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Conservation of salivary secretion and facial nerve function in partial superficial parotidectomy

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Abstract. Conventional total superficial parotidectomy (TP) has commonly been used, but partial superficial parotidectomy (PP) offers the possibility of better preserving glandular function and avoiding palsy of the facial nerves. In this study, the extent to which saliva secretion and facial nerve function were conserved in patients who received TP vs. PP was compared. Data were collected from patients who received a PP ($n = 163$) or a TP ($n = 105$) for benign primary tumours in the superficial lobe of the parotid glands between 1995 and 2009 at a single hospital. The incidence of transient facial paralysis was significantly lower in patients who received PP than in those who received TP. Secretory function was preserved for patients with a conserved Stensen's duct, whereas patients in whom the duct had been ligated lost secretory function. Partial superficial parotidectomy reduces the incidence of postoperative facial nerve dysfunction and is conducive to preserving Stensen's duct and saliva secretion.

Key words: parotidectomy; partial superficial parotidectomy; saliva flow rate; Stensen's duct.

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Approximately 75% of parotid gland tumours are benign. About 80% of the time, they are located in the superficial lobe of the parotid gland, lateral to the facial nerve. A conventional total superficial parotidectomy (TP) is commonly performed to surgically remove benign parotid tumours that are restricted to the superficial lobe. In this procedure, the superficial lobe is completely resected and the integrity of the facial nerve anatomy is maintained. The goal of surgical treatment is the complete excision of the lesion with complete anatomical and functional preservation of the facial nerve.[1] Most of the time, a considerable amount of non-tumourous parotid tissue is also resected and the intraparotid facial nerve is fully dissected to separate it from this tissue, which may disrupt Stensen's duct, leading to a high incidence of secretory hypofunction and facial nerve paralysis or weakness.[2] TP has recently come to be considered unnecessary for preventing recurrence in the majority of patients, depending on the histology, size, and location of the tumour.[3] Therefore, the surgical practice for benign parotid tumours has evolved such that TP is now less common than partial superficial parotidectomy (PP). In a PP, the parotid tumour is resected with a surrounding 0.5–1 cm cuff of normal parotid tissue, or the tail of the parotid gland is resected when the tumour is located in the posterio-inferior portion. This method removes only the tumour-bearing area and obviates the need for more extensive facial nerve dissection to preserve healthy tissues. The functional

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parotidectomy (FP) became established on the basis of PP. An FP includes the management of the PP and the lifting incision, and conservation of the superficial musculo-aponeurotic system (SMAS) flap, the great auricular nerve, and Stensen's duct. This preserves more of the function of the parotid gland and the related tissues, improves cosmetic results, and minimizes the incidence of facial nerve paralysis and other side effects. The FP is now the treatment of choice for most patients with benign tumours in the superficial lobe of the parotid gland.

Damage to the facial nerve is one of the most serious complications of parotid gland surgery. As many as 30–65% of patients experience transient weakness from facial nerve paralysis, and 3–6% experience permanent dysfunction of the facial nerve following TP.[4] In addition, xerostomia can reduce a patient's quality of life after parotidectomy. In the present study, the outcomes of the use of PP compared with TP performed during the same time-interval at a single institution were reviewed. Specifically, the conservation of salivary secretion and facial nerve function was compared between patients who received PP and TP.

Subjects and methods

A total of 268 patients with previously untreated benign parotid tumours within the superficial lobe, who underwent a primary parotidectomy between 1995 and 2009, were included in this study. Of these patients, 105 received a TP and 163 received a PP. For all patients, the diagnosis was confirmed by pathological examination of the excised tumours. The median age of the patients was 51 years (range 6–81 years); 118 were female and 150 were male (male to female ratio 1.27:1) (Table 1).

The medical records were reviewed to obtain the following information: patient demographics, preoperative clinical assessment, histological findings, and postoperative transient facial paralysis. Intraoperative details were recorded by the surgeons at the time of surgery and included the location and size of each tumour and its relationship to the facial nerve, the extent of surgery, which branches of the facial nerve were dissected, and the management of the Stensen's duct.

In this study, TP constituted removal of the entire lateral lobe of the parotid gland and complete facial nerve dissection. FP included the management of the PP and the lifting incision, and conservation of the SMAS flap, the great auricular nerve, and Stensen's duct. PP was defined as any procedure in which less than a superficial lobectomy was performed; all 163 patients who received a PP received an FP, so these terms are used interchangeably. In a TP, the intraparotid facial nerve can be dissected using either an anterograde or retrograde technique. Retrograde dissection of the facial nerve has been more popular in China and this practice was followed in the current study. Using this method, the peripheral branches were identified first, and then dissected proximally to the bifurcation or main trunk. After the skin flap was raised, the resection of the parotid gland began from the anterior border, where Stensen's duct emanates from the gland onto the masseter muscle, and the facial nerve was separated away from the tumour. Whenever the facial nerve was found to lie across the duct, efforts were made to preserve the duct; if, however, the intraparotid facial nerve was below Stensen's duct, the duct was transected and ligated. When the bifurcation and main trunk of the facial nerve became exposed, the superior parotid gland was resected at its posterior border with the tumour[5] (Fig. 1). If the tumour was less than 2 cm in diameter or if the tumour was located in the tail of the parotid gland, a PP was carried out.

In the PP, only a portion of the facial nerve, i.e. the peripheral branches beyond the tumour site, was meticulously dissected, and the parotid tumour was resected with a surrounding 0.5–1 cm cuff of normal parotid tissue[6] (Fig. 2), except when the tumour abutted the plane of the facial nerve. The Stensen's duct was usually preserved in the PP unless it hindered the procedure of tumour resection.

Transient facial palsy at 1 week after surgery was recorded in the case notes. All patients were followed for at least 6 months after surgery; follow-up ranged from 6 to 159 months, and the median follow-up time was 18 months. The patients were asked to give a history and were given a clinical examination. Every patient was examined by palpation for recurrence of the tumour. When a recurrence was suspected, ultrasound, computed tomography, or magnetic resonance imaging was performed to confirm or exclude this diagnosis. They were also given a questionnaire on postoperative complications, and formal tests for facial movement and secretion function. The objective clinical evaluation of postoperative complications in all patients was performed by a single clinician (Dr. Zhang) who was blinded to the details of the surgery.

All patients eligible for the study were evaluated by an index score created specifically to evaluate facial motor function and salivation. The severity of the patient's loss of salivation was rated using a scale from 1 (fully satisfied with current status without any discomfort) to 4 (extremely uncomfortable). Facial nerve dysfunction was evaluated using the House–Brackmann grading system,[7] which includes six grades ranging from grade I (normal function) to grade VI (complete loss of facial motor function), and the branches of the facial nerve that appeared to be paralyzed were recorded.

Saliva flow rates in the operated and contralateral parotid glands were

Table 1. Patient characteristics.

	Total superficial parotidectomy (TP) (n = 105)		Partial superficial parotidectomy (PP) (n = 163)		Total (n = 268)	
	No.	%	No.	%	No.	%
Sex						
Male	59	56.2	91	55.8	150	56.0
Female	46	43.8	72	44.2	118	44.0
Surgery position						
Left	55	52.4	81	49.7	136	50.7
Right	50	47.6	82	50.3	132	49.3
P*athologic diagnosis*						
Pleomorphic adenomas	71	67.6	86	52.8	157	58.6
Warthin's tumour	26	24.8	52	31.9	78	29.1
Basal cell adenoma	4	3.8	16	9.8	20	7.5
Other types	4	3.8	9	5.5	13	4.9
The management of the Stensen's duct						
Preserving the duct	35	33.3	130	79.8	165	61.6
Ligating the duct	70	66.7	33	20.2	103	38.4
Recurrence of the tumour	0	0	1	0.6	1	0.37

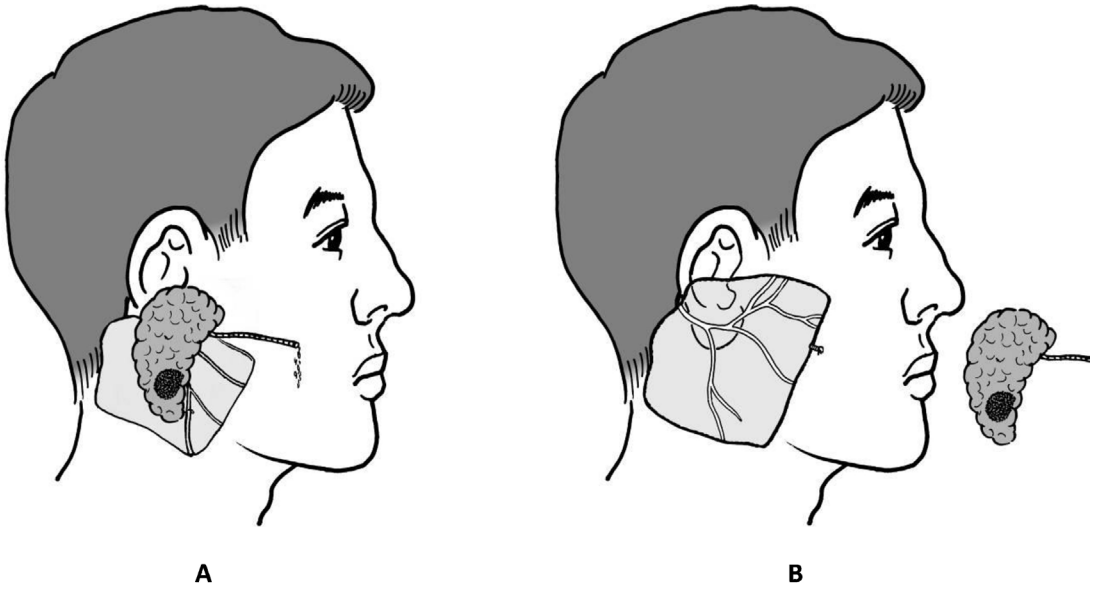

Fig. 1. Total superficial parotidectomy (TP): the entire superficial parotid gland is removed with the tumour; all of the branches of the facial nerve distributions are exposed. (A) Before operation. (B) After TP.

measured by sampling the secreted saliva using a Lashley cup. First, the unstimulated saliva flow was collected for 5 min; then, after resting for 10 min, salivation was stimulated by application of 2% citric acid to the dorsal surface of the anterior tongue with a saturated cotton swab, five times at 15-s intervals. The stimulated saliva flow was also collected for 5 min and compared between the operated and contralateral sides.

The study had institutional review board approval and written informed consent was obtained from each patient. All data collected were entered onto code sheets which were then captured in a database. Data were presented either as means with standard deviations or as percentages when appropriate. All statistical analyses were performed using SPSS 13.0 for Windows. All categorical variables were analyzed in a univariate analysis using χ^2 tests; *t*-tests were employed when continuous variables were encountered. Saliva flow rates were compared between TP and PP by independent samples *t*-test, and saliva flow rates of the operated and contralateral sides for both TP and PP were compared by paired samples *t*-test. Incidences of recurrence in the two groups were analyzed by Fisher's exact test. *P*-values of less than 0.05 were interpreted as statistically significant.

Results

Information was obtained from the patient case notes and a contemporaneous database; patients presenting symptoms of

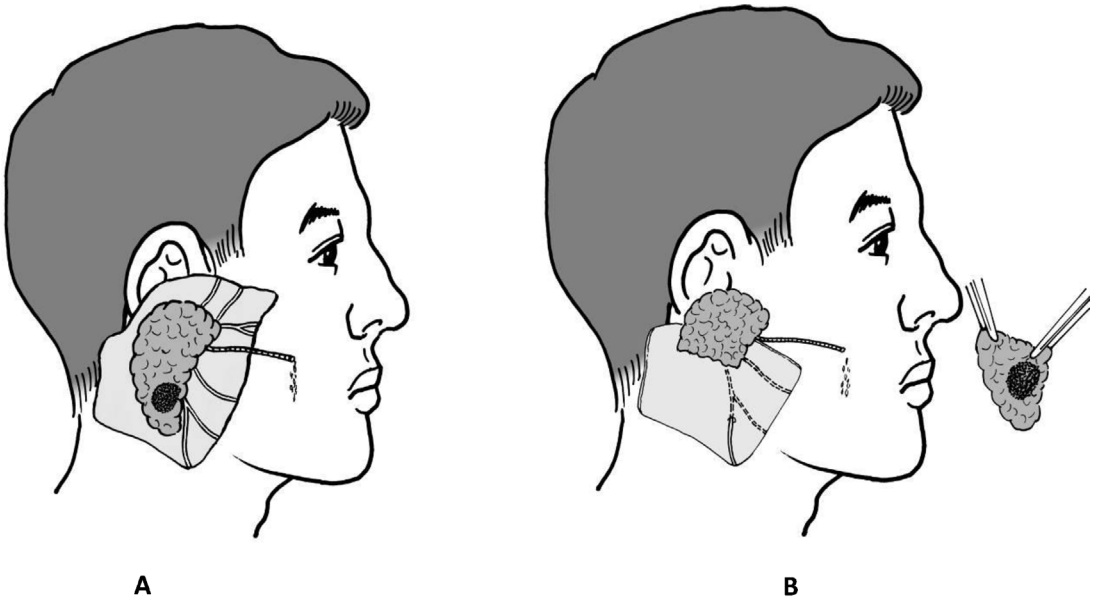

Fig. 2. Partial parotidectomy, a component of partial superficial parotidectomy (PP). The parotid tumour is resected with a surrounding 0.5–1 cm cuff of normal parotid tissue. Only a portion of the facial nerve branches is dissected. Most of the gland is preserved. (A) Before operation. (B) After PP.

complications following total or partial superficial parotidectomy were investigated by Dr. Zhang. During the study period, a total of 268 patients with a benign tumour in the superficial lobe of the parotid gland were treated with parotid surgery, including 163 (60.8%) who received a PP and 105 (39.2%) who received a conventional TP. Among them, 136 patients (50.7%) had a tumour located on the left side of the face, and 132 (49.3%) had a tumour on the right side. Of all 268 patients in this series, 75 were followed up for 6–12 months, 161 for 13–24 months, 16 for 25–36 months, and 11 for more than 37 months after the operation. Histologically, the tumours were pleomorphic adenomas in 157 patients (58.6%), Warthin's tumour in 78 patients (29.1%), and basal cell adenomas in 20 patients (7.5%); the rest were benign lesions of other types ($n = 13$, 4.9%). One patient with a Warthin's tumour had recurrence after PP. There was no statistically significant difference in the recurrence rate between the TP and PP groups, which were 0% and 0.6%, respectively ($P = 0.608$).

Facial nerve function

The most common surgical complication was transient facial palsy. The overall transient palsy rate was 24%. According to the surgical records, an average of 3.55 ± 1.152 branches of the intraparotid facial nerve were dissected for each patient in the TP group, and an average of 1.58 ± 0.974 branches for each patient in the PP group ($P = 0.006$). Facial nerve function was assessed at 1 week postoperatively, and palsy rates were compared among patients with TP vs. PP. The incidence of temporary facial nerve dysfunction was higher in patients who had TP (34/105, 32.4%), compared with PP (29/163, 17.8%) ($P = 0.005$). There were proportionally more patients with multi-branch nerve palsy in the TP group (6/105, 5.7%) than in the PP group (6/163, 3.7%; Table 2), however there was no statistically significant difference. A permanent palsy was more common in the TP group (4/105, 3.8%) compared with the PP group (3/163, 1.8%), however the difference failed to reach statistical significance ($P = 0.324$) (Table 2). All seven patients with permanent dysfunction of the nerve branches had mild dysfunction, defined as House–Brackmann grade II. In most of them (5/7, 71.4%), the nerve affected was the marginal mandibular branch. The marginal mandibular facial nerve was involved during the surgery of 83 of 105 (79.0%) patients in the TP group and 94 of 163 (57.7%) patients in the PP group. More details regarding postoperative facial nerve function are provided in Tables 2 and 3.

Table 2. The number of patients who developed palsy of a facial nerve branch after total superficial parotidectomy and partial superficial parotidectomy.

Palsy	Total superficial parotidectomy (TP) ($n = 105$)			Partial superficial parotidectomy (PP) ($n = 163$)		
	0[a]	1	>1	0	1	>1
Temporary, no. (%)[b]	71 (67.6)	28 (26.7)	6 (5.7)	134 (82.2)	23 (14.1)	6 (3.7)
Permanent, no. (%)	101 (96.2)	3 (2.9)	1 (0.9)	160 (98.2)	2 (1.2)	1 (0.6)

[a] The numbers in this line represent the number of nerve branches affected.
[b] $P = 0.005$ between TP (34/105, 32.4%) and PP (29/163, 17.8%) for the incidence of temporary facial nerve dysfunction.

Table 3. Incidence of palsy among specific facial nerve branches.

Palsy	Total superficial parotidectomy (TP) ($n = 105$)		Partial superficial parotidectomy (PP) ($n = 163$)	
	Temporary	Permanent	Temporary	Permanent
Mandibular, no. (%)	34 (32.4)	3 (2.9)	25 (15.3)	2 (1.2)
Buccal, no. (%)	6 (5.7)	0 (0)	6 (3.7)	1 (0.6)
Zygomatic, no. (%)	4 (3.8)	1 (1.0)	5 (3.1)	0 (0)
Temporal, no. (%)	2 (1.9)	1 (1.0)	5 (3.1)	1 (0.6)

Saliva flow rate

The saliva flow rate was measured during follow-up, after surgery. The mean saliva flow rate on the side of the operated gland was significantly lower than that on the contralateral side (unstimulated $P = 0.005$, and stimulated $P < 0.001$). Statistically significant differences in mean saliva flow rate were found among patients who received TP vs. PP in both the unstimulated and stimulated groups (unstimulated $P < 0.001$, and stimulated $P < 0.001$), as shown in Table 4. Patients who received TP were at greater risk of having the parotid duct dissected and ligated than patients who received PP (70/105, 66.7% vs. 33/163, 20.2%, $P < 0.001$). Among patients in whom Stensen's duct was preserved (165/268; 61.6%), the mean postoperative parotid saliva flow rates on the operated side were 0.1105 g/5 min and 0.5261 g/5 min, under unstimulated and stimulated conditions, respectively, contrasting with a parotid saliva flow rate of 0 g/5 min under either condition among patients in whom the duct was ligated. Among the 165 patients in whom the duct was preserved, there were statistically significant differences in mean saliva flow rates between patients who received TP ($n = 35$) and PP ($n = 130$) (unstimulated $P = 0.001$, and stimulated $P = 0.001$). The receipt of TP was consistently associated with a lower mean saliva flow rate for both unstimulated and stimulated groups than receipt of PP (for patients with TP, mean unstimulated and stimulated saliva flow rates were 0.0357 g/5 min and 0.2369 g/5 min, respectively, vs. 0.1306 g/5 min and 0.6040 g/5 min for patients with PP; Table 5). Furthermore, the mean saliva flow in the operated side was found to be significantly lower than that of the contralateral side under both stimulated and unstimulated conditions for both the TP and PP groups, $P < 0.001$ (Table 6).

Discussion

Surgical procedures for a benign disease of the parotid gland should achieve complete disease remission with minimal sur-

Table 4. Postoperative mean saliva flow rate on the operated side.

Type	Saliva flow rate (g/5 min)	
	Unstimulated	Stimulated
Total superficial parotidectomy (TP)	0.0119 ± 0.0036	0.0790 ± 0.0407
Partial superficial parotidectomy (PP)	0.1042 ± 0.0258	0.4817 ± 0.0510
P-value	<0.001	<0.001

Table 5. Postoperative mean saliva flow rate on the operated side with preserved Stensen's duct (g/5 min).

Type	Saliva flow rate (g/5 min)	
	Unstimulated	Stimulated
Total superficial parotidectomy (TP)	0.0357 ± 0.0078	0.2369 ± 0.0893
Partial superficial parotidectomy (PP)	0.1306 ± 0.0176	0.6040 ± 0.0598
P-value	0.001	0.001

Table 6. Mean saliva flow rate on the operated and contralateral side for total superficial parotidectomy and partial superficial parotidectomy (g/5 min).

Type	Unstimulated		Stimulated	
	TP	PP	TP	PP
Operated side	0.0119 ± 0.0036	0.1042 ± 0.0258	0.0790 ± 0.0407	0.4817 ± 0.0510
Contralateral side	0.1513 ± 0.0281	0.1892 ± 0.0293	0.9592 ± 0.0973	0.9852 ± 0.0659
P-value	<0.001	<0.001	<0.001	<0.001

TP, total superficial parotidectomy; PP, partial superficial parotidectomy.

gical morbidity; it is also important to reduce sequelae to secure a satisfactory quality of life after surgery. As a surgical technique, PP aims to completely excise the tumour with a smaller free margin of normal parotid parenchyma around the tumour (at least 0.5–1 cm), i.e. to obtain a clear surgical margin while anatomically and functionally preserving the facial nerve.[1] In our study, there was no significant difference in tumour recurrence between the two techniques of parotidectomy, although one Warthin's tumour recurred in the PP group, possibly because there were multiple foci of the tumour originating from residual lymph nodes.[8] PP is therefore comparable to TP in terms of the recurrence rate of the tumour.

In the PP procedure, most of the superficial lobe of the gland was preserved and facial nerve dissection was limited to the area immediately surrounding the tumour, which reduced the extent of facial nerve dissection compared with TP. In TP, all of the branches of the facial nerve distributions were dissected away from the tumour and surrounding tissues, no matter whether anterior dissections beginning from the main trunk or retrograde dissections beginning from the peripheral branches were performed. The extent of surgical resection was correlated with the risk of facial nerve injury; less unavoidable exposure will result in less inadvertent injury. In our present series, the more extensive procedures in the TP group were associated with a 2.2 fold increase in the number of nerve branches dissected (3.55 ± 1.152 branches) compared with the PP group (1.58 ± 0.974 branches). During the first postoperative week, transient postoperative facial nerve dysfunction occurred in 17.8% of the patients in the PP group vs. 32.4% in the TP group, which compares well with the 30–60% reported incidence in a published study.[1] The incidence of transient postoperative facial nerve weakness was much lower following PP than TP surgery techniques. These findings are consistent with those of previous reports, and consequently PP has been endorsed by other authors[3,9] as the procedure of choice for previously untreated benign parotid tumours lying superficial to the plane of the facial nerve. Although most cases of postoperative facial nerve dysfunction are transitory in nature, it can nevertheless impair the patient's quality of life and cause distress.

For the patients in the current study, permanent facial nerve palsy was mild in extent: all seven such patients presented with grade II facial nerve paralysis at more than 6 months of follow-up. Interestingly, mandibular marginal branch palsy alone was involved in 32.4% of TP patients and 15.3% of PP patients. Because this is the longest of all facial nerve branches[10,11] and proximal to the tail of the parotid gland, which is most frequently affected by the tumours, it is probably not surprising that the mandibular marginal branch was the most commonly injured in our series, a finding that is in keeping with those of previous studies.[1,12] In contrast to a TP, a PP is more difficult to perform and can only be performed by a surgeon with great experience. This method of surgery demands a highly skilled surgeon who is intimately familiar with the anatomy.

In our study, parotid gland function after the parotidectomy was directly evaluated by measuring the saliva flow rate. We measured all saliva flow rates in the same room, under quiet conditions, between the hours of 9:00 and 11:00 a.m. to minimize the effects of temperature and circadian rhythm on saliva flow. In patients given TP, the Stensen's duct was ligated and cut. With duct ligation, there is spontaneous atrophy of the glandular acini and the parotid gland loses secretory function. We found that the facial nerve was above the parotid duct in most patients, giving us the anatomical basis to preserve the duct. In this way, the saliva secreted from the parotid remnant was discharged into the mouth through the duct, and partial function of the gland could be preserved. In patients in our study in whom the duct was preserved, glandular function was decreased postoperatively (after removal of part of the normal glandular parenchyma adjacent to the tumours), but saliva flow from the residual gland was well preserved. In patients in whom the duct was resected, the saliva flow rate was reduced to zero and saliva secretion on the operated side was lost. Therefore, ligation of the parotid duct should be avoided. We have demonstrated that patients who received PP were left with a higher saliva flow rate than patients who received TP, both under unstimulated and stimulated conditions. In a further analysis of only the patients in whom the Stensen's duct was preserved, there was still an obvious statistical difference in saliva flow rate between those who received TP vs. PP. Because the superficial part of the parotid gland comprises approximately 80% of the volume of the parotid parenchyma and provides 85–89% of saliva secretion,[13,14] incomplete excision of the superficial lobe of the parotid gland could preserve partial function. A good correlation between gland volume and saliva flow rate has been reported.[9] Less extensive surgery, with preservation of Stensen's duct, was important for achieving good functional restoration of the gland.

In conclusion, a partial superficial parotidectomy could reduce the incidence of postoperative facial nerve weakness and preserve Stensen's duct and more function of the gland in terms of saliva secretion. A partial superficial parotidectomy is the surgical modality of choice for primary benign tumours less than 2 cm in size in the superficial lobe of the parotid gland.

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Competing interests

None declared.

Ethical approval

Ethical approval was granted by the Research and Ethics Committee of the Peking University School of Stomatology.

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