Comparison of Multi-View Videofluoroscopy and Nasopharyngoscopy in the Assessment of Velopharyngeal Insufficiency

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Ratings and drawings of multi-view videofluoroscopic and nasopharyngoscopic studies of the velopharyngeal valve in 25 subjects with velopharyngeal insufficiency (VPI) were compared. The videofluoroscopic projections assessed were lateral, base, and Towne views. The Towne view was visually compared with flexible fiber optic nasopharyngoscopic studies in the same subjects. The Towne view was found to compare well with nasopharyngoscopic examination, and lateral view alone was found to be inadequate for the description of velopharyngeal movements.

KEY WORDS: velopharyngeal insufficiency, palate, pharynx, cleft palate, hypernasal speech, nasopharyngoscopy

The lateral, frontal, and base views have been used in the fluoroscopic assessment of velopharyngeal closure for over 25 years (Ashley et al, 1961; Skolnick, 1969, 1970; Shprintzen et al, 1974, 1975; Skolnick et al, 1975; Warren and Hoffman, 1981). More recently, the Towne projection has been advocated because it may be more effective in detecting velopharyngeal insufficiency than the base view, particularly in patients with large adenoids (Cotton and Quattromani, 1977; Quattromani et al, 1977; LaRossa et al, 1980).

Nasopharyngoscopy has been used in the diagnosis of VPI for nearly as long as multi-view radiographic procedures (Pigott et al, 1969). Although a number of centers use both multi-view videofluoroscopy and nasopharyngoscopy in the diagnosis of VPI, these techniques have not often been compared (Sinclair et al, 1982; Shprintzen, 1983). To date, no comparisons have considered the Towne projection.

The purpose of this study was to compare ratings of velopharyngeal closure in the three following videofluoroscopic views: lateral, base, and Towne. The results of the Towne view were also compared with those of nasopharyngoscopy.

METHOD

Twenty-five subjects with hypernasal speech were prospectively studied using videofluoroscopy and nasopharyngoscopy. They ranged in age from 4 to 41 years with a mean age of 12.3 years. Only three patients were over 17 years of age. The etiologies of hypernasal speech included cleft palate, neurologic impairment, structural anomalies of the pharynx, and postadenotonsillectomy hypernasality. Two subjects had velo-cardio-facial syndrome, one had hemifacial microsomia, and one had de Lange syndrome. In all 25 subjects, the videofluoroscopic examinations included lateral and Towne views during the phonation of a series of standard nonnasal phrases. Twenty-two of these subjects also had a base view study. Videotapes were reviewed at the end of each examination, and drawings of the velopharyngeal orifice at rest and during speech were made by the authors.

At the outset of the radiographic examination, 1 to 2 ml of high density barium was instilled into each nostril and sniffed back into the nasopharynx with the patient supine. The patient was upright for the lateral view, prone for the base view, and supine for the Towne view (Fig. 1). The same standard speech sample was recited by all patients, and the entire examination was recorded on videotape with simultaneous sound. At the end of each examination the videotapes were reviewed, and drawings of the shape of the portal at rest and during phonation in the Towne view were made by the authors (Fig. 2).

Nasopharyngoscopy was accomplished within 3 weeks of the fluoroscopic examinations using a Machida 3L nasopharyngolaryngoscope. The nasal passage was anesthetized using a mild topical anesthetic of 2 percent tetracaine hydrochloride with 0.5 percent phenylephrine (Shprintzen et al, 1985). The nasopharyngoscope was inserted into the nose and positioned in the nasopharynx to allow viewing of
Velopharyngeal closure was judged as adequate, inadequate, or uncertain from each radiographic view and from the endoscopic studies. The results from each separate judgment were then tabulated. The shape of the velopharyngeal orifice at rest and at maximum closure in the drawings from Towne view were visually compared with those from the endoscopic studies. Comparison was judged as excellent when the drawings were identical in shape of the orifice, degree of closure, and location of gap; good when the type and extent of closure were identical with a minor difference in shape (Figs. 2 and 3); and unsatisfactory when any other differences were present. No attempt was made to compare the absolute size of the orifice or velopharyngeal gap because the images were not on the same scale.

**RESULTS**

The ratings of velopharyngeal closure are shown in Table 1. In 12 of the patients the lateral view showed what appeared to be adequate closure, but the other radiographic views and endoscopy usually indicated VPI. In two patients the Towne projection was difficult to interpret and there were two failed nasopharyngoscopic studies. In seven patients the base view was difficult to interpret, and velopharyngeal closure could not be reliably rated. Two patients showed complete closure in all radiographic projections although the closure was inconsistent. Comparison of the findings from the Towne view and nasopharyngoscopy was excellent in 13 subjects, good in six, and unsatisfactory in six.

**DISCUSSION**

Lateral view videofluoroscopy alone does not permit adequate assessment of VPI (Skolnick, 1969, 1970; Skolnick et al, 1973; Shprintzen et al, 1974, 1975). In this study and in our earlier investigations (Stringer and Witzel, 1985, 1986), the lateral view was associated with a large number of false positive findings for adequate closure. The Towne view may demonstrate VPI better than the base view, especially in patients with short necks that prevent hyperex-
tension, or with large adenoids that alter the plane of velopharyngeal closure out of the angulation of the base view (Skolnick, 1970). Interpretation of the base view can also be complicated by overlying structures (Shprintzen, 1983; Stringer and Witzel, 1986) and by posterior movements of the tongue toward the pharynx, which occurs during the production of pharyngeal fricatives and other compensatory articulations.

Comparison of the drawings of the Towne view with the endoscopic drawings was good or excellent in 19 of the 25 patients. The Towne projection provides an oblique view along the velopharyngeal orifice. When adenoids are present, the angle of velopharyngeal closure within the nasopharynx becomes obliquely oriented so that the Towne projection can look at the closure process en face, as does nasopharyngoscopy.

In six patients there was an unsatisfactory comparison between the Towne view and endoscopy. In one patient the videofluoroscopy was difficult to interpret and, in another, fluoroscopy failed to show evidence of velopharyngeal insufficiency that was apparent on the endoscopic examination. In two subjects the endoscopic studies were compromised by poor compliance and excessive mucus. In two other subjects asymmetry was observed on fluoroscopic examination, but not on endoscopic investigation. This type of discrepancy would be important to resolve if surgeons rely on videofluoroscopic and nasopharyngoscopic data to "tailor" their operations (Shprintzen et al, 1979). It is probable that the fluoroscopic evidence was more accurate in this respect. According to Shprintzen (1983), fluoroscopic and endoscopic studies can disagree as often as 30 percent of the time, usually related to the superior ability of multi-view videofluoroscopy to assess the true extent of lateral pharyngeal wall motion. Even though each method may provide important information, both examinations are needed to evaluate velopharyngeal function fully. Discrepancies between the techniques must be resolved if surgeons are to rely on such studies to specify these operations (Shprintzen et al, 1979).

Each technique has advantages and disadvantages. The radiographic examination is quick and easily tolerated so that compliance is rarely a problem. Videofluoroscopy is available at almost all hospitals. The only modification involved relative to the classically used lateral view phonation study is the use of several views, learning to position the patient, using an appropriate speech sample, and interpreting the results. Patients must be irradiated briefly, but the use of new remote imaging systems with overtable x-ray tubes and rare earth filtration (e.g., ytterbium) minimizes risk to both patient and clinical staff. Because time is limited during the examination, experimentation with the patient's speech is also limited. Neck flexion associated with the Towne view may mask VPI, just as hyperextension of the neck in the base view may exaggerate or uncover VPI (McWilliams et al, 1968). However, when overtable x-ray tubes are used, the Towne view can now be taken with the patient in a normal upright position (Fig. 4).

Nasopharyngoscopy permits prolonged and repeated viewing. Endoscopy also has biofeedback potential (Siegel-Sadewitz and Shprintzen, 1982; Yamaoka, 1983; Hoch et al, 1986; Witzel et al, 1988; Witzel et al, 1989). Although
reports are preliminary, it does seem that altering abnormal
velopharyngeal closure is possible in at least some individu-
als. The anatomy of the entire vocal tract including the
larynx, epiglottis, posterior tongue, tonsils, adenoids, pos-
terior and lateral pharyngeal walls, velum, Eustachian
tubes, and nose is easily examined. The major disadvan-
tages of endoscopy are that it can be uncomfortable in some
patients and young children may be uncooperative. Only
one view is seen, and even that may be obscured by mucus
on occasion. Furthermore, a topical anesthetic is often nec-
essary, which may not be available in certain clinical set-
tings.

CONCLUSIONS

Radiographic examination in the lateral view alone is
insufficient to identify velopharyngeal function. The Towne
projection is a useful second view that usually compares
well with nasopharyngoscopy. Nasopharyngoscopy comple-
ments the use of multi-view videofluoroscopy in the diag-
nosis of VPI.

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Commentary

Although the authors have demonstrated that the Towne
view can be used as an alternate view for imaging of the
velopharyngeal portal en face when the base view is unsuccess-
ful (because the patient has enlarged adenoids or is
unable to adequately hyperextend the neck), I believe that
the Towne view should not be considered a replacement for
the base view in evaluating the velopharyngeal portal.
As pointed out by the authors, the Towne view may be

FIGURE 4 Patient in the upright position for the Towne view with
overtable x-ray equipment.
performed with the head flexed upon the neck. The antero-posterior dimension of the velopharyngeal portal is reduced in this position, as compared with its dimension when the head is in neutral position as it is for the lateral projection. Using two different positions of the head for different fluoroscopic views changes the dimensional relationships of the velopharyngeal portal and may affect the degree of velopharyngeal insufficiency that is produced when the patient phonates in each of these views. I believe that to evaluate accurately the Towne projection as part of the multi-view videofluoroscopic study, the lateral view should be obtained with the head positioned in the same degree of flexion as it is for the Towne view, so that the examiner could relate dimensions of the velopharyngeal portal in the same plane between the Towne and the lateral view.

Because the authors have used only the lateral and Towne or base views to image the velopharyngeal portal radiographically, the reader may get the impression that multi-view videofluoroscopy requires only the lateral and an en face view of the velopharyngeal portal. In my estimation this is incorrect. The reader should appreciate that multi-view videofluoroscopy requires the use of the frontal projection as well. The frontal projection provides important information about medial movement of the lateral pharyngeal walls along the entire vertical extent of the nasopharynx that cannot be obtained on the base or Towne view or with nasendoscopy. The en face views of the portal and nasendoscopy do not demonstrate the vertical position at which the lateral pharyngeal walls move and the vertical relationship of the moving lateral pharyngeal walls to the movements of the posterior pharyngeal wall and the velum. Although all of these structures often move at the same level, there are many cases in which the lateral pharyngeal walls may move at a different vertical position from the posterior pharyngeal wall or velum. An en face view of the portal, whether by videofluoroscopy or endoscopy, may give incomplete information about the effectiveness of velopharyngeal closure. This information becomes especially important in evaluating patients who demonstrate persistent hypernasal speech following pharyngeal flap surgery. The pharyngeal flap may be at an inappropriate level in relation to the maximal medial movement of the lateral pharyngeal walls. The use of the frontal view preoperatively is the most valuable projection for prescribing surgery.

Therefore, although the Towne view can be used as a substitute for the base view, the reader should appreciate that multi-view videofluoroscopy requires three, not two, views. It is also important to position the patient the same way for at least two views to eliminate possible discrepancies caused by head position.

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