

Oral and Plunging Ranulas: What is the Most Effective Treatment?

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Objectives/Hypothesis: Preferred treatment of oral/plunging ranulas remains controversial. We present our experience with ranulas at the University of North Carolina (UNC) and review the literature.

Methods: Retrospective review. From 1990 to 2007, 16 oral ranulas and 10 plunging ranulas were treated at UNC. Combining the UNC series with the literature identified 864 cases for review. An online survey was conducted to identify current treatment patterns.

Results: In the UNC series, procedures for oral ranulas varied from ranula excision (50%), combined ranula and sublingual gland excision (44%), excision of the ranula along with the sublingual gland and submandibular gland (6%). A cervical approach was used in nine plunging ranula cases. One case was treated transorally with sublingual gland removal and evacuation of the ranula. Otherwise, the plunging ranula was removed along with the sublingual gland (20%), submandibular gland (50%), or both (20%). One hundred fifty-one complications were identified from the literature. Recurrence was considered a complication and was most prevalent (63%). Nonrecurrent complications included tongue hypesthesia (26%), bleeding/hematoma (7%), postoperative infection (3%), and Wharton's duct injury (1%). Sublingual gland excision yielded the fewest complications (3%). Procedures and associated complication rates were: transoral excision of sublingual gland (3%); transoral excision of sublingual gland and ranula (12%); marsupialization (24%); transcervical

excision of sublingual gland, submandibular gland, and ranula (33%); OK-432 (49%); and aspiration (82%).

Conclusions: Based on our review, definitive treatment yielding lowest recurrence and complication rates for all ranulas is transoral excision of the ipsilateral sublingual gland with ranula evacuation.

Key Words: Ranula, plunging ranula, treatment, surgical approach, complications, recurrence.

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INTRODUCTION

Ranulas are mucoceles that develop as a result of mucous extravasation from the sublingual gland and typically present in the floor of mouth. Plunging ranulas present as a cervical swelling after herniation of the pseudocyst through the mylohyoid muscle. The preferred treatment of both oral ranulas and plunging ranulas is controversial. Therapeutic modalities range from the injection of sclerosing agents to various surgical techniques. One of the most controversial issues is whether the ranula itself requires excision.

Although surgery is considered the mainstay of therapy, recommendations for the preferred approach and technique are quite variable.^{1–12} In fact, some authors suggest ranulas, both oral and plunging, are best managed by marsupialization or ranula excision, whereas others recommend removal of the ranula along with the sublingual gland.^{4,13} Other authors feel that removal of the submandibular gland is important in the management of the plunging ranula.¹⁴ The preferred surgical management of plunging ranulas remains particularly elusive given the sparsity of scientific evidence available for analysis.

The lack of a standardized treatment algorithm compelled our group to review the oral and plunging ranula cases at our institution. Combined with the literature, we report the largest review to date of ranulas, both oral and plunging. To develop a snapshot of current treatment methods, we performed an online survey of the members of the American Head and Neck Society.

MATERIALS AND METHODS

Twenty-eight patients at the University of North Carolina hospitals were identified between 1990 and 2007 to

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TABLE I.
University of North Carolina Retrospective Data for Ranulas.

Patient	Age	Sex	Race	Location	Size, cm	Revision	Approach	Procedure	Recurrence	Type of Ranula
1	5 mo	M	C	Right	0.5	No	Transoral	R		Oral
2	3 y	M	AA	Right	0.6	No	Transoral	R		Oral
3	4 y	M	AA	Extends to both sides	6	No	Transoral	R		Oral
4	7 y	M	C	Right	0.8	No	Transoral	R		Oral
5	8 y	F	N/A	Right	2	No	Transoral	SLG+R		Oral
6	9 y	F	C	Right	1	No	Transoral	R	6 wk	Oral
7	10 y	M	C	Left	2.1	No	Transoral	R		Oral
8	12 y	M	AA	Right	2.3	No	Transoral	R		Oral
9	12 y	F	AA	Left	6.2	No	Transoral	SLG+R		Oral
10	18 y	M	C	Left	3.5	No	Transoral	SLG+R		Oral
11	25 y	M	N/A	Right	7.1	No	Transoral	SLG+R		Oral
12	27 y	F	C	Left	0.3	No	Transoral	R		Oral
13	32 y	F	C	Left	0.3	No	Transoral	SLG+R		Oral
14	44 y	F	C	Left	0.3	No	Transoral	SLG+R		Oral
15	51 y	F	C	Left	2	No	Transoral+cervical	SLG+R+SMG		Oral
16	57 y	F	AA	Left	3	Yes	Transoral	SLG+R		Oral
1	17 y	M	AA	Right	N/A	Yes	Cervical	R+SMG		Plunging
2	21 y	F	C	Left	3.6	No	Cervical	R+SMG		Plunging
3	29 y	F	AA	Right	3.1	Yes	Cervical	R+SMG		Plunging
4	31 y	M	H	Right	4.5	No	Cervical	R+SMG		Plunging
5	34 y	F	C	Right	4.5	Yes	Cervical	SLG+R	8 mo	Plunging
6	36 y	M	C	Right	2.1	No	Transoral+cervical	SLG+R		Plunging
7	37 y	F	C	Left	2.2	No	Cervical	R+SMG		Plunging
8	37 y	M	C	Right	4.9	Yes	Transoral+cervical	SLG+R+SMG		Plunging
9	39 y	M	C	Left	1	Yes	Transoral+cervical	SLG+R+SMG		Plunging
10	65 y	M	C	Right	N/A	Yes	Transoral	SLG		Plunging

M = male; C = Caucasian; R = ranula; AA = African American; F = female; SLG = sublingual gland; N/A = information not available; SMG = submandibular gland.

have the diagnosis code for ranula (ICD-9 code 527.6). A retrospective chart review gathered the following data for each patient: age, sex, location of ranula, ranula size, pathology, primary versus revision surgery, surgical approach, and postoperative complications. Two patients were excluded from the study series based on the final pathology, one of which was a follicular cyst, the other a mucocele of the lip. Information about complications for eight patients was not available, so the remaining 18 patients were included in our summary.

A literature review using PubMed identified 995 additional ranula cases from 21 different case series, single case reports were excluded. The total case volume in each series ranged from two to 450, with a median of 20 cases. The number of cases identified from each study and the procedures used to treat oral and plunging ranulas was tallied. Each series was reviewed to identify the number of ranulas, surgical approach (oral vs. cervical), methods of treatment, and complications. Eleven papers reported on only one type of procedure, six reported on two procedures, and the three remaining papers reported on three, four, and five different procedures, respectively. A total of 149 reported cases, from four separate papers, did not comment on complications other than recurrence and were excluded. This left 846 cases suitable for review.

Case series data from the literature review were combined with the series from the University of North Carolina to bring the total number of cases to 864. Due to the scarcity of literature comparing various procedures, the data were combined from all the case series over the 12 reported treatment methods. This decision assumed that the patient characteristics and other variables surrounding the surgeries were similar across all the series. Summary tables identify complications including recurrence, tongue hypesthesia, Wharton's duct injury, bleeding and/or hematoma, and postoperative infection. Additionally, separate summary tables for oral and plunging ranulas were created based on the information from those papers that distinguished the two from one another. The total number of complications was reported. This reflects the sum of all the individual complications. Each complication was attributed to one individual except in one case, where one patient was reported to have two complications.

In an attempt to identify current treatment patterns with respect to the management of oral and plunging ranulas, an eight-question survey was created and sent via email to members of the American Head and Neck Society. Responses were anonymously tallied using an online survey vehicle (Survey-Monkey.com). There were a total of 220 respondents, but not all questions were answered by every individual. Answers were broken down into percentages.



Fig. 1. A 65-year-old male with a plunging ranula. Preoperative (A) and postoperative (B) photos 2 months after transoral excision of sublingual gland alone with evacuation of the ranula. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

RESULTS

Institutional Retrospective Data

A total of 26 ranulas were identified at our institution over an 18-year period (Table I). There were 54% male and 46% female patients with an average age of 25.6 and a median age of 26. Of the 26 ranulas identified, 16 were oral (62%) and 10 were plunging (38%). Seven cases were revision cases: one oral ranula had been treated with marsupialization, and six patients with plunging ranulas had prior procedures (two patients had multiple prior procedures). These included: aspiration (one), excision of ranula (two), marsupialization (three), submandibular gland excision (three), and unknown (one).

The 16 oral ranulas were nearly equally distributed on the right ($n = 7$, 44%) and left ($n = 8$, 50%), whereas one case (6%) was considered bilateral, extending to both sides of the floor of mouth. Ranula size was based on the pathology report. These were distributed as follows: <1 cm ($n = 6$, 37%); 1 cm to 2 cm ($n = 3$, 19%); >2 cm ($n = 7$, 44%). Each of the 16 cases was surgically treated. A transoral approach was used for 94% ($n = 15$) of the cases, and a combined transoral and cervical approach was used in 6% ($n = 1$) of the cases. The procedures for oral ranulas varied from ranula excision ($n = 8$, 50%), combined ranula and sublingual gland excision ($n = 7$, 44%), and excision of the ranula along with the sublingual gland and submandibular gland ($n = 1$, 6%).

Of the 10 plunging ranulas identified, 70% were on the right ($n = 7$). All but one of the plunging ranulas removed was >2 cm, although the size for 2 cases were not recorded in the pathology report. Ranula size was as follows: 1 cm to 2 cm ($n = 1$, 10%); >2 cm ($n = 7$, 70%); unknown ($n = 2$, 20%). A cervical approach was used in nine of 10 cases. In one case a plunging ranula was

treated using only a transoral approach. In all other cases the plunging ranula was removed along with the sublingual gland ($n = 2$, 20%), the submandibular gland ($n = 5$, 50%), or both ($n = 2$, 20%). In the transoral case, the sublingual gland was removed and the ranula was evacuated (not excised, see Fig. 1).

Of the 26 ranulas surgically treated at our institution, there were two recurrences, one oral ranula and one plunging. The oral ranula recurred 6 weeks after transoral excision of the ranula. The revision procedure for this case involved transoral excision of the ranula and the sublingual gland. There is no evidence of recurrence with follow-up of 6 months. The plunging ranula recurred 8 months after excision of the ranula and submandibular gland. In the revision procedure, the plunging ranula alone was excised through a transcervical approach. The patient had persistent swelling in the submental region 2 weeks postoperatively, but there was no other documentation beyond this period as the patient was lost to follow-up.

Other than one case of recurrence, no complications were documented after treatment of oral ranulas. One additional complication was documented after treatment of a plunging ranula. This involved transient tongue hypesthesia that lasted for 2 months.

Reported Cases in the Literature

Of the 864 cases reviewed, there were 297 oral ranulas, 117 plunging ranulas, and 450 ranulas, which were not further classified. These 450 cases were extracted from the Zhao⁴ series, but the authors did not distinguish between oral and plunging ranulas. The complication rates (which includes recurrences) reported in the Zhao⁴ series for the treatment of 450 oral, mixed,

and plunging ranulas were as follows: marsupialization (67%), ranula excision (62%), excision of sublingual gland and ranula (13%), and excision of sublingual gland (3%).

Table II summarizes the number of complications associated with the various procedures employed to treat both oral and plunging ranulas. It is worthwhile to emphasize that the most common complication is recurrence. The complication rate ranged from 3% for sublingual gland excision to 82% for aspiration. Highlighted procedures in order of increasing rate of complications are as follows: transoral excision of sublingual gland (3%); transoral excision of sublingual gland and ranula (12%); marsupialization (24%); transcervical excision of sublingual gland, submandibular gland, and ranula (33%); OK-432 (49%); and aspiration (82%). Of the 151 complications related to the treatment of oral and plunging ranulas, recurrence was the most prevalent ($n = 96$, 63%), followed by tongue hypesthesia ($n = 39$, 26%), bleeding/hematoma ($n = 10$, 7%), postoperative infection ($n = 5$, 3%), and Wharton's duct injury ($n = 1$, 1%). It should be noted that if the sublingual gland was removed with or without the ranula, the recurrence rate ranged from 0% to 2%.

In comparing overall complication rates (Table II), removal of the sublingual gland alone was associated with the lowest risk of complications, compared to the other nine treatment modalities. We chose to distinguish recurrence from other surgical complications because of the implication that further surgery is likely warranted. Complication rates other than recurrence rates were not much different when comparing sublingual gland excision alone with less invasive procedures such as OK-432 injection, aspiration of ranula, isolated ranula excision, and marsupialization of the ranula. However, recurrence rates were much higher for these less invasive procedures when compared to surgical excision of the sublingual gland alone. Recurrence rates were 82% for aspiration of ranula, 49% for OK-432 injection (initial injection), and 24% for marsupialization. With excision of the sublingual gland alone, the recurrence rate was only 1%.

Table III summarizes complication rates for oral ranulas. Unfortunately we were unable to find a case series in which oral ranulas were treated with sublingual gland excision alone. However we were able to ascertain that complication rates (including recurrence rate) were lower for sublingual gland plus ranula excision compared to less invasive techniques such as OK-432 sclerotherapy and aspiration. Likewise, recurrence rates were lower in sublingual gland excision combined with ranula excision when compared to marsupialization or ranula excision only. There appeared to be a strong association between leaving the sublingual gland in place and a higher recurrence rate. However, authors reporting results using marsupialization as the primary treatment for oral ranulas experienced a lower incidence of tongue hypesthesia and bleeding/hematoma when compared to sublingual gland plus ranula excision.

Table IV summarizes complication rates for plunging ranulas. Thirty-seven cases of plunging ranulas were

treated using a transoral approach. In 24 cases both the sublingual gland and ranula were removed, whereas in 13 cases only the sublingual gland was excised. These two transoral procedures had a combined complication rate of 3% ($n = 1$). The combined recurrence and complication rates were less for these methods of treatment than that of sclerotherapy with OK-432, ranula excision only, submandibular gland plus ranula excision, sublingual gland plus ranula excision via a cervical approach, and ranula plus sublingual and submandibular gland excision. Temporary or permanent nerve injury was not limited to the lingual nerve. The marginal mandibular nerve was injured in five cases, four of which involved a cervical approach to remove the sublingual gland and ranula. Marginal mandibular nerve weakness resolved in each of these cases by 3 months postoperatively.

Ranula Treatment Survey

An online survey of the membership of the American Head and Neck Society was undertaken. Results from the survey are presented in Table V. Of the 220 respondents, most identified themselves head and neck surgeons (73%). Ninety-seven percent of all participants said they would use a transoral surgical approach to remove an oral ranula, but answers varied on the specific procedure. The most popular treatment methods included: sublingual gland and ranula excision (32%), marsupialization (30%), and ranula excision alone (25%). About half of the surgeons surveyed (52%) had surgical experience with 10 or less oral ranulas.

For a plunging ranula the three most popular surgical approaches were combined approach (49%), transoral approach (27%), and cervical approach (23%). Preferred management of plunging ranulas included: excision of the sublingual gland and ranula (39%), excision of the ranula, sublingual and submandibular gland (23%), ranula excision only (14%), and excision of the sublingual gland with evacuation of the ranula (13%). The level of experience for plunging ranulas ranged from 0 to >30, with 80% of surgeons having treated no more than 10 plunging ranulas.

DISCUSSION

There are a variety of methods used to treat ranulas. One often referenced surgical atlas recommends treating oral ranulas with excision of the ranula's cystic wall, preferably with the sublingual gland.¹⁴ This same atlas advocates excision of both the sublingual and submandibular gland for plunging ranulas.¹⁴ Another author from a popular text writes, "Plunging ranula is best treated with a combination transoral excision of the cyst and sublingual gland and a cervical approach to excise the plunging ranula portion."¹³ It is likely that the diverse opinions relative to the treatment of oral and plunging ranulas are responsible for the absence of a consensus treatment guideline published by the American Academy of Otolaryngology/Head & Neck Surgery. We will highlight the various treatment modalities based on the published literature and summarize the complication rates below.

TABLE II.
Recurrences and Complications Associated With the Treatments for Oral and Plunging Ranulas (n = 864).

	Sublingual Gland Excision	OK-432*	Aspiration	Ranula Excision	Marsupialization	Submandibular Gland Excision	Submandibular Gland+Ranula	Sublingual Gland+Ranula (Unspecified Incision)	Sublingual Gland+Ranula (Transoral Incision)	Sublingual Gland+Ranula (Cervical Incision)	Sublingual+Submandibular Glands + Ranula
Recurrences	3/299 (1.0%)	39/79 (49.4%)	9/11 (81.8%)	16/36 (44.4%)	23/95 (24.2%)	0/1 (0%)	1/3 (33.3%)	3/139 (2.2%)	0/170 (0%)	0/16 (0%)	2/15 (13.3%)
Complications											
Tongue hypesthesia	6/299 (2.0%)	0/79 (0%)	0/11 (0%)	3/36 (8.3%)	0/95 (0%)	0/1 (0%)	1*/3 (33.3%)	15/139 (10.8%)	7/170 (4.1%)	4/16 (25%)	3/15 (20%)
Wharton duct injury	0/299 (0%)	0/79 (0%)	0/11 (0%)	0/36 (0%)	0/95 (0%)	0/1 (0%)	0/3 (0%)	0/139 (0%)	1/170 (0.6%)	0/16 (0%)	0/15 (0%)
Bleeding/hematoma	0/299 (0%)	0/79 (0%)	0/11 (0%)	0/36 (0%)	0/95 (0%)	0/1 (0%)	0/3 (0%)	0/139 (0%)	8/170 (4.7%)	2/16 (12.5%)	0/15 (0%)
Post-op infection	0/299 (0%)	0/79 (0%)	0/11 (0%)	1/36 (2.8%)	0/95 (0%)	0/1 (0%)	0/3 (0%)	0/139 (0%)	4/170 (2.4%)	0/16 (0%)	0/15 (0%)
Total	9/299 (3.01%)	39/79 (49.4%)	9/11 (81.8%)	20/36 (55.6%)	23/95 (24.2%)	0/1 (0%)	2/3 (66.7%)	18/139 (12.9%)	20/170 (11.8%)	6/16 (37.5%)	5/15 (33.3%)
Ranula total	299	79	11	36	95	1	3	139	170	16	15
Oral total	0	40	11	5	86	0	0	9	146	0	0
Plunging total	13	39	0	5	0	1	3	1	24	16	15
Zhao study	286			26	9			129			
Sublingual Gland Excision	Ref. 4, 8, 11	OK-432* Ref. 15, 16, 17	Aspiration Ref. 18	Ranula Excision Ref. 4, 6, 26	Marsupialization Ref. 3, 4, 19, 20, 21, 22	Submandibular Gland Excision	Submandibular Gland+Ranula	Sublingual Gland+Ranula (Unspecified Incision) Ref. 4, 19	Sublingual Gland+Ranula (Transoral Incision) Ref. 3, 4, 10, 11, 12, 20, 22, 26	Sublingual Gland+Ranula (Cervical Incision) Ref. 3, 6, 7, 26	Sublingual+Submandibular Glands + Ranula Ref. 26
Sample sizes of studies that were combined to get total	2, 11, 286	21, 26, 32	11	2, 3, 5,†, 26	6, 7, 7, 9, 10, 56	1	3,†	10, 129	1, 2, 3, 4, 6, 6,†, 13, 67, 68	1, 2, 2,†, 5, 6	2,†, 13

Post-op = postoperative; Ref. = references from which case series were extracted.

*Rate based on initial injection; number of injections ranged from 1 to 5, with an average of 1.8 injections per person.

†Taken from the University of North Carolina series.

TABLE III.
Complications Associated With the Treatments for Oral Ranulas.

	OK-432*	Aspiration	Ranula Excision	Marsupialization	Sublingual Gland+Ranula (Transoral Approach)
Recurrences	23/40 (57.5%)	9/11 (81.8%)	1/5 (20%)	17/86 (19.8%)	0/146 (0%)
Complications					
Tongue hypesthesia	0/40 (0%)	0/11 (0%)	0/5 (0%)	0/86 (0%)	7 [†] /146 (4.8%)
Wharton duct injury	0/40 (0%)	0/11 (0%)	0/5 (0%)	0/86 (0%)	1/146 (0.7%)
Bleeding/hematoma	0/40 (0%)	0/11 (0%)	0/5 (0%)	0/86 (0%)	7/146 (4.8%)
Post-op infection	0/40 (0%)	0/11 (0%)	0/5 (0%)	0/86 (0%)	4/146 (2.7%)
Oral ranula total	23/40 (57.5%)	9/11 (81.8%)	1/5 (20%)	17/86 (19.8%)	19/146 (13.0%)
Reference	15, 17	18	6, 26	3, 19, 20, 21, 22	3, 12, 20, 22 [‡]

Post-op = postoperative.

*Rate based on initial injection.

[†]Two cases did not resolve; two 2 cases ranula marsupialized, not excised.

[‡]Taken from the University of North Carolina series.

Oral Ranulas

Sclerotherapy (OK-432). Sclerotherapy has been advocated as a nonsurgical treatment for oral ranulas. Most of the data involves the use of a sclerotherapeutic agent made from a mixture of a low virulence strain of *Streptococcus pyogenes* incubated with benzylpenicillin (OK-432). Proponents of sclerotherapy with OK-432 (picibanil) argue that the advantage over surgery is that the treatment outcomes are the same, if not better, without the risk to the lingual nerve.^{15,16} In a prospective study, Roh¹⁵ treated 19 oral ranulas with a 74% success rate. However, an average of 2.26 injections and a range of one to five injections were required for resolution of the oral ranula.¹⁵ The authors make note that it is difficult to prevent the OK-432 injection from leaking outside of the pseudocyst once the ranula is punctured, which in their opinion contributes to a higher recurrence in oral ranulas when compared to plunging. Some authors advocate that surgery should not be the main-

stay of therapy, rather it should be reserved for patients that are refractory to sclerotherapy.^{16,17}

Aspiration. Zhi et al.¹⁸ used aspiration in 11 infants (age <3 months) with oral ranulas, nine of which recurred. This yields a recurrence rate of 82%. No other complications were documented. The authors recommend conservative management for infants up to the age of 1 year old. They outline a graduated approach beginning with aspiration, whereas marsupialization is reserved for recurrences. If the ranula still recurs after these procedures, then excision of ipsilateral sublingual gland and ranula is recommended.

Marsupialization. A number of authors recommend marsupialization of the ranula as the preferred method of treatment, particularly in children.¹⁹⁻²³ In a retrospective review of 9 cases, Yuca et al. conclude that marsupialization is suitable and effective for treating pediatric oral ranulas. For recurrent cases they recommend marsupialization combined with sublingual gland

TABLE IV.
Complications Associated With the Treatments for Plunging Ranula.

	OK-432*	Ranula Excision	Submandibular Gland+Ranula	Sublingual Gland Excision	Sublingual Gland+Ranula (Transoral Approach) [†]	Sublingual Gland+Ranula (Cervical Approach)	Sublingual+Submandibular Glands+Ranula
Recurrences	16/39 (41.0%)	0/5 (0%)	1/3 (33.3%)	0/13 (0%)	0/24	0/16 (0%)	2/14 (14.3%)
Complications							
Tongue hypesthesia	0/39 (0%)	2 [‡] /5 (40%)	1 [§] /3 (33.3%)	0/13 (0%)	0/24	4 /16 (25%)	3/14 (21.4%)
Wharton duct injury	0/39 (0%)	0/5 (0%)	0/3 (0%)	0/13 (0%)	0/24	0/16 (0%)	0/14 (0%)
Bleeding/hematoma	0/39 (0%)	0/5 (0%)	0/3 (0%)	0/13 (0%)	1/24 (4.2%)	2/16 (12.5%)	0/14 (0%)
Post-op infection	0/39 (0%)	1/5 (20%)	0/3 (0%)	0/13 (0%)	0/24	0/16 (0%)	0/14 (0%)
Plunging ranula total	16/39 (41.03%)	3/5 (60%)	2/3 (66.7%)	0/13 (0%)	1/24 (4.2%)	6/16 (37.5%)	5/15 (33.3%)
Reference	16, 17	6, 26	[¶] 1	7, 8, 11	10, 11, 26	3, 6, 7, 26	26

Post-op = postoperative.

*Rate based on initial injection.

[†]Ranula drained or excised.

[‡]One case with permanent lingual nerve damage & temporary marginal mandibular nerve palsy (2 cases in the series had partial SLG removal).

[§]Dysarthria that resolved after 2 months.

^{||}marginal mandibular nerve paresis that resolved in 3 months.

[¶]Taken from the University of North Carolina series.

TABLE V.
Responses to Survey Questions.

Question	Answer Choices	Reponses
What surgical approach would you use to treat an oral (simple) ranula?	Transoral approach	212 (97%)
	Cervical approach	1 (0%)
	Combined transoral and cervical approach	4 (2%)
	Other	2 (1%)
What surgical procedure would you use to treat an oral (simple) ranula?	Marsupialization	67 (30%)
	Ranula excision	56 (25%)
	Sublingual gland excision with evacuation of ranula	22 (10%)
	Sublingual gland+ranula excision	70 (32%)
	Submandibular gland+ranula excision	1 (0%)
	Sublingual gland+submandibular gland+ranula excision	1 (0%)
	Other	3 (1%)
How many oral (simple) ranulas have you treated?	0	7 (3%)
	1-3	31 (15%)
	4-10	70 (34%)
	11-20	56 (27%)
	21-30	22 (11%)
	>30	20 (10%)
	What surgical approach would you use to treat a plunging ranula?	Transoral approach
Cervical approach		49 (23%)
Combined transoral and cervical approach		105 (49%)
Other		3 (1%)
What surgical procedure would you use to treat a plunging ranula?	Marsupialization	9 (4%)
	Ranula excision	31 (14%)
	Sublingual gland excision with evacuation of ranula	27 (12%)
	Sublingual gland+ranula excision	84 (39%)
	Submandibular gland+ranula excision	11 (5%)
	Sublingual gland+submandibular gland+ranula excision	49 (23%)
	Other	6 (3%)
How many plunging ranulas have you treated?	0	15 (7%)
	1-3	70 (35%)
	4-10	76 (38%)
	11-20	23 (12%)
	21-30	11 (6%)
	>30	5 (3%)
	Please tell us your age range.	20-30 years
31-40 years		41 (19%)
41-50 years		67 (30%)
51-60 years		66 (30%)
61-70 years		36 (16%)
>70 years		9 (4%)

excision.²⁰ Simple marsupialization is associated with recurrence rates ranging from 14% to 67%.^{4,9,20}

Due to the high recurrence rates, modified marsupialization techniques have been devised. Baurmash²³ advocates marsupialization followed by packing. He argues that modified marsupialization with packing reduces recurrence 10% to 12%.²³ The packing is felt to eradicate ranulas while decreasing the risk of injury to Wharton's duct and the lingual nerve.²⁴ Baurmash²⁴ supports this conservative approach because sublingual

gland removal is more invasive and may be inappropriate treatment when the diagnosis of ranula is uncertain or if the ranula is less than 2 cm in size.

Other modified marsupialization techniques include suturing the edges of the pseudocyst prior to unroofing the lesion²² and micro-marsupialization, which entails passing several 4-0 silk sutures directly through the ranula and tying them with minimal tension.²¹ These modified marsupialization techniques have reported recurrence rates ranging from 10% to 43%.²¹⁻²³ Based

on our review of the available data in the literature, the average recurrence rate after simple or modified marsupialization of an oral ranula is 20%.

Ranula excision. Excision of the ranula is a recognized treatment option for oral ranulas and was performed in several cases at our institution. Of the surgeons responding to our survey, 25% preferred this treatment modality for oral ranulas. Although this is a common clinical practice, there are no recent published reports advocating isolated ranula excision. In the review by Zhao et al., they identified 26 ranulas treated with excision of the ranula alone and reported a recurrence rate of 58%. The manner in which their data is reported makes it impossible to distinguish if the recurrence rate is for removal of an oral or plunging ranula. The recurrence rate in our institutional series for oral ranula excision alone was 12%.

Sublingual gland plus ranula excision. Excision of the sublingual gland and ranula is recommended by a number of authors.^{2-4,9,12} Removal of the sublingual gland is argued to be the definitive treatment associated with the least risk of recurrence. Although in our review of the 146 cases in the literature, the recurrence rate was 0%; the morbidity of sublingual gland excision coupled with ranula excision cannot be dismissed. There is greater risk to the lingual nerve during dissection of the ranula sac. Of the 146 cases from the literature, there were seven reported cases of lingual nerve hypesthesia, five of which resolved. Although the incidence of neural injury appears low, we believe this complication is likely under-reported. Proponents of sublingual gland excision for the treatment oral ranulas note that if oral ranulas do recur, they are at some risk of presenting as plunging ranulas. Incidentally, we found two patients with oral ranulas initially treated with marsupialization that presented to our institution with a plunging ranula.

Sublingual gland excision with ranula evacuation. Although removal of the sublingual gland alone is considered by many to be definitive treatment for ranulas, there are no series available for comparative analysis. In the Zhao²⁵ series, which included both oral and plunging ranulas, excision of the sublingual gland (with evacuation of the ranula) was associated with a 1% risk of recurrence. After review of the complications in their series of 450 ranulas, Zhao et al.²⁵ conclude that the safest and most effective therapeutic treatment for oral ranulas is excision of the sublingual gland and evacuation or drainage of the ranula.

Plunging Ranulas

Sclerotherapy (OK-432). Plunging ranulas have also been treated with sclerotherapy.¹⁵⁻¹⁷ Fukase et al.¹⁷ reports 100% resolution of 11 cases of plunging ranula after multiple injections; however, the success rate after the first injection was only 45.5%. Only after multiple treatments, which ranged from one to three injections for over one half of the cases, did the remaining plunging ranulas demonstrate clinical resolution. Rho et al.¹⁶ found the success rate for treating plunging ranulas in their series was only 33.3% after one injection of OK-

432. They postulate that the discrepancy in success rate compared to Fukase et al.¹⁷ is due to the differing concentrations of OK-432 upon successive sclerotherapy treatments and the use of more sensitive modalities of detecting recurrence (ultrasound and computed tomography scans vs. clinical exam).¹⁶

Ranula excision. Excision of the plunging ranula has been reported with limited success. Davison et al.²⁶ and Ichimura et al.⁶ review a total of five cases that were treated by transcervical removal of the plunging ranula alone. Although there were no recurrences in this combined series, three of the five patients had complications. Two had tongue hypesthesia and one had a postoperative infection.

Submandibular gland plus ranula excision. There are no published reports that looked at plunging ranulas treated by removal of the ranula and submandibular gland. We had three patients treated in this fashion at our institution, and two suffered complications. One experienced a recurrent ranula whereas the other noted transient tongue hypesthesia.

Submandibular and sublingual gland excision plus ranula excision. Based on our survey, 23% of head and neck surgeons would treat a plunging ranula with excision of the ranula along with removal of the sublingual and submandibular gland. Davison et al.²⁶ reports a series of 13 plunging ranulas treated using this method. Two cases recurred and three patients experienced tongue hypesthesia. Davison concludes that "removal of the sublingual gland via either a cervical or intraoral approach is important in the management of this condition. Excision of the pseudocyst is probably unnecessary and places surrounding structures at risk of damage, but a biopsy of the pseudocyst wall is important to confirm the diagnosis."²⁶

Sublingual gland plus ranula excision. Some authors advocate removal of the sublingual gland and the ranula using a combined transoral and cervical approach.^{6,13,26} The complication rate from the combined transoral-cervical approach was 37%. Interestingly, this same procedure is associated with only a 4% complication rate when using a transoral approach.^{10,11} We identified 24 cases in which the transoral approach was used and no recurrences were reported.^{7,10,11,26}

Sublingual gland excision. Two case series comprising 13 plunging ranulas were identified where treatment involved only removal of the sublingual gland.^{8,11} No recurrences or complications were reported. In the senior author's experience, excision of the sublingual gland is associated with evacuation of the ranula itself. Hidaka et al.⁸ concludes that plunging ranulas are best managed with a transoral approach to remove the sublingual gland. They use a drain placed in the sublingual space and sutured to the oral mucosa until postoperative day 4 to facilitate drainage of the ranula. Zhao et al.,²⁵ in their follow-up research devoted to complications related to the surgical management of ranulas, suggest that removal of the sublingual gland without excising the ranula will minimize complications. Three authors, 20 years prior, made similar

conclusions; however, no prospective follow-up study was performed.^{1,27,28}

CONCLUSION

Management of Oral Ranulas and Plunging Ranulas

Upon review of the reported case series, we believe that the definitive treatment yielding the lowest recurrence and complication rates for both oral and plunging ranulas is removal of the ipsilateral sublingual gland with evacuation of the ranula. Excising ranulas is unnecessary because they are not true cysts, and attempts to excise the ranula in conjunction with the sublingual gland likely places the lingual nerve and submandibular duct at even more risk due to more invasive dissection. Alternative first line treatment for oral ranulas is marsupialization, although the recurrence rate is higher. In the case of plunging ranulas, cervical incisions are commonly used to remove the ranula and the submandibular gland. This places the marginal mandibular and hypoglossal nerves at unnecessary risk. The cervical approach for plunging ranulas is not warranted because ranula excision is unnecessary and the submandibular gland has no causal relationship to ranula formation.

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