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# Fixed presurgical orthopaedics for bilateral cleft lip and palate

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*Background:* Presurgical orthopaedics has been employed since the 1950s as an adjunctive neonatal therapy for the correction of cleft lip and palate. It is accepted that presurgical orthopaedic plates facilitate lip repair and balanced orofacial growth.
*Aims:* The aims of this retrospective study of newborns with bilateral cleft lip and palate were two-fold: to describe the use of a fixed appliance to reposition the displaced fragments, and to determine if the magnitude of the palatal changes was age-related.
*Methods:* Study models of 12 infants with bilateral cleft lip and palate were used. The models recorded the condition prior to expansion (2-3 weeks after birth) and at the end of retention (at the time of lip surgery). The intercanine width, intertuberosity width, palatal length, palatal depth and intercanine arch length were measured.
*Results:* As a result of the expansion the intercanine width and intertuberosity width increased, and the palatal length and intercanine arch length decreased. These changes were not age-related.
*Conclusions:* Fixed presurgical orthopaedic expansion appliances can be used to expand the upper facial skeleton in newborns.
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## Introduction

Displacement of the maxillary segments occurs in children with cleft lip and palate. In infants with complete unilateral clefts the lesser segment is often rotated outwards, backwards and in some children upwards, whereas the greater segment is in a normal position. In bilateral cases both maxillary segments nearly always collapse towards the midline with insufficient space for the premaxillary fragment, which is often displaced labially. In infants with bilateral clefts some form of orthopaedic treatment is generally necessary to reposition the segments prior to surgery. This can involve either a removable appliance to move the maxillary fragments outwards combined with an external bandage to restrain the premaxillary fragment or a surgically placed fixed intra-oral device that does not require external strapping or rely on parent/patient compliance. The objective of both forms of treatment is to produce a well-aligned maxillary alveolar arch,[1] thereby facilitating surgical closure of the cleft and lip.

The aims of this study were two-fold: to describe the use of a fixed appliance to reposition the displaced fragments and to determine if the palatal changes were age-related.

## Materials and methods

This is a retrospective study of 12 bilateral cleft lip and palate (BCLP) infants from 2–3 weeks of age to 3–6 months of age (the time of lip surgery). All children were treated at the Combined Cleft Lip and Palate and Craniofacial Deformities Clinic, Kelantan, Malaysia. Study models recording the condition prior to orthopaedic treatment and at the end of retention (the time of lip surgery) were used. Five palatal dimensions were measured on the casts and correlated with age at the start of treatment.

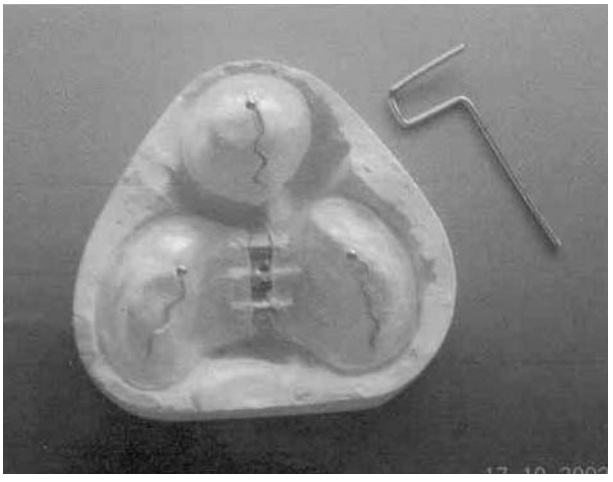

Figure 1. Presurgical orthopaedic appliance.

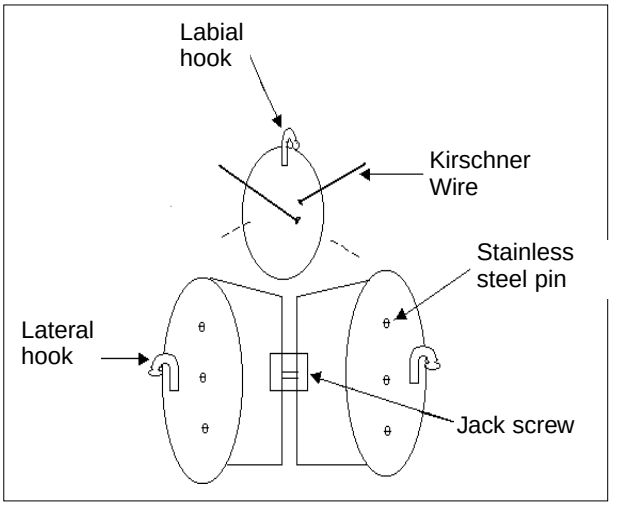


Figure 2. Components of the appliance.

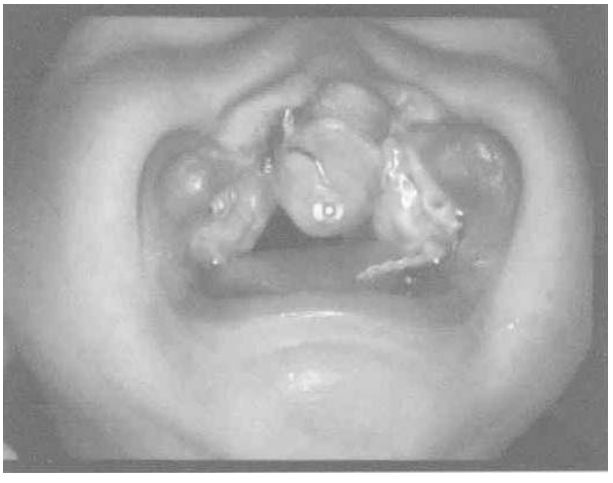

Figure 3. An appliance *in situ*.

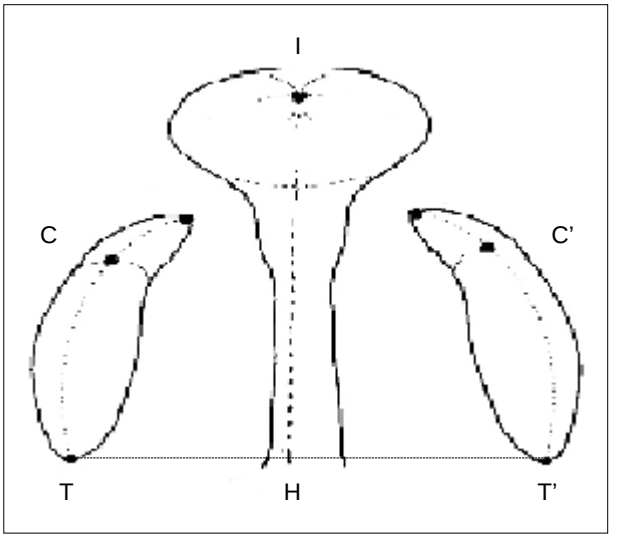


Figure 4. The measurements made on the study models. C-C width: Intercanine width; T-T width: Intertuberosity width; I-H length: Palatal length; H-D depth: Palatal depth (not shown); C-C arch length: Intercanine arch length or the canine to canine outer labial arch distance, measured from the intersections of the line C-C' and the buccal surfaces of the maxillary processes, and labial to the premaxillary process. This distance recorded the position of the premaxilla pre- and post-treatment.

### *Inclusion criteria*

Infants with bilateral cleft lip and palate who had presurgical orthopaedic treatment with an intra-oral fixed appliance.

Infants attended the Combined Cleft Lip and Palate and Craniofacial Deformities Clinic, Kelantan.

Pretreatment and post-treatment study casts were available.

Parents agreed to the treatment.

### *Exclusion criteria*

Infants who did not complete maxillary arch expansion treatment at the Combined Cleft Lip and Palate and Craniofacial Deformities Clinic.

Pretreatment and/or post-treatment study casts were not available.

Subjects with medical conditions likely to affect normal growth and development, such as Down's syndrome, Pierre Robin syndrome, Crouzon's syndrome.

Three subjects with BCLP were excluded from the study: one subject was excluded because his parents failed to activate the screw as instructed, and two patients continued treatment at hospitals closer to their residences.

### *Description of the appliance*

The appliances were made on upper study casts taken 2–3 weeks after birth. The appliance consisted of two hard acrylic caps covering the palatal processes. These were lined with soft acrylic extending into the nasal cavity, and joined with a small jack screw.[2] Two small lateral hooks were placed in the acrylic covering the alveolar ridges. An acrylic labial cap also covered the premaxillary fragment with a small hook embedded in the acrylic covering, or close to, the labial surface (Figure 1).

The appliance was fitted under general anaesthesia. The labial cap was fixed to the premaxillary fragment by passing two crossed Kirschner wires through the premaxillary fragment and holes drilled in the labial acrylic cap (Figures 2 and 3). Three stainless steel pins were also passed through each palatal process and acrylic cap. The pins fixed the appliance to the underlying processes. Each pin was 2 mm in diameter and approximately 11-13 mm in length.

Two days after insertion of the appliance two lengths of power chain were placed from the labial hook to both the lateral hooks. The length of the chain was adjusted to retract the premaxillary fragment. The parents were also instructed to activate the midline screw once a day for two weeks. Each turn of the midline screw gave approximately 0.25 mm of expansion per day. The subjects were reviewed weekly and the chain replaced if necessary. When the desired expansion and archform had been achieved activation was ceased, and the appliance was used to retain the expansion obtained until lip surgery at approximately 3–6 months of age. Both the end of expansion and time of lip surgery (the end of retention) were determined by the clinicians responsible for the patients' care.

### *Measurements*

The horizontal distances were measured on the pre-treatment and post-treatment dental casts with a Fowler digital sliding caliper (Figure 4).[3,4] The measurements were carried out by a microcomputer linked to the caliper.

C-C' width: Intercanine width or palatal anterior arch width.

T-T' width: Intertuberosity width or palatal posterior arch width.

I-H length: Palatal length.

C-C' arch length: Intercanine arch length or the canine to canine outer labial arch distance, measured from the intersections of the line C-C' and the buccal surfaces of the maxillary processes, and labial to the premaxillary process. This distance recorded the position of the premaxilla pre- and post-treatment.

H-D: Palatal depth. This is the perpendicular distance from a clear acetate sheet laid on the alveolar processes to the intersection of the midline of the palate and the line joining distal margins of the alveolar processes. Measured with the aid of a clear acetate sheet scribed with two lines at right angles to each other and a vertical wire marker inserted through the sheet at the intersection of the two lines.

### *Data management*

To test the reproducibility of the measurements all measurements were repeated two weeks after the first set of measurements. Using the paired *t*-test we found no significant differences between the two sets of measurements. We also calculated the intra class correlation coefficients and none fell below 0.996. We concluded that that method of measurement met the requirements of the study.

The data were analyzed using the Statistical Package for the Social Sciences v11.0 (SPSS Inc., Chicago, USA). Changes in the measurements were evaluated using two-related sample analysis and Wilcoxon signed ranks test. The correlation between the variables and age were calculated using Spearman rank correlation coefficients.

## Results

The appliances were well tolerated by all patients, and no appliance was lost. The parents were able to activate the midline screw and look after the appliance. The use of power chain proved to be a convenient method to retract the premaxillary fragments.

The intercanine width (C-C' width) and intertuberosity width (T-T' width) increased significantly, and palatal length (I-H length) and inter-

Table I. Palatal changes.

| Measurement (mm) | Pretreatment median (IQR) | Post-treatmen median (IQR) | Difference median (IQR) | Z* | *p* |
|---|---|---|---|---|---|
| C-C′ width | 22.47 (4.22) | 24.70 (1.84) | 2.34 (1.81) | -2.197 | 0.028 |
| T-T′ width | 33.80 (7.87) | 39.50 (4.37) | 4.69 (6.49) | -2.981 | 0.003 |
| I-H length | 30.68 (4.17) | 28.05 (4.87) | -2.14 (5.50) | -2.746 | 0.006 |
| H-D depth | 13.92 (3.85) | 13.92 (3.11) | .00 (1.01) | -1.483 | 0.138 |
| C-C′ arch length | 47.25 (3.78) | 41.74 (6.17) | -3.43 (6.90) | -3.059 | 0.002 |

* Wilcoxon signed ranks test

Table II. Correlations between the palatal changes and age at the start of treatment.

| Palatal changes (mm) | r | *P* |
|---|---|---|
| C-C′ width | 0.133 | 0.681 |
| T-T′ width | 0.057 | 0.859 |
| I-H length | -0.068 | 0.833 |
| H-D depth | -0.060 | 0.853 |
| C-C′ arch length | 0.255 | 0.424 |

canine arch length (C-C' arch length) decreased significantly (Table I). Only the palatal depth (H-D depth) change was not significant. Age at the start of treatment was not significantly correlated with any measurement (Table II).

## Discussion

The fixed presurgical orthopaedic appliance used in this study proved to be an effective means of increasing the width of the palate and retracting a displaced premaxillary segment without external bandaging. The appliances remained *in situ* for the full period of the study, they were well tolerated by both parents and patients, and no wires became infected or were lost. Because the appliances were fixed *in situ* lack of parental compliance was not an issue. In this group of subjects the palatal changes were not age-related.

It has been claimed that presurgical orthopaedics results in a well-aligned alveolar arch[1] that facilitates surgical closure of a bilateral cleft lip and palate. It has also been claimed that this form of treatment results in improved speech and facial aesthetics.[5] However, others maintain that presurgical orthopaedics may inhibit maxillary growth,[6] and lead to an increase in dental caries if the teeth have emerged.[7] Fixed presurgical orthopaedic treatment has some additional disadvantages: it requires access to an operating theatre and a surgeon and an anaesthetist, with the associated costs; the Kirschener wires may become infected and even lost, insertion of the wires through the maxillary processes can interfere with the developing teeth (although we have not experienced any problems to date), and it requires parental cooperation to activate the screw.

Activation of the expansion screw increased the palatal width and enabled the premaxillary segment to be retracted into position. The end point of activation was determined by the limitations of the screw and by clinical judgment. In this group of patients further palatal expansion may be necessary at some point in the future.[8,9] The use of power chain to retract the premaxilla was convenient for both parents and clinician and was replaced, when necessary, at the weekly visits. A decrease in overall length of the palate and retraction of the premaxillary segment in BCLP infants can assist the reconstruction of both nose and lip and result in a more favorable occlusion.[8,10,11–13] Other researchers have reported similar results with presurgical orthopaedic treatment.[12,14–17]

The method of fixed presurgical orthopaedic treatment used in the present study looks promising because it does not rely on parent/patient compliance, and the desired expansion and retraction were obtained relatively quickly. No adverse effects were encountered in this short-term study of selected patients. The possibility of damage to the developing teeth exists and should be addressed in a long-term study. Future studies will use a larger sample size and compare the palatal changes in a fixed group with those in an age- and gender-matched group treated with removable appliances and external bandaging.

## Conclusions

Fixed presurgical orthopaedic expansion appliances can be used to expand the upper facial skeleton in newborns and retract a displaced premaxillary segment without external strapping. Because the appliance is fixed *in situ*, patient and parent compliance is assured.[18] Offset against this are the additional costs associated with use of an operating theatre and surgeon. Furthermore, insertion of wires through the maxillary processes in infants could interfere with the developing teeth.

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