Evaluation of Surgical Completeness in Endoscopic Thyroidectomy Compared With Open Thyroidectomy With Regard to Remnant Ablation

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Purpose: To assure the surgical completeness of the bilateral axillo-breast approach (BABA) endoscopic thyroidectomy (ET), we compared ET and open thyroidectomy (OT) by means of the radioactive iodine (RAI) uptake of remnant thyroid.

Materials and Methods: From January 2003 to May 2007, 46 patients who had received RAI ablation after total thyroidectomy because of papillary thyroid microcarcinoma were enrolled. Of total, 25 patients underwent ET and the other 21 underwent OT. The RAI activity of remnant thyroid was measured by the neck-to-skull uptake ratio on the first postoperative RAI ablation scan. Stimulated thyroglobulin levels, the total number of RAI ablation sessions, and doses of RAI for completion of ablation were also compared.

Results: There were no significant differences in regards of the RAI uptake ratio, the stimulated thyroglobulin level, the total number of RAI ablation sessions, and doses of RAI for completion of ablation, between ET and OT groups.

Conclusion: The completeness of the surgical removal by BABA ET was comparable with that of OT. The BABA ET might give a safe option for patients with low-risk thyroid cancer.

Key Words: radioactive iodine (RAI) uptake, remnant thyroid, surgical completeness, endoscopic thyroidectomy, bilateral axillo-breast approach (BABA)

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In 1997, Hüscher et al[1] first reported an endoscopic technique to treat thyroid disorder. Since then, many surgeons have performed thyroidectomies using various endoscopic techniques, including cervical, chest wall, axillary, and breast approaches.[2–8] Endoscopic thyroidectomy (ET) has an advantage over conventional open thyroidectomy (OT) in that the former leaves no or minimal scar on the anterior neck area. Most of the patients requiring thyroidectomy are women, who are generally concerned about the neck scar after thyroid surgery. Moreover, in some cultural societies, including Asian countries, a scar on the anterior neck is of much significant concern.

Bilateral axillo-breast approach (BABA) ET was developed in Seoul National University Hospital in 2004 and had been applied to benign and malignant thyroid diseases since then.[9,10] The BABA method could well visualize both lobes, including the parathyroid glands and the recurrent laryngeal nerves (RLN), thus particularly fit for total thyroidectomy. Chung et al[10] showed that the BABA technique is as suitable for total thyroidectomy as OT, as indicated by the comparable postoperative complication rates and postoperative thyroglobulin (Tg) levels; moreover, it achieves excellent cosmetic results.

Several recent reports[9–11] have described the use of ET to treat selected cases of papillary thyroid carcinoma (PTC). It was a matter of concern that endoscopic thyroid surgery would leave more remnant thyroid tissue than OT because of an incomplete surgical resection. However, there has been little study, which investigated the surgical completeness of ET compared with OT.[11,12] For evaluation of surgical completeness, nuclear imaging method is optimal in that it clearly shows remnant thyroid tissue, and it may provide quantitative data.

The purpose of this study is to compare the surgical completeness achieved by BABA ET and OT by measuring the postoperative I-131 uptake and Tg levels on the first postoperative radioactive iodine (RAI) ablation scan. The total number of RAI ablation sessions and the total RAI doses needed to achieve complete ablation were also compared between ET and OT groups.

MATERIALS AND METHODS

Study Population

From a series of 218 patients, 25 consecutive patients (age, 40.8 ± 7.2 years; range, 24–51) were enrolled with papillary thyroid microcarcinoma (tumor size <1 cm) as the ET group. Between June 2004 and May 2007, they underwent BABA ET at Seoul National University Hospital and underwent RAI ablation. Among a total of 343 patients, 21 patients (age, 49.7 ± 6.9 years; range, 40–63) were enrolled with papillary thyroid microcarcinoma as the OT group. They were operated from January 2003 to April 2005 using a conventional open method and underwent RAI ablation. Other patients from each group were excluded from the analysis because of the following criteria: lobectomy only or lateral neck dissection (n = 34 and 84, respectively, from each group) and no complete RAI ablation (n = 159 and 238, respectively). Among the 46 patients who were included in the final analysis, 8 patients (1 patient in ET group and 7 patients in OT group) received RAI ablation because of worrisome pathology, which fell into the category of which RAI ablation is no longer recommended by the revised American Thyroid Association guidelines.[13]

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Operation Methods of Open and BABA Endoscopic Thyroidectomy

All procedures were performed by 1 surgeon (Y.K.Y.). The patients in the OT group received conventional open total thyroidectomy with use of a 3.5- to 5.0-cm low collar incision. Patients in the ET group underwent the operation by using the unique BABA method previously described.[9]

RAI Ablation and Image Analysis

Ablation of the remnant thyroid was performed 108 ± 95 days after surgery by administering 1.11 GBq of I-131 orally after >4-week restriction of thyroid hormone and 2-week low-iodine diet. Serum levels of Tg and thyroid-stimulating hormone (TSH) were measured on the day of RAI administration. A whole-body scan for RAI was performed 3 days after administration by using a gamma camera equipped with high-energy collimators. Ablation of the remnant thyroid was repeated until remnant thyroid tissue could not be detected on the ablation scans.

Postoperation remnant thyroid was assessed by the remnant uptake of RAI on the first postablation scan. To measure the uptake of remnant thyroid, a rectangular region of interest (ROI) that encircled all of the remnant activity and thyroid bed was drawn on the neck. Afterward, another ROI of the same size and shape was drawn on the brain area as a reference region (Fig. 1), and the counts of both ROIs were measured. The count ratio between the 2 ROIs, designated as the thyroid-to-background ratio (TBR), was calculated and represents the amount of the remnant thyroid. The total session numbers of RAI ablation therapy and doses of RAI needed to achieve a complete ablation were also investigated to measure the surgical completeness of the 2 operative methods.

Statistical Analysis

χ^2 test was used to evaluate differences between the ET and OT groups in terms of clinicopathological factors. Statistical analysis was performed by using the SPSS 17.0 for Windows (SPSS, Chicago, IL) program, and $P < 0.05$ was considered statistically significant. TBR data, total RAI session numbers, and doses of RAI were analyzed by unpaired Student *t* tests and Mann-Whitney *U* tests. Ninety-five percent confidence intervals (CI) of differences of both groups were also calculated.

RESULTS

The clinicopathological characteristics of both groups, including mean age, gender distribution, mean tumor size, presence of multifocality, disease extent, and presence of lymph node metastasis, are summarized in Table 1. The 2 groups did not differ significantly except for gender distribution and mean age. Complication rate was also not significantly different between ET and OT groups. Transient hypocalcemia was noted in 4/25 (16%) after ET and 3/21 (14.3%) after OT. Permanent hypocalcemia was not found after ET, but in 1 case (4.8%) after OT. Transient RLN palsy was developed in 7/25 (28%) in ET group and 2/21 (9.5%) in OT group. However, permanent RLN palsy was not developed in both groups.

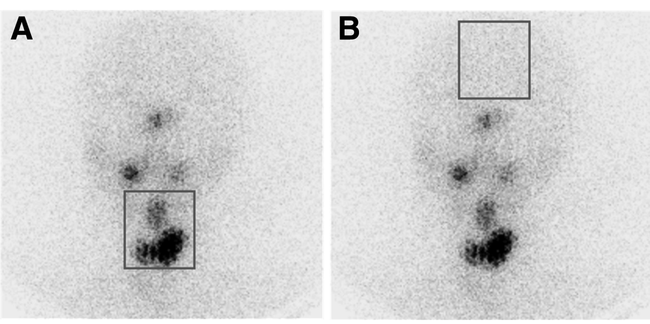

FIGURE 1. Measurement of region of interest (ROI) count. **A,** ROI count at remnant thyroid. **B,** ROI count at brain area as a reference region.

TABLE 1. Comparison of the Patient Characteristics in the ET and OT Groups

Characteristics	ET (n = 25)	OT (n = 21)	P
Male/female	0/25	4/17	0.022
Mean age, y (range)	40.8 ± 7.2 (24–51)	49.7 ± 6.9 (40–63)	<0.0001
Mean size of tumor on histologic examination, cm (range)	0.71 ± 0.18 (0.4–1.0)	0.77 ± 0.16 (0.4–1.0)	0.247
Multifocality	12 (48%)	13 (61.9%)	0.346
Extrathyroid extension	20 (80%)	14 (66.7%)	0.305
Lymph node metastasis	9 (36%)	3 (14.3%)	0.095

ET indicates endoscopic thyroidectomy; OT, open thyroidectomy.

TABLE 2. Comparison of the ET and OT Groups in Terms of TSH and Stimulated Tg Levels, TBRs, and Total RAI Ablation Session Numbers and Doses

Indices of Remnant Thyroid	ET (n = 25)	OT (n = 21)	P
TSH level (μIU/mL)	94.4 ± 59.1	83.5 ± 39.0	0.473
Stimulated Tg level (ng/mL)	1.6 ± 1.6	1.7 ± 2.1	0.829
TBR	23.7 ± 18.8	20.6 ± 21.6	0.305
RAI ablation			
Total no. sessions	2.28 ± 0.61	2.38 ± 0.59	0.389
Total dose (mCi)	71.2 ± 22.0	77.1 ± 29.4	0.391

ET indicates endoscopic thyroidectomy; OT, open thyroidectomy; TSH, thyroid-stimulating hormone; Tg, thyroglobulin; TBR, thyroid-to-background ratio; RAI, radioactive iodine.

Table 2 summarizes the TSH and stimulated Tg levels on the day of remnant thyroid ablation, the TBRs on the first ablation scan, and the total number of RAI ablation sessions and doses of RAI between the ET and OT groups. Three days after first I-131 administration, patients underwent whole-body RAI scan. The TBRs measured from the first ablation scans were 23.7 ± 18.8 (range, 2.9–88.5) for ET group and 20.6 ± 21.6 (range, 3.6–72.8) for OT group, which were not significantly different from each other (P = 0.305, 95% CI of difference = −15.1 to 8.9) (Fig. 2).

At the time of first RAI ablation, the mean TSH levels were 94.4 ± 59.1 (range, 18.1–256) μIU/mL in ET group and 83.5 ± 39.0 (range, 13.2–155) μIU/mL in OT group. The mean stimulated Tg levels of the ET and OT groups were 1.6 ± 1.6 and 1.7 ± 2.1 ng/mL, respectively. The 2 groups did not differ significantly in terms of TSH and Tg levels (P = 0.473 and 0.829, respectively, 95% CI of Tg difference = −1.0 to 1.2) (Figs. 3A, B) (Table 2).

After first RAI ablation, RAI ablations were repeated until there is no evidence of remnant thyroid tissue on postablation scan. The mean total number of RAI ablation sessions and total RAI doses needed for complete ablation were 2.28 ± 0.61 versus 2.38 ± 0.59 times, and 71.2 ± 22.0 versus 77.1 ± 29.4 mCi for the ET and OT groups, respectively. The 2 groups did not differ significantly in

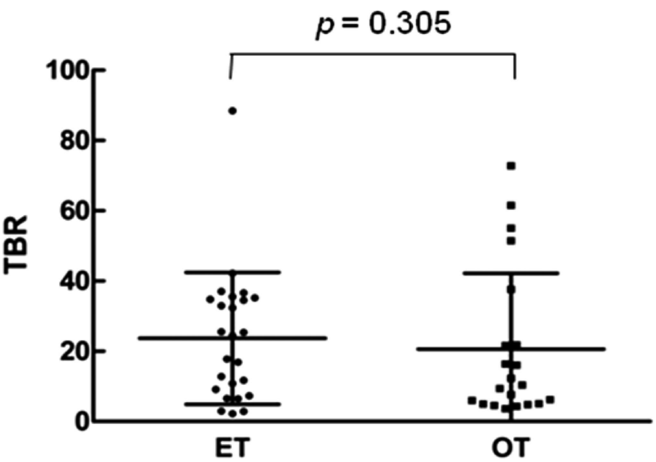

FIGURE 2. Comparison of thyroid-to-background ratio (TBR) between ET and OT groups. Transverse long bar indicates average. Error bar indicates standard deviation.

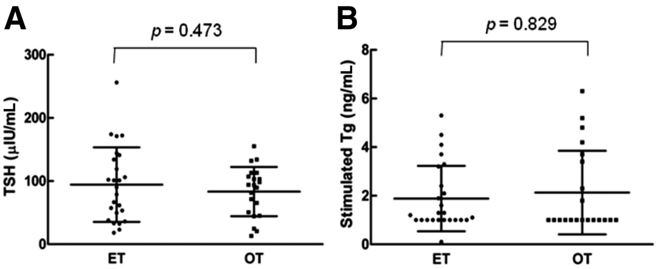

FIGURE 3. Comparison of thyroid-stimulating hormone (TSH) and stimulated thyroglobulin (Tg) levels at first ablation between ET and OT groups. **A,** TSH level (μIU/mL). **B,** Stimulated Tg level (ng/mL). Transverse long bar means average. Error bar indicates standard deviation.

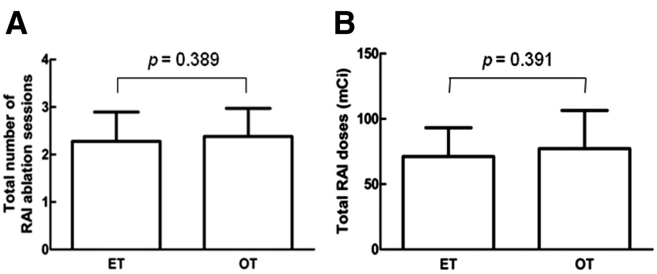

FIGURE 4. Comparison of the total number of radioactive iodine (RAI) ablation sessions and total RAI doses for complete ablation between ET and OT groups. **A,** Total number of RAI ablation sessions. **B,** Total RAI doses. Error bar indicates standard deviation.

terms of the total ablation numbers and doses ($P = 0.389$ and 0.391, 95% CI of difference = −0.259 to 0.459 and −9.39 to 21.19, respectively) (Fig. 4).

DISCUSSION

The aim of this study was to investigate whether the BABA ET can achieve comparable surgical completeness with that of OT, by measuring the thyroid remnant. For this purpose, Tg levels and RAI uptakes in the remnant thyroid were measured, which are considered to be reliable surrogate markers that reflect the amount of residual thyroid tissue after thyroidectomy.[14,15] In this study, ET and OT did not differ significantly in terms of stimulated Tg levels or the RAI uptakes of remnant thyroid. In addition, there were no differences between the 2 groups in regards of the total number of RAI ablation sessions or the total RAI doses needed for a complete ablation. Thus, it seems that BABA ET can clear thyroid tissue as completely as conventional OT.

In the view of clinical outcome, we already demonstrated that BABA ET shows insignificant postoperative complications and good cosmetic results in a previous study, which include the population of the present study.[10] BABA method is a pure endoscopic technique concordant with the definition of ET, a surgical technique in which the thyroid is entirely dissected with the help of an endoscope in a closed area. Moreover, BABA technique is currently combined with robotic surgery system and under examination for the feasibility and postoperative outcomes.[16,17]

Two reports on the completeness of endoscopic surgical resection in PTC also showed similar results. Miccoli et al[12] showed that PTC patients treated by minimally invasive video-assisted thyroidectomy have the same degree of I-131 uptake as OT-treated patients. Salvatori et al[18] also reported that video-assisted thyroidectomy and conventional OT yielded similar postoperative RAI uptakes, off T4-Tg levels, and successful ablation rates. In the latter report, thyroid uptake was calculated to estimate the burden of remnant thyroid as the ratio of the thyroid counts divided by a standard count by using a gamma probe.

Instead of measuring remnant thyroid by conventional RAI uptake scan with gamma probe,[18] TBR was measured in the current study for quantification of I-131 uptake, which was calculated by count ratio of thyroid bed and brain area. TBR is an easy and reliable measurement of remnant amount in RAI postablation scans because RAI uptake is in proportion to the amount of remnant thyroid tissue. In this study, the brain was used as background that only has blood pool activity, as iodine cannot pass through the blood-brain barrier, and the brain was included in the same scan field.

The current study is statistically underpowered to prove noninferiority of ET to OT because of small case number, and there is not sufficient evidence to validate the use of ET for thyroid cancers at present.[19] Thus, we expect that further clinical trials of larger scale will validate the noninferior surgical completeness and efficacy of ET, as its surgical completeness was demonstrated to be basically comparable to that of OT in the present study. In addition, BABA ET including combined robotic surgery method will become a more reliable method for thyroid cancer surgery in the near future.

CONCLUSION

The surgical completeness of BABA ET was comparable with that of OT in terms of remnant thyroid on the first postoperative RAI scan and the requirement of RAI therapy for complete ablation. The BABA ET may provide a safe option for patients with low-risk thyroid cancer who are concerned with the scar and other surgical complications.

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