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A pilot study of modified resection for anterior floor of the mouth squamous cell carcinoma without infiltration of the mandible

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ABSTRACT

Objective: To explore the application of modified resection compared with traditional segmental resection of the mandible for patients with anterior floor of the mouth and tongue squamous cell carcinoma (SCC) without infiltration of the mandible.

Subjects and Methods: This is a retrospective study including 36 eligible patients with anterior floor of the mouth SCC(9 patients received modified mandibulectomy, and 27 patients received segmental mandibulectomy).

Results: No patients in the modified mandibulectomy group developed recurrence in the floor of the mouth, and all of the patients survived. Only one patient developed osteoradionecrosis. When the modified mandibulectomy group was compared with the segmental mandibulectomy group, the former exhibited a lower recurrence rate in the floor of the mouth (0.0% vs. 14.8%), less blood loss (516.7 ± 70.7 ml vs. 533.3 ± 93.0 ml), shorter durations of gastric tube placement (11.4 ± 4.5 days vs. 20.7 ± 11.9 days) and tracheostomy (6.9 ± 0.6 days vs. 8.5 ± 1.6 days), a lower postoperative infection rate (11.1% vs. 18.5%), and a shorter postoperative hospital stay (13.7 ± 3.8 days vs. 15.9 ± 5.1 days).

Conclusion: This modified mandibulectomy method is safe and feasible and is recommended for further prospective study in a clinical setting.

1. Introduction

Floor of the mouth squamous cell carcinoma (SCC) accounts for approximately 10% of whole oral cavity SCC; the floor of the mouth is a rare subsite, with an SCC incidence rate that is obviously lower than those for the tongue (≈40%), gingiva (≈30%), and buccal tissue (≈20%) (Feng et al., 2017b; Xu et al., 2018). Anterior floor of the mouth SCC is a very rare subsite, accounting for only approximately one-sixth of whole mouth floor SCC cases. Currently, surgical treatment is the mainstream option in the area of oral and maxillofacial surgery for the management of anterior floor of the mouth SCC(Kansy et al., 2017; Schramm et al., 1980). However, when lesions reach the lingual gingiva, there is no greater controversy regarding the management of these lesions than the optimal treatment for preserving the mandibular inferior margin, periosteum, and even selected muscle groups attached to the chin (Kansy et al., 2017). Currently, there are two mainstream surgical management strategies adopted in such cases. Some authors believe that marginal mandibulectomy can be performed in most carcinomas of the floor of the mouth that abut the anterior mandible if there is no radiologic evidence of bony invasion or clinical evidence of fixation (Patel et al., 2008). Preservation of the mandibular inferior margin, geniohyoid, and anterior belly of the digastric muscle could avoid functional disabilities such as decreased efficiency of mastication and swallowing, poor intelligibility of speech, incontinence of saliva, and morbidity associated with a loss of blood supply (Beecroft et al., 1982; Komisar and Barrow, 1994). However, other authors believe that segmental anterior mandibulectomy and resection of muscle groups attached to the chin are the best and safest surgical management strategies for patients with anterior floor of the mouth SCC adjacent to or reaching the lingual periosteum. In particular, sufficient tumor-free margins were recently redefined in European guidelines as a clinical safety margin of approximately 10 mm from the tumor corresponding to an R0 situation, with a tumor-free margin of at least

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3–5 mm at histopathologic analysis (Wolff et al., 2012), while the American National Comprehensive Cancer Network (NCCN) guidelines define sufficient tumor-free margins as a clinical safety margin of 1.5–2 cm, with a tumor-free margin of at least 5 mm at histopathologic analysis (Pfister et al., 2016). In addition, primary reconstruction with vascularized osteomyocutaneous flaps or free bone transplantation has produced good results in recent years in both esthetic and functional evaluations and has solved some functional problems.

However, even though great advances have been made in the area of reconstruction, no one method has eliminated all of the functional problems associated with anterior mandibular segmental resection leading to loss of a natural muscle group attached to the chin. Therefore, the key for solving these problems is to clarify the safety of preserving the mandibular inferior margin, geniohyoid, and anterior belly of the digastric muscle. For preservation of the mandibular inferior margin, previous studies have verified that the mandibular periosteum is not the lymphatic drainage route of oral cancer metastases if the periosteum is not directly infiltrated by a tumor (Marchetta et al., 1971). Therefore, for anterior floor of the mouth SCC without infiltration of the mandible, the only remaining core question of surgical controversy is the feasibility of preserving the geniohyoid and anterior belly of the digastric muscle during marginal mandibulectomy. Namely, the key for the resection of anterior floor of the mouth SCC is the question regarding the safety boundary for the bottom margin.

In our department, anterior floor of the mouth SCC was mainly treated via segmental mandibulectomy before 2013. However, after 2013, we developed a modified resection method in which the mandibular chin with the geniohyoid and the anterior belly of the digastric muscle are restored after radical resection of a primary tumor and marginal mandibulectomy. As the modified mandibulectomy method has been increasingly applied, we have realized that the method probably presents an advantage over traditional segmental mandibulectomy in either its oncological or functional results. Therefore, a pilot study was conducted to explore the feasibility of this approach in the clinic and to assess differences in the intraoperative details, complications, recurrence rates in the floor of the mouth, and prognosis.

2. Materials and methods

This study was conducted in full accordance with ethical principles, including those of the World Medical Association's Declaration of Helsinki (2002 version), and with the approval of the Institutional Review Board of the Beijing Stomatological Hospital of Capital Medical University. The medical records of all patients who were treated via primary resection for anterior floor of the mouth SCC were reviewed at the Department of Oral and Maxillofacial-Head and Neck Oncology, Beijing Stomatological Hospital, Capital Medical University. First, between June 2013 and December 2016, 9 patients with anterior floor of the mouth SCC received the modified mandibulectomy that had been introduced as an innovative surgical method. Between July 2007 and December 2016, all remaining patients with anterior floor of the mouth SCC served as controls for the conventional surgical method. We reviewed the records and then restaged the tumors according to the 2002 version of the UICC/AJCC classification and based on the initial clinical description. The patient inclusion criteria comprised the following: (1) pathological diagnosis of SCC; (2) primary tumor located in the anterior floor of the mouth and lesions reaching the lingual gingiva; (3) no infiltration of the mandible according to enhanced computed tomographic (CT) and/or magnetic resonance imaging (MRI) examination; (4) no infiltration of the geniohyoideus, hyoglossus, mylohyoid, and anterior belly of the digastric muscle according to CT scanning and/or MRI examination; and (5) no evidence of distant metastasis (the typical appearance of anterior floor of the mouth SCC meeting the inclusion criteria is shown in Fig. 1).

2.1. Surgical management

In this study, all of the patients were divided into two groups according to the resection method: modified mandibulectomy with preservation of the mandibular chin (modified mandibulectomy) and segmental mandibulectomy.

The operating procedure of the modified mandibulectomy group was as follows: (1) The mandibular chin was temporarily detached and was then pulled down, with the geniohyoid and anterior belly of the digastric muscle attached after completion of the bilateral neck dissections. The bottom boundary of primary tumors could then be detected under direct vision (Fig. 2). (2) Bottom boundary detection: If there was a sufficient safety margin, the mandibular chin with the geniohyoid and anterior belly of the digastric muscle was restored after radical resection of the primary tumor and upper mandible (Fig. 3). (3) Flap reconstruction of postoperative defects was followed by resetting the detached mandibular chin (Figs. 4 and 5). A noteworthy detail of the modified mandibulectomy was that the osteotomy horizontal line of the upper mandibular resection was located in the chin of the mandible between the upper and lower mental ridges, i.e., the osteotomy horizontal line was located between the genioglossus and the geniohyoid. The position of the osteotomy horizontal line was the same whether hard tissue or soft tissue flap reconstruction was employed and whether the subjects were edentulous patients or had preserved teeth at the time of surgery. If there was a risk of tumor infiltration into the gap between the genioglossus and geniohyoid in the operating step (2), the operation was converted to segmental mandibulectomy.

The operating procedure for the segmental mandibulectomy group was continuous resection of the primary tumor, segmental mandible, muscle group of the floor of the mouth, and bilateral neck dissection tissues.

Patients who had pathologically invaded nodes in the neck were treated with radiotherapy (RT) within 4–8 weeks. A conventional RT regimen, which consisted of five 200-cGy fractions per week administered from Monday to Friday, was followed. The total dose for the primary tumor bed, which involved neck nodes, was >6,000 cGy. Chemoradiotherapy with cisplatin (30 mg/m^2 weekly) was recommended for patients who presented with extracapsular spread (ECS).

2.2. Follow-up

Enhanced CT and/or MRI radiographs and/or other imaging examinations conducted every six months for all patients were necessary for the early detection of abnormalities. Patients could return to the hospital for a visit at any time if certain clinical signs or symptoms were found. The cut-off date for follow-up was May 2018. The main outcome assessment parameters were the floor of the mouth recurrence (FMR) rate and the disease-specific survival (DSS) rate. The secondary outcome assessment parameters were the operative time, blood loss, postoperative length of hospital stay, postoperative infection rate, and osteoradionecrosis rate.

3. Results

3.1. Safety and feasibility of the modified mandibulectomy method

From June 2013 to December 2016, 9 cases were primarily anterior floor of the mouth SCC with lesions reaching the lingual gingiva but with no infiltration of the mandible, geniohyoideus, hyoglossus, mylohyoid, or anterior belly of the digastric muscle by

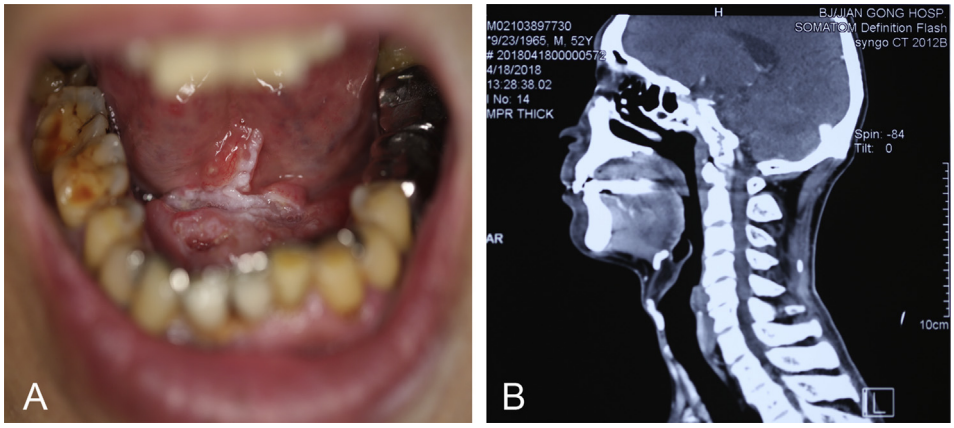

Fig. 1. A typical image of anterior floor of the mouth squamous cell carcinoma meeting the inclusion criteria (an independent case from April 2018 in our hospital). A: intraoral photograph showing a tumor located in the anterior floor of the mouth; B: sagittal view of a magnetic resonance scan showing an anterior floor of the mouth tumor reaching the lingual gingiva, but without infiltration of the mandible, geniohyoideus, hyoglossus, mylohyoid, or anterior belly of the digastric muscle.

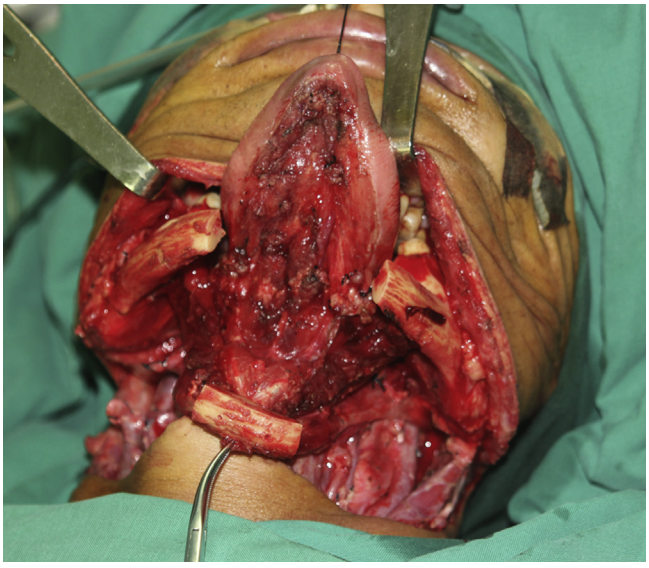

Fig. 2. Surgical procedure applied in the modified mandibulectomy group in this study. Step 1: The mandibular chin was temporarily detached, with the geniohyoid and anterior belly of the digastric muscle attached after completion of the bilateral neck dissections.

CT scan and/or MRI examination. The clinicopathological data of these 9 patients are listed in Table 1.

The operating procedure was successfully completed in the 9 patients according to the management procedures for the modified mandibulectomy group. In addition, no patients were converted to the segmental mandibulectomy group. According to the follow-up results, only 1 patient with multiple oral dysplastic lesions exhibited metachronous carcinoma in the gingiva, and 1 patient experienced a second primary carcinoma in the esophagus. However, importantly, neither of these patients had FMR, and all 9 patients survived. Five patients underwent postoperative RT, and 1 of these patients developed osteoradionecrosis.

3.2. Whether high-risk patients received RT did not significantly affect the rate of local-regional relapses

In the modified mandibulectomy group, 5 (83.3%) of 6 high-risk patients (T3-or T4-tumors or pN + status) received postoperative RT and 1 (16.7%) patient with T3N0M0 did not receive postoperative

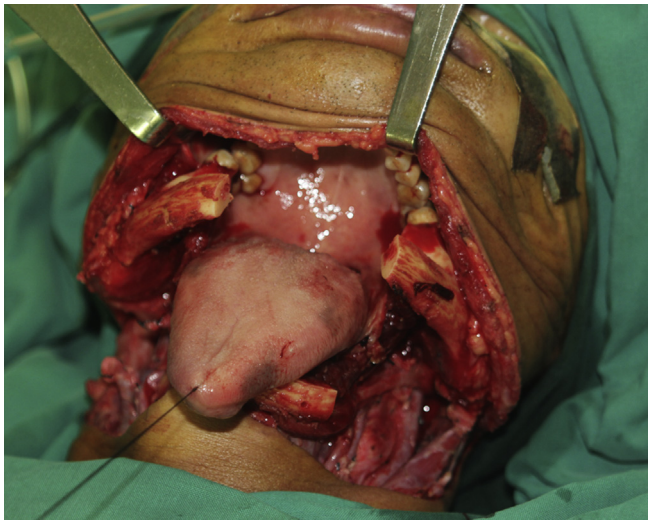

Fig. 3. Surgical procedure applied in the modified mandibulectomy group in this study. Step 2: If the bottom boundary detection left a sufficient safety margin, the mandibular chin with the geniohyoid and the anterior belly of the digastric muscle were restored after radical resection of the primary tumor and marginal mandibulectomy.

RT. The follow-up results showed that all of the 9 (100.0%) patients with or without RT did not develop local-regional relapses. And in the segmental mandibulectomy group, there were 11 (40.7%) of 27 high-risk patients (T3-or T4-tumors or pN + status) who received postoperative RT. Three (27.3%) of the 11 patients developed local-regional relapses (2 in FM and 1 in neck). As a comparison, the remaining 16 (59.3%) patients did not receive postoperative RT, and 4 (25.0%) of these patients had FMR (local relapse) (Table 2). The follow-up results showed that the rates of local-regional relapses were also similar between receiving (27.3%) and not receiving RT (25.0%) for the high-risk patients in the segmental mandibulectomy group. Namely, whether they received RT did not significantly affect the rates of local-regional relapse in the study.

3.3. Comparisons of recovery speed, postoperative complication rates, osteoradionecrosis rates, and prognosis between the modified mandibulectomy group and the segmental mandibulectomy group

The follow-up study continued until May 2018. The median follow-up times were 48 months [interquartile range, 24.5–53.5

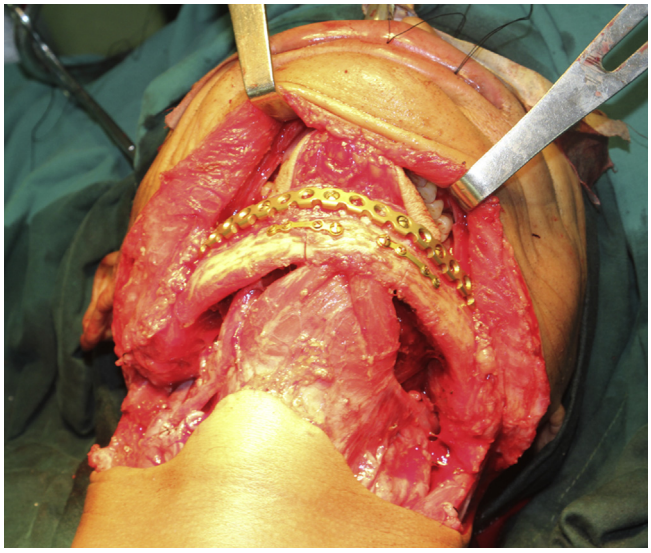

Fig. 4. Surgical procedure of the modified mandibulectomy group in this study. Step 3: Reconstruction of the postoperative defect using a free fibular flap was followed by resetting the detached mandibular chin.

months] in the modified mandibulectomy group and 39 months [interquartile range, 22–68 months] in the segmental mandibulectomy group. All of the patients received postoperative gastric tube placement and tracheostomy. To further analyze the advantages and disadvantages of the modified mandibulectomy method, we preliminarily attempted to compare the intraoperative details, postoperative infection rates, durations of gastric tube placement and tracheostomy, osteoradionecrosis rates, and prognosis of the patients undergoing modified mandibulectomy with those who received the segmental mandibulectomy method. The results showed that the patients in the modified mandibulectomy group had a better DSS rate (100.0% vs. 48.1%) and disease-free survival rate (77.8% vs. 48.1%) than the patients in the segmental mandibulectomy group. Due to the presence of some pN + patients who did not receive adjuvant RT/chemoradiotherapy in the segmental mandibulectomy group, the results may lead to statistical bias in the comparison of prognosis between the modified mandibulectomy group and the segmental mandibulectomy group. Therefore, the differences in prognosis between the two groups when pN + patients who did not receive adjuvant therapy were excluded were further analyzed. Specifically, in the segmental group, a total of 7 patients with pN + status never received adjuvant therapy, 3 of whom remained alive, while 4 of these patients died during the evaluated period (Table 2). After these 7 patients

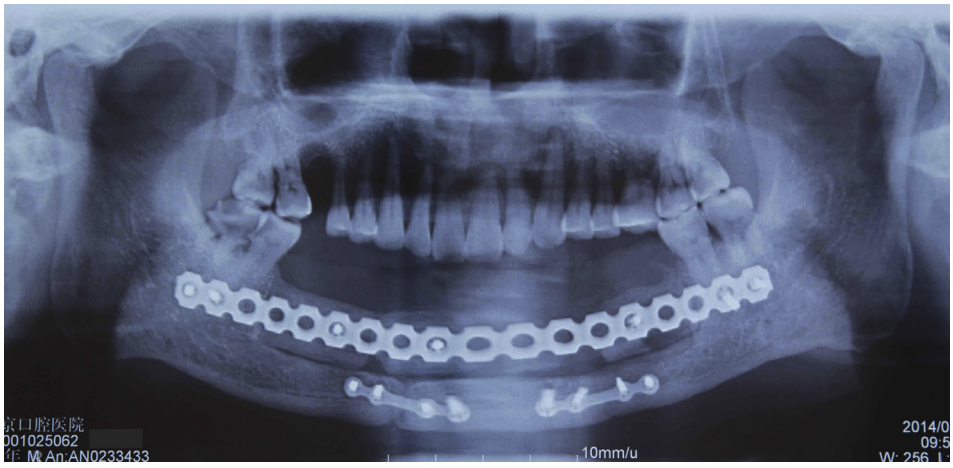

Fig. 5. Surgical procedure of the modified mandibulectomy group in this study. Panoramic radiograph 6 months after surgery.

Table 1
Clinicopathological data, treatment, and prognosis of the modified mandibulectomy group in this study (n = 9).

No.	Age (years)	Sex	Site	pTNM stage	Pathological grade	Growth pattern[a]	Tobacco use	Alcohol use	Primary treatment	Neck dissection	Relapse/ sites	Metachronous carcinoma	DFS (ms)	Salvage treatment	Censor/ (time, ms)
1	57	male	FM	T3N0	II	Ulcerative	Yes	Yes	Fibular flap	Bi-MRND	N	N	59	N	Survival/59
2	51	Male	FM + T	T4aN1	II	Ulcerative	Yes	No	Fibular flap + RT	Bi-SOND	N	N	55	N	Survival/55
3	43	Male	FM	T2N1	II	Exophytic	Yes	Yes	ALT flap + RT	Bi-MRND	N	Y/gingiva	14	S + CCRT	Survival/52
4	62	Male	FM	T3N1	II	Exophytic	No	No	Fibular flap + RT	Bi-MRND	N	N	49	N	Survival/49
5	65	Male	FM	T1N1	II	Exophytic	No	No	ALT flap + RT	Bi-SOND	N	N	48	N	Survival/48
6	67	Male	FM	T2N0	II	Exophytic	Yes	Yes	ALT flap	Bi-SOND	N	N	32	N	Survival/32
7	52	Male	FM	T2N0	II	Ulcerative	Yes	No	ALT flap	Bi-SOND	N	N	25	N	Survival/25
8	51	Male	FM	T2N0	I	Exophytic	Yes	Yes	Forearm flap	Bi-SOND	N	N	24	N	Survival/24
9	51	Male	FM + T	T4N1	II	Infiltrative	Yes	Yes	Fibular flap + RT	Bi-SOND	N	Y/esophagus	10	Quit	Survival/17

Note: DFS: disease-free survival; FM: floor of the mouth; T: tongue; MRND: modified radical neck dissection; RND: radical neck dissection; SOND: supraomohyoid neck dissection; ALT: anterolateral thigh flap; S: surgery; RT: radiotherapy; CCRT: concurrent chemoradiotherapy.

[a] The infiltrative growth pattern was defined as the clinical features of primary tumors that obviously invaded deep tissues and formed infiltration masses. The clinical differences among the infiltrative, ulcerative, and exophytic patterns were as follows: the ulcerative pattern presented an ulcerated appearance, and the exophytic pattern presented the characteristic of the mass rarely invading deep tissue.

were excluded from the analysis of survival rates, the results showed that the patients in the modified mandibulectomy group exhibited similarly better DSS (100.0% vs. 50.0%) and disease-free survival rates (77.8% vs. 50.0%) than patients in the segmental mandibulectomy group. Therefore, we believe that the modified mandibulectomy approach is a safe surgical method.

Additionally, when the modified mandibulectomy group was compared with the segmental mandibulectomy group, the former presented a lower FMR rate (0.0% vs. 14.8%), less blood loss (516.7 ± 70.7 ml vs. 533.3 ± 93.0 ml), shorter durations of gastric tube placement (11.4 ± 4.5 days vs. 20.7 ± 11.9 days) and tracheostomy (6.9 ± 0.6 days vs. 8.5 ± 1.6 days), a lower postoperative infection rate (11.1% vs. 18.5%), and a shorter postoperative hospital stay (13.7 ± 3.8 days vs. 15.9 ± 5.1 days). However, the modified mandibulectomy group exhibited a slightly longer operative time than the segmental mandibulectomy group (541.7 ± 69.7 min vs. 509.3.5 ± 100.5 min), while the two groups showed similar osteoradionecrosis rates (20.0% vs. 25.0%) (Table 3).

4. Discussion

When an anatomical region such as the oral cavity, with a multitude of complex functions and a high density of important anatomical structures, is the primary site of tumor resection, it is not merely an academic problem but a true problem in everyday clinical medicine, with enormous consequences for every patient involved. If selected margins are located too closely, the risk of incomplete resection and subsequent recurrence increases; if margins are placed too widely, esthetic impairments and functional restrictions of speech, chewing, and swallowing may be tremendous, permanently limiting the patients' quality of life (QOL).

Knowledge of the mandibular blood supply and related surgical modifications has permitted us to preserve the mandibular arch in the case of selected lesions of the floor of the mouth. We have completed modified resection of the mandibular chin that preserves the geniohyoid and anterior belly of the digastric muscle during treatment of anterior floor of the mouth SCC. All patients in our study underwent preoperative enhanced CT scans and/or MRIs to rule out mandibular invasion. We did not find evidence of bone invasion in any of our patients. Only one patient had osteoradionecrosis of the mandibular chin, which was restored after postoperative RT. We believe that this outcome resulted from the measures taken to preserve the blood supply of the geniohyoid and anterior belly of the digastric muscle because the periosteal blood supply of the mandibular chin, which is the predominant blood supply in the adult mandible, was never interrupted.

More importantly, the results showed that patients in the modified mandibulectomy group displayed a lower FMR rate and a higher survival rate than patients in the segmental mandibulectomy group. In fact, only 1 patient in the modified mandibulectomy group experienced recurrence in the superficial gingiva rather than the floor of the mouth. As this patient presented the characteristic of multiple oral dysplastic lesions, we believed that the primary resection based on modified mandibulectomy for anterior floor of the mouth SCC was clean. However, for the patients with multiple oral dysplastic lesions, it was difficult to prevent cancerization with just a single operation. Our previous studies have shown that multiple oral dysplastic lesions are an important factor in multiple primary carcinomas (Feng et al., 2016; Feng et al., 2017a). Although we believed that the tumor relapse was attributed to a second primary carcinoma, local recurrence was still defined because the relapse site in the gingiva was close to the primary sites. In view of the fact that no patients developed FMR, the surgical method of modified mandibulectomy was determined to be safe and feasible. Additionally, the modified mandibulectomy group presented another advantage regarding the flexibility of choice for reconstruction methods over the segmental mandibulectomy group. Specifically, the reconstruction methods of the modified mandibulectomy group could use either a bone tissue flap or soft tissue flap because the chin of the mandible is ultimately continuous. However, only hard tissue flaps are recommended for the reconstruction methods applied in the segmental mandibulectomy group. For the modified mandibulectomy group, if tumors were extensive and involved the floor of the mouth and the tongue, both a fibular flap and anterolateral thigh (ALT) flap were ideal choices. However, if tumors were rather small and were only located in the floor of the mouth, a forearm flap could also be recommended as a choice in our department.

The modified mandibulectomy was also different from traditional marginal mandibulectomy. The difficulty in the resection of anterior floor of the mouth SCC mainly involved the safety of the bottom margin. Traditional marginal mandibulectomy was performed by directly resecting the upper mandible, and it was difficult to clearly detect the bottom boundary between the geniohyoid and the genioglossus, leading to possible lower surgical safety concerns. Inversely, the first step of the modified mandibulectomy was temporary detachment of the mandibular chin, which was subsequently pulled down. The bottom boundary of primary tumors could then be detected under direct vision. If there was a sufficient safe bottom boundary, an upper marginal mandibulectomy was performed while the mandibular chin with the geniohyoid and the anterior belly of the digastric muscle were precisely and actively restored. Therefore, modified mandibulectomy approach presents an advantage over traditional marginal mandibulectomy in the use of clear surgical boundaries and a clear surgical field.

In this study, considering the small sample sizes of the two groups, an analysis of *P* values between the groups with the aim of determining the prognostic difference would have been imprudent. However, the trends in the FMR and DSS rates of the modified mandibulectomy group never decreased compared with those of the traditional segmental mandibulectomy group. At the same time, the modified mandibulectomy group exhibited a lower complication (postoperative infection) rate than the segmental mandibulectomy group because the former procedure could reduce the formation of dead space. In addition, the lower level of blood loss and the shorter postoperative hospital stay observed in the modified mandibulectomy group (compared with the segmental mandibulectomy group) showed that the former group presented an advantage in terms of recovery speed. Furthermore, all patients in the modified mandibulectomy group experienced shorter durations of gastric tube placement and tracheostomy. As earlier resumption of oral intake and attained speech could indirectly reflect better postoperative swallowing function, it was believed that the preservation of the geniohyoid and the anterior belly of the digastric muscle attached in the mandibular chin was likely valuable in the modified mandibulectomy group (Inokuchi et al., 2016; Palmer et al., 2005). Furthermore, many studies have shown that the geniohyoid plays an essential role in opening the upper esophageal sphincter. The anterior belly of the digastric muscle is associated with greater hyoid displacement when swallowing solid food. In addition, the geniohyoid and anterior belly of the digastric muscle are important muscles modulated by a central pattern generator that modifies the level of muscle activity during pharyngeal swallowing in response to input from mechanoreceptors in the oral cavity (Inokuchi et al., 2014; Inokuchi et al., 2016). Thus, although we have no direct evidence to show the functional advantage of modified mandibulectomy, the method can theoretically preserve a better swallowing function than traditional resection.

Table 2
Clinicopathological data, treatment, and prognosis of the segmental mandibulectomy group in this study (n = 27).

No.	Age (years)	Sex	Site	pTNM stage	Pathological grade	Growth pattern[a]	Tobacco use	Alcohol use	Primary treatment	Neck dissection	Relapse/ sites	Metachronous carcinoma	DFS (ms)	Salvage treatment	Censor (time, ms)
1	47	Male	FM + T	T4N1	III	Exophytic	Yes	Yes	Fibular flap	RND + SOND	N	N	116	N	Survival/116
2	65	Male	FM	T3N0	II	Exophytic	Yes	Yes	Fibular flap	Bi-SOND	N	N	108	N	Survival/108
3	61	Male	FM + T	T4N0	II	Exophytic	Yes	Yes	Fibular flap	Bi-SOND	Y/FM	N	61	Quit	Death/68
4	46	Male	FM	T2N1	II	Exophytic	Yes	Yes	Fibular flap	Bi-SOND	N	N	76	N	Survival/76
5	61	Male	FM	T2N1	II	Infiltrative	Yes	Yes	Fibular flap	Bi-SOND	Y/FM	N	31	Quit	Death/39
6	55	Male	FM + T	T4N0	II	Infiltrative	No	No	Fibular flap	Bi-SOND	Y/FM	N	10	S	Death/26
7	54	Male	FM + T	T4N0	II	Infiltrative	Yes	Yes	Fibular flap	RND + SOND	N	N	72	N	Survival/72
8	61	Male	FM + T	T4N0	I	Exophytic	Yes	Yes	Fibular flap	RND + SOND	N	N	68	N	Survival/68
9	51	Male	FM	T3N1	II	Ulcerative	Yes	Yes	Fibular flap + RT	Bi-SOND	N	N	67	N	Survival/67
10	49	Male	FM + T	T4aN2c	I	Infiltrative	Yes	Yes	Fibular flap + RT	RND + SOND	Y/distant	N	2	Quit	Death/4
11	55	Male	FM	T3N2c	I	Infiltrative	Yes	Yes	Fibular flap	RND + SOND	Y/distant	N	17	Quit	Death/20
12	59	Male	FM + T	T4N0	II	Ulcerative	Yes	Yes	Fibular flap	Bi-MRND	Y/FM	N	35	Quit	Death/45
13	56	Male	FM	T3N0	I	Ulcerative	Yes	Yes	Fibular flap	Bi-SOND	N	Y/esophagus	23	Quit	Death/29
14	55	Male	FM + T	T4N2c	I	Ulcerative	Yes	Yes	Fibular flap + CCRT	Bi-SOND	Y/FM	N	10	Quit	Death/12
15	62	Male	FM + T	T4N0	II	Ulcerative	Yes	Yes	Fibular flap	Bi-SOND	Y/distant	N	25	Quit	Death/27
16	51	Male	FM + T	T4N0	III	Ulcerative	Yes	Yes	Fibular flap	Bi-SOND	N	N	94	N	Survival/94
17	55	Male	FM + T	T4aN0	I	Infiltrative	No	No	Fibular flap + RT	Bi-SOND	Y/neck	N	21	CCRT	Death/66
18	55	Male	FM + T	T4aN2c	I	Infiltrative	Yes	Yes	Fibular flap + RT	RND + SOND	N	N	66	N	Survival/66
19	47	Male	FM	T2N2	II	Ulcerative	Yes	Yes	Fibular flap + RT	MRND + SOND	N	N	65	N	Survival/65
20	36	Male	FM + T	T4N1	II	Infiltrative	Yes	Yes	Fibular flap + RT	Bi-SOND	N	N	65	N	Survival/65
21	47	Male	FM + T	T4aN2c	II	Infiltrative	Yes	No	ALT + RT	MRND + SOND	N	N	28	N	Survival/28
22	48	Male	FM + T	T4aN2c	II	Infiltrative	Yes	Yes	Fibular flap + CCRT	MRND + SOND	Y/FM	N	9	CCRT	Death/14
23	58	Male	FM	T1N1	II	Exophytic	Yes	Yes	Fibular flap + RT	Bi-SOND	N	N	28	N	Death (asphyxia)/ 28
24	58	Male	FM	T3N1	I	Infiltrative	Yes	Yes	Fibular flap	Bi-SOND	N	N	10	N	Survival/10
25	42	male	FM + T	T4aN2c	II	Ulcerative	Yes	Yes	Fibular flap	Bi-SOND	Y/distant	N	4	Quit	Death/8
26	53	Male	FM + T	T4aN2c	II	Ulcerative	Yes	Yes	ALT flap + CCRT	RND + MRND	Y/distant	N	26	Quit	Death/30
27	60	Male	FM	T2N2b	I	Exophytic	Yes	Yes	Fibular flap	Bi-SOND	N	Y/esophagus	3	Operation	Death/22

Note: DFS: disease-free survival; FM: floor of the mouth; T: tongue; MRND: modified radical neck dissection; RND: radical neck dissection; SOND: supraomohyoid neck dissection; ALT: anterolateral thigh flap; S: surgery; RT: radiotherapy; CCRT: concurrent chemoradiotherapy.

[a] The infiltrative growth pattern was defined as the clinical features of primary tumors that obviously invaded deep tissues and formed infiltration masses. The clinical differences among the infiltrative, ulcerative, and exophytic patterns were as follows: the ulcerative pattern presented an ulcerated appearance, and the exophytic pattern presented the characteristic of the mass rarely invading deep tissue.

Table 3
Intraoperative details, postoperative complications, osteoradionecrosis, and prognosis between the modified mandibulectomy group and the segmental mandibulectomy group.

	Modified mandibulectomy group	Segmental mandibulectomy group
Operative time, minutes, mean ± SD	541.7 ± 69.7	509.3.5 ± 100.5
Blood loss, ml, mean ± SD	516.7 ± 70.7	533.3 ± 93.0
Postoperative infection rate	1/9, 11.1%	5/27, 18.5%
Duration for gastric tube placement, days	11.4 ± 4.5	20.7 ± 11.9
Duration for tracheostomy, days	6.9 ± 0.6	8.5 ± 1.6
Postoperative hospital stay, days, mean ± SD	13.7 ± 3.8	15.9 ± 5.1
Osteoradionecrosis	1/5, 20.0%	3/12, 25.0%
FMR, rate	0/9, 0.0%	4/27, 14.8%
DSS, time, median (range), months; rate	48 (17–59); 9/9, 100.0%	39 (4–116); 13/27, 48.1%

Note: SD: standard deviation; FMR: floor of the mouth recurrence; DSS: disease-specific survival.

This study primarily compared modified mandibulectomy with segmental mandibulectomy in terms of intraoperative details, complications, and prognosis, and the results showed that the modified mandibulectomy approach presents meaningful benefits for clinical management. However, this study was retrospective, and the sample size was small; consequently, it was a pilot study, and bias was unavoidable. The percentage of high-risk patients between the two groups may be unbalanced. It may be a hidden reason for the worse prognosis after segmental mandibulectomy. Therefore, the conclusions regarding difference of relapse and survival rate between the two groups should be interpreted with caution. Additionally, some follow-up data were missed, and the retrospective nature of the study resulted in a lack of detailed data regarding QOL. Moreover, all of the patients who did not undergo postoperative radiotherapy and never experienced relapse in the two years postoperative were suggested to receive dental rehabilitation. Recently, some patients in the study were treated with distraction osteogenesis and/or dental implantation as the dental rehabilitation goal. Although no patients in the study had yet completed the entire dental rehabilitation procedure, these patients will experience a better quality of life, chewing function, and aesthetic results in the near future. These issues were the limitations of this pilot study. But the pilot study on application value of the modified mandibulectomy in rare anterior floor of the mouth SCC is still reasonable. We will address these limitations in future research by conducting a prospective study with a larger sample size.

5. Conclusion

The modified mandibulectomy approach shows promise for reducing surgical trauma, decreasing postoperative infection rates, improving recovery speeds, and also probably increasing survival rates for surgical management of anterior floor of the mouth SCC. Therefore, this modified mandibulectomy method is safe and feasible and is recommended for further prospective study in a clinical setting.

Conflicts of interest

None to declare.

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References

Beecroft WA, Sako K, Razack MS, Shedd DP: Mandible preservation in the treatment of cancer of the floor of the mouth. J Surg Oncol 19(3): 171–175, 1982
Feng Z, Xu QS, Niu QF, Qin LZ, Li JZ, Su M, et al: Risk factors for patients with multiple synchronous primary cancers involving oral and oropharyngeal subsites. Oral Surg Oral Med Oral Pathol Oral Radiol 121(4): 360–366, 2016
Feng Z, Xu QS, Qin LZ, Li H, Huang X, Su M, et al: Second primary cancer after index head and neck squamous cell carcinoma in Northern China. Oral Surg Oral Med Oral Pathol Oral Radiol 123(1): 95–102, 2017a
Feng Z, Xu QS, Wang C, Li JZ, Mao MH, Li H, et al: Lymph node ratio is associated with adverse clinicopathological features and is a crucial nodal parameter for oral and oropharyngeal cancer. Sci Rep 7(1): 6708, 2017b
Inokuchi H, González-Fernández M, Matsuo K, Brodsky MB, Yoda M, Taniguchi H, et al: Electromyography of swallowing with fine wire intramuscular electrodes in healthy human: activation sequence of selected hyoid muscles. Dysphagia 29(6): 713–721, 2014
Inokuchi H, González-Fernández M, Matsuo K, Brodsky MB, Yoda M, Taniguchi H, et al: Electromyography of swallowing with fine wire intramuscular electrodes in healthy human: amplitude difference of selected hyoid muscles. Dysphagia 31(1): 33–40, 2016
Kansy K, Mueller AA, Mücke T, Koersgen F, Wolff KD, Zeilhofer HF, et al: A worldwide comparison of the management of T1 and T2 anterior floor of the mouth and tongue squamous cell carcinoma - extent of surgical resection and reconstructive measures. J Craniomaxillofac Surg 45(12): 2097–2104, 2017
Komisar A, Barrow HN: Mandible preservation in cancer of the floor of the mouth. Anatomical and oncological considerations. Arch Otolaryngol Head Neck Surg 120(11): 1197–1200, 1994
Marchetta FC, Sako K, Murphy JB: The periosteum of the mandible and intraoral carcinoma. Am J Surg 122(6): 711–713, 1971
Palmer PM, McCulloch TM, Jaffe D, Neel AT: Effects of a sour bolus on the intramuscular electromyographic (EMG) activity of muscles in the submental region. Dysphagia 20(3): 210–217, 2005
Patel RS, Dirven R, Clark JR, Swinson BD, Gao K, O'Brien CJ: The prognostic impact of extent of bone invasion and extent of bone resection in oral carcinoma. Laryngoscope 118(5): 780–785, 2008
Pfister DG, Spencer S, Adelstein D, Adkins D, Brizel DM, Burtness B, et al: NCCN guidelines version 1.2016 panel members. Head and neck cancers. J Natl Compr Cancer Netw, 2016
Schramm Jr VL, Myers EN, Sigler BA: Surgical management of early epidermoid carcinoma of the anterior floor of the mouth. Laryngoscope 90(2): 207–215, 1980
Wolff KD, Follmann M, Nast A: The diagnosis and treatment of oral cavity cancer. Dtsch Arzteblatt Int 109(48): 829–835, 2012
Xu QS, Wang C, Li B, Li JZ, Mao MH, Qin LZ, et al: Prognostic value of pathologic grade for patients with oral squamous cell carcinoma. Oral Dis 24(3): 335–346, 2018