The reconstruction of head and neck defects with the submental island flap

D Xuwei¹, X Jian¹*, L Xueqin²*, Z Xianjie¹, Y Jianbo¹, L Wei¹, M Ligen¹

Abstract

Objective
The aim of our report is to evaluate the outcomes of the submental island flap reconstruction for defects after ablation in patients with head and neck cancer.

Methods
All patients who underwent reconstruction for head and neck defects with the submental island flap at the Cancer Center for Guangxi Medical University between January 2008 and May 2012 were observed. The site of the tumour, the clinical stage, the technique of flap harvesting, the outcome of cosmesis and function were recorded. Unlike the experience of other colleagues, for patients with tongue and mouth floor cancers, we developed some special operative techniques for reconstruction of defects.

Results
There were 12 men and 6 women, with ages ranging from 34 to 77 years (mean ± SD of 55.17 years). The sites of tumour were the tongue, hard palate, soft palate, mouth floor; face, gingival, maxillary sinus and buccal mucosa. The sizes of the flaps ranged from 4 × 3 cm to 10 × 7 cm, with a median of 5.6 × 4.2 cm. Seven patients underwent radiotherapy after the surgery; the radiation dose ranged from 23.5 to 60 Gy. The follow-up period ranged from 1 to 50 months, with a median of 20.3 months. The long-term cosmesis and functions were perfect in most patients. Five patients died of metastasis and one patient died of acute coronary syndrome.

Conclusions
The submental island flap is a reliable alternative for reconstruction of head and neck defects in cancer patients. For colossal defects in the mouth floor, the submental island flap should involve with the submandibular gland, anterior belly of digastric muscle and mylohyoid muscle.

Introduction
Reconstruction of defects following ablation of the head and neck tumours is a challenging problem. Several methods of reconstruction for the head and neck defects have been developed, such as radial forearm free flap, anterolateral thigh free flap, and free flap, anterolateral thigh free flap, and platysma flap. However, these methods have their own limitations. In recent years, the submental island flap has been increasingly used in the reconstruction of head and neck defects. The submental island flap was first described by Martin et al. in 1993. In 1996, for the first time, Sterne and Hall reported the use of the submental island flap for reconstruction in oral cancer. In the past 20 years, the submental island flap has been used for reconstruction of defects of the mouth, face, upper aerodigestive tract, palate and hypopharyngeal region.

Flap design and operative technique
First the pinch test was conducted to ensure the donor site can be the primary closure. If the test was positive, the flap was useful for repairing. The incisions of the submental island flap were marked, whose size was determined by the lesion in the primary tumour. The upper border of flap was below the mandible, about 1.5 cm in the midline, and the lateral edges of

Licensee OA Publishing London 2013. Creative Commons Attribution License (CC-BY)

flap did not exceed the mandibular angle bilaterally. Before harvesting the flap, the primary tumour was dissected, and the resection margins were confirmed to be histologically free of tumour on frozen sections. In addition, to avoid recurrence, the neck resection was made. Dissection of the flap proceeded in the subplatysmal plane and pedicles were identified. The flap was lifted off the contralateral anterior belly of the digastric; the ipsilateral anterior belly of the digastric was abscised cling to its mandibular attachment and at the intermediate tendon. Meanwhile, level 1A was cleared.

The submental vessels were dissected off the submandibular gland, whose branch supplying the gland was ligated. The vessels were carefully traced to the facial artery and vein. After the submental artery was given off, the distal portion of the facial artery was ligated. To prevent flap loss and other problems, an average of 1 to 2 cm of subcutaneous tissue was preserved around the vascular pedicle. The skin of the donor site could be sewn up together directly. If the skin tension was too large, the donor site was repaired by free grafts. If the submental vessels, musculodigastricus and donor site skin were invaded by lymph nodes, or the submental lymph nodes were swollen, this flap had to be abandoned. For patients with tongue or mouth floor cancers, a boarder and thicker flap, which was involved with the submandibular gland, was used for reconstruction of large defects.

Results
There were 12 men and 6 women, with ages ranging from 34 to 77 years (mean ± SD of 55.17 years). The tumour sites included the tongue, hard palate, soft palate, floor of the mouth, face, gingival, maxillary sinus and buccal mucosa. The hard palate and the tongue were the common primary sites. All patients had histological diagnosis, and squamous cell carcinoma was the most common pathology type. All patients underwent neck dissection before flap harvesting. The skin paddles of the flaps ranged from 4 × 3 to 10 × 7 cm, with a median of 5.6 × 4.2 cm. The primary site of the tumour, clinical stage and flap sizes of all cases are shown in Table 1.

As shown in Figure 1, a tongue cancer patient underwent tumour ablation and submental island flap transplantation. This patient developed nasopharyngeal carcinoma and underwent radiotherapy 10 years ago; therefore, the donor site could not be closed primarily and free skin graft was used for reconstruction.

Of the 18 cases, 7 cases received post-operative radiation, whose doses ranged from 23.5 to 60 Gy. There was no flap loss in these patients. The other patients had not received radiation due to financial burden.

All patients were followed-up for 1 to 50 months, with a median follow-up duration of 20.3 months. Five patients died of distal metastasis, and one elderly patient died of acute coronary syndrome. The long-term cosmesis and function of speech and swallowing were excellent in all cases. Donor site healed in all cases, leaving inconspicuous scars. There was no complete flap loss in all cases. One patient developed partial flap loss resulting from infection at the site of the surgery.

Discussion
Reconstruction of head and neck defects after tumour ablation is important for head and neck cancer patients. Various techniques were developed, including free skin grafts, free flap and pedicle flaps. Free skin grafts are limited to be used for reconstruction of defects in patients with head and neck benign tumours. Free flap has many advantages, including its thin and pliable nature, its ease of harvesting and acceptable donor site morbidity. However, it has unavoidable limitations, such as functional problems and increased potential for flap failure associated with microsurgery\(^a\). At the same time, this operative technique is complicated, time consuming and requires advanced microsurgical techniques. After surgery, the complications, heavy economic burden and long-term immobilization and anticoagulant therapy may be challenged as well. For some patients with hypertension, diabetes and atherosclerosis, the free flap is liable to necrosis. Also, for some patients who underwent neck surgery, the blood vessels were damaged; therefore, the free flap could be used for reconstruction. Under these conditions, the pedicle skin flap can be used for most defects in the head and neck, such as the nasolabial flap, platysmasmusculocutaneous flap and sternocleidomastoid musculocutaneous flap. When the donor vessels were intact, the surgical technique became simple and consumed less time. However, some pedicle flaps, such as forehead and platysmasmusculocutaneous flaps, flap have disadvantages: such as large scarring in the donor site, with imperfect function after surgery.

In the past two decades, the submental island flap has been widely used for reconstruction of the head and neck defects. Compared with other pedicle flaps, the submental island flap has many advantages. It is thin and pliable, and a large surface area may be harvested; the largest skin padde can be 15 × 6 cm. Further, as the flap is adjacent to the surgical defect, it is easy to harvest. A rich vascular network between the ipsilateral and contralateral facial arteries and veins allows the submental flap to be used safely in patients who have received prior radiation treatment in a therapeutic dose. The submental island flap provides excellent colour and texture that matches to facial skin, and a concealed donor-site incision that can be closed primarily. Compared with other pedicle flaps, the submental flap leads to excellent cosmesis and function of speech and swallowing were excellent in all cases. Donor site healed in all cases, leaving inconspicuous scars. There was no complete flap loss in all cases. One patient developed partial flap loss resulting from infection at the site of the surgery.

Discussion
Reconstruction of head and neck defects after tumour ablation is important for head and neck cancer patients. Various techniques were developed, including free skin grafts, free flap and pedicle flaps. Free skin grafts are limited to be used for reconstruction of defects in patients with head and neck benign tumours. Free flap has many advantages, including its thin and pliable nature, its ease of harvesting and acceptable donor site morbidity. However, it has unavoidable limitations, such as functional problems and increased potential for flap failure associated with microsurgery\(^a\). At the same time, this operative technique is complicated, time consuming and requires advanced microsurgical techniques. After surgery, the complications, heavy economic burden and long-term immobilization and anticoagulant therapy may be challenged as well. For some patients with hypertension, diabetes and atherosclerosis, the free flap is liable to necrosis. Also, for some patients who underwent neck surgery, the blood vessels were damaged; therefore, the free flap could be used for reconstruction. Under these conditions, the pedicle skin flap can be used for most defects in the head and neck, such as the nasolabial flap, platysmasmusculocutaneous flap and sternocleidomastoid musculocutaneous flap. When the donor vessels were intact, the surgical technique became simple and consumed less time. However, some pedicle flaps, such as forehead and platysmasmusculocutaneous flaps, have disadvantages: such as large scarring in the donor site, with imperfect function after surgery.

In the past two decades, the submental island flap has been widely used for reconstruction of the head and neck defects. Compared with other pedicle flaps, the submental island flap has many advantages. It is thin and pliable, and a large surface area may be harvested; the largest skin padde can be 15 × 6 cm. Further, as the flap is adjacent to the surgical defect, it is easy to harvest. A rich vascular network between the ipsilateral and contralateral facial arteries and veins allows the submental flap to be used safely in patients who have received prior radiation treatment in a therapeutic dose. The submental island flap provides excellent colour and texture that matches to facial skin, and a concealed donor-site incision that can be closed primarily. Compared with other pedicle flaps, the submental flap leads to excellent cosmesis and function of speech and swallowing were excellent in all cases. Donor site healed in all cases, leaving inconspicuous scars. There was no complete flap loss in all cases. One patient developed partial flap loss resulting from infection at the site of the surgery.

Discussion
Reconstruction of head and neck defects after tumour ablation is important for head and neck cancer patients. Various techniques were developed, including free skin grafts, free flap and pedicle flaps. Free skin grafts are limited to be used for reconstruction of defects in patients with head and neck benign tumours. Free flap has many advantages, including its thin and pliable nature, its ease of harvesting and acceptable donor site morbidity. However, it has unavoidable limitations, such as functional problems and increased potential for flap failure associated with microsurgery\(^a\). At the same time, this operative technique is complicated, time consuming and requires advanced microsurgical techniques. After surgery, the complications, heavy economic burden and long-term immobilization and anticoagulant therapy may be challenged as well. For some patients with hypertension, diabetes and atherosclerosis, the free flap is liable to necrosis. Also, for some patients who underwent neck surgery, the blood vessels were damaged; therefore, the free flap could be used for reconstruction. Under these conditions, the pedicle skin flap can be used for most defects in the head and neck, such as the nasolabial flap, platysmasmusculocutaneous flap and sternocleidomastoid musculocutaneous flap. When the donor vessels were intact, the surgical technique became simple and consumed less time. However, some pedicle flaps, such as forehead and platysmasmusculocutaneous flaps, have disadvantages: such as large scarring in the donor site, with imperfect function after surgery.

In the past two decades, the submental island flap has been widely used for reconstruction of the head and neck defects. Compared with other pedicle flaps, the submental island flap has many advantages. It is thin and pliable, and a large surface area may be harvested; the largest skin padde can be 15 × 6 cm. Further, as the flap is adjacent to the surgical defect, it is easy to harvest. A rich vascular network between the ipsilateral and contralateral facial arteries and veins allows the submental flap to be used safely in patients who have received prior radiation treatment in a therapeutic dose. The submental island flap provides excellent colour and texture that matches to facial skin, and a concealed donor-site incision that can be closed primarily. Compared with other pedicle flaps, the submental flap leads to excellent
swallowing and speech functions. In addition, the vascular pedicle length of flap can range up to 8 cm, providing an arc of rotation, extending from the medial canthus to zygomatic arch. It allows the flap to be used for reconstruction of the lower face, tongue, palate, buccal mucosa, mouth floor, laryngeal region etc. For patients with the upper-third facial cancers, common submental island flaps cannot reach the defective sites. Therefore, a reverse submental island flap has been designed using retrograde blood flow by dividing the facial vessels proximal to the origin of the submental artery. Karacal et al. used this technique in six patients for peri-orbital soft tissue and socket reconstruction with good results. Chen et al. reported that there was no serious change in the mean intra-arterial pressure in the facial artery after proximal ligation and occlusion of the opposite relevant artery, which suggested that the reverse facial–submental artery island flap is reliable.

The submental artery is a well-defined and consistent branch of the facial artery. It arises deep to the submandibular gland and passes forward and medially across the mylohyoid muscle. At its origin, the diameter of the submental artery ranges from 1.0 to 2.0 mm (mean 1.7 mm). The submental artery may be superficial (30%) or deep to the digastric muscle (70%). Sebastian et al. indicated that the terminal submental vessels are protected by including the overlying segment of the anterior belly of

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender</th>
<th>Age (years)</th>
<th>Tumour site</th>
<th>Clinical staging</th>
<th>Pathology</th>
<th>Flap size (cm × cm)</th>
<th>Postoperative radiation</th>
<th>Follow-up (months)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>70</td>
<td>Hard palate</td>
<td>T3N0M0</td>
<td>ACC</td>
<td>5 × 4 cm</td>
<td>RT (60 Gy)</td>
<td>38</td>
<td>Dead</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>69</td>
<td>Face</td>
<td>T2N0M0</td>
<td>BCC</td>
<td>10 × 7 cm</td>
<td>None</td>
<td>50</td>
<td>Alive</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>60</td>
<td>Soft palate</td>
<td>T2N1M0</td>
<td>SCC</td>
<td>4 × 3 cm</td>
<td>None</td>
<td>3</td>
<td>Alive</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>77</td>
<td>Face</td>
<td>T2N1M0</td>
<td>SCC</td>
<td>6 × 5 cm</td>
<td>None</td>
<td>34</td>
<td>Dead</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>44</td>
<td>Hard palate</td>
<td>T4N1M0</td>
<td>SCC</td>
<td>6 × 4 cm</td>
<td>None</td>
<td>13</td>
<td>Dead</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>43</td>
<td>Tongue</td>
<td>T3N1M0</td>
<td>SCC</td>
<td>7 × 5 cm</td>
<td>RT (40 Gy)</td>
<td>12</td>
<td>Dead</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>38</td>
<td>Tongue</td>
<td>T2N0M0</td>
<td>SCC</td>
<td>4 × 3 cm</td>
<td>None</td>
<td>36</td>
<td>Alive</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>66</td>
<td>Gum</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>6 × 5 cm</td>
<td>RT (30 Gy)</td>
<td>39</td>
<td>Alive</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>60</td>
<td>Tongue</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>5 × 4 cm</td>
<td>None</td>
<td>1</td>
<td>Alive</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>51</td>
<td>Hard palate</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>5 × 4 cm</td>
<td>None</td>
<td>13</td>
<td>Dead</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>65</td>
<td>Maxillary sinus</td>
<td>T4N1M0</td>
<td>ACC</td>
<td>5 × 4 cm</td>
<td>RT (23.5 Gy)</td>
<td>7</td>
<td>Dead</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
<td>45</td>
<td>Tongue</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>6 × 4 cm</td>
<td>None</td>
<td>22</td>
<td>Alive</td>
</tr>
<tr>
<td>13</td>
<td>F</td>
<td>69</td>
<td>Buccal mucosa</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>5 × 3 cm</td>
<td>RT (50 Gy)</td>
<td>12</td>
<td>Alive</td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>68</td>
<td>Mouth floor</td>
<td>T2N0M0</td>
<td>Adenocarcinoma</td>
<td>6 × 5 cm</td>
<td>None</td>
<td>34</td>
<td>Alive</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>34</td>
<td>Hard palate</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>5 × 4 cm</td>
<td>RT (50 Gy)</td>
<td>32</td>
<td>Alive</td>
</tr>
<tr>
<td>16</td>
<td>M</td>
<td>52</td>
<td>Mouth floor</td>
<td>T3N0M0</td>
<td>SCC</td>
<td>6 × 5 cm</td>
<td>None</td>
<td>16</td>
<td>Alive</td>
</tr>
<tr>
<td>17</td>
<td>M</td>
<td>37</td>
<td>Tongue</td>
<td>T2N1M0</td>
<td>SCC</td>
<td>4 × 3 cm</td>
<td>None</td>
<td>1</td>
<td>Alive</td>
</tr>
<tr>
<td>18</td>
<td>M</td>
<td>45</td>
<td>Tongue</td>
<td>T2N1M0</td>
<td>SCC</td>
<td>5 × 4 cm</td>
<td>RT (50 Gy)</td>
<td>2</td>
<td>Alive</td>
</tr>
</tbody>
</table>

Table 1 Patient characteristics

M, male; F, female; SCC, squamous cell carcinoma; ACC, adenoid cystic carcinoma; BCC, basal cell carcinoma; RT, radiotherapy.
digastic muscle. Further, the underlying mylohyoid muscle can be cut or a strip of it included with the pedicle when the flap needs to be tunneled to a defect medial to the mandible. In our experience, the terminal submental vessels were all located deep within the digastic muscle. All harvested flaps were included with the anterior belly of digastic muscle, and no flap loss occurred.

As for the perforator vessels, Matsui et al. described that although flaps with a single dominant perforator initially showed signs of altered flap metrics, in 6 h, the perfused area of the flap was equivalent to flaps having multiple preserved perforators. To obtain the best outcome, we preserved all perforator vessels. Around the vascular pedicle, an average of 1 to 2 cm of subcutaneous tissue was preserved; thus, we could avoid vascular injury or vasospasm. Chen et al. coincidently used a similar technique, in which an average of 1.5 to 2 cm of subcutaneous tissue was preserved around the vascular pedicle to prevent any possible venous problems.

In patients with tongue and mouth floor cancers, the defects following tumour ablation are too large. We found that the common submental island flap was too thin and prone to the development of a dead space in the mouth floor, which can lead to infection and fistula. Also, the wound healed with considerable difficulty. We once used the sternocleidomastoid flap for reconstructing the cavity; the following difficulties in turning around the however unacceptable. Therefore, we exploited a new approach, in which the submental island flap could be involved with the submandibular gland, anterior belly of digastic muscle and mylohyoid muscle. In our observation, for 7 patients with tongue or mouth floor cancers, the functional results in terms of speech and swallowing were satisfactory, and the outcomes were excellent. Further, there were no fistula of the mouth floor and no submandibular lymph node recurrence. The new flap proved to be a reliable option for reconstruction of the colossal defects in the mouth floor.

The submental island flap still has some limitations, including the risk of nodal metastases and difficulty in clearing the level I lymph nodes. For patients with palpable or radiologically demonstrable neck node metastases, the submental island flap should be avoided.

For treatment of patients with head and neck cancers, an adequate dissection and flap harvesting technique, careful patient selection and close observation are important. Based on our experience, systematic follow-up treatment may be required for preventing distal metastasis.

**Conclusion**
The submental island flap is a reliable alternative for reconstruction of the head and neck defects following tumour ablation. It provides excellent functional and cosmetic results. For colossal defects in the mouth floor, the submental island flap should be involved with the submandibular gland, anterior belly of digastic muscle and mylohyoid muscle.

**References**


