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The effects of forceps delivery on facial growth

Nicholas Germane, DMD Loretta Rubenstein, DDS

Abstract

Postnatal growth of the face is a composite function of genetic and environmental factors. A sudden traumatic insult due to the use of forceps at birth could have long-term effects which could detrimentally influence growth and development. This study examines the development of the skeletal and dental components of forceps vs. non-forceps-delivered patients. The association between delivery methods as related to TMJ problems, bruxism, posterior crossbites, and molar arch width differences was evaluated in 16 forceps-delivered and 29 naturally delivered patients. Results showed no statistically significant difference between delivery method and TMJ problems, posterior crossbites, bruxism, or molar arch width. It was noted that the non-forceps group had a higher incidence of posterior crossbite and narrower molar arch width. The forceps-delivered group had a higher percentage of bruxism and TMJ pain and/or noise. It was also noted that the small sample size may have influenced the statistical relationships.

Introduction

The use of obstetrical forceps in medical history can be traced as far back as 1720, when they were first introduced as a new approach in aiding delivery (Shute 1973). The primary function of forceps is to apply traction, mimicking the normal birth mechanism (Mines 1970). Any excess pressure applied with the forceps handles causes compression of the forceps on the fetal head and may lead to tissue damage. In a random series of deliveries the average maximum traction using two different types of forceps was 43.5 pounds, while the average maximum compressive force against the fetal head was 4.55 pounds (Pearse 1972).

The head, being the most common presenting part of the body during delivery, is subject to more trauma than any other part of the fetus. The most frequently seen head injuries after birth are cephalomatomas, skull fractures, intracranial hemorrhages, and peripheral nerve injuries (Rubin 1964). Fractures may involve the internal and external auditory canal and may be seen passing through the temporomandibular joint and the mastoid or sigmoid plates (Kornblut 1974). Since normal anatomy is not fully completed at birth, these injuries may lead to an anomalous development of the injured nerves or tissues (Bresnan 1971).

Facial nerve injuries, which manifest as facial palsy or paralysis, are seen after difficult or instrument deliveries. This injury is not uncommon, because in infant's skulls the mastoid process is absent or poorly developed, and the facial nerve emerges directly from the stylomastoid foramen onto the lateral surface of the skull. Compression of this area can cause bruising or laceration of the nerve. Improvement is usually seen in 3 to 4 days, and function should return in 3 to 4 weeks (Bresnan 1971). One study showed that following facial nerve injury 16% of infants had facial weakness and atrophy which persisted for 30 to 42 months (Rubin 1964). Damage to the neurotropic factor of the growth process can lead to changes in the transport of neurosecretory material through the network of nerves. The neurotropic factor is a network of nerves that link feedback mechanisms of the functional matrix system for normal muscle and bone development (Enlow 1982).

Postnatal growth of the human face is a composite function of many variables. Intrinsic factors, such as genetic and endocrine effects, and extrinsic factors, such as nutrition and trauma, can act to alter growth. The effect of nutrition generally has to be long term to influence growth, whereas a sudden insult due to trauma can have long term effects on growth even though it is of short duration. Any changes in growth can cause malformations of the face and cranium, which in turn, can detrimentally influence the individual's ability to function physiologically and psychologically (Linn 1966).

A prevailing theory of growth of the face is that the genetic and epigenetic determinants of skeletal development occur in response to chronological and morphological events occurring in non-skeletal tissues, organs, and functioning spaces (Moss and Salentijn 1969a and b). Epigenetic regulation of the craniofacial skeletal entities determines the size, shape and location of the skeletal units. This hypothesis suggests that there is not a sufficient amount of information residing in the genome to regulate the specific growth; therefore, numerous environmental insults often become the regulatory mechanisms (Moss 1981).

At the time of birth, the cranium, which usually presents first, is often exposed to excessive trauma. Normal birth itself is relatively traumatic to the fetus, but an added insult can result with forceps use during delivery. In forceps-delivered patients, where pressure is introduced to the posterior mid-face region, trauma may induce subsequent alteration of growth in these regions. Any trauma to the contiguous structures of the oropharyngeal or nasal cavities could lead to a change of expression in the spacial position and size of the oropharyngeal components. Among other changes, this could lead to a decrease in posterior face height which could manifest as a vertical facial growth pattern. Additionally, the width of the maxilla may be decreased with a consequent unilateral or bilateral skeletal crossbite. A combination of the above may cause occlusal disharmonies which may manifest as bruxism. Trauma to the midface also could cause damage to the temporomandibular joint and its contiguous structures. Early damage in the posterior region of the face, therefore, could be related to developmental problems later in life.

The purpose of this study is to test six basic hypotheses on the development of skeletal and dental components of forceps- verses non-forceps-delivered individuals:

1. If there is a difference in dental or skeletal development
2. If there is an association with incidence of temporomandibular problems
3. If there is an association with bruxism
4. If there is an association with presence of posterior crossbites
5. If there is a difference with respect to maxillary arch width
6. If there is a difference with respect to mandibular arch width.

Methodology

A correspondence survey of 800 Caucasian university pediatric patients who had complete birthing records and were between the ages of 12 and 15 years produced two groups of participants. A total of 45 individuals responded and were divided into two groups according to delivery method. The first group (N) consisted of 29 patients (13 males and 16 females) who had been delivered by natural (i.e., without mechanical intervention) birth methods and had no history of congenital defects or orthodontic care. The second group (F) consisted of 16 patients (11 males and 5 females) whose birth was assisted with forceps, but again without a history of congenital defects or orthodontic care. All were in the permanent dentition stage: five had unerupted maxillary canines, one unerupted mandibular canine, and one had missing mandibular first permanent molars due to caries.

This age group was chosen for two reasons. First, it was desirable that each be in the adult dentition stage to minimize differences in arch dimensions due to the transition from mixed to early permanent dentition. Second, detrimental effects on growth often manifest and become more apparent during the period of adolescent growth.

Each patient was given a thorough orthodontic evaluation which included health history, facial and oral photographs, impressions for study casts, lateral and A-P cephalograms, panoramic, and intraoral and extraoral examinations. An occlusal analysis and measurements were made on the casts by calipers accurate to 0.01 mm (Sinclair and Lewis 1983). Lateral cephalograms were digitized on a HIPAD® digitizer (accurate to 0.01 mm) and analyzed to produce sagittal cephalometric measurements listed in Tables 1 and 2. The A-P cephalograms were traced by hand (accurate to 0.5 mm) to produce the coronal cephalometric measurements listed on Tables 1 and 2. The 15 variables in these tables were chosen to give indications of skeletal or dental growth and development in different planes of space but be derived independent of each other. The timing of the adolescent growth spurt for the individuals (expected to occur in this age group) was

TABLE 1. Statistical Summary of Non-Forceps Delivered Patients Used in Multivariate *t*-test. (in degrees unless otherwise noted, N = 29)

Variable	*Mean*	*SD*	*Min*	*Max*
1. ANB diff	2.99	2.73	−3.44	7.84
2. 1/ to NA	21.56	6.19	12.09	37.51
3. /1 to NB	24.98	8.09	3.78	36.53
4. ANS-PNS to SN	6.05	3.60	0.08	12.65
5. Occl to SN	13.90	3.31	9.55	21.21
6. Facial Axis	88.39	4.25	80.10	95.63
7. FMA	25.23	4.79	15.75	34.85
8. 6/ to PTV (mm)	15.59	4.10	6.90	22.40
9. N-S-Ar	121.43	5.02	111.18	134.63
10. S-Ar-Go	146.60	6.47	134.42	157.97
11. Ar-Go-Me	125.32	5.75	113.10	139.22
12. SGo (mm)	76.97	7.07	60.98	90.81
13. IMW	54.96	3.48	47.00	60.50
14. MAXW	60.80	4.56	52.00	68.00
15. NMe (mm)	119.00	6.85	108.15	132.63

TABLE 2. Statistical Summary of Forceps-Delivered Patients Used in Multivariate *t*-test. (in degrees unless otherwise noted, N = 16)

Variable	*Mean*	*SD*	*Min*	*Max*
1. ANB	3.94	2.19	0.10	9.51
2. 1/ to NA	20.28	6.22	9.18	32.58
3. /1 to NB	29.27	3.79	21.75	33.83
4. ANS-PNS to SN	5.17	3.23	0.17	10.81
5. Occl to SN	15.30	4.13	8.66	23.42
6. Facial Axis	87.98	3.09	82.98	93.05
7. FMA	25.47	3.99	17.25	33.23
8. 6/ to PTV	19.34	2.70	15.80	23.80
9. N-S-Ar	120.29	4.63	109.40	128.20
10. S-Ar-Go	148.50	5.16	139.86	159.13
11. Ar-Go-Me	125.13	5.94	112.03	134.89
12. SGo (mm)	78.71	5.63	63.30	85.64
13. IMW	56.43	3.82	49.00	61.50
14. MAXW	61.50	3.74	56.00	70.00
15. NMe (mm)	123.04	7.74	108.40	138.79

most likely different, but this should average out in the cephalometric data for the two groups.

The clinical examinations noted anteroposterior, transverse, and vertical discrepancies, and the presence of popping, clicking, and/or pain in either or both of the temporomandibular joints. The health history included questions related to bruxism, injury to the face, and pain in the temporomandibular areas.

The six specific hypotheses were tested statistically and their results are reported. To test whether there was a difference in skeletal or dental development between the delivery groups, a multivariate *t*-test on 15 specific, nonrelated measurements was performed. It was necessary to choose a number of variables smaller than the number of subjects in the smallest group for this test to be valid. To maintain an overall Type I error (alpha level) of 0.06, the alpha level for each test was adjusted to 0.01 (0.06/6). This is referred to as a Bonferroni correction. This test was chosen because due to the large number of variables, Student's *t*-tests would have yielded inflated results.

The hypotheses regarding posterior crossbites, bruxism, and temporomandibular problems were analyzed by the Fisher's exact test. The two-sided univariate *t*-tests were used to analyze whether there were differences in arch widths between the two groups. Finally, a one-sided univariate *t*-test was used to analyze whether the arch widths for the forceps-delivered group were more narrow than the non-forceps-delivered group.

Results

Two groups of growing patients were studied: 29 non-forceps-delivered (N) (Table 1) and 16 forceps-delivered (F) patients (Table 2). The two groups were tested to determine whether there was a difference between the forceps-delivered and the non-forceps-delivered groups with respect to the 15 (Tables 1 and 2) dental/skeletal variables. The multivariate *t*-test indicated that there was no difference ($P = 0.26$) between the two groups for this sample.

The categorical data in response to the presence of unilateral or bilateral temporomandibular joint noise and/or pain by delivery method was compared by two-way analysis. Unilateral and bilateral joint noises were combined due to the small number of responses. Fisher's exact test was calculated to determine the association between delivery method and TMJ noise and/or pain. This test indicated no association ($P = 0.455$) between delivery method and TMJ problems.

A two-way classification for presence of posterior buccal segment crossbite by delivery method was made. Both unilateral and bilateral responses were combined due to the low number of responses. Fisher's exact test was calculated and indicated no association ($P = 0.641$) between the two delivery groups and posterior crossbites. The non-forceps group had a higher incidence of posterior crossbites (four) in this sample than the forceps-delivered group (one).

Similarly, the two-way classification of participants who admitted a history of bruxism was summarized by delivery method. Fisher's exact test was calculated, and again no association was found ($P = 0.655$) between bruxism and delivery method.

Both maxillary molar and mandibular molar width were measured on study casts and compared by delivery method. A two-sided univariate *t*-test was used to determine if the two differed significantly by delivery method. Also, a one-sided univariate *t*-test was preformed to determine if the maxillary arch or mandibular arch was significantly more narrow for forceps-delivered participants. Neither test, the two-sided (UM: $P = 0.96$ and LM: $P = 0.99$) or one-sided univariate *t*-test (UM: $P = 0.08$ and LM: $P = 0.02$), indicated a statistical significance at the overall 0.01 level.

Discussion

Non-normal delivery has been associated with abnormal development of the face and contiguous structures. Grosfeld et al. (1980) found an increased incidence of temporomandibular joint disorders, a higher proportion of distocclusions, but a similar number of crossbites in four-year olds with breech delivery verses normal vaginal delivery. Clayman and Goldberg (1983) have indicated that there was a relationship between the use of obstetrical forceps and temporomandibular problems when a matched group of active TMJ patients and acquaintances were compared. There were two possible sources of bias which Clayman and Goldberg admitted in their study: 1) the participants were shown the research protocol prior to entering the study, and 2) each participant was asked to choose his/her matched pair. The present study found no association between forceps delivery and TMJ disorders. The forceps-delivery group did have a higher percentage (5/16 or 31.25%) of TMJ pain and/or noise than the non-forceps-delivered group (5/29 or 17.24%).

Possible narrowing of the maxilla, as manifest in skeletal or dental crossbites, has been associated with non-normal delivery. Schoenwetter (1974) surveyed 700 treated cases and found that 25 of 27 patients who presented with crossbites had difficult or instrument deliveries. Schoenwetter relied on birthing information supplied by the mothers. Grosfeld et al. (1980) found a similar distribution of crossbites in breech-delivered children. The present study found no association between delivery method and presence of crossbite. The non-forceps group showed a slightly higher number of posterior crossbites (4/29 or 13.79%) than the forceps-delivered group (1/16 or 6.25%).

One might expect a more narrow maxillary arch in the forceps-delivered group due to the positioning of the instrument. In this case, a narrow maxillary arch relative to the mandibular arch could present as crossbite relationships. The present study found no difference in arch widths in either the maxilla or mandible. Contrary to what one might expect, the data indicate that the arches for the forceps-delivered group are wider than the non-forceps-delivered group in both arches. However, at the 0.01 alpha level, this study could only detect true differences of 3.67 mm and 2.78 mm with 80% power for mandibular molar and maxillary molar widths respectively. This is specifically due to the sample size. Additionally, the maxillary first molar of the forceps-delivered group tends to be more anterior (measured from PTV) than that of the non-forceps-delivered group (Table 1 and 2). Therefore, the maxillas of the forceps-delivered group are wider with greater depth than the non-forceps-delivered group. These increased arch depth and widths for the forceps-delivered group cannot be explained.

Any differences in occlusal relationships between the two arches may manifest as interferences. Interferences in either balancing side contacts or centric relation to centric occlusion premature contacts could be detrimental to the masticatory elements. This study looked at bruxism as an indicator of occlusal problems and found no association relative to delivery method. The forceps-delivered group had a slightly higher incidence (3/14 or 21.43%) of bruxism than the non-forceps group (4/29 or 13.79%).

The statistical relationships may have been influenced by the small sample size of the forceps-delivered group (16). As mentioned above, a higher incidence of TMJ pain or noise and bruxism were reported for the forceps-delivered group. On the other hand, contrary to what was expected, the forceps-delivered group had wider arches. Further studies of these relationships on this subject may prove statistically meaningful for larger sample sizes.

There was no mention in earlier studies whether the forceps delivery were "low", "middle" or "high". This refers to the position of the baby in the vaginal canal at the time of forceps use. The "high" forceps delivery is the most difficult and incurs the highest incidence of facial trauma at the time of birth. Consequently, "high" forceps deliveries are discouraged and surgical intervention preferred (O'Leary 1980). The forceps-delivered group in this study consisted of "low" deliveries as determined from their birthing records. No "middle" or "high" delivered individuals were available in the original 800 polled for this study. Therefore, no effects due to positioning of the infant at the time of delivery were superimposed on this study.

This study did not attempt to distinguish the type of forceps used in the delivery, since one could not ascertain from the birthing records the type of forceps utilized. There is an indication of lower morbidity when different types of forceps, which are designed to reduce the compressive force on the fetal skull during delivery, are utilized in deliveries (Marshall and Healy 1987). Further study of the growth and development of the face after forceps delivery should take into account the type of forceps used in the delivery.

Finally, newer methods of assisted vaginal delivery, the most recent being vacuum extraction, have been introduced to supplant forceps delivery. These methods are currently being evaluated for their medical effectiveness (Carmody et al. 1986 and Broekhuizen et al. 1987). Further study to determine the long-term growth implications of these methods is still necessary. Currently, there is no indication from this forceps-delivered sample that there are any long-term effects on growth or development of the face, jaws, or occlusion.

Conclusions

1. There were no statistically significant cephalometric differences between the two groups.
2. There was no association between delivery method and incidence of temporomandibular joint dysfunction, posterior segment, crossbite, or bruxism.

3. There is no statistically significant difference between forceps- verses non-forceps-delivered groups with respect to maxillary or mandibular arch width.

Dr. Germane and Dr. Rubenstein are assistant professors, department of orthodontics, school of dentistry, Virginia Commonwealth University, Richmond, VA.

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Dental x-ray guidelines

The Food and Drug Administration, advised by a panel of ADA and other dental organization representatives, has developed voluntary guidelines for dentists on use of X-rays for asypmtomatic patients.

Guidelines are based on:

- Whether the patient is making a new or recall visit;
- The age or developmental status of the patient;
- The patient's risk category.

The guidelines endorse taking a history and performing a clinical examination of the patient before deciding on the necessity for dental radiographs. But the panel said the guidelines neither preclude nor require x-rays when clinical judgement suggests otherwise.

The 32-page report, "The Selection of Patients for X-ray Examinations: Dental Radiographic Examinations," is available for $2 per copy by ordering GPO No. 017-015-00236 from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.