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Research Article

Robotic Thyroid Surgery - Initial Experience and Surgeon's Perspective from a Regional Centre in Singapore

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Abstract

Introduction: Over the past decade, the application of robotic surgery has brought about significant changes in various surgical fields. In particular, there has been a tremendous evolution in the surgical approaches for thyroidectomy over the past two decades. This study aims to describe our initial local experience in transaxillary robotic thyroidectomies in a regional center in Singapore. **Methods:** A retrospective review of consecutive patients who underwent robotic thyroid surgery between January 2016 to July 2019 at Changi General Hospital [CGH], Singapore was performed. All robotic thyroidectomies were performed using the da Vinci Surgical system (Intuitive Surgical, Sunnyvale, California). **Results:** The median age was 41 years old (range, 36 to 57) with all of the patients being female (100.0%). Majority of the patients were Chinese (75.0%) while there were 2 of other races (25.0%). All patients were of ECOG 0 status (100.0%). 4 patients underwent robotic-assisted left hemithyroidectomy (50.0%) while 1 patient (12.5%) underwent robotic-assisted right hemithyroidectomy followed by a robotic-assisted left completion hemithyroidectomy for malignancy. 3 patients underwent robotic-assisted right hemithyroidectomy (37.5%). Out of the 8 patients, 3 patients had papillary micro carcinoma (37.5%) while 1 patient had T1aN1 papillary carcinoma (12.5%) and the other 4 patients had benign diagnoses (50.0%). The median operative time was 180 minutes (range, 165 to 200 minutes). There median hospital stay was 3 days (range, 2 to 3 days). None of the 8 patients had post-operative hypocalcaemia or RLN palsy. There were no post-operative complications or mortality reported. The median follow-up duration was 8.3 months (range, 0.5 to 36.1 months). There were no patients with local or distant recurrence. **Conclusion:** Our initial experience shows that robotic thyroidectomies can be safely performed in a regional centre in Singapore. Initial learning curve is steep, and formal cost benefit analysis may be useful before embarking upon robotic thyroidectomies.

Introduction

Over the past decade, the application of robotic surgery has brought about significant changes in various surgical fields [1]. In particular, there has been a tremendous evolution in the surgical approaches for thyroidectomy over the past two decades [2]. The first endoscopic thyroidectomy was first performed in 1997 introducing the era of minimally invasive and remote-access approaches for thyroidectomy [3]. Notably, the Da Vinci robotic system was first utilized for trans axillary thyroidectomy by Chung in 2007 [4]. With the advent of minimally invasive techniques, endoscopic and robotic thyroidectomies have been more and more common in specialised centres [5]. These techniques offer a 3-dimensional magnified view of the surgical area, hand-tremor filtration and fine motion scaling. Furthermore, studies have reported better outcomes with shorter hospital stay, less post-operative pain and better cosmetic results [6,7]. Despite the proposed limitations of limited visibility and steep learning curve as well as reduced cost

benefit ratio, minimally invasive methods are becoming popular among patients. This study aims to describe our initial local experience in trans axillary robotic thyroidectomies. A description of our surgical approaches and technique as well as outcomes will be examined. This will be followed by a discussion highlighting the challenges faced setting up this service in conjunction with review of the literature.

Methods

A retrospective review of consecutive patients who underwent robotic thyroid surgery between January 2016 to July 2019 at Changi General Hospital [CGH], Singapore was performed. Preoperative diagnosis of patients with thyroid nodules was determined by ultrasound examination and all patients underwent fine-needle aspiration biopsy preoperatively. All robotic thyroidectomies were performed using the da Vinci Surgical system (Intuitive Surgical, Sunnyvale, California). The approach used was selected on the basis of the extent of disease and patients' preference. All patients underwent informed consent for robotic thyroid operation.

The indications for robotic thyroidectomy were benign thyroid nodules less than 5 cm in diameter or differentiated thyroid carcinoma of less than 4 cm with or without minimal extrathyroidal extension (ETE) and small lymph node metastases in the central compartment. Contraindications included large differentiated thyroid carcinoma with gross ETE, large multiple cervical lymph node metastases in the central or lateral compartment, distant metastasis, recurrent tumour and patients with a history of neck or thyroid surgery or irradiation.

Endoscopic-Robotic Thyroidectomy Approach

After general anaesthesia induction, patient was placed in the supine position with slight extension of the neck. This neck extension was achieved by using either a shoulder roll which offers additional supports to the upper back and scapula. The ipsilateral arm was then extended and rotated superiorly fully exposing the axilla. An incision was made at anterior axillary line to level of pectoralis major and port inserted (port 1) followed by carbon dioxide insufflation (Figure 1). A further 2 ports inserted at right axilla (port 2) and periareolar region (port 3) (Figure 2). Once the pectoralis major is exposed, dissection over the clavicle is performed until the Sternocleidomastoid (SCM) muscle is exposed. Once the SCM is exposed, dissection proceeds by opening the avascular plane between the clavicular and sternal heads of the SCM. The SCM was divided between muscle heads with omohyoid identified and mobilised. Subsequently, the dissection is then carefully performed directly underneath the strap muscles exposing the thyroid gland. Chung's retractor inserted and secured. An additional incision was made inferiorly for the fourth port (port 4).
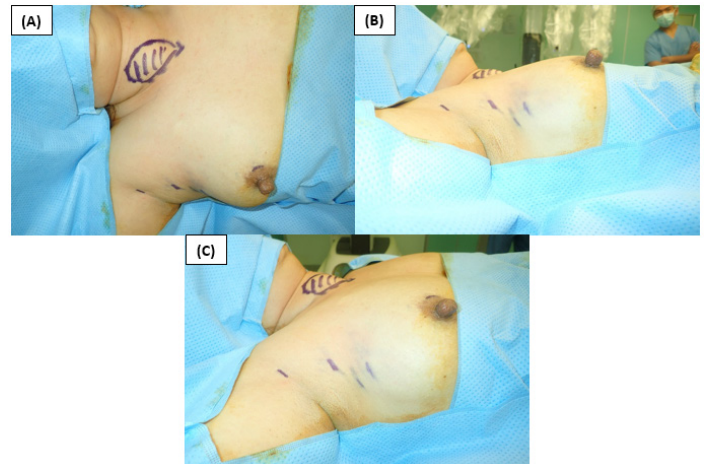
Figure 1: Pre-operative Marking of Right Thyroid Lesion and Incisions. **(A)** Top-down view **(B)** 30-degree view **(C)** Lateral view.
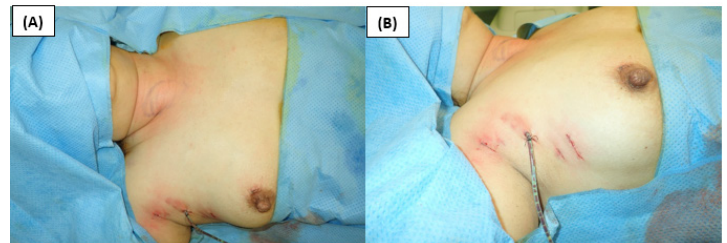
Figure 2: Post-operative Incisions and Drain. **(A)** Top-down view **(B)** Lateral view.

Docking Stage

Once adequate working space is achieved, the robot is advanced towards the patient from the contralateral side in preparation for the docking of the arms. For the right sided approach, the arm closest to the head of the patient carries the Maryland dissector (Ar m 2), followed by the second arm holding the 30 degree camera (Arm 3). On the arm next to the camera, the Prograsp forceps (Arm 1) is inserted. The arm closest to the patient's feet carries the Harmonic scalpel (Arm 4). The order is reversed when the procedure is approached via the left side.

Console Stage

Once the ideal docking of the robotic arms is achieved, the proceeds to the console stage. The superior pole is first dissected where superior and middle thyroid vessels were ligated and transected. The Recurrent Laryngeal Nerve (RLN), superior and inferior parathyroids were identified and preserved. Subsequently, the inferior thyroid vessels were ligated and transected. Dissection continues superiorly towards the ligament of Berry while carefully dissecting the thyroid gland off the trachea and

adjacent structures. The isthmus is then divided which completes the hemithyroidectomy. Once the specimen is removed via main incision, careful examination of the surgical field is performed to ensure adequate haemostasis. Finally, a drain is placed at the surgical bed with subcutaneous and skin closure with Vicryl and Monocryl respectively (Figures 2 and 3).
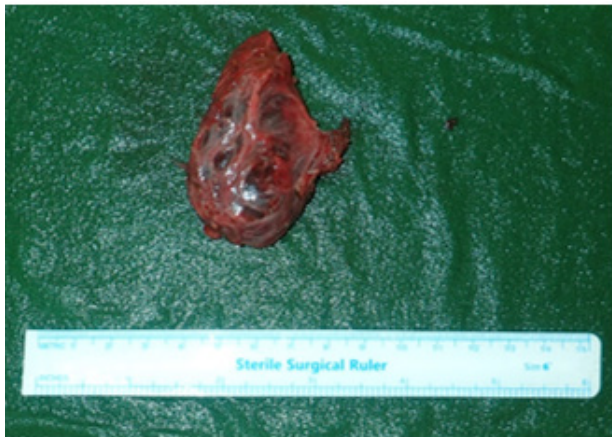
Figure 3: Right Hemithyroidectomy Specimen.

Transaxillary Robotic Thyroidectomy Approach

After general anaesthesia induction, patient was placed in the supine position with slight extension of the neck. This neck extension was achieved by using either a shoulder roll which offers additional supports to the upper back and scapula. The ipsilateral arm was then extended and rotated superiorlu fully exposing the axilla. A 6 cm line was drawn just posterior to the anterior axillary fold. This arm was padded and secured. Following proper positioning, the patient's arm, neck and chest is prepped and draped exposing the axilla, neck and upper chest. Then the incision along the premarked line and the subcutaneous flap was raised. Once the pectoralis major is exposed, dissection over the clavicle is performed until the Sternocleidomastoid (SCM) muscle is exposed. Once the SCM is exposed, dissection proceeds by opening the avascular plane between the clavicular and sternal heads of the SCM. The SCM was divided between muscle heads with omohyoid identified and mobilised. Subsequently, the dissection is then carefully performed directly underneath the strap muscles exposing the thyroid gland. Chung's retractor is inserted. An additional incision was made inferior to main incision for insertion of the fourth port.

Docking Stage

Once adequate working space is achieved, the robot is advanced towards the patient from the contralateral side in preparation for the docking of the arms. For the right sided approach, the arm closest to the head of the patient carries the Maryland dissector (Arm 2), followed by the second arm holding the 30 degree camera (Arm 3). On the arm next to the camera, the Prograsp forceps (Arm 1) is inserted. The arm closest to the patient's feet carries the Harmonic scalpel (Arm 4). The order is reversed when the procedure is approached via the left side.

Console Stage

Once the ideal docking of the robotic arms is achieved, the proceeds to the console stage. The superior pole is first dissected where superior and middle thyroid vessels were ligated and transected. The recurrent laryngeal nerve (RLN), superior and inferior parathyroids were identified and preserved. Subsequently, the inferior thyroid vessels were ligated and transected. Dissection continues superiorly towards the ligament of Berry while carefully dissecting the thyroid gland off the trachea and adjacent structures. The isthmus is then divided which completes the hemithyroidectomy. The camera is then changed to Arm 2 and the hemithyroid specimen placed into 5mm endopouch through Arm 3. Once the specimen is removed via main incision, careful examination of the surgical field is performed to ensure adequate haemostasis. Finally, a drain is placed at the surgical bed with subcutaneous and skin closure with Vicryl and Monocryl respectively.

Data Collection

Our study was a retrospective review. We collected patient and tumour characteristics, including operative time, post-operative stay, histopathological results, number of retrieved lymph nodes and postoperative pain for included patients, using electronic medical records as well as case notes. Total operative time was defined as time from first incision to completion of skin closure, and included docking and undocking of the robot. Continuous variables were expressed as the median with range included and categorical variables as the number with the percentage. All data were anonymised and stored in secure SPSS data base.

Results

Patient Characteristics

The characteristics of the 8 patients included in the study are shown in Table 1. The median age was 41 years old (range, 36 to 57) with all of the patients being female (100.0%). Majority of the patients were Chinese (75.0%) while there were 2 of other races (25.0%). All patients were of ECOG 0 status (100.0%). 4 patients underwent robotic-assisted left hemithyroidectomy (50.0%) while 1 patient (12.5%) underwent robotic-assisted right hemithyroidectomy followed by a robotic-assisted left completion hemithyroidectomy for malignancy. 3 patients underwent robotic-assisted right hemithyroidectomy (37.5%). Out of the 8 patients, 3 patients had papillary micro carcinoma (37.5%) while 1 patient had T1aN1 papillary carcinoma (12.5%) and the other 4 patients

had benign diagnoses (50.0%). The median operative time was 180 minutes (range, 165 to 200 minutes). There median hospital stay was 3 days (range, 2 to 3 days). None of the 8 patients had post-operative hypocalcaemia or RLN palsy. There were no post-operative complications or mortality reported. The median follow-up duration was 8.3 months (range, 0.5 to 36.1 months). There were no patients with local or distant recurrence.

	Number	Percentage (%)
Gender		
Female	8	100.0
Male	0	0
Race		
Chinese	6	75.0
Others	2	25.0
Age (at diagnosis) Median (range)		
	41 (36 to 57)	NA
ECOG Status		
0	8	100.0
1	0	0
3	0	0
4	0	0
Operation		
Robotic-assisted right hemithyroidectomy	2	25.0
Robotic-assisted left hemithyroidectomy	6	75.0
Operative Time (min)		
180 (165 to 200)		
Hospital Stay (days)		
3 (2 to 3)		
Histological Diagnosis		
Papillary microcarcinoma	3	37.5
Papillary carcinoma	1	12.5
Adenomatoid goitre	1	12.5
Adenomatoid nodule	1	12.5
Follicular adenoma	2	25.0
Tumour Size (mm)		
Papillary microcarcinoma	3.0 (1.0 to 8.0)	NA
Papillary carcinoma	6.3 (2.5 to 10)	NA

Number of Patients with Lymph Nodes Retrieved		
	1	12.5
Number of Lymph Nodes Retrieved/ Number of Lymph Nodes Positive		
	6/6	100
Post-Operative Complications		
Hypocalcaemia	0	0
Recurrent laryngeal nerve palsy	0	0
Local Recurrence		
Yes	0	0
No	8	100.0
Distant Recurrence		
Yes	0	0
No	8	100.0
Follow-up Duration (based on last follow-up visit in months)		
	8.3 (0.5 to 36.1)	NA

Table 1: Summary of Patient Characteristics.

Discussion

Endoscopic thyroidectomy is a well-established alternative to conventional open thyroidectomy but it does suffer several limitations. To mention a few, endoscopic thyroidectomies rely on a human assistant to hold the camera, which may lead to unstable view. Secondly with limited degrees of freedom of movement, dissection around the recurrent laryngeal nerve as well as berry's ligament may be difficult. Hence the robotic platforms have evolved to address the potential short comings of endoscopic thyroidectomies [8]. Davinci Xi system used by us, provides magnified 3D stable vision with tremor free movement with 360 degrees of freedom of movement. Out institution is a tertiary referral centre with an established Head and Neck surgical service, which receives referrals from other hospitals as well other services within the same unit. Service is provided by three consultants, out of which 2 consultants provide robotic thyroid operations. We started the robot assisted surgical service in 2016, and with increasing numbers throughout the years. To date we have performed 8 such cases.

Interestingly all our patients were females. Median age of presentation was 41 years. Given that the superior cosmetic results of robotic surgery it is indeed not surprising that young to middle aged female patients opt for robotic thyroidectomies, while their older counterparts opted for conventional thyroidectomies.

Majority of the nodules that were removed were papillary micro carcinomas with median size of 1.5mm. Left hemithroidectomy was performed more commonly than right, and no total thyroidectomies were performed. Exact reasons for this appears unclear, but it is possible that patients opted for conventional open operation in instances where total thyroidectomy was recommended as they may prefer having single neck scar compared to bilateral axially scars. It is also possible that larger nodules may be offered total thyroidectomy and by virtue of size as large nodules may pose challenges for robotic approach.

Mean operative time in our series was 180 minutes, and this is longer than conventional open thyroidectomy. Given the fact that there is a steep learning curve, it is expected that the initial robotic procedures may take longer time, but as surgeons gain experience with the technique, docking time will be less and procedures will take less time. Hospital stay ranged from 2 to 3 days. There was no post-operative hypocalcaemia or recurrent laryngeal nerve palsy reported, although we understand that these complications are rare and our numbers are small. Mean follow up duration was 8.3 months, and during this period patients were followed up in clinic with routine clinical examination supplemented by neck ultrasound. We did not come across any local recurrence, though this may be attributed to a short follow-up period. Majority of patient had pain scores of 0 prior to discharge with no reported dissatisfaction with scar appearance.

Although our numbers may be small, the results thus far have been encouraging. It has demonstrated feasibility of performing robot assisted thyroid surgeries in a regional centre in Singapore. Although Korean and North American experience is impressive, where there are studies involving 100 or more patients [9,10], being a small country, Singapore will not have such vast numbers but we have demonstrated that even with smaller numbers we are able to gain proficiency in the procedure. From the surgical perspective, improved three dimensional vision, steadiness of camera, improved range of movement and comfort of operating from a seated console was cited as clear benefits by the surgeons in our centre. One challenge of the robotic approach is that the approach to the thyroid is always lateral, as opposed to the usual midline approach in conventional open thyroidectomies. Generally, thyroid and endocrine surgeons are more familiar with anterior approach than lateral approach and the anatomy may be confusing to the inexperienced. At our centre we circumvented the problem by employing the lateral approach routinely for open thyroidectomies so that the surgeons are more familiar with the anatomy. We propose this to any other centre planning to start a robotic thyroidectomy programme, as surgeons in our centre greatly benefited from the exposure.

Unique complication with regards to robotic approach include subcutaneous emphysema in upper neck and thorax, brachial neuropraxia due to extreme positioning of the upper limbs, bruising of the ipsilateral shoulder and subcutaneous haematoma [11]. The absence of such complications in our series may be due to our smaller numbers which are not large enough to manifest such complications. Interestingly, given the large space available for the haematoma to dissipate, chance of having a post-operative neck haematoma causing airway obstruction may be theoretically much less compared to open conventional thyroidectomy. One other aspect we would like to bring the attention of the reader is that validation and standardisation of robotic thyroidectomy procedure is still at its infancy. Uniform credentialing standards do not exist at this point, and surgeons at our centre learned the basics during HMDP overseas as well as personal proctoring by surgeons at other local institutions. If robotic thyroidectomy is to expand locally a standardised credentialing and proctorship programme would be useful. Live surgery demonstrations, Cadaveric workshops, review of surgical videos as well as per operative surgical stimulations are useful resources for the surgeons to familiarise with the robotic system and controls as well as to get hands on experience.

When introducing a new procedure, patient safety remains a paramount concern [12]. Although many industry driven courses exist, it is the practicing surgeon's responsibility to ensure that complication rates are acceptable. We recommend that an honest upfront discussion with the patient with data of one's own statistics

and experience, and potential complications that may occur such as conversion to open. This is especially important considering the steep learning curve of the procedure where 40 to 45 cases have been described for trans axillary robotic thyroidectomy [13,14]. From a patients perspective the most important consideration of minimally invasive thyroidectomy is avoiding a cervical scar. This was clearly evident in our study. Although it may not be an important consideration to many older patients, a subset of patients seem to consider it as the main factor in choosing a thyroid operation - hence it is an important skill to develop, so that the surgeon is equipped to cater to this specific subset of patients. It would be interesting to see if there is any difference in quality of life with robotic vs endoscopic / conventional open approaches [15] for thyroidectomies among local population, though our numbers are too small to allow any meaningful analysis at present.

Finally careful cost benefit analysis should be conducted before embarking on robotic thyroidectomies [16,17]. Costs should include the initial costs of procuring the robotic system, costs for surgeon training, and increase in theatre time. It should also look at the potential complications and take into consideration the financial impact of these. Finally careful analysis as to how much of the above should be transferred to the patient. We believe our numbers are still too small to conduct a formal cost benefit analysis, hence larger prospective studies are needed in the future.

Conclusion

In conclusion, our initial experience shows that robotic thyroidectomies can be safely performed in a regional centre in Singapore. Initial learning curve is steep, and formal cost benefit analysis may be useful before embarking upon robotic thyroidectomies. Standardization of the procedure with universal credentialing may be useful and allow the procedure to be more widely accepted. Surgeons newly introducing the procedure should carefully audit their results to see whether the adverse effects are within the limits of acceptability as well as an aid in counselling patients.

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