Prediction of Velopharyngeal Competency

D. R. VAN DEMARK, Ph.D.
DAVID P. KUEHN, Ph.D.
R. F. THARP, M.A.
Iowa City, Iowa 52242

Although there are various diagnostic tools for assessment of velopharyngeal competency such as lateral x-rays, cinefluorography, manometers, nasal air flow and articulation tests (*1, 3, 4, 6, 7, 8, 11*), it is extremely difficult for the speech clinician to predict which individuals with clefts will need secondary palatal management. In fact, quite often the clinician will conduct a trial therapy period to see if progress is made before referral for consideration of secondary management (*6*). Therefore, the question asked in this study was: Are there measures which are predictive of the need for further palatal management?

Procedure

SUBJECTS. One hundred eight subjects with cleft palate were selected for comparative purposes with a previous report (*9*). They were selected on the basis that an articulation test was available within the age-test period of 79 to 90 months. In addition, clinical ratings of velopharyngeal competency and lateral x-rays were available. Subjects who at the time of test had obturation, a pharyngeal flap or did not continue on the research project for at least one year after the base test were excluded from the study. A total of 75 subjects qualified. The subjects had a mean age of 84 months (range 79 to 90) at the initial test period and 162 months (range 103 to 242) at the time of preparation of this report. Therefore, the average intervening time period was 6½ years.

PREDICTIVE MEASURES. Three measures were evaluated for their prognostic value. One measure was the Iowa Pressure Articulation Test (*7*). This test was originally constructed to help discriminate between speakers possessing velopharyngeal competency and those who do not. On this test, scores were determined on a correct/incorrect basis. Three categories were arbitrarily defined: (1) articulation scores above 50%, (2) articulation scores between 50% and 34%, and (3) articulation scores below 34%. The second measure was judgment of velopharyngeal competency made by the

The authors are affiliated with the Department of Otolaryngology and Maxillofacial Surgery, University of Iowa, Iowa City, Iowa. D. R. Van Demark is Associate Professor. David Kuehn is Research Scientist. R. F. Tharp is Senior Research Assistant.

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speech pathologist at the time of examination (*5, 9*). On this measure (1) indicated adequate velopharyngeal competency, (2) indicated marginal velopharyngeal competency, (3) indicated inadequate velopharyngeal competency. A third measure used, similar to a video tape rating system developed by McWilliams and Bradley (*2*), was the degree of velopharyngeal closure as observed on lateral x-ray on sustained phonation of either /s/ or /u/. The following rating system developed by Enemark as reported by Van Demark (*10*) and illustrated in Figure 1 was utilized: (1) indicated a tight velopharyngeal seal, (2) indicated velopharyngeal closure with approximately 2 mm of contact, (3) indicated touch closure, (4) indicated a velopharyngeal space of less than approximately 2 mm, and (5) indicated a velopharyngeal space greater than 2 mm. The x-ray (/s/ and /u/) which exhibited the greater degree of velopharyngeal closure was used as the predictive measure. Using this classification system, the first two authors viewed each x-ray independently and assigned a rating. Interjudge reliability was determined by comparing ratings of both /s/ and /u/ for 28 subjects chosen randomly. The same rating was used by both judges for 89% of the /s/ x-rays and 93% of the /u/ x-rays. Differences in rating for a given x-ray never exceeded one category. For example, if one judge rated an x-ray as 3, or touch closure, a rating in disagreement by the other judge would be either 2 or 4 and never 1 or 5. In cases where disagreements occurred, the films were viewed again and a judgment was agreed upon.

In retrospect, the question was asked if any or a combination of the three measures could predict the 19 subjects (25%) who were secondarily managed. The poorest rating in each measure would presumably lead to the recommendation of further management. Therefore, if a subject obtained an articulation score of lower than 34%, a clinical rating of inadequate velopharyngeal closure, or an x-ray rating of 5, we predicted that these subjects would in fact receive secondary management.

Results and Discussion

Four possible categories exist in predicting velopharyngeal closure. For a particular subject and at a given point in time, a prediction can be made that the subject either will or will not eventually need further management, specifically a pharyngeal flap, to improve his speech. At a later time, the subject either does or does not receive the flap. Assuming that we had predicted the subject would need a flap and that he did indeed subsequently receive the flap, we would consider this as a hit (See Table 1). Conversely, if we had predicted that the subject would not need a flap and subsequently no flap was received, we would consider this a correct rejection. An ideal predictive measure is one which leads to no false-positives, that is, the recommendation of a pharyngeal flap when in fact a flap is not needed, and no misses in which case no flap is recommended, but subsequently a flap is

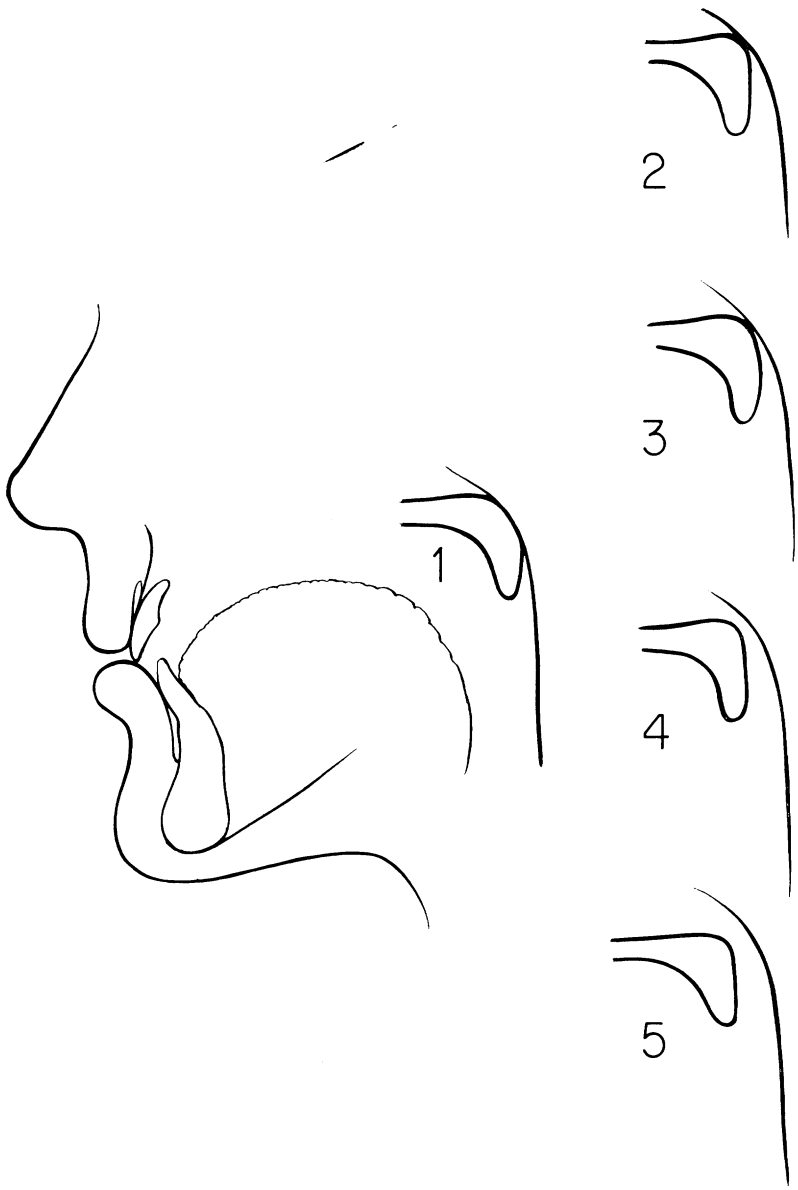

FIGURE 1. An illustration of Enemark's classification system of rating velopharyngeal competency. (1) indicates a tight velopharyngeal seal, (2) indicates velopharyngeal closure with approximately 2 mm of contact, (3) indicates touch closure, (4) indicates a velopharyngeal space of less than approximately 2 mm, and (5) indicates a velopharyngeal space greater than 2 mm.

TABLE 1. Contingency table showing the four possible categories involved in predicting secondary palatal management.

prediction	*treatment*		*prediction total*
	flap received	*flap not received*	
Flap predicted	(Hit) a%	(False positive) b%	(a + b)%
Flap not predicted	(Miss) c%	(Correct rejection) d%	(c + d)%
Treatment total	(a + c)%	(b + d)%	100%

needed. Thus, an ideal predictor is one which leads only to outcomes which are appropriate; that is, either hits or correct rejections.

The data in the present study were analyzed in reference to contingency tables as exemplified by Table 1. The predictive measures were initially analyzed individually and then in all possible combinations. Table 2a shows the results of using clinical judgment of velopharyngeal competency as a predictive measure. It was found that 90% of the predictions were appropriate in that 17% were hits and 73% were correct rejections. Clinical judgment appears to be a conservative predictive measure since only 2% were false-positives. When x-ray rating was used as the predictive measure (Table 2b), subsequent treatment was appropriately predicted for 92% of the 75 subjects. X-ray ratings resulted in more false-positives, but also fewer misses. As a single predictive measure, articulation score (Table 2c) approached the ideal more closely than clinical judgment or x-ray rating in that only 5% of the predictions were inappropriate. Articulation score on the IPAT appears to be sensitive in terms of speech prognosis since only 1% of the subjects received a flap which had not been predicted.

TABLE 2. Results of using single measures to predict secondary palatal management: a) clinical judgment, b) x-ray rating, c) articulation score.

predictive measure	*prediction*	*treatment*		*prediction total*
		flap received	*flap not received*	
(a) Clinical judgment	Flap predicted	17%	2%	19%
	Flap not predicted	8%	73%	81%
	Treatment total	25%	75%	100%
(b) X-ray rating	Flap predicted	23%	5%	28%
	Flap not predicted	3%	69%	72%
	Treatment total	26%	74%	100%
(c) Articulation score	Flap predicted	24%	4%	28%
	Flap not predicted	1%	71%	72%
	Treatment total	25%	75%	100%

TABLE 3. Results of using measures in paired combinations to predict secondary palatal management: a) articulation score and clinical judgment, b) clinical judgment and x-ray rating, c) articulation score and x-ray rating.

predictive measure	*prediction*	*treatment*		*prediction total*
		flap received	*flap not received*	
(a) Articulation score and clinical judgment	Flap predicted	17%	0%	17%
	Flap not predicted	8%	75%	83%
	Treatment total	25%	75%	100%
(b) Clinical judgment and x-ray rating	Flap predicted	17%	2%	19%
	Flap not predicted	8%	73%	81%
	Treatment total	25%	75%	100%
(c) Articulation score and x-ray rating	Flap predicted	23%	1%	24%
	Flap not predicted	3%	73%	76%
	Treatment total	26%	74%	100%

The predictive measures also were analyzed in paired combinations. Table 3a shows the results of using both articulation score and clinical judgment. In this case, it was predicted that patients receiving an articulation score below 34% *and* a clinical rating of inadequate velopharyngeal competency would eventually need further management. Conversely, for patients receiving articulation scores and clinical ratings above the established cut-off, the prediction was that those patients would not need a flap. It can be seen that 92% of the predictions were appropriate and these two predictive measures in combination are highly conservative in that no false-positives resulted. Table 3b shows the results of combining clinical judgment and x-ray ratings. The results are quite similar to those above. Ninety percent of the predictions were appropriate in terms of subsequent treatment. Combining articulation test scores and x-ray ratings (Table 3c) appears to be quite accurate in terms of predicting future treatment since only 4% of the predictions were inappropriate. That is, false-positives and misses amounted to only 1% and 3% respectively.

Finally, Table 4 shows the results of combining all three measures. In this case, it was predicted that a patient would receive a flap *only* if he received poor ratings on all three measures. It can be seen that 92% of the predictions were appropriate, 8% of the predictions were misses, and there were no false-positives.

To the degree that predictive measures are not ideal, we must judge the value of a predictor by taking into consideration the relative number of false-positives and misses and decide whether we want a conservative predictor or one which is more liberal. For example, in terms of physical risk involved in surgery, expenses, and so on, we would not want to consider secondary management for a child if he did not need it. In this regard,

TABLE 4. Results of using a combination of all three measures, clinical judgment, x-ray rating, and articulation score to predict secondary palatal management.

prediction	*treatment*		*prediction total*
	flap received	*flap not received*	
Flap predicted	17%	0%	17%
Flap not predicted	8%	75%	83%
Treatment total	25%	75%	100%

a conservative predictor is one which leads to relatively few false-positives regardless of the number of misses. If we are more concerned about the child's speech and have reason to believe surgical risk is minimal, we may choose a more liberal approach. In this case, we want a predictive measure that leads to relatively few misses while the number of false-positives is of secondary importance as long as the number is reasonable.

Considering the three predictive measures individually and in all possible combinations, it was found that the predictor closest to the ideal was a combination of articulation score and x-ray rating. Each of the measures alone or in combination resulted in no more than 10% inappropriate predictions. The most conservative predictor was the clinical judgment rating whether or not it was combined with the other measures.

In practice there are many patients who exhibit a marginal mechanism and the question of secondary management is important. If adequate predictors can be formulated, the need for trial therapy periods and indecision concerning management procedures can be reduced. We view this study as a preliminary attempt in the study of prediction of management. It is possible that other measures might be better predictors. Furthermore, since our goal in cleft palate management with regard to speech is to provide the child with an adequate physiological mechanism at the earliest possible age, it is desirable that we make an accurate prediction concerning flap management while the child is still very young. In the future, we plan to continue our search for predictive measures and to determine whether these measures may be utilized at an early age in life.

Summary

The question posed in this study was, are there measures which are predictive of the need for further palatal management? Articulation scores, lateral x-rays and clinical judgments of velopharyngeal competency were examined for 75 subjects in retrospect to determine their predictive value. Each of the measures resulted in at least 90% appropriate predictions. The combination of articulation score and lateral x-ray rating appeared to be the best predictor for this particular sample in that subsequent treatment

was correctly predicted for 96% of the subjects. We view this study as a preliminary attempt in the prediction of further management and in future studies will consider age at the time of prediction and other possible predictor variables.

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