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Complex reconstruction technique applied in advanced head and neck cancer

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Abstract

Complex reconstruction skills in advanced head and neck cancer (HNC) could resolve the key problem of large defects after tumor resection. We combined the anterolateral thigh free flap, fascia lata flap, and greater saphenous vein graft in the reconstruction process of salvage surgery. Seven patients suffering from advanced HNC who experienced the failure of multiple therapeutic methods were enrolled in our study between June 2017 and January 2018. They all agreed to voluntarily undergo the tumor excision and complex reconstruction procedure we developed. The total flap size ranged from 20 × 13 cm to 30 × 15 cm. The length of the greater saphenous vein graft ranged from 4 to 11 cm. The hospitalization period ranged from 7 to 33 days. All of the flaps were viable, but in 1 patient, oral flap edge infection and necrosis necessitated partial debridement on day 7 postoperatively. All donor sites were closed primarily. We report our experience with this surgical method for complex reconstruction in advanced HNC patients.

Abbreviations: ALT = anterolateral thigh, CSF = cerebrospinal fluid, GSV = greater saphenous vein, HNC = head and neck cancer, LCFA = lateral circumflex femoral artery, MDT = multidisciplinary team, VLM = vastus lateralis muscle.

Keywords: advanced stage, anterolateral thigh, complex reconstruction, fascia lata flap, greater saphenous vein, head and neck cancer

1. Introduction

Head and neck cancer (HNC) refers to a series of malignancies comprising a variety of tumors that stem from the larynx, nasopharynx, oropharynx, hypopharynx, ear, lip, or oral cavity.[1] For advanced HNC, even with treatment with developing surgical, nonoperative, and comprehensive methods, the postoperative recurrence rate reaches up to 20% to 30%, with or without distant metastasis; however, the median survival time is only 6 months.[2] Surgery combined with radiation, chemotherapy, immunotherapy, and targeted therapy administered via a multidisciplinary team (MDT), which aims to control the symptoms or achieve limited metastasis resection to improve the quality of life of patients surviving with advanced HNC, has gained increasing acceptance. Advanced HNC often grows invasively and transregionally; consequently, a couple of adjacent structures, such as the orbit, oral cavity, pharynx, larynx, cervical vessels, and base of the skull, need to be resected simultaneously. While transferred tissue, such as a free flap with a vascular pedicle, is always needed to repair large defects following head and neck tumor resection, if the tissue is insufficient, direct suturing is impossible.[3]

An ideal flap suitable for head and neck reconstruction should be flexible for design (one or more flaps on 1 pedicle), adequate in tissue volume, have potential for reinnervation (suitable blood vessel size and length), and be easy to dissect.[4] The anterolateral thigh (ALT) free flap, based on the lateral circumflex femoral vessels, has been accepted as an extremely versatile flap for composite soft tissue defects since Song et al[5] first described it in 1984. As a universal flap, the ALT flap was popularized by surgeons for utilization in the reconstruction of defects in the head and neck.[6–8] The fasciae lata flap is commonly applied in reconstruction of the anterior skull base in endoscopic surgery.[9,10] The fascia lata flap can be used to successfully repair small defects (less than 10 mm) with 2-layer reconstruction, as well as larger skull base defects (larger than 20 mm) with a combination of fat or nasoseptal pedicled flaps.[11] In advanced HNC, extensive tumor resection can lead to large defects in the skull base and the leakage of cerebrospinal fluid (CSF). Nevertheless, the fasciae lata flap usually satisfies the need for the repair of large defects in the skull base.

Advanced HNC is always treated with radiotherapy and intra-arterial chemotherapy, which damage the local vessels to a certain extent. Therefore, surgeons face a challenge in that branches of the cervical vein or artery may be unhealthy and inadequate for anastomosis. Use of the greater saphenous vein (GSV) graft to prolong the free flap vessel is uncommon, having been reported in few cases.[12–14]

When failure of the MDT model occurs in advanced HNC, salvage surgery could be used to resolve large and complex defects

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resulting from tumor resection. Joining the ALT flap with the fascia lata flap could provide a sufficient tissue volume for three-dimensional cranio-orbitofacial reconstruction. The GSV graft supplies adequate vessels for the flap, which could help eliminate the area limitation of free flaps. In this study, we applied a complex procedure (ALT/fascia lata flap with GSV graft) for the reconstruction of large defects in the head and neck region in 7 cases.

2. Patients and methods

2.1. Patients

The criteria for inclusion in the study were as follows: patients with large head and neck defects (greater than 20×10 cm),[15] and inadequate vessels and skull base defects. All patients were treated with tumor excision and radiotherapy or chemotherapy before undergoing surgery in our department.

From June 2017 to January 2018, 7 patients with advanced HNC recurrence after MDT therapy underwent complex reconstruction following tumor resection using the ALT/fascia lata flap and GSV graft at the Department of Oto-Rhino-Laryngology of West China Hospital, Sichuan University, Chengdu, Sichuan. The study was approved by the ethics committee of the West China Hospital, Sichuan University. All tumor resection and reconstruction procedures were performed by the authors (C.F. and L.J.). The study data included demographics, flap size, skull base defect size, recipient vessels, harvest time, GSV length, and postoperative length of stay. In our study, wound infection, hemorrhage, CSF leak, and flap loss were considered complications.

2.2. Operative technique

Commonly, the lateral circumflex femoral artery (LCFA) gives off 3 branches after separating from the profunda femoris: the transverse branch, the oblique branch, and the descending branch. The descending branch always acts as a nutrient vessel for the ALT flap through septocutaneous or musculocutaneous perforators. Thus, color duplex ultrasonography or enhanced magnetic resonance imaging is needed to visualize the branches, especially the descending branch, of the LCFA despite the rare variation of absence (<1%).[16] Our team prefers to apply a simultaneous 2-team approach during flap harvest in tumor resection. We always draw a line joining the anterior superior iliac spine and the superolateral patella, which corresponds to the septum between the vastus lateralis muscle (VLM) and the rectus femoris muscle. We also mark the midpoint of the line, where the skin vessels supplying the ALT flap are usually located. During the initial stage of flap harvest, a curved incision along the medial half of the line is made, followed by dissection through the subcutaneous fat to the fascia lata femoris. The fascia lata flap is then harvested to repair the skull base defect (Fig. 1). During dissection of the intermuscular

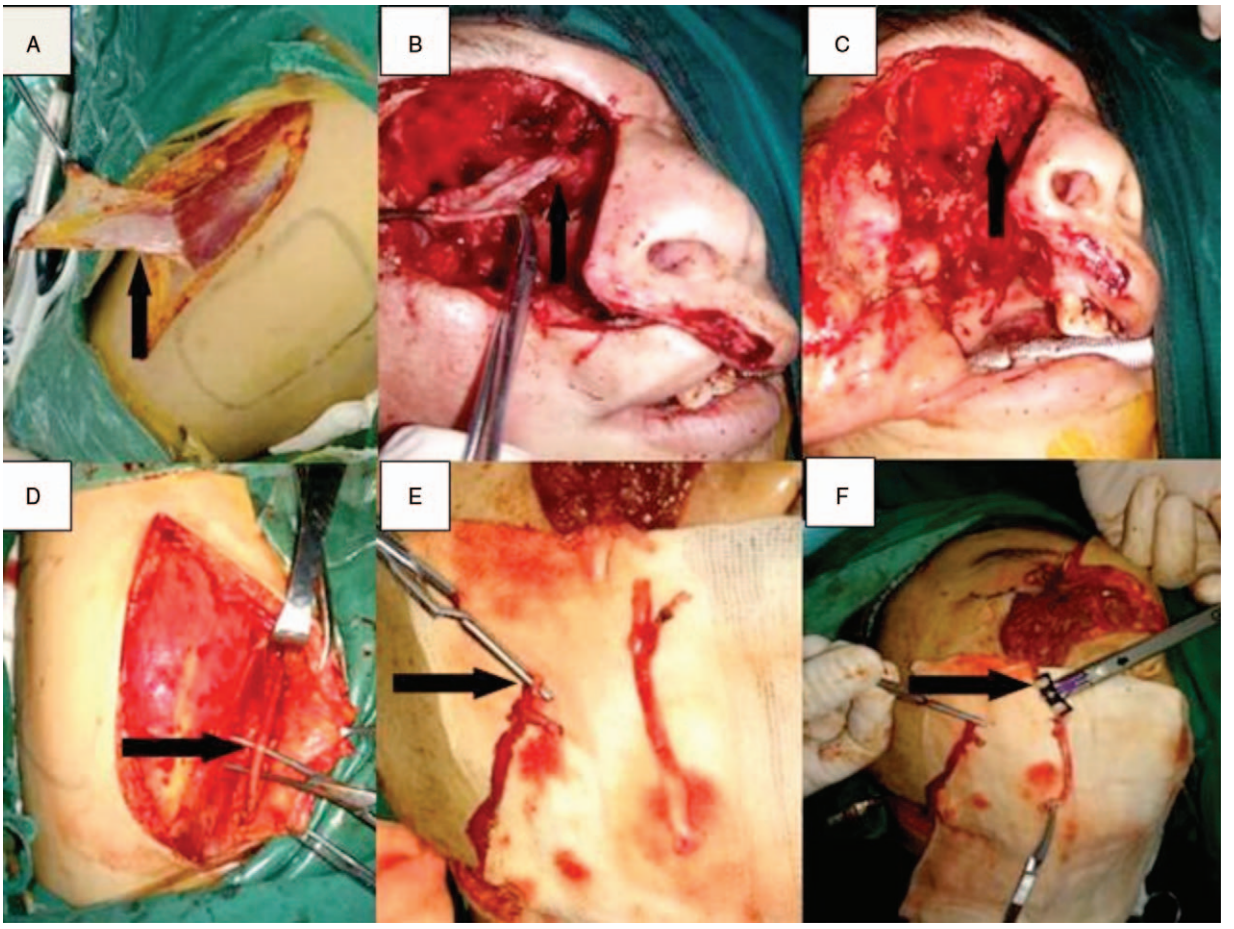

Figure 1. . (A) Harvest of the fascia lata flap (black arrow). (B and C) Suturing of the fascia lata flap to healthy soft tissue to repair the skull base (black arrows). (D) Harvest of the GSV graft (black arrow). (E and F) GSV graft bypass by vascular anastomosis with the facial and free flap pedicle arteries (black arrows). GSV = greater saphenous vein.

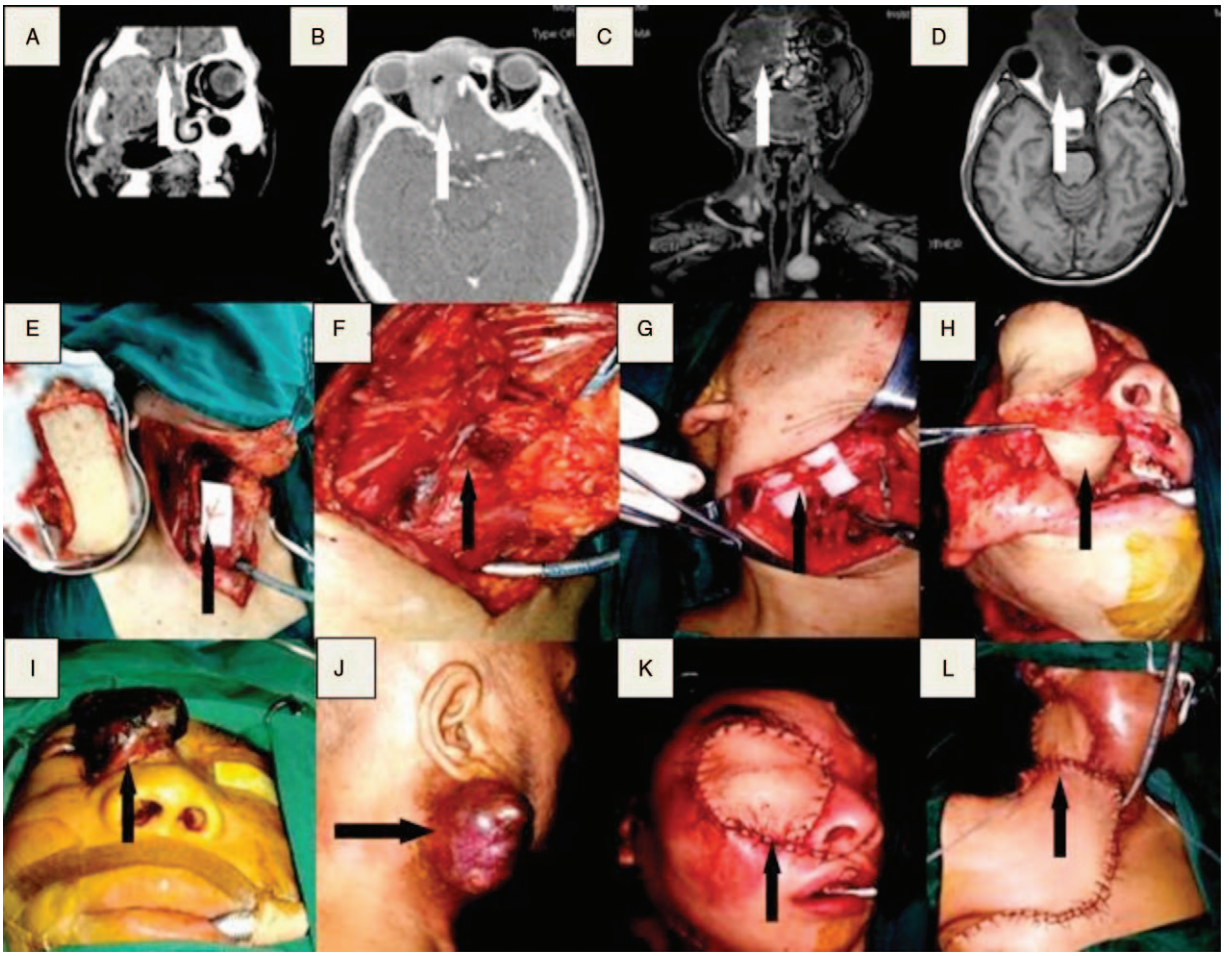

Figure 2. . (A–D) Magnetic resonance imaging and computed tomography scans showing tumor invasion of the base of the skull and adjacent structures (white arrows). (E–H) Anastomosis of the greater saphenous vein graft with far vessels and free flap pedicle vessels (black arrows). (I and J) Malignant lesions in advanced head and neck cancer. (K and L) After complex reconstruction.

septum between the rectus femoris muscle and VLM, the descending and transverse branches of the LCFA are identified and preserved. The septocutaneous or musculocutaneous perforators are carefully verified and tracked to the main pedicle. A muscle flap from the VLM is also harvested to fill the dead space and strengthen the fascia lata around the cranial defect. The required size of the free myocutaneous flap is designed to be slightly larger than the tumor volume to ensure adequate tissue repair. The saphenous vein graft, worked as an overpass when the vascular pedicle is inadequate to reach recipient vessels, is harvested from the same incision of the myocutaneous flap (Fig. 1). The GSV graft can be anastomosed with both the artery and vein of the free flap or surgical field. When different surfaces in 3 dimensions need to be repaired, the ALT free flap is dissected into distinct skin paddles on the basis of separate vascular perforators (Fig. 2).[17,18]

3. Results

The patients enrolled in our study consisted of 1 female and 6 males, aged 33 to 78 years, with a mean age of 59.3 years (Table 1). The total flap size ranged from 20×13 cm to 30×15 cm, dissected into 1 or 2 skin paddles. The flap recipient vessels varied by patient and included the facial, transverse facial, lingual, and superior thyroid arteries. The recipient veins included the common facial, posterior facial, external jugular, internal jugular, and transverse cervical veins (Table 2). The hospitalization period ranged from 7 to 33 days. All of the flaps were viable, but in 1 patient, oral flap edge infection and necrosis

Table 1

Patient demographics.

Items	No. of patients (%)
Mean age (yr)	59.3 (33–78)
Sex	
Male	6 (85.71%)
Female	1 (14.29%)
Primary site	
Nasal sinus	4 (57.16%)
Middle ear	1 (14.28%)
Parotid gland	1 (14.28%)
Orbital cavity	1 (14.28%)
Pathology	
Adenocarcinoma	1 (14.28%)
Adenoid cystic carcinoma	2 (28.60%)
Squamous carcinoma	1 (14.28%)
Sarcomatoid carcinoma	1 (14.28%)
Fibroblastic carcinoma	1 (14.28%)
Myofibrosarcoma	1 (14.28%)

Table 2

Clinical data of patients undergoing complex reconstruction using ALT/fascia lata flap with GSV graft.

Items	Numbers
Flap size (cm^2)	331.4 (20×13–30×15)
Skull base defect (cm^2)	15.6 (2.5×3–5×5)
Veins	
Common facial vein	3
Posterior facial vein	1
Anterior facial vein	1
External jugular vein	6
Internal jugular vein	1
Transverse cervical vein	1
Arteries	
Superior thyroid artery	2
Lingual artery	1
Facial artery	3
Arteria transversa faciei	1
Length of graft vein (cm)	6.9 (4–11)
Harvest time (min)	56.4 (40–115)
Postoperation length of stay (d)	12.8 (7–33)

ALT = anterolateral thigh, GSV = greater saphenous vein.

necessitated partial debridement on day 7 postoperatively. All donor sites were closed primarily. After 1 year follow-up, no complications were found in them.

4. Discussion

The main surgical procedures required for advanced or recurrent invasive HNC are excision and simultaneous reconstruction. The options for reconstruction after tumor excision depend on the defect volume and location. In our study, the defect ranged from 200 to 360 cm^2 in size and often involved with a dura mater defect and vessel shortage. Therefore, we chose a complex reconstruction strategy consisting of the ALT flap, the fascia lata flap, and the GSV graft, which was effective and has rarely been reported in the literature. We report on the successful treatment of 7 patients with complex reconstruction after head and neck tumor resection. All the flaps and donor sites healed normally.

The ALT flap is a versatile flap in head and neck reconstruction that not only satisfies all kinds of defect volumes but is also flexible in terms of the placement direction. In our patients, the largest ALT flaps harvested were up to 15 cm wide by 30 cm long and were supported by 1 vascular pedicle. Although Yildirim et al[19] reported that flap harvest as large as 20 cm (in width) by 26 cm (in length) has been successfully applied, we still kept our maximum ALT flap as 450 cm^2 so that avascular necrosis could be avoided with only 1 pedicle.[19] The descending branch of the LCFA could usually afford the harvest of a large flap, with as many as 2 or 3 myocutaneous flap islands supported by 2 or 3 cutaneous perforators.[20,21] Therefore, in our study, no flap necrosis was found, even though there was 1 instance of infection or ischemia in the part of the edge of a large flap. Primary closure was obtained in most cases. We could make full use of the advantages of the ALT flap in reconstruction, such as its flexibility in style and bulk. Flexible style refers to variable flaps, including musculocutaneous, subcutaneous, fasciocutaneous, and adipofascial flaps. Flexible bulk refers to sufficient tissue for eliminating the dead space and protecting important adjacent structures, such as the carotid artery and vein, thus guarding against infection, bleeding, fistula, and other complications.[22]

The fascia lata flap was usually harvested when the deep fascia surrounding the tensor fasciae lata muscles was stripped. The fascia lata flap is sufficiently tough and dense to bear a certain degree of weight and pressure, and the facia lata is considered to be the thickest fascia in the body. Both the fascia lata and dura mater consist of the same kind of biofilm. However, the fascia lata is thicker than dura mater and is composed of a large number of interwoven fibroblasts, forming a tough structure. The free tensor facia lata flap survived with nutrition provided by the ascending and transverse branches of the LCFA.[23] We repaired the skull base defect with the fascia lata flap, suturing it to dura mater and mucous membrane in the nasal cavity. On the one hand, this approach allowed the flap to be fixed in the right location and prevent CSF leakage; on the other hand, it facilitated the establishment of a blood supply and the healthy growth of the fascia lata flap. In all the patients in this study, dura mater defects were primarily sealed without complications such as CFS leakage or intracranial infection. Our experience demonstrates that the method applied for suturing of the fascia lata flap was effective and reliable for skull base defect repair.

The GSV is a superficial vessel between layers of dermis and muscular fascia; it is joined by several vascular branches and flows into the common femoral vein. There are several small perforating branches between the GSV and deep vein during the course of the vessel.[24]

The GSV graft was first applied in heart disease for coronary artery bypass grafting in 1971. With the development of coronary artery bypass grafting, the left internal mammary artery and other vessels have been commonly adopted in clinical applications; however, the GSV graft also plays an important role as an alternative conduit.[25] In our study, all patients underwent radiotherapy for advanced HNC, which resulted in short, unhealthy local vessels. During the process of harvesting the ALT flap, the GSV graft was harvested simultaneously. In our practice, the GSV graft was used to rescue the vessel shortage encountered during tumor excision in HNC patients previously treated with radiotherapy, without the occurrence of thrombosis or necrosis. Additionally, GSV bypass grafting was performed through vascular anastomosis with deficient recipient vessels involving various arteries, such as the facial, transverse facial, lingual, and superior thyroid arteries, and veins, including the common facial, posterior facial, external jugular, internal jugular, and transverse cervical veins. Chang et al[26] reported that a 12-cm length of saphenous vein graft was used to prolong the pedicle of free flap, whereas we just harvested as long as 11-cm in our cases. Vascular diseases such as malformation (stenosis), varicose vessels, thrombosis, and idiopathic vasculitis were viewed as contraindications of GSV graft, which were not found in our cases. We used both vascular stapler and microscopic suture in vessel graft and showed satisfactory effect. Skills such as appropriate suture density, vascular cavity patency, and heparinization are the key to the success of microvascular anastomosis.

The complex reconstruction method we performed is suitable for the surgical repair of large defects in the treatment of advanced or recurrent HNC along with comprehensive therapy. These patients shared some characteristics as follows:

1. tumor tissue infringed on a wide range of adjacent areas, including the skull base, resulting in complex defects;
2. neoplasm invasiveness and radiotherapy or other therapeutic methods gave rise to vessel damage and shortage; and

3. salvage surgery was the only option for these patients, who experienced the failure of comprehensive MDT therapy, such as chemoradiotherapy, targeted therapy, and immunotherapy.

For these patients, we preferred the complex reconstruction surgery consisting of the ALT/fascia lata flap and GSV graft because of the following reasons:

1. the complex flaps and GSV graft could be harvested simultaneously from 1 location;
2. the flap design could eliminate the vessel length limitation;
3. a sufficient quantity of tissue from the ALT flap could strengthen the skull base repair and eliminate the dead space without the insertion of a drainage tube;
4. 2 teams could simultaneously operate on the patient; and
5. the donor site could be primarily closed without a skin graft and with few complications.

It is a novel method and notion to combine ALT flap, fascia lata flap, and GSV graft as complex reconstruction after head and neck tumor resection. We acquired satisfactory result after 1 year follow-up, without complication in them. Parkes et al[27] applied ALT flap in cranio-orbitofacial reconstruction. Three cases of CSF leak were encountered, 2 of whom required reoperation using a vascularized nasal septal flap in 1 instance and a fat graft combined with a pericranial flap in the other. The main factor for the postoperative flap failure in their study was infection.[27] Hill and Rinker[28] documented that free flaps that have been utilized in reconstruction after orbital exenteration and craniectomy include the ALT flap and rectus abdominus myocutaneous flap; both achieved good therapeutic effect. However, the volume of muscle and skin of rectus abdominus myocutaneous flap was a little smaller than ALT flap in slim patient without enough physical exercise, hence we prefer the latter one. Meanwhile, the complex reconstruction method could solve the problem of large tissue defect, dura mater defect, and vessel shortage simultaneously, which could not be settled merely by traditional method such as pectoralis major musculocutaneous flap, etc.

Accordingly, there are some shortcomings or key points requiring attention regarding the complex reconstruction:

1. it is a heavy workload for a single surgeon;
2. some male patients have to deal with hair on the transferred flap; and
3. more samples and longer observation periods are needed to gain sufficient experience with this complex reconstruction procedure.

Overall, complex reconstruction with the ALT/fascia lata flap and GSV graft is optional and effective for salvage surgery in advanced HNC patients. Innovative microvascular free tissue transfer could meet the needs of reconstruction of various scopes and types. If we apply appropriate reconstruction methods, as reported in patients with advanced malignant tumors in the head and neck, more options will be available, and survival could be prolonged.

5. Conclusion

Complex reconstruction with the ALT/fascia lata flap and GSV graft could repair large defects after tumor resection for advanced HNC. The skills applied in patients with recurrent HNC after MDT treatment are feasible and of clinical significance. Infection of the complex flaps and donor sites was rare. There were no serious complications after the surgery. In clinical application, when a large compound defect occurs after resection for HNC, the composite reconstruction method described above could be used for repair.

Author contributions

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Investigation: Tengfei Ma.
Methodology: Dan Lv, Haiyang Wang.
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Supervision: Shixi Liu, Fei Chen.
Writing – original draft: Weigang Gan.

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