DEVELOPMENT ON THE MAXILLARY OF PATIENTS WITH A UNILATERAL TOTAL CLEFT WITH THE USE OF A ORTHOPAEDIC PLATE. TWO-DIMENSIONAL CAST ANALYSIS

ABSTRACT

Objectives: In this non-randomized and retrospective study the morphological maxilla changes of patients with unilateral total clefts which have been treated by an early orthodontic therapy during the first two years after birth have been documented and investigated.

Methods: The maxilla models which have been studied belong to a collection of the Orthodontic Department of the Heinrich-Heine-University of Düsseldorf, Germany. The gypsum models had been taken at a patients age of 0 to 6 months before lip plastic, 6 to 12 months after lip plastic and 12 to 24 months before palate plastic surgery. The surfaces were digitized two-dimensionally by a flat screen scanner and evaluated. The metric analysis of the models was conducted by the help of the programme WINCEPH 4.15 (Compudent, Germany). The statistical evaluation was carried out by the help of the programme SPSS.

Results: The cleft widths decreased steadily during the development. The alveolar widths have increased with all patients in the anterior, the median, and the posterior region; the maxilla length increased at all patients. The rotations of large and small segments revealed no significant angular deviations.

Conclusions: The study reconfirms that by an early orthodontic treatment a narrowing effect on the clefts takes place; by keeping the tongue away from the palate cleft the alteration of the palatal roof angle is limited and by this measure the entire maxilla cleft situation is considerably improved.

Keywords: Orthopaedic Plate, Two-Dimensional Cast Analysis, unilateral cleft.
INTRODUCCIÓN

According to a WHO report on Congenital Anomalies and Public Health the frequency of clefts among new-born children is in the order of 1:600 [1]. Up to the middle of the 20th century the medical treatment of cleft patients lay in the hands of general, plastic or dental surgeons. The treatment aimed at the improvement of the aesthetic appearance and anatomic structure. Linguistic utterance, nasal breathing and occlusion were frequently hampered.

Nowadays the treatment of cleft patients (patients with cleft-lip and palate, in the following also denoted as CLP) is very complex. For an optimal result the treatment of cleft patients starts at birth and is extended until the patient is grown-up and should be supervised by an interdisciplinary and specialized working group. This co-operation of different medical branches is granting a comprehensive medical care of the children concerned and be considered state of the art.

There is still a lack of scientific evidence about the efficiency of orthopaedic plates and their effect on the maxilla. The orthopaedic plate resolves feeding problems; prevents nasal regurgitation, choking, and excessive air intake; reduces the time required for feeding; and allows better maxillary growth before surgery [2, 3]. The orthopaedic plate helps the tongue to be positioned in the correct place and contributes to speech development [4, 5]. Many authors suggest that orthopaedic plates should be applied as early as possible to avoid post-surgical problems [6, 7]. It is the goal of this retrospective study to reduce the controversial discussions on the advantages and disadvantages of early orthodontic treatment of patients with unilateral cleft lip and palate.

METHODS AND PATIENTS

The goal of this investigation was to study the development of the maxilla of cleft patients from birth to two ages. The study was based on selected gypsum models collected by the orthodontic department of the Heinrich-Heine-University during a period from 1980 to 2001. For being considered within this study an early surgical orthodontic treatment of the patients was prerequisite. For an unequivocal comparison children with additional anomalies were excluded from the sample as well as all those who were not suffering from the complete shape of lip-, maxilla- and palate-cleft. Models which were not being in a perfect shape or without a clear anatomic structure and all those which could not easily be scanned were rejected.

The sample comprised 113 patients, 56 being males and 57 females; 77 of them, (m 36, f 41), had a left side CLP while 36 patients (m 24, f 12) showed a right side CLP. All patients had received a passive plate according to Hotz and Gnoinski (1976) [8, 9], being implanted within 24 to 48 hours after birth and carried...
during the whole day during the first year. The lip plastic had been conducted within the 4th or 6th month according to the modified method of Tenison or Rendal (1959) [10, 11]. After the surgical treatment the plate was re-implanted. The closure of the palate was conducted within the 2nd to the 3rd year according to the method of Veau Rosenthal [12]. The development of the cleft maxilla for every patient was documented at defined time by situation models (Table 1).

The analysis of the models was based on the definitions of Asley Montague, Sillman, Stöckli and Bolter [13-16]. The surfaces of all models were digitalized two-dimensionally, computer-based revised and evaluated. The metric evaluation and analysis of the models were conducted by the programme WINCEPH 4.15 (Company of Computent, Germany), which is based on the described landmarks of Bolter, Seckel et al and Stöckli [15-17] Figure 1 [18] and Table 2 and 3.

Figure 1. Measuring points on maxillary cast of UCLP. Landmarks on maxillary cast of patients with unilateral cleft lip and palate (*: cleft side). The definition of the landmarks and the Distance measured in the two-dimensional cast analysis is as follows: (Table 2 and 3). [18, 19]

<table>
<thead>
<tr>
<th>Table 1. Documentation stages</th>
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<tr>
<td><strong>Cast</strong></td>
</tr>
<tr>
<td>A1</td>
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<td>A2</td>
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<td>A3</td>
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<tr>
<th>Table 2. Landmarks on maxillary cast of patients with unilateral CLP*</th>
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<tr>
<td><strong>Landmark</strong></td>
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<tr>
<td>Maxillary Cast</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>P'/P'</td>
</tr>
<tr>
<td>C1/C1'</td>
</tr>
<tr>
<td>C2/C2'</td>
</tr>
<tr>
<td>Q'/Q'</td>
</tr>
<tr>
<td>TK/TK</td>
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<td>T/T</td>
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| Landmarks on the cleft edges | |
|-----------------------------|
| WC1/WC1' | perpendicular to the course of the alveolar crest on the level of C1 and C1', respectively. |
| WC2/WC2' | perpendicular to the course of the alveolar crest on the level of C2 and C2', respectively. |
| WTK/TTK | perpendicular to the course of the alveolar crest on the level of TK and TK', respectively |

* = the cleft side; CLP = cleft lip and palate.
Table 3. Distances measured in the two-dimensional cast analysis (\(^{\prime}\): Cleft side).

<table>
<thead>
<tr>
<th>Distances Measured</th>
<th>Description</th>
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<tbody>
<tr>
<td>P-P(^{\prime})</td>
<td>anterior cleft width</td>
</tr>
<tr>
<td>WTK-WTK(^{\prime})</td>
<td>posterior cleft width on the level of T and T(^{\prime})</td>
</tr>
<tr>
<td>C2-C2(^{\prime})</td>
<td>anterior alveolar arc width</td>
</tr>
<tr>
<td>TK-TK(^{\prime})</td>
<td>posterior alveolar arch width</td>
</tr>
<tr>
<td>AKL (TK-C2+C2-I+I-P)</td>
<td>distance TK-P, approximated length of the crest of the alveolar ridge of the non-cleft segment.</td>
</tr>
<tr>
<td>AKL(^{\prime}) (P(^{\prime})-C2(^{\prime})+TK(^{\prime})-C2(^{\prime}))</td>
<td>distance TK(^{\prime})-P(^{\prime}), approximated length of the crest of the alveolar ridge of the cleft segment.</td>
</tr>
<tr>
<td>I-C2I-T</td>
<td>anterior alveolar arch length</td>
</tr>
<tr>
<td>C2I-T-I-T</td>
<td>posterior alveolar arch length</td>
</tr>
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</table>

Figure 1. Two-dimensional digitized cast of the upper jaw of a patient with complete left unilateral cleft lip and palate. Localization of Landmarks and measured distances.
At these models all relevant measurements can be taken, such as maximum length and width of the palate, the longitudinal and transversal component of the alveolar cleft width, the posterior und anterior alveolar arch width as well as the anterior und posterior cleft width. The reference points are called according to their location maxilla crest points or cleft edge points. The maxilla crest points had a central role in the analysis, because they were used for the local determination of the cleft edge and segmental base points. Could a single measurement point not unequivocally be defined, the resulting dependant point couldn’t either be determined. All the other measurements, however, were carried out.

Figure 2 a, b, c shows a series of models from the study.

Due to the sufficient sample size it was possible to check the normal distribution of the individual values. A significant deviation from the normal distribution is given when $p < 0.05$; in this case non-parametric tests have to be applied for the variables in question. The normal test check is preferably conducted according to the Kolomogorov-Smirnov test. All normal distribution tests of this study were controlled by a bilateral significance check. For this two combined normally distributed samples were compared with each other by the help of the t-test; two combined not normally distributed samples, however, were controlled by the Wilcoxon test.
RESULTS

Cleft data as measured

The cleft width decreased uniformly in the course of the time:

- \( WC_1/WC_1' = 8.05/3.88 \) [mm]
- \( WC_2/WC_2' = 9.90/6.20 \) [mm]
- \( WT/WT' = 8.92/5.43 \) [mm]

It was observed that the values for WT and WT' for the rear cleft width differed less significant from each other. The cleft widths in the region of the alveolar cleft poles developed within the period from Z1 (birth) to Z3 (before lip plastic) from 0.43 mm to 17.70 mm.

Cleft data as measured in the alveolar arch region and maxilla

Alveolar arch region: The alveolar width increased uniformly in the anterior, median and posterior region:

- \( C_1/C_1' = 26.4 \) [mm] at T1
- \( C_1/C_1' = 27.7 \) [mm] at T3
- \( C_2/C_2' = 34.8 \) [mm] at T1
- \( C_2/C_2' = 36.9 \) [mm] at T3

The rear alveolar arch width showed a lesser alteration of the values; the median values at the different times T1 to T3 were T1:T2:T3 = 34.7:37.5:37.6 [mm]. Within the investigation period all patients showed a significant increase in the values for the distance Lm-Lm'.

Alveolar crest length: The values for the alveolar crest length of the small and large segment increased had the same results. On the cleft side within the period T1 to T3 the crest length grew from 26.7 mm to 30.2 mm, on the non-cleft side the value were 43.3 mm and 49.0 mm.

Buccal segment length: On the cleft side no significant differences were observed in the buccal segment length during the period T1 to T3. On the non-cleft side during this period the mean value of the buccal segment length decreased from 18.1 mm at T1 to 16.7 mm at T3, which is statistically not considered as significant.

Frontal segment length: The mean value of the frontal segment length of the small and large segment during the period T1 to T3 grew from 17.2 mm to 22.8 mm. The statistical significance according to the Wilcoxon test is \( p < 0.000 \).

Sagittal asymmetry: The distance between the points C2 and C2' in the sagittal median level grew during the period T1 to T3 from 2.9 mm to 3.1 mm, which is statistically denoted as non significant.

Rotation of the large and small segment

The measurement of the angles during the period under consideration did not reveal statistically significant deviations. This is particularly true for the rotation of the buccal segment in direction of the tuber basis on the sound side, for which the angle C2-TT' was measured. For the angle C2'T'-T, by which the rotation of the buccal segment in direction of the tuber basis on the cleft side is described, a small decrease from 147.5° to 143.0° was observed, which statistically is considered as non significant.

Considering the angle MV between the lines T-T' and T-M a similar result is obtained. In this it was during the period T1 to T2 a small angular increase from 139.2° to 143.7° and during the period T1 to T3, however, a decrease from 139.2° to 138.2° measured.
DISCUSSION

Critical comment on the methodology

In the professional literature some papers can already be found on studies of temporal changes of the maxilla of LMP-patients. The methods applied for conducting the measurements were quite different, the first difference being the dimensionality: the morphological alterations of reference points, so called landmarks, can be seized by two- or three-dimensional measurements on the alveolar crest.

The accuracy of length or angle measurements is also influenced by the identification of the landmarks and, last but not least, by the experience and skill of the researcher and the quality of the models. The dimensionality of the measurement, however, is of minor importance [18-20].

False interpretations of the results can also arise by an inaccurate determination of the landmarks and by the choice of the reference level. Sometimes the quality of the models varies, when different Orthodontic surgeons were involved in the manufacturing of the models. In this study - as a matter of principle - inaccuracies could appear in the definition of the anatomic landmarks within the computer model and in the photos. Therefore for revealing a potential intra-individual measurement mistake a randomly selected group of 20 photos was measured and evaluated for a second time by the same person. The determination of a potential mistake was calculated according the Dahlberg formula [21].

By this control procedure an intra-individual measurement mistake of 0.6 mm was revealed. This value is clinically irrelevant as most authors tolerate measurement deviations of up to 10% or 0.5 mm, respectively [17].

Discussion of our own research results

Cleft widths and cleft zone: Within our model series we observed a significant decrease of the palate cleft width in the anterior, median and posterior region, which coincides well with results of Kahl [22] and Prahl Charlotte [23]. With our patients the reduction of the cleft widths in the region of the alveolar cleft poles and within the anterior palate cleft was especially evident, particularly after the cleft plastic. This result is reconfirmed as our values at the time T2 - i.e. after the lip plastic - coincide perfectly with values given by Kahl [22].

With our patients at the time T1 the widths of the palate clefts was larger than those described in other papers. The lip plastic also had a favourable influence on the palate cleft width at the time T3. Furthermore our results coincide with those given by Opitz, Kahl and Braumann [22-24], who had also found a significant decrease of the palate cleft in all three regions beyond the time of the lip plastic. At the time T1 Kahl and Braumann had observed larger values than we in the transversal component. This reconfirms that by our treatment a 'collapse' was prevented, which means that there was no rotation of the small segment into the direction of the palate.

SUMMARY

The study reconfirms that by an early orthodontic treatment a narrowing effect on the clefts takes place by keeping the tongue away from the palate cleft. The alteration of the palatal roof angle is limited and by this measure the entire maxilla cleft situation is considerably improved. Surgical closure of the lip had a significant effect upon reduction of the alveolar and palatal cleft and upon maxillary segmental relationships and positioning. The reduction of the palatal cleft after lip surgery was attributed to segmental repositioning.
ACKNOWLEDGEMENTS

I am deeply in debt to Prof. Dr. Dieter Drescher, Director of the Orthodontic Department of the Heinrich Heine University - Germany, who gave me the free access to the exceptional collection of cast of cleft from individual ages between birth and three years. I thank him for his help and efforts.

I thank Frau Dr. Gudrun Lübberink und Herr Dr. Lars Fuck, for all their efforts, time, help, and wisdom and especially for the patience. Dr. Lars Fuck help with the evaluations of the cast was invaluable, I thank you for that and for introducing me to the world of health technology assessment.

Last I am grateful for the help and support I received from my friends reviewing the manuscript.

REFERENCES


