Chapter 1

Introduction
Summary

This chapter gives a review of the literature from the pioneer era of surgeons who have aimed to treat cleft lip and palate up to the present day. In the early days the treatment consisted of surgical lip closure only. Following the introduction of general anaesthesia, surgeons have been able to develop techniques to close the palatal cleft also. Nowadays many techniques or variations of existing techniques are proposed both for lip surgery and for palatal closure. The main disadvantage of these techniques, especially those for closure of the palatal defect, is that patients, who had palatal surgery in early childhood, gradually develop a growth disturbance of the maxilla and often a vast lateral compression of the dento-alveolar part of the maxilla. It is not clear whether these growth disturbances may be attributed to the congenital malformation itself, to the cleft surgery, or to both. In an attempt to answer these questions, a study was performed on dental casts of unoperated adult cleft patients. The aims of this study were firstly to evaluate the final transversal development of the dental arches and the palatal vault in 4 main categories of cleft patients without the influences of previous surgical treatment and secondly, in the event of developmental disturbances being found, to define the extent and location of the disturbances.
1.1 Introduction

Cleft lip and/or palate is the most widely known congenital malformation of the orofacial region. The incidence varies considerably among races and nationalities and depends also on the type of cleft (Fraser, 1971). The overall incidence of cleft lip (CL), cleft palate only (CPO) and cleft lip and palate (CLP) ranges from 1.45 to 1.57 per 1000 in Europe. Orientals show a higher, and black people a lower incidence (Derijcke et al, 1996). As no reliable figures on the incidence of clefts in Indonesia are available, Godfrey (1994) estimated cleft births in that country on the basis of two hypothetical incidence rates for orofacial clefting. With an incidence of 1 per 750 live births in the year 2000, the number of patients with clefts would be 4260; with an incidence of 1 per 1500, this figure would be 2130.

According to Berkowitz (1996) a cleft of the lip and/or palate is “a structural defect that usually affects other functional areas” (e.g. speech, hearing, feeding) and causes repeated middle-ear infections. This definition shows that CLP patients have a diversity of problems that cannot be handled by one specialist. In developed countries a multidisciplinary team of specialists is therefore involved in the treatment of cleft patients. The Cleft Palate Team includes a plastic surgeon, an orthodontist, a paediatrician, an oral and maxillofacial surgeon, an ENT specialist, a speech therapist, a geneticist, nurses, a psychologist and a social worker. These specialists not only participate in the active treatment of the individual patient but should also, in an ideal situation, perform research on the topic. Although the surgical/orthodontic treatment schedule differs slightly from centre to centre, it generally has the following components:
- infant orthopaedics,
- surgical closure of the lip,
- surgical closure of the soft / hard palate,
- bone grafting of the alveolar cleft,
- orthodontic treatment,
- secondary corrections of lip and nose,
- osteotomies of the maxillofacial skeleton, if necessary.

In many cases the initial orthodontic treatment continues through childhood and adolescence. The patients need regular ENT check-ups in order to minimize middle ear infections and to prevent hearing loss. The speech therapist assists the patient in developing normal speech. Throughout the
treatment period the patient and the parents are supported by the social worker and, if necessary, by a psychologist.

Since the malformation is clearly visible in the face, both patients and doctors are eager to treat this condition at the earliest possible stage. Early surgical closure of the lip and palate offers patients normality both from the aesthetic and from the functional aspect. For this reason, early surgical treatment was the “state of the art” for decades. On the other hand, subsequent facial and maxillary arch development from childhood into maturity may be influenced by early interventions, with disturbances then developing both at the skeletal and at the dento-alveolar level. The negative sequelae develop gradually during facial growth, culminating when the patient reaches maturity. On the skeletal level there is frequently an underdevelopment of the maxilla in three spatial planes. On the dental level a transversal maxillary arch collapse often occurs, resulting in a unilateral or bilateral cross bite accompanied by crowding and retroclination of the upper incisors. As these sequelae develop gradually over time, there is an understandable tendency to consider them as the price that has inevitably to be paid for the advantages that early surgical closure of the lip and palate brings.

The factors underlying these sequelae are not yet fully understood. From the theoretical standpoint, the factor(s) responsible for the congenital malformation may also be responsible for the disturbance of the final craniofacial development. It is also possible that the disturbed facial growth may be induced by excessive scar tissue resulting from the successive surgical interventions carried out in early childhood for treatment of the cleft. Nowadays the general view is that the two factors are interrelated, but the contribution of each factor to the final development of the middle third of the facial skeleton is not yet fully understood.

The answer to this question is of cardinal importance for the quality of surgical treatment of the cleft lip and palate patient. If the congenital malformation itself is the main cause of the disturbed maxillofacial development, it might be difficult to improve the final treatment outcome. On the other hand, if the surgical interventions are the main factor underlying the disturbed facial growth, it might be possible to reduce the extent of the growth disturbances and thus to achieve a better result by improving the treatment technique. Research into the craniofacial and dental status of unoperated cleft patients will provide more insight into the intrinsic maxillary growth deficiency and consequently into the possible effects of surgery.
1.2 History of surgical correction of cleft lip and palate

In the Chin dynasty (229-317 AD) there already was a surgeon who performed surgery for a harelip. This unknown Chinese surgeon was probably the first to perform the surgical repair of a cleft lip (Rogers, 1964). According to Rogers (1971) in the textbook “Cleft Lip and Palate: surgical, dental and speech aspects“ edited by Grabb et al (1971), Jehan Yperman (1295-1351) was apparently the first person to describe cleft lip repair in detail. Pierre Franco in his famous 1556 text entitled “Des bouches ou lèvres fendues de nativité, ou autrement” describes an operation for closure of a cleft lip after removing a piece of epithelium, skin or mucosa on both sides of the cleft, by means of a knife, scissors or even a cautery! He further mentioned that subjects with a cleft palate always speak through their nose. In 1561 he recommended, as described by Francis (1963) and by Barsky (1964), in cases of a small palatal cleft a kind of obturator with a cotton plug in order to improve the speech. In the chapter on the history of cleft palate surgery in the book edited by Grabb et al (1971) Hendrik van Roonhuyze (1622-1672) is mentioned as one of the first to recommend surgical closure of the cleft lip at a very young age i.e. at about 3 or 4 months.

Up until the 19th century, such operations were performed without any type of anaesthesia. This meant that lip closure had to be performed as fast as possible. Without general anaesthesia it was moreover impossible to close a palatal defect. According to Dorrance (1933), a surgeon by the name of Collis used chloroform for general anaesthesia in palatal surgery in Dublin in 1867. He was, therefore, able to operate on a quiet and immobile patient. Yet it was only in the 20th century that operations for closure of the lip and/or palate received a more scientific basis. The German surgeon Langenbeck (1861) and the French surgeon Veau (1931) described the principles of surgical procedures, which are still in use today, though in modified form.

1.3 The influence of surgical treatment on maxillofacial growth

1.3.1 General remarks

Apart from any embryonic distortion and intrinsic growth deficiency, facial growth in cleft lip and palate patients is likely to be affected as a consequence of surgical repair, orthodontic treatment, and functional adaptations. Despite the combined efforts of a multidisciplinary team, a considerable number of
patients still develop growth disturbances, which are clearly visible after completion of the craniofacial development, i.e. after the patients have reached adulthood (figure 1.1).

Relatively few authors describe long-term results after surgical interventions. Early landmark studies are the paper by Graber (1949) that documented severe three-dimensional maxillary collapse in patients with complete clefts following surgical repair, and the study by Dahl (1970) evaluating the craniofacial morphology of 272 adults operated for different types of clefts. These authors also showed that the affected maxillary growth is likely to influence the physiological growth of the mandible.

There is a considerable discrepancy among studies concerning the group of patients that finally ends up with a maxillary growth deficiency. Levin (1963) reports that this happened in 29.6% of the total cleft population of his institution and in 52.4% of the cases that were most severe at birth.

![Figure 1.1](image.png)

Figure 1.1 Patient with a complete unilateral cleft lip, alveolus and palate, who was operated in early life, demonstrating a midfacial deficiency.

Besides the underdevelopment of the maxilla the position of the alveolus and teeth is often impaired. The dento-alveolar impairment is of course most clearly visible in the cleft patients who have not (or not yet) undergone an orthodontic treatment. There is a lateral compression of the alveolar parts of the maxilla resulting in anterior and/or posterior cross bite, severe crowding of the teeth, especially in the premolar area, and subsequently an impaired occlusion (figure 1.2).
Figure 1.2a
Dental casts of a patient with a unilateral complete cleft lip, alveolus and palate demonstrating underdevelopment of the maxilla (courtesy P. Nollet, UMC St Radboud, Nijmegen).

Figure 1.2b
Severe lateral compression of the alveolar parts of the maxilla in a cleft patient.

The missing teeth frequently observed outside the cleft area (figure 1.3) accentuates both the retroposition of the maxilla and the relative shortness of the maxillary dental arch (Bohn, 1963; Olin, 1964; Lekkas et al, 2000; Lekkas et al, 2001). Orthodontic treatment plays a role of paramount importance in the prevention and treatment of maxillary arch collapse and in the alignment of the teeth, but there is always a considerable relapse tendency even after successful orthodontic treatment (figure 1.4).
In the next paragraphs the subsequent surgical procedures and their effect on maxillofacial growth and maxillary arch dimensions in CLP patients are outlined: primary periosteoplasty, primary bone grafting, lip surgery, palatal surgery, pharyngeal flap surgery, and early secondary bone grafting. For an extensive overview the reader is referred to the state-of-the-art article on this topic by Kuijpers-Jagtman and Long (2000).

**Figure 1.4**  
b. During orthodontic treatment.

### 1.3.2 Primary periosteoplasty

Based on the phenomenon of subperiosteal bone formation for the purpose of creating bone continuity over the alveolar defect, Skoog (1965) from Uppsala (Sweden) introduced primary repair of the complete alveolar cleft utilizing a periosteal flap. This technique is usually performed at the time of lip repair but is also sometimes carried out as a delayed procedure when the patient is aged between 2 and 10 years. However, in longitudinal follow-up studies the
Uppsala group noted negative growth effects and therefore abandoned primary periosteoplasty in 1977. They revealed that facial growth seemed to be less favourable in patients subjected to infant periosteoplasty compared with those who had delayed periosteoplasty (Hellquist et al, 1983; Hellquist and Svärdström, 1986). Besides these studies from the Uppsala group, a large series of reports on infant periosteoplasty has been published by a Prague-based team (Smahel and Müllerova 1994, 1995). Utilization of a narrower periosteal flap produced less extensive exposure of the anterior maxilla than in the Skoog method. However, at 15 years of age patients still showed a marked maxillary retraction with a flattening of the face, an impairment of the sagittal jaw relationship and a reduction in the prominence of the upper lip (Smahel and Müllerova 1994, 1995), although the results were better than after primary bone grafting (see below).

Although infant periosteoplasty seems no longer to be widely performed at most European centres, Millard (1980) and Millard and Latham (1990) from the United States continue to attract attention with their pinned palatal appliance. However, a definitive long-term assessment of this therapy has yet to be performed (Kuijpers-Jagtman and Long, 2000).

1.3.3 Primary bone grafting
In order to prevent relapse of the maxillary segments and to create the opportunity to move teeth into the cleft area, it is essential to transplant bone into the cleft area. Depending on the age at which surgery is performed, the procedure is divided into primary and secondary bone grafting. Primary bone grafting takes place at or around the time of lip repair, while the term secondary bone grafting refers to the reconstruction of the alveolar cleft defect in the mixed dentition period.

Primary bone grafting was first utilized in the late 1950s (Nordin and Johansson, 1955; Schmid, 1955). After 1975 several centres reported midfacial growth inhibition and discontinued the use of primary bone grafting (Friede and Johanson, 1982; Pfeiffer, 1986; Reichert and Manzari, 1990; Lilja et al, 1996; Smahel et al, 1998). Over the years, however, a few centers continued to use this technique. Since 1965 Kernahan and Rosenstein (Chicago, USA) have used this procedure, claiming that the timing and surgical aspects of the placement of the bone graft are significantly different from those of other techniques and are critical to its success (Kernahan and Rosenstein, 1990). Trotman et al (1996) compared a Chicago sample with a similar sample from the Lancaster Cleft Palate Clinic in which no primary or
secondary bone grafting was performed. Ten years after treatment, the group of patients who underwent primary bone grafting had significantly fewer protrusive maxillae than the non-grafted sample, but this did not result in a Class III relationship of the jaws.

1.3.4 Lip surgery
In an attempt to minimize the long-term impairment of maxillary growth, surgical interventions for the closure of a lip, alveolus and palate defect are performed at different stages. In general, the lip is closed within months of birth. The influence of lip closure on the final development of the facial skeleton and position of the teeth is disputed. Some authors consider lip closure to be of only minor influence (Dahl, 1970; Ross, 1987) whereas others believe that it has a substantial influence on the final development of the face (Bardach, 1990).

Concerning the effect on maxillofacial growth, it is now generally assumed that the effect of lip closure is restricted to the anterior part of the maxilla (Pruzansky, 1955; Mazaheri et al, 1971; Wada and Miyazaki, 1975; Kramer et al, 1994) and that any effects on maxillary growth are overshadowed in the long-term by the subsequent palate repair, usually 6 to 18 months later.

1.3.5 Palatal surgery
Usually, the cleft in the soft palate is closed at a fairly early age, just before the child starts its speech development. Many authors state that such an early closure is important for optimal speech development (Malek et al, 1986; Witzel et al, 1984). The operation for closure of the hard palate is generally considered to be the key factor in the development of dento-alveolar and facial growth disturbances. Palatal surgery may have a minor short-term effect on palatal growth but, as growth in the posterior region continues until maturity, the restricting effect of palatal surgery on the three-dimensional growth of the maxilla may be considerable. Therefore, in an attempt to minimize the effect of palatal surgery on the physiological growth of the cleft maxilla, surgical closure of the hard palate is postponed as long as possible in some treatment protocols (Schweckendiek, 1951, 1978; Krause, 1976; Friede and Johanson, 1982; Capelozza Filho et al, 1996). Not all authors, however, consider hard palate surgery to be the most important factor in the collapse of the maxillary segments. Da Silva Filho and Capelozza (1989) state that the influence of palatal surgery on the dentofacial morphology of the patient is
minimal and statistically insignificant whereas the role of lip closure is of paramount importance.

The factors underlying the deficient growth of the maxilla are a matter of controversial discussion. Some authors attribute it to the presence of the cleft itself. Others believe that the deficient growth is the result of the primary surgery, resulting in formation of scar tissue at the lip, and soft or hard palate level affecting normal growth of the maxilla (Dahl, 1960; Schweckendiek, 1978; Spauwen et al, 1993). In general, most authors agree that palatal surgery appears to have a significant impeding influence on the sagittal, vertical, and transversal development of the maxilla.

1.3.6 Pharyngeal flap surgery

Pharyngeal flap surgery (PFS) is widely used to correct velopharyngeal incompetence in patients with cleft palate. The flap remains attached to the posterior pharyngeal wall (inferiorly or superiorly based) while the other end is sutured to various locations on the soft palate to diminish the size of the pharyngeal port. A superiorly based pharyngeal flap performed at the age of about 4 years seems to be universally favoured (Berkowitz, 1996).

In theory, facial growth might be altered both mechanically and functionally by PFS. It is difficult to conclude from the existing literature whether PFS will have a negative effect on subsequent growth. No prospective studies could be found in which pre- and postoperative assessments of both nasal resistance and facial growth were performed. It can be concluded that the influence of PFS on facial growth is probably small and inconsistent (Kuijpers-Jagtman and Long, 2000).

1.3.7 Early secondary bone grafting

Nowadays, secondary bone grafting is the procedure most commonly used to reconstruct the defect in the alveolar process. The benefit of restoration of the cleft alveolar ridge continued to be appreciated with respect to support for the teeth adjacent to the cleft, stabilizing the cleft maxillary segment, eliminating the notched alveolar ridge, and supporting the alar bases (Long, 1995). Boyne and Sands (1972, 1976) readdressed the bone grafting issue in the mixed dentition with a technique that is still in standard use today at many centres. With the continued concern about possible scar-induced inhibition of any surgery, the postponement of the secondary bone grafting was similar in its logic to the delaying of palatal surgery. However, if carried out before eruption of the permanent canine on the cleft side, it seemed to carry with it
none of the burdens that have dampened the interest in delayed palate surgery. Semb (1988) and Levitt et al (1999) both provided evidence of favourable growth results after secondary alveolar bone grafting.

1.4 The adult unoperated cleft

1.4.1 General remarks
In order to obtain insight into the effect of the cleft on the final development of the maxilla, it is necessary according to McCance et al (1990) to examine adult patients with an unoperated cleft lip and palate and compare them with non-cleft controls of the same racial group. They stated that many researchers had attempted to do so, but that the results of most studies had been compromised by the small sample size, the heterogeneity of the sample, and inclusion of partly operated as well as totally unoperated cases. A study of a sufficiently large sample of patients of the same racial group who have different types of clefts and have reached maturity without surgical treatment would make a substantial contribution to solving the problem. Data on adult cleft patients who have undergone no surgery at all are very rare. These patients are found only in remote areas where proper medical care for cleft patients is not yet available. In these regions local hospitals are able to provide only basic medical care (figure 1.5). Most people live in small villages spread over a vast rural area. In order to reach the local hospital, cleft patients have to travel several hours.

Figure 1.5 Regional hospital in Indonesia, providing basic medical care.
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Figure 1.6  Map of Nusa Tenggara Timur and Timor Timur.

The life expectancy in general is relatively low in these remote areas, and for cleft patients, especially for the most severe cases, it is even lower than for the non-cleft population. Therefore only some of the individuals born with severe clefts will reach maturity. The logistical problems of a cleft mission are immense. Cooperation with local authorities including regional governors, social workers, local religious leaders, local administrative officials and the authorities of the local hospitals are of paramount importance. When patients are transported to the hospital, accommodation and food should be provided, not only for the patients themselves but also for a member of the family who accompanies the patient. Because of the absence of almost any basic material, a team of different specialists has to go to local hospitals, bringing with them all paramedics, instruments and materials necessary for either the appropriate registrations for the scientific analysis or the surgical treatment of the patients. Because of these difficulties, scientific publications on unoperated clefts are relatively rare.

1.4.2  Former studies of unoperated clefts

The first fairly extensive study of unoperated adult cleft patients was presented by Ortiz-Monasterio and co-workers in 1959, whose collective comprised 19 unoperated adult cleft individuals, 18 with unilateral and 1 with bilateral cleft lip and palate. Shortly afterwards, Innis (1962) presented a preliminary report on 50 patients with cleft lip and alveolus or cleft lip, alveolus and palate, who had reached maturity without having undergone any surgery in infancy or childhood. These patients were studied cephalometrically. No attempt was made to analyze the corresponding dental casts. The author used standard measurements of the Down’s cephalometric analysis for the study of facial growth of the cleft group and compared them
to a control group taken from the same population. In the study by Law and Fulton (1959) the sample was not truly unoperated, as unoperated patients were mixed with patients who had previously undergone lip surgery. Only 7 (15%) of the 47 patients described were truly unoperated. The remaining 40 had undergone lip surgery long before the investigation. Therefore this study may be seen as a study of the effect of lip surgery on the development of the facial skeleton rather than as a study of unoperated adult cleft patients. The same holds true for the study by Mestre et al (1960), whose collective was claimed to comprise 49 “unoperated” cleft patients, whereas fully unoperated patients were, in fact, analyzed together with patients who had already undergone lip surgery. In their sample 22 patients had an unoperated palatal cleft only and 27 patients unoperated unilateral cleft lip, alveolus and palate. However, 21 of these 27 patients had had an earlier lip repair and only 6 of them had not been operated at all. In actual fact, 3 groups of patients were combined and analyzed as one entity. The analysis was cephalometrically based, with no dental cast analysis being performed.

In their final paper on this subject, Ortiz-Monasterio et al (1974) enrolled 450 patients with a cleft lip, alveolus and palate treated in late childhood or in adulthood. It is difficult to say how many truly unoperated individuals with various types of clefts were included in this study. Nor is it clear whether patients from the former study published in 1959 (Ortiz-Monasterio et al, 1959) were included in this paper and, if so, how many. Finally it is not clear what the authors defined as unoperated cleft patients, since patients who had previously undergone lip surgery were classified as “unoperated”.

A better analysis of unoperated adult cleft patients can be found in the paper by Bishara et al (1976). Although the sample size was small, the term “unoperated adult cleft patients” used in the title is justified. Moreover the authors were the first to try to compare different types of unoperated clefts with each other. Such a comparison was also made by Hardjowasito (1989) who studied 43 unoperated UCLA and 25 unoperated UCLP adults. Dental casts were available from all patients, and head films from 37 (11 UCLP and 26 UCLA). The cephalometric analysis showed that the craniofacial growth had followed the normal pattern, resulting in normal facial morphology. There was no significant difference between UCLP and UCLA subjects. The results of the dental cast analysis are outlined in the next paragraph.

More recently, Mars and Houston (1990), McCance et al (1990), Motohashi et al (1994), and Capelozza et al (1996) also presented studies of
unoperated adult cleft patients. Although the quality of the samples is improving, McCance et al (1990) still consider the small sample size, the heterogeneity of the population (grouping different cleft types together), the combining of partially operated cases with fully unoperated cases, wide age ranges, and inclusion of partially operated cases to be severe drawbacks of most studies. However, in the more recent papers the number of patients analyzed as well as the quality of the analysis and therefore the results of the study and the conclusions are much more reliable than in earlier papers.

### 1.4.3 Dental cast analysis of unoperated clefts

Although the number of papers on cephalometric analysis of unoperated adult cleft patients is increasing and our knowledge of the effect of the cleft on the facial skeleton has consequently improved, these studies provide no insight into the effect of clefts on the maxillary and eventually on the mandibular dental arch. Studies of the effect of clefts on the final development of the maxillary dental arch are fragmentary and very rare. Collecting appropriate dental casts from unoperated cleft patients especially with different kind of clefts is difficult. In very remote areas where unoperated adult cleft patients are usually found, oral hygiene is poor and dental care rudimentary and mostly limited to extraction of painful teeth. However, these extractions make a dental cast useless for most measurements. The paper on dental casts published by McCance et al (1990) exemplifies the problem of performing reliable measurements on dental casts even when only 2 teeth are missing due to earlier extractions.

Crabb and Foster (1977) reported on the position of the teeth in 10 adult cleft lip and palate patients, focusing on the sagittal relationship of the occlusion. No attempt was made to measure the lateral compression of the maxillary segments. They found some localized three-dimensional aberrations only in the vicinity of the dento-alveolar cleft. However, their sample size was small and a control group from the same population was lacking. Furthermore they assumed the non-cleft side to be normal and consequently used it as the control side. However, Derijcke et al (1994) and Lekkas et al (1997) demonstrated that the non-cleft side is also affected by the cleft and consequently must not be used as a control.

In the study by Sidhu et al (1982) dental casts of 10 unoperated adult cleft patients were analyzed. Four of them had a complete bilateral and the other six a complete unilateral cleft lip and palate. That study displayed the same disadvantages as mentioned above, i.e. a small sample size and mixed
patient groups, as the authors classified patients who had undergone treatment before the age of 13 years as unoperated in the belief that surgery after that age would have no effect on the dimensions of the dental arches. Furthermore the measurements were performed with a Korkhaus calliper. Although the series is small, the authors are the first to have analyzed and compared two different groups of unoperated adult cleft patients.

More recently McCance et al (1990) also studied dental casts of 41 unoperated adult patients with complete unilateral cleft lip and palate. The group may be classified as “truly unoperated“ because these 41 individuals had not previously undergone any treatment for cleft lip and/or palate. The dental casts of the maxillary arch were analyzed using a reflex microscope. The authors concluded that, “although there is some degree of hypoplasia of the maxilla these differences are small and would not account for any gross maxillary hypoplasia, frequently reported in surgically repaired unilateral cleft patients”. Da Silva Filho et al (1998a) studied the transversal dimensions of the maxillary dental arch of 31 unoperated adults with complete bilateral cleft and compared them with a non-cleft group. As they used Xerox copies of the upper dental casts for measuring purposes, the measurements were in fact two-dimensional. They concluded that the individuals of the cleft group had a more narrow maxillary arch width and a longer arch length compared with the non-cleft individuals. On the other hand Mars and Houston (1990) found in UCLP patients that the width of the maxillary dental arch was only slightly reduced and the arch length was normal. Hardjowasito (1989) detected in adult UCLP patients antero-posterior alveolar maxillary growth disturbances, which were expressed in the form of dental arch asymmetry.

In conclusion it can be stated that our knowledge of dental arch dimensions in unoperated cleft lip and palate individuals is somewhat limited. This is due mainly to methodological problems such as small sample size, 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 account of the three-dimensional aspect of the deformity. Therefore it is still difficult to base conclusions regarding the effect of surgery on our present knowledge of the final dento-alveolar morphology in unoperated cleft lip and palate individuals.
1.5 **Aim of the present study**

The aim of the present study was to analyze the width of the maxillary and mandibular dental arch, and the width and elevation of the palatal shelves in patients with different types of untreated clefts and to compare them with each other and with non-cleft controls from the same racial population. For this purpose, several expeditions were undertaken to treat cleft patients in remote regions of the Indonesian archipelago. In the period 1986-1997 more than 2400 cleft patients of all ages, 337 of them adults, underwent surgery and 267 participated in the study. The patients studied in this thesis were divided into 4 main groups:

- Unilateral cleft lip and alveolus (UCLA),
- Bilateral cleft lip and alveolus (BCLA),
- Unilateral cleft lip, alveolus and palate (UCLP),
- Bilateral cleft lip, alveolus and palate (BCLP).

The dental casts of these groups will be analyzed and compared with a sample of non-cleft individuals from the same population. Moreover the different groups will be compared with each other in order to determine whether there is an effect of the congenital malformation and if so, whether it is the same for each type of cleft.

1.6 **References**


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