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ORIGINAL ARTICLE

# Transoral vestibular robotic thyroidectomy in pediatric thyroid disease: 5 case reports

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## Abstract

**Background** The safety and feasibility of transoral endoscopic thyroidectomy vestibular approach in pediatric patients has been clinically proven, and its cosmetic results have been recognized by children and their families. However, there are no reports on using transoral robotic in pediatric thyroid surgery. In this study, we report the experience of 5 cases of transoral vestibular robotic thyroidectomy in treating of thyroid disease in children.

**Patients and Methods** Retrospective analysis of clinical data of five children who underwent robotic thyroid surgery via the TOVRT in our hospital from February 2021 to April 2023, including operation time, tumor diameter, postoperative hospitalization time, and surgical complications. All five patients were operated on by the same team, and the postoperative pathological results were all follicular adenoma of thyroid. The children had a strong desire for cosmetic surgery, and their families voluntarily chose the robotic surgical system for their surgery.

**Results** All five patients underwent unilateral thyroid lobectomy without conversion to open surgery. All patients were female, with a mean BMI of (19.63 ± 1.79) kg/m$^2$ and the mean age was (14.40 ± 2.33) years. The average operation time was (52.00 ± 5.10) mins, the average tumor diameter was (41.60 ± 8.41) mm, and the average postoperative hospital stay was (3.60 ± 0.49) days. There were no complications such as hypoparathyroidism, recurrent laryngeal nerve injury, genioglossal nerve injury, or skin necrosis.

**Conclusion** The transoral vestibular robotic thyroidectomy is safe and feasible, providing a new treatment option for pediatric thyroid diseases that require surgical treatment.

**Keywords** Transoral approach · Pediatric · Surgical approach · Robotic thyroidectomy · Follicular adenoma of thyroid

## Introduction

In recent years, the incidence of thyroid diseases requiring surgical treatment in children is increasing year by year [1]. The surface scars caused by traditional surgery have a significant psychological burden and social impact on children and their families. However, laparoscopic or robotic thyroid surgery with different approaches is most commonly used in adults, among which the transoral vestibular approach can achieve the requirement of an utterly scarless body surface in children, and the therapeutic efficacy of this approach in pediatric endoscopic thyroid surgery has been clinically verified [2, 3]. However, there are no reports on applying this approach to pediatric robotic thyroid surgery. In this paper, we present the experience of the application of transoral vestibular robotic thyroidectomy (TOVRT) in five pediatric cases.

## Patients and methods

Retrospective analysis of clinical data of 5 cases of robotic thyroid surgery via the transoral vestibular approach admitted to the Thyroid and Breast Surgery Department of the 960th Hospital of the PLA Joint Logistics Support Force (Former Jinan Military General Hospital of PLA) from February 2021 to April 2023. All surgeries were performed by the same robotic surgeon, and the chief surgeon communicated sufficient with the monitoring of the five children before surgery. After obtaining informed consent, the

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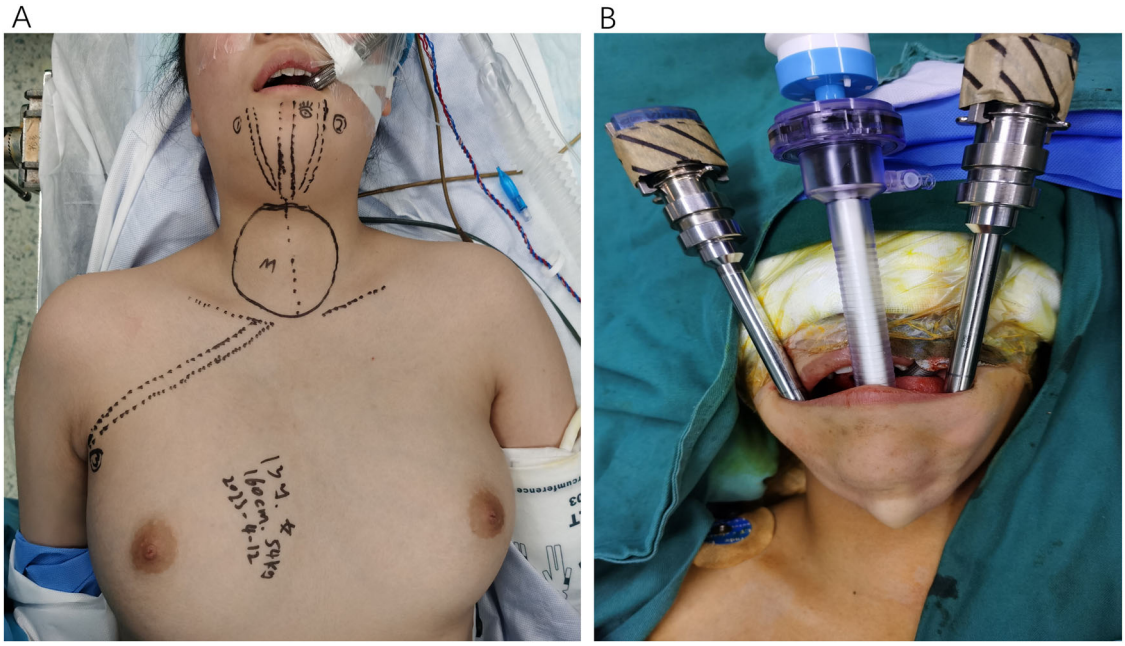


**Fig. 1** **A** Body surface marking tunnel running. **B** Two trocars with a diameter of 8 mm were placed in the corner incision and one trocar with a diameter of 10 mm was placed in the lower lip frenulum

child's guardian signed a consent form for surgical risks and complications, and this study has been reviewed and approved by the Ethics Committee of the 960th Hospital of the Chinese People's Liberation Army Joint Logistics Support Force (2022 Scientific Research Ethics Review No. 125).

Inclusion criteria: (1) age ≤18 years; (2) tumor diameter ≤6 cm; (3) hyperthyroidism, thyroid volume ≤50 ml.

Exclusion criteria: (1) previous neck surgery and ablation history; (2) thyroid tumor with severe thyroid inflammatory disease; (3) thyroid malignancy; (4) oral infection; (5) cervical deformity.

The cosmetic effect was evaluated using the Visual analogue scale (VAS), with higher scores indicating higher satisfaction. Postoperative pain was evaluated using the numerical rating scale (NRS), with lower scores indicating less pain.

## Preoperative preparation

Laryngoscopy showed normal vocal cords. Preoperative psychological counseling and oral care were performed. Antibiotics were used prophylactically before and after surgery for 30 min to prevent incision infection. Before surgery, ultrasound-guided thyroid nano-carbon suspension injection (Chongqing Lummy Pharmaceuticals, China) was performed to facilitate negative visualization of the parathyroid gland. The incision position was marked on the body surface before surgery. The fine needle aspiration cytology results of the thyroid nodules were considered follicular tumors. The procedure was performed by da Vinci Si surgical system (Intuitive Surgical, Inc., Sunnyvale, CA).

## Surgical technique

All patients underwent general anesthesia via oral intubation with a nerve monitoring tube (Shanghai NCC Medical Co., LTD, China), and the tube was fixed above the left corner of the mouth, as shown in Fig. 1A. The patient is placed in a supine position with the neck extended. Use sterile film to seal both ears, nostrils, and eyes. The mouth and vestibule were washed with 0.1% retouch povidone iodine and then washed with 0.9% sodium chloride solution. An inverted "U" incision about 20 mm long was made at the end of the frenulum of the lower lip with monopolar electrocautery, and the incision was made to the periosteal surface as a lens hole. Use monopolar electrocautery to make longitudinal incisions near the mouth corners on both sides, with a length of about 5 mm as operating holes, without additional incisions. Inject 10 mL of saline containing adrenaline (1 mL:500 mL) into the submental region and the incision channels on both sides. Blunt dissociation to the thyroid cartilage plane was performed using a dissection stick along the tunnel and trocars were placed (Fig. 1B). Children's skin is delicate, do not use brute force to operate, to avoid the dissection stick through the skin.

The mechanical arm was docked. During the operation, the CO2 insufation pressure was maintained at a low

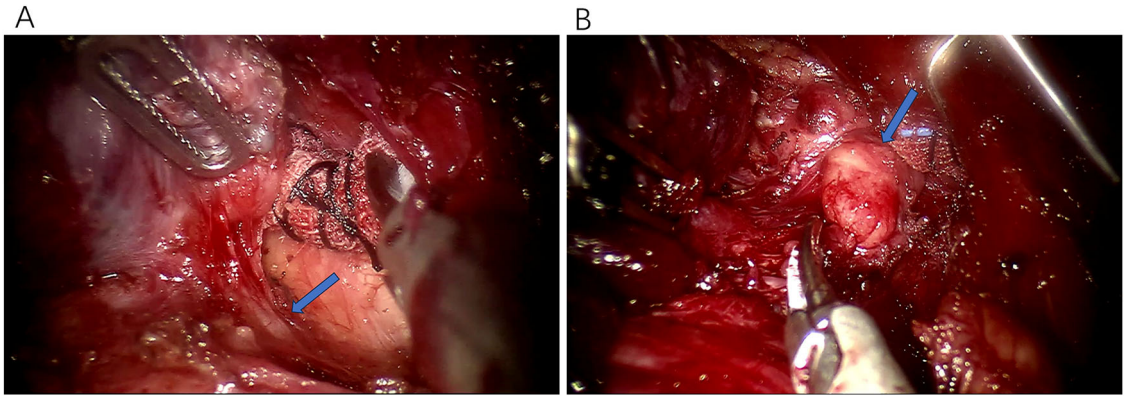


**Fig. 2** **A** Right recurrent laryngeal nerve. **B** Right inferior parathyroid gland

**Table 1** General conditions and surgical results of the patient

| Patient | Age (years) | BMI (kg/m$^2$) | Tumor Size(mm) | Tumor Location | FNA (Bethesda) | Operating Time (mins) | Follow Up(months) | NRS scores | VAS scores |
|---|---|---|---|---|---|---|---|---|---|
| Pt 1 | 13 | 21.48 | 36 | Right lobe | 3 | 50 | 10 | 3 | 10 |
| Pt 2 | 18 | 21.53 | 53 | Left lobe | 2 | 55 | 19 | 2 | 9 |
| Pt 3 | 11 | 17.78 | 40 | Right lobe | 2 | 60 | 24 | 3 | 9 |
| Pt 4 | 15 | 20.05 | 49 | Left lobe | 2 | 45 | 36 | 3 | 10 |
| Pt 5 | 15 | 17.30 | 30 | Left lobe | 3 | 50 | 41 | 2 | 10 |

*Pt* Patient, *FNA* Fine needle aspiration

pressure of 5 mmHg (1 mmHg = 0.133 kPa) and high flow state. Prograsp forceps was placed into trocar for the left corner incision, and harmonic curved shears or Maryland bipolar forceps were placed into trocar for the right corner. Harmonic curved shears was used for coagulating tissue. Maryland bipolar forceps was used with Prograsp forceps to separating tissues or to seek recurrent laryngeal nerves (RLN). The harmonic curved shears was used to expand the operating space, down to the suprasternal notch, and on both sides to the lateral margin of the sternocleidomastoid (SCM) muscle. The harmonic curved shears was used to cut the midline fascia of the strap muscles, expose the enlarged thyroid gland, locate the cricothyroid muscle and thyroid cartilage, cut off the pyramidal lobe, expose the trachea, and dissected the isthmus. Pull the thyroid gland inward, and the anterior cervical muscle group was suspended and draw outward with laparoscopic hook or suture. The peripheral thyroid fascia was severed along the true thyroid envelope, the middle thyroid vein was closed, and the common carotid artery was exposed. Then fully exposed along the cricothyroid space, free the upper pole of the thyroid, if necessary, part of the sternothyroid muscle can be severed. The harmonic curved shears was used to cut off the upper pole of the thyroid gland and double migrate to coagulate the blood vessels in the upper pole of the thyroid gland. Pay attention to protect the external branches of the superior laryngeal nerve and the upper parathyroid gland and its blood supply. The RLN was located with the help of an intraoperative nerve monitor attached to electrodes at the tail of the Maryland bipolar forceps (Fig. 2A). After identifying the route of RLN and fully protecting it, Berry's ligament was cut with harmonic curved shears. Coagulation of free glands along the true capsule of the thyroid gland from top to bottom, closure of the lower polar blood vessels, and complete removal of the thyroid gland lobe. Pay attention to protecting the parathyroid gland during surgery (Fig. 2B). An endoplastic bag was used to collect the excised thyroid gland lobe from the operation area, and remove it from the lens hole. Repeatedly rinse the surgical area and subcutaneous tunnel with sterile distilled water (42 °C), and suture the midline fascia of the strap muscles. The detailed operation has been described in a previous study from our team [4–6].

## Results

All surgeries were completed without conversion to open surgery. The general conditions and surgical results of the patients are detailed in Table 1. All five patients were female; all underwent unilateral thyroid lobectomy, with an average age of (14.40 ± 2.33) (from 11–18 years), an average operation time of (52.00 ± 5.10) (range 45 to 60 mins), and an average hospitalization time of (3.60 ± 0.49) days.

All patients had no surgical complications, no hypoparathyroidism, no injury to the recurrent laryngeal nerve or mental nerve, no seroma, no numbness of the mandible, and no infection in the surgical area. The average follow-up time was 26 months (range 10–41 months), with no tumor implantation.

## Discussion

The incidence rate of thyroid solid nodules in children is 1–1.7% lower than that in adults, but the upward trend of thyroid malignant tumors in children is mainly concentrated in 10–18 years old [1, 7, 8]. Due to the fact that children are in the golden period of physical and mental development, and thyroid function is crucial for their intellectual and physical development, it is necessary to consider performing thyroid surgery on children carefully. The common causes of thyroid surgery in children in clinical practice include: 1. Benign tumors with prominent protrusions in the neck that affect regular learning and life; 2. Confirmed malignant thyroid tumor; 3. Thyroid nodules with uncertain malignancy and potential for malignancy, such as rich blood supply, localization, hypoechogenicity, etc. In benign or uncertain benign or malignant tumors, special attention should be paid to the diagnosis and treatment of thyroid follicular tumors. The sensitivity and specificity of ultrasound examination for thyroid follicular tumors are 18.2 and 88.7%, respectively, and 11.9% of thyroid follicular tumor patients cannot determine benign or malignant through fine needle aspiration [8, 9]. Malignant thyroid follicular tumors are prone to distant bone and lung metastases. Therefore, for symptomatic thyroid follicular tumors, surgical treatment is recommended first [10]. In this study, all five patients had prominent neck tumors with a diameter greater than 30 mm, which caused difficulties in their daily life and learning. The ultrasound examination and fine needle puncture results also indicated thyroid follicular tumors. Therefore, surgery is the preferred treatment option for the children in this study.

Children are a particular group, with different levels of understanding of diseases, and different perceptions of the severity of the disease itself and its impact on quality of life, especially for thyroid cancer patients [10]. However, pediatric diseases have a more significant impact on parents' psychological emotions, more easily causing anxiety or self-blame, and even leading to depression. With the development of thyroid surgery, regardless of benign or malignant thyroid disease, standardized thyroid surgery can significantly improve the survival rate and quality of life of children, reducing the distress caused by the disease itself to family members [11]. Affected by parents' concept of beauty and the proliferation of electronic products with image transmission functions, children are increasingly paying attention to their own appearance changes and pursuit of beauty at an earlier age. The scars caused by traditional open surgery have a profound impact on children, causing more significant psychological and social dysfunction than the thyroid disease itself. Children who are overly concerned about scars can lead to severe psychological disorders, such as depression [12]. Minimally invasive approaches away from the neck avoid neck scars, but the non-concealed incision still causes distress to the child's life. The transoral vestibular approach is widely used in adults, and its safety and feasibility have been clinically verified [4, 13, 14]. This approach can achieve complete scarring on the body surface, making it the best minimally invasive path for cosmetic effects, suitable for parents and children who are overly concerned about scars. According to the literature search, there is currently no experience sharing of robotic pediatric thyroid surgery via transoral vestibular approach [12]. In this study, five children underwent robotic surgery via transoral vestibular approach ultimately, and the mean NRS score was $(2.60 \pm 0.49)$ points; the mean NSS score was $(9.60 \pm 0.49)$ points.

Compared to endoscopic systems, robotic surgical systems have a more flexible control system with a 3D field of view and 7 degrees of freedom for surgical instruments. They can filter out physiological tremors in the hands, achieve more precise surgical operations, increase surgical safety, and reduce surgical complications. When developing this surgical approach for patients, we should draw on the experience of Bakkar et al. [15]. Before surgery, we should provide detailed information to the patient and their family about the advantages and disadvantages of this type of surgery to ensure that they can withstand the associated surgical risks and complications. Reiter's study on 1595 children with total thyroidectomy found that there was no significant difference in the incidence of short-term postoperative complications between benign and malignant thyroid tumors, and it suggested that the experienced surgical team had the same incidence rate of surgical complications as adults [16]. Min Jung Lee found that recurrent laryngeal nerve injury only occurred in the endoscopic group by comparing laparoscopic and robotic thyroidectomy via the transoral vestibular approach [13]. However, in Lee JK's study of 26 children undergoing robotic thyroid cancer surgery via bilateral axillo-breast approach, there were two patients with permanent hypothyroidism, which was related to the more enormous surgical scope [16]. In this study, the surgical scope was relatively small, and there were no symptoms of hypothyroidism. Jun Ho Lee found through a survey of 240 cases of laparoscopic and robotic thyroidectomy through transoral approach that the robot group had more central lymph node dissection than the laparoscopic surgery group,

and had shorter hospital stays and lower pain scores [13]. In contrast, the laparoscopic group had more skin sensory abnormalities in the lower jaw area than the robot group, and there was one patient with permanent sensory abnormalities. In this study, all five patients completed surgery without serum swelling, and there were no complications such as recurrent laryngeal nerve and mental nerve injury. The mean follow-up of 26 months showed no recurrence or tumor implantation, and no discomfort such as numbness or swelling of the mandibular skin.

The robotic surgery system is safe and feasible for adult applications, providing a new option for thyroid surgery in children. The transoral vestibular approach can achieve complete scarring-free on the body surface, meeting the aesthetic needs of children and their families. Currently, although there are few robotic thyroid surgeries in children through the transoral vestibular approach, and there is insufficient clinical experience, with the diversification of robotic surgery systems and the popularization of clinical applications, it is believed that in the future, more children and their parents will recognize the advantages of robotic surgery systems and choose this method for surgery for children.

## Conclusions

The robotic surgical system has stable vision, precise and accurate operation, and few surgical complications. Whereas TOVRT is most commonly used in adult thyroid diseases, applying the surgical experience of this modality to pediatric patients can improve surgical safety. Reducing family anxiety about the disease in children, while also avoiding psychological problems caused by scars, providing a new treatment option for pediatric thyroid disease.

### Data Availability

No datasets were generated or analysed during the current study.

**Author Contributions** M.W. and Q.H. wrote the main manuscript text, G.W. and X.L. prepared figures and L.Z. and Y.G. critical revision, All authors reviewed the manuscript.

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### Compliance with ethical standards

**Conflict of interest** The authors declare no competing interests.

**Ethics** Written informed consent was obtained from the patients/their parents for the publication of this case report.



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