



# The application of subcapsular saline injection during bilateral axillo-breast approach robotic thyroidectomy: a preliminary report

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## Abstract

**Purpose** Saving the parathyroid gland during robotic thyroidectomy is challenging. This study evaluated the application of a novel method, subcapsular saline injection (SCASI), to save the parathyroid gland during bilateral axillo-breast approach (BABA) robotic total thyroidectomy.

**Methods** Of the 81 included patients operated on from 2014 to 2016, 31 and 50 underwent BABA robotic total thyroidectomy with and without SCASI, respectively. Serum concentrations of parathyroid hormone (PTH), calcium, and ionized calcium were measured at 1 day and 9 months postoperatively. Transient hypoparathyroidism was defined as PTH < 10.0 pg/mL after 1 day and permanent hypoparathyroidism as PTH < 15.0 pg/mL at 9 months.

**Results** There were no significant clinicopathologic differences between the two groups. The rate of transient hypoparathyroidism was significantly lower in the SCASI group than in the non-SCASI group [16.1% (5/31) vs. 44% (22/50),  $p < 0.01$ ]. However, the rates of permanent hypoparathyroidism [0% (0/31) vs. 4% (2/50),  $p = 0.699$ ] did not differ significantly.

**Conclusions** SCASI is a feasible and safe method of saving the parathyroid gland during BABA robotic total thyroidectomy.

**Keywords** Bilateral axillo-breast approach · Robotic thyroidectomy · Parathyroid · SCASI · Subcapsular saline injection

## Introduction

The risk of hypoparathyroidism after total thyroidectomy is an important issue. The rates of temporary and permanent hypoparathyroidism after open total thyroidectomy are reported to be 1.6–50% and 0–10%, respectively [1, 2]. The rates of temporary and permanent hypoparathyroidism after

robotic total thyroidectomy, however, are slightly higher, at 30.1–39.1% and 1.5–1.9%, respectively [3, 4]. Parathyroid glands may be identified during robotic total thyroidectomy by staining with indocyanine green (ICG) [5]. To our knowledge, however, no studies have evaluated surgical methods of preserving the parathyroid glands in patients undergoing robotic total thyroidectomy. Barriers to robot thyroid surgery are related to the preservation of the parathyroid glands. The tip thickness of the robot equipment is usually more than 2 mm, which is thicker than the tools used in open surgery. The blunt point of robotic instruments makes it difficult to perform detailed operations. In addition, the surgical skill and experience of the operator in robot surgery are also related. Therefore, innovative methods are needed in order to preserve the parathyroid glands and reduce hypoparathyroidism in patients undergoing robotic thyroid surgery.

Subcapsular saline injection (SCASI) is an effective way of preserving parathyroid glands, especially the upper parathyroid gland, during conventional total thyroidectomy [6]. Following the lateral dissection of the thyroid gland, a saline solution space is created by injecting 1–2 cc of saline into the capsule with a 26-gauge needle.

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Although this method reduces mechanical and thermal injury to the parathyroid gland in patients undergoing conventional total thyroidectomy, no study to our knowledge has assessed its effects in patients undergoing robotic thyroid surgery.

In the present study, we evaluated the applicability of the SCASI method to robotic thyroid surgery and the resulting incidence of hypoparathyroidism.

## Methods

### Patients

Patients who underwent bilateral axillo-breast approach (BABA) robotic total thyroidectomy for thyroid nodules or thyroid cancer from January 2014 to March 2016 were retrospectively evaluated. Patients who underwent re-implantation of parathyroid glands into the neck or arm were excluded. Patients were divided into two groups: those who underwent conventional robotic total thyroidectomy from 2014 to 2015 without the SCASI method and those who underwent robotic total thyroidectomy with the SCASI method from 2015 to 2016. Clinical data collected included patient sex, age, tumor size, pathology, central neck dissection, lateral neck dissection, Hashimoto thyroiditis, presence of parathyroid in the specimen, and duration of follow-up (months). Blood samples were collected 1 day and 9 months after surgery, and concentrations of parathyroid hormone (PTH), calcium (Ca), and ionized calcium (iCa) were measured. Transient and permanent hypoparathyroidism were defined as a PTH concentration lower than 10 ng/ml on the first postoperative day and lower than 15 ng/ml at 9 months postoperatively, respectively [7, 8].

The study protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital (B-1609/361–108).

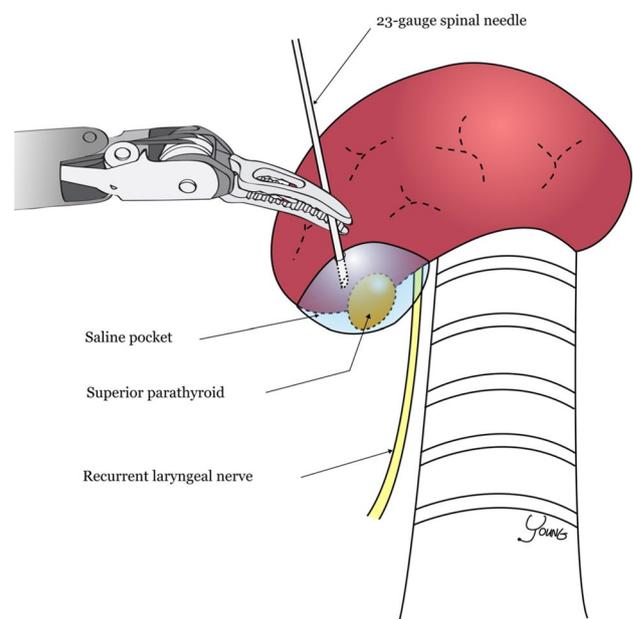
### BABA procedure

The patient was placed in the supine position with the thyroid surgery pillow on the patient's back. A 1:200,000 solution of epinephrine in normal saline was injected into the subcutaneous fat layer on the patient's chest, and an incision was made on both sides of the circumareolar breast and axilla. Using a vascular tunneler, the operation space was secured at the depth of the subcutaneous fat layer, and medical carbon dioxide, at a pressure of about 6–8 mmHg, was injected to secure a surgical working space. The surgeon inserted a trocar into the four incisions and docked the robot [9–11].

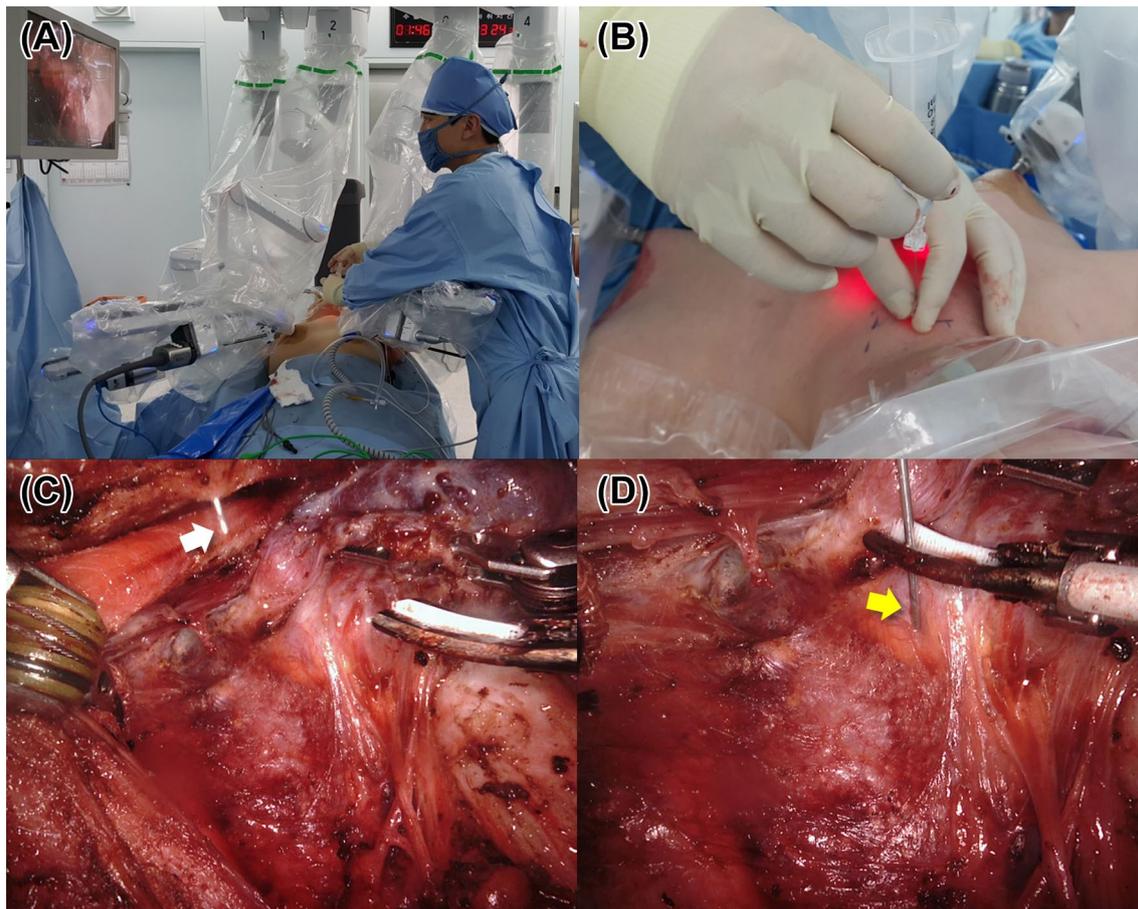
### SCASI procedure

The SCASI method requires the performance of isthmectomy and dissection of the lateral side of the thyroid. Following isthmectomy, the upper pole of the thyroid can be exposed by medial traction of the thyroid gland and its lateral dissection. The SCASI method is optimally performed when the upper pole of the thyroid gland, including the upper parathyroid gland, is exposed (Fig. 1). The SCASI method applied to the upper parathyroid glands is possible on both sides.

The surgical assistant prepared a 23-gauge spinal needle with a capacity of 5–10 cc. The surgeon then recognized the approximate position of the upper parathyroid gland by pressing the skin on the outside while watching the monitor (Fig. 2a). The assistant inserted the spinal needle about 1–2 cm below the parallel line of the cricothyroid muscle (Fig. 2b). The operator grasped the needle with the robot arm and guided it, while the surgical assistant gently pushed the spinal needle slightly toward the head of the patient, as guided along the robot arm (Fig. 2c, d). The needle was inserted to the depth of the subcapsular layer, while avoiding small blood vessels identified in the field of vision, thereby preventing unnecessary bleeding. As directed by the surgeon, the assistant injected 2–4 cc of normal saline into the subcapsular layer (Fig. 3a, b). Injections could be performed once or twice as needed. The spinal needle was removed. Once the parathyroid gland became visible, it was dissected from the thyroid gland using an energy device at a safe



**Fig. 1** Conceptual illustration of subcapsular saline injection during robotic total thyroidectomy



**Fig. 2** The role and position of the assistant. **a** The assistant is looking for the puncture site by external palpation of the patient's neck. **b** Puncture site. **c, d** Insertion of the needle from outside (white triangle) and drawing of the needle by the robotic instrument (yellow arrow)

surgical layer (Fig. 3c, d). All SCASI procedures required precise communications between the surgeon and surgical assistant.

### Analyses

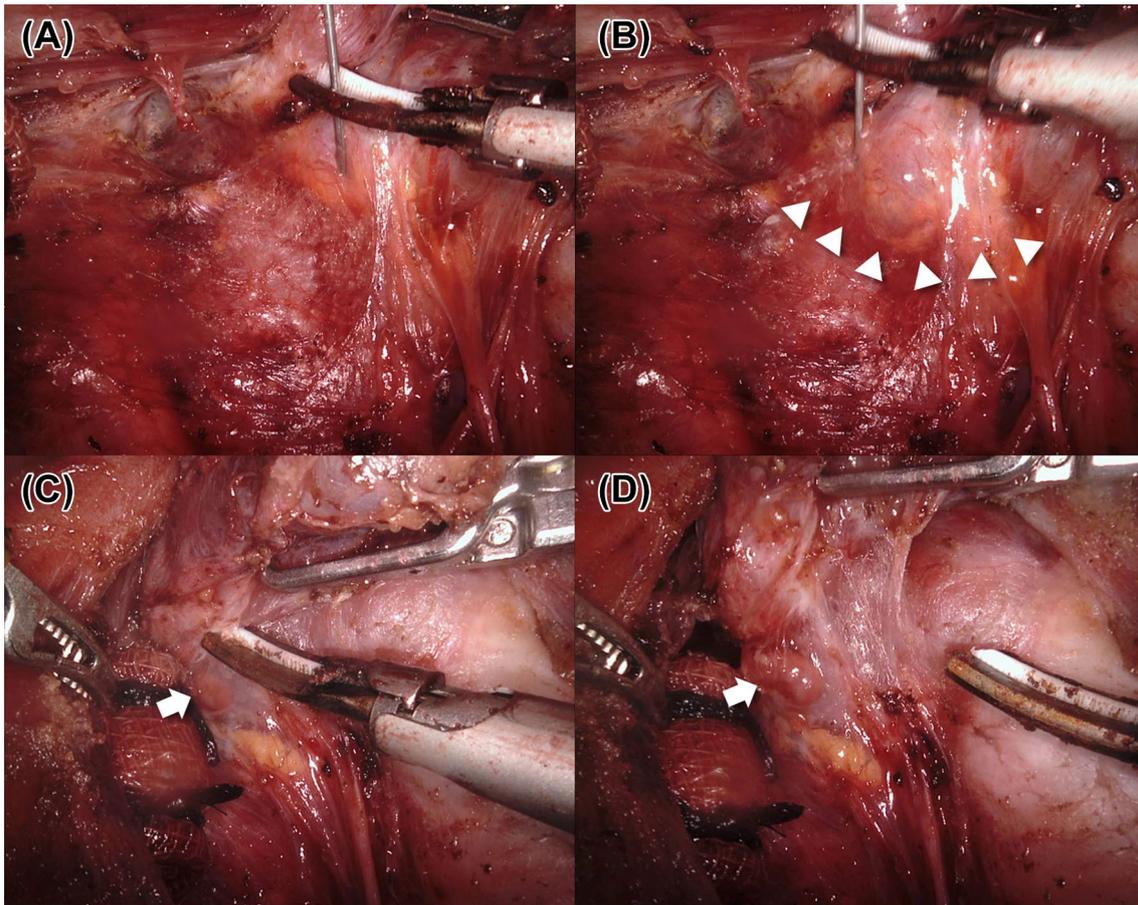
Continuous data were analyzed using Student's *t* test, and categorical data were analyzed using Chi-square tests. A *p* value < 0.05 was considered statistically significant. All statistical analyses were performed using the SPSS software program, version 20 (IBM Corp., Armonk, NY, USA).

### Results

Of the 81 patients who underwent BABA robotic total thyroidectomy, 31 patients were operated by SCASI method and 50 patients were operated by non-SCASI method. The clinical and pathological characteristics of these two groups are shown in Table 1. There were no differences in age, sex, tumor size, pathology, central neck dissection,

lateral neck dissection, Hashimoto thyroiditis, and number of parathyroid glands in the specimen. However, mean follow-up was significantly shorter in the SCASI than in the non-SCASI group (5.3 vs. 11.4 months, *p* = 0.029).

The concentrations of PTH, Ca, and iCa, and the incidence of temporary hypoparathyroidism, in the two patient groups are shown in Table 2. 1 day and 9 months after surgery, PTH, Ca, and iCa concentrations were higher in the SCASI group than in the non-SCASI group, but the differences were not statistically significant. The rate of temporary hypoparathyroidism, determined 1 day after surgery, was significantly lower in the SCASI group than in the non-SCASI group (16.1% vs. 44%, *p* = 0.019). Although the rate of permanent hypoparathyroidism, determined after 9 months, was lower in the SCASI group than in the non-SCASI group (0% vs. 4%, *p* = 0.699), the difference was not statistically significant. The only symptoms of hypoparathyroidism observed were tingling senses around the lips or fingertips, with no severe symptoms such as tetany noted.



**Fig. 3** Results of subcapsular saline injection. Views **a** before and **b** after saline injection, showing saline insufflation of the subcapsular area (white triangles). **c, d** Views showing the superior parathyroid

gland floating inside the saline pocket and its preservation after fine dissection (white arrow)

**Table 1** Characteristics of patients who did and did not undergo SCASI during robotic total thyroidectomy

	SCASI ( <i>n</i> = 31)	Non-SCASI ( <i>n</i> = 50)	<i>p</i>
Sex (M:F)	4:27	7:43	0.889
Age (years)	35.3 ± 10.25 (19–56)	34.2 ± 10.0 (19–58)	0.135
Tumor size (cm)	1.03 ± 1.02 (0.4–3.0)	0.97 ± 0.94 (0.7–2.3)	0.788
Pathology			
PTC	29 (93.5%)	48 (96.0%)	0.639
Graves' disease	2 (6.5%)	2 (4.0%)	0.584
Central neck dissection	29 (93.5%)	48 (96.0%)	0.837
Ipsilateral	12 (38.7%)	23 (46.0%)	
Bilateral	17 (54.8%)	25 (50.0%)	
Lateral neck dissection	2 (6.5%)	3 (6.0%)	0.935
Number of patients with Hashimoto thyroiditis	14 (45.1%)	21 (42.0%)	0.45
Parathyroid in the specimen			NS
1	7 (22.6%)	10 (20%)	
2	3 (9.7%)	6 (12%)	
3	0 (0.0%)	0 (0.0%)	
Follow-up (months)	5.3 ± 0.4	11.4 ± 3.2	0.029

SCASI subcapsular saline injection, PTC papillary thyroid carcinoma

**Table 2** Postoperative outcomes of patients who did and did not undergo SCASI during robotic total thyroidectomy

	SCASI (n=31)	Non-SCASI (n=50)	p
1 day postoperative lab results			
PTH (pg/mL, 15–65)	17.9 ± 10.8 (4.4–43.5)	13.0 ± 8.96 (3.5–48.2)	0.518
Calcium (mg/dL, 8.8–10.5)	8.26 ± 0.46 (7.2–9.5)	8.11 ± 0.49 (7.3–9.3)	0.385
iCa (mmol/L, 1.035–1.250)	1.103 ± 0.084 (0.929–1.330)	1.078 ± 0.073 (0.922–1.236)	0.574
Transient hypoparathyroidism (PTH < 10 pg/mL 1 day postoperatively)	5 (16.1%)	22 (44%)	0.019
9 months postoperative lab results			
PTH (pg/mL, 15–65)	29.9 ± 14.0 (16.7–70.6)	26.8 ± 12.8 (10.0–64.0)	0.170
Calcium (mg/dL, 8.8–10.5)	8.71 ± 0.49 (7.4–9.5)	8.65 ± 0.49 (7.0–9.6)	0.312
iCa (mmol/L, 1.035–1.250)	1.156 ± 0.074 (0.927–1.258)	1.148 ± 0.099 (0.883–1.294)	0.618
Permanent hypoparathyroidism (PTH < 15 pg/mL 9 months postoperatively)	0 (0.0%)	2 (4.0%)	0.699

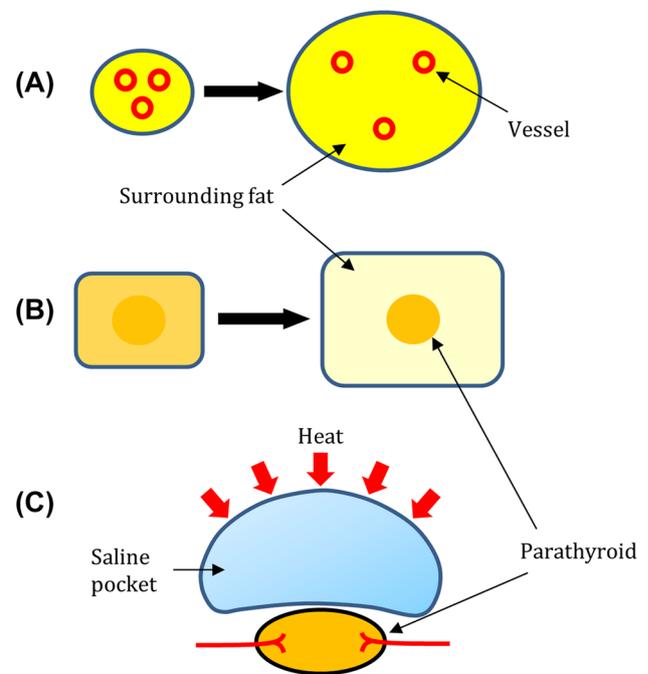
SCASI subcapsular saline injection, PTH parathyroid hormone, iCa ionized calcium

## Discussion

Symptoms of hypoparathyroidism after thyroid surgery are important issues for the patient. Although symptoms due to hypoparathyroidism are usually mild, they can extend to severe opisthotonos [12]. Ca supplements can relieve various symptoms of hypoparathyroidism after thyroid and parathyroid surgery. However, lifelong treatment with Ca supplements is burdensome and may cause side effects, such as constipation and urinary stones [13].

Even though Ca supplementation can alleviate the symptoms of hypoparathyroidism, it is better to prevent hypoparathyroidism and thereby stop these symptoms occurring. Surgeons have long been interested in preserving the parathyroid glands. Whenever possible, surgery should seek to preserve the parathyroid glands. Methods range from traditional techniques for preserving anatomical parathyroid vessels to new procedures that use ICG [5, 14]. Despite efforts to preserve the parathyroid glands, they are unintentionally removed in some cases. Parathyroid glands unintentionally removed during surgery or of poor color can be re-implanted into the sternocleidomastoid (SCM) or forearm muscle, with a success rate of 87% [15].

We recently reported the SCASI technique, a surgical method of preserving the parathyroid glands via the subcapsular injection of saline [6]. In that previous study, we found that the SCASI method was useful for preserving the parathyroid glands during open thyroidectomy. The SCASI method has three advantages over other techniques for preserving the parathyroid glands (Fig. 4). The first is the space expander effect. Injecting normal saline can expand the space between the major structures, including the parathyroid vessels, protecting these structures from the dissector. The second advantage is the extraction effect. Although colored yellow, the parathyroid gland



**Fig. 4** A schematic showing the effects of subcapsular saline injection. **a** Space expansion effect. **b** Extraction effect. **c** Saline pocket effect (like a car airbag)

is difficult to distinguish from the similarly colored surrounding fat layer. Injection of normal saline, however, lightens the color of the surrounding fat layer, making the yellow color of the parathyroid gland more distinct. The third effect is the saline pocket effect. The formation of a saline pocket around the parathyroid glands can protect them against dissector heat and mechanical stimulation. In addition, SCASI is not only applicable to open thyroid surgery, but also to robotic thyroid surgery. This

study therefore sought to demonstrate the effectiveness of SCASI in robotic thyroid surgery.

According to a survey of literature published to date, the rates of transient hypoparathyroidism are reported to range from 30.1 to 39.1% and the rates of permanent hypoparathyroidism from 1.5 to 1.9% in patients undergoing robotic thyroid surgery [3, 4]. These rates are similar to or slightly higher than those of open thyroidectomy, suggesting that preservation of the parathyroid glands is more difficult during robotic than during open surgery. Several reasons have been suggested, including differences in operative performance related to the surgeon's learning curve for BABA robotic total thyroidectomy [16]. Another reason may be associated with the operator's surgical skill, with the incidence of hypoparathyroidism being reported to be 18.7% for high-volume surgeons (> 90 operations per year), which is significantly lower than the rate of 32.1–49.1% for low- and intermediate-volume surgeons (< 90 operations per year) ( $p < 0.001$ ) [17]. Finally, the blunt dissector of the robotic arm may have a negative effect on the preservation of the parathyroid glands. The robotic arms are small and intricate, but not yet fine enough to prevent the fine blood flow from the parathyroid glands. For example, the smallest dissector of a robotic device is about 2 mm thick, which is thicker than the instrument used for open thyroidectomy and thicker than the blood vessels feeding the parathyroid glands, making exquisite dissection difficult. The higher incidence of hypoparathyroidism following robotic than open thyroidectomy may be associated with psychological resistance by the surgeon to the initial performance of robotic thyroidectomy.

Our study identified differences in the incidence of hypoparathyroidism between the SCASI and non-SCASI groups. The rate of transient hypoparathyroidism was significantly lower in the SCASI group than in the non-SCASI group [16.1% (5/31) vs. 44% (22/50),  $p < 0.01$ ]. Furthermore, permanent hypoparathyroidism was not observed in any patients in the SCASI group [0% (0/31)], but was detected in 4% (2/50) of patients in the non-SCASI group. However, this difference was not statistically significant ( $p = 0.699$ ). This is probably due to the insufficient number of patients. This study showed that these effects of the SCASI method were also applicable to robotic thyroidectomy, reducing the rates of temporary and permanent hypoparathyroidism.

In the present study, SCASI was only applied to the upper parathyroid glands due to the anatomical locations of the lower parathyroid glands. The positions of the upper parathyroid glands remain relatively constant, while the locations of the lower parathyroid glands between the thymus and the thyroid gland are uncertain [18]. In addition, other studies have shown that the lower parathyroid glands can be preserved, but this is relatively difficult [19]. Robotic surgery in South Korea involves prophylactic cervical lymph node dissection, making it more difficult to preserve the lower

parathyroid glands than the upper ones [20]. We believe that preserving the two upper parathyroid glands using the SCASI method significantly affects the prognosis of the patient.

One limitation of this study is that the patients were not randomly assigned to groups. However, a single endocrine surgeon performed all of the operations and had conducted robotic surgery in 500 cases prior to this study. The lack of randomization may have had a minor impact on the study, and further randomization studies are needed. A second limitation of our research is the lack of temporal concurrency. The SCASI method was established in February 2015. Therefore, before February 2015, surgery was performed using the non-SCASI method, and since February 2015, the SCASI method has been applied. In the future, this will be studied through prospective studies. A third limitation is that the mechanism via which the parathyroid function is preserved remains unclear. The aforementioned three effects of SCASI may protect the vasculature around the parathyroid glands from direct thermal and mechanical injury and preserve the parathyroid function. However, the preservation of the blood flow around the parathyroid glands should be confirmed by further studies.

Despite the use of various surgical procedures and intra-operative identification methods, the parathyroid glands are not noticeably reduced or eliminated, making their preservation difficult [21, 22]. Effort must be made to understand vascular structures and save the parathyroid glands during every operation. We believe that the SCASI method can be an alternative procedure to help preserve the parathyroid function.

In conclusion, this study confirmed that the SCASI method is as applicable to robotic total thyroidectomy as to open thyroidectomy. The SCASI method is equally effective in protecting parathyroid glands from mechanical stimulation and thermal injury in robotic thyroidectomy.

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## Compliance with ethical standards

**Conflict of interest** Hyeong Won Yu, In Eui Bae, Jin Wook Yi, Joon-Hyop Lee, Su-jin Kim, Young Jun Chai, June Young Choi, and Kyu Eun Lee have neither actual nor potential conflicts of interest to declare.

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