50	2	adenoma	TT	64	52	130	none	0	0	satisfied	no
20	f	41	2	adenoma	LL	43	MD	90	none	MD	MD	MD	MD
21	f	43	1	adenoma	RL	35	MD	83	none	0	0	satisfied	yes
22	f	36	1	adenoma	LL	69	MD	144	none	0	0	indifferent	yes
23	f	61	2	adenoma	LL	45	MD	96	none	0	0	satisfied	yes

TT = Total thyroidectomy; LL = left lobectomy; RL = right lobectomy; CT = completion thyroidectomy; Hypo-Ca = transitory hypocalcaemia; MD = missing data; Conv = conversion to an open neck thyroidectomy; VHI = Voice Handicap Index; SIS = Swallowing Impairment Index.

a Maryland dissector, and one supporting the Harmonic curved shears. The fourth arm supported an 8-mm grasping forceps that was inserted via the submammary trocar. After docking the robotic system, the surgeon carried out the thyroidectomy using the daVinci console as already described [1, 6]. Briefly, the Maryland forceps were used to orient the thyroid tissue and the Harmonic curved shears used to dissect surrounding tissues and provide haemostasis. Inferior laryngeal nerves were systematically identified and preserved. The dissection was carried out as close as possible to the thyroid in order to minimize the risk of parathyroid gland injury. After removal of thyroid tissue, a closed suction drain was inserted into the thyroid bed and the incisions were closed in two layers. The patient was discharged home 24 h postoperatively. When hypocalcaemia occurred, a conventional treatment using alfacalcidol was introduced and patients would be discharged following biological and clinical normalisation.

Results

From September 2010 to June 2012, 23 patients underwent robot-assisted thyroidectomy using a unilateral transaxillary approach (table 1). The indication for total

or partial thyroidectomy was enlarging thyroid nodules in 19 patients and Graves' disease in the remaining 4 cases. The patient's motivation for robotic thyroidectomy was to avoid a scar on the neck and a subjective belief that the surgery would be of 'better quality' despite balanced and detailed information surrounding the technique and its associated risks including an operative 'learning curve'. Patients were on average 42.6 years old (range 30–64) and included 2 men and 21 women. Patients' BMI was 24.4 on average (range 18.5–31.2).

The average size of the thyroid nodules was 29 mm (range <10–50). We carried out total thyroidectomy in 9 patients, right lobectomy in 6 patients, left lobectomy in 7 patients, and a completion thyroidectomy (right lobectomy) in 1 patient.

For all patients except one, the procedure was completed without complications. Mean total operative time (from the end of induction of anaesthesia to the completion of skin closure) was 134 min (range 62–229). The mean time required to create the working space and dock the robot (from skin incision to the beginning of the con-

sole procedure) was 49 min (range 37–77). The mean console time was 66 min (range 18–134). In all cases the dissection of the thyroid was complete and no visible residue was present at the Berry's ligament or at the upper pole area.

With respect to complications, we observed a single case of internal jugular vein injury (ipsilateral to the axilla incision) by the robotic instruments that occurred during the console time, whilst removing the thyroid gland. A conversion to an open neck approach was necessary to control the bleeding and was achieved without major blood loss (<200 ml). Minor postoperative complications were apparent in 5 cases. One patient experienced a postoperative seroma in relation to the prepectoral working space dissection and whilst a further patient experienced a limited hematoma in the same area. Both resolved spontaneously within 4 weeks. We observed transient postoperative hypocalcaemia, treated for 6 weeks by decreasing doses of alfacalciferol in 3 patients. No patient presented postoperative vocal cord palsy. No patients required pain medication in addition to our current 'open neck thyroidectomy' protocol (paracetamol 1 g every 8 h for 3 days) following surgery. Patients were discharged home without drains after 1, 2 or 3 nights in 4, 18 and 1 cases, respectively.

Pathologic diagnoses included benign follicular adenoma in 18 patients, benign adenoma with lymphoid thyroid in 1 patient, and benign adenoma with Graves' illness in 4 patients. No cases of carcinoma were detected on definitive pathologic examination.

At postoperative follow-up, dysaesthesia was present on the prepectoralis region of 11 patients and resolved spontaneously after 8 weeks. 19 patients enrolled in this study completed the VHI-10 and SIS-6 questionnaires between 3 and 18 months after surgery. The mean score for the VHI-10 was 0.66 point (range 0–8) and the mean score for the SIS-6 was 0.27 point (range 0–4). Concerning the cosmetic result of the scar, 16 patients were either satisfied or very satisfied, 3 were indifferent, and none were very unsatisfied or unsatisfied.

Discussion

Since the first description of robot-assisted endoscopic thyroidectomy in 2007, several papers have been published describing the feasibility and safety of this new surgical technique. Its functional results, cosmetic advantages and technical limitations have been studied on large series of patients and a learning curve has been proposed

[10, 11]. However, all this literature relies on the singular experience of a group of South Korean surgeons working in different institutions but with the same medical background and in the same country. The specificity of the management of thyroid nodules in South Korea in terms of screening, surgical indications, surgeons training, number of thyroid surgery centre as well as the morphology of Korean people raise some questions concerning the reproducibility of these remarkable results elsewhere in the world. To date, only 9 reports of transaxillary robotic thyroidectomy carried out outside Korea have been published. Those papers describe preliminary experiences based on a very limited number of cases. Further, they tend to validate the Korean results but state that for a safe implementation of this new technique a proper evaluation on European/Western patients is mandatory [11–18].

Our study is the third, yet the largest report of transaxillary robotic thyroidectomy on European patients. Although based on a limited number of patients treated by a single surgical team (B.L., G.C.), this initial series confirms that this technique is feasible and can be safely performed in a selected population.

We consider this preliminary experience very promising because (1) in the context of a preliminary experience, we were able to operate all patients without any major complication and with functional results and length of hospital stay comparable to open neck surgery, and (2) we observed a high level of global satisfaction of the patients, particularly in terms of cosmetic results as well as postoperative results comparable to other conventional techniques in terms of postoperative dysphonia and dysphagia.

On the other hand, however, we did identify possible issues that may limit the development and popularisation of robotic transaxillary thyroidectomy in European countries. Firstly, this technique is a complicated multistep procedure that dramatically changes the surgical paradigm for thyroidectomy. As stated by Kuppersmith and Holsinger [12], it requires a concerted effort from the surgeons and associated operating room staff to learn how to position the patient, to create the working space through the axilla (which requires identification and dissection of the great vessels of the neck), to manipulate and dock the robot and finally to use the robot to remove the thyroid via a lateral approach.

Despite the significant experience of our unit, both in terms of routine thyroid surgery (approx. 300 cases per annum) and in robotic surgery (90 procedures at the time of the study), the implementation of this new procedure remained time-consuming and technically demanding [5].

The indications for robotic thyroidectomy remain relatively limited with the present daVinci robotic system and its restricted instrumentation. As previously suggested, we are of the opinion that the best candidates are slim patients (BMI <22) presenting small unilateral thyroid nodules (<3–4 cm), benign or with a low risk of malignancy. The presence of thyroiditis, multiple or bilateral nodules, a BMI >25 or nodules of the superior pole make the surgery considerably more difficult, yet may still be manageable by experienced robotic surgeons. Plunging thyroid, nodule size >6 cm, previous history of neck surgery or irradiation should be considered absolute contraindications. We also consider that malignant tumours must be excluded until sufficient data are collected to assess the oncological validity of this surgical approach. It is worth mentioning that given those limited indications the potential number of cases of robotic surgery would be less than 20–30 cases per year in most European centres, which is probably a limit under which it becomes difficult to reach the learning curve and to maintain sufficient robotic surgical skills.

Specific complications not normally seen in thyroid surgery have been described in association with techniques such as that evaluated here. These rare but potentially severe complications include brachial plexus neuropraxia and great vessel injury. The absence of brachial plexus neuropraxia in our series is due, at least in part, to the modified arm positioning described by Kuppersmith and Holsinger [12] (forearm bent at 90° and arm position checked in the operative room before patients anaesthesia to ensure an absence of pain or discomfort) (fig. 1). Internal jugular vein injury by the robotic instruments did occur in a single case within our cohort. This complication transpired on a patient with a large and very anterior vein that significantly obstructed the lateral view of the thyroid gland despite a large dissection during the working space creation. A conversion to an open neck approach was necessary to control bleeding with no major blood loss (<200 ml). As proposed by Kuppersmith and Holsinger [12], preoperative ultrasound evaluation of the size and position of the internal jugular vein in relationship to the thyroid gland may be helpful to identify impending problems and thus allow surgeons to elect a traditional surgical approach.

Robotic thyroidectomy remains considerably more expensive than conventional open neck thyroidectomy at present. This is due to the procurement cost of the robotic system and associated annual maintenance, the cost of disposable instruments, and as a consequence of the increased theatre times of procedures and a lack of significant gains in terms of length of hospital stay [12, 19,

20]. Such financial considerations, however, should not be an obstacle to the development of innovative surgical techniques and the costs of robotic techniques will certainly decrease dramatically in the near future. It is, however, understood that in the context of depressed global economies this parameter could be a serious barrier to the further development of this encouraging technique.

Whilst electing transaxillary robotic surgery, patients within our cohort placed more emphasis on the cosmetic benefits of the procedure than on the risks associated with a new technique and its consequent learning curve for the operating surgeons. This data illustrates the fact that, even in Europe, the presence of a scar in the neck is a great concern for a growing number of patients. The development of ‘no scar’ procedures is truly in agreement with the evolution of patient’s demand and the transaxillary robotic technique is currently the most promising solution to achieve this goal.

Conclusion

Several extracervical approaches to endoscopic thyroid surgery have been developed in the last few years; however, the introduction of the daVinci robotic system has definitively revolutionised and popularised the concept of remote thyroid surgery [2]. We found that the transaxillary approach for robotic thyroidectomy is both feasible and safe to be implemented in the practice of experienced European thyroid surgery teams. To popularise this robotic surgery in Europe a multi-institutional comparative study is necessary to properly evaluate the benefits and to better delineate the indication and contraindications. Expert collaborations, drawing on shared experiences and with a properly organised training system, is necessary to ensure safe adoption of the technique in Europe. In the interim, this innovative technique should be carried out by skilled surgeons within the context of clinical studies with appropriate ethical approval and informed consent. We anticipate the evolution of specific instrumentation and improved robotic technology that will certainly facilitate the further development of this procedure, thus improving its safety and expanding its indications in a near future.

Disclosure Statement

The authors have no conflicts of interest to disclose.

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