Chapter 4

Maxillary arch width in unoperated
ULCA and UCLP subjects
Summary

In this chapter the transversal maxillary arch dimensions of two types of unilateral clefts in untreated adult individuals are compared to each other and to a control group of the same population. The material consisted of dental casts of adult unoperated cleft patients divided into two groups: UCLA (n=168) and UCLP (n=68). Dental casts of 24 non-cleft control subjects were available from the same population. The dental casts were digitized three-dimensionally using an industrial coordinate measuring machine. Maxillary transversal dimensions were calculated, using the cusps of the teeth as reference points.

The dental cast analysis revealed that the maxillary arch dimensions in UCLA were essentially normal except for the intercanine distance. This was also expressed by the upper arch ratio showing that in UCLA the mean intercanine width is 60.4% of the first intermolar width, while in the control group this value is 64.2% (p=0.00005). In the UCLP group the maxillary width at the level of the second molar was significantly larger compared to the control group. The mean difference for the 171-271 distance (distobuccal cusps) was 3.3 mm (SE 0.8) and for the 172-272 distance (mesiobuccal cusps) 1.8 mm (SE 0.7). Consequently, there is a mesio-palatal rotation of the second molar. The arch width at the level of the first molar and second premolar was not statistically different in comparison with the controls. Between the first premolars, the maxillary width of the UCLP group was 2.1 mm (SE 0.6) smaller compared to the control group (p=0.0008). At the level of the canine this difference was even more obvious and came up to 6.1 mm (SE 0.6) (p=0.00005). The upper arch ratio shows that in UCLP the mean intercanine width is only 53.1% of the intermolar width.

In conclusion, the presence of a cleft has an influence on the final development of the dento-alveolar part of the maxilla: the more extensive the cleft, the bigger the effect on the dental arch. However, the effect is limited to the vicinity of the cleft in the anterior region only. These findings support the hypothesis that in treated cleft palate patients developmental disturbances of the maxillary arch are primarily due to surgery. However, the findings also suggest that each type of cleft has its own intrinsic characteristic dental arch form. Surgical procedures might influence subsequent growth, which makes the intrinsic deviation clinically manifest.


4.1 Introduction

Patients who had their cleft defect surgically repaired in early childhood often show growth disturbances after having reached maturity, resulting in retrusion of the midface and distortion of the dento-alveolar structures. As Ross (1970) correctly stated an important feature of these growth aberrations is the progressive or accumulated nature of the defect. Following the initial operative treatment there is always a tremendous improvement, both aesthetically and functionally. From an aesthetic point of view, the closure of the lip almost leads to a normalization of facial appearance. In patients with a palatal defect the operation closes the communication between the nasal and oral cavity, normalizing feeding and improving the speech. This initial, almost ideal, situation deteriorates gradually up to maturity, when inhibition of maxillary development becomes obvious. Millard (1980) stated that the final development of the face with a cleft is influenced by a combination of an inherent and an inductive factor. The presence of a cleft itself is the inherent factor, while the cumulative effects of surgical procedures are considered as the inductive factor. The final result depends therefore on the type and degree of the deformity at birth and the effect of surgical and orthodontic treatment during childhood and adolescence.

From the literature it is difficult to get insight into the effects of inherent and inductive factors affecting the development of the dento-alveolar structures of the maxilla in adulthood. It is to be expected that the effect of surgical treatment, if any, may be less extensive in UCLA patients. In this group the surgical treatment is limited to the closure of the lip and alveolar part of the maxilla only; there is neither elevation of palatal flaps, nor scar formation on the palate as in the CLP group and therefore no major influence of the operation on the final development of the maxilla and dento-alveolar structures may be expected. Only a few publications deal with the transversal maxillary dimensions in early operated UCLA patients. These are mostly studies on babies and young children roughly up to seven years of age (Robertson and Fish, 1975; Hellquist et al, 1983; Honda et al, 1995; Kramer et al, 1994, 1996). Only in the publications of Hellquist et al (1983) and Spauwen et al, 1993) some patients older than 13 years were included. Even fewer are the publications concerning the transversal dimensions of unoperated adult UCLA subjects (Innis, 1962; Bishara et al, 1985; Hardjowasito and Latief, 1988; Hardjowasito, 1989).
Innis (1962) studied 6 adult UCLA patients (20-35 years old) comparing them with a thousand adults belonging to the same tribe. A medial collapse of the alveolar arch was most evident in the canine and premolar region at the cleft side; the molars were in good occlusion and no cross-bite was seen. The maxillary width of the cleft and the control groups were comparable. Bishara et al (1985), studying a group of unoperated UCLA subjects in the ages from 7 to 50 years, also found a tendency to an edge-to-edge relationship or a cross bite in the canine region because the cleft segment tended to rotate medially. They concluded that the effect of the cleft of the lip and alveolus seemed to be limited to that part of the dentofacial complex that surrounds the cleft area. Several other studies cannot be considered to study unoperated UCLA as different types of clefts were analyzed within the same group (Law and Fulton, 1959; Mestre et al, 1960; Hagerty et al, 1964; Ortiz-Monasterio et al, 1974).

UCLP is a more frequent and more severe type of orofacial clefting than UCLA and requires extensive treatment, but the final result is not always satisfactory (Enemark et al, 1990). It is therefore not surprising that a large amount of studies is devoted to UCLP. They mainly concentrate on the analysis of the facial skeleton and are therefore mostly conducted on cephalograms (Hayashi et al, 1976; Smahel, 1984; Semb, 1991; Smahel and Brejcha, 1983; Smahel et al, 1994; Roberts-Harry et al, 1996). Studies on the transversal dimensions of the UCLP maxilla are mostly performed on dental casts of babies (Aduss and Pruzansky, 1968; Huddart et al, 1969; Shaw, 1978; Stöckli, 1971; Hagerty et al, 1994), dental casts of children in the deciduous dentition (Huddart and Bodenham, 1972; Robertson, 1974; Robertson and Fish, 1975; Kramer et al, 1996) and of children during the mixed dentition period (Wada et al, 1984; Athanasiou et al, 1988). Athanasiou et al (1987, 1988) also conducted longitudinal studies from the deciduous dentition up to the early permanent dentition (up to 12 years of age). They found that the width of the maxilla between the canines, the second premolars and first molars was always smaller than in non-cleft controls at the investigated ages. Vargervik (1981) described a sample of 16-year-old early operated patients, but the sample size is too limited to draw reliable conclusions. From the studies on early operated UCLP it can be concluded that at birth the maxillary arch dimensions in UCLP are larger than in controls (Kramer et al, 1994; Prahl et al, 2001, 2003), but in the course of time there is a predominant tendency to develop maxillary compression.
Data on maxillary arch width of unoperated UCLP patients are rare. As for operated UCLP, authors paid initially more attention to the skeletal analysis than to the dental cast analysis (Ortiz-Monasterio et al, 1959; Law and Fulton, 1959; Mestre et al, 1960; Innis, 1962; Hardjowasito, 1989). To our knowledge Bishara et al (1976) are the first who tried to analyze dental casts of unoperated UCLP subjects. Bishara et al (1976) described clinically the dental casts from a sample of 11 adult unoperated UCLP individuals. Five of them showed no cross-bite at all, three had only unilateral cross bites; and two other patients showed unilateral compression at the canine area of the cleft side only. In one patient the canine and the first premolar of the cleft side showed a cross bite. Finally two patients had incomplete buccal occlusion on the non-cleft side. In another publication of Bishara et al (1985) 12 patients with UCLP were analyzed of whom only two were older than 20 years, so the sample may not be considered as an adult sample. McCance et al (1990) studied maxillary arch width of 41 adult unoperated UCLP patients with the reflex microscope. The UCLP group showed a slight maxillary compression of 1.5 mm in the second molar region, with a maximum compression of 5 mm in the canine region resulting in a V-shaped maxillary dental arch. Da Silva Filho et al (1992) studied the maxillary width in a sample of 97 untreated UCLP subjects. In males they found a slight but significant narrowing of the maxilla from the first molar up to the canine. In females, as far as the inter-first molar and the inter-second premolar width were concerned, the width of the cleft group was not significantly different from the control group. Only the inter-first premolar and inter-canine width were significantly narrower in the cleft group than in the control group.

In conclusion it can be stated that our knowledge of dental arch dimensions in unoperated cleft lip and palate individuals is still limited. This is mainly due to methodological problems such as small sample sizes, heterogeneity of the samples, and lack of a control group. Furthermore the measurements performed on dental casts were mostly two-dimensional, which fails to take into account the three-dimensional aspect of the deformity. The effect of UCLA seems to be limited to the region of the cleft only, but data on this topic are limited. In unoperated UCLP, the inherent factor - the presence of the cleft - seems to have a minor effect on the transversal maxillary arch dimensions. Further study of adult unoperated cleft subjects is useful for a better understanding of differences among various cleft types while eliminating the superimposing effect of surgical or orthodontic treatment. Therefore the purpose of this chapter is to compare
transversal maxillary arch dimensions between two types of clefts in untreated individuals, UCLA and UCLP, and to compare these with a non-cleft sample of the same population.

4.2 Material and methods

Transversal maxillary arch dimensions of patients with unoperated UCLA and UCLP were measured on dental casts. The distribution of the unoperated cleft sample according to cleft type and age is given in table 2.1.

The control group consisted of 24 randomly selected non-cleft individuals from the surrounding population (see table 2.3 and 2.4). The dental casts were digitized according to the protocol as described in chapter 2. For every molar, 2 points were recorded: the tip of the distobuccal cusp and the tip of the mesiobuccal cusp. In the case of abrasion of a cusp, the centre of the abraded cusp was used as the reference point. For the premolars and the canines, the tip of the buccal cusps was recorded. Between corresponding points at the right and left side the following distances in the maxilla were calculated:

171 - 271 distance between distal cusps of the right and left second molar.
172 - 272 distance between mesial cusps of the right and left second molar.
161 - 261 distance between distal cusp of the right and left first molar.
162 - 262 distance between mesial cusp of the right and left first molar.
151 - 251 distance between buccal cusps of the right and left second premolar.
141 - 241 distance between buccal cusps of the right and left first premolar.
131 - 231 distance between cusps of the right and left canine

The upper arch ratio (%) was calculated as 131-231 distance / 161-261 distance * 100.

Means and standard deviations were calculated for all variables. Occasionally in the cleft groups models were missing or teeth were extracted. Therefore the numbers differ per variable. The t-test was used to determine whether the mean values of the cleft groups showed significant differences from each other and from the control group. The level of significance was set at p<0.05.
4.3 Results

Means and sd (in mm) for maxillary arch dimensions at the level of the canine, first premolar, second premolar, first molar, and second molar in adult unoperated UCLA and UCLP subjects as compared with the control group are summarized in table 4.1. Box-whisker plots of the maxillary arch width in the UCLA, UCLP and control are shown in figure 4.1.

The transverse maxillary arch dimensions in the UCLA group did not show significant differences with the control group from the second molar up until the first premolar. Only at the level of the canine, close to the alveolar cleft, the intercanine distance was significantly smaller in the UCLA group (p=0.03). This was also expressed by the upper arch ratio showing that in UCLA the mean intercanine width is 60.4% of the intermolar width, while in the control group this value is 64.2% (p=0.00005).

In the UCLP group the maxillary width at the level of the second molar was significantly different compared to the control group. The mean difference for the 171-271 distance (distobuccal cusps) was 3.3 mm (SE 0.8); for the 172-272 distance (mesiobuccal cusps) this was 1.8 mm (SE 0.7). Consequently there is a mesio-palatal rotation of the second molar. The arch width at the level of the first molar and second premolar was not statistically different compared to the corresponding measurements in the control group. Between the first premolars, the maxillary width of the UCLP group was 2.1 mm (SE 0.6) smaller compared to the control group (p=0.0008). At the level of the canine this difference was even more obvious and came up to 6.1 mm (SE 0.6) (p=0.00005). The upper arch ratio showed that in UCLP the mean intercanine width was only 53.1% of the intermolar width, while in the UCLA group this value was 60.4% and in the control group even 64.2% (p=0.00005).

As the second molars in the UCLP group are positioned laterally and the first premolar and canines medially, the upper arch of the UCLP subjects has the tendency to loose the U-shaped configuration of the normal non-cleft dental arch and to become more or less V-shaped, which is also expressed by the upper arch ratio. In three patients a scissors bite was found with the teeth of the lateral part of the maxilla located outside the corresponding teeth of the mandible. In two of them the scissors bite was found at the lesser segment. The third one showed a scissors bite of the major segment, which is the non-cleft side. On the other hand in the latter subject the tip of the upper canine was located medially of the tip of the contralateral mandibular canine.
Table 4.1  Mean and SD (in mm) of transversal maxillary dental arch dimensions for unoperated UCLA and UCLP and the non-cleft controls. For explanation of the variables see Materials and methods section.

<table>
<thead>
<tr>
<th>COMPARISON OF MAXILLARY TRANSVERSAL ARCH DIMENSIONS (IN MM) BETWEEN UNOPERATED ADULT UCLA, UCLP AND THE CONTROL GROUP</th>
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<td>UPPER ARCH RATIO (%)</td>
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DIFF = difference in arch width between UCLP and BCLP and control and between UCLA and BCLP
S.E = standard error of difference
LOWER ARCH RATIO = 131-231 distance / 161-261 distance * 100 (%)
Comparing the maxillary arch width between UCLA and UCLP as shown in table 4.1, the intermolar width at the second molars was significantly larger in UCLP than in UCLA. More anteriorly, at the level of the first molar and second premolar the difference between the two groups was not significant and gradually decreased. At the level of the first premolars the arch width in UCLP was 1.9 mm (SE 0.5) smaller than in UCLA subjects (p=0.0001). Also the intercanine width was smaller in UCLP as compared to UCLA.

4.4 Discussion and conclusions

There are only a few publications in the literature dealing with transversal measurements of the dento-alveolar part of the maxilla of unoperated UCLA
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patients. Apart from a preliminary report from our group on a small subsample of the same population (Derijcke et al, 1994) the present study is the first one dealing with the analysis of maxillary transversal arch width of unoperated adult UCLA subjects in a really large sample, which is -to our knowledge- the largest one described in the literature. The number of the analyzed subjects is sufficient to allow reliable conclusions on this topic.

In our sample up to the level of the first premolar the transversal dimensions of the maxilla of the unoperated UCLA group are not significantly different from the transversal dimensions of the non-cleft population. This is in accordance with the findings of Bishara et al (1985) but is in contradiction with the findings of Innis (1962), who found compression in the maxillary premolar area. However, the samples in both studies were small and the statistical analysis especially by Innis (1962) is insufficient to allow reliable conclusions. The same holds good for the publications of Hardjowasito and Latief (1988) and Hardjowasito (1989). The only significant difference between the UCLA-group and the control group was found in the canine area. The maxillary intercanine width was significantly smaller in the UCLA group. Whether this reduction of the intercanine width is of skeletal or dental origin or both is not clearly understood. The presence of the alveolar cleft may be the cause of local segmental collapse, resulting in a reduction of the intercanine distance. A medial dental collapse of the canine itself due to the absence or reduction in size of the lateral incisor at the cleft side might also be a local factor responsible for this phenomenon.

In unoperated adult UCLP subjects a different pattern for maxillary arch width was found compared to the UCLA and compared to the control group. At the level of the second permanent molar the maxilla was found to be wider in UCLP than in UCLA and the controls. The values point to a mesio-palatal rotation of the second permanent molar that has not been described previously in the literature. McCance et al (1990) noticed a slight narrowing of the maxilla at this place. The reason of this contradiction is not clear; the slightly different method used to assess the dental casts or the small sample size in their study might explain this. In our UCLP sample the intermaxillary width at the level of the first molar and second premolar was found to be normal. This is in contradiction with the findings of McCance et al (1990) and Da Silva Filho et al (1992) who found some compression in this area. The difference, however, is marginal and in the sample of Da Silva Filho et al (1992) only statistically significant in males. More anteriorly in the first premolar and canine region the arch width was significantly smaller in the
UCLP group compared to the UCLA group as well as the non-cleft control group. These findings are in agreement with the literature (Crabb and Foster, 1977; Bishara et al, 1985; McCance et al, 1990; Da Silva Filho et al, 1992). Although significantly smaller, the difference between cleft and control group was only 2 mm at the first premolar, but the constriction was more obvious at the canine area, where the intercanine width was approximately 6 mm less than the control group.

Change of the general arch form of the maxilla in UCLP to a V-shape as McCance et al (1990) have already described, was also observed in several individuals in our sample. In contrast to McCance et al (1990) the change of the shape of the dental arches in our sample may not only be attributed to the constriction of the entire maxilla, but is due to a combination of enlargement of the maxillary width at the second molar area combined with constriction in the first premolar and canine region.

In conclusion, the presence of a cleft has an influence on the final development of the dento-alveolar part of the maxilla: the more extensive the cleft, the more extensive the effect on the dental arch. The compression of the maxilla is limited to the vicinity of the cleft in the anterior region. These findings support the hypothesis that, in treated cleft palate patients, developmental disturbances of the maxillary arch are primarily due to surgery. However, the findings also suggest that each type of cleft has its own intrinsic characteristic dental arch form. Surgical procedures might influence subsequent growth, which makes the intrinsic deviation clinically manifest.

4.5 References

ADUSS H, PRUZANSKY S. Width of cleft at level of the tuberosities in complete unilateral cleft lip and palate. Plast Reconstr Surg 1968;41:113-123.


