ORIGINAL ARTICLE

COMPARISON OF RECONSTRUCTIVE PROCEDURES IN PRIMARY VERSUS SECONDARY MANDIBULAR RECONSTRUCTION

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Abstract: *Background.* Few reports have compared reconstructive outcomes of primary versus secondary mandibular reconstruction.

Methods. A retrospective chart review was performed on 149 patients following primary ($n = 110$) and secondary reconstruction ($n = 39$).

Results. There was no statistically significant difference in patient demographics between the 2 groups. The secondary reconstruction mandibular defects were more extensive; significantly more involved the condyle or the central portion of the mandible. The vascularized fibular flap was most commonly used (primary 82%, secondary 69%). The overall complication rate was similar in both groups. There was no statistical difference in the frequency of complications between the primary or secondary reconstruction groups (acute, $p = .40$; late, $p = .17$).

Conclusions. Success in secondary mandibular reconstruction could be achieved utilizing a range of osseous free flaps, and there was no increased rate of complications compared with primary mandibular reconstructions. ©2007 Wiley Periodicals, Inc. *Head Neck* **30:** 341–345, 2008

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Mandibular reconstruction after major ablative surgery remains one of the most challenging of all plastic surgical procedures. The function of the oral cavity for mastication, speech, swallowing, respiration, and continence must be preserved whenever possible, and because cosmesis is a concern for patients, closely matched donor tissue is preferable. The difficulty of reconstructive procedures in this region is further compounded by the unfavorable environment for successful microsurgical reconstruction; wound bed contamination, irradiated tissue, and patient comorbidities are part of most mandibular reconstruction cases. It

might be predicted that secondary reconstruction would pose even greater reconstructive challenges due to a previously operated and scarred surgical field. However, relatively few studies have critically analyzed the differences between primary and secondary mandibular reconstruction. Although numerous studies have included secondary reconstruction cases in their series, in many cases no attempt was made to interpret the differences between primary and secondary operative procedures in the outcome of the patient, or the studies were restricted by a small sample size or lack of statistical analysis.[1–13]

It is important to understand if there are differences in the patient population, their tissue defects, or reconstructive procedures, and if these differences increase complications and flap failure rates in secondary reconstruction patients. This knowledge would be instructive for surgeons who are planning secondary reconstruction and useful for patient education and prognosis. The aim of this study was to compare the reconstructive procedures of patients who underwent primary and secondary mandibular reconstruction.

MATERIAL AND METHODS

This was a retrospective study based on reconstructive procedures performed at Toronto General Hospital between 1993 and 2003. The majority of the ablative procedures were performed by 4 head and neck surgeons, and the reconstructive procedures were performed by 2 of the study authors (PCN and RWG). Approval for chart review was obtained from the institutional Research Ethics Board. There were 110 patients who had undergone primary mandibular reconstruction, and 39 patients had secondary reconstruction.

The differences between the 2 groups were evaluated using Student's unpaired t test for the continuous data variables, and chi-square analysis or Fisher's exact test was used for the categorical data. Data analysis was performed using GraphPad InStat statistical software, version 3.00 (San Diego, CA).

RESULTS

The demographic profile and medical comorbidity of the 2 groups was similar (Table 1), with respect to age, sex, follow-up period, smoking history, and alcohol consumption. Patients were considered to have a comorbid illness if they had 1 or more of the following: a history of hypertension, diabetes, ischemic heart disease, peripheral vascular disease, neurologic disease, renal failure, significant respiratory illness, or other significant disorders. There was no significant difference in the proportion of patients who had 1 or more comorbid illnesses ($p = .1331$).

Table 1. Profile of patients undergoing primary versus secondary reconstruction.

	Primary, $n = 110$	Secondary, $n = 39$	p value*
Age, y			
Mean ± SD	58 ± 15	49 ± 15	.83
Range	14–82	14–83	
Sex, %			
Male	39	41	.85
Female	60	59	
Time since reconstruction, y	3 ± 2	3 ± 3	.26
Medical comorbidity, %	54	47	.55
Smoking history, %			
Smoker	59	59	.35
Ex-smoker	16	8	
Nonsmoker	25	33	
Alcohol consumption	65	41	.053

**Differences in parameters were assessed using Student's t test or chi-square analysis.*

The original diagnosis was similar in both groups, with squamous cell carcinoma being the most common pathology (primary reconstruction group 80%, secondary reconstruction group 72%). Other diagnoses included benign and malignant tumors, osteomyelitis, and trauma only in patients who had secondary reconstruction. The indications for mandibular reconstruction were different between the groups. In the primary reconstruction group, 71% of patients required surgery as treatment of their primary tumor, 16% needed surgery after recurrent cancer, and 10% of patients developed osteoradionecrosis necessitating mandibular reconstruction. In contrast, only 28% of patients in the secondary reconstruction group had recurrent tumor as the reason for surgery. The remainder of the patients had osteoradionecrosis (23%) or other chronic complications (49%) such as fistulae, exposed hardware, deformity, or other problems, which required another osseous reconstruction. A significant difference was found in the location of the defects ($p = .018$) and specifically, the secondary reconstruction group had a higher number of complex defects involving the central segment of the mandible.

Adjuvant therapy received by the 2 groups was tabulated, and there was no difference in the proportion of primary versus secondary reconstruction patients who received chemotherapy ei-

Table 2. Osseous flap choice in primary versus secondary reconstructions.

Flap choice	Primary, no.	Secondary, no.
Fibula	89	27
Iliac crest	9	10*
Scapula	9	1
Radial forearm	3	1

**Significantly more iliac crest flaps in secondary reconstructions, $p = .03$.*

ther preoperatively (2.7% vs 10.2%, respectively; $p = .07$) or postoperatively (8.2% vs 2.6%, respectively; $p = .45$). In total, 103 patients (primary group, $n = 78$; secondary group, $n = 25$) reported that they received either preoperative or postoperative radiation therapy.

Differences were observed in the osseous flap choice for mandibular reconstruction. The free fibula was the osseus flap most frequently used in both the groups (Table 2). There was statistically significant more iliac crest flaps used in the secondary reconstruction group ($p = .03$). Regarding recipient vessels, the facial artery ($n = 50$) or superior thyroid artery ($n = 44$) was used for almost 85% of the primary reconstructions. These vessels were employed frequently in secondary reconstruction cases as well, but a variety of other vessels were also used, including the external carotid, the lingual, and the transverse cervical arteries. A similar pattern was seen with venous anastomosis; the most frequent vein used for primary reconstruction was the external jugular ($n = 35$), and for secondary reconstruction was a branch of the internal jugular ($n = 10$). However, a greater range of recipient veins was used, including the external jugular, the facial, the internal jugular, and the anterior jugular veins. Because some patients had more than 1 venous anastomosis, the groups were not independent and therefore, statistical comparison was not performed on the choice of veins for anastomosis. The use of arteriovenous loops or cephalic turnups was not more prevalent in secondary reconstructions when compared with primary reconstruction.

The 2 outcomes of primary and secondary reconstruction, which were measured in this study, included length of hospital stay and complication rates. The length of stay of the primary (23 ± 16 days) versus secondary (22 ± 21 days) groups was similar ($p = .59$). Also, there was no significant difference in the overall proportion of patients who experienced 1 or more complications, with 39% of the primary reconstruction group and 54% of the secondary reconstruction group, having experienced at least 1 complication ($p = .13$). The complications were further subdivided into early versus late complications and surgical versus medical problems (Table 3). There was no increase in the reported complications following secondary reconstructions (acute complications $p = .40$; late complications $p = .17$). Six patients in the primary group and 1 patient in the secondary group had lost only the cutaneous portion of their flap, with subsequent successful coverage with another local or free flap. Medical complications were almost twice as prevalent in the primary reconstruction group. Late complications of surgery, occurring

Table 3. Comparison of complications in primary versus secondary reconstruction.

	Primary, no.	Secondary, no.
Early complications		
Operative	31	8
Complete flap loss	4	3
Skin loss; bone coverage with 2nd flap	6	1
Flap compromise ⇒ salvage	5	1
Partial flap necrosis	4	2
Neck wound problem	2	0
Dehiscence & fistula	1	1
Donor site complication	2	0
Hematoma	3	0
Other operative complication	4	0
Nonoperative	26	7
Intraoral plate or bone exposure	0	0
Wound dehiscence	8	0
Orocutaneous fistula	2	1
Minor flap necrosis	1	1
Infection	5	0
Donor site problem	4	2
Venous congestion salvaged with leeching	1	1
Hematoma or seroma—bedside management	5	2
Medical	29	5
Late complications	19	11
Hardware exposure, treated conservatively	1	0
Hardware removal (exposed or symptomatic)	11	6
Plate # or exposure requiring new plate and/or flap	2	1
ORN-related problems (nonunion, drainage, etc)	1	3
Nonunion requiring bone graft	1	1
Late infection or wound requiring operative I&D	3	0

after the patient had been discharged from hospital, were slightly higher in the secondary reconstruction group, and problematic hardware or complications related to osteoradionecrosis were the most common (Table 3).

DISCUSSION

This retrospective study is 1 of the larger reported series on mandibular reconstruction, and is 1 of the few works, which has attempted to analyze the differences between primary and secondary cases. Several other studies have discussed secondary mandibular reconstruction, but most are descriptive reports lacking statistical analysis. Ferrari et al[13] reported 10 successful cases of secondary reconstruction (2 iliac crest and 8 free fibular transfers) in previously irradiated patients. Wei et al[11] performed 20 secondary mandibular reconstructions with fibular osteocutaneous flaps after the failure of primary reconstruction using a reconstruction plate and soft tissue free flap. Two patients had failure of the cutaneous portion of their free tissue transfer and required salvage closure with a local flap. Markowitz et al[5] compared 9 primary and 5 secondary reconstructions. They noted a larger soft tissue defect in the secondary reconstruction group. All flaps survived in their series, but 60% of patients who underwent secondary reconstruction had complications. The 2 groups were well matched with respect to demographics, preexisting comorbidity, and type of pathology at original diagnosis.

The 2 groups in this series were comparable with respect to demographics, preexisting comorbidity, and original diagnosis (Table 1). However, the secondary reconstruction group had a higher proportion of defects involving the condyle or central segment. In hemimandibulectomy defects, reconstruction of an adequate articular surface for mandibular excursion remains a difficult problem. The central defect[14] poses several unique problems, including restoration of stomal competence, adequate labiobuccal sulcus to permit fitting of dentures or osseointegrated implants, and proper lip height and shape for cosmesis. Given these differences in the ablative defects, it was not surprising to find a significant difference in the use of the type of osseocutaneous flap required for the reconstruction in our series of patients. The free fibula was the most commonly employed tissue transfer in both groups, but in secondary cases, a significantly higher number of free iliac crest flaps was used, reflecting the greater size and complexity of the bone and soft tissue defects in these cases. Other surgeons have relied on the free fibula and iliac crest transfers for the majority of their mandibular reconstructions. Cordeiro et al[15] used the free fibular transfer for 90% of their reconstructions. Urken et al[10] reported a large case series of 210 free tissue transfers in which they employed the iliac crest osseocutaneous flap most commonly (67 cases), followed by the free fibular flap (46 cases). In our patients, the free fibula remains the tissue transfer of choice unless it is unavailable as a donor site, or if more substantial soft tissue is required for intraoral and/or extraoral defects.

The complication rate in this study was similar to that reported by other authors.[10,15] Urken et al[10] reported a total flap loss rate of 4% and partial flap necrosis rate of approximately 5%. In our investigation, the flap loss rate in primary reconstructions (4%) was less than in secondary reconstructions (8%), but the combined number of total failures was relatively small (7 of 149 cases; 4.7%). The overall proportion of patients who experienced 1 or more complications was not significantly different. Length of stay was also not significantly different between the groups. Thus, despite the additional challenges posed by secondary reconstruction, the postoperative morbidity was not necessarily higher.

Limitations of this study include the retrospective design and a relatively short duration of follow-up. Because of the large referral area, many patients are sent back to their home region for follow-up. Because detailed information on aesthetic or functional outcomes was not consistently available in patient charts, we were unable to comment on these important aspects of mandibular reconstruction. Prospectively, collected data on these issues will be an important future area of investigation.

Despite these limitations, this study has extended the current understanding of the unique challenges of secondary reconstruction. Success in secondary mandibular reconstruction can be achieved utilizing a range of osseous free flaps and there is no increase in complication rate in the patients undergoing secondary mandibular reconstructions.

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