Levator palati and palatal dimples: their anatomy, relationship and clinical significance

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Summary—To achieve the best results in cleft palate repair it is necessary to be aware of the normal anatomy. In a series of cadaver dissections, the levator palati muscle was found to occupy the intermediate 40% of the length of the soft palate. This normal distribution should be the aim at cleft palate repair.

Observation of the oral surface of the palate during production of the sound “Ah” reveals palatal dimpling. This has been observed in many normal and cleft palate subjects. The dimpling has been reproduced in cadavers by levator palati traction and been found on dissection and serial histological section to correspond to the levator insertion.

It is now generally accepted that the levator palati muscle is essential for normal velopharyngeal closure (Maue-Dickson, 1979) and emphasis is now placed on the correction of the abnormal levator insertion in cleft palate repair to achieve better velopharyngeal function (Braithwaite, 1964; Braithwaite and Maurice, 1968; Kriens, 1969). Correction of abnormal levator anatomy has also been reported to improve function in some patients with velopharyngeal incompetence following cleft palate repair (Edgerton and Dellon, 1971).

To achieve optimal muscle correction it is necessary to understand the muscular anatomy in both the normal and cleft palate subject and some information is available in the literature (Ruding, 1964; Fára and Dvorák, 1970; Edgerton and Dellon, 1971; Maue-Dickson, 1979). In the normal subject the levator muscles fan out in the palate to join each other in the midline. In the cleft palate patient while some fibres reach the free margin of the cleft, a significant bundle runs forward to gain attachment to the posterior edge of the hard palate.

The surgeon at operation requires an indication of how far posteriorly the levator muscles must be moved to reproduce the normal anatomy as closely as possible. The first aim of this study is an attempt to answer this question.

Palatal dimples

If the oral surface of the palate is observed while a subject says “Ah”, the palate is seen to arch and convexities occur at the point, or points, of maximum excursion. The apices of these concavities can be termed palatal “dimples”. No reference can be found in the literature to dimples seen in this manner. If dimples gave an indication of levator insertion or activity they would be of potentially great clinical significance. The second aim of this study was to investigate the relationship between palatal dimples and levator anatomy in the normal palate.

Methods

Twenty fresh adult cadavers were studied. With the brain removed from the skull, a portion of the skull base was removed allowing access to the origins of the paired levator muscles from the petrous temporal bones. These were freed without disturbing the palate, pharynx or tongue. Traction was then applied to the levators, both singly and together, to simulate levator activity in the palate in vivo. With a cleft palate gag in place, the effects of traction could be observed orally. The position of the observed dimples was marked with ink.

The palates were removed intact, including a portion of hard palate, the faucial pillars and a length of levator in its extravelar course. They were either dissected under the operating microscope or fixed in formal saline for serial section. In order to avoid distortion of palates for sectioning, a mould was made of the palate in situ using polyurethane foam. After marking the dimple sites with sutures, the palates were fixed on the foam moulds.
Clinical observation of dimples
The palates of more than 500 subjects both normal and cleft, of varying ages, were observed at rest and saying "Ah".

In the normal subject dimples are always present. They usually occur at the junction of the middle and posterior thirds of the soft palate length, slightly away from the midline. There is some variability of position in both antero-posterior and transverse axes, and also in configuration. There may be only one midline dimple. When bilateral, they may occasionally be asymmetric. A typical normal configuration is seen in Figure 1.

In the cleft palate subject the findings are different. Prior to repair, dimples are rarely visible, but grooves in the soft palate can be seen running obliquely forwards to the posterior edge of the hard palate. Following cleft palate repair, dimples may appear in approximately the normal position; they may also be absent or quite asymmetric. Frequently they are situated more anteriorly than normal (Fig. 2).

It has been the authors' clinical experience that abnormality of these dimples following palate repair was often associated with abnormal speech and with abnormality of the muscle insertions, as judged both by nasendoscopy and at palate repair.

Dimple reproduction in cadavers
In all cadavers, oral palatal dimpling could be produced by traction on the levator muscles. Traction on either one or both levators produced ipsilateral or bilateral dimpling respectively (Fig. 3). Dimples appeared in positions similar to those in life, although their configuration was usually more acute.

In two of the normal subjects observed in life, who subsequently died and were having post-mortem examinations performed for other reasons, it was possible to reproduce palatal dimples. The ante- and post-mortem dimple positions were identical.

Palatal dissections
Dissection commenced from the nasal surface. After removal of the mucosa the most nasal structure was the palatal aponeurosis. Formed by the paired tensor palati muscles this was thick and broad anteriorly at the hard palate, becoming attenuated as it tapered to the midline halfway back in the soft palate. No muscle was inserted...
onto its nasal surface. A less substantial fibrous layer passed deep to the musculus uvulae, enclosing this structure. No effect on the aponeurosis or palate could be demonstrated by traction on the tensor muscles, many of whose fibres were firmly attached to the hamulus.

The levator muscles expanded fan-like from their compact bellies to the midline where they joined (Fig. 4). The position of the levators in the midline was measured in relation to palatal length and dimple position. Palatal length was measured from posterior edge of hard palate to the free margin of the soft palate, excluding the uvula. It varied between 30 and 50 with a mean of 40 mm.

Dimple position was at a mean of 24 mm from the posterior edge of the hard palate (Fig. 5), while

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Figure 2—Oral view of patient with previously repaired cleft subject and poor speech (A) at rest (B) saying “Ah”. Note that the dimple is situated further anteriorly (indicated by arrow).

Figure 3—Oral view of normal palate at post-mortem with a tongue gag in place (A) at rest (B) simulating levator action by traction on the muscles, bilaterally. Note the creation of dimples (indicated by the arrows).
Figure 4—(A) Nasal view of a dissected soft palate, showing the arrangement of the muscles. (B) Schematic drawing of same palate. The levator muscle occupies the intermediate 40% of the soft palatal length.
Figure 5—Representative vertical sections through a palate, with the nasal surface uppermost. The darkly staining areas are the mucous glands. (A) at the dimple region, the muscle closely approaches the oral mucosa (indicated by the arrow). (B) in the anterior soft palate a thicker layer of glandular tissue separates muscle from oral mucosa.

The levator insertion spanned 17 mm on average at its broadest, with its anterior and posterior limits respectively 11 and 28 mm from the posterior edge of the hard palate. Expressed in simpler terms this is the intermediate 40% of the soft palatal length.

The dissections showed that the dimples were close to the posterior border of the levators, and were related to the point where the fibres of levator and palatopharyngeus muscles intermingled and became inseparable. This intermingling can be seen in Fig. 4. In three cadavers where simulated dimples had been asymmetric, dissection revealed a corresponding muscular asymmetry.

No levator fibres were seen to join the musculus uvulae, enter the uvula itself, or to gain attachment to the hard palate directly.

Serial sections
The palate serial sections confirmed the position of the aponeurosis nasal to the levator and demonstrated the abundant glandular tissue on the oral surface of the palate. In the region of the dimple,
however, the glandular layer is thinner and the muscle fibres of the levator approach the mucosa closely. A few fibres and some fibrous tissue bands anchor the muscle to the oral mucosa in this region, but in no other area of the palate (Fig. 5).

Discussion

Levator anatomy

Previous anatomical studies have described the general arrangement of the levator within the palate. Ruding (1964) described the levator insertion as extending from aponeurosis to uvula and measured the levator span at its maximum at 20 to 25 mm. Edgerton and Dellon (1971) measured the width of the levator insertion anatomically and found this to be 10 mm. Neither study related this anatomical measurement to the overall palatal length.

In the present investigation the average width of the levator at its insertion was found to be 17 mm and this was the intermediate 40% of the soft palatal length. The significance of these measurements is to give the surgeon an idea of what represents the normal to assist him in cleft palate repair.

Veloplasty

The importance in cleft palate repair of correcting the abnormal levator insertion to reconstitute the velopharyngeal valving mechanism has been stressed by several writers (Braithwaite, 1964; Ruding, 1964; Braithwaite and Maurice, 1968; Kriens, 1969 and 1970; Katsuki, 1975). There is no clear indication, however, as to how radical such an operation should be. Ruding (1964) stated that the large portion of the levators attached to the hard palate must be detached and sutured one to another across the midline, but not how far posteriorly this should be. Braithwaite and Maurice (1968) suggested that the further backwards the muscular displacement, the more effectively would muscular continuity be achieved. They further recommended wide dissection in the space of Ernst to narrow the sphincter. Kriens (1969) recognised the importance of muscle sling reconstitution, but did not state how far the muscle should be retro-positioned. Edgerton and Dellon (1971) suggested that the levator bundles, once freed, be rolled 180° upon themselves and sutured to the musculus uvulae near the uvular base.

In the present study the normal levator muscle has been found to occupy the intermediate 40% of the soft palatal length, and this seems a logical target to aim for at veloplasty. In practice, the operation involves freeing the muscle and the aponeurosis on its nasal surface from the hard palate, from the nasal mucosa and from the oral layer of mucosa and glandular tissue. To achieve the desired retro-displacement, this separation of the palatal layers needs to be radical both on the oral and nasal surfaces, almost as far as the Eustachian orifice. It is unnecessary to fracture the hamulus or dissect in the space of Ernst (where the nerve supply of the levators may be in jeopardy). A three layer palatal closure is performed using monofilament nylon for the muscle, suture of which is facilitated by the associated aponeurosis. A suture immediately anterior to the sutured muscles holds oral and nasal layers together, eliminates dead space and prevents any tendency to relapse.

Palatal dimples

Clinical observation of the oral surface of the palate is regarded as unhelpful (Morley, 1966) and has received scant attention. Pigott (1969) suggested that, compared with endoscopy, it is not helpful in predicting velopharyngeal closure.

Podvinec (1952) was probably the first author to observe and comment on dimpling of the palate, which he saw during a modified Valsalva type of manoeuvre. They were seen “anterior to the uvula” and he considered them to represent the point of crossing of the levator and the palatopharyngeus slings.

Our observations of dimples in subjects were during production of the sound “Ah”, although the sound “Ee” produces greater palatal lift and better velopharyngeal closure (Sommerlad, 1981). “Ah” allows vision of the palate, while “Ee” does not, and presumably is more related to events during speech than is Podvinec’s method of observation.

In the normal individual, dimples are always present, usually at the junction of the middle and posterior thirds of the soft palate. We have been able to reproduce dimples at corresponding positions in cadavers by traction of the levator muscles alone. The measurements of dimple position (mean 24 mm from the hard palate in an average palate of length 40 mm) correlate with the positions as seen in life. They further correlate with the observations of Hoopes et al. (1969), during lateral cineradiography, of a “locus of levator activity” seen 25 mm posterior to the posterior nasal spine.
The relationship of dimples to levator muscles in the palate dissections was that they occurred at the point where levator and palato-pharyngeus muscles intermingle, close to the posterior limit of the levator. The firm attachment of muscle to oral mucosa at the dimple site by fibrous strands helps to explain the mechanism of dimple production.

The difference in the configuration of the dimples in life, and simulated at post-mortem, can be explained by the absence of palatopharyngeus action in the latter situation.

In patients with repaired palatal clefts, dimples may be absent or abnormally anterior in position, presumably reflecting inadequate muscular correction. Many of these patients have velopharyngeal incompetence. The authors have observed that following a palate re-repair in such patients, or following repair of submucous cleft palates, by levator retro-displacement, speech is improved and the observed dimple positions are shifted backwards toward the normal situation.

From the evidence it seems reasonable to conclude that oral palatal dimpling is related to levator insertion and that oral examination of the palate is of greater value than is generally recognised. It can be a valuable adjunct to the standard techniques of nasendoscopy and cineradiography in assessing both the surgical results of cleft palate repair and patients with speech problems.

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