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Non-Robotic, Endoscopic Hemi-Thyroidectomy via Retro-auricular Single-incision Approach : A Preclinical Feasibility Study in Cadavers

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후이개 절개를 이용한 내시경 갑상선 절개술-전임상 사체연구

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= **국문초록** =

목 적

CO2 가스 삽입 없이 내시경 보조 갑상선 절제술, 특히 액와 절개를 이용하는 경우의 대부분은 기구 사용을 용이하게 하기 위하여 흉부 또는 유륜에 절개를 넣어 시행하는 것이 대부분이다. 본 연구는 후이개 절개를 통하여 추가적 절개 없이 내시경을 이용한 갑상선 절제술 및 중심 임파선 절제술이 가능한지의 여부를 사체연구를 통하여 확인해 보고자 한다.

방 법

사체 이용 해부 및 수술. 후이개 내시경 보조 갑상선 절제술이 가능한지의 확인은 수술 시야 및 접근성, 수술 완성도, 그리고 주요 구조물의 보존 여부인 3가지 항목으로 평가하였다.

결 과

수술 시야는 기구를 다루고 수술을 하기에 충분하였으며, 추가 절개 없이 수술을 완성할 수 있었다. 절제된 갑상선 조직의 피막은 손상되지 않았으며, 잔존 갑상선 조직이 없음을 수술 부위를 통하여 확인하여, 수술의 완성도 여부를 평가할 수 있었다. 모든 사체에서 되돌이 후두신경 및 상 또는 하부갑상선의 보존을 확인하였으며, 주변 구조물들의 손상이 없음을 확인하였다.

결 론

로봇이 아닌 후이개 절개를 이용한 내시경 보조 갑상선 절제술은 시행 가능한 접근법 및 수술방법이라 사료된다.

중심 단어 : 내시경 · 후이개절개 · 갑상선 · 중심임파선.

Introduction

Endoscopic or robotic thyroid surgery is now accepted as an alternative to conventional open thyroidectomy because it offers a better cosmetic result. Most gasless endoscopic thyroidectomies, especially via transaxillary or axillo-breast approach, require an additional incision on the chest or mam-

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mary areola for instrumentation and to facilitate the procedure.[1-3)]

Facelift incision which has cosmetic benefit has been used for the parotidectomy[4,5)] and benign neck mass excision,[6)] and is familiar to head and neck surgeons. Recently, Terris et al. developed a robotic facelift thyroidectomy technique.[7-9)] This surgery has several advantages, including decreased invasiveness compared to the previous transaxillary approach, familiar anatomy and surgical approach, and fewer complications. However, endoscopic hemi-thyroidectomy via retro-auricular single incision approach without robotic assistance has rarely been described in the literatures.[10)]

We aimed to evaluate the preclinical feasibility of non-robotic, endoscope-assisted hemi-thyroidectomy and central neck dissection via a retro-auricular single incision approach in cadavers. To identify feasibility, the three categories of accessibility, surgical completeness, and preservation of adjacent structures were evaluated.

Materials and Methods

1. Cadavers

Three fresh, unembalmed human cadavers were obtained from the Department of Anatomy of The Catholic University of Korea. The three cadavers were male. The causes of death were cardiovascular disease in one and old age in two cadavers. The absence of prior neck surgery was confirmed by the lack of a neck scar.

2. Equipment and Instruments

A 5-mm, 30-degree rigid telescope(Olympus, Tokyo, Japan) was used for visualization of the surgical field. Endoscopic instruments such as Babcock forceps, right-angled forceps, and short Maryland forceps(Olympus, Tokyo, Japan) as well as a Harmonic scalpel(Johnson and Johnson, Cincinnati, OH) were used. To create working space, an external retractor(Marina Medical, Sunrise, FL) was used.

3. Surgical procedure

1) Positioning and creation of the working space

With a cadaver placed in the supine position, the neck was slightly extended and rotated in the counter direction. Landmarks such as mandible angle, thyroid cartilage, cricoid cartilage, and sternal notch were marked. The retro-auricular incision was curved posteriorly at the level of the tragus to avoid an acute angle, and the occipital direction incision was continued inferiorly behind the hairline(Fig. 1A). Dissection was performed inferiorly to the clavicle and sternal head of the sternocleidomastoid muscle(SCM) and laterally to the lateral border of the inferior portion of the SCM. The SCM was fully dissected down to the clavicle. In the postero-superior portion, the subcutaneous flap was performed at neck level Va. Dissection was performed superiorly to the superior border of the thyroid cartilage below the submandibular gland(SMG), and the midline dissection was performed medially(Fig. 1B). The skin flap was elevated under direct vision above the external jugular vein and greater auricular nerve to access the subplatysmal plane. After creating working space, the 5-mm, 30-degree telescope was placed face-down at the center and was held by the assistant surgeon. The SCM was fixed to the posterior skin by suture for lateral retraction(Fig. 2A). Right-angled forceps and a Harmonic device were used to dissect the strap muscles alternatively in the dominant hand, and short Maryland forceps was used in the non-dominant hand. The omohyoid muscle was identified and positioned superiorly (Fig. 2A). After identification of the lateral border of the sternohyoid and sternothyroid muscle, the retractor was inserted

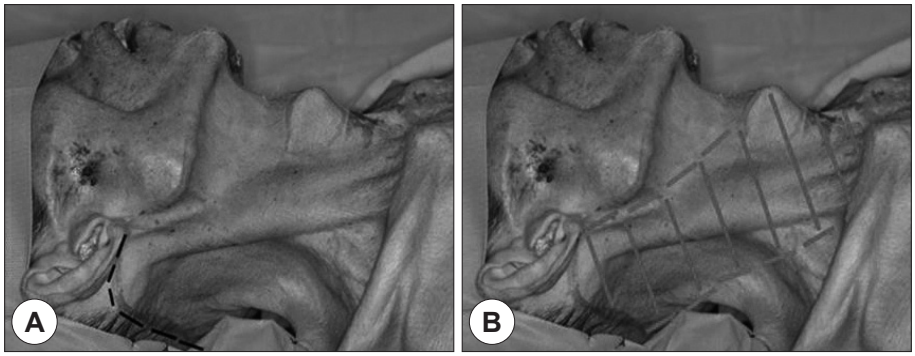

Fig. 1. Retro-auricular incision and dissection area. A : The retro-auricular incision curved posteriorly at the level of the tragus, and the occipitally directed incision was continued inferiorly behind the hairline(broken line). B : Subplatysmal flap dissection was performed within the marked area.

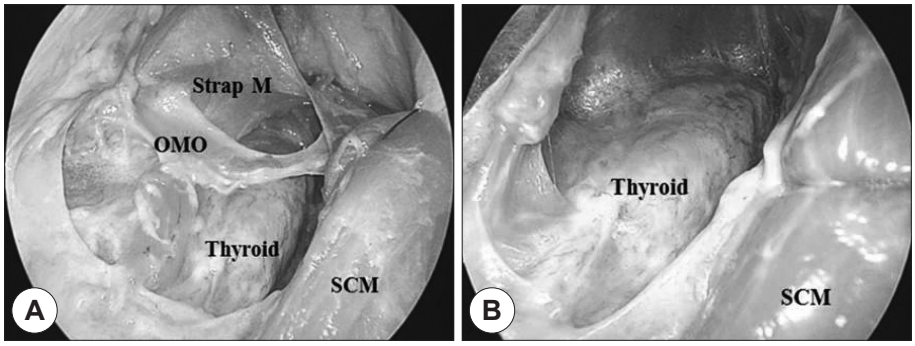

Fig. 2. Skin flap and working space. A : The sternocleidomastoid muscle(SCM) was fixed to the posterior skin by suture. The omohyoid muscle(OMO) was dissected and positioned superiorly and ventrally. B : The thyroid gland was visible after the retractor was applied under strap muscles.

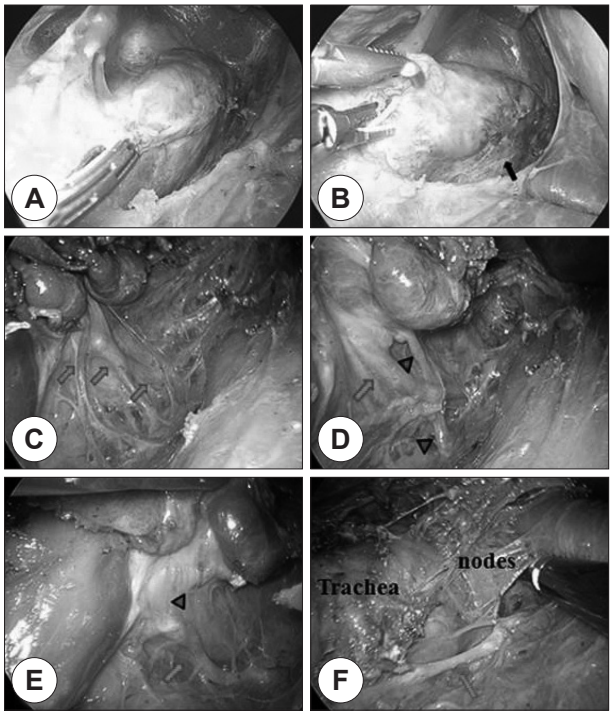

Fig. 3. Surgical procedures. A : The dissection of the superior vascular pedicle was performed by a Harmonic device. B : The superior parathyroid gland(arrow) was identified and left intact. C : The recurrent laryngeal nerve(arrows) was identified naturally during the dissection of the peri-thyroid fascia. D : Inferior thyroid artery(arrowheads) crossed the recurrent laryngeal nerve(arrow). E : Recurrent laryngeal nerve(arrow) was positioned ventrally before dissection near the Berry ligament(arrowhead). F : Central neck node dissection was performed in a superior to inferior fashion with preservation of the recurrent laryngeal nerve(arrow).

underneath these muscles and fixed. Then the thyroid gland was visualized(Fig. 2B).

2) Endoscopic hemi-thyroidectomy and central neck dissection

Surgical procedures were performed by one operator(S.Y. Lee). The surgical procedure began with isolation and ligation of the superior pedicle. With careful manipulation, the superior pole was fully exposed(Fig. 3A). The superior thyroid vessels were divided close to the thyroid gland using the

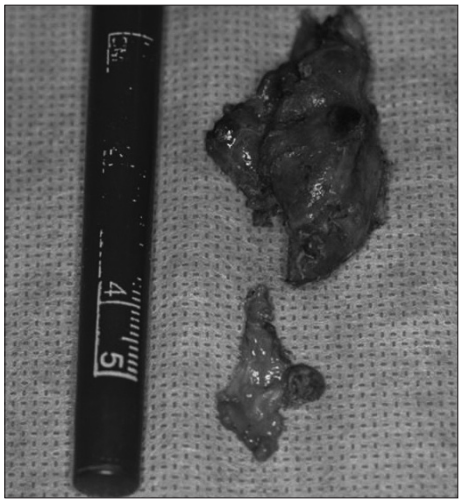

Fig. 4. Specimens of the hemi-thyroid and central nodes.

Harmonic device to avoid injury to the external branch of the superior laryngeal nerve. The thyroid gland was then retracted dorsally. Dissection was performed in a superior to inferior fashion. The superior parathyroid gland was identified during dissection and was left(Fig. 3B). Dissection close to the peri-thyroid fascia was performed using an endoscopic dissector and the Harmonic device. During dissection, the inferior parathyroid gland was identified and left. The recurrent laryngeal nerve(RLN) was identified within the dissected fascia during the dissection because of the peri-thyroid fascia dissection(Fig. 3C). The 5-mm telescope was moved inferiorly to enable dissection in a lateral to medial fashion, which is a familiar approach for surgeons. After identification of the RLN, careful dissection of the lower pole of the thyroid was performed. The inferior thyroid artery was divided close to the thyroid gland to avoid injury to the RLN(Fig. 3D). Finally, near Berry's ligament, the RLN was placed ventrally(Fig. 3E), and great care was taken to avoid thermal injury by the Harmonic device. The thyroid gland was fully mobilized, and was dissected from the trachea and the isthmus

using the Harmonic device. Ipsilateral central neck dissection was performed from superior to inferior with preservation of the RLN(Fig. 3F). The specimen was extracted through the skin incision(Fig. 4).

Results

Hemi-thyroidectomy and ipsilateral central neck dissection were done on the right side in two of the cadavers and on the left in the other. The mean procedure time was 80 minutes from skin incision to specimen out.

The feasibility of endoscopic hemi-thyroidectomy through a retro-auricular single-incision approach was verified by assessing the accessibility, surgical completeness, and preservation of adjacent structures. After incision and flap elevation, adequate working space was created with the retractor, and no additional incision was needed. With the 5-mm telescope, the working space was relatively large and could be alternatively positioned during surgery. During the central neck dissection, RLN was easily isolated and preserved with a magnified view. Accessibility through the retro-auricular single incision approach was identified. To confirm surgical completeness, we inspected the thyroid specimen and surgical field. After thyroidectomy and central neck dissection, the specimen was observed to determine whether the thyroid capsule was disrupted. Further, we assessed the surgical field to determine whether remnant thyroid tissue remained. There was no capsule injury in the specimen and no remnant thyroid tissue in the surgical field. We inspected the preserved structures and surveyed for complications. In all thyroidectomies, structural preservation of the RLN and superior or inferior parathyroid glands was identified. There was no tracheal or esophageal injury. The internal jugular vein was not injured and was kept intact. No skin flap injury was identified.

We successfully performed hemi-thyroidectomy and central neck dissection in all three cadavers.

Discussion

Conventional thyroidectomy requires an anterior neck incision and leaves a prominent scar on the neck. As the incidence of thyroid disease which is required surgical treatment is increasing, an endoscopic or robot-assisted remote approach is now accepted as an alternative to conventional open thyroidectomy because of cosmetic benefit. The most representative remote access is through the axillary incision, which is intended to minimize scar visibility. However, this approach has several disadvantages for both the surgeon and the patient. For example, possibility and worries of major complications including injury to the brachial plexus and arm paralysis, injury to the pectoralis muscle fascia, or perforation of the esophagus or trachea have been reported.[11] An unfamiliar anatomical approach for the surgeon can contributes to these complications. Patient safety should take precedence over cosmetic results. Recently, Terris DJ et al. developed a robotic facelift thyroidectomy technique.[7-9] This surgery has several advantages including decreased invasiveness compared to the previous axillary approach, familiar anatomy and surgical approach to the surgeon, and fewer complications.

Single-incision surgery with a robotic system has been well described. However, most gasless non-robotic, endoscopic thyroidectomies require additional incision on the chest or mammary areola for instrumentation and to facilitate the procedure.[1-3,12-14] In this study, a single retro-auricular incision enabled endoscopic hemi-thyroidectomy and central neck dissection without an additional incision. When there is sufficient height, usually over 4 to 5-cm, and enough working space, an additional incision or port may not be needed. However, we performed the procedure only in elderly cadavers which had little subcutaneous fat. Thick subcutaneous fat and skin flaps would complicate the ability to have sufficient height or enough working space. Further verification should be needed whether this approach will be feasible for a heterogeneous cohort of patients such as obese or patients who have a prominent SCM muscle.

For better instrumentation and larger working space, the hairline incision may extend inferiorly, and then the endoscope can be variously positioned. Using a smaller diameter (5-mm) telescope instead of a 10-mm rigid endoscope which usually using the robotic surgery resulted in a relatively larger working space. Making enough working space is important for instrumentation and for patient's safety.

When compared with robotic thyroidectomy, endoscopic procedure gives some benefits such as tactile feedback. With familiar anatomy and tactile feedback, adjacent key structures such as the trachea and esophagus can be more easily identified and preserved. During the dissection near the Berry ligament, a lateral to medial dissection as in conventional open thyroidectomy could be performed by moving the endoscope inferiorly. And the cost will be much lower than the ro-

botic procedure.

The advantages of a retro-auricular approach compared to an axillary approach are the complete elimination of the possibility of brachial plexus injury,[15] familiar anatomy for the surgeon, and a comparable cosmetic benefit. In this study, central neck dissection through the retro-auricular incision was performed in a superior to inferior manner, and the RLN was preserved with good visualization of the inferior aspect. However, through the previous axillary approach, endoscopic central neck dissection seems to be occasionally difficult especially in a patient who has a prominent clavicle.[16]

The retro-auricular incision is placed posteriorly, so surgeons can be concerned about complications such as skin flap necrosis, alopecia, and ear lobe deformities. In our previous study, with this incision, skin necrosis is extremely rare, and an acute angle between the retro-auricular and hairline incisions should be avoided.[5]

Postoperative or functional outcomes such as postoperative voice function, serum Tg, parathyroid hormone or calcium level of this specific operative technique cannot be addressed naturally in cadavers. Further investigation will be needed.

In conclusion, our study demonstrates the feasibility of using non-robotic, endoscope-assisted hemi-thyroidectomy with a gasless, retro-auricular single-incision approach by presenting results on the accessibility, surgical completeness, and preservation of adjacent structures. Non-robotic, endoscopic retro-auricular approach is feasible with complete thyroid removal and structural preservation of the RLN and parathyroid glands.

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