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RESEARCH PAPER

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Robot-assisted resection of lateral neck cysts using a postauricular approach

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Abstract

Objectives: The Da Vinci robotic surgical system was used for head and neck surgery. This study aimed to investigate the feasibility, safety, and effect of postauricular approach on the resection of lateral neck cysts.

Methods: Eleven patients with lateral neck cysts were enrolled in this retrospective study and accepted robot-assisted surgery via a postauricular approach. Data on volume of cervical cysts, length of incision, bleeding volume, mean operating time, and hospitalization time were analyzed. The postoperative esthetic satisfaction of patients was investigated.

Results: In this case series, the average length of the incision was 6.67 cm. Bleeding volumes ranged from 10 to 20 mL. Average operation time was 55 min. Four patients developed postauricular numbness after the operation, and all recovered over 3 months. No other serious adverse events occurred after the operation. Postoperative cosmetic outcomes were satisfactory. During the follow-up median period of 38.2 months, there was no evidence of recurrence or long-term complications.

Conclusion: Robot-assisted resection for lateral neck cysts via a postauricular approach is feasible and safe and yields excellent cosmetic outcomes.

KEYWORDS

cosmetic, Da Vinci robotic surgical system, lateral neck cysts, postauricular approach, robotic surgery

Key points

Robot-assisted resection of lateral neck cysts by using a postauricular approach could yield excellent cosmesis and comprehensive resection without severe complications. It is technically feasible and could be considered an alternative choice for patients with lateral cervical cysts.

Ping Han and Fa-Ya Liang contributed equally to the article.

INTRODUCTION

Congenital neck cysts can be divided into medial and lateral cysts. Medial lesions consist of thyroglossal dermoid cysts, duct cysts, and bronchogenic cysts, while lateral lesions consist of branchial cleft cysts and cystic lymphangiomas.[1] Branchial cleft cysts are the most common lateral neck cysts,[2] accounting for 95% of branchial cleft anomalies.[3,4] The incidence of lymphangiomas internationally is approximately 1/6000–16,000,[5] approximately 75%–80% of which occurs in the neck.[6] When lateral cervical cysts grow sufficiently large, they can lead to facial and neck deformities and even the occurrence of dyspnea, dysphagia, or dysphonia.[7] Conventional surgical incisions are located in the lateral neck region, which leaves a noticeable scar after surgery, which may influence psychological development during childhood.[8,9] Given that surgical scholars have launched a variety of endoscopic approaches for resection of the thyroid, parathyroid gland, and parotid gland,[10] the surgical techniques for resecting neck cysts have been improved successfully by using endoscopy. On the basis of various remote approaches for resection of the thyroid and parotid gland and selective lateral neck dissection of our surgical team,[11–13] we successfully applied endoscopic techniques to the resection of lateral neck cysts, mainly including the posterior occipital approach,[14] retroauricular hairline approach,[15] and anterior chest approach.[16] However, endoscope-assisted neck cystectomy still has some limitations for surgeons. For instance, two-dimensional imaging lacks a sense of space and depth, and straight, long endoscopic instruments could cause collisions frequently in such a narrow space.[17] Some of these limitations that emerged in endoscope-assisted surgery could be overcome by the Da Vinci robotic surgical system due to its three-dimensional (3D) imaging and Endo-wrist system, which would facilitate the surgical procedure. As reported, a transaxillary and retroauricular approach for thyroglossal duct cysts,[18,19] a postauricular facelift incision for branchial cleft cysts,[20] a transoral approach for vallecular cysts,[21] thyroglossal duct cysts[22] and second branchial arch cysts[23] have been applied by robot assistance.

On the basis of our experiences with endoscopic-assisted cervical operation, our surgical team launched robot-assisted resection of lateral neck cysts through a postauricular approach. This study introduces our preliminary experiences with this approach since July 2018.

METHODS

Since July 2018, 11 patients with lateral neck cysts have accepted robot-assisted surgery via a postauricular approach in the Department of Otolaryngology of our Hospital. Most patients presented a painless sphere-like, fluctuant, or soft cervical mass. Comprehensive physical examination together with ultrasonography is usually carried out to ascertain the cystic nature of the lesion. Computed tomography (CT) or magnetic resonance imaging (MRI) could provide spatial information, volume, and extent of the mass, especially its relationship to the surrounding carotid sheath (Table S1 and Figure 1A,B).

All operations were carried out by a single surgeon using the Da Vinci surgical system. The inclusion criteria included the following: (1) clear boundary of neck cysts; (2) no history of neck surgery, radiotherapy, or burns; and (3) strong esthetic intention. The exclusion criteria included (1) neck cysts with unclear boundaries, acute inflammation, or fistula; (2) previous surgery or radiotherapy on the neck; and (3) contraindications for general anesthesia.

Before the operation, the parents or their guardians were offered three surgical approaches for lateral neck cysts: a conventional open approach and an endoscopic or robot-assisted approach via a postauricular incision. All patients or their guardians were also informed of the benefits and drawbacks of each approach, and these 11 patients preferred robot-assisted surgery and provided their full informed consent. Clinical information, including age, sex, size and site of cervical cysts, pathological results, bleeding volume, operation time, and hospitalization time, was collected for analysis.

Surgical procedures

Instruments

Da Vinci robotic surgical system (Intuitive Surgical Inc.) is employed with four arms. In addition, an electrical knife, pipette, and adjustable retractors are also used in this operation.

Anesthesia and patient positioning

All patients accepted general anesthesia and then were placed in the supine position, with the head rotated to the contralateral side of the operation (Figure 1C).

Surgical incision

Methylene blue was used to mark the designed postauricular incision, which originated from the mastoid 2 cm behind the ear, turned posteriorly at the upper third level of the auricle, and followed the occipital hairline without a horizontal portion. At a total length of approximately 6–8 cm, a skin incision was made following the mark according to the size and site of the lateral cysts (Figure 1C).

Skin flap separation

The skin flap was separated in the direction of cervical cysts under the platysmal layer and elevated by a retractor over the sternocleidomastoid (SCM). Separation boundaries of flaps could reach the midline of the neck anteriorly, the level of the cricoid cartilage inferiorly, and the lower border of the mandible superiorly. During the surgical procedure, in cases where the cyst is situated in the upper neck region, it is generally deemed sufficient to separate the flap to the level of the cricoid cartilage. Conversely, when dealing with a cyst in the lower neck, downward separation to the lower

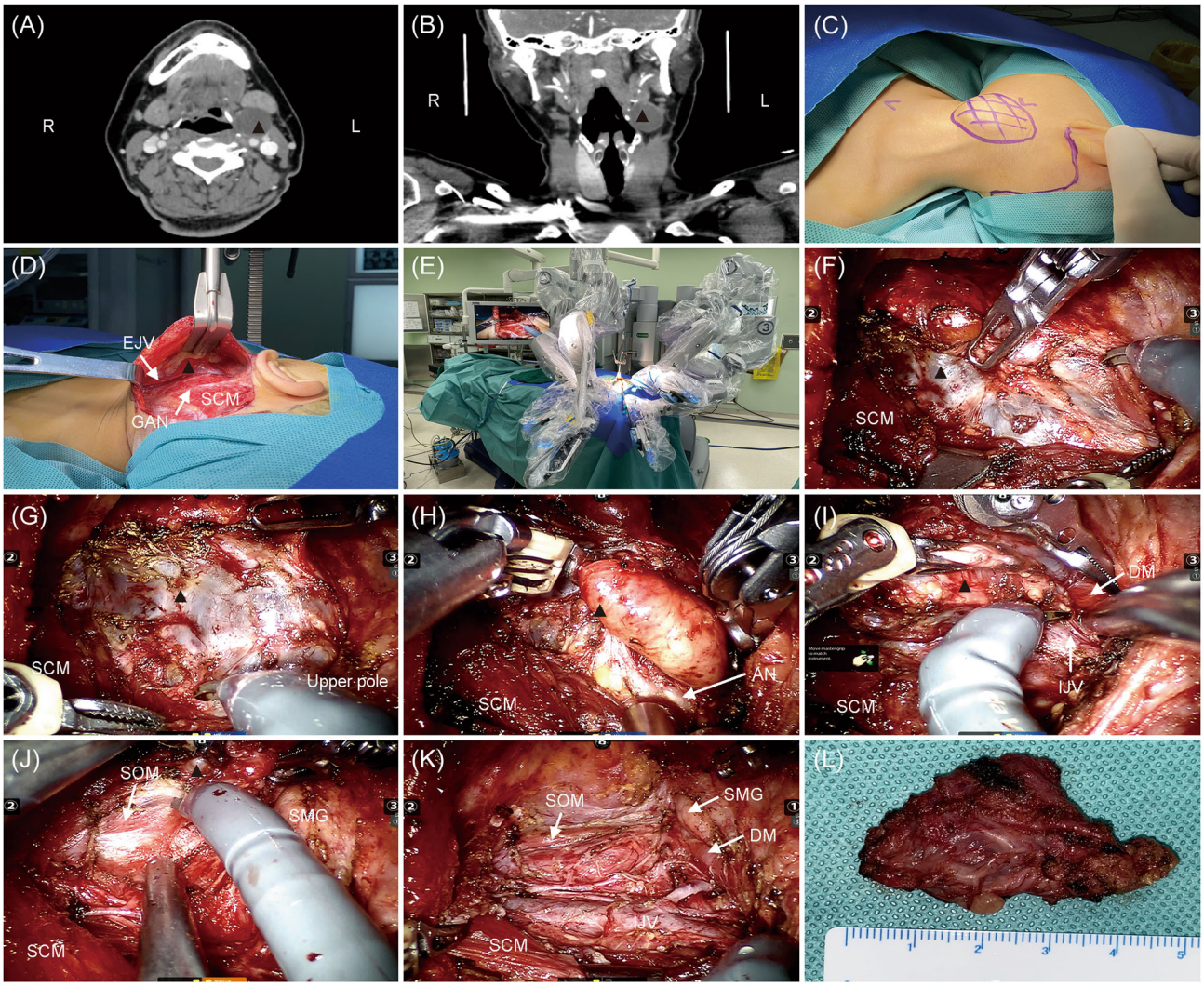

FIGURE 1 Surgical excision of the lateral cervical cyst. (A) and (B) Computed tomography (CT) to determine the size and extent of the mass and to demonstrate its relationship to surrounding structures. (C) The patient was placed in the supine position under general anesthesia, with the head rotated to the contralateral side of the approach. methylene blue was used to mark the designed postauricular incision. (D) Elevated skin flap under the platysma over the sternocleidomastoid muscle (SCM) under direct vision. The external jugular vein (EJV) and greater auricular nerve (GAN) were protected (▲cervical cysts). (E) Three robotic arms were docked through the postauricular incision port. (F) The SCM muscle and the posterior belly of the digastric muscle were fully exposed and adequately retracted to fully expose the neck cysts. (G) The upper pole and lower pole of the cyst were usually dissected. (H) The cyst was peeled from the deep connective tissues, and the accessory nerve (AN) was protected. (I) The upper pole of the cyst was located superior to the posterior abdomen of the digastric muscle (DM) and deep to the internal jugular vein (IJV). (J) The cyst was turned from back to front and dissociated from the scapulohyoid muscle (SOM) and submandibular gland (SMG). (K) Complete removal of the cysts. (L) The cyst was removed from the operation space.

border of the cyst may be deemed appropriate. Attention was given to protect the external jugular vein (EJV) and the great auricular nerve (GAN) during the separation of the skin flap (Figure 1D).

Docking the robotic arms

An external retractor with a lift system was inserted into the operation space, providing a wide space for robotic arms and full exposure for surgeons. Three robotic arms were then docked through the postauricular incision ports. A dual-channel 30° endoscope was installed on the camera arm, electric scissors were installed on the first arm, a Maryland bipolar dissector was on the second arm, and grasp forceps were on the third arm (Figure 1E and Figure S1).

Exposure and excision of cysts

After docking of the robotic arms and instruments, the cyst was lifted up by grasp forceps, and its posterior margin was resected (Figure 1F), which was usually under the anterior margin of the SCM. SCM and the posterior belly of the digastric muscle (DM) were

retracted for full exposure of the upper and lower poles of the cyst (Figure 1G). The spinal accessory nerve (AN) was identified and protected where it entered the SCM muscle (Figure 1H). Then, the upper pole of the cyst was usually dissociated, and the cyst was separated from the connective tissues. During this process, attention should be given to avoid injuring the structures beneath the neck cysts, such as the internal jugular vein (IJV) (Figure 1I), common carotid artery, and vagus nerve (Figure 1J).

Management of the surgical cavity

When cysts were completely removed, the operation space was washed with plenty of normal saline followed by adequate hemostasis (Figure 1K,L). Negative pressure drainage was placed before suturing.

RESULTS

This was a retrospective study of 11 patients with lateral neck cysts in our hospital, from July 2018 to October 2023, including seven females and four males. All patients accepted robotic-assisted neck cyst resection via a postauricular incision. All operations were successful without intraoperative conversion to open operation.

The median age of the patients was 22 years old (3–48 years) at surgery. The volume of the cervical cysts ranged from (3.0 × 2.7 × 0.7) cm to (5.0 × 3.0 × 2.2) cm. The incision was 6.67 cm (6–8 cm) in length on average. The average bleeding volume during the operation was 15.5 mL (10–20 mL), and the mean operating time was 55 min (45–90 min). The negative pressure drainage tube was pulled out 48–72 h (mean 67.6 h) after the operation, and the mean hospitalization time was 3.4 days (ranging from 2 to 4 days). Pathologically, nine patients were diagnosed with a second branchial cleft cyst (six right and three left) and two with cystic lymphangiomas (left) (Table 1).

The wound was well-healed without evidence of infection, seroma, hemorrhage, or necrosis of the retroauricular skin flap. Four patients (36.3%) developed postauricular numbness after the operation, and all recovered over 3 months. There were no injuries to the vagus nerve, accessory nerve, or marginal mandibular branch of the facial nerve. The cosmetic outcomes were satisfactory for the patients or parents after surgery. No recurrence or adverse effect for neck development was observed during a mean follow-up of 38.2 months (range: 27.9–68.0 months) (Figure 2).

TABLE 1 The clinical characteristics of the patients.

Characteristics	Cases
Age (years)	22 (3–48)
Gender	
Male	4
Female	7
Cysts type	
Second branchial cleft cyst	9
Cystic lymphangiomas	2
Volume of the cervical cysts (cm^3)	3.0 × 2.7 × 0.7–5.0 × 3.0 × 2.2
Incision length (cm)	6.67 (6–8)
Bleeding volume (ml)	15.5 (10–20)
Operating time (min)	55 (45–90)
Time to extubation (hour)	67.6 (48–72)
Hospitalization time (day)	3.4 (2–4)

DISCUSSION

With the improvement and application of endoscopic instruments, endoscope-assisted resection of neck lesions has been widely applied in clinical practice. A diversity of hidden surgical approaches, including axilla, breast, and anterior chest,[20] have been employed to avoid visible scars in the neck, which have been considered minimally invasive, safe, effective, and feasible. However, the surgeon carries long instruments and performs the operation through a long and narrow working port, affecting the precision of the operation to some extent.

In recent years, the postauricular approach has been employed to carry out robot-assisted resection of neck cysts.[18,20,24] The Da Vinci Surgical System is an outstanding robot-assisted surgery system with many advantages. First, it has two flexible endoscopic arms that allow operations to be performed freely and precisely within a narrow working space. In addition, the endoscopic arms are also equipped with two integrated cameras, which can provide the surgeon with a clear operative field through a single retroauricular incision. The Da Vinci Surgical System can significantly avoid the "lever effect" and collisions. In addition, it reduces hand tremors, allows fine motion scaling and multiarticulate motion, and improves the precision and accuracy of operation. Meanwhile, the surgeon could conduct the surgery remotely from the console, increasing a sense of comfort. On the basis of our experience with endoscopic-assisted surgery for lateral neck cysts,[14,16] we carried out robot-assisted resection for 11 patients since 2018. All operations were successfully conducted and no intraoperative conversion to open operation was performed. Therefore, robot-assisted resection of lateral neck cysts is feasible.

Lateral neck cysts may develop recurrence due to incomplete resection of the cyst, including residual fistula, epithelial tissue, and intraoperative cyst rupture,[3] especially for second branchial cleft cysts. It has been reported that the recurrence rate after resection of the second branchial cleft cysts is lower than 3%.[25] In our robotic-assisted opinion, the significant advantage of magnification of 3D views contributes to recognizing the fistula or cystic wall, facilitating the recognition of the tissue of the fistula or cystic wall. The cystic masses were resected entirely without any residual tumor. No evidence of patient recurrence was observed during the follow-up period. Thus, application of the robot system could be beneficial for comprehensive resection of lateral neck cysts.

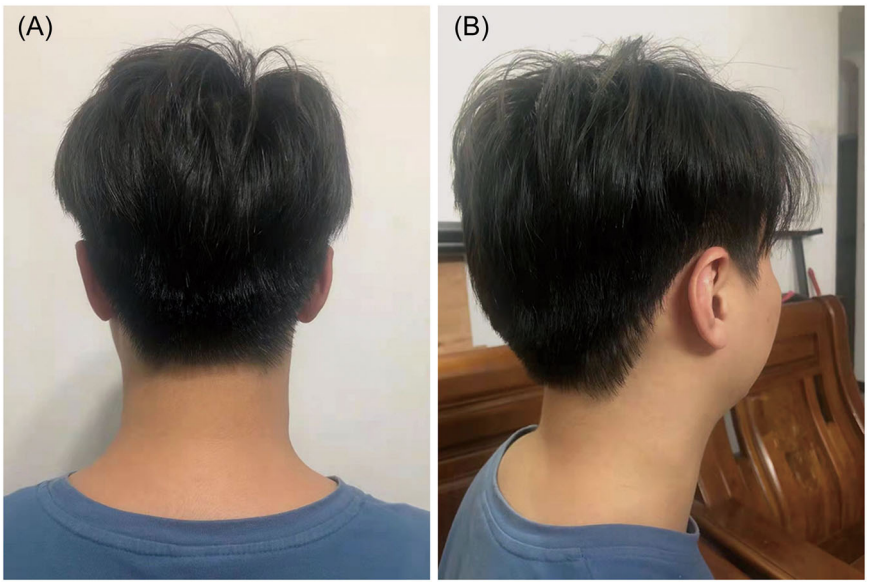

FIGURE 2 Outside view of a patient after 2-year follow-up period. (A) and (B) The postauricular scar was concealed behind the auricle and hair and yielded satisfied cosmetic outcomes.

Significant bleeding, great auricular nerve injury, and postauricular skin necrosis are potent complications of this approach. A postauricular incision should be designed optimally to avoid sharp angle forms and the incidence of flap necrosis. Lateral cervical cysts, including second branchial cleft cysts and cystic lymphangiomas, can be related to vital vessels and nerves in the neck, such as the contents of the carotid sheath. With the help of the magnified 3D vision of the robotic system, it is much easier to recognize important nerves and blood vessels, excise neck cysts and obtain access to deep structures, avoiding injury to important anatomic structures. In our study, the bleeding volume was minimal, and no transient or permanent injury occurred to the marginal mandibular branch of the facial nerve or vagus nerve. However, four patients developed postauricular numbness after the operation, and all recovered over 3 months; thus, great auricular nerve injury was better protected during flap dissociation. In addition, no severe postoperative hypesthesia or paresthesia occurred in the skin flap area, and prolonged hospital stays were not necessary. Therefore, this surgical procedure is safe for adoption.

In the postauricular approach, the incision was located approximately 0.5 cm beneath the hairline so that the scar would be hidden after surgery. Even though incision hypertrophic scars along the hairline can occur after operation,[26] they can also be well hidden by the natural hair and auricle. In our series, all cases were satisfied with the postoperative outcomes without hypertrophic scars. Notably, care needs should be taken to the knife angle of the incision, avoiding damage to hair follicles and formation of scarring alopecia.

The disadvantage of the current robotic system can be attributed to a lack of tactile feedback and arm collisions when operating in a very narrow operation space.[27] In addition, purchasing and maintaining the instruments and consumables could be expensive, and a longer operating time also limits its universal application.[28,29] The sample of this retrospective study is still limited, and it is necessary to enroll more patients and to launch a prospective control study in the future.

CONCLUSION

Robot-assisted resection of lateral neck cysts by using a postauricular approach could yield excellent cosmesis and comprehensive resection without severe complications. It is technically feasible and could be considered an alternative choice for patients with lateral cervical cysts.

AUTHOR CONTRIBUTIONS

Ping Han was involved in study design and revising it critically for important intellectual content. Fa-Ya Liang collected pictures and revised the article. Pan Song was involved in data analysis and drafting the article. Ying Li contributed to data analysis and revising the article. Pei-Liang Lin revised the article and made suggestions. Ren-Hui Chen revised the article and made suggestions. Jian-Ming Fan collected clinical data of patients. Xiao-Ming Huang was involved in substantial contributions to conception and design, revising it critically for important intellectual content, and final approval of the version to be published.

CONFLICT OF INTEREST STATEMENT

Professor Xiao-Ming Huang is a member of the World Journal of Otorhinolaryngology – Head & Neck Surgery (WJOHNS) editorial board and is not involved in the peer review process of this article. The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

Publicly available data used in this study are described in the material and method. Further information is available from the corresponding author upon request.

ETHICS STATEMENT

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the ethics committee of Sun Yat-sen Memorial Hospital, Sun Yat-sen University (Ethics approval number: SYSKY-2024-237-01). Written informed consent was obtained from all patients.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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