

# Clinical and Anatomic Study on the Ducts of the Submandibular and Sublingual Glands

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**Purpose:** To investigate the relationship between the ducts of the submandibular gland (SMG) and sublingual gland (SLG) and discuss its clinical application relating to SMG radiologic examinations and transfer.

**Materials and Methods:** The microanatomy of the SMG and SLG was investigated by use of 30 adult cadavers through anatomic dissection by use of a microscope. The relationship between the SMG and SLG ducts was observed and recorded during operations of microvascular autologous SMG transfer in 63 cases of severe keratoconjunctivitis sicca.

**Results:** There were 3 patterns of SLG and SMG duct anatomic variation: 1) The SMG and SLG have their own respective ducts that secrete separately at the orifices of the ducts in the floor of the mouth. 2) The SLG has a major duct that joins the duct of the SMG. 3) The SLG only has many fine ducts (7-15) that secrete in the floor of the mouth.

**Conclusions:** The anatomy of the ducts of the SMG and SLG is quite complicated. More attention should be paid to the anatomy of the ducts during surgery or imaging procedures related to the SMG. *Crown Copyright © 2010 Published by Elsevier Inc on behalf of American Association of Oral and Maxillofacial Surgeons. All rights reserved. J Oral Maxillofac Surg 68:606-610, 2010*

Sialography is a traditional technique for the evaluation of inflammatory disease of the submandibular gland (SMG). In recent years sialendoscopy has been widely used in the diagnosis and treatment of sialolithiasis and inflammation of the SMG.<sup>1</sup> A new technique has been described in which severe keratoconjunctivitis sicca is managed by microvascular

autologous SMG transfer.<sup>2-7</sup> In this operation the Wharton duct is transferred with the SMG to the upper lateral conjunctiva fornix to replace the lacrimal gland. One of the key elements of the operation is harvesting of an intact duct.<sup>7</sup>

It has generally been accepted that the SMG has a major duct opening at the floor of the mouth. How-

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ever, the sublingual gland (SLG) has 2 types of secretory ducts: the major duct and the minor duct opening at the sublingual caruncle.<sup>8-10</sup> Although most gross anatomy textbooks have presented these descriptions of the SMG and SLG ducts, few studies on the relationship between them have been reported.

In this report we will dictate an improved understanding of the anatomy and the relationship between the SMG and SLG ducts, which should be helpful for surgery related to the SMG and SLG.

## Materials and Methods

### SPECIMENS AND DISSECTIONS

Thirty adult cadavers fixed with 10% formalin were the subjects of the anatomic study. The dissection was standardized in each case. The skin in the submandibular triangle together with the ramus and the body of mandible was removed to completely expose the SMG and SLG bilaterally. Consequently, 60 SMGs and SLGs were exposed for microscopic analysis. The relationship between the ducts of the SMG and SLG was investigated. In addition, the length and diameter of the ducts were measured with a sliding caliper.

The mucous membrane, which covers the orifice of the SMG and SLG ducts surrounding the sublingual caruncle, was dissected and embedded in paraffin in routine fashion; sectioned at the sagittal plane and transverse plane, respectively; and then stained with hematoxylin-eosin. All sections were analyzed under a light microscope.

### PATIENT COLLECTION

Between December 2002 and December 2007, 63 patients (30 male patients and 33 female patients), with a mean age of 38 years (range, 9-69 years), with severe keratoconjunctivitis sicca were treated by microvascular autologous SMG transfer (58 unilaterally and 5 bilaterally). A total of 68 glands were transferred. The relationship between the ducts of the SMG and SLG was recorded prospectively in the operative notes.

### SURGICAL PROCEDURES FOR DISSECTION OF SMG DUCT

The SMG duct was cannulated with a blunt probe, and an incision was made around the SMG duct orifice, leaving an attached cuff of mucosa. Then, the mucosa was incised longitudinally along the floor of the mouth for a distance of approximately 5 cm. The duct was dissected free of tissue from front to back, and the lingual nerve was protected. If the major duct of the SLG joined the SMG duct, the SLG duct was cut. The end proximal to the SMG duct was ligated 2 mm away from it, and the other

end of the SLG duct was reopened at the floor of the mouth. If the major SLG duct opened separately at the floor of the mouth, the SLG duct was kept intact when possible. After the microscopic dissection, the entire Wharton duct was delivered with the SMG including the facial artery and vein.

The clinical and cadaveric studies were undertaken independently by different persons without knowledge of each other's results.

### STATISTICAL ANALYSIS

SPSS statistical software (version 10.0; SPSS, Chicago, IL) was used, and data are presented as mean  $\pm$  SD.

## Results

### CADAVERIC ANATOMIC FINDINGS

The SMG duct courses between the mylohyoid and hyoglossus muscles, extends anteriorly, and opens at the sublingual caruncle. The mean length of the SMG duct was  $62.0 \pm 2.3$  mm, and the mean diameter was  $3.0 \pm 1.2$  mm. The major SLG duct originates from the center of the gland.

We observed 3 types of associations between the SMG duct and SLG duct in this study: 1) In 22 of 60 cases (36.7%), only minor SLG ducts were identified communicating with the oral mucous membrane (Fig 1A). The number of minor ducts ranged from 7 to 15 with a mean diameter of  $0.98 \pm 0.10$  mm and a mean length of  $1.25 \pm 0.4$  mm. 2) In 24 of 60 cases (40%), the major SLG duct was fused to the middle section of the SMG duct (Fig 1B), with a mean diameter of the duct of  $2.13 \pm 0.52$  mm. 3) In 14 of 60 cases (23.3%), with a mean diameter of the duct of  $3.25 \pm 1.26$  mm, a major SLG duct coursed along the deep surface of the gland's lingual border separately (Fig 1C) and opened at the sublingual caruncle (Fig 1D).

In addition, there were 2 ducts in 1 case that coursed parallel to the floor of the mouth and opened at the sublingual caruncle, respectively (Fig 1E). This duct was bifid, with one duct originating at the hilum of the main body of the gland and the other at the extension of the gland onto the tongue. One possibility was that both of these ducts came from the SMG; the other possibility was that one duct came from the SMG and the other came from the SLG.

### CLINICAL FINDINGS

In the group of 63 cases (68 glands) undergoing SMG transfer, clinical observation mirrored the cadaveric findings because 3 patterns were identified. In the first group (25 glands [36.8%]), the SLG only had a minor duct without a major duct. In the second group (36 glands [52.9%]), the SLG had a major duct

**FIGURE 1.** Anatomic study on ducts of the SMG and SLG. *A*, Type I: SLG only has small ducts. *B*, Type II: The major duct of the SLG joins the SMG duct. *C*, Type III: The SMG duct and the major SLG duct course parallel. *D*, The SMG duct and the major SLG duct open at the sublingual caruncle, respectively. (The transverse plane of the 2 ducts crosses the sublingual caruncle plane.) (Hematoxylin-eosin stain, original magnification  $\times 2$ .) *E*, Double ducts. *Red arrow*, SMG; *green arrow*, SLG; *yellow arrow*, SMG duct; *blue arrow*, SLG duct; *pink arrow*, orifice.

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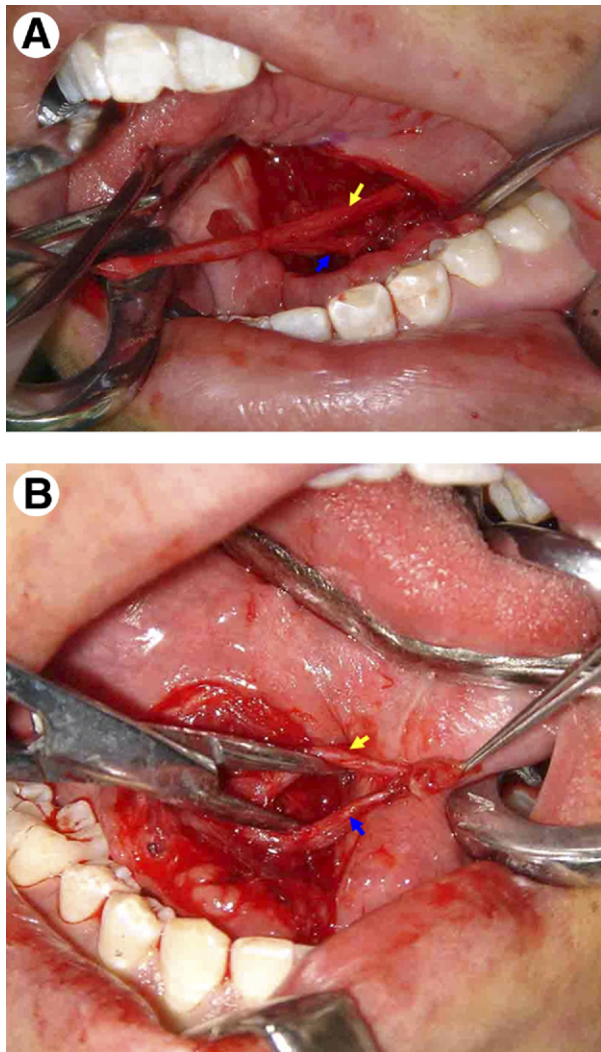
that joined the duct of the SMG (Fig 2A). In the third group (7 glands [10.3%]), the SMG and SLG had their own ducts, respectively, and opened separately at the floor of the mouth (Fig 2B).

During the follow-up period, with a mean of 2.6 years (range, 3 months to 5 years), the duct became obstructed in 4 of 63 cases, 2 of which occurred at the orifice in the fornix of the eye. Two cases of fistula were recorded. A ranula occurred at the floor of the

mouth in 7 cases (4 in the group without a major SLG duct and 3 in the group with a major SLG duct joining the SMG duct). Statistical analysis showed no significant difference between these 2 groups.

## Discussion

It has been described that the SLG has 2 types of excretory ducts. The minor duct comprises 8 to 15



**FIGURE 2.** Clinical study on the ducts of SMG and SLG. A, Type II: The SLG has a major duct that joins the duct of the SMG. B, Type III: The SMG and SLG have their own ducts, respectively, and open separately at the floor of the mouth. Yellow arrow, SMG duct; blue arrow, SLG duct.

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ducts opening into the sublingual fold, whereas the major duct opens alone or in conjunction with the SMG duct at the sublingual caruncle.<sup>8-10</sup>

Our study analyzed anatomic results of 30 adult cadavers (60 SMGs and SLGs) and obtained morphologic data about the relationship of the SLG and SMG ducts. In 14 glands the major duct of the SLG opened directly at the sublingual caruncle. In 24 glands the major SLG duct joined the SMG duct and opened together at the sublingual caruncle. Interestingly, in 22 glands the major SLG duct was absent. Instead, there appeared to be only several small SLG ducts that opened at the mucous membrane of the oral floor. In the clinical study the association between the SMG and SLG ducts was the same. Of the glands, 52.9%

(36/68) showed that the major SLG duct joined the SMG duct, which is higher than that of the cadaveric anatomic study (40% [24/60]), whereas 36.8% of glands (25/68) did not show a major SLG duct in the clinical study, which is similar to the cadaveric anatomic findings (36.7% [22/60]).

These anatomic characteristics of these 2 ducts are of significance in clinical practice. First, if the major SLG duct opens directly into the sublingual caruncle, it can be difficult to distinguish the orifice of the SMG from that of the SLG. During procedures for sialography or interventional sialendoscopy, patients are conscious without general anesthesia. Milking the SMG to stimulate secretion is the key factor in finding the proper ductal orifice. However, during SMG transfer, patients are under general anesthesia and there is little secretion coming from the ductal orifice of the SMG. Thus it is more difficult to distinguish the orifice of the SMG from that of the SLG. When we insert the probe into the duct through the ductal orifice, the possibility of inserting to the SLG duct could not be eliminated. If we just cut a cuff of mucosa around the probe, this cuff will sometimes comprise the mucosa around the SLG ductal orifice, and the mucosa around the SMG ductal orifice will be lost. This will increase scarring of the orifice and cause stricture of the orifice after operation.<sup>7</sup> To avoid this situation, a relatively wider cuff of mucosa is preserved in the early period. Because the orifices of the ducts of the SMG and SLG are in close proximity, the SMG duct has mucosa around its orifice even through the probe is inserted into the SLG duct. The same situation may occur during sialography. Occasionally, the tube inserts into the SLG duct. Only sialograms of the SLG could be obtained. This technique has since been modified as follows: the medium part of the SMG duct is exposed first during the operation, and then the duct is dissected to the orifice in an anterograde manner, so the mucosa around the orifice is kept intact.

Second, if the major SLG duct joins the SMG duct, ligation of the SLG duct near the SMG duct is critical to avoid fistula of the duct after surgery. Before transfer of the duct of the SMG to the upper lateral conjunctiva fornix through the subcutaneous tunnel, irrigation of the duct with normal saline solution is necessary to check for fistula of the duct.<sup>7</sup> Because of this anatomic characteristic, imaging of both the SMG and SLG could be obtained on the same sialogram during sialography of the SMG.

Theoretically, reopening the SLG duct at the floor of the mouth could decrease the incidence of ranula after operation. However, the results of our study could not support this hypothesis. Ranula occurred in 4 cases in the group without a major SLG duct and in 3 cases in the group with a major SLG duct joining the SMG duct.



Double ducts of the SMG were suspected in 1 case in this study. The ducts originated from the hilum and the extension of the gland, respectively, and opened at the sublingual caruncle. Chen et al,<sup>11</sup> Towers,<sup>12</sup> and Gadodia et al<sup>13</sup> also reported this rare variation. However, controversy remains as to whether this variation involves an accessory SMG duct or SLG duct.<sup>14,15</sup> If the presence of double ducts of the SMG is proven, then treating bilateral dry eyes with 1 transferred SMG through transfer of double ducts could be considered.

In summary, this study investigated the microanatomic and clinical findings of the SMG and SLG ducts to provide morphometric data that may be useful when performing sialography, sialoendoscopy, and SMG transfer.

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