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Endoscope-assisted extracapsular dissection of benign parotid tumors through a single cephaloauricular furrow incision versus a conventional approach

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Abstract
Background A few modified approaches have been reported for performing endoscope-assisted dissections of benign parotid tumors, but none that use incisions totally hidden in a natural furrow. This study evaluated the feasibility of performing endoscope-assisted extracapsular dissections of benign parotid tumors using a single cephaloauricular furrow incision.
Methods Forty-six patients with benign parotid superficial lobe tumors were randomly divided into two groups: an endoscope-assisted (21 patients) group or a conventional (25 patients) surgery group. Perioperative and postoperative outcomes of the patients were evaluated, including the maximum diameter of the tumors, length of the incision, operating time, estimated blood loss during the operation, amount and duration of drainage, satisfaction scores based on the cosmetic results, perioperative complications, and follow-up information.
Results The diameters of the tumors were comparable between the groups, and all operations were successfully performed as planned. The mean length of the incision in the endoscope-assisted group (3.6 ± 0.5 cm) was significantly shorter than that in the conventional group (9.1 ± 1.9). Meanwhile, the intraoperative blood loss, amount of drainage, perioperative complications, and cosmetic outcomes were all improved in the endoscope-assisted group. No tumor recurrence was found during 11–40 months of follow-up.
Conclusions Cephaloauricular furrow incisions were totally and naturally hidden in this procedure. Endoscope-assisted extracapsular dissections of benign parotid tumors via a small cephaloauricular furrow incision were found to be feasible and reliable, providing a minimally invasive approach and a satisfactory appearance.

Keywords Endoscopy · Cephaloauricular furrow incision · Parotid tumors · Extracapsular dissection

Benign parotid gland tumors account for the majority of parotid gland neoplasms [1, 2]. Conventional parotid surgeries begin with a modified Blair incision, an S-shaped preauricular and submandibular incision which not only leaves a large S- or Y-shaped scar at the incision site of some patients but also results in a significant amount of operational trauma, higher possibilities of facial paralysis, more bleeding, and longer operation times [3]. Therefore, patients often worry about not only the surgical invasiveness of the procedure but also about the possibility of postoperative scars, especially when a hypertrophic scar or keloid occurs on the naked surface of the face and neck.

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Additionally, there is a general consensus in the medical literature that Asian and African populations have a greater propensity for forming keloids and hypertrophic scars than Caucasian populations [4, 5].

In the past 20 years, advancements in minimally invasive techniques have allowed for better cosmetic outcomes and reductions in surgical morbidity [3, 5–8]. Endoscope-assisted surgery has emerged as the standard and most preferred technique in a number of surgical disciplines because of its advantages, including magnified, illuminated, and adequate operative views, decreased risks of injuring anatomic structures, significant decreases in scarring, and reduced wound healing times [9–14]. Lin et al. [15] reported the first endoscope-assisted surgery on the parotid gland via a short incision in 2000, which was followed by the development of modified approaches in recent years [3, 6–8, 16]. However, such operations are not yet standard procedures in the parotid region because of the anatomical complexity of this region and the fact that incisions cannot be totally hidden in an adjacent natural furrow. In this study, we present an endoscope-assisted approach for dissecting benign parotid tumors through a small cosmetic cephaloauricular furrow incision, and we compare the perioperative and postoperative outcomes of this procedure with those of patients undergoing parotid dissection via conventional approaches.

Materials and methods

Patients

Forty-six patients with benign parotid superficial lobe tumors admitted to the Department of Oral and Maxillofacial Surgery of Sun Yat-Sen Memorial Hospital between January 2012 and May 2015 were enrolled in this study. All patients were evaluated via ultrasound, computerized tomography (CT), or magnetic resonance imaging (MRI) and underwent aspiration biopsies of their parotid tumor before the operation. The inclusion criteria were a benign parotid superficial lobe tumor, no history of radiotherapy, and no preexisting facial paresis. Patients with suspicious malignant parotid tumors, sialadenitis in the acute inflammatory stage, and recurrent tumors were excluded. All patients consented to the procedure after they were fully informed about the advantages and disadvantages of both procedures. The patients were randomly divided into two treatment groups: endoscope-assisted dissections via a small cephaloauricular furrow incision or a conventional S-shaped preauricular and submandibular approach. The surgical procedures were approved by the Ethics Committee of Sun Yat-Sen Memorial Hospital. A single surgeon (Song Fan) performed all operations in this study.

Surgical technique

Surgical Instruments

The KARL Storz Endoskope system, with a 0° and 30° endoscope (4 mm diameter, 30 cm length; Stryker Endoscopy, San Jose, CA, USA), was used for tumor visualization during the operation. After the endoscopic instruments were introduced, an assistant was responsible for holding the endoscope. Harmonic scalpels were also used for tissue manipulation and dissection [5].

Endoscope-assisted extracapsular dissection

Under general anesthesia, the patient was placed in a supine position with the neck slightly extended by inserting a soft pillow under the shoulder and with the head inclined to the healthy side. A small cephaloauricular furrow incision was planned out and then made using a standard surgical scalpel (Fig. 1C). Generally, the length of incision was longer (0.5–1.0 cm) than the maximum diameter of the tumor, as assessed via MRI or CT scans. The incision was made from the earlobe along the cephaloauricular furrow and extended, at a maximum, to the convex point of the auricle.

When the incision reached the subcutaneous tissue, the skin flap was elevated anteriorly to expose the sternocleidomastoid (SCM) muscle, and the exposure of the superficial layer of the parotid gland was enabled using monopolar cautery under endoscopic visualization (Fig. 2A). The great auricular nerve was carefully identified and protected. Meanwhile, subcutaneous adipose tissue was dissected away as needed when the tumor was located just underneath the skin. To provide adequate visualization for the tumor dissection, the whole skin flap was separated to an extent that exceeded the size of the tumor (Fig. 3). After the working space was completely established, an assistant pulled the skin-subplatysmal flap away from the dissection site with a long, narrow retractor.

The next step in the procedure was to dissect the superficial layer of the parotid gland and identify the tumor. To preserve the integrity of the tumor encapsulation, some parenchymal tissue above the tumor was removed as needed when dissecting the tumors and associated connective tissue (Fig. 2B, C). Notably, a dissection was performed between the posterior region of the parotid gland and the SCM muscle when the tumor was located in the inferior lobe. However, the main trunk of the facial nerve was identified when the tumor was in the middle or superior lobe. Any peripheral branches of the facial nerve encountered were gently retracted away from the tumor, and the dissection plane was maintained only around the tumor. To enable a detailed dissection, a 30° endoscope

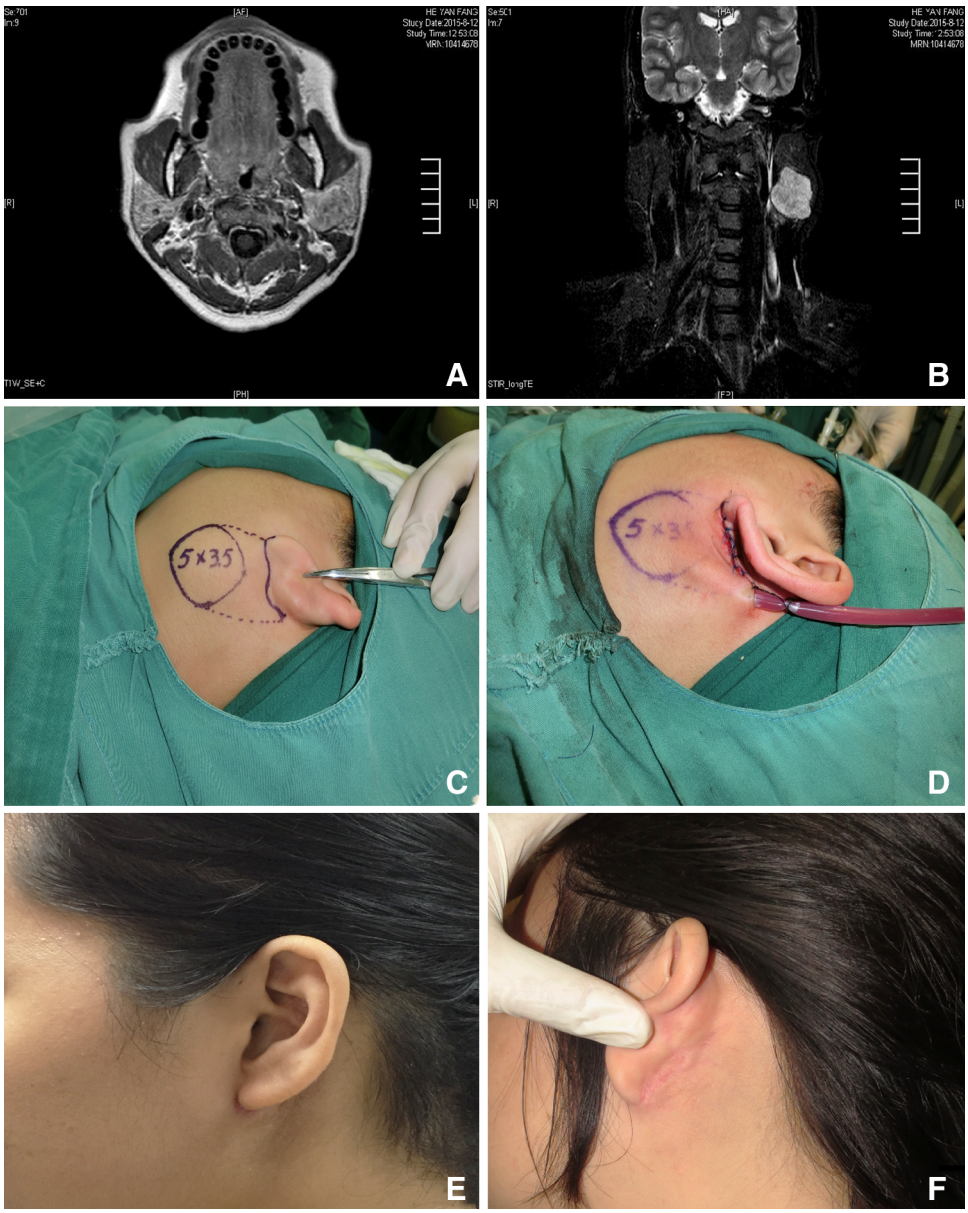

Fig. 1 **A**, **B** 34-year-old female patient presented with a 3.6 × 3.3 cm left parotid mass in MRI scan. The mass was confirmed to be a pleomorphic adenoma; **C** the incision design and the potential establishment of a working space; **D** a 4.5-cm incision was made along the cephaloauricular furrow and sutured; **E**, **F** postoperative scar was concealed in the cephaloauricular furrow was seen at a 3-month follow-up

was applied to provide adequate illumination and a magnified anterior, superior, and inferior view of the tumor. In addition, a nerve monitoring system (NIM 3.0, Medtronic Inc., Minneapolis, MN, USA) with 0.5 to 0.8 mA per stimulus was used as necessary. After tumor removal, the great auricular nerve (Fig. 2D) and peripheral branch of the facial nerve (Fig. 2E) were observed in the operative field and frozen-biopsy sampling was performed to confirm that the tumors were benign. Finally, the surgical field was irrigated and thorough bleeding control was performed, followed by the placement of a closed suction drain and the performance of cosmetic skin repair. After the operation, belladonna tablets were taken orally to reduce parotid gland secretion. Sutures were removed 7 days after the operation.

Conventional approach

The conventional approach was performed using an "S"-shaped preauricular and submandibular incision.

Monopolar cautery and a harmonic scalpel were used for flap elevation and ligation, consistent with the conventional procedure. The other steps were similar to those used in the endoscopic group.

Surgical outcome assessment

The perioperative and postoperative outcomes of the patients were evaluated, including the maximum diameter of the tumors, incision length, operating time, estimated blood loss during the operation, rate of conversion to an

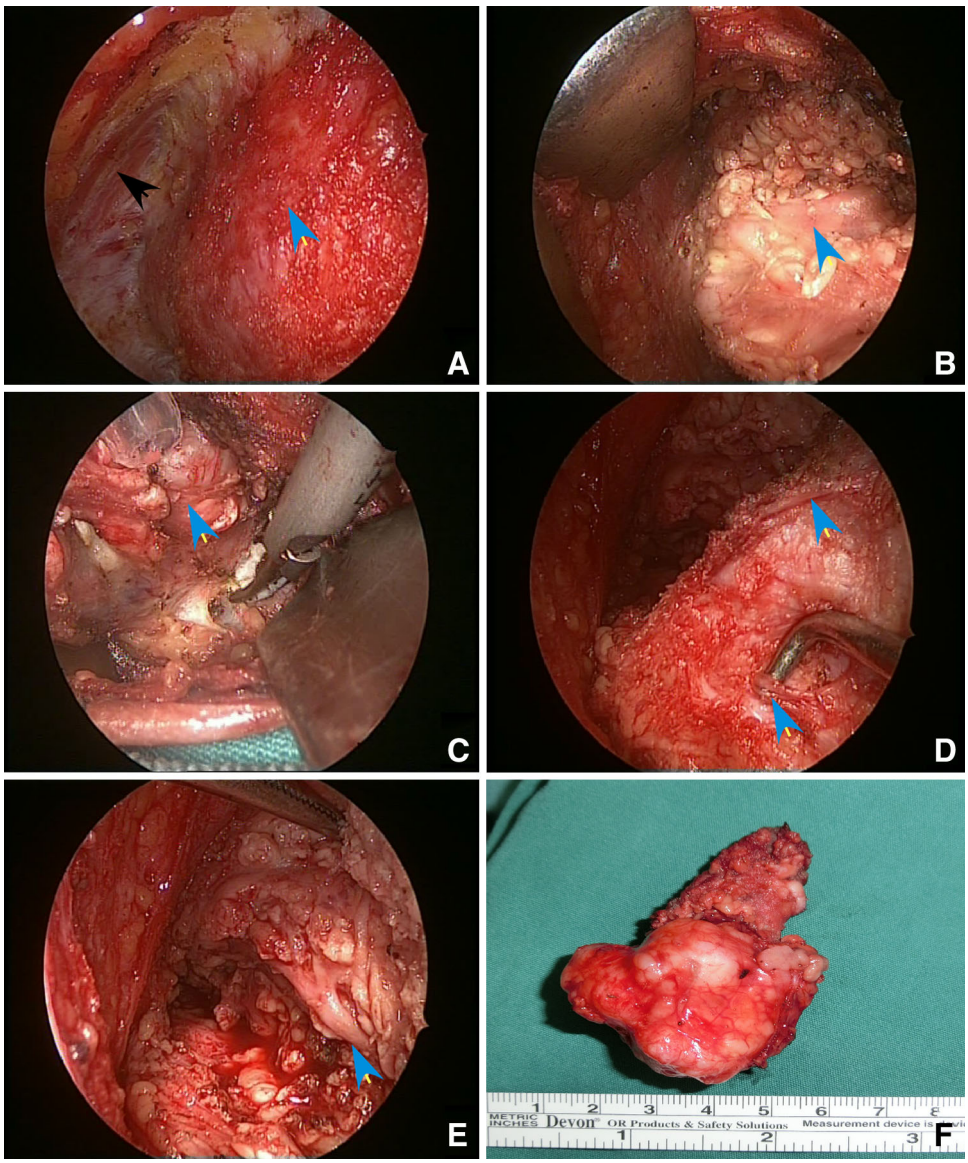

Fig. 2 **A** Scalp flap was dissected anteriorly to expose the sternocleidomastoid (SCM) muscle (*black arrow*) and the superficial layer of the parotid (*blue arrow head*); **B**, **C** exposure and dissection of the tumor; **D** the great auricular nerve; **E** mandibular branch of the facial nerve; **F** the specimen, a 3.6 × 3.3 cm mass with some parenchymal tissue above the tumor

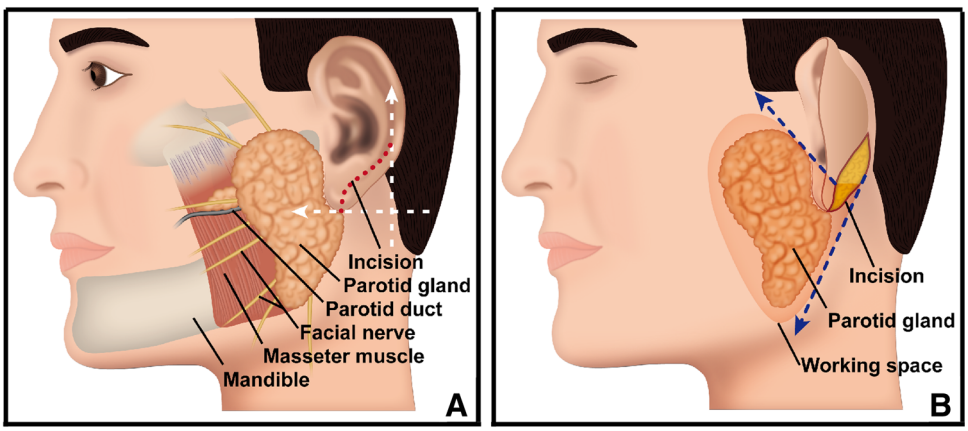

Fig. 3 Cephaloauricular furrow incision (**A**) and the working space (**B**) it provides, which covers the whole parotid field

open procedure (endoscope-assisted surgery), amount and duration of drainage, perioperative local complications, pathological results, satisfaction scores based on the cosmetic results, time of follow-up, and tumor recurrence. Postoperative drainage was measured every 24 h, and the drain was removed once the drainage was <20 ml per 24 h. A visual analog scale (VAS) was applied 1 month after surgery to assess patient's satisfaction with the appearance of their scar [5]. Student's *t* tests and Chi-squared tests were used for the comparisons between the two groups. Statistical analyses were performed using the SPSS 18.0 package (SPSS, Chicago, IL, USA), and a *p* value of <0.05 was considered to indicate statistical significance.

Results

The age, sex, and pathological results of the two groups were not significantly different (Table 1). The perioperative data and treatment outcomes are reported as the mean ± standard deviation unless otherwise indicated. All 21 cases of endoscope-assisted surgery performed via a small cephaloauricular furrow were successfully conducted without any conversion to an open procedure as a result of unexpected bleeding or the potential for nerve injury. The maximum diameters of the tumors were not significantly different between the two groups. However, there was a significant difference in the incision length between the two study groups ($p = 0.002$). The average incision length was 3.6 ± 0.5 cm (range 2.5–4.5 cm) in the endoscope-assisted group and 9.1 ± 1.9 cm (range 6.2–12.4 cm) in the conventional group. The mean operation times of two groups were comparable, but blood loss (23.6 ± 8.9 ml) and the amount of drainage (30.8 ± 8.7 ml) during endoscope-assisted surgeries were significantly different from the values in the conventional group (90.7 ± 34.3 ml and 54.9 ± 12.7 ml, respectively). The duration of drainage of the two groups showed no significant difference. Generally, the occurrence of perioperative complications, including postoperative numbness of the earlobe, temporary facial paresis, salivary fistulas, seromas/hematomas, Frey's syndrome, skin burns/necrosis, and wound infections, were

Table 1 Patient demographics, operative data, and follow-up results

Variable	Endoscopic group ($n = 21$)	Conventional group ($n = 25$)	*p*
Sex, male/female	14:7	15:10	0.641
Age (y), median (range)	38.7 (23.4–52.7)	43.3 (26.8–57.2)	0.624
Tumor diameter [cm (range)]	2.7 ± 1.6 (1.8–3.8)	2.8 ± 1.9 (1.4–4.3)	0.871
Length of incision [cm (range)]	3.6 ± 0.5 (2.5–4.5)	9.1 ± 1.9 (6.2–12.4)	**0.002**
Intraoperative blood loss (ml)	23.6 ± 8.9	90.7 ± 34.4	**<0.001**
Convert to open procedure	0	–	
Operation time [min (range)]	83.1 ± 21.3	79.4 ± 17.5	0.264
Amount of drainage (ml)	30.8 ± 8.7	54.9 ± 12.7	**0.026**
Duration of drainage (days)	2.6 ± 0.3	3.1 ± 0.8	0.814
Complications			**0.017**
Numbness of earlobe	2	7	0.151
Temporary facial paresis	2	6	0.252
Salivary fistula	1	2	
Seroma/hematoma	1	0	
Frey's syndrome	0	1	
Skin burn/necrosis	0	–	
Wound infection	0	0	
Pathology			0.861
Pleomorphic adenoma	12	13	
Warthin tumor	7	11	
Basal cell adenoma	2	0	
Benign lymphoepithelial lesion	0	1	
Satisfaction of appearance	9.1 ± 1.4	6.3 ± 2.6	**0.012**
Median follow-up [months (range)]	25 (11–39)	27 (12–40)	0.915
Tumor recurrence	0	0	

Bold values are statistically significant ($p < 0.05$)

significantly different between the two groups, and morbidities involving numbness of the earlobe and temporary facial paresis were more frequent in the conventional group. All patients in the endoscope-assisted group were significantly more satisfied with their cosmetic outcomes than were the patients in the conventional group ($p = 0.012$), and no tumor recurrence was found over a median follow-up period of 25 months in the endoscope-assisted group and over 27 months in the conventionally treated group.

Discussion

The traditionally recommended procedure for removing small benign tumors located in the superficial lobe of the parotid gland is a superficial or partial parotidectomy [17]. Parotidectomy is a well-established surgical technique and is performed using an S-shaped, Y-shaped, or facelift incision to allow for complete tumor resection with a safe facial nerve dissection. However, it involves a long and obvious incision and a high degree of surgical trauma, which does not conform to the principles of modern surgery: minimal invasiveness.

The advent of minimally invasive techniques began in the 1980s, and minimally invasive surgical techniques have been attracting interest in all surgical specialties, including abdominal, thoracic, and, most recently, head and neck surgery [5]. Recently, the endoscope-assisted extracapsular dissection of benign tumor has been reported [3, 6, 7, 15, 18]. Endoscopic techniques provide a magnified, illuminated, and adequate operative view, allowing the surgeon to identify pertinent anatomical features more easily and thus perform a detailed surgical dissection. Meanwhile, extracapsular dissection is an alternative approach for removing neoplasms that involves a detailed dissection immediately outside the tumor capsule and preserving the facial nerve, which is distinct from procedures involving enucleation or traditional parotidectomies [6]. In extracapsular dissections, the uninvolved parotid parenchymal tissue is preserved, extensive facial nerve dissections are avoided, and the tumor is removed with an intact capsule. This technique also allows for an increased preservation of parotid secretory function. Although extracapsular dissection has been considered with caution because of the traditional view that some parotid tumors (notably pleomorphic adenomas) can breach their capsule, theoretically increasing the risk of recurrence following surgeries close to the capsule, previous reports have shown no difference in recurrence rates between extracapsular dissections and conventionally superficial parotidectomies [6, 19, 20]. However, at present there is no unified standard incision for endoscopic parotidectomies, which is a technique that is still in the exploratory stage.

A few approaches have been reported for endoscope-assisted dissection of parotid surgery [3, 6–8]. We think the following aspects must be considered when planning the incision. First, endoscopic surgeries are suitable for places that have natural cavities, which the parotid gland area does not have. Therefore, the explored approach needs to first create an adequate working cavity to perform the endoscopic surgery. In the present study, we found that cephaloauricular furrow incisions from the earlobe to the convex point of the auricle could span the entire region of the parotid gland. Meanwhile, it is also beneficial to rapidly and successfully make a good working space above the superficial layer of the parotid and to make sure that the great auricular nerve is carefully identified and protected. Second, the key point of endoscope-assisted parotid surgery is to safely dissect the tumor without facial nerve damage. As we mentioned previously, extracapsular dissections that maintain the surgical plane around the tumor is beneficial for protecting facial nerves. In our procedures, we made incisions 0.5–1.0 cm longer than the maximum diameter of the tumors and used a 30^0 endoscope to achieve good illumination and magnification in anterior, superior, and inferior views of tumors. All these procedures allow for a detailed tumor dissection and for nerves to be identified. Third, surgeons should aim to strike a balance between scarless surgery and minimal invasiveness [5] and should choose an approach that takes both factors into account. As far as we know, only endoscope-assisted extracapsular dissections using only hairline incisions result in concealed scalp scars [6]. However, a hairline approach involves a greater distance from the incision to reach the site of the dissection, which leads to desirable neck cosmesis at the cost of a possible increase in soft tissue dissection. In the present study, cephaloauricular furrow incisions were located close to the operative fields and were frequently invisible even if a hypertrophic scar developed because they were hidden by the auricle and hair. All of patients in the endoscopic group were satisfied with the incision scar. Importantly, compared with the conventional group, the length of the incision was shorter, the intraoperative bleeding volume and amount of drainage were reduced, and the incidence of complications was lower. Therefore, we think that the cephaloauricular furrow approach is superior to conventional techniques in regard to surgical invasiveness.

There were some limitations in this study. First, the sample size and follow-up was limited which may attribute the bias of the results, and we think a larger series of patients with longer follow-ups should be evaluated in a future study. Second, we found that the maximum cephaloauricular furrow incision was 4.5 cm in our patient population. It will be difficult to apply this approach to patients with larger tumors. Third, compared with hairline

incisions for endoscopic surgery, the cephaloauricular furrow provides a limited surgical space. We have presented several advanced techniques for endoscope-assisted surgeries [5, 21], and we explored there use in the approach described in the present study. Fourth, with the popularization of robotic surgery, we also think robot-assisted dissections through cephaloauricular furrow incision should be investigated in the further study.

In conclusion, cephaloauricular furrow incisions are totally hidden by the auricle. Endoscope-assisted extracapsular dissections of benign parotid tumors via a small cephaloauricular furrow incision are technically feasible and reliable, with satisfactory cosmetic results and minimal invasiveness.

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Compliance with ethical standards

Disclosures Song Fan, Guo-kai Pan, Wei-liang Chen, Zhao-yu Lin, Fa-ya Liang, Qun-xing Li, Da-ming Zhang, You-yuan Wang, Han-qing Zhang, Wei-xiong Chen, Rui Chen, Xiao-ming Huang, Jian-tao Ye, and Jin-song Li have no conflict of interest or financial ties to disclose.

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