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# Changes in occlusion and maxillary dental arch dimensions in adults with treated unilateral complete cleft lip and palate: a follow-up study

Agneta Marcusson and Gunnar Paulin
Department of Dentofacial Orthopaedics, University Hospital, Linköping, Sweden

SUMMARY The purpose of this study was to evaluate the occlusion and maxillary dental arch dimensions in adults with repaired complete unilateral cleft lip and palate (UCLP) and to investigate the patterns of change in early adulthood.

Study models from 39 patients (25 men, 14 women; mean age 24.7 years, range 20.2–29.3 years) with a diagnosis of complete UCLP taken at a follow-up examination were analysed and compared with the study models taken at baseline examination (mean age 19.1 years, range 16.0–20.6 years). Lip closure was carried out according to the Millard technique and palatal closure according to the Wardill–Kilner technique. All patients had received orthodontic treatment with fixed appliances. The patients were divided into three groups according to the type of retention in the upper arch: no retention ($n$ = 15), retention with a bonded twisted retainer ($n$ = 13), an onlay or fixed bridge ($n$ = 11). Occlusion was evaluated according to a scoring system. The maxillary dental arch dimensions were measured with a video imaging system.

There was a significant deterioration in the total occlusal score during the follow-up period and this was larger on the cleft than on the non-cleft side. There were no significant differences in the anterior scores. A comparison of the transversal and sagittal maxillary arch dimensions revealed significant differences in all measurements during the follow-up interval. The reduction was largest for the maxillary second premolar width, followed by the first molar width. The overjet differed significantly between the registrations. The occlusal score and the maxillary arch dimensions were reduced in all of the three subgroups, but there were no differences between the groups.

## Introduction

There is evidence in the literature that cleft repair in children with complete unilateral cleft lip and palate (UCLP) interferes with growth of the maxilla (Long *et al.*, 2000). An important long-term goal in the treatment of children with cleft lip and palate (CLP) is a young adult that is functionally habilitated (e.g. acceptable speech, appearance, mastication, and educational attainment) and psychologically adjusted (Endriga and Kapp-Simon, 1999). The primary surgical procedures have a dramatic effect on the facial appearance of the child. They also create a base for feeding and speech development but may have long-term negative effects on facial growth and dental occlusion (Ross and Johnston, 1972). Scar tissue is believed to be the most important factor that disturbs craniofacial growth and development in patients with CLP (Ross and Johnston, 1972; Mars and Houston, 1990; Normando *et al.*, 1992; Trotman *et al.*, 1993; Filho *et al.*, 1996; Ramstad and Jendal, 1997). Maxillary retrusion with anterior and lateral crossbites is a very common finding in patients with clefts, regardless of treatment approach (Mars *et al.*, 1992). Surgical procedures that minimize poor midfacial growth without disturbing speech development or cosmetic results must be used. The treatment of malocclusion in cleft palate children is the most time-consuming procedure and, for the patient, perhaps the most laborious part of the rehabilitation programme. Numerous authors have summarized the most common problems with occlusion and alignment (Ross, 1975; Cooper *et al.*, 1979; Subtelny, 1990; Vargervik, 1990). The relative severity of the problems seems to have decreased at many centres, leading to the possibility of more successful orthodontic treatment results for a larger percentage of patients (Long *et al.*, 2000). However, impaired sagittal and transversal maxillary growth together with disturbed development of the dentition still require extensive orthodontic treatment in many patients with UCLP.

Although most patients with UCLP undergo orthodontic treatment, few studies on long-term post-treatment stability of the teeth and the maxillary segments in adult patients with UCLP have been carried out. Longitudinal studies of dentofacial development in adolescents with UCLP have found that the occlusion deteriorates between 16 and 20 years of age, a dentofacial development that is interpreted as being unfavourable and a relapse after orthodontic treatment (Enemark *et al.*, 1990; Paulin and Thilander, 1991).

Because of decreased maxillary growth, orthodontic treatment has often involved transversal and sagittal expansion of the dental arches. The stability of the orthodontic and prosthodontic results of treatment of patients with UCLP has been described in follow-up investigations (Brägger *et al.*, 1991; Ramstad and Jendal, 1997). A slight decrease in the upper dental arch width was found in these studies, accompanied by a slight increase in the number of teeth in crossbite in the investigation of Brägger *et al.* (1991). Thus, it is important to evaluate the possible effects of post-treatment changes for each individual when choosing the type and time of retention.

The purpose of the present longitudinal study was to investigate post-treatment changes in the maxillary arch and occlusion of adults with repaired complete UCLP.

## Materials and methods

### *Patients*

The material consisted of study models from 39 patients (25 men, 14 women) with complete UCLP. Dental casts from an examination at approximately 19 years of age (baseline) and from a follow-up examination at about 25 years of age were analysed. The mean follow-up time was 5.6 years (range 0.9–9.6 years) (Table 1). All patients were treated according to the protocol used by the cleft palate team at the University Hospital in Linköping, Sweden. The material was chosen from 54 consecutive non-syndromic UCLP patients born between 1968 and 1977. Fifteen patients were excluded as follows: removable lingual appliance in the upper arch ($n$ = 6); no study model at the baseline or at the follow-up examination ($n$ = 5); orthodontic treatment, prosthodontic treatment or orthognathic surgery after the baseline examination ($n$ = 4).

The primary surgery had been performed at the Department of Plastic Surgery with lip closure at 3 months of age using the Millard technique and palatal closure at 18 months of age using the Wardill–Kilner technique. One surgeon carried out all the lip surgery and another all the palatal surgery. The secondary surgery—bone grafting, lip plasty and rhinoplasty—was undertaken by three plastic surgeons.

**Table 1** Age (years) distribution for the subjects ($n$ = 39) at the two registrations.

| | Mean | Standard deviation | Range |
|---|---|---|---|
| Baseline | 19.1 | 0.95 | 16.0–20.6 |
| Follow-up | 24.7 | 2.5 | 20.2–29.3 |
| Interval between registrations | 5.6 | 2.2 | 0.9–9.6 |

All patients had worn fixed orthodontic appliances which had been removed at least 1 year before baseline. The patients were divided into three groups according to the retention in the upper arch: no retention ($n$ = 15), retention with a bonded twisted retainer extended canine to canine ($n$ = 13), an onlay or fixed bridge to replace one missing tooth ($n$ = 11).

### *Occlusion*

To describe anterior and lateral crossbites, the principles used by Hellquist *et al.* (1983) and a modification of the scoring system developed by Huddart and Bodenham (1972) were used. The maxillary tooth was given a score depending on its relationship to its opponent in the mandibular arch (no crossbite = 0; edge to edge = –1; crossbite = –2. All maxillary teeth except the lateral incisors and the second and third molars were included in the analysis (Figure 1). The total crossbite score (0 to –20), as well as the scores for the different segments of the maxillary arch, i.e. anterior (central incisors 0 to –4) and lateral segments (canine tooth to first molar 0 to –8), were calculated. If a tooth was missing it was given a score corresponding to the mean value of the neighbouring teeth within the segment. The sums of the segment scores were rounded up to the nearest negative integer. Lateral crossbite was considered when the subject had a score less than or equal to –4 and anterior crossbite when the score was less than or equal to –3.

### *Maxillary arch dimensions*

The length and width of the dental arches were measured as shown in Figure 2. The reference points, marked with a pencil on the dental casts, were the contact point of the central incisors, the tips of the canines, the tips of the buccal cusps of the second premolars (if missing, the

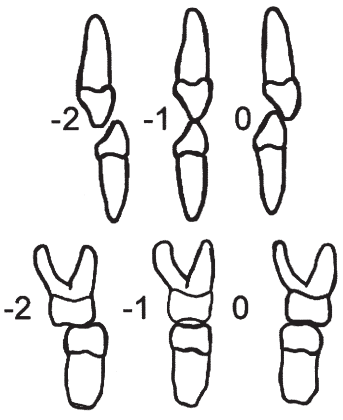


**Figure 1** Method for the evaluation of the occurrence of crossbite according to Huddart and Bodenham (1972). Scores were calculated for different segments of the maxillary dental arch as well as for the whole arch (laterals excluded).

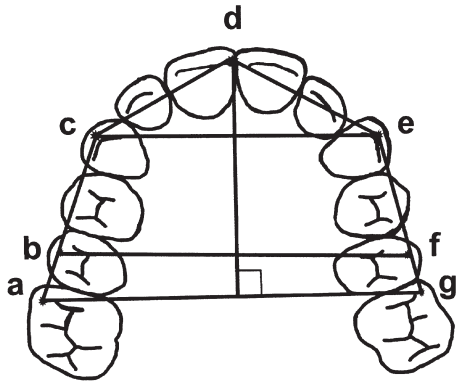


**Figure 2** Measurement of the maxillary arch dimensions: a–g, first molar width; b–f, second premolar width; c–e, canine width; d to line a–g, sagittal arch length. The distances a–c–d and g–e–d represent the length of the lateral segment.

first premolar was marked), and the tips of the mesiobuccal cusps of the first molars. In the event of attrition, the centre of the abraded surface was marked. The measurements were made using a video imaging system (FACAD, Innovativ Vision AB, Linköping, Sweden) with a resolution of 0.3 mm. Each cast was placed under the video camera. The reference points were digitized on a video screen with ×3 magnification. The casts were digitized twice and if the difference between the two measurements was smaller than 0.5 mm the values from the first measurements were used. If the difference was larger than 0.5 mm, a third digitization was made and the mean value of the two closest readings was used. Adjustment to a scale of 1:1 was computerized.

Overjet and overbite were measured at the mesiobuccal part of the most proclined upper central incisor. The registrations were made to the nearest 0.5 mm using a sliding calliper.

### *Error of the method*

Repeat measurements for error were performed on 30 randomly chosen dental casts, covering the full age range, to study the random error of the digitizing method. The casts were digitized twice by one author (AM) with a 1 week interval. No significant differences between the first and second measurements were found using the paired *t*-test. The precision of the measurement was calculated according to the formula $S_e = \sqrt{(\Sigma d^2/2n)}$ (Dahlberg, 1940). The range of precision varied between 0.13 (maxillary first molar width) and 0.18 (maxillary sagittal length and maxillary canine width). The square of precision ($S_e^2$) was less than 3 per cent of the total variance of the measured distances.

### *Statistics*

Descriptive statistics, including means and standard deviations, were calculated for the various measurements. A paired Wilcoxon signed rank test was used to determine any statistically significant changes between follow-up and baseline registration. Differences between the subgroups and gender were assessed using the Kruskal–Wallis test. *P*-values of less than 0.05 were accepted as significant.

## Results

### *Occlusion*

At baseline, 44 per cent of the patients had a total occlusal score (≤ –4) equivalent to crossbite on two or more teeth, 25 per cent (≤ –1 to < –4) crossbite on one or two teeth and 31 per cent (≥ –1 to 0) nearly normal occlusion. The frequency of an occlusal score less than or equal to –4 was 10 per cent for the anterior segment, 23 per cent for the non-cleft side, and 31 per cent for the cleft side (Figure 3). The deterioration in the total occlusal score during the follow-up interval was significant, whereas the anterior score was unchanged (Figure 4). In addition, no differences related to the type of retention were found between the groups. In 46 per cent of the subjects the total occlusal score remained unchanged or improved by less than one point during the follow-up interval. Reductions of one to two points were seen in 31 per cent and of more than four points in 23 per cent (Figure 4). Changes in the anterior score were found in 13 per cent, in the non-cleft side score in 28 per cent, and in the cleft side score in 48 per cent. A trend for an increasing frequency of crossbite on the cleft side during the follow-up interval (from 31 to 41 percent) was seen. Crossbites on the non-cleft side (23 percent) and anterior crossbites (10 percent) did not change (Figures 3 and 4).

### *Maxillary arch dimensions*

Significant differences between the transverse and sagittal maxillary arch dimensions were found for all measurements during the follow-up interval (Table 2). The reduction in the maxillary second premolar width was largest, followed by the first molar width. The overjet differed significantly between registrations. A slight reduction was apparent in the total sample as well as in the three subgroups. The overbite decreased in the group without retention but did not differ significantly in the other groups. The arch lengths on the cleft and non-cleft sides did not differ in the amount of reduction. The maxillary arch dimensions were reduced in all three subgroups, but there were no significant differences between the groups.

## Discussion

Relatively few descriptions of the longitudinal changes in the dental arches of subjects with UCLP that occur

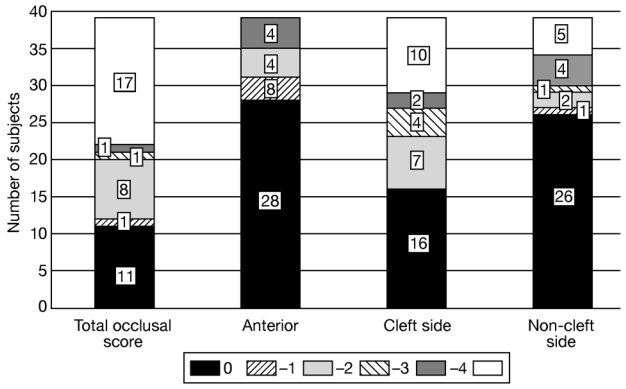


**Figure 3** The distribution of the total occlusal score and the occlusal score for each segment at baseline ($n = 39$).

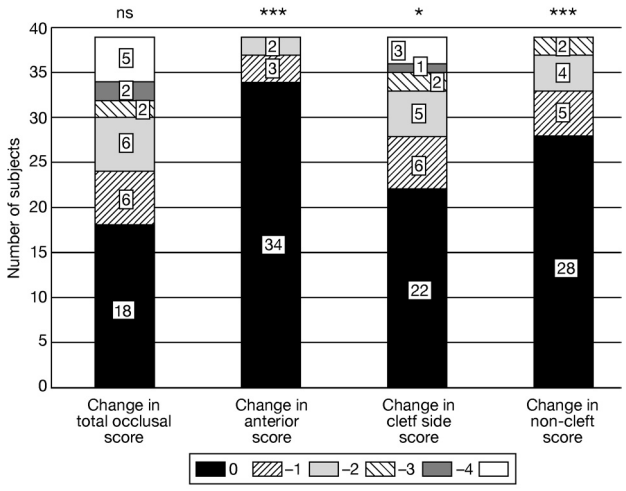


**Figure 4** The distribution of the changes in the total occlusal score and the occlusal score for each segment from baseline to follow-up ($n = 39$). *$P < 0.05$; ***$P < 0.001$; ns = not significant.

beyond the age of 20 years have been published (Brägger *et al.*, 1991; Ramstad and Jendal, 1997). In this study, the mean value of the follow-up interval was 5.6 years (range 1–10 years) from a baseline mean age of 19 years (range 16–20 years).

To discriminate the classification categories, the scoring system of Huddart and Bodenham (1972) was preferred, similar to other reports (Mars *et al.*, 1987). This scoring system was chosen because the reliability and consistency of this method is greater than that of a descriptive classification (Heidbuchel and Kuijpers-Jagtman, 1997). The severity of crossbite is taken into account and it is easier to assess statistically (Huddart and Bodenham, 1972). The most striking observation in this study was the statistically significant reduction in arch width, arch length, and occlusal score subgrouped according to retention. The essence of the change was that the dental arches became shorter and narrower. The deterioration was largest for the second premolar width followed by the first molar width, which is similar to the results of other studies (Hellquist *et al.*, 1978; Brägger *et al.*, 1991; Ramstad and Jendal, 1997; Schultes *et al.*, 2000). However, the dental changes were generally small and of clinical significance only in some cases. Ramstad and Jendal (1997) reported that although most post-treatment dental changes had taken place during the initial 5 years, complete stability had still not been reached at their final observation at 32 years of age. In the present study, an increased number of crossbites on the cleft side was found at the follow-up examination. Aesthetically, such a development may be a disadvantage because the premolars and the first molars become palatally displaced behind the anterior teeth, giving the maxillary anterior teeth a disproportionate prominence (Ramstad and Jendal, 1997). Permanent bilateral retention in the premolar–first molar area is seemingly required if such a change is to

**Table 2** Difference (mm) and *P*-values for the maxillary arch dimensions between the two registrations with the subjects grouped according to type of retention and the total sample.

| Measurement | No retention ($n = 15$) | | Bonded retainer ($n = 13$) | | Onlay/fixed bridge ($n = 11$) | | *P*-values between groups | Total sample ($n = 39$) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | | Mean | SD | *P*-value |
| Maxillary canine width | –0.7 | 0.9 | –0.6 | 0.6 | –0.5 | 0.8 | ns | –0.6 | 0.8 | <0.001 |
| Maxillary second premolar width | –1.6 | 1.4 | –1.7 | 1.6 | –1.7 | 1.4 | ns | –1.7 | 1.4 | <0.001 |
| Maxillary first molar width | –1.7 | 1.6 | –1.1 | 1.3 | –1.4 | 1.3 | ns | –1.4 | 1.4 | <0.001 |
| Maxillary sagittal length | –1.0 | 0.9 | –0.6 | 0.8 | –0.6 | 0.9 | ns | –0.8 | 0.9 | <0.001 |
| Arch length cleft side | –1.5 | 1.3 | –0.7 | 0.9 | –0.9 | 0.7 | ns | –1.1 | 1.1 | <0.001 |
| Arch length non-cleft side | –1.1 | 1.4 | –1.0 | 1.2 | –1.1 | 0.9 | ns | –1.0 | 1.2 | <0.001 |
| Overjet | –0.2 | 0.6 | –0.4 | 0.7 | –0.2 | 1.2 | ns | –0.3 | 0.8 | <0.05 |
| Overbite | –0.3 | 1.1 | 0.0 | 0.8 | 0.0 | 0.7 | ns | –0.1 | 0.9 | ns |

ns, non-significant *P*-values > 0.05; SD, standard deviation.

be prevented. From a functional point of view, this does not seem to be a problem for developing signs of temporomandibular dysfunction (Marcusson *et al.*, 2001). Irrespective of the type of retention on the maxillary anterior teeth (canine to canine), the patterns of post-treatment changes were the same for both the occlusal score and the dental arch dimensions in the three subgroups. These findings might be explained by the fact that the primary cleft repair surgery is probably the dominant variable for the post-treatment transverse changes in the maxillary arch. As concluded by Derijcke *et al.* (1994), each type of cleft has its own characteristic dental arch form, influenced by surgical procedures, which makes the intrinsic deviation clinically manifest. Palatal inclination of the maxillary incisors is seen in almost all patients with a complete cleft and is probably related to the long-term influence of CLP surgery. The decrease in the overjet and sagittal length (with no differences between the subgroups) in this investigation seems to be part of the relapse after orthodontic treatment and primary lip surgery (Filho *et al.*, 1996). The post-treatment changes in the present group with onlay/fixed bridges appear to be in contrast with those seen in other follow-up studies (Brägger *et al.*, 1991; Ramstad and Jendal, 1997), but the results are not comparable as the measurement methods and the prosthodontic retention used were different.

Prospective randomized controlled trials on primary CLP surgery and critical evaluation of the long-term effects of orthodontic treatment and need for retention may hopefully minimize the individual burden of orthodontic treatment and comprehensive routine registrations (Long *et al.*, 2000).

## Conclusion

Subjects with treated UCLP experienced a decrease in the width and length of the maxillary arch in early adulthood. There was a significant deterioration in the occlusal score and the maxillary arch dimensions during the follow-up period. This was found irrespective of the type of retention.

## Address for correspondence

Agneta Marcusson
Department of Dentofacial Orthopaedics
University Hospital
SE-581 85 Linköping
Sweden

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