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Effect of neonatal laryngoscopy and endotracheal intubation on palatal symmetry in two- to five-year-old children

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Abstract

Although neonatal laryngoscopy and endotracheal intubation have a potential of causing palatal deformation, it is not known whether such effects are persistent. Measurements of stone casts of 31 prematurely born, low birth-weight, intubated, 2- to 5-year-old children and 18 similar nonintubated children showed no asymmetry of the palate in the intubated group compared with the nonintubated group. Also, palatal symmetry did not appear to be affected by the length of intubation. Growth and remodeling of the palate probably repair any deformation of the palate resulting from the intubation process.

Laryngoscopy and endotracheal intubation often are required in the neonatal period for prematurely born, very low birth-weight infants to manage respiratory distress. However, complications can arise from these procedures, many of which are traumatic. These include laryngeal edema and tracheitis[1] and tracheal stenosis.[2] An important oral complication is notching of the alveolar ridge caused by continual trauma of the tube abutting against it.[3-5] In addition, hypoplasia of the maxillary anterior teeth has been reported.[6-7] Recently, Nowak and Erenberg found that 61% of low birth-weight, intubated premature infants had either a palatal or alveolar ridge groove when examined at about 23 days after birth.[8]

Thus, it is well established that endotracheal intubation has a potential of altering palatal configuration in the neonatal period. However, no long-term studies have been done to determine whether such alterations of palatal shape are persistent. This study examined palatal and dental arch symmetry in a group of 2- to 5-year-old, very low birth-weight children who were born prematurely and intubated in the neonatal period, to determine the effects of laryngoscopy and endotracheal intubation on palatal and arch symmetry.

Patients and Methods

The patients in this study were children attending the Growth and Development Clinic of the Mater Children's Hospital, South Brisbane. This clinic, established in 1978, provides a multidisciplinary follow-up of all surviving infants of low birth weights managed at the Mater Mother's Hospital.[9,10]

Of 63 children who were available for study, palatal impressions were obtained from 49 children (23 males and 26 females). All were prematurely born, with birth weights between 605 g and 1500 g (mean 1213 g). Eighteen received endotracheal intubation and mechanical ventiliation in the neonatal period, while 31 did not. At the time of dental examination, the ages of the children ranged from 26 months, to 5 years, 5 months (mean 3 years, 3 months). None of the patients in this study had any neurological abnormalities or facial dysmorphology (one child with cleft palate was excluded). In addition, a history of constant thumb or finger sucking up to a year prior to the dental examination excluded a patient from the study. Also, no children in the study had undergone further episodes of intubation since leaving the hospital after birth.

The dental examinations were performed under ideal conditions at the University of Queensland Dental School. Obvious palatal defects such as grooves, as well as dental defects were recorded in a comprehensive chart. Postnatal medical and dental histories were obtained from the parents. Maternal and neonatal medical histories were obtained from hospital records.

A compound maxillary impression supported on a plastic spoon was taken of each patient (Fig 1). Stone models later were formed from these impressions.

Palatal asymmetry can be expected to be accompanied by arch asymmetry. Since trauma from the laryngoscope and orotracheal tube is observed mainly in the alveolar part of the palate, any palatal distortion would manifest primarily as arch distortion. Arch asymmetry can be measured by comparing the location of corresponding selected reference points on a pair of contralateral teeth. The spacial location of the reference point on each tooth can be determined by the values of the x, y,and z coordinates of the Cartesian scale, with reference to a particular fixed plane (Fig 2). Comparison of the coordinates of the reference point on a tooth with that of the tooth on the other side of the arch will show discrepancies of the arch form in three dimensions; the horizontal (x coordinate), vertical (y coordinate), and depth (z coordinate).

The teeth at which measurements were taken were the primary lateral incisors, canines, and first molars. Since the second primary molars had not erupted in all subjects, measurements were not taken at these teeth. The reference point on each tooth on the model was located on the gingival margin by drawing tangents to the mesiopalatal and distopalatal surfaces and projecting a line bisecting the angle of their intersection to the gingival margin. These reference points were marked on the model. In addition, the median palatal raphe also was marked and used as a reference line to determine symmetry of the palate and dental arch in the horizontal dimension. As there are no absolute reference points, the combined palatal and dental arch symmetry is assessed by these measurements hereafter called palatal and arch symmetry. Measurement from the cusp tips was not made because it was considered that some distortion of the compound impression may have occurred in that region.

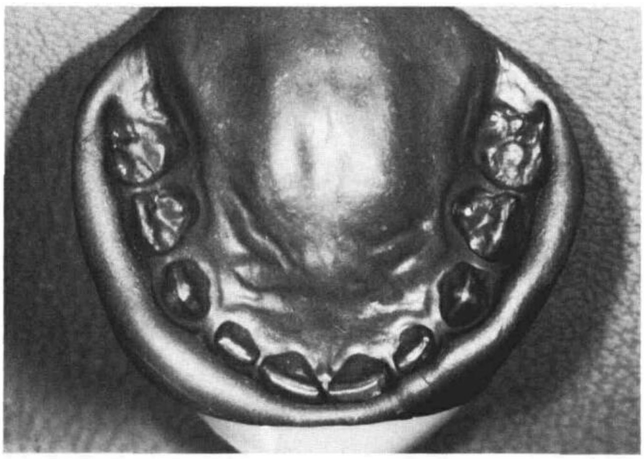

FIG 1. Maxillary compound impression taken of a three-year-old girl in the study. The impression was supported on a plastic spoon.

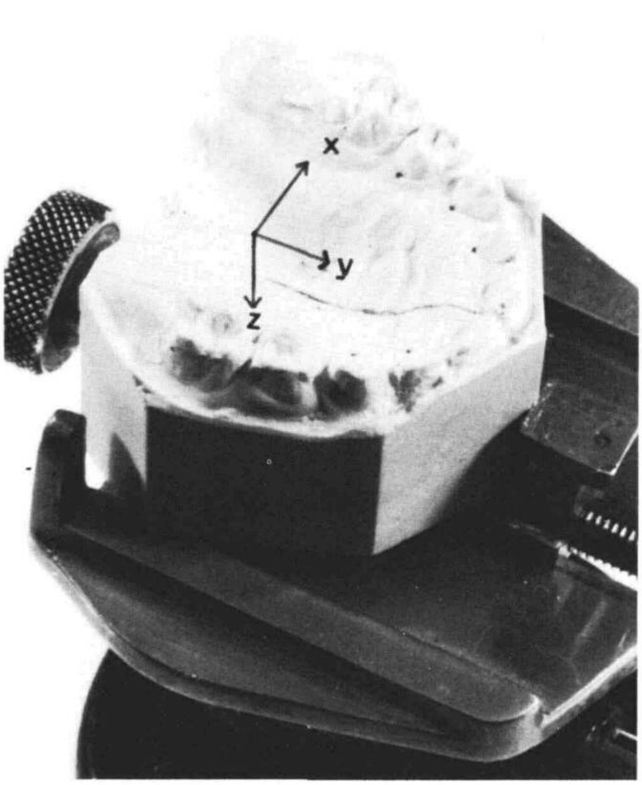

FIG 2. Dental model mounted on an adjustable stand in preparation for measurements to be taken at the Olivetti-Inspector machine. The x, y, and z axes of the Cartesian coordinate system have been drawn in the photograph to depict the relationship of the reference points to these axes.

The reference point on the right primary lateral incisor is designated B_1 and that on the left incisor is B_2 (Fig 3). The point on the median raphe on the same x axis as B_1 is designated B_4 and that on the same x axis as B_2 is B_3. Thus the x coordinate of B_4 (xB_4) minus the x coordinate of B_1 (xB_1) will give the width of B_1 to the midline raphe. Similarly xB_2 minus xB_3 will give the width of B_2 to the midline raphe. The difference of these two widths measures palatal and arch asymmetry horizontally at the two reference points.

Similarly, the difference in the y coordinates of B_1 and B_2 measures palatal and arch asymmetry vertically; the difference in the z coordinate measures palatal and arch asymmetry in depth. The horizontal reference plane for the z measurements was that defined by D_1, D_2, and the incisive papilla.

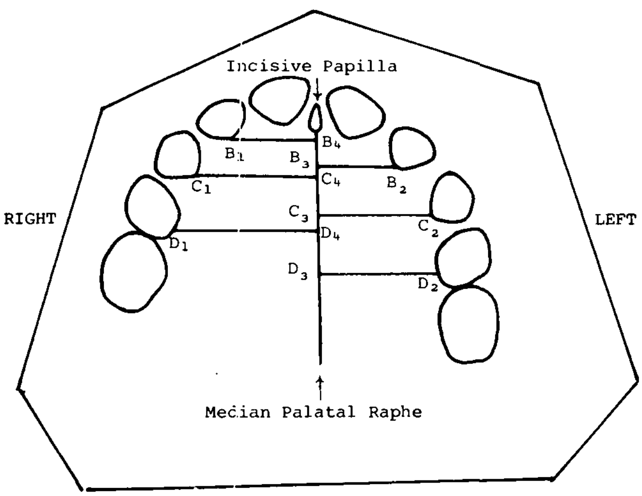

Fig 3. Diagrammatic representation of a maxillary dental cast used in the study, depicting the reference points on the teeth and the median palatal raphe.

Reference points on the other teeth were numbered correspondingly and similar determinations of differences at the various locations were computed. The data were analyzed using the Student's *t* test to determine statistical differences between the groups.

The *x*, *y*, and *z* coordinates of each reference point on a tooth can be determined directly using the Olivetti Inspector machine,[a] located at the Telecom Workshop at Bulimba, Queensland. This is an advanced measuring device which permits fast and accurate measurement of dimensions and marking of production pieces in engineering (Fig 4). Essentially, it allows direct measurement of dimensions on the three Cartesian axes on a millimeter scale with high accuracy. For this study, measurements were taken to the nearest .1 mm. The measurements are read directly on a display panel. In addition, the machine can reset each axis in any point of the travel, and can lock on each of the three axes. The machine calibration was checked against a millimeter scale for each of the three axes prior to taking any measurements.

Before measurements were taken of a model, it first was mounted on a stand with an adjustable table. The points D_1, D_4, and the center of the incisive papilla were made coplanar and all measurements were made relative to this plane.

To determine the accuracy of the impression method and of the measurements of the palate, a preliminary experiment was performed. Three patients (aged 3 years, 2 months; 3 years, 1 month; and 4 years, 5 months) not forming part of the study population had maxillary compound impressions taken, employing a technique identical to that used in the study.

[a] Olivetti Australia Pty. Ltd., Bowen Hills, Queensland, Australia.

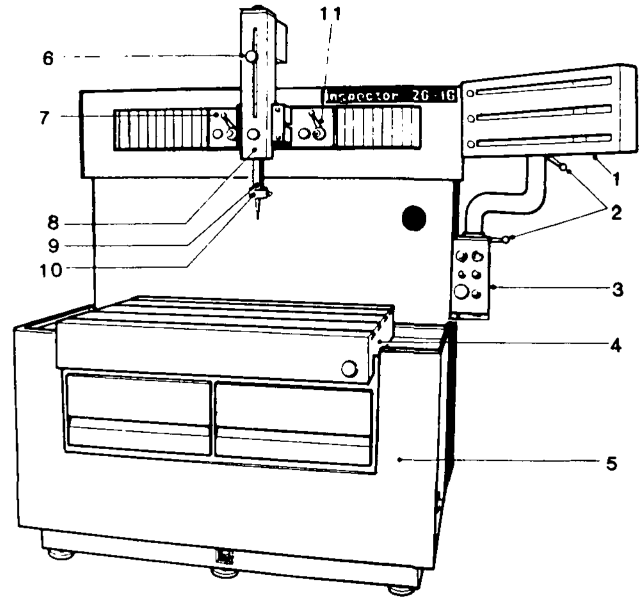

Fig 4. Diagrammatic representation of the Olivetti-Inspector machine used for palatal measurements. Key to diagram:

1. Display of measurements in *x*, *y*, *z* coordinates
2. Locks for display units
3. Switch on panel
4. Worktable
5. Electronic processing unit
6. Lock for *z* axis
7. Lock for *x* axis
8. *x* axis unit
9. *z* axis quill
10. Hand grip
11. Lock for *y* axis

Two impressions were taken from each of these patients and each stone model was measured three times.

Table 1 shows the results of the preliminary experiment. The accuracy of the measuring technique was shown by the small standard deviation (0.1-0.4 mm) of three measurements taken of any one model.

In addition, the reproducibility of the impression and model-forming methods was established as follows. The mean differences between the left and right reference points on each model were compared to that of another model taken from the same patient. These differences measure the symmetry of the palate and arch of each model at the various reference points. As shown in Table 1, comparison of these measurements of symmetry of the two models taken from each patient showed no statistical differences between models ($p > 0.1$). This was true for all measurements taken at all Cartesian axes of reference.

Results

No palatal grooves were observed on clinical examination of the 31 children intubated during the neonatal period.

Table 2 shows the measurements of palatal and

TABLE 1. Palatal Symmetry in Patients in Preliminary Experiment: Validation of Method

Model	*Reference Teeth*	*Mean difference (mm ± SD of 3 measurements) between reference points on the contralateral teeth indicated, taken at each Cartesian axis of reference*		
		x	*y*	*z*
Patient 1				
First model	D | D	1.2 ± 0.3*	0†	0†
Second model		1.2 ± 0.1	0†	0†
First model	C | C	0.6 ± 0.2	0.2 ± 0.1	0.2 ± 0.2
Second model		0.6 ± 0.3	0.6 ± 0.3	0.2 ± 0.1
First model	B | B	0.6 ± 0.2	0.4 ± 0.1	0.1 ± 0.1
Second model		0.4 ± 0.2	0.3 ± 0.2	0.1 ± 0.1
Patient 2				
First model	D | D	1.1 ± 0.2	0†	0†
Second model		1.1 ± 0.4	0†	0†
First model	C | C	0.3 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Second model		0.6 ± 0.3	0.1 ± 0.1	0.1 ± 0.1
First model	B | B	0.3 ± 0.3	0.3 ± 0.2	0.1 ± 0.1
Second model		0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.2
Patient 3				
First model	D | D	1.5 ± 0.2	0†	0†
Second model		1.2 ± 0.2	0†	0†
First model	C | C	0.7 ± 0.3	0.3 ± 0.3	0.3 ± 0.1
Second model		0.5 ± 0.4	0.4 ± 0.2	0.2 ± 0.2
First model	B | B	0.5 ± 0.4	0.3 ± 0.2	0.2 ± 0.2
Second model		0.6 ± 0.4	0.3 ± 0.2	0.3 ± 0.1

* The standard deviation indicates the degree of measurement error of the three measurements taken of each model.
Set to zero to provide a reference point for other measurements.
Comparison between the two models from any one patient showed no statistical difference with regard to each Cartesian axis of reference.

arch symmetry in the intubated and nonintubated groups of children. As determined by Student's *t* test, there are no significant differences between the location of a reference point on a tooth on the right side compared to that on the tooth on the left. These reference points showed no significant differences in the Cartesian axes, indicating that the palate and arch are symmetrical at all these reference points ($p > 0.1$). The possibility that positive palatal asymmetry could be compensated for by complementary negative arch asymmetry is highly unlikely, since the forces tending to produce both act in the same direction.

To examine the possible effects of the length of intubation on palatal and arch asymmetry, the palatal measurements of a group of 13 children intubated for 3-10 days were compared with 9 children who were intubated for more than 20 days. As can be seen in Table 3 there were no significant differences in the measurements between these two groups ($p > 0.1$), *indicating that the length of intubation does not affect* palatal asymmetry.

The group of eight children who had endotracheal intubation for less than a day would have been subjected to the effects of the laryngoscope, but would have had minimal effects of the endotracheal tube. Comparison between this group and the nonintubated group again showed no statistical difference in the measurements of palatal symmetry ($p > 0.1$, Table 4), showing that limited use of the laryngoscope alone is not likely to affect palatal and arch symmetry.

The standard deviations of the measurements in most of the study groups are larger than those of the measurements in the preliminary validation of data experiment. This indicates that the potential exists to detect differences in the measurements in the study groups, taking into account measurement errors. Therefore, such differences did not in fact exist, and palatal and arch symmetry between both groups of intubated and nonintubated children was demonstrated.

Table 2. Measurements of Palatal Symmetry

Group	Reference Teeth	Mean difference (mm ± SD) of reference points on the contralateral teeth indicated, taken at each Cartesian axis of reference		
		x	*y*	*z*
Intubated	D | D	0.9 ± 0.7	0*	0*
Nonintubated		0.7 ± 0.5	0*	0*
Intubated	C | C	0.8 ± 0.7	0.5 ± 0.4	0.2 ± 0.1
Nonintubated		0.7 ± 0.5	0.5 ± 0.4	0.3 ± 0.2
Intubated	B | B	0.4 ± 0.3	0.4 ± 0.2	0.2 ± 0.2
Nonintubated		0.5 ± 0.4	0.4 ± 0.3	0.2 ± 0.2

The difference between intubated and nonintubated children were insignificant at all the reference points, in all three dimensions ($p > 0.1$).
* Set to zero.

Table 3. Effect of Length of Intubation on Palatal Symmetry

Group*	Reference Teeth	Mean difference (mm ± SD) of reference points on the contralateral teeth indicated, taken at each Cartesian axis of reference		
		x	*y*	*z*
Group 1	D | D	0.9 ± 0.5	0	0
Group 2		0.9 ± 0.6	0	0
Group 1	C | C	0.8 ± 0.8	0.6 ± 0.4	0.3 ± 0.2
Group 2		0.5 ± 0.5	0.6 ± 0.5	0.4 ± 0.2
Group 1	B | B	0.4 ± 0.3	0.5 ± 0.3	0.2 ± 0.2
Group 2		0.4 ± 0.4	0.3 ± 0.3	0.3 ± 0.2

The differences between the groups were insignificant at all the reference points in all three dimensions ($p > 0.1$).
* Group 1 (N = 13) were intubated for 3-10 days.
Group 2 (N = 9) were intubated for 20-64 days.

Table 4. Effect of Short-Term Intubation (< 1 Day) on Palatal Symmetry

Group	Reference Teeth	Mean difference (mm ± SD) of reference points on the contralateral teeth indicated, taken at each Cartesian axis of reference		
		x	*y*	*z*
Intubated for < 1 day (N = 8)	D | D	0.9 ± 0.7	0	0
Nonintubated (N = 18)		0.7 ± 0.5	0	0
Intubated for < 1 day	C | C	1.0 ± 0.8	0.4 ± 0.3	0.2 ± 0.2
Nonintubated		0.7 ± 0.5	0.5 ± 0.4	0.2 ± 0.1
Intubated for < 1 day	B | B	0.5 ± 0.4	0.3 ± 0.3	0.1 ± 0.1
Nonintubated		0.5 ± 0.4	0.4 ± 0.2	0

The differences between the groups were insignificant at all the reference points in all three dimensions ($p > 0.1$).

Discussion

Various types of equipment have been devised by researchers over the years to measure palates. Korkhaus invented the symmetrograph (1930) which transcribes actual palatal shape in two dimensions onto a piece of paper mounted vertically.[11] Lebret used this method successfully (1962) to measure growth changes of the palate.[12] Redman et al. used a specially constructed device which measures the height, width, and depth of palates directly in the mouth (1966).[13] This device requires much cooperation from the patient and would not be suitable for young children.

Van der Linden suggested measurement of dental casts using a three-dimensional coordinate system with a device called the Optocom.[14] The Olivetti-Inspector machine used in this study measured the dental casts using a similar principle, but it is a more sophisticated and accurate machine. Its technique of measurement is simple, and is the most suitable and accurate device available for palatal measurements in young children.

The results of the preliminary experiment indicated that the impression-taking and model-pouring method used in this study is accurate and reproducible. Impression taking in 2- or 3-year-old children requires skill in patient management, and the impression technique of using compound supported on a plastic spoon appeared to be very well accepted by all patients in this study. Other authors also have used compound impressions to study palate shapes in children successfully.[8,12]

The fact that laryngoscopy and endotracheal intubation can have traumatic effects on the oral tissues in the neonatal period has been established. Various authors have observed the development of grooves on the alveolar ridge and palate in infants who were intubated after birth.[3-5,8] In addition, dilaceration of a developing incisor tooth germ was reported in the study of Boice et al., implicating a displacing force in the anterior alveolar region.[3] This traumatic force could have resulted from the application of either the laryngoscope or endotracheal tube during the neonatal period. The incidence of hypoplasia of the teeth associated with laryngoscopy and endotracheal intubation provides further proof of trauma resulting from these procedures.[6,7]

Although laryngoscopy and endotracheal intubation have a potential for causing palatal deformation, this study has shown that no palatal and arch asymmetry is evident in 2- to 5-year-old children intubated in the neonatal period. No significant differences were found in the measurements taken on the left and right sides in both intubated and nonintubated groups. In addition, the length of intubation does not appear to affect palatal symmetry.

Growth changes and remodeling of the palate and alveolus in the first few years of life probably correct any deformation caused by laryngoscopy and endotracheal intubation. That growth changes can allow for remodeling of the palate is seen in patients with thumb or finger sucking habits. Most cases of uncomplicated palatal deformities resulting from digit sucking are resolved once the habit is discontinued.[15]

Conclusions

This study has shown that no palatal or arch asymmetry is evident in 2- to 5-year-old children who had neonatal laryngoscopy and endotracheal intubation compared to a group of nonintubated children. This finding indicates that although laryngoscopy and endotracheal intubation have a potential to cause palatal and arch deformation, there are no persistent detrimental effects on these structures.

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Quotable quote: smoking and ulcers — time to quit

Since the turn of the century evidence has been accumulating that peptic ulcer and smoking are associated strongly. Much of this evidence is analyzed in the Surgeon General's 1979 report, *Smoking and Health*. The report concludes that there is an increased frequency of smoking in patients with duodenal and gastric ulcer as compared with controls, that there is a significantly increased (about twofold) prevalence of both duodenal and gastric ulcers in smokers as compared with nonsmokers, that the magnitude of the increased prevalence increases with the number of cigarettes smoked, that smoking retards the healing of gastric and duodenal ulcers, and that mortality from peptic ulcer is higher in smokers (especially male smokers) than in nonsmokers. Nothing has changed these conclusions, but additional studies, recently summarized, have helped to resolve some lingering doubts about the causal relation between smoking and ulcer disease.

The large study reported by Sontag and collaborators in this issue of the *Journal* indicates that recurrences of duodenal ulcer are more common in smokers than in nonsmokers during placebo (>threefold) and cimetidine (>twofold) therapy.

Physicians who still insist that undeniable evidence of association is not proof of causation should instruct their patients with ulcers to "disassociate" themselves from smoking. Naught but good can come of it. Predictably and unfortunately, many will choose cimetidine maintenance therapy over a smokeless life.

McCarthy DM: Smoking and ulcers — time to quit. N Engl J Med 311:726–27, 1984.