The influence of unilateral cleft lip and palate on maxillary dental arch morphology

Omar Gabriel da Silva Filho; Adilson Luiz Ramos; and Ruy Cesar Camargo Abdo

Unilateral cleft lip and palate (Figure 1) is the most frequent human cleft, representing 33% of such deformities. It completely cleaves lip and palate, dividing the maxilla into two well-distinguished segments: a major one (non-cleft side) and a minor one (cleft side).

The anatomical conformation of the maxilla in cleft patients is distorted before birth. Anteroposterior length, as well as transverse dimensions, especially in the region of the tuberosity, are enlarged. The anterior extremity of the larger segment is usually protruded. These changes result from a divergence caused by displacement of the maxillary segments.

Treating these malformations requires a number of early surgical procedures (Figure 2). These surgeries, as well as hypoplasia of the margins of the cleft, influence future maxillary growth.

Following lip and palate surgery during childhood, resulting muscular forces and cicatricial fibrosis alter future growth of the jaw, causing constriction of the maxillary dental arch (Figure 3). These post-operative morphological alterations result in a medial displacement of the palatal segments[2-11] and show a clear tendency to intensify during growth. This atresia of the maxillary dental arch is responsible for the frequency of crossbites in cleft lip and palate patients[4,9,12-,15] (Figure 3).

Professionals dealing with cleft lip and palate patients understand that early restorative surgeries negatively influence maxillary dental arch morphology. Nevertheless the influence of an isolated cleft on dental arch development has not been adequately investigated.[5,8,16,17] The study of dental arches in unoperated cleft lip and palate adult patients is an excellent way to evaluate the influence of clefts on arch development while at the same time comparing the resulting morphology with that of patients who have had early surgery.

Abstract

A sample of 97 untreated cleft lip and palate adult patients, with and without Simonart's band,was analyzed. The dimensions and form of the maxillary dental arches were analyzed. Comparison of this sample with a "normal" group indicated maxillary dental arch size and shape are distorted by the presence of a cleft which is characterized by a constriction that becomes more severe in the medial and anterior regions. The presence of Simonart's band affects the cleft arch form, redirecting the anterior extremity of the major segment towards the minor segment.

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Key words

Cleft lip and palate • Dental arch form • Dental arch dimensions.

Table 1
Distribution of cleft lip and palate sample according to sex, side of cleft and presence of Simonart's band

	Right Side		Left Side		
Sex	Band	No Band	Band	No Band	Total
Male	2	17	10	34	63
Female	1	10	2	21	34
Total	3	27	12	55	97

Figure 1A-B
Adult patient with unoperated unilateral cleft lip and palate. Facial characteristics include a complete lip bipartition with nasoseptal and nasal tip deviation to the non-cleft side and a nasorostral flattening to the cleft side. Note the jaw is internally divided into two distinguished segments which cut the alveolar edge in the region of the lateral incisor.

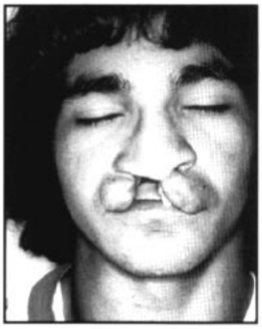
Figure 1A

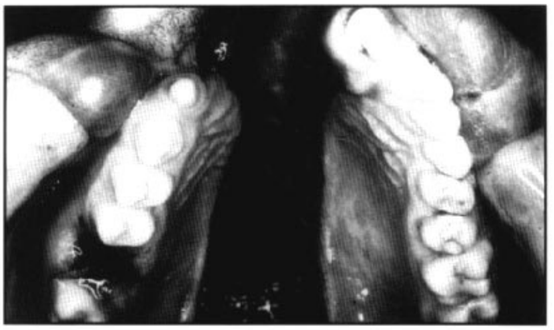
Figure 1B

Figure 2 A-B
Lip and palate surgical reconstruction (cheiloplasty and palatoplasty) become necessary after 3 and 12 months respectively, for the subsequent morphological and functional improvement of the cleft patient.

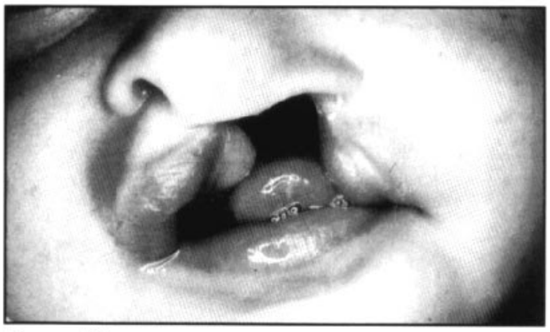
Figure 2A

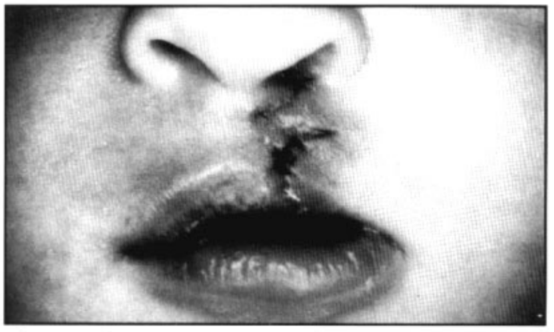
Figure 2B

Figure 3A-B
This unilateral cleft lip and palate patient had surgery during childhood (cheiloplasty and palatoplasty) without subsequent orthodontic treatment. Note the tendency for maxillary dental arch constriction resulting in total crossbite.


Figure 3A


Figure 3B

Figure 4A-B
A unilateral cleft lip and palate patient with Simonart's band. The maxillary involvement is complete, but the lip presents with a slight continuity of soft tissue in the nasal base. Alveolar segments are collapsed.


Figure 4A


Figure 4B

Table II
Mean, standard deviation and Student's"t" test for maxillary dental arch dimensions in the control group

Arch Dimensions	Male (N=22) $\bar{x}$	SD	Female (N=29) $\bar{x}$	SD	"t"
anteroposterior	38.886	2,02	36.345	1,94	**
inter canine	35.982	2,32	33.738	2,19	**
inter first premolar	43.782	2,37	41.724	2,18	**
inter second premolar	49.373	2,96	46.883	2,34	**
inter first molar	54.214	3.58	52.241	2,81	*

* = 5% level of significance; ** = 1% level of significance; NS = not significant

Table III
Mean, standard deviation and Student's"t" test for maxillary dental arch dimensions in the cleft lip and palate group (left and right side) withouth Simonart's band

Arch Dimensions	Male (N=63) $\bar{x}$	SD	Female (N=34) $\bar{x}$	SD	"t"
anteroposterior	37.798	4,08	36.599	3,92	NS
inter canine	30.262	4,54	30.119	3,53	NS
inter first premolar	39.808	4,86	38.126	4,59	NS
inter second premolar	46.465	4,88	45.000	4,57	NS
inter first molar	52.224	3,94	50.399	4,36	NS

NS = not significant

Material and methods

The sample in this study consisted of untreated, adult unilateral cleft lip and palate patients with and without Simonart's band. Plaster models were obtained at the Documentation Sector at Hospital de Pesquisa e Reabilitacao de Lesoes Labio-Palatais from Universidade de Sao Paulo - Bauru - Sao Paulo. These models were gathered on adults over the age of 15 years, a Brazilian ethnic group (except people of African and Asian ancestry) with no syndromes and with most of their permanent teeth present.

Individuals in the cleft lip and palate sample were further divided into groups according to sex, cleft side and presence of Simonart's band (Figure 4), as illustrated in Table I. Simonart's band is defined as a soft tissue strip often associated with a muscular layer near the base of the nose and partially joining the separated lip segments (Figures 4 and 9). It does however, interfere with the alveolus, which remains separate.

A control sample consisted of 51 non-cleft patients with "normal" patterns of occlusion. It was obtained from Orthodontics "Normal Pattern" File of Hospital de Pesquisa e Reabilitacao de Lesoes Labio-Palatais from Universidade de Sao Paulo. The control sample consisted of 29 females and 22 males. The mean age of cleft patients was 22 years 6 months, ranging from 15 to 52 years; the mean age of the control sample was 19 years 5 months, ranging from 15 to 25 years.

Plaster models were placed with their occlusal surfaces on the center of a 1035 copying and printing machine glass plank (Xerox Corporation, New York), and photocopy prints were made (Figures 5 and 6).

Distances between canines, first and second premolars and first molars were measured on the prints. Sagittal length was obtained from the mean point of the inter first molar distance to the most labial incisor surface (Figure 6). These measurements were made by three different observers.

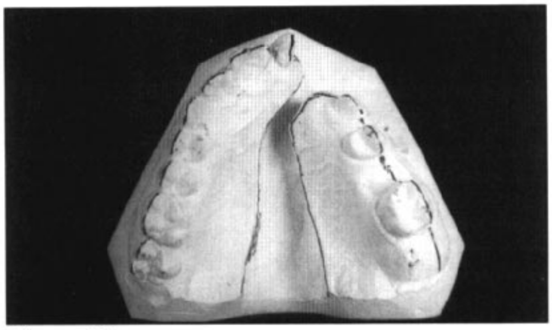

Figure 5A

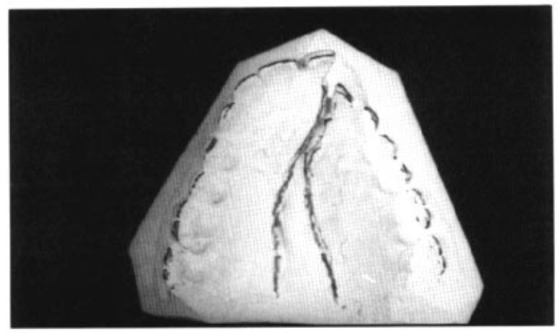

Figure 5B

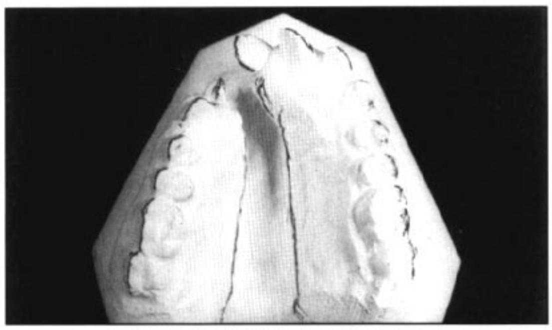

Figure 5C

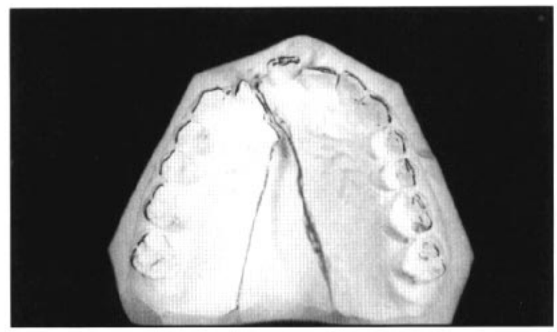

Figure 5D

Figure 5A-D
Plaster models of the maxillary dental arches with left-sided clefts (A-B) and right-sided clefts (C-D). The buccal margins of the occlusal and incisal surfaces of the teeth were outlined with a pencil to make evident their contours in the xerox images. These models also illustrate alveolar segment relationships without and with contact.

Using a digitizer table (Hipad Digitizer, Houston Instrument, Austin, Texas) the measurements were transfered to a microcomputer (Unitron Ap II plus Brasil-SP) with 0.125mm accuracy. Measurement error was assessed by the variance calculated among the observers and ranged from 0.063 to 0.224.

To clarify the interpretation of dental arch measurements, the mean dental arch form was established by developing contouring diagrams with the same digitizer table connected to a microcomputer (PC XT, Microtec MF 88, Sao Paulo, Brasil). A mean diagram was established to represent the maxillary arches of the cleft group, with and without Simonart's band, and the maxillary arches in the normal group (printed with a 7470A Plotter Hewlett Packard, USA, connected to a PC).

Results

The mean dimensions of the maxillary dental measurements in the normal group are shown in Table II. The student's-t test was applied to verify the influence of sex on dental arch measurements and showed that dimensions were larger among males than among females (Table II).

The cleft lip and palate group without Simonart's band showed no difference in the maxillary dental arch dimensions when the left-sided cleft group was compared to the right-sided cleft group. As a consequence, the cleft side was ignored. While there was a slight tendency for increased dental arch dimension in males, the difference was not statistically significant as shown in Table III. Bishara[16] and MacCance[17] found no sexual dimorphism in dental arch dimensions. The cleft factor reduced the influence of sex on dental arch dimensions. Because there was sexual dimorphism in the normal group, comparisons between the cleft lip and palate groups and the normal group were performed separately for each sex.

The comparison between maxillary dental arch mean dimensions in the cleft group and the control group (Table IV) explains the influence of the cleft on the maxillary dental arch.

Discussion

As cited before, the maxillary arch is divided into two segments, the major (non-cleft) and the minor (cleft) segment (Figures 1, 2, 4 and 5). The former is anteriorly protruded, and the latter remains retruded. The cleft group diagram (Figure 7) represents the maxillary arch by means of two curves separated by a cleft up to the lateral incisor. The sagittal length of the cleft arch is determined by the most labial incisor in the major segment. No statistically significant differences were found between the anteroposterior dimensions of the cleft and the normal maxillary arches. This data seems surprising, as excessive overjet is common in untreated cleft lip and palate patients. However, it becomes clear when this overjet is attributed to an anteroposterior Class II positioning of apical base.[18,19] The maxilla in untreated patients projects itself in relation to cranial base, whereas the mandible is retruded (Table V). The apical base relationship, as defined by ANB angle,

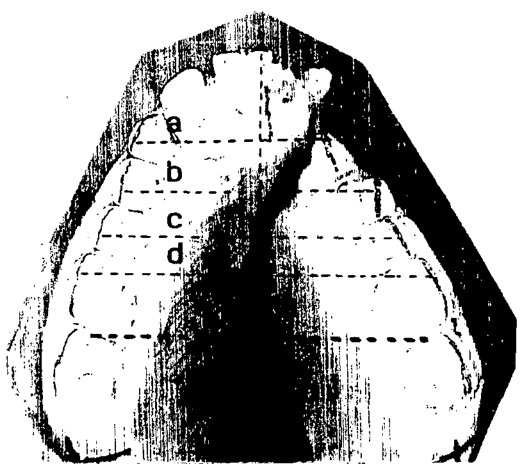

Figure 6

is unreliable, suggesting an anteroposterior skeletal discrepancy tending towards Class II. This Class II skeletal relationship may be confirmed by examining the relationship between dental arches (Figure 8). In this sample, a Class II relationship was present in 63.5% of the cases in the major segment and in 81.8% of the cases in the minor segment.

In a review of transverse dimensions, the maxillary arch was constricted in cleft patients (Table IV). The cleft itself, as well as its functional balance, influences the maxillary dental arch transverse dimension independently of surgical procedures. This constriction is slight in the molar region, about 2mm, and more pronounced in the anterior regions, with a mean of about 5mm in the canine region. Table IV shows that statistical significance in the posterior region of the dental arch decreases to 5% in males and is not statistically significant for females. This means that the cleft's influence is markedly greater in the anterior region of the dental arch. The lesser interference in the posterior region, when compared in females, may be due to the fact that this dimension is smaller in females than in males in the non-cleft sample. This adds to the tendency for no sexual dimorphism in the cleft group. Superimposition of normal and cleft diagrams confirms the characteristic constriction of the cleft arch. The tendency for medial rotation of the minor segment is noted with the rotation center near the molar region[1,8] (Figure 7). The major segment also contributes to cleft arch constriction, but at a clearly reduced rate. The quantitative evaluation of the maxillary cleft dental arch made by Capelozza F^{o}[5] and McCance[17] is in accordance with this work.

In this sample of 97 patients, 15 cases (15.4%) had Simonart's band. Diagrams showing the configuration and displacement of the palatal segments in the presence of Simonart's band (Figure 10) indicate that the presence of this structure influences maxillary dental arch behavior. In patients with Simonart's band, the shape with no contact was not found. The shape without contact was the major occurrence in patients without the band. Figure 4 shows a cleft patient with band and the maxillary dental arch collapsed. When measuring arch dimensions and making diagrams, the cleft group was subdivided, based on the presence or absence of Simonart's band (Table I). Few of the female cleft lip and palate patients had this structure (two left-sided cleft and one right-sided cleft). This small sample compromised the accuracy of statistical tests in this group, as well as

Table IV
Statistical comparison ("t" value) between normal group and cleft lip and palate group without Simonart's band

	Male (GL = 71; Nt =73)		Female (GL=58; Nt=60)	
anteroposterior	1.186	NS	0.314	NS
inter canine	5.587	**	4.732	**
inter first premolar	3.642	**	3.834	**
inter second premolar	2.590	*	1.987	NS
inter first molar	2.033	*	1.930	NS

* = 5% level of significance
** = 1% level of significance
NS = not significant

Table V
Cephalometric data comparing spacial position of mandible and maxilla obtained from Taniguchi[19] using Duncan's test (D_2)

Cephalometric measurements	Unoperated cleft lip, palate	Normal	Measurement Error	D_2
SN.ENA	89,30	86,17	0,83	2,32*
SNA	86,13	82,25	0,83	2,32*
SNB	79,03	79,69	0,81	2,27NS
ANB	7,12	2,15	0,60	1,68*

NS = not significant
* = 5% level of significance

Figure 6
Xerox copies of the plaster models identified buccal contours of the dental arches sufficiently to obtain transverse and sagittal dental arch dimensions. The diagram representing this contour was easily made. a = inter canine distance; b = inter first premolar distance; c = inter-second premolar distance; d = inter-first molar distance; e = sagittal length.

Figure 7A-B
Superimposition of diagrams representing normal arch and dental arch contours for right-sided cleft group (A) and left-sided cleft group (B), with no Simonart's band. The most clearly identified changes are caused by the lesser segment, which shows a medial rotation.

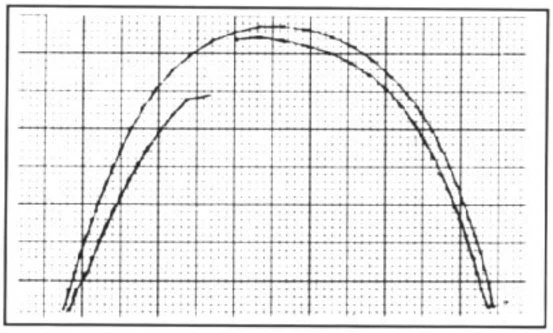

Figure 7A

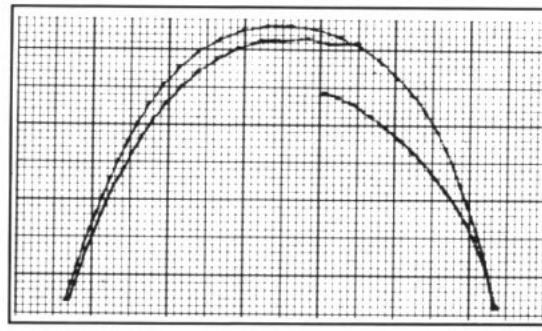

Figure 7B

Figure 8A-B
Note the Class II relationship between maxillary and mandibular dental arches in a complete unilateral cleft lip and palate unoperated patient (with no Simonart's band).

Figure 8A

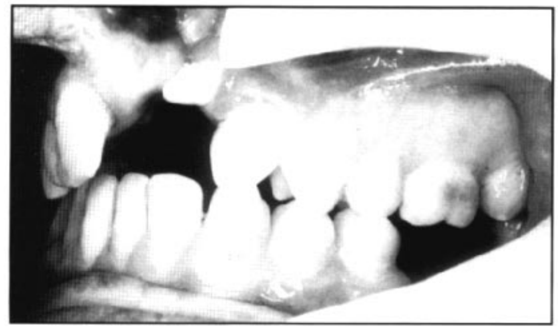

Figure 8B

Figure 9A-B
Unilateral cleft lip and palate patient, with Simonart's band. Contact between the two palatal segments enhanced the determination of symmetrical maxillary dental arch morphology.

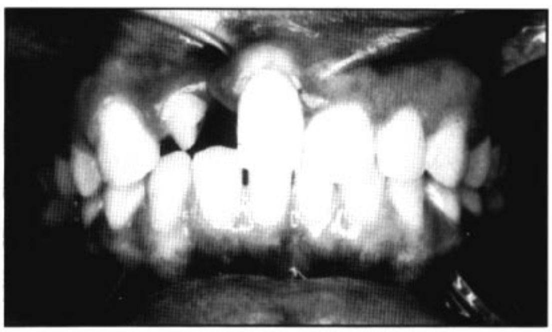

Figure 9A

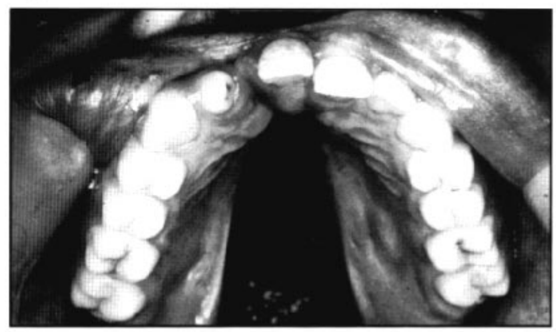

Figure 9B

Figure 10A-B
Superimposition of cleft patients' diagrams, with and without band, right (A) and left sided (B). Superimposition reveals changes in the arch morphology, introduced by the presence of a band.

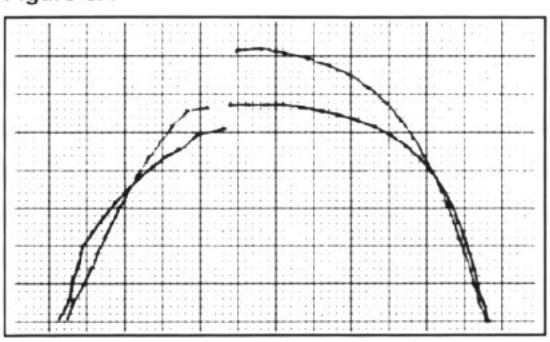

Figure 10A

Figure 10B

the contouring diagram. Hence, only males were compared.

The means for dental arch dimensions in the banded and band-free cleft groups indicated sexual dimorphism was not a factor. Thus, it seems that the cleft hides sex interference in dental arch dimensions, independently of the presence of Simonart's band.

When comparing the length of dental arches for groups with and without Simonart's band, the only difference was a reduced anteroposterior length of the arch in the band group (Table VII). The presence of this structure was sufficient to alter buccal rotation in the anterior extremity of the major segment. This fact is proved by superimposition of the diagrams in Figure 10. This behavior induced by Simonart's band is also evident when comparing maxillary dental arch length in the control group and cleft group with band. In the cleft group with band, arch length was less

Table VI
Mean, standard deviation and Student's "t" test for maxillary dental arch dimensions in the cleft lip and palate group (left and right side) with Simonart's band

Arch Dimensions	Male (N=12) $\bar{x}$	Male (N=12) SD	Female (N=3) $\bar{x}$	Female (N=3) SD	"t"
anteroposterior	34.833	2,20	36.56	1,64	NS
inter canine	29.950	3,43	32.20	5,13	NS
inter first premolar	39.36	3,68	40.76	3,53	NS
inter second premolar	46.79	3,95	46.66	3,10	NS
inter first molar	53.01	4,11	49.96	0,89	NS

NS = not significant

Table VII
Statistical comparison between the cleft groups with and without Simonart's band (males only)

Arch Dimensions	"t" values Males (GL = 61; nt = 63)	
anteroposterior	2.425	*
inter canine	0.222	NS
inter first premolar	0.229	NS
inter second premolar	-0.214	NS
inter first molar	-0.616	NS

* = 5% level of significance
NS = not significant

Table VIII
Statistical comparison between the normal group and the cleft group with Simonart's band (males only)

Arch Dimensions	"t" values Males (GL = 32; nt = 34)	
anteroposterior	5.420	**
inter canine	6.106	**
inter first premolar	3.957	**
inter second premolar	2.159	*
inter first molar	0.889	NS

** = 1% level of significance
* = 5% level of significance
NS = not significant

than normal (Table VIII).

Conclusions

After comparing maxillary dental arch morphology in 97 untreated cleft lip and palate patients and 51 patients with normal occlusion, we may conclude that:

1) Maxillary dental arch dimensions and morphology are distorted by the presence of a cleft.

2) The maxillary dental arch is characterized by a constriction that is more severe in the medial and anterior regions as a consequence of medial displacement of the palatal segments, primarily the minor segment. Simonart's band was present in 15.4% of the unilateral cleft lip and palate patients in this study.

3) Simonart's band affects the maxillary dental arch size and shape, redirecting the anterior extremity of the major segment towards the minor segment.

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