Updates in Surgery (2021) 73:1459–1465
https://doi.org/10.1007/s13304-021-01035-1

ORIGINAL ARTICLE

Postoperative quality of life and cosmetic outcome between minimally invasive video-assisted thyroidectomy and bilateral axillo-breast approach robotic thyroidectomy: a single center retrospective cohort study

Wei-Hsin Chen[1,2] · **Chih-Yi Chen**[1,3]

Received: 10 December 2020 / Accepted: 16 March 2021 / Published online: 23 March 2021

Abstract
Different approaches to endoscopic thyroidectomy utilize incisions that result in inevitable physical trauma to patients since postoperative tissue fibrosis and scars will influence their quality of life for a lifetime. Over the past few years, most studies have discussed the safety concerns of different kinds of endoscopic thyroidectomy; conversely, there has been less discussion on postoperative quality of life. Because most patients undergoing thyroidectomy for cancer or benign diseases are likely to have long-term survival, it is essential to study the cosmetic outcome of patients' scars from minimally invasive video-assisted thyroidectomy (MIVAT) and bilateral axillo-breast approach (BABA) robotic thyroidectomy on quality of life. From July 2015 to December 2017, 95 patients—60 who underwent MIVAT and 35 who underwent BABA robotic thyroidectomy—were retrospectively studied. Patient demographics, operative indications, pathologic findings, pain scores after surgery, complications, perception of scars, and overall satisfaction were compared between the two groups. The cosmetic outcome and overall satisfaction were evaluated at least 2 years after the operation using the patient scar assessment questionnaire and the 36-item short form health survey (SF-36). There was no statistically significant difference in scar perception between the two groups. However, in the SF-36, the MIVAT group had better satisfaction than the BABA robotic group regarding general health, vitality, mental health, and health change. MIVAT and BABA robotic thyroidectomy can be safely performed in selected patients, and patients who underwent MIVAT had better postoperative qualities of life than those who underwent the BABA robotic approach.

Keywords Endoscopic thyroidectomy · Robotic thyroidectomy · MIVAT · BABA thyroidectomy

Introduction

Thanks to the development and improvement of surgical devices, different types of endoscopic thyroidectomies have emerged in the last 20 years [1]. Different approaches to thyroidectomies result in different degrees of physical and psychiatric trauma to patients [2, 3] since resulting distinct incisions and scars induce different perceptions in patients [4, 5]. Most studies have compared the surgical results between traditional approaches and a certain type of endoscopic thyroidectomy [6, 7], but comparisons of two different types of endoscopic thyroidectomy are rare. Patients' postoperative qualities of life have rarely been studied. Our study endpoints were cosmetic and overall patient satisfaction outcomes between two central access endoscopic thyroidectomies: minimally invasive video-assisted thyroidectomy (MIVAT) and bilateral axillo-breast approach (BABA) robotic thyroidectomy. Surgical results, such as operative time, pathologic findings, postoperative pain score, and complications, were also assessed.

✉ Chih-Yi Chen
cshy1566@csh.org.tw

[1] Institute of Medicine, Chung Shan Medical University, No. 110, Sec. 1, Jianguo N.Rd., Taichung 40201, Taiwan

[2] Division of General Surgery, Department of Surgery, Taichung Veterans General Hospital, Taichung, Taiwan

[3] Division of Thoracic Surgery, Chung Shan Medical University Hospital, Taichung, Taiwan

Methods

Study population

From July 2015 to December 2017, a total of 95 patients who underwent MIVAT or BABA robotic thyroidectomy (60 in the MIVAT group and 35 in the BABA robotic group) were retrospectively studied. Of the 95 patients, two patients in the MIVAT group who underwent completion thyroidectomy and one patient in the BABA robotic group who had a history of thyroidectomy were excluded. Therefore, 92 patients were included in this study (Table 1).

Selection of thyroid surgery

In clinical practice, the same selection criteria were used for both approaches, namely a dominant nodule up to 4.0 cm and total thyroid volume less than 30 cc. If the preoperative fine needle aspiration cytology (FNAC) showed suspicious for malignancy or malignant cell, no gross extrathyroid extension, lateral lymph node metastasis or distant metastasis on imaging studies should be required. Two surgeons performed both operations at the time.

The patients chose one of these two operations according to their understanding of the operation procedure, locations of incisions, and possible complications. The patients' private insurance coverage was also important in making a decision. In Taiwan, national health insurance does not cover endoscopic or robotic thyroid surgery, and patients must pay extra fees for these two kinds of surgeries. It should also be noted that robotic surgery was much more expensive than MIVAT.

Surgical techniques

MIVAT

We adopted Miccoli's method [8] and modified the incision length to 1.5–2.5 cm corresponding to the patients' skin elastic condition. The operative space was maintained through external retraction. A 30° 5-mm endoscope was used during the endoscopic procedure. The upper pole of the thyroid was dissected and divided with a harmonic

Table 1 Patient characteristics and surgical outcomes

Variables	MIVAT ($n=58$)	BABA ($n=34$)	P value
Gender (n, %)			1.000[a]
Male	6(10.30%)	4(11.80%)	
Female	52(89.70%)	30(88.20%)	
Age, years (mean ± SD, range)	46.09 ± 12.8 (18–73)	46.62 ± 12.70 (22–73)	0.848[b]
BMI, kg/m^2 (mean ± SD, range)	22.26 ± 3.12 (16–30)	24.11 ± 4.27 (15–36)	0.019 [b]
Predominent tumor size, cm (mean ± SD, range)	2.78 ± 1.19 (0.70–5.80)	2.54 ± 1.32 (0.50–6.60)	0.387 [b]
Preoperative FNAC			
Nondiagnostic or unsatisfactory	5	5	
Benign	33	15	
Atypia	10	3	
Follicular neoplasm	4	2	
Suspicious for malignancy	3	1	
Malignant	3	8	
Postoperative diagnosis			
Benign	44	22	
Malignant	14	12	
Extent of surgery			
Lobectomy	48	20	
Total thyroidectomy	10	9	
Lobectomy and subtotal Thyroidectomy	0	3	
Bilateral subtotal thyroidectomy	0	2	
Postoperative pain score (mean ± SD, range)			
Operative day	2.33 ± 1.42 (0–6)	2.47 ± 1.48 (1–6)	0.647[b]
Postoperative day 1	1.17 ± 1.22 (0–6)	1.06 ± 0.78 (0–3)	0.586[b]

[a]With one expected cell count less than five, Fisher's exact test was conducted

[b]An independent-samples t test was conducted

scalpel under endoscopic vision. The rest of the procedure was transferred to an open operation after the upper pole was divided. Subcuticular absorbable sutures and skin adhesive glue were used to close the wound. Drains were not routinely used.

BABA robotic thyroidectomy This approach was the same as that used in Seoul University Hospital [9]. The anterior neck subplatysmal flap was performed using a harmonic scalpel. The da Vinci Si System (Intuitive Surgical, Inc., Sunnydale, CA, USA) was used during the entire procedure. BABA incisions were made in the skin crease of the bilateral axilla and bilateral upper margin of the areola. The length of the incision was 1 cm for the three robotic instruments and 2 cm over the right areola for the robotic endoscope. Four robotic arms were used in all operations, and the endoscope, harmonic curved shears, and Maryland dissector were inserted through the right areolar incision. The procedure began with lower pole dissection and ended after dividing the upper pole. Subcuticular absorbable sutures and skin adhesive glue were used to close the wounds. Drains were used on a case-to-case basis.

Intraoperative neuromonitoring (IONM) Both approaches were performed under IONM using the Nerve Integrity Monitor (NIM-Response 3.0 System, Medtronic Xomed, Jacksonville, FL, USA), followed by Chiang's four-step procedure [10].

Analysis of epidemiological data and surgical results Data were collected regarding age, sex, body mass index (BMI), pathologic thyroid volume and weight, dominant nodule diameter, operative time, postoperative pain score, final histology report, and complications.

The total operating time was calculated from the time of the skin incision to closure. A standard visual analogue score (VAS) was used to assess the severity of postoperative pain using a scale of 0 (no pain) to 10 (worst pain imaginable) on the operative day (approximately four to eight hours after surgery) and postoperative day 1 (approximately 14–20 h after surgery).

Assessment and analysis of cosmetic and satisfaction outcome The cosmetic outcome of the scar was evaluated using the patient scar assessment questionnaire (PSAQ) 2 years after the operation. The PSAQ introduced by Durani et al. for measuring linear scars [11] and its validity and reliability in patients following thyroid surgery have been examined [12]. The PSAQ is a 39-item scale composed of five subscales: scar appearance, symptoms, consciousness, satisfaction with scar appearance, and satisfaction with scar symptoms. The symptoms subscale was omitted from the analysis because of its poor reliability concerning the type of scar assessed in this study. For each subscale, a higher score reflected a poorer outcome [11].

Assessing the postoperative physical and mental quality of life was evaluated at the same time as the PSAQ using the 36-Item Short Form Survey (SF-36) [13]. The SF-36 taps eight health concepts: physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to personal or emotional problems, emotional well-being, social functioning, energy/fatigue, and general health perceptions. It also includes a single item that provides an indication of perceived change in health. Higher scores (0–100) indicate a better quality of life. The completed questionnaires were obtained via phone calls. The study nurses were not involved in surgery and clinical care.

Statistical analysis

Summary statistics are presented for all demographic and surgery-related characteristics. Continuous variables were expressed as the mean with the standard deviation and categorical variables as the number with the percentage. The MIVAT approach was compared to the BABA robotic approach using the *t* test, Welch *t* test, Mann–Whitney *U* test, χ^2 test, or Fisher's exact test depending on the sample size. Differences were considered significant at $P < 0.05$. Data analysis was performed using IBM SPSS Statistics for Windows, version 22 (IBM Corp., Armonk, NY, USA).

Results

Ten total thyroidectomies and 48 lobectomies were performed in the MIVAT group. Nine total thyroidectomies, three lobectomies with subtotal thyroidectomies, two bilateral subtotal thyroidectomies, and 20 lobectomies were performed in the BABA robotic group. There were 6 males and 52 females in the MIVAT group and 4 males and 31 females in the BABA robotic group. The mean patient age was 46.1 years in the MIVAT group and 46.6 years in the BABA robotic group.

The preoperative diagnosis revealed clinically benign thyroid disease in most of the patients in both groups (Table 1). The final pathologic diagnosis showed 14 patients with malignancy in the MIVAT group and 12 patients in the BABA robotic group. The mean dominant nodule size was 2.8 cm in the MIVAT group and 2.5 cm in the BABA robotic group, without statistical significance. The mean volume and weight of resected thyroid glands for lobectomies and total thyroidectomies showed no statistical difference between the two groups (Table 2).

The highest postoperative pain score on the operative day and postoperative day 1 showed no difference between the two groups.

Table 2 Comparison of operative time, resected thyroid weight and volume between lobectomy and total thyroidectomy

Variables	MIVAT (58)	BABA (29)	*P* value
Operative time (min)			
Total thyroidectomy	157.63 ± 17.73	260.45 ± 93.55	0.028
Lobectomy	98.47 ± 23.62	220.74 ± 88.07	< 0.05
Resected thyroid weight			
Total thyroidectomy	26.38 ± 15.29	24.32 ± 22.25	0.830
Lobectomy	16.36 ± 18.28	13.52 ± 7.90	0.550
Resected thyroid volume			
Total thyroidectomy	24.39 ± 10.61	19.76 ± 16.29	0.494
Lobectomy	14.01 ± 11.28	12.32 ± 5.52	0.536

Complications included two transient laryngeal nerve injuries in the MIVAT group and one in the BABA robotic group. Two patients had temporary hypocalcemia in the MIVAT group and one in the BABA robotic group.

We compared the operative time for lobectomy and total thyroidectomy in both groups and found that the BABA robotic group had a longer operation time than the MIVAT group (Table 2). Most patients were discharged on postoperative day 1 or 2.

Finally, a successful questionnaire was administered to 50 patients in the MIVAT group (50/58, 86.2% of the MIVAT group) and 28 in the BABA robotic group (28/34, 82.4% of the BABA robotic group). 83% of the involved patients completed the cosmetic and overall satisfaction questionnaire. The mean time to collect the questionnaires was 38.72 ± 11.71 months in the MIVAT group and 41.17 ± 8.12 months in the BABA robotic group, which were not statistically different ($P = 0.26$).

In the PASQ questionnaire, there was no statistical difference between the MIVAT and BABA robotic groups (Table 3).

Table 3 Patient scar assessment questionnaire (PSAQ) scores

PSAQ	BABA (*N* = 28)	MIVAT (*N* = 50)	*P* value
PSAQ A	14.11 ± 2.90	13.4 ± 3.21	0.337
PSAQ C	7.18 ± 1.59	7.22 ± 1.81	0.920
PSAQ SA	14.89 ± 3.33	13.72 ± 4.13	0.176
PSAQ SS	9.14 ± 2.10	8.5 ± 2.49	0.231

PSAQ patient scar assessment questionnaire, *A* appearance, *C* consciousness, *SA* satisfaction with appearance, *SS* satisfaction with symptoms

In the SF-36, the scores in domains of general health, vitality, mental health, and health change were better in the MIVAT group than in the BABA robotic group (Table 4).

Discussion

Endoscopic thyroidectomy can be safely performed by well-trained surgeons in high-volume hospitals. MIVAT and BABA robotic thyroidectomy have been compared with traditional thyroidectomy with regard to its safety in previous studies [6, 14]. Studies have shown that the two kinds of endoscopic thyroidectomy can be safely performed with a low complication rate, similar to the traditional method. Our study also showed low complication rates in both patient groups.

Both MIVAT and BABA robotic thyroidectomy are endoscopic central access operations, though BABA robotic thyroidectomy is a remote access approach with four small incisions that requires extensive neck subplatysmal flap preparation before thyroidectomy, while MIVAT is a direct access endoscopic thyroidectomy with only one incision on the neck. This means that patients will have different degrees of physical trauma and different numbers and locations of postoperative scars. However, the length of the scars was nearly the same in both groups.

For postoperative pain, our results showed no statistical difference in the highest pain score on operation day and postoperative day 1 between the groups with small incisions, which differed in the number of incisions and extensive neck flap dissection. Miccoli et al. reported less immediate pain (24 h after the operation) in the MIVAT group than in the traditional cervical incision [2], and Kim's study showed that there was less pain on postoperative day 0 in the BABA robotic group than in the open thyroidectomy group [15]. One prospective study conducted by Ryu compared the

Table 4 Short form 36-item health survey questionnaire (SF-36) scores

	BABA (*N* = 28)	MIVAT (*N* = 50)	*P* value
PF	95.18 ± 14.24	95.40 ± 12.97	0.945
RP	89.29 ± 31.50	86.00 ± 33.18	0.258
BP	94.38 ± 9.78	90.55 ± 19.79	0.341
GH	55.65 ± 16.40	67.75 ± 19.68	0.007
VT	53.75 ± 17.98	68.40 ± 23.04	0.005
SF	90.18 ± 19.35	97.00 ± 10.28	0.092
RE	94.05 ± 20.39	88.00 ± 31.41	0.363
MH	78.43 ± 16.81	87.28 ± 13.15	0.012
HC	38.40 ± 24.04	53.00 ± 19.97	0.009

PF physical functioning, *RP* role-physical, *BP* bodily pain, *GH* general health, *VT* vitality, *SF* social functioning, *RE* role-emotional, *MH* mental health, *HC* health change

robotic transaxillary approach and conventional incision and found that the incision, which was 5–6 cm in both groups, did not induce more postoperative pain in the robotic transaxillary group even though it required a more extensive subcutaneous dissection [16]. Based on the aforementioned three studies and our own, we can conclude that skin flap dissection may not increase postoperative pain and that a smaller incision results in less pain. These results indicate that postoperative pain may have a greater association with the length of incisions than with skin flap dissection.

When evaluating patients' scar perception and cosmetic outcome, our study showed no statistical difference between the MIVAT and BABA robotic groups on the PASQ questionnaire. Materazzi et al. reported the cosmetic outcome after MIVAT (1.5 cm incision) versus robot-assisted transaxillary thyroidectomy (RATT, 5–7 cm incision). Both approaches in the study were single incisions, but were different in length and location. They reported that patients who received MIVAT had better results in scar appearance and satisfaction with appearance [17]. This result showed that smaller incisions and scars resulted in better cosmetic results than longer scars, even when the scar was hidden. Another study compared different kinds of endoscopic thyroidectomy, such as transaxillary and postauricular facelift approaches, with traditional surgery and reported that small or hidden incisions would yield better cosmetic results [18]. What is noteworthy is that since transaxillary thyroidectomy is a lateral approach method that requires a much longer incision and larger subplatysmal flap than MIVAT, we conducted this study such that both the approach direction and the length of incisions were similar but different in terms of physical trauma, such as subplatysmal flap preparation, number of incisions, and resulting scars, to determine whether the small hidden scars can obtain better cosmetic results. In our study, which compared one small incision with four small hidden incisions, there was no statistical difference in the perception of scars between the two groups. The perception of scars may be influenced by cultural differences and personality. Our study showed that small hidden scars do not necessarily ensure better cosmetic results for patients. The advantages of small hidden scars may be neutralized by a greater number of scars.

With regard to the SF-36 for evaluation of postoperative quality of life, our study revealed that the MIVAT group had better results in areas of general health, vitality, mental health, and health change. In contrast, in Materazzi's study, scores in the domains of social activity and general health were higher in the RATT group than in the MIVAT group because of hidden scars, while bodily pain scored higher in the RATT group than in the MIVAT group because of longer scars [17]. However, in Koo's study that compared BABA robotic thyroidectomy with the conventional operation, there was no difference in physical distress levels, though there was less scarring and psychological distress [5]. Furthermore, in Song's study that compared robot-assisted transaxillary thyroidectomy with the conventional approach, the total health-related quality of life was similar in both groups [19]. Based on our study and on previous studies, the results suggested that hidden scars may not guarantee a better quality of life for patients in social communication since fibrosis due to scars or flap dissection, number of scars, and cultural differences are still important factors to be taken into account. Thus, whether hidden scars result in a better postoperative quality of life remains controversial.

It is known that remote access endoscopic thyroidectomy, such as a postauricular facelift, transoral, transaxillary, or BABA approach, will result in more physical trauma than minimally invasive anterior cervical approaches since the former methods inevitably create bigger neck subplatysmal flaps for operation space [20], and the MIVAT procedure requires only small flap preparation. The location of incisions and trajectory routes of trocars become scars and fibrotic tissue after surgery. Bakkar et al. found that all patients reported a bothersome long-standing pulling sensation along the surgical track that produced a poor outcome in some scales of the SF-36 survey [21]. In a study comparing postoperative cosmesis in transaxillary, postauricular facelift, and conventional transcervical thyroidectomy, the results showed that scar healing was worse in the transaxillary and facelift approaches despite better cosmetic results [22]. If the scar becomes hypertrophic or keloid, and the fibrotic tissue results in skin tightness, this leads to lifelong complications for the patient. However, in our study, MIVAT caused less physical trauma and fibrotic tissue formation than BABA robotic thyroidectomy and enabled better postoperative quality of life.

The timing of evaluating cosmetic results in our study was at least two years after surgery, which was much later than previous studies that evaluated cosmetic results just 2, 3, 6, or 12 months after surgery [17, 18, 22, 23]. Our study is the first long-term observation of patients' perception of scars after endoscopic thyroidectomy using direct and remote access approaches. The natural course and maturation of scar tissue require at least one year [24]. We consider our timing for the evaluation of cosmetic results and patient satisfaction to be more appropriate based on the theory of wound healing.

In our study, small scars on the neck and small hidden scars on the bilateral axilla and areola seemed to make no difference in patients' scar perception. However, the postoperative quality of life differed between the two groups. The MIVAT group had better results regarding general health, vitality, mental health, and health change. This indicates that less physical trauma and fewer resulting scars will lead to a better postoperative quality of life. Hence, MIVAT remains the gold standard for endoscopic thyroidectomy for patients

who will undergo thyroid surgery; however, BABA robotic thyroidectomy still has its place for patients who wish to avoid a scar on the neck.

Teamwork for endoscopic thyroidectomy is very important for shortening the operating time. The BABA robotic procedure requires more time for robot docking, extensive dissection of the subplatysmal flap, and undocking the machine. These procedures increase the total operating time. In our unpublished results, we found that it can be further shortened after training of operating room colleagues, especially in robotic surgery.

The limitation of this study was that it was not a randomized control trial with a limited number of patients. In Taiwan, the cost is much higher for robotic procedures than MIVAT procedures, which require a large amount of funds for randomized control studies. We conducted this retrospective cohort study to understand cosmetic outcome and postoperative quality of life. A better knowledge of these operations can guide the choice of tailored surgery for patients.

Surgeons should balance the consideration of minimally invasive dissection and cosmetic advantages, and clearly and fully explain the surgical results for patients prior to thyroidectomy.

We have entered the era of tailored surgery for patients who need thyroidectomy, and further studies comparing different kinds of endoscopic surgery are necessary and would be of great value.

Conclusion

There was no statistically significant difference in the perception of scars between MIVAT and BABA robotic thyroidectomy. However, patients who underwent MIVAT had better postoperative qualities of life than those who underwent the BABA robotic approach.

Acknowledgements Thanks to Ms. Yi-Ting Chang for questionnaire collection, Ms. Pao-Nuan Hsieh for data analysis and Ms. jeng-Ya Hsin for English correction.

Funding Not applicable.

Availability of data and material Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval The study was conducted in compliance with ethical standard.

Research involving human participants and/or animals Study has been approved by the institutional ethics committee and have been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Informed consent Informed consent was obtained from all patients for being included in the study.

Consent to participate Informed consent was obtained for questionnaire.

References

1. Linos D (2011) Minimally invasive thyroidectomy: a comprehensive appraisal of existing techniques. Surgery 150(1):17–24. https://doi.org/10.1016/j.surg.2011.02.018
2. Miccoli P, Rago R, Massi M et al (2010) Standard versus video-assisted thyroidectomy: objective postoperative pain evaluation. Surg Endosc 24(10):2415–2417. https://doi.org/10.1007/s00464-010-0964-7
3. Paek SH, Kang KH, Kang H, Park SJ (2016) Comparison of postoperative surgical stress following robotic thyroidectomy and open thyroidectomy: a prospective pilot study. Surg Endosc 30(9):3861–3866. https://doi.org/10.1007/s00464-015-4689-5
4. Lu JH, Materazzi G, Miccoli M, Baggiani A, Hu S, Miccoli P (2012) Minimally invasive video assisted thyroidectomy versus endoscopic thyroidectomy via the areola approach: a retrospective analysis of safety, postoperative recovery, and patient satisfaction. Minerva Chir 67(1):31–37
5. Koo DH, Kim DM, Choi JY, Lee KE, Cho SH, Youn YK (2015) In-depth survey of scarring and distress in patients undergoing bilateral axillo-breast approach robotic thyroidectomy or conventional open thyroidectomy. Surg Laparosc Endosc Percutan Tech 25(5):436–439. https://doi.org/10.1097/SLE.0000000000000187
6. Shan L, Liu J (2019) Meta-analysis comparison of bilateral axillo-breast approach robotic thyroidectomy and conventional thyroidectomy. Surg Innov 26(1):112–123. https://doi.org/10.1177/1553350618817145
7. Arora A, Garas G, Sharma S, Muthuswamy K, Budge J, Palazzo F, Darzi A, Tolley N (2016) Comparing transaxillary robotic thyroidectomy with conventional surgery in a UK population: a case control study. Int J Surg 27:110–117. https://doi.org/10.1016/j.ijsu.2016.01.071
8. Miccoli P, Berti P, Raffaelli M, Conte M, Materazzi G, Galleri D (2001) Minimally invasive video-assisted thyroidectomy. Am J Surg 181(6):567–570. https://doi.org/10.1016/s0002-9610(01)00625-0
9. Lee KE, Rao J, Youn YK (2009) Endoscopic thyroidectomy with the da Vinci robot system using the bilateral axillary breast approach (BABA) technique: our initial experience. Surg Laparosc Endosc Percutan Tech 19(3):e71–e75. https://doi.org/10.1097/SLE.0b013e3181a4ccae
10. Chiang FY, Lee KW, Chen HC et al (2010) Standardization of intraoperative neuromonitoring of recurrent laryngeal nerve in thyroid operation. World J Surg 34(2):223–229. https://doi.org/10.1007/s00268-009-0316-8
11. Durani P, McGrouther DA, Ferguson MW (2009) The Patient Scar Assessment Questionnaire: a reliable and valid patient-reported outcomes measure for linear scars. Plast Reconstr Surg 123(5):1481–1489. https://doi.org/10.1097/PRS.0b013e3181a205de
12. Economopoulos KP, Petralias A, Linos E, Linos D (2012) Psychometric evaluation of Patient Scar Assessment Questionnaire

following thyroid and parathyroid surgery. Thyroid 22(2):145–150. https://doi.org/10.1089/thy.2011.0265
13. Newnham EA, Harwood KE, Page AC (2007) Evaluating the clinical significance of responses by psychiatric inpatients to the mental health subscales of the SF-36. J Affect Disord 98(1–2):91–97. https://doi.org/10.1016/j.jad.2006.07.001
14. Lombardi CP, Carnassale G, D'Amore A et al (2017) Morbidity from minimally invasive video-assisted thyroidectomy: a general review. Gland Surg 6(5):488–491. https://doi.org/10.21037/gs.2017.06.05
15. Kim MK, Kang H, Choi GJ, Kang KH (2019) Robotic thyroidectomy decreases postoperative pain compared with conventional thyroidectomy. Surg Laparosc Endosc Percutan Tech 29(4):255–260. https://doi.org/10.1097/SLE.0000000000000689
16. Ryu HR, Lee J, Park JH, Kang SW, Jeong JJ, Hong JY, Chung WY (2013) A comparison of postoperative pain after conventional open thyroidectomy and transaxillary single-incision robotic thyroidectomy: a prospective study. Ann Surg Oncol 20(7):2279–2284. https://doi.org/10.1245/s10434-012-2557-2
17. Materazzi G, Fregoli L, Manzini G, Baggiani A, Miccoli M, Miccoli P (2014) Cosmetic result and overall satisfaction after minimally invasive video-assisted thyroidectomy (MIVAT) versus robot-assisted transaxillary thyroidectomy (RATT): a prospective randomized study. World J Surg 38(6):1282–1288. https://doi.org/10.1007/s00268-014-2483-5
18. Lee DW, Ko SH, Song CM, Ji YB, Kim JK, Tae K (2020) Comparison of postoperative cosmesis in transaxillary, postauricular facelift, and conventional transcervical thyroidectomy. Surg Endosc 34(8):3388–3397. https://doi.org/10.1007/s00464-019-07113-1
19. Song CM, Ji YB, Bang HS, Park CW, Kim DS, Tae K (2014) Quality of life after robotic thyroidectomy by a gasless unilateral axillary approach. Ann Surg Oncol 21(13):4188–4194. https://doi.org/10.1245/s10434-014-3879-z
20. Duke WS, Chaung K, Terris DJ (2014) Contemporary surgical techniques. Otolaryngol Clin North Am 47(4):529–544. https://doi.org/10.1016/j.otc.2014.04.002
21. Bakkar S, Al Hyari M, Naghawi M, Corsini C, Miccoli P (2018) Transoral thyroidectomy: a viable surgical option with unprecedented complications-a case series. J Endocrinol Invest 41(7):809–813. https://doi.org/10.1007/s40618-017-0808-6
22. Kim WW, Lee J, Jung JH, Park HY, Tufano RP, Kim HY (2018) A comparison study of the transoral and bilateral axillo-breast approaches in robotic thyroidectomy. J Surg Oncol 118(3):381–387. https://doi.org/10.1002/jso.25175
23. Lang BH, Wong KP (2013) A comparison of surgical morbidity and scar appearance between gasless, transaxillary endoscopic thyroidectomy (GTET) and minimally invasive video-assisted thyroidectomy (VAT). Ann Surg Oncol 20(2):646–652. https://doi.org/10.1245/s10434-012-2613-y
24. Dordea M, Aspinall SR (2016) Short and long-term cosmesis of cervical thyroidectomy scars. Ann R Coll Surg Engl 98(1):11–17. https://doi.org/10.1308/rcsann.2016.0022.PMID:26688393;PMCID:PMC5234393