Bulb Fitting and Placement in Prosthetic Treatment of Cleft Palate

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Prosthetic facilitation of palatopharyngeal closure involves careful fitting and placement of the prosthesis, particularly the bulb portion. Presumably the bulb is fitted so that during speech and during other acts that require closure, the walls of the pharynx and sometimes the palate make contact with the bulb. At other times an airway into the nasal passages is maintained (*10*). The prosthodontist also undertakes to place the bulb above the palate plane in order to take advantage of maximal pharynx movement (*1*) and to reduce interference with tongue movement in articulation (*10*).

This paper is concerned with assessment by cinefluorography of the fitting and placement of the bulb and with the relationship between articulation and palatopharyngeal closure for children with palatal defects which have been prosthetically managed. The specific goals are: a) to describe from cinefluorographic film the movement of the posterior pharyngeal wall and the movement of the palatal tags or palate in closure against the obturator during speech by a sample of cleft palate children; b) to determine the relationship between bulb-posterior pharyngeal wall contact and articulation and to compare the articulation of subjects with more extensive contact with that of subjects having less extensive contact; c) to determine the relationship between an index of bulb size and articulation and to compare the articulation of subjects with larger bulbs with that of subjects having smaller bulbs; d) to determine the relationship between bulb height above a designated reference plane and articulation and to compare the articulation of subjects whose bulbs extend high above the plane with that of subjects whose bulbs extend less far; and e) to determine the relationship between bulb extension below a designated plane and articulation and to compare the articulation of subjects whose bulbs extend farthest below the plane with that of subjects whose bulbs extend less far below the plane.

All observations and measurements were made from cinefluorographic film in lateral projection. Such film permits the needed assessment of the relationship between obturator bulb and posterior pharyngeal wall in

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midline, but since the film is limited to only two planes it does not provide information about bulb-tissue relationships lateral to midline.

Procedure

SUBJECTS. Nineteen cleft palate children, 13 boys and six girls, who ranged in age from seven years, 10 months to 12 years, 11 months at the time of filming served as subjects for this study. Each had been treated prosthetically to facilitate speech. The subjects were filmed and recorded as they came into the cleft palate clinic. For certain analyses the film of only 17 subjects could be used. Among the subjects were persons who had previously undergone surgical repair of cleft palate and others for whom the appliance was the only method of palate repair provided. All subjects wore fixed speech appliances. Where the soft palate had previously been repaired surgically, the bulb was attached to the palate portion by means of a metal strip. When classified according to the Veau system, two subjects had class I clefts, two had class II clefts, eight had class III clefts, and seven had class IV clefts. All subjects except one had average or higher intelligence as measured by the Peabody Picture Vocabulary Test. The single exception had a Peabody IQ of 60.

ARTICULATION. Articulation skills were measured by use of a 67-item single word articulation test involving all single consonants except /h/ as they appear at the beginning, middle, and end of words. Each response was judged to be either correct or incorrect from tape recordings. Percentage of responses correct was used as the articulation score. The articulation testing procedure was described in detail in previous reports (*7*, *8*). The mean articulation score for the total group was 72% with a range from 34.32% to 97.01%.

FILMING AND FILM ANALYSIS. Filming was done with a Phillips cinefluorographic unit containing a nine-inch screen, image intensifier, and dynapulse. The principal items of film analysis equipment were a Perceptoscope variable speed projector and a tracing cabinet. This equipment and techniques for its use have been described elsewhere (*3*, *4*, *5*, *6*, *9*).

The film of each child included the same sequence of activities: a) the act of swallowing barium; b) phonation of the vowels and consonants /ɑ/, /*i*/, /u/, /s/, /z/, /p/, /b/; c) phonation of the syllables /*s*is/, /sɑs/, /*t*it/, /tɑt/; d) phonation of the sentences, *He gave me a beet to eat, The cars are parked on the arcade,* and *See Lee sleeping by the seat;* e) the act of blowing into a manometer; f) counting from one through six; and g) swallowing barium. The subjects were stopped after each unit.

MEASUREMENTS. Except for the swallowing sequences, the film was examined in its entirety from slow motion projection. For those subjects who showed an open space between the bulb and the posterior wall of the pharynx during phonation or rest, the projector was stopped on a suitable frame and the maximum distance observed for each condition

was measured and recorded. Where no space was present either during phonation or rest, the fact was noted. Measurement of the vertical dimension of each bulb, which was used as an index to total bulb size, was made from any clear frame and measurements of extent of bulb-posterior pharyngeal wall contact, height of bulb above a plane, and depth of bulb below that plane were made from a frame showing the subject during phonation of /aɪ/ in the word *by* in the third sentence. (The first frame of maximal mandible descent after phonation of the /b/ in the word *by* was chosen for the measurement because it was easy to identify.) The four measurements were made as follows. *Extent of Contact:* a caliper was used to measure the length of contact between the bulb and the posterior pharyngeal wall. This was accomplished by measuring the distance between the superior and inferior points where the bulb and pharyngeal wall broke contact. *Bulb Size:* bulb size was defined by caliper measurement of the greatest distance between the most superior and most inferior points of the bulb as viewed in the cinefluorographic film. *Height above Plane:* the caliper was used to measure the distance extended by the bulb above a plane drawn from the anterior tubercle of the atlas to the anterior nasal spine. The two points used in this measurement were in a perpendicular or right angle orientation to the reference plane. *Depth Below Plane:* the measurement of depth below the designated plane was similar to the preceding measure except for direction. However, because of the irregular form of the bulb, one measure was not a linear extension of the other.

Correlation coefficients (Spearman rank order, *11*) were computed between each of the four measurements described above and the measurement of articulation. Also, for each measurement the subject group was divided into a high measure group and a low measure group, omitting entirely the middle subject (for that measure). For each measure the articulation of the high group was compared with that of the low group for difference in central tendency by use of the Mann Whitney U test (*11*).

Reliability

All observations and measurements used in this study were done twice, once by each author. Reliability of closure pattern judgment was obtained by comparing the observations of each judge. One investigator found 68% of the 19 children to have closure of the obturator against the posterior pharyngeal wall at all times whereas the second observer described 84% of the subjects as having continual contact. Thus the two judges disagreed on three out of 19 judgments.

Spearman rank order correlation coefficients and Wilcoxon Matched-Pairs Signed-Ranks tests were computed for the four duplicate measurements (*11*). Spearman correlations for each pair of measurements were as follows: extent of contact, .86; bulb size, .92; height above

plane, .94; and depth below plane, .73. Each correlation was significant at or beyond the 2% level. The Wilcoxon Test for difference in central tendency indicated that none of the differences between the sets of measurements were significant. This relatively good agreement for the measurements involving the plane between the anterior tubercle of the atlas and the anterior nasal spine was surprising since the anterior landmark for the construction of the plane appeared to be generally obscure in the films.

Results

The results reported below are based on the observations and measurements made by the senior author. Her tabulation of the frequency of occurrence of continual bulb-posterior pharyngeal wall contact was the more conservative.

Closure Patterns. Thirteen of the 19 children had continual closure of the obturator against the posterior pharyngeal wall throughout the filming. This contact was continual whether or not the subjects were phonating. Each of the remaining six children had a small opening between the bulb and the pharyngeal wall at least occasionally when in the neutral or rest position. The average amount of maximum opening was 1.4 mm. Two of these six children had an average bulb-pharyngeal wall gap of 1.25 mm while phonating. Five of the children exhibited some rocking motion of the bulb caused by tongue or palate contact. In eight of the children movement of the hemi-palate or surgically repaired palate was observed. In one of these subjects, palate movement closed a gap that otherwise existed between the palate and the bulb.

Bulb-posterior Pharyngeal Wall Contact and Articulation. A Spearman rank order correlation coefficient was computed to measure the relationship between extent of bulb-pharyngeal wall contact and articulation. The obtained coefficient of .11 was not statistically significant. The Mann Whitney U which was computed to determine whether subjects with greater contact between the obturator and posterior pharyngeal wall differed in articulation from those with less contact was so large that the probility associated with its occurrence was not statistically significant. Thus the two groups were not significantly different in articulation. The average extent of bulb-pharyngeal wall contact was 17.76 mm for the total group. The measurement ranged from 2.5 mm to 28.2 mm.

Bulb Size and Articulation. A Spearman r of .03 was obtained for the measures of bulb size and articulation. The Mann Whitney U Test indicated that the group with larger bulbs did not differ significantly in articulation from the subjects with smaller bulbs. The average bulb size as measured was 23.64 mm with a range from 16.4 to 31.3 mm.

Height above Plane and Articulation. A Spearman correlation of .57 was obtained for the height-above-plane measures and the artic-

ulation scores. This coefficient was significant at the 2% level. The Mann Whitney U Test applied to articulation scores of subjects whose speech bulbs extended high above the plane as contrasted with the group whose bulbs extended less high resulted in a U of 15 which was significant at the 5% level. Subjects whose bulbs extended less high tended to have better articulation scores. The mean height of the bulb above the plane was 14.16 mm for the total group with a range from 8 to 19.5 mm.

Depth below Plane and Articulation. A Spearman correlation coefficient for the measure depth of bulb extension below the designated plane and articulation score was .49 which was not significant at the 5% level. Nor was the Mann Whitney U for difference between bulb extension groups significant. The group whose bulbs extended lower did have a tendency to have the better articulation scores. The mean depth of the bulb below the designated plane was 7.25 mm for the 17 subjects (for whom films were available). The measurements ranged from 2 mm to 14.5 mm. It is emphasized that the two measures utilizing the plane are independent of one another.

Discussion

The majority of the children in the present study had continual contact of the obturator bulb against the posterior pharyngeal wall during rest and phonation. This suggests that the bulbs may not permit nasal respiration; however, the children may have passages lateral to midline that permit nasal breathing. It would be interesting to know whether the persons with continual closure are habitual mouth breathers.

The subjects in this study all regularly attended a cleft palate clinic where the prosthodontist utilizes speech pathologists' recommendations in fitting and adjusting the obturators. Probably the continual bulb-posterior pharygeal wall contact is a result of the speech pathologists' requests that the bulbs be enlarged to enhance speech learning. Such enlargement may well enhance responsiveness to speech instruction, but the speech pathologist should determine if good articulation once acquired can be maintained even though the bulb is reduced (*2*).

Five children out of the 19 in the current study were observed to have some movement of the speech bulb during phonation even though the appliances were all of the fixed type. This displacement is reportedly undesirable from the dental point of view because it results in wear and strain on the teeth. In one subject, closure was achieved by the palate contacting the bulb and pushing it against the posterior wall of the pharynx. The appliance movement observed occurred even though the subjects all receive frequent prosthodontic care. We wonder if the children who displace their bulbs by tongue pressure are persons who were urged to speak well when their speech mechanisms were inadequate for the task. Perhaps the tongue bumps the bulb frequently because of learned compensatory tongue movements.

The measurements and statistical comparisons made in this study indicate that bulbs with less bulk are associated with articulation that is as good as that present in persons whose bulbs are larger. Similarly, relatively small bulb-posterior pharyngeal wall contact appears to facilitate articulation as well as does greater contact. The relationship between articulation and bulb height in relation to a designated plane is greater than the relationships between articulation and bulb size or extent of contact. Ultimately, of course, the bulb must be molded into a space surrounded by mobile tissue. The size and shape must accommodate that tissue and at the same time facilitate closure adequate to support good oral breath pressure during speech. From the results of the four measures in the present study, the bulb should be formed and positioned so that the posterior and lateral pharyngeal walls can contact it, but any material not contributing to this objective should be removed. Some of the bulbs appeared to have more cephalad to caudad bulk than necessary for closure. In keeping with the findings of Abram and Subtelny (*1*) the bulb should be located high enough to take advantage of maximum pharyngeal wall movement, but it should not extend farther than necessary for this accomplishment. The caudad portion of the bulb should not extend so low that it interferes with tongue movement. The measurements used do not indicate where the bulb-pharyngeal wall contact occurred in relation to palate plane, nor does this study yield findings which pertain to the width of the bulb. It may be more difficult to trim excess material from the bulb of the open cleft patient than from bulbs attached to wires molded to fit under palates. In the former instance the bulb is a direct extension of the palate portion of the prothesis which must be fitted carefully against palate halves.

Several points about procedure seem relevant. First, it is important that speech bulbs be wrapped in foil for cinefluorographic study. Otherwise they are very difficult to visualize on film. However, barium placed in the noses of these subjects was of no help at all. Indeed, it sometimes obscured the region of the anterior nasal spine. Use of a template made from a still x ray might facilitate identification of the anterior nasal spine in cinefluorographic film. Bulb size could have been more adequately measured by noting amount of water displacement resulting from immersion of the bulb.

In future studies of obturation and articulation, it would be desirable to fit the bulb to the experimenter's criteria and then to manipulate the subject's articulation responses by application of specific teaching programs.

Summary

This study was concerned with cinefluorographic assessment of the fitting and placement of obturator bulbs in cleft palate children and with the relationship between articulation and palatopharyngeal clo-

sure. Films of 19 children were utilized for the analyses. The majority of the subjects were observed to have continual closure of the bulb against the posterior pharyngeal wall during rest and/or phonation throughout the film. In five of the subjects the obturator was observed to be displaced by tongue or palate movement. Correlations were obtained between articulation scores and measurements of extent of bulb-posterior pharyngeal wall contact, bulb size, extension of bulb above a designated plane, and extension of the bulb below that plane. The subjects with high readings on each measure were compared for articulation skill with the subjects having low readings. The only statistically significant results involved the height above plane measure.

The conclusion was reached that the bulb should be formed and positioned so that it can be contacted by the posterior and lateral pharyngeal walls. Any material not contributing to this objective should probably be removed. The bulb should be located high enough to take advantage of posterior pharyngeal wall movement, but it should not extend higher than necessary to meet these requirements.

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