A cephalometric intercentre comparison of patients with unilateral cleft lip and palate at 5 and 10 years of age

Filomena Del Guercio*, Maria Costanza Meazzini*, Giovanna Garattini**, Alberto Morabito***, Gunvor Semb**** and Roberto Brusati*

*Department of Maxillo-Facial Surgery, University of Milan, Regional Center for CLP, Departments of **Orthodontics and ***Biomedical Statistics, San Paolo Hospital, Milan, Italy and ****Oslo Cleft Team, Department of Plastic Surgery, National Hospital, Norway

SUMMARY The aim of this study was to evaluate any differences between the craniofacial growth of unilateral cleft lip and palate (UCLP) patients who underwent surgery in the Milan CLP centre with those from the Oslo CLP centre at 5 and 10 years of age.

The Milan sample comprised 88 UCLP patients (60 males, 28 females) at 5 years of age and 26 patients (17 males, 9 females) at 10 years of age, all operated on by the same surgeon. The Oslo sample consisted of 48 UCLP patients (26 males, 22 females) aged 5 years and 29 patients (20 males, 9 females) aged 10 years treated by four different surgeons. Lateral cephalometric radiographs obtained for both samples were analysed and angular measurements and ratios were calculated both for the hard and soft tissues. Statistical analysis was undertaken with an unpaired t-test.

At 5 years of age, there were neither sagittal nor vertical hard tissue differences between the two groups. With regard to the soft tissues, only the naso-labial angle showed a statistically significant difference (Milan greater than Oslo by 5 degrees, \(P < 0.01\)). At 10 years of age, both SNA and ANB differences were larger in the Oslo group than in the Milan group, >2.6 degrees, \(P < 0.01\) and >2.9 degrees, \(P < 0.001\), respectively.

At 5 years of age, the Milan UCLP sample had the same maxillary protrusion as the Oslo group, while at 10 years of age, the Milan sample were slightly less protruded than the Oslo group.

Introduction

Numerous cephalometric studies (Ortiz-Monasterio et al., 1966; Huddart, 1969; Da Silva Filho et al., 1992; Capelozza Filho et al., 1996) on cleft lip and palate (CLP) patients have shown that maxillary growth in operated CLP patients is often restricted three-dimensionally.

However, no consensus has been reached as to the cause of this growth inhibition. Surgical treatment is viewed as the variable most influencing craniofacial growth (Ross, 1987; Shaw et al., 1992).

It is still controversial as to which type of surgical repair most negatively influences growth. Some authors (Bardach and Mooney, 1984; Kapuçu et al., 1996; Capelozza Filho et al., 1996; Huang et al., 2002) consider lip closure as the most important factor responsible for maxillary growth restriction, while others palatal surgery (Ross, 1987; Liao and Mars, 2005).

Secondary bone grafting is carried out usually before the eruption of the canines or, in some centres, before the eruption of the permanent maxillary lateral incisors (Eldeeb et al., 1986; Bergland et al., 1986; Lilya et al., 2000). According to Semb (1988), secondary bone grafting after 8 years of age does not have any adverse influence on anteroposterior or vertical maxillary growth, while Enemark et al. (1987) and Daskalogiannakis and Ross (1997) report a negative influence on vertical growth when bone grafting is performed before 10–11 years of age.

The iatrogenic effect of surgical repair, on the other hand, has been shown to be strongly linked to the experience of the surgeons and their surgical skill (Shaw et al., 1992).

Intercentre studies allow for comparison between different surgical protocols applied in different centres in order to define the protocol from which the best results in terms of growth, dental occlusion, and aesthetics can be obtained (Shaw et al., 1992).

The results for the Oslo centre have been previously compared with other European centres and maxillary growth of the subjects has been shown to be among the best in Europe (Molsted et al., 1992).

The Milan surgical protocol consists of lip, nose, and soft palate repair at 4–6 months of age (Brusati and Mannucci, 1992) and early secondary gingivoalveoloplasty (ESGAP) at 18–36 months of age during hard palate repair. Pre-surgical orthopaedics are performed in 60 per cent of patients. The Milan ESGAP seems to allow for excellent ossification (no necessity for secondary bone grafting), but at this time, it is not possible to determine its influence on maxillary growth (Meazzini et al., 2007).
The Oslo CLP team use a different surgical protocol including lip closure (Millard procedure) at 3 months of age with hard palate repair by a one-layer vomer flap without any pre-surgical orthopaedics, and posterior palate closure at 18 months of age according to von Langenbeck (Semb, 1991). The alveolar cleft is repaired with a bone graft between 8 and 11 years of age (Bergland et al., 1986).

The objective of this study was to determine whether there is any difference between the craniofacial growth of unilateral cleft lip and palate (UCLP) patients treated in the Milan CLP centre and those patients from the Oslo CLP centre at 5 and 10 years of age.

Subjects and methods
The Milan 5-year-old sample comprised 88 consecutively treated UCLP (60 males, 28 females) non-syndromic patients, with an average age of 5 years 1 month, all operated on by the same surgeon, and the 10-year-old sample 26 consecutively treated UCLP (17 males, 9 females) non-syndromic patients, with an average age of 9 years 10 months, all operated by the same surgeon. None of the subjects were omitted from the sample because of missing records or other reasons. All patients were Caucasian and of Italian origin.

The Oslo 5-year-old sample comprised 48 consecutively treated UCLP (26 males, 22 females) non-syndromic patients with an average age of 5 years 9 months and 29 consecutively treated UCLP (20 males, 9 females) non-syndromic patients, with an average age of 10 years treated by four different surgeons. All subjects were Caucasian of Norwegian origin.

Lateral cephalometric radiographs were obtained for both groups at 5 and 10 years of age. The radiographs (Figure 1) were traced by one trained operator (FDG).

The parameters evaluated on the lateral radiographs are listed in Table 1. Linear measurements were not compared as absolute values, as it was not possible to calculate the radiographic magnification obtained with different machines, since the technical parameters were not reported.

Statistical analysis
An unpaired \(t\)-test was used to determine any differences between the two samples. The same experienced operator retraced, after an interval of 1 month, 25 blindly selected radiographs to avoid bias linked to groups. Method error analysis was carried out using the formula of Dahlberg (1940). For all variables, the measurement error was less than 3 per cent of the total variance. Furthermore, systematic error was estimated with a one-sample \(t\)-test, while random error was evaluated through the coefficient of reliability as suggested by Houston (1983).

Figure 1 Skeletal and soft tissue landmarks measured on the lateral cephalometric radiographs. S (sella) midpoint of the fossa hypophysealis; Ba (basion) most postero-inferior point of the clivus; Ans (anterior nasal spine) most anterior point of antero-posterior profile of the upper jaw; Pns (posterior nasal spine) most posterior point of the bony palate; N (nasion) anterior point at the fronto-nasal suture; Point A deepest anterior point in the concavity of the anterior maxilla; Point B deepest anterior point in the concavity of the anterior mandible; Pg (pogonion) the most projecting point in the contour of the chin; Ar (articulare) intersection of a line along the posterior border of the mandible and the inferior border of the basilar occipital bone; Go (gonion) intersection between a line bisecting the posterior and inferior borders of the mandible and the contour of the chin; Gn (gnathion) point of intersection between the contour of the chin and a line bisecting the inferior border of the mandible and a line passing through N and Pg; n (nasion) most posterior point at the fronto-nasal suture level on the soft tissues; an (anterior nasalis) tip of the nose on the soft tissues; sn (subnasalis) point of intersection between the base of the nose and upper lip on the soft tissues; ss (subspinale) most posterior point in the anterior concavity of the upper lip on the soft tissues; sm (supramentale) most posterior point in the anterior concavity of the lower lip; pg (pogonion) most anterior point of the mandibular profile in the mental region on the soft tissues; gn (gnathion) most inferior point of the mandibular profile in the mental region on the soft tissues; ia (labiale inferiorioris) most projecting point, on the frontal plane, of the upper lip; li (labiale inferiorioris) most projecting point, on the frontal plane, of the lower lip.

Results
Five years of age

Hard tissue variables. Sagittal dimensions. There was no significant difference in maxillary prominence, although in the sagittal jaw relationship, there was a statistically significant difference between the Milan and Oslo UCLP samples (Table 1). There was no significant difference in cranial base angulation \((P > 0.05)\).

Vertical dimensions. There was no significant difference in palatal inclination. Craniomandibular, intermaxillary, and mandibular angles were significantly larger in the Milan UCLP sample \((P < 0.001)\).

Soft tissue variables. There was no significant difference in the sagittal protrusion of the upper lip, while the sagittal
interlip relationship in the Milan group was significantly smaller than in the Oslo sample (Table 1). Naso-labial angle was larger in the Milan UCLP sample and the difference was statistically significant \( (P < 0.01) \).

**Ten years of age**

**Hard tissue variables.** Sagittal dimensions. There was a significant difference in maxillary prominence and in sagittal jaw relationship between the Milan and Oslo samples \( (P < 0.01); \) Table 1). The Oslo UCLP sample was more protruded than the Milan sample at the dentoalveolar level, although there was no difference in the protrusion of anterior nasal spine.

Vertical dimensions. There was no significant difference in any of the vertical dimensions.

---

**Table 1**  Hard and soft tissues measurements at 5 and 10 years of age for the Milan and Oslo unilateral cleft lip and palate patients.

|                  | Milan          | Oslo          | Mean difference |
|------------------|---------------|--------------|----------------|
| SNA              | 5 years       | 79.8 (4.1)   | 80.5 (3.9)     | −0.7           |
|                  | 10 years      | 75.4 (3.7)   | 78.0 (3.6)     | −2.6           |
| S–N–Ans          | 5 years       | 84.1 (4.1)   | 83.7 (4.0)     | 0.4            |
|                  | 10 years      | 80.5 (3.8)   | 82.2 (3.9)     | −1.7           |
| S–N Pns–Ans      | 5 years       | 11.2 (4.6)   | 10.1 (3.6)     | 1.1            |
|                  | 10 years      | 11.8 (3.8)   | 9.4 (4.1)      | 2.4            |
| SNB              | 5 years       | 74.6 (3.2)   | 74.4 (2.9)     | 0.2            |
|                  | 10 years      | 75.4 (3.4)   | 75.1 (3.6)     | 0.3            |
| S–N–Pg           | 5 years       | 74.6 (3.2)   | 74.3 (3.0)     | 0.3            |
|                  | 10 years      | 76.4 (3.7)   | 76.0 (3.4)     | 0.4            |
| S–N Go–Gn        | 5 years       | 38.4 (4.4)   | 35.5 (4.3)     | 2.9            |
|                  | 10 years      | 37.7 (4.4)   | 36.3 (3.9)     | 1.4            |
| Ar Go–Gn         | 5 years       | 135.4 (4.8)  | 129.4 (4.0)    | 6.0            |
|                  | 10 years      | 132.7 (4.7)  | 131.5 (4.5)    | 1.2            |
| ANB              | 5 years       | 5.2 (3.3)    | 6.4 (2.9)      | −1.2           |
|                  | 10 years      | −0.0 (3.1)   | 2.9 (2.7)      | −2.9           |
| Pns–Ans Go–Gn    | 5 years       | 27.5 (4.8)   | 25.3 (4.5)     | 2.2            |
|                  | 10 years      | 26.1 (5.0)   | 26.8 (5.2)     | −0.7           |
| N–A–Pg           | 5 years       | 170.9 (6.7)  | 167.5 (5.7)    | 3.4            |
|                  | 10 years      | 182.4 (7.0)  | 176.0 (5.4)    | 6.4            |
| LFH/TFH          | 5 years       | 60.13%       | 60.13%         | 0.0%           |
|                  | 10 years      | 56.8%***     | 58.3%***       | −1.5%          |
| Ba–S–N           | 5 years       | 128.4 (4.9)  | 128.5 (5.5)    | −0.1           |
|                  | 10 years      | 130.1 (5.1)  | 128.9 (5.0)    | 1.2            |
| Ba–S–Pns         | 5 years       | 60.7 (5.3)   | 64.4 (5.6)***  | −3.7           |
|                  | 10 years      | 59.7 (5.0)   | 58.6 (4.6)     | 1.1            |
| S–n–ss           | 5 years       | 85.0 (4.0)   | 84.9 (3.5)     | 0.1            |
|                  | 10 years      | 87.3 (4.2)   | 89.5 (3.1)     | −2.2           |
| S–n–sm           | 5 years       | 78.9 (3.4)   | 78.1 (2.6)     | 0.8            |
|                  | 10 years      | 81.2 (4.2)***| 78.0 (2.5)***  | 3.2            |
| ss–n–sm          | 5 years       | 6.0 (2.6)*   | 7.0 (2.0)*−     | −1.0           |
|                  | 10 years      | 3.6 (2.8)*** | 6.1 (2.2)***   | −2.5           |
| ss–n–pg          | 5 years       | 5.5 (2.8)    | 5.9 (2.3)      | −0.4           |
|                  | 10 years      | 3.9 (1.5)*** | 5.6 (1.9)***   | −1.7           |
| n–sn–pg          | 5 years       | 167.1 (6.0)  | 167.8 (4.9)    | −0.7           |
|                  | 10 years      | 171.2 (6.4)  | 167.9 (3.6)    | 3.3            |
| A–N–ss           | 5 years       | 5.3 (3.3)    | 4.4 (3.3)      | 0.9            |
|                  | 10 years      | 12.3 (2.5)   | 12.3 (2.6)     | 0.0            |
| an–sn–Is         | 5 years       | 127.7 (10.0) | 123.0 (10.5)** | 4.7            |
|                  | 10 years      | 119.2 (10.6) | 118.1 (12.7)   | 1.1            |

\*\( P < 0.05; \) **\( P < 0.01; \) ***\( P < 0.001.\)

**Soft tissue variables.** The sagittal relationship was significantly less favourable in the Milan UCLP sample compared with the Oslo UCLP sample \( (P < 0.001); \) Table 1).

**Discussion**

The results of the present study showed no differences in maxillary protrusion at 5 years of age between the two groups.

These data confirm cephalometrically the findings obtained using the 5-year yardstick by Flinn et al. (2006), where the 5-year-old dental arch relationship of patients from three different centres (Oslo, Norway; Milan, Italy; and Lancaster, Pennsylvania, USA) were compared. The results showed that between the three centres there were no statistically significant differences, even though the protocols differed.

In this study, the Milan sample showed a more divergent mandibular pattern and a more open gonial angle than the Oslo sample, demonstrating a different pattern of mandibular growth. Semb (1988) reported that after bone grafting there was a tendency towards posterior rotation of the mandible. Furthermore, Trotman et al. (1996) found that in patients who had undergone primary grafting, the mandibular growth pattern was different from the non-grafted group with a clockwise rotation of the mandible. ESGAP might therefore explain the difference in mandibular rotation. This apparent mandibular compensation which differentiated the Milan sample from the Oslo sample at 5 years of age was not significant at 10 years of age. A possible explanation might be that by 10 years of age, most of the Oslo sample had undergone secondary bone grafting.

The present results show that at 10 years of age, the Oslo sample was significantly more protruded at the maxillary dentoalveolar level than the Milan sample, although, there was no difference in protrusion of anterior nasal spine. Soft tissue differences confirmed a larger upper lip protrusion for the Oslo sample. At present, there is no explanation for this dentoalveolar growth difference at 10 years of age. The improved growth of the Oslo group compared with the Milan sample might be related to the different surgical protocols. Intrinsic racial differences might also be a confounding factor. Although there are cephalometric studies on the Norwegian population (El-Batouti et al., 1994; Axelsson et al., 2003), no data exist on craniofacial growth of Italians. There is a great variability in the Italian race due to Spanish and Austro-Hungarian domination in Northern Italy and Swedish domination in Southern Italy, but no studies have analysed this variability. Certainly, long-term data will be needed for a more definitive conclusion.

**Conclusions**

At 5 years of age, the Milan UCLP group appears to have the same maxillary protrusion as the Oslo sample, while at 10
years of age, the Milan UCLP sample appears to be slightly less protruded when compared with the Oslo group.

**Address for correspondence**

Filomena Del Guercio  
Via Saritarena 1  
Bollate  
Milano 20021  
Italy  
E-mail: filomena.delguercio@libero.it

**References**

Axelsson S, Kjær J, Bjørnland T, Storhaug K 2003 Longitudinal cephalometric standards for the neurocranium in Norwegians from 6 to 21 years of age. European Journal of Orthodontics 25: 185–198

Bardach H, Mooney MP 1984 The relationship between lip pressure following lip repair and craniofacial growth: an experimental study in beagles. Plastic and Reconstructive Surgery 73: 544–555

Bergland O, Semb G, Åbyholm F, Borchgrevink H, Eskeland G 1986 Secondary bone grafting and orthodontic treatment in patients with bilateral complete clefts of the lip and palate. Annals of Plastic Surgery 17: 460–474

Brusati R, Mannucci N 1992 The early gingivoperiosteoplasty. Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery 26: 65–70

Capelozza Filho L, Normando AD, da Silva Filho OG 1996 Isolated influences of lip and palate surgery on facial growth: comparison of operated and unoperated male adults with UCLP. Cleft Palate-Craniofacial Journal 33: 51–56

Dahlberg G 1940 Statistical methods for medical and biological students. George Allen & Unwin Ltd, London

Da Silva Filho Jr OG, Normando AD, Capelozza Jr L 1992 Mandibular morphology and spatial position in patients with clefts: intrinsic or iatrogenic? Cleft Palate-Craniofacial Journal 29: 369–375

Daskalogiannakis J, Ross RB 1997 Effect of alveolar bone grafting in the mixed dentition on maxillary growth in complete unilateral cleft lip and palate patients. Cleft Palate-Craniofacial Journal 34: 455–458

El-Batouti A, Øgaard B, Bishara SE 1994 Longitudinal cephalometric standards for Norwegians between the ages of 6 and 18 years. European Journal of Orthodontics 16: 501–509

Eldeeb M, Hinrichs JE, Waite DE, Bandt CL, Bevis R 1986 Repair of alveolar cleft defects with autogenous bone grafting: periodontal evaluation. Cleft Palate Journal 23: 126–136

Enemark H, Sindet-Pedersen S, Bundgaard M 1987 Long term results after secondary bone grafting of alveolar clefts. Journal of Oral and Maxillofacial Surgery 45: 913–919

Flinn W, Long RE, Garattini G, Semb G 2006 A multicenter outcomes assessment of five-year-old patients with unilateral cleft lip and palate. Cleft Palate-Craniofacial Journal 43: 253–258

Houston WJB 1983 The analysis of errors in orthodontic measurements. American Journal of Orthodontics 83: 382–390

Huang C, Liou EW, Chen Y, Noordhoff MS 2002 Effects of cheiloplasty on maxillary dental arch development in infants with unilateral cleft lip and palate. Cleft Palate-Craniofacial Journal 39: 513–516

Huddart AG 1969 Maxillary arch dimensions in normal and unilateral cleft lip and palate subjects. Cleft Palate-Craniofacial Journal 6: 471–487

Kapucu M, Gursu KG, Enacar A, Aras S 1996 The effect of cleft lip repair on maxillary morphology in patients with unilateral complete cleft lip and palate. Plastic and Reconstructive Surgery 97: 1371–1375

Liao YF, Mars M 2005 Long-term effects of lip repair on dentofacial morphology in patients with unilateral cleft lip and palate. Cleft Palate-Craniofacial Journal 42: 526–535

Lila J, Kalaaji A, Friede H, Elander A 2000 Combined bone grafting and delayed closure of the hard palate in patients with unilateral cleft lip and palate: facilitation of lateral incisor eruption and evaluation of indicators for timing of procedure. Cleft Palate-Craniofacial Journal 37: 98–105

Mezzini MC, Tortora C, Morbihito A, Garattini G, Brusati R 2007 Alveolar bone formation in patients with unilateral and bilateral cleft lip and palate after early secondary gingivo-alveolo-plasty: long term results. Plastic and Reconstructive Surgery 119: 1527–1537

Molsted K, Asher-McDade C, Battström Y 1992 A six center international study of treatment outcome in patients with clefts lip and palate: Past 2. Craniofacial form and soft tissue profile. Cleft Palate-Craniofacial Journal 29: 398–403

Ortiz-Monasterio F, Serrano A, Barrera G, Rodriguez-Hoffman H, Vinagres E 1966 A study of untreated adult cleft palate patients. Plastic and Reconstructive Surgery 38: 36–41

Ross BR 1987 Treatment affecting facial growth in complete unilateral cleft lip and palate. Part I: treatment affecting growth. Cleft Palate Journal 24: 4–23

Semb G 1988 Effect of alveolar bone grafting on maxillary growth in unilateral cleft lip and palate patients. Cleft Palate Journal 25: 288–295

Semb G 1991 A study of facial growth in patients with unilateral cleft lip and palate treated by the Oslo CLP team. Cleft Palate-Craniofacial Journal 28: 1–21

Shaw WC et al. 1992 A six-center international study of treatment outcome in patients with clefts of the lip and palate: part 5. General discussion and conclusions. Cleft Palate-Craniofacial Journal 29: 413–418

Trotman CA, Long, RE, Rosenstein SW, Murphy C, Johnston JR L 1996 Comparison of facial form in primary alveolar bone-grafted and nongrafted unilateral cleft lip and palate patients: intercenter retrospective study. Cleft Palate-Craniofacial Journal 33: 91–95