Anatomical Characteristics of Palatoglossus and the Anterior Faucial Pillar

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Palatoglossus and the anterior faucial pillar were studied using three techniques: 1) gross dissection, 2) radiographic filming, and 3) histological sectioning. The total subject sample included 25 normal adult male and female cadavers.

Palatoglossus has a flattened belly within the faucial pillar, a fan-shaped termination within the palate, and a vertical tapering termination within the tongue. The region of attachment into the palate differs among individuals which could influence its relative importance in velar versus lingual movement.

The pillar contains a large investment of loose connective tissue which also penetrates palatoglossus. The collagenous framework would apparently allow expansion of the pillars but also prevent rupture of the tissue at extreme extension. The anterior portion of the pillar contains a sheath of elastic fibers with a density gradient increasing from the tongue to the soft palate. The elastic fibers, which also intermingle with palatoglossus fascicles, could provide a restorative force in lowering the palate, helping to keep the nasopharyngeal airway patent.

Palatoglossus is classified as a muscle of the soft palate in the 1968 Nomina Anatomica although some authors describe it in relation to the lingual muscles. The classification is somewhat arbitrary since the muscle attaches to both movable structures. However, as pointed out by Crouch (1972), its embryological origin and innervation are more similar to those of the palatal muscles. The lingual muscles receive their innervation from the hypoglossal nerve and the palatal muscles excluding tensor veli palatini, are supplied through the pharyngeal plexus.

Although there is general agreement concerning the anatomical characteristics of palatoglossus, few details about its morphology have been provided (Dickson et al., 1974). For example, its size has not been well-documented. Luschka (1868) reported that palatoglossus is only 1.5 and 3 mm in its narrow and wide diameters at the level of the anterior faucial pillar. However, according to Hoeve's (1910) manual of dissection, palatoglossus is 13 mm in diameter and is cylindrically shaped. Reports regarding the size of palatoglossus in cleft palate individuals also are disparate. Veau (1931) and later Kriens (1975) found palatoglossus to be extremely hypoplastic in cleft palate newborns. In contrast, Fara and Dvorak (1970) reported "comparatively good development" of palatoglossus in relation to other palatal muscles in 18 stillborn children with cleft palate.

Palatoglossus is in a position to lower the palate, elevate the tongue dorsum, and constrict the anterior faucial pillars. It is generally agreed that tongue elevation and constriction of the fauces helps to propel the bolus of food toward the esophagus during swallowing. This activity also tends to occlude the oral cavity thus preventing retrograde flow. However, such action may not occur in those cleft palate and normal individuals who utilize the...
so-called “free fall” mechanism of swallowing (Flowers and Morris, 1973).

The function of palatoglossus during speech has not yet been resolved. Electromyographic activity recorded from palatoglossus in association with velar and lingual movements varies between speakers (Fritzell, 1969; Lubker et al., 1970; Lubker and May, 1973; Bell-Berti, 1976; Benguerel et al., 1977). As pointed out by Bell-Berti (1976) it is not known whether such variation is due to idiosyncratic behavioral differences or to anatomical factors.

The anterior faucial pillar has received little attention in the literature in spite of the fact that it is the site of a common surgical procedure, tonsillectomy. Even with present day surgical techniques the anterior faucial pillar is invaded in some cases which undoubtedly injures palatoglossus and causes considerable scarring (B.F. McCabe, personal communication). Tissue contracture due to scarring might be expected to constrain velar elevation in these cases. However, speech problems apparently have not been documented in relation specifically to the effects of this surgical trauma.

The purpose of the present study is to provide additional information concerning the anatomy of palatoglossus and its surrounding anterior faucial pillar, all of which is necessary to clarify the uncertainties and conflicts related to the configuration and function of the muscle-pillar complex.

Procedure

The sample included 25 heads from adult human male and female cadavers representative of the fifth, sixth, or seventh decades at the time of death. They were selected from bodies donated to the University of Iowa for medical research. Available medical histories indicated no gross orofacial pathologies and none of the subjects had undergone tonsillectomy. This was verified by both investigators during dissection.

The study was conducted in three phases. The first phase consisted of gross dissection of fourteen cadaver heads which were sectioned parasagittally as close to the midline as possible to provide a medial-to-lateral dissection approach. In this approach, the anterior faucial pillar was easily accessible (Figure 1). The mucous membrane and submucous fascia of the anterior faucial pillar were removed with relative ease exposing the palatoglossus muscle (Figure 2). (The muscle attachments were dissected after the second phase had been completed). The widest diameter of the muscle was measured with a caliper midway between the tongue and soft palate. Levator veli palatini also was exposed with dissection extending as close to the origin and insertion as possible without damaging or displacing the attachments. The levator diameter also was measured to provide a comparison with that of palatoglossus. The measurement was made in the region of the auditory tube orifice after torus tubarius had been removed. It should be pointed out that these measurements may deviate somewhat from muscle size in vivo due to fixation artifacts.

The second phase of the study provided an indication of possible force vectors of palatoglossus and levator relative to the soft palate. Radiographic filming was utilized and involved wrapping the midportion of palatoglossus and levator with a radiopaque thin metal foil (Dryfoil) to enable visualization of the muscles. A blunt-end thumb forceps was used to guide the foil through the bed which lay deep to each muscle. The foil was then folded securely around the muscle belly. The muscle was not displaced during this procedure and the muscle attachments were left intact. Hemisections from nine cadavers were x-rayed in lateral, frontal, and basal projections using a cephalostat.

In four of the specimens, the jaw opening appeared to be unnaturally large. The x-ray films were repeated for these specimens with the jaw in a more closed position. Lateral radiographs showed that a closer jaw position had no effect on levator position but changed the orientation of palatoglossus. Since the palatoglossus muscle attachments were intact, raising the jaw, which also raised the tongue, decreased the angle formed by palatoglossus and the hard palate. That is, the angle became more acute.

The third or histologic phase involved sectioning of undissected blocks of tissue from eleven cadavers. These blocks consisted of the
entire anterior faucial pillar with lingual and palatal tags attached. However, because of the excessively large size of the blocks otherwise required, the lingual and palatal tags were not extended to the midline. The tissue blocks were post-fixed in 10 per cent formalin prior to paraffin embedding and sectioning. Serial sections at 15 μm intervals proceeded superiorly into the soft palate and inferiorly into the tongue. Thus, transverse sections were obtained in the soft palate and tongue portions as well as the anterior faucial pillar.

A spectrum of histological detail was visualized by using: 1) hematoxylin-eosin (H & E) for general histology, 2) periodic acid-Schiff (PAS) for staining salivary glands, 3) Mallory triple stain (MTS) for differentiating muscle from connective tissue, and 4) Verhoeff - Van Gieson method (VVG) for differentiating collagenous fibers from elastic fibers. Each section of a series was stained with one of the above methods in consecutive groups of four. This procedure provided a means of following muscle fascicles, salivary glands, and connective tissue elements from the attachment in the palate through the anterior faucial pillar to the termination in the tongue.

**Results**

**Macroscopic Observations.** The anterior faucial pillar was well-defined in all specimens. The bulge which projected medially coursed between the soft palate and tongue (Figure 1). After removing the mucous membrane, palatoglossus was found to have a flattened belly within the anterior faucial pillar. In most specimens, a substantial investment of connective tissue was noted within the muscle itself as well as within the surrounding tissue of the anterior faucial pillar. The muscle portion within the anterior faucial pillar was found to have fairly uniform dimensions along its length (Figure 2). Table 1 compares the diameters of palatoglossus and levator veli palatini muscles and shows that palatoglossus is a much smaller muscle than levator averaging less than 5 mm in diameter, only about half that of levator. The widest dimension was oriented obliquely but primarily anterior-to-posterior in most specimens. In four of the fourteen specimens dissected the widest dimension was in a more medial-to-lateral orientation.

A fan-shaped termination within the soft

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**FIGURE 1.** Parasagittal section showing the undissected anterior faucial pillar (arrow) bulging into the oral cavity. Tongue (T); Hard Palate (HP).
palate was observed in all specimens. Muscle fibers began diverging at the most superior level of the anterior faucial pillar. At this point, the fibers were rather superficial as they were throughout the length of the anterior faucial pillar. More medially, the muscle fascicles were found to spread and proceed superiorly away from the oral surface of the soft palate. Fiber termination within the tongue was very difficult to follow beneath the lingual surface using gross dissection. The palatoglossus muscle was consistently anchored firmly at the point of entry to the tongue.

Lateral radiographs indicated that potential force vectors of palatoglossus in relation to the tongue and soft palate varied for different specimens. The configuration shown in Figure 3A was expected on the basis of textbook drawings of the region (for example, Woodburne, 1973). Specifically, the lines of potential force for palatoglossus and levator are directed toward each other in the soft palate, independent of the open or closed jaw position. The configuration shown in Figure 3B is quite different. In this specimen, the potential force vector for palatoglossus is directed much more inferiorly and posteriorly, toward the uvula. Again, this was true whether the jaw was in an open or closed position. Lateral radiographs of six of the nine hemisections exhibited a relationship among palatoglossus, levator, and the soft palate similar to that shown in Figure 3B, whereas the remaining three were similar to that of Figure 3A. The size of palatoglossus did not appear to be systematically related to the particular anatomical arrangement.

**Microscopic Observations.** Histological sections stained with H & E, MTS, and VVG provided detailed information concerning the course and terminations of palatoglossus. A cross-section through the middle of the anterior faucial pillar is illustrated in Figure 4. At this level, palatoglossus is in close proximity to the much larger tongue elevator, styloglossus. Palatoglossus muscle fascicles in the
TABLE 1. Diameters in millimeters of palatoglossus and levator veli palatini muscles.*

<table>
<thead>
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<th>Specimen</th>
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<th>Levator</th>
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<tr>
<td></td>
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<td>4.9</td>
<td>—</td>
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<td>—</td>
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<td>M10</td>
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<tr>
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</tr>
<tr>
<td>Mean</td>
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<td>3.97</td>
</tr>
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* Palatoglossus was measured midway between the tongue and soft palate. Levator was measured in an area deep to torus tubarius. M and F designate sex of specimen. A periodontal cyst was observed just anterior to palatoglossus in Subject M10; accordingly, the muscle was not measured.

Anterior faucial pillar are rather loosely arranged with a considerable amount of connective tissue interspersed and surrounding the whole muscle (Figure 4). With the H & E method the superficial muscle fibers stained darker (more eosinophilic) than the deeper fibers.

At the level of the soft palate, palatoglossus fascicles diverged from the central band of the muscle resulting in a fan-shaped termination (Figure 5). The muscle fascicles pass medially and intermingle with mucous glands and loose connective tissue lying deep to the mucosa. It was not possible to follow the fascicles all the way to the midline in the soft palate due to the limited block size. Therefore, the description in most anatomy texts indicating that palatoglossus fibers in the soft palate are continuous with those of the opposite side could not be evaluated.

Figure 6, a representative cross-section, shows the terminal fascicles of palatoglossus within the tongue. Observations of serial sections in this region indicated that palatoglossus fascicles are cohesive in the tongue and are surrounded by a fascial sheath. These fibers gradually terminate along this funnel-shaped membrane resulting in an inferiorly-directed tapering insertion in the laterodorsal aspects of the tongue. This is contrary to many textbook descriptions which indicate that palatoglossus blends with muscles of the tongue.

Using the PAS method to enhance visualization of the mucous glands, an abundance of submucosal glandular tissue was found lining the oral surface of the soft palate which agrees with most textbook descriptions of this region. Mucous glands also were found within the anterior faucial pillar between palatoglossus, styloglossus, and stylopharyngeus muscles (Figure 4). The presence and wide distribution of these glands were consistent in all the specimens studied.

MTS staining showed a surprisingly large proportion of connective tissue elements in relation to muscle for ten of the eleven specimens sectioned. The anterior faucial pillar is subject to frequent strain during speech and swallowing and there is need to restore the structure to its resting configuration. A question thus arose as to the composition of the connective tissue elements. A restorative force could be provided by elastic fibers if they are present in the connective tissue. VVG staining for elastic fibers was used to determine whether such fibers exist in the anterior faucial pillar. Elastic fibers were found in a concentrated sheath in the anterior portion of the anterior faucial pillar (Figures 4 and 7). The right portion of Figure 7 shows that the elastic fibers are kinked and rather loosely-arranged within the anterior faucial pillar. Because of this arrangement, the individual fibers varied in their directionality. However, serial sections clearly indicated that the fibers collectively form a well-defined layer that extends from the tongue to the soft palate in the anterior region of the anterior faucial pillar. The elastic layer follows the contour of the anterior faucial pillar. That is, between the soft palate and tongue, it has primarily a vertical orientation. As the anterior faucial pillar blends into the soft palate, the elastic layer assumes a transverse orientation which is just deep to the oral mucous membrane. The elastic layer was found to have a quantitative density gradient that increases from the tongue to the soft palate.

Elastic fibers were interspersed among the palatoglossus muscle fascicles but not within
FIGURES 3A and B. Lateral-view radiographs of two different cadaver hemisections showing relationship between palatoglossus (bottom arrow in each x-ray) and levator veli palatini (top arrow in each x-ray). Muscle fiber direction within each bundle is approximately perpendicular to corresponding arrow. Muscle attachments were left intact. Radiopaque thin metal foil was wrapped around the midportion of each muscle to accentuate its course.

Discussion

The results generally indicate that palatoglossus has a fan-shaped attachment in the
FIGURE 4. Transverse section through the midportion of the anterior faucial pillar. Anterior is bottom of figure, medial to the left. Palatoglossus muscle fascicle (PG), band of elastic fibers (EF), mucous gland (MG), styloglossus (SG), and stylopharyngeus (SPh) are indicated. MTS × 15.

FIGURE 5. Transverse section within soft palate just superior to the anterior faucial pillar. Palatoglossus muscle fascicles (PG) can be seen diverging from the more central portion (C) of the muscle. Anterior is top of figure, medial to the left. The anterior faucial pillar is lateral to the oral mucous membrane (OMM) which is cut obliquely in region indicated by the arrow. Mucous glands (MG) also are shown. H & E × 25.
FIGURE 6. Transverse section through the terminal fascicles of palatoglossus within the tongue. Arrows point to interstitial tissue region surrounding the muscle. VVG × 27.

FIGURE 7. Transverse section (left portion of figure) through the anterior faucial pillar showing band of black-stained elastic fibers (EF) in the anterior region. A portion of the oral mucous membrane (OMM) is shown. Medial is bottom of figure, posterior to the left. VVG × 47. A higher magnification of boxed area is shown at right portion of figure. The blackest elements are elastic fibers (EF). Lighter structures are muscle and collagenous tissue. VVG × 240.

soft palate, courses through loose connective tissue within the anterior faucial pillar, and has a tapering termination in the tongue. It appears that palatoglossus would generate a much smaller contractile tension than its antagonist levator veli palatini and its synergist styloglossus because of its relatively small cross-sectional size and large investment of connective tissue.

The biomechanics of tongue elevation versus velar lowering resulting from or assisted by palatoglossus contraction would depend,
FIGURE 8. Section through palatoglossus (PG) and styloglossus (SG). Blackstained elastic fibers intermingling with collagenous fibers (examples shown by arrows) are found among palatoglossus fascicles but not styloglossus. At this level, palatoglossus has begun a transverse course into the soft palate. Antero-medial is to the left of the figure. VVG × 95.

FIGURE 9. Transverse section within the soft palate near the oral surface showing dense meshwork (M) and also narrower bundles (B) of elastic fibers. Individual muscle fibers of palatoglossus (PG) may be seen. Anterior is bottom of figure, medial to the left. VVG × 270.

of course, on which structure is relatively fixed by other musculature and which is more free to move at any given instant in time. However, the movement produced by palatoglossus contraction, whether it is tongue elevation, velar lowering or perhaps both, also would be influenced by the location of applied force, that is the place of palatoglossus termination. The region of termination within the tongue was fairly constant across specimens. How-
ever, the attachment site in the soft palate varied. In most specimens, this region was nearer the uvula than the rim of the hard palate (Figure 3B), a region which is clearly not a rigid anchoring point toward which the tongue might be pulled. This suggests a limited mechanical ability for palatoglossus in elevating the tongue but favorable in lowering the soft palate, especially if the tongue is relatively stable. In these specimens the palatoglossus-soft palate mechanism could be categorized as a Class II lever system in which the load lies between the applied force and the fulcrum. The load consists of the bulk of the soft palate. The applied force is through palatoglossus and the fulcrum is the posterior rim of the hard palate or perhaps the point of levator insertion if this muscle is in a firmly contracted state. A Class II lever always operates with a mechanical advantage, in this case to lower the palate. This would appear to be an important mechanism in propelling a bolus of food toward the esophagus and tightly approximating the soft palate and tongue dorsum during the latter stages of swallowing.

For those individuals in whom palatoglossus is relatively large and attaches into the anterior portion of the velum (Figure 3A), the ability to elevate the tongue would be increased considerably, especially if the velum is stable. In terms of velar lowering, a Class III lever system exists which involves an applied force between the load (soft palate) and the fulcrum (rim of hard palate) and always operates with a mechanical disadvantage. Perhaps in these individuals the primary mechanism in approximating the tongue and soft palate during deglutition is tongue elevation rather than velar lowering.

Electromyographic activity recorded from palatoglossus has been reported in relation to both tongue elevation and velar lowering during speech production in normal speakers and also during swallowing (Fritzell, 1969; Lubker et al., 1970; Lubker and May, 1973; Bell-Berti, 1976; Benguerel et al., 1977). However, palatoglossus apparently is not active in velar lowering in all individuals (Bell-Berti, 1976).

The connective tissue fibers observed within the anterior faucial pillar were not compact and straight as those of tendon. This looser fiber arrangement apparently would be fairly extensible (Harkness, 1968) and allow surface area expansion of the anterior faucial pillar which is necessary during velar elevation for swallowing and speech. As a result of the anterior faucial pillar expansion, the collagenous fibers presumably would be straightened and aligned in the direction of the applied force. Further expansion or rupture of the anterior faucial pillar could be prevented by the low extensibility and high tensile strength characteristics of the collagenous fibers (Chvapil, et al., 1973).

The anterior faucial pillar and soft palate could be restored to the resting (palate lowered) configuration on the basis of three forces: muscle contraction, gravity, and tissue elasticity. The presence of elastic fibers in the soft palate, anterior faucial pillar, and between palatoglossus fascicles suggests their functional utilization in helping to restore the palate to the rest position. Lowering the palate by elastic recoil would have the virtue of conservation of muscle effort, would be highly automatic, and could also oppose the force of gravity. The latter is an important consideration in terms of sleeping in the supine position. The effects of gravity in this body position might actually tend to approximate the palate and pharyngeal walls. However, elasticity of the anterior faucial pillar would tend to keep the nasopharyngeal airway patent without the need for continuous muscle contraction. Bloom and Fawcett (1975) reported that elastic fibers also are present within the muscles of the pharynx. These fibers could aid in maintaining a patent nasopharyngeal airway. It is known that changes in elastic tissue occur as a function of age which presumably lead to a decrease in resiliency and a concomitant lax condition (Yu and Blumenthal, 1967). Such a lax state might possibly contribute to mouth breathing and snoring in the supine position in older individuals (see also Boulware, 1969 for theories of snoring).

The mechanism of elastic recoil also may be a factor in velar lowering during speech in some individuals. In an electromyographic study, Bell-Berti (1976) concluded for three of her four subjects that “opening of the [velopharyngeal] port results from the natural tendency of tissue to return to its rest position, and not from increased activity in any muscle.” The finding of elastic fibers in the anterior faucial pillar lends support to this statement.
As stated previously, none of the subjects in this study had undergone a tonsillectomy. It is possible that although changes occur as a result of this operation in some cases, such as scarring of the anterior faucial pillar, functional characteristics return to the presurgical state. In this regard, it is known that collagen remodeling may occur over several months following wounding (Hunter and Finlay, 1976). Such an extended remodeling process might be necessary in accommodating the continual stresses normally occurring in the velopharyngeal region. An important requirement is that the soft palate not be tethered by the scar tissue. Expansion of the anterior faucial pillar area by velar elevation especially in the earlier stages of healing may be helpful in permanently elongating otherwise contracted scar tissue (Arem and Madden, 1976). If the palatoglossus muscle fibers are not actually extracted, they are likely to regain function since even a minced muscle replaced into the bed from which it came will regenerate, reinervate, and regain at least some degree of function (Carlson, 1972). Finally, elastin may also regenerate during the healing process (Bhangoo and Church, 1976) which would more fully restore the functional integrity of the pillar-muscle mechanism.

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