Anatomical Variation of the Submandibular Gland Duct. A Unreported Anomaly

Humberto Ferreira-Arquez

Abstract

Background: The submandibular gland is the second largest major salivary gland and weighs 7-16 gr. The gland is located in both sides of the face, at the same level of the body of the jaw, in the submandibular triangle. The submandibular duct or Wharton’s duct exits anteriorly, coursing deep to the lingual nerve and medial to the sublingual gland, the main excretory duct of the submandibular gland, whose diameter is of 2 to 3 mm and approximately 4-5 cm long. It empties lateral to the lingual frenulum through a papilla in the floor of the mouth behind the lower incisor tooth. The purpose of this study was to determine the morphologic features and describe an unusual anatomical variation of the path of the submandibular duct.

Methods and Findings: A total of 17 cadavers were used for this study in the Morphology Laboratory at the University of Pamplona. In a cadaver were findings: The excretory duct of the left submandibular gland had an external location that ascends and crosses vertically off the body of the mandible, in its termination it is divided in four ducts that had separate openings into the oral cavity upon a small papillae independent, opposites to the first and second lower molar Crown.

Conclusions: Awareness of potential variations of the excretory ducts of the salivary glands can aid in the accurate diagnosis and treatment of patients with salivary conditions as well as help surgeons avoid further complications or duct lacerations during surgical procedures.

Keywords
Submandibular Gland; Submandibular Duct; Wharton’S Duct; Anatomical Variation.

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Introduction
The submandibular gland (in older texts, this gland was sometimes referred to as “the submaxillary gland”) is the second largest major salivary gland and weighs 7-16 gr and its surrounded by its own capsule to separate it from other organs. It is divided in a lateral face, medial face, inferior border and anterior, top and posterior prolongation. The gland is located in both sides of the face, in the pit of the submandibular region, at the same level of the body of the jaw, in the submandibular triangle, which has a superior boundary formed by the inferior edge of the mandible and inferior boundaries formed by the anterior and posterior bellies of the digastic muscle. Also lying within the triangle are the submandibular lymph nodes, facial artery and vein, mylohyoideus muscle, and the lingual, hypoglossal, and mylohyoid nerves. Most of the submandibular gland lies posterolateral to the mylohyoideus muscle [1-3]. During neck dissection or submandibular gland excision, this mylohyoideus muscle must be gently retracted anteriorly to expose the lingual nerve and submandibular ganglion. Often, smaller, tongue-like projections of the gland follow the duct, as it ascends toward the oral cavity, deep to the mylohyoideus muscle. However, these projections should be distinguished from the sublingual gland which lies superior to the mylohyloideus muscle [2].

The submandibular gland (SMG) has both mucous and serous cells, but with major predominance in the human being of serous secretion that empty into ductules, which in turn empty into the submandibular duct or Wharton’s duct. The duct exits anteriorly from the sublingual aspect of the gland, coursing deep to the lingual nerve and medial to the sublingual gland. It eventually forms Wharton’s duct between the hyoglossus muscle medially and the mylohyoideus muscles laterally, on the genioglossus muscle. Wharton’s duct, the main excretory duct of the submandibular gland, whose diameter is of 2 to 3mm and approximately 4-5 cm long, running superior to the hypoglossal nerve while inferior to the lingual nerve. It empties lateral to the lingual frenulum through a papilla in the floor of the mouth behind the lower incisor tooth [1, 3]. The purpose of this study was to determine the morphologic features and describe an unusual anatomical variation of the path of the submandibular duct or Wharton’s duct.

Methods
This work was previously approved by the Ethics Committee in Research and Environmental Impact of the University of Pamplona, confirmed by resolution 030 of January 16 of 2014 and Resolution No. 008430 of 1993 of October 4 of the Ministry of Health of Republic of Colombia by which regulates the scientific, technical and administrative norms for health research. This descriptive cross-over study was designed to determine the morphologic features and anatomical variations of the submandibular duct. The region of 34 submandibular triangles were studied serially during the years 2013-2016 in 15 male and 2 females (n=34), embalmed adults cadavers in the laboratory of Morphology of the University of Pamplona. The cadavers had no trace of scars, adhesions or signs of trauma or operation. This study was carried out by routine dissection classes for undergraduate medical student’s. Measurements were taken with assistance of a sliding Vernier caliper with an accuracy of 0.01 mm during the course of the anatomical dissection. The data thus obtained were recorded in a physical matrix and were consigned in digital media using Excel tables. Topographic details of the variations were examined, recorded and photographed.

Results
The anatomical variations described were found during routine dissection in one male cadaver of 75 years (2.94%). The submandibular triangle and cheeks region containing the duct was carefully
dissected and the neighboring anatomic structures were taken. The anatomical findings were:

The excretory duct of the left submandibular gland (wharton’s duct) had an external location that ascends and crosses vertically off the body of the mandible, passes anterior to the masseter muscle, in its termination it is divided in four ducts (D1, D2, D3, D4) that pierce the buccinator muscle. Figure 1 and 2.

They had separate openings into the oral cavity upon small papillas independent, opposites to the first and second lower molar Crown. The Table 1 summarize length and diameter of the wharton’s duct.

Table 1. Measurement of the wharton’s duct on the left side.

<table>
<thead>
<tr>
<th></th>
<th>Wharton’s duct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>44.5</td>
</tr>
<tr>
<td>Diameter</td>
<td>3.65</td>
</tr>
<tr>
<td>Distance between tragus and emergence point</td>
<td>65.3</td>
</tr>
<tr>
<td>Distance between zygomatic arch and emergence point</td>
<td>65.4</td>
</tr>
<tr>
<td>Distance between angle of mandible and emergence point</td>
<td>25.3</td>
</tr>
<tr>
<td>Distance between commissure of lips and end point</td>
<td>70.32</td>
</tr>
</tbody>
</table>

In the remaining 33 submandibular triangle and cheeks regions (97.06%) the submandibular duct courses between the mylohyoideus and hyoglossus muscles, extends anteriorly, and opens at the sublingual caruncle.

The mean length of submandibular duct was 61.85 ± 2.35 mm, and the mean diameter was 3.0 ± 1.17.

Accessory salivary tissue was identified in 12 of the 17 cadavers examined (70%). These were bilateral in 5 (42%), right-sided in 4 (33%) and left-sided in 3 (25%).

There was no evidence of accessory duct of the submandibular gland
Discussions

The embryonic origin of the major salivary glands is characteristic of tubuloacinous glands, which arise from primordial cellular cords in which rapid proliferation of the epithelial (parenchymatous) elements leads to evagination into the underlying mesenchymal tissue. The distal duct branches repeatedly during this evagination process. The terminal end is surrounded by a knob-like enlargement of cells (acini) which then hollows out by cellular rearrangement, leading to the final tubuloacinous appearance. Condensation of the adjacent fascia produces the external capsule [4]. Embryologically, the submandibular glands originate in this fashion late in the fifth to sixth week. Paired primordial cords .arise in the anterior alveololingual groove and grow first backward along the floor of the mouth and then ventrally near the angle of the mandible. Anteriorly, the duct opens into the mouth just lateral to the midline and adjacent to the frenulum under the tongue. The capsule is derived from. the superficial layer of the deep cervical fascia [5].

Gaur et al described a right submandibular gland with three separate ducts which opened independently into the oral cavity. The authors considered that the submandibular gland develops as an invagination of the endoderm from the floor of the developing pharynx during the sixth week of fetal life. The duct branches in an arboreal fashion, increasing in number and decreasing in caliber. If multiple primordia develop it would lead to the formation of as many number of ducts and glands. The glandular tissue of these primordia, if closely placed and compactly covered by connective tissue should form a single submandibular gland having multiple ducts, each opening separately in the mouth [6].

To date, congenital abnormalities of the submandibular duct, including imperforate submandibular duct and large dilatation of the duct, have been reported [7, 8]. However, extensive review of the literature revealed previous reports of anatomical variations of the submandibular ducts [9-18]. Pownell et al reported on the aetiology of ductal formation deformities and suggested that anomalies of the duct can result if the developing duct invaginates in 2 places or if premature ventral branching of the duct occurs with duplication. Adhesion of endothelium of the dilated duct might divide into a double endocavity. Extracellular matrix protein, fibronectin, is essential for cleft formation during the initiation of epithelial branching. Fibronectin mRNA appears transiently and focally in developing cleft regions of the submandibular gland epithelia accompanied by an adjacent loss of cadherin localisation [10, 19]. Cadherin is one of the most important glycoproteins that promote cell-to-cell adhesion. Similarly, it is suspected that accumulation of fibronectin or loss of cadherin localisation has a possible role in duplication of the duct [10].

Although the larger duct of the submandibular gland is usually anatomically consistent, rare variations and anomalies of the ductal arrangement may occur. Rose described a case in which Wharton’s duct seemed to bifurcate, with one end opening into the sublingual papilla and a second (of equal size) into the mouth opposite the second molar. He noted that the anterior limb was blocked by a sialolith and postulated that this second limb may have represented a fistulous tract. Sialography was not done [7]. Waller described an embryo in which the submandibular duct opened into the pharynx near the isthmus of the fauces [18]. Manzur-Villalobos et al reported a cadaver in which an externally located right submandibular duct anastomosed with the parotid duct and led to the buccal mucosa adjacent to the second molar. The morphological feature of the submandibular duct reported in the present case is divergent with those of the reported case in the literature. The case presented in the present study is considered it as a rare variation has not been previously described. It is the first case reported so far in the available scientific literature.
Accessory salivary tissue was identified in 70% of the cadavers in this study. Nathan and Luchansky and Engel et al identified accessory salivary tissue in 40% and 42%, respectively [20, 21]. Accessory salivary tissue in this study was bilateral almost half the time. Additionally, similar to the reports of Gaughran [22] and Engel et al [21] accessory salivary tissue was identified within, or adjacent to, mylohyoid defects within the anterior two thirds of the muscle.

Any salivary tissue existing apart from the major (parotid, submandibular, and sublingual) or minor salivary glands in the oral cavity, pharynx, and upper airway is called heterotopic [23, 24]. These tissues are mostly seen in the neck as draining sinus [25], fistulas [26, 27], cysts [27], and tumoral masses either benign or malignant in origin [23]. However, accessory salivary glands differ from the heterotopic tissues because they are seen along a major salivary duct [24]. Histologic features of the accessory and main salivary glands do not demonstrate any differences, and all disorders of the major salivary glands may occur in the accessory glands [24, 28, 29]. The parotid gland is the most commonly encountered location for the accessory glands with tributary ducts [30, 31].

Accessory salivary tissue ranges in size from a few millimeters to a few centimeters. Accessory salivary tissue may measure as large as 3 cm in diameter. It is these larger deposits of tissue that may be confused both clinically and radiologically for pathologic abnormality. Larger accessory salivary tissue may occur in the accessory glands with tributary ducts [30, 31].

Accessory salivary tissue typically manifests attenuation on CT scans that is the same, or slightly higher, than that of orthotopic salivary tissue. The slightly higher attenuation occasionally encountered may reflect increased enhancement related to inflammatory changes [21, 32].

The pathological conditions of the salivary glands such as calculi (which account for 80-90% of all salivary stones), inflammatory disorders, mass lesions and penetrating trauma can be assessed by sialography [33]. The duct is cannulated through the ostium and retrograde instillation of water or oil soluble contrast media helps in location and evaluation of these diseases by observing the disturbance of the ductal architecture. About 90% of all salivary calculi occur in the submandibular gland and approximately 20% of these are radiolucent [34]. Though majority of salivary calculi are radiopaque, it is commonly recognized that because of technical problems, only 50% of such calculi are seen on plain X-ray film. This highlights the importance of sialography as a diagnostic procedure. Radiolucent stones or any other pathology present in the accessory ducts may inadvertently be overlooked if sialography is not performed by injecting the contrast media into each of these ducts. Awareness of the possibility of multiple ducts opening separately or anatomical variation in the position of the duct is important to a surgeon and to a radiologist performing this investigative procedure [6]. Sialography is regarded as the diagnostic procedure of choice for the detection of various conditions of the salivary glands, including mass lesions, inflammatory disorders, calculi and penetrating trauma. Sialendoscopy has been widely used in the diagnosis and treatment of siaolithiasis and inflammation of the submandibular gland [35]. A technique has been described in which severe keratoconjunctivitis sicca is managed by microvascular autologous submandibular gland transfer. In this operation the Wharton’s duct is transferred with the submandibular gland.
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 [36].

Conclusion
Awareness of potential variations of the excretory ducts of the salivary glands can aid in the accurate diagnosis and treatment of patients with salivary conditions as well as help surgeons avoid further complications or duct lacerations during surgical procedures. A thorough anatomical knowledge of these variations is very useful for Anatomist, Ophthalmologists, Oral surgeons, Oral and maxillofacial surgeons, Plastic surgeons, Otolaryngologists and Radiologists.

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Competing interests
None

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References

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