Cleft lip and palate is a facial and oral malformation caused by abnormal facial development during early pregnancy. Orofacial clefts occur in about 1 in 1000 births in Europe, making it one of the most common birth defects. A combined cleft lip and palate is the most common presentation with about 50%; less than 20% of the patients have an isolated cleft lip. The etiology is complex and many unknown environmental and genetic factors contribute to the origin of cleft lip and palate. In around 35% of the patients another congenital anomaly is found and there are over 200 syndromal associations.

Cleft lip and palate patients may have a higher risk for behavioral problems, dissatisfaction with facial appearance, impairment of certain aspects of social functioning and of teasing and bullying. This makes nasolabial appearance an important factor in treatment outcome. In most cases the surgical repair of the cleft lip is the first operation performed. Improvement of nasolabial appearance and symmetry is an important outcome of this operation. Therefore, it’s essential to have a reliable assessment method to compare the results of cleft lip and palate surgery. For the assessment of nasolabial appearance in cleft palate patients, mostly assessments on two- or three-dimensional photographs combined with ordinal scales or symmetry measurements are used. However, none of these methods have been generally accepted. This thesis started with an overview of the different assessment methods. Further, multiple assessment methods were compared and a new, easy to use and reliable two-dimensional assessment method was developed.
In Chapter 1 a general introduction was given and the aim and outline of this thesis were described.

In Chapter 2 all methods of assessing cleft-related deformities were reviewed and it was concluded that 3D asymmetry assessments seems to be the most reliable method in assessing cleft-related facial deformities. However, scoring on 2D photographs is easier to perform and more applicable in daily practice because all cleft patients are photographed through the course of their treatment.

In Chapter 3 the scoring system by Prahl et al. was compared to a simplified version of this scoring system. The simplified version consisted of a 5-point scale and no reference photographs were used. It was concluded that the two tested systems were equivalent in their reliability and outcome. Therefore it was recommended that the least complicated scoring system be used, namely the 5-point scale without a reference photograph. In addition, we concluded that the nose and the lip should be assessed separately because when they are assessed together the score for the lip dominates the overall scoring. Since the reliability was still rather low, we also concluded that further efforts should be made to improve the observational reliability.

In Chapter 4 the scoring systems presented and compared in chapter 3 were compared with the most frequently used 2D scoring system, the Asher-McDade Aesthetic Index. We concluded that the scoring system by Asher-McDade et al. is superior to the scoring system by Prahl et al. and to the simplified version of this system. However, all the scoring systems were able to accurately score cleft lip and palate-related deformities. Further, it was concluded that there is still a need for a more reliable and easier-to-use 2D scoring system.
In **Chapter 5** a new scoring system for cleft patients around the age of six was presented, namely the Cleft Aesthetic Rating Scale (CARS). For the development of this new assessment system, we used our earlier rating experience and a combination of the scoring systems described in chapter 3 and 4. With this new method the nose and lip were rated on a 5-point ordinal scale and a sliding reference photographic scale was used to support the ratings. This study showed that this new scoring system is easy to use and is a reliable method to assess the aesthetic result of large groups of cleft patients around the age of six. Only three observers were needed to come to reliable results.

In **Chapter 6** the CARS for 18-year-old cleft patients was presented and tested on its reliability, when used by professionals and by laypeople (medical students). It was concluded that this system can be used reliably by both professionals as well as medical students when three or more observers are used.

In **Chapter 7** the computer-based assessment program SymNose was tested. This system evaluates the asymmetry level of the nose and upper lip for the frontal view of the 2D photograph and evaluates the asymmetry level of the nose and nostrils for the basal view. It was found that SymNose should be used by two or more observers to achieve high to very high reliability.

Since there is no gold standard for measuring the aesthetic results of cleft patients, it is essential to compare the different assessment methods. Therefore, in the last study of this thesis (**Chapter 8**) a comparison was performed between four different assessment methods. In 3D photographs asymmetry was assessed by using facial distance mapping and aesthetic assessment was performed by using a modified Asher-McDade rating index. In the same group of patients also their
2D photographs were assessed. Aesthetic assessment was performed by using the CARS and 2D asymmetry assessment was performed by using SymNose. This last study led to very interesting results; it showed that the different assessment methods were not in agreement. Two-dimensional and 3D assessments showed low to very low correlations. Moreover, the 2D symmetry assessments by SymNose showed almost no correlation with the 3D symmetry assessment.

In Chapter 9 the results and the future perspectives were discussed. It can be concluded that in case of 2D aesthetic assessments, the nose and the lip should be assessed separately because, when assessed together, the lip is dominating the overall scorings. Further, the scoring system by Asher-McDade et al. is superior to the scoring system by Prahl et al. and to the simplified version of this system. However, all of these scoring systems were able to accurately score cleft lip and palate-related deformities. The Cleft Aesthetic Rating Scale (CARS) is an new scoring system which is easy to use and is a reliable method to assess the aesthetic results of large groups of cleft patients around the age of six. Only three observers were needed to come to reliable results and the CARS for patients around the age of 18 can reliably be used by both professionals as well as medical students. SymNose is a practical and reliable tool for the assessment of large caseloads of 2D photographs of cleft patients for research purposes. However, the last study of this thesis showed that different 2D and 3D nasolabial assessment methods were not in agreement. The 2D symmetry assessments by SymNose showed almost no correlation with the 3D symmetry assessment. Three-dimensional symmetry assessment was highly reliable but showed a poor correlation to both 3D and 2D aesthetic assessments. More research is needed to determine what the best method of assessing outcomes of surgical correction of cleft-related deformities is.
In the near future the CARS will be further improved and also a basal reference scale is under development. By adding the basal view, the CARS can also be used for the aesthetic assessment of different surgical techniques and for evaluating secondary nose corrections in cleft patients. Currently, the CARS is also used to assess and compare the results of different Dutch cleft teams.