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Original Article

Single-Port Transaxillary Robotic Thyroidectomy (START) for Benign Thyroid Tumors

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Conflict of Interest
No potential conflict of interest relevant to this article was reported.

ABSTRACT

Purpose: Single-port transaxillary robotic thyroidectomy using the da Vinci SP® system with a two-step retraction method is known to be a practical surgical method that maximizes the cosmetic and functional benefits for patients and reduces the workload fatigue of surgeons by increasing robotic dependency. This study aimed to evaluate its technical feasibility in the treatment of benign tumors.
Methods: We retrospectively analyzed the data of patients who were diagnosed with benign thyroid disease after undergoing single-port transaxillary robotic thyroidectomy with a two-step retraction method using the da Vinci SP® robotic system at Severance Hospital, Yonsei University College of Medicine, Seoul, Korea, between May 2019 and May 2022. Patients with Graves' disease were excluded from this study.
Results: Twenty-two patients were enrolled in this study, 21 females and one male, with a mean age of 32.7 years (range: 17–52 years). The mean body mass index was 22.5±3.1 kg/m^2 (range: 18.0–29.7 kg/m^2). The mean tumor size was 2.8±1.5 cm (range, 0.4–5.9 cm), and the mean operation time was 173.4±26.8 min (range, 128–226 min). There were no intraoperative complications. The mean estimated blood loss was 3.2±7.6 mL (range, 0–30 mL). No serious postoperative complications occurred, except one case of seroma.
Conclusion: Single-port transaxillary robotic thyroidectomy's utilization of a narrow working space is useful for benign thyroid tumors. It is feasible and safe for experienced robotic surgeons treating benign thyroid tumors.

Keywords: Single-port transaxillary robotic thyroidectomy; Da Vinci SP robotic system; Robot surgery; Thyroid nodule

INTRODUCTION

Technological advances have led to the development of highly sophisticated robotic surgeries (1,2). This is meaningful for thyroid disease because the highly visible neck scar is transferred to another hidden area of the bodies (3-7). However, the preoperative diagnosis of thyroid tumors remains vague, especially for benign tumors (8). Tumors classified as Bethesda category IV, or sometimes III, after fine needle aspiration (FNA) require diagnostic operations, which means that, preoperatively, we cannot guarantee whether the tumor is

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Author Contributions

Conceptualization: Jin Kyong Kim, In A Lee, Kee-Hyun Nam; Data curation: Jin Kyong Kim, In A Lee; Investigation: Jin Kyong Kim, Sang-Wook Kang, Jong Ju Jeong; Methodology: Jong Ju Jeong, Kee-Hyun Nam, Woong Youn Chung; Project administration: Cho Rok Lee, Kee-Hyun Nam, Woong Youn Chung; Resources: Jin Kyong Kim, In A Lee; Software: In A Lee, Jin Kyong Kim, Cho Rok Lee; Supervision: Jong Ju Jeong, Kee-Hyun Nam, Woong Youn Chung; Validation: Cho Rok Lee, Sang-Wook Kang; Visualization: Jin Kyong Kim, In A Lee, Cho Rok Lee; Writing - original draft: Jin Kyong Kim, Cho Rok Lee, Kee-Hyun Nam; Writing - review & editing: Jin Kyong Kim, Cho Rok Lee, Kee-Hyun Nam.

benign or malignant (9). Even for a large (>4 cm) nodule that is proven to be benign, the current American Thyroid Association guidelines suggest diagnostic surgery based on clinical concerns (9).

Usually, patients hesitate to undergo the diagnostic operation if their thyroid tumor cannot be definitely classified as benign or malignant because of the potential postoperative difficulties, even if the final diagnosis confirms a benign disease. Postoperative scarring is one of the biggest issues because benign tumors are prevalent in young women, and tumors that require diagnostic removal are often larger than usual and might require a larger than normal incision.

For these patients, robotic thyroidectomy can be one of the best choices to satisfy both diagnostic and cosmetic objectives. As one of the most active robotic thyroid centers in the world, our institution has continuously developed the transaxillary approach for robotic thyroidectomy (3,10-13). We recently reported our new technique using the da Vinci SP® system (Intuitive Surgical, Sunnyvale, CA, USA), single-port transaxillary robotic thyroidectomy (START), with a two-step retraction method (14). This method maximizes the utilization of the transaxillary robotic working space while minimizing invasiveness. In this study, we aimed to introduce our experience with START for benign thyroid tumors.

MATERIALS AND METHODS

1. Patients

We retrospectively analyzed the data of patients who were diagnosed with benign thyroid disease after undergoing START with a two-step retraction method using the da Vinci SP® robotic system at Severance Hospital, Yonsei University College of Medicine, Seoul, Korea, between May 2019 and May 2022. All the surgeries were performed by a single surgeon (Kee-Hyun Nam). Patient selection from an outpatient clinic included only those patients with a preference for START. Demographic characteristics including age, sex, body mass index (BMI), indications for surgical treatment, operative data, postoperative complications, and pathology results were collected from electronic medical records. Patients with Graves' disease were excluded from this study. This study was conducted in accordance with the 1964 Declaration of Helsinki (as revised in 2013) and was approved by the local institutional review board of our institution. The requirement for informed consent was waived because of the retrospective nature of this study (approval no. 4-2022-0550).

2. Operative procedures

The standard two-step retraction method was used in all patients (14). Under general anesthesia, the patient was placed in a supine position with a backrest to extend the neck. The arm on the lesion side was draped without fixation for adjustment during the entire operation. Along the natural skin crease on the axilla of the lesion side, a 3.5 to 4.0 cm incision was made according to the tumor size. After the skin flap was dissected from the axilla to the sternocleidomastoid muscle (SCM) along the anterior surface of the pectoralis major muscle, a narrow version of Chung's retractor was inserted between the dividing heads of the SCM and the sternal head of the SCM was retracted upward with the retractor. Subsequently, the da Vinci SP® system was docked and the strap muscles were elevated from the thyroid gland until the contralateral thyroid gland was exposed through the avascular space beneath the strap muscles. The field surgeon then reinserted Chung's retractor

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under the strap muscles and retracted them. After the two steps of retraction, robotic thyroidectomy, as in conventional transaxillary robotic surgery, was performed (12).

The settings of the da Vinci SP® system we used were as follows: the camera was inserted into the bottom of the port lumen, and Cardiere forceps for traction were placed on the top. Two Maryland forceps were inserted into the bilateral lumens, while both Marylands were connected to a bipolar energy source, Erbe (Erbe USA Inc., Marietta, GA, USA). After the operation, a drain with negative pressure was inserted into the surgical field to prevent accumulation of hematoma or seroma in all patients. The drain was removed on the day of discharge; the clinical pathway of our institution included discharge of patients on the third postoperative day (POD). A more detailed START procedure was established as previously described (14).

3. Statistical analyses

Details on clinicopathological characteristics, surgical data, and complications were obtained from our institutional database. Continuous quantitative data were expressed as mean ± standard deviation (SD). Categorical qualitative data were expressed as percentages. All data were analyzed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA).

RESULTS

We analyzed the data of 22 patients who underwent START with a two-step retraction method between May 2019 and May 2022 and were diagnosed with benign thyroid diseases. All operations were completed successfully without open conversion, and all tumors in the specimen remained intact when retrieved through the skin incision. **Table 1** lists the clinical characteristics of the 22 patients. Among the 22 patients, 21 were female and one was male, with a mean age of 32.7 years (range: 17–52 years). The mean BMI was 22.5±3.1 kg/m^2 (range: 18.0–29.7 kg/m^2).

Table 2 shows the preoperative indications for the decision to perform surgery. Five patients presented with a preoperative FNA biopsy result as Bethesda category II. Their mean tumor size was 4.9±0.7 cm (range: 4.1–5.9 cm). The number of patients with Bethesda category III

Table 1. Clinical characteristics of patients with benign thyroid tumors

Variables	Values
Sex, male: female	1:21
Age (yr)	32.7±8.7 (17–52)
BMI (kg/m^2)	22.5±3.1 (18.0–29.7)

Data are expressed as number of patient numbers (%) or mean ± SD (range).
BMI = body mass index.

Table 2. Indication for the decision on surgery

FNA biopsy result (Bethesda category)	Tumor size on US (cm)	Values
II	4.9 ± 0.7 (4.1–5.9)	5 (22.7)
III (FLUS)	2.7 ± 0.8 (1.9–4.0)	5 (22.7)
IV	2.7 ± 1.6 (1.0–5.1)	11 (50.0)
V	0.4	1 (4.5)

Data are expressed as number of patient numbers (%) and mean ± SD (range).
FNA= fine needle aspiration; US= ultrasonography; FLUS= follicular lesion of undetermined significance.

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Table 3. Operative data and postoperative outcomes of patients

Operation	Values
Approach side of axilla (right vs. left)	14:8
Operative extent	
Hemithyroidectomy	20 (90.9)
Bilateral total thyroidectomy	1 (4.5)
Completion of total thyroidectomy	1 (4.5)
Tumor size (cm)	2.8±1.5 (0.4–5.9)
Final pathology	
Adenomatous hyperplasia	8 (36.4)
Follicular adenoma	5 (22.7)
Hurthle cell adenoma	3 (13.6)
NIFTP	6 (27.3)
Operation time (min)	110.3±17.8 (73–141)
Working space	26.6±9.5 (10–50)
Docking	3.2±1.1 (2–5)
Console	59.8±14.6 (40–99)
Estimated blood loss (mL)	3.2±7.6 (minimal–30)
Intraoperative complications	0 (0)
Postoperative complications	1 (4.5)
Seroma	1 (4.5)
Length of postoperative hospital stays (days)	3.0±0.3 (2–4)

Data are expressed as number of patients (%) or mean ± SD (range).
NIFTP = noninvasive follicular thyroid neoplasm with papillary nuclear features.

(follicular lesion of undetermined significance [FLUS]) and IV were 5 and 11, respectively, with the mean tumor size of 2.7±0.8 cm (range: 1.9–4.0 cm) and 2.7±1.6 cm (range: 1.0–5.1 cm), respectively. There was only one patient whose FNA result was category V and was diagnosed with a 0.4 cm noninvasive follicular thyroid neoplasm with papillary nuclear features (NIFTP).

Table 3 summarizes the operative data and postoperative outcomes of patients. Fourteen patients underwent START through the right axilla and eight through the left axilla. Twenty patients underwent hemithyroidectomy and one patient underwent bilateral total thyroidectomy due to a multinodular goiter. One patient, who underwent left hemithyroidectomy in 2017 and was previously diagnosed with 4.2 cm minimally invasive follicular carcinoma, underwent completion of total thyroidectomy due to an increasing FLUS lesion. The total mean tumor size was 2.8±1.5 cm (range: 0.4–5.9 cm); eight patients had adenomatous hyperplasia, five had follicular adenoma, three had Hurthle cell adenoma, and six had NIFTP. The mean total operative time was 110.3±17.8 min (range: 73–141 min). The working space, docking, and console time were 26.6±9.5 min (range: 10–50 min), 3.2±1.1 min (range: 2–5 min), and 59.8±14.6 min (range: 40–99 min), respectively. The mean estimated blood loss during the operation was 3.2±7.6 mL (range: 0–30 mL) and there were no intraoperative complications. Only one patient had a postoperative seroma, which was resolved after aspirating 33 cc of seroma on her first postoperative visit to the outpatient clinic. Except for two patients who wanted to shorten or prolong the postoperative hospital stay for 2 or 4 days after the operation, patients were discharged on the third POD.

The preoperative neck computed tomography images of the patient with the largest tumor size (5.9 cm, preoperative FNA category II) in this study are provided in **Fig. 1**. Her BMI was also the highest among all patients (29.7), and the final diagnosis of the tumor was follicular adenoma. **Fig. 2** shows the incision site of the patient 6 months after the operation, which became almost indistinguishable from the previous natural skin crease before the operation, after complete healing.

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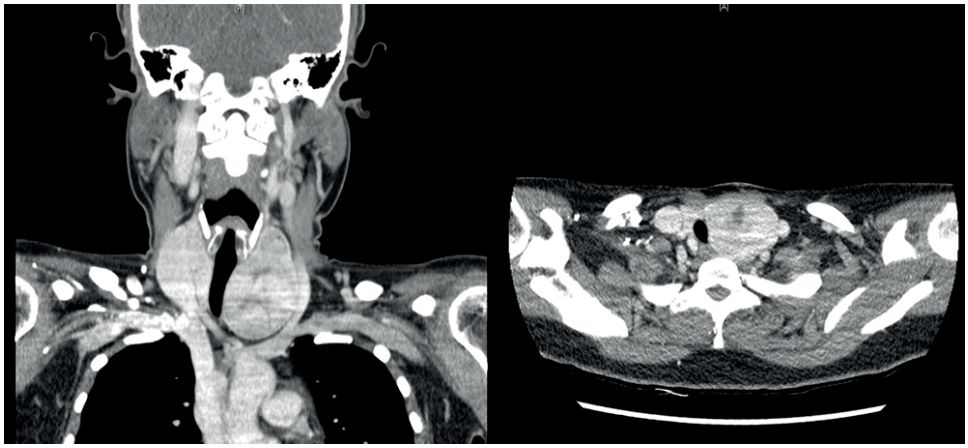

Fig. 1. Preoperative neck computed tomography images of the patient with the largest tumor size (5.9 cm, preoperative fine needle aspiration category II) in this study.

Fig. 2. Site of incision after complete healing.

DISCUSSION

In our previous study (14), we demonstrated that START with a two-step retraction method is a practical surgical method that maximizes the cosmetic and functional benefits for patients and reduces the workload fatigue of surgeons by increasing robotic dependency. This was possible owing to the introduction of the da Vinci SP® system, which facilitated a deep and narrow approach through a single 2.5 cm cannula attached to multi-jointed arms, including a 3-D high-resolution camera.

In this study, we aimed to determine the safety and feasibility of the same method for benign thyroid tumors. When a benign thyroid tumor requires surgical intervention, it tends to be larger than usual, because the indication for surgery itself includes “increasing” or “large (>4

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cm)" tumors (9). For thyroid surgeons who are beginning their robotic training, large benign tumors are often more challenging than training on smaller cancers. However, we hope to apply the benefits of START with a two-step method for patients with benign tumors.

Our results show excellent operative and postoperative outcomes. Although the mean tumor size was 2.8 cm and tumors over 4 cm existed, the operation time was not prolonged compared with the operation time for lobectomy with the two-step retraction method in our previous study (116.7 vs. 110.3 min) (14). Moreover, the mean estimated blood loss was only 3.2 mL and there were no intraoperative complications, including recurrent laryngeal or major vessel injuries. Only one patient had a postoperative seroma that was completely resolved after the first aspiration. Except for two patients who wanted to prolong or shorten the postoperative hospital stay by 1 day each, all the patients were discharged on the third POD following the clinical pathway of our institution. The length of the incision was not greater than 4 cm, even with larger tumors, and became almost indistinguishable from the previous natural skin crease after complete healing.

With our current study and the previous study on Graves' disease (15), we can demonstrate that START using the da Vinci SP® system with a two-step retraction method is a practical method even for goiters with a small incisional length (3.5–4 cm). The length of the axillary incision is even smaller than the usual length created for the same procedure with conventional thyroidectomy. This is possible because the narrow and deep access of the da Vinci SP® system can maximize the utilization of the operative field by creating the exact amount of operative field required around the central neck area according to the necessity of each case. Therefore, the incision only aided the inlet of the robot apparatus and the outlet of the specimen and did not influence the visualization of the operative field.

The present study has some limitations. The most important limitation of this study is its retrospective design. In addition, the START technique is suitable for only experienced robotic surgeons. We believe that further experience will enable multicenter and prospective studies regarding the safety and feasibility of START for benign tumors.

CONCLUSION

START's utilization of a narrow working space is useful for surgically treating benign thyroid tumors, and is especially feasible and safe for experienced robotic surgeons.

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