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A new digital measurement system for assessing the lip in patients with cleft lip and palate (CLP)

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ABSTRACT

Objective: In order to better and more objectively assess and compare the aesthetics of the lip, we offer an inovative, digital measurement method.
Patients and method: Patients were divided into 2 groups:
a) patients with unilateral CLP and
b) patients with bilateral CLP.
Based on standardised photos from 3 different directions, lip symmetry and aesthetics were assessed. A new digital measurement system was used, which was integrated into a proven clinical programme. Different symmetry indices were compared with a non-cleft control group. In addition, the function was investigated and a standardised questionnaire was used.
Results: In total, 92 patients with operated CLP could be recruitetd and showed significant residual asymmetry compared to the control group with 49 patients. The results were more symmetrical in group b) than in group a). In contrast, scar width and scar aesthetics as well as orofacial function were better in group a). The preoperative cleft width showed a positive correlation with the postoperative scar width and scar aesthetics. Socioeconomic factors were not related to surgical outcome. Satisfaction of affected children and parents correlated with objectively assessed scar aesthetics and function. There was no correlation between satisfaction and symmetry or cleft width or scar width.
Conclusion: The presented measurement system can be used excellently and effectively in clinical routine, especially for the inexperienced examiner, for fast and yet detailed, objective recording of findings. The measurement results can be analyzed comparatively and interpreted predictively for diagnostics, planning and therapy.

1. Introduction

Cleft lip and palate (CLP) is one of the most common congenital malformations in Central Europe, with an estimated ratio of 1:500–600.[1,2] They have been well studied with regard to prevalence, gender and lateral distribution.[1,2] However, to the best of our knowledge, there is no international standardised, comparative method for the assessment of long-term outcomes with regard to function and aesthetics. In order to be able to evaluate the care of patients with CLP more uniformly and objectively we would like to offer an inovative, digital measurement method. The practicability and successful application in regard to the nose could be shown in a previous investigation. The transfer of this technology allows surgically treated patients with CLP to be evaluated and compared in detail. The evaluation includes function and aesthetics of the lip in an individual, continuous and practical manner and can be used in everyday clinical practice. The aim of this study is to determine which objective measurement parameters are decisive for the subjective perception of the surgical outcome and which influence the preoperative cleft width has on the postoperative outcome. Further it was analyzed whether or not socioeconomic factors are

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possible influencing factors regarding the postoperative result.

2. Materials and methods

2.1. Ethical statement

The present study was approved by the ethics committee (ethics vote: 19–1255_1). Written informed consent has been obtained from all participating patients or, in the case of minors, from their parents or legal guardians.

2.2. Patients and method

This study was conducted over a 2-year period (2020–2022) at one specialized center. Patients with nonsyndromic CLP were divided into groups:

(a) patients with unilateral CLP and
(b) with bilateral CLP.

Patients were further subdivided in the groups according to whether a cleft lip and alveolus was present or a cleft lip and palate.

All patients with CLP were operated on using the Tennison-Randall technique. Lip and nasal floor closure was performed by a surgeon at 3–6 months of age. Patients with syndromic clefting were excluded, as well as if the primary surgery was not performed at our center.

The standardised photos of the face taken in clinical practice from three different directions (1. Full face, (frontal analysis), 2. Profile (profile analysis) and 3. From caudal (nasal base analysis)) were measured in detail for symmetry using the new digital system integrated into the proven clinically programme ivoris®(DentalSoftwarePower) immediately before the surgical procedure under anesthesia.[3]

For the true-to-scale image measurement, an individual distance calibration was performed based on the horizontal iris diameter, since the iris hardly changes after the 3rd month of life independent of gender.[4] Due to the iris calibration, the measurement and the comparison of the measured values remained constant regardless of the imaging technique. Subsequently, the anthropometric measurement landmarks known from the literature[5] were supplemented by additional, individual points and special symmetry indices were collected (Table 1).

In the presence of a cleft, the lip length was measured on the medial and lateral cleft margins. The width of the cleft was measured between the nasal sill and the white roll (mucocutaneous junction) of the lip. Measurements were taken on each side in patients with bilateral CLP. The non-cleft was measured as in the control group (Fig. 1). The measured distances and angles, which were collected for both halves of the face, were compared to each other and in relation to a control group without cleft formation using the Cleft Lip Component Symmetry Index (CLCSI) according to Amaratunga.[6] The larger the value, the more strongly 2 distances deviated from each other and the more unsymmetrical they become in relation to each other. For the total symmetry, the average of all symmetry values was formed.

For angular measurements, the number of degrees was specified (Table 1). The control group consisted of children of comparable age. Measurements were also performed - if possible - under anesthesia during the course of other interventions. This ensured accurate measurement even in children with low compliance.

In addition, a clinical optical assessment was performed. Scar aesthetics were assessed using a modified Vancouver Scare Scale (NSc) at rest and under function (kissing mouth, lip tips). Function was also assessed using a function score (FSc) clinically visually as well as manually by palpation (palpable muscle bulge/muscle gap/scar bulge at rest (lip closure) and in function (kissing mouth, smile). The lower the measured score, the more aesthetic the result or the better the function (Table 2).

Socioeconomic factors (e.g. family history, accompanying therapy measures, social anamnestic data (age, occupational status, school education)), psychosocial stress and satisfaction of patients and their parents before and after surgery were measured by standardised questionnaire. The main aim was to evaluate the lip aesthetically and functionally and thus to elicit satisfaction with the surgical result by selecting the answer options on a Likert scale of very good, good, satisfactory, sufficient and unsatisfactory, both in terms of function and for aesthetics.[7] Overall satisfaction was rated as yes or no.

Statistical analysis was performed using SigmaPlot 13 graphics and statistical software (Systat Software GmbH, Erkrath, Germany).

Table 1
Definition for some of the landmarks/measurement points and the distances or angles between them, as well as formulas.

Landmarks/measurement points and the distances between them/formulas for calculation of scores and indices	Definition
a	lowest point of the cupid's bow
b	columella base
c	corner of the mouth
d	lip red, highest point of the cupid's bow
e	nose entrance
I	inner iris margin
I'	outer iris margin
n	nasion (lowest point between forehead and nose in profile view)
co	columella
sn	subnasale (lowest point between columella and upper lip in profile view)
OL	most anterior point of the upper lip in profile view
pog	pogonion (most anterior point of the chin in profile view)
α	nasolabial angle (OL-sn-columella tangent)
δ	facial contour angle/face convexity (n-sn-pog)
distance:$\overline{cd}$	lateral lip length (both right and left)
distance:$\overline{da}$	median lip length (both right and left)
distance:$\overline{cb}$	lip slope (right and left respectively)
distance:$\overline{de}$	vertical lip length (both right and left)
distance:$\overline{ec}$	lip diagonal (right and left respectively)
distance:$\overline{cc}$'	mouth width
distance:$\overline{ab}$	philtrum length
distance:$\overline{ii}$'	iris diameter
distance:$\overline{sc}$R1/scR2	scar edge right
distance:$\overline{sc}$L1/scL2	scar edge left
Formula	
$CLCSI = \frac{\text{Measured value of the right side}}{\text{Measured value of the left side}} \times 100$	Cleft Lip Component Symmetry Index = Symmetry measurement between two measured values; the measured value of the right side is divided by the measured value of the left side and the result is multiplied by 100
$Sym_{distance} = \sqrt{(\overline{distance} - \overline{distance}')^2}$	symmetry measurement between two distance measurements
$Sym_{total} = \frac{Sym_{distance} + Sym_{distance} + \ldots}{number\ of\ distance\ measurements}$	total symmetry as the sum of all individual symmetry distance measurements divided by the number of distance measurements
$Scarescore\ (NSc) = \frac{\sum \text{scar values}}{number\ of\ measurements} x100$	scar score as the sum of the individual scar values divided by the number of measurements
$Functionscore\ (FSc) = \frac{\sum \text{function values}}{\text{number of measurements}} x100$	functional score as the sum of the individual function values divided by the number of measurements

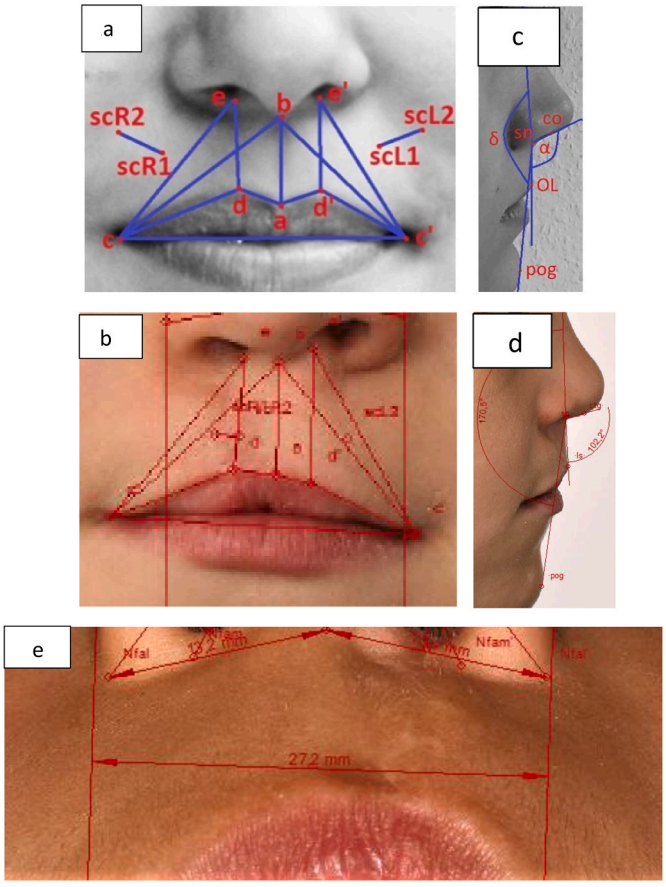

Fig. 1. a-e: Standardised photographs in three different planes (1a: full face control group, 1b: full face right unilateral CLP, 1c: control group in profile, 1d: right unilateral CLP profile, 1e: left unilateral CLP caudal (nasal base analysis)). The red lines and values indicate various detailed symmetry indices. Individual distance calibration is performed based on the horizontal iris diameter.

The Mann-Whitney-Utest was used for all comparisons. The effect size r was then determined and classified according to Cohen.[8] A one-factor analysis of variance was calculated for the group comparison of symmetry. Post-hoc tests with a Bonferroni correction were then performed. Other parameters, such as corrective surgery, social factors, and overall satisfaction, were calculated for group comparison using chi-square scatter test. Influences and correlations of parameters on the respective overall results were determined using Pearson's correlation analyses. In the absence of prerequisites for correlation analysis according to Pearson, the non-parametric alternative according to Spearman was used. In the parametric analyses, dependent and independent t-tests were used. For nonparametric analyses, tests according to Wilcoxon and Mann-Whitney-U were used. A p-value <0.05 was considered statistically significant, a p-value >0.1 as not significant.

3. Results

In total 92 patients with non-syndromic CLP could be recruited. 30 were female (32.6 %) and 62 patients were male (67.4 %). The ratio of male to female patients with CLP was 2:1.

Group a) accounted for 65 patients (70.65 %). 43 patients of group a) were male (66.15 %) and 22 patients were female (33.85 %). Group a) contained 19 patients with right-sided cleft and 46 patients with left-sided cleft (right-to-left ratio: 1:2.4).

Group b) accounted 27 patients (41.54 %). 19 patients of group b) were male (70.37 %) and 8 patients were female (29.63 %).

The control group consisted of 49 patients without cleft formation. 26 were female (53 %) and 23 (47 %) are male.

23 patients had an isolated cleft of the primary palate (upper lip, alveolar ridge and anterior palate up to the foramen incisivum). The same number of patients showed only a partial cleft of the primary palate. 69 patients showed cleft of the primary and secondary palate and as many showed continuous cleft of the primary and secondary palate.

The median age of the studied patient collective is 9 years overall. Within group a), the median age is 9.5 years, and within group b), it is 7.5 years.

The median value at the time of simultaneous lip and nasal floor closure in group a) was 5 months compared to group b) with 6 months.

Postoperatively, all patients with CLP showed a residual asymmetry that differed statistically significantly ($p = 0.0005$) from the nasolabial symmetry of the healthy control group (Table 3).

Comparing the groups, patients in group a) had statistically significantly less symmetry of lip length ($n = 65$; mean $= 1.87 \pm 0.99$ mm; $p < 0.0005$) than patients in group b ($n = 27$; mean $= 0.89 \pm 0.60$ mm). The operated side in group a) was statistically significantly shorter than the side without clefting. The mean deviation from the overall symmetry

Table 2
Statistical evaluation of different parameters in the respective groups; a) patients with unilateral CLP, b) patients with bilateral CLP.

Assessment aspects of the aesthetic scar assessment (NSc)	Rating score in words	Frequency			Percentage (%)		
		total	a)	b)	total	a)	b)
Relaxed lips closure	completely	73	57	16	79.3	87.7	59.3
	conditionally	11	6	5	12.0	9.2	18.5
	incompletely	8	2	6	8.7	3.1	22.2
Scar height and bulge formation	none	82	59	23	89.1	90.8	85.2
	<1 mm	10	6	4	10.9	9.2	14.8
	>1 mm	–	–	–	–	–	–
Scar retraction and notches	none	81	58	23	88.0	89.2	85.2
	low	10	7	3	10.9	10.8	11.1
	medium	1	–	1	1.1	–	3.7
	clearly	–	–	–	–	–	–
Hardening of the scar	none	66	55	11	71.7	84.6	40.7
	low	21	10	11	22.8	15.4	40.7
	medium	5	–	5	5.4	–	18.5
Tension/scar traction	none	68	55	13	73.9	84.6	48.1
	low	16	8	8	17.4	12.3	29.6
	medium	4	2	2	4.3	3.1	7.4
	clearly	4	–	4	4.3	–	14.8
Redness of the scar	none	51	42	9	55.4	64.6	33.3
	low	30	20	10	32.6	30.8	37.0
	medium	6	2	4	6.5	3.1	14.8
	clearly	5	1	4	5.4	1.5	14.8
Stitching punctures visible	no	70	53	17	76.1	81.5	63.0
	small	18	10	8	19.6	15.4	29.6
	medium	4	2	2	4.3	3.1	7.4
	clearly	–	–	–	–	–	–
Step formation in lip red and white	none	50	40	10	54.3	61.5	37.0
	low	26	16	10	28.3	24.6	37.0
	medium	15	8	7	16.3	12.3	25.9
	clearly	1	1		1.1	1.5	
Assessment aspect Function score (FSc)							
Palpable muscle gap	no	39	33	6	42.4	50.8	22.2
	small	34	24	10	37.0	36.9	37.0
	clearly	19	8	11	20.7	12.3	40.7
Bulging of the muscle at kissing mouth/ lip tips	none	43	35	8	47.3	53.8	30.8
	low	34	27	7	37.4	41.5	26.9
	clearly	14	3	11	15.4	4.6	42.3
Scar bulge	none	50	40	10	54.9	61.5	38.5
	low	34	22	12	37.4	33.8	46.2
	clearly	7	3	4	7.7	4.6	15.4
Lip closure for kissing mouth	completely	66	53	13	72.5	81.5	50.0
	conditionally	24	12	12	26.4	18.5	46.2
	incompletely	1	–	1	1.1	–	3.8
Fading of the scar/philtrum when smiling	no	65	57	8	72.2	89.1	30.8
	low	21	7	14	23.3	10.9	53.8
	clearly	4	–	4	4.4	–	15.4

Table 3
Dependence between preoperative cleft width, lip length, overall symmetry, scar width, scar aesthetics (NSc), lip function and social factors, cleft group and corrective surgery (* = significance).

Dependent Variable	test	group (n)	gap width in mm	p-value
Parental stress preoperatively	Independent *t*-Test	loaded (47)	13.43 ± 4.27 mm	0.143
		not loaded (42)	12.12 ± 4.04 mm	
	χ2-Test 5.687			0.017*
Parental stress postoperatively	Mann-Whitney-U-Test	loaded (19)	Median: 12.00 mm	0.057
		not loaded (70)	Median: 16.00 mm	
Child is addressed	Independent *t*-Test	yes (48)	13.59 ± 4.03 mm	0.030*
		no (41)	11.69 ± 4.16 mm	
Parents are addressed	Independent *t*-Test	yes (45)	13.52 ± 4.11 mm	0.051
		no (44)	11.96 ± 4.13 mm	
Does the child feel affected?	Independent *t*-Test	yes (29)	13.15 ± 4.14 mm	0.591
		no (60)	12.49 ± 4.21 mm	
Participation in leisure activities	Mann-Whitney-U-Test	yes (69)	Median: 13 mm	0.875
		no (18)	Median: 12 mm	
			Mean value (in mm) distance: resp.	
Unilateral left CLP	Dependent *t*-Test	47	L: 12.92 ± 2.55 R: 14.70 ± 2.48	<0.0005*
Unilateral right CLP	Dependent *t*-Test	18	L: 14.70 ± 2.00 R: 13.18 ± 2.05	<0.0005*
Bilateral CLP	Wilcoxon test	27	L: 12.89 ± 1.72 R: 13.25 ± 1.72	<0.086
			Mean value Sym_total (in mm)	
Corrective surgery	Independent *t*-Test	yes (21)	1.61 ± 0.62	0.858
		no (71)	1.58 ± 0.55	
Parental stress postoperatively	Independent *t*-Test	Loaded (19)	1.51 ± 0.61	0.489
		not loaded (73)	1.61 ± 0.55	
Child is addressed	Independent *t*-Test	yes (50)	1.61 ± 0.56	0.588
		no (42)	1.55 ± 0.57	
Parents are addressed	Independent *t*-Test	yes (46)	1.59 ± 0.51	0.889
		no (46)	1.58 ± 0.61	
Does the child feel affected?	Independent *t*-Test	yes (29)	1.55 ± 0.46	0.703
		no (63)	1.60 ± 0.60	
Participation in leisure activities	Independent *t*-Test	yes (72)	1.59 ± 0.56	0.756
			Scar width in mm (Median)	
Parental stress postoperatively	Mann- Whitney-U-Test	loaded (19)	3.90	0.159
		not loaded (73)	3.23	
Child is addressed	Mann-Whitney-U-Test	yes (50)	3.79	0.013*
		no (42)	3.11	
Parents are addressed	Mann-Whitney-U-Test	yes (46)	3.67	0.109
		no (46)	3.24	
Does the child feel affected	Mann-Whitney-U-Test	yes (29)	3.67	0.258
		no (63)	3.18	
Participation in leisure activities	Mann-Whitney-U-Test	yes (62)	3.23	0.089
			NSc (Median)	
Parental stress postoperatively	Mann-Whitney-U-Test	loaded (19)	9.09	0.451
		not loaded (73)	9.09	
Child is addressed	Mann-Whitney-U-Test	yes (50)	9.09	0.030*
		no (42)	4.54	
Parents were addressed	Mann-Whitney-U-Test	yes (46)	11.36	0.027*
		no (46)	6.81	
Does the child feel affected?	Mann-Whitney-U-Test	yes (29)	9.09	0.743
		no (63)	9.09	
Participation in leisure activities	Mann-Whitney-U-Test	yes (72)	9.09	0.318
			FSc (Median)	
Corrective surgery	Mann-Whitney-U-Test	yes (21)	30	0.118
		no (71)	20	
Parental stress postoperatively	Mann-Whitney-U-Test	loaded (19)	20	0.806
Child is addressed	Mann-Whitney-U-Test	yes (49)	30	0.006*
		no (41)	15	
Parents are addressed	Mann-Whitney-U-Test	yes (44)	20	0.967
		no (46)	20	
Does the child feel affected ?	Mann-Whitney-U-Test	yes (29)	30	0.282
		no (61)	20	
Participation in leisure activities	Mann-Whitney-U-Test	yes (72)	20	0.631
		no (18)	20	
	(p)Symmetry results (Sym_total)	**(p)scar width**	**(p)NSc**	**(p)FSc**
Cleft width	Pearson	0.227	0.035*	0.037*	0.389
Cleft width unilateral	Pearson	0.321	0.175	0.156	0.963
Cleft width bilateral	Pearson	0.974	0.499	0.183	0.245
Age at operation	Spearman	0.024*	0.011*	0.730	0.866
Age at examination	Spearman	0.003*	0.824	0.480	0.32
Age mother	Pearson	0.146	0.470	0.820	0.903
Age father	Pearson	0.035	0.804	0.318	0.822
School degree mother	Spearman	0.702	0.103	0.529	0.138
School degree father	Spearman	0.719	0.147	0.100	0.138

was 1.63 ± 0.53 mm for group a) and 1.48 ± 0.63 mm for group b). The control group had the highest overall symmetry and the lowest mean deviation (0,92 ± 0,44 mm). In contrast, the results with regard to scar width, scar aesthetics and orofacial function were statistically significantly better for group a) ($p < 0.0005$) than for group b). Overall and within groups, NSc correlated statistically significantly with Fsc ($p < 0.0005$; in detail: p(muscle bulge) = 0.008, p(scar bulge) = 0.001, p(lip closure in kissing mouth) = 0.001, p(fading of philtrum) = 0.001), but neither correlated with symmetry (p = 0.811). Moreover Table 3 shows a positive statistically significantly correlation between preoperative cleft width and postoperative scar width (p = 0.035) and scar aesthetics (p = 0.037). The mean scar width was 3.77 ± 2.03 mm and ranged from the minimum value of 0.96 mm to the maximum value of 11.48 mm. The

mean value of the Nsc was 12.75 + 12.77 and ranged between 0 and a maximum value of 50 (Table 4). 84.8 % of all patients showed a NCs <25, 15.2 % of the patients showed a NCs >25. None of the patients showed a value > 50. Functional outcomes ranged from a minimum value of 0 to a maximum value of 80.0, with a mean value of 26.11 ± 22.2 (Table 4). The FSc correlated statistically significantly with satisfaction on the individual parameters of lip mobility (p(muscle gap) = 0.002, p(bulging of muscle) = 0.001, p(bulging of scar) = 0.044, p(lip closure in kissing mouth) = 0.013.

The older the patients were at the time of surgery, the more statistically significantly symmetrical (p = 0.024) was the postoperative outcome (Table 3). However, the older the patients were at the time of study, nasolabial symmetry was statistically significantly worse (p = 0.003) and scar width (p = 0.011). Patients who had undergone corrective surgery (22.8 %) showed no difference in symmetry and function from those without corrective surgery (77.2 %), regardless of the number of corrective surgeries. The median for no corrective surgery (n = 71, median = 3.74 mm) was lower than for one or more corrective surgeries performed (n = 21, median = 4.28 mm). The median NSc when corrective surgery was not performed was also lower (n = 71, median NSc = 4.55) than when one or more corrective surgeries were performed (n = 21, median NSc = 13.64). However, both scar width and scar aesthetics improved statistically significantly with corrective surgery (p = 0.004 and p = 0.008). The results between preoperative cleft expression and corrective surgery were statistically significant (p = 0.001). In group a), 13.8 % underwent one or more corrective surgeries, whereas in group b) 44.4 % did.

Socioeconomic factors were not related to cleft width or postoperative outcomes. In both cleft groups, the number of parents with jobs was statistically significantly higher than the number of unemployed, with fathers more likely to be employed than mothers in each case. The age of the parents was similar in each case. In group a), the parental education level was slightly higher than in group b).

As shown in Table 3, symmetry, scar width, scar aesthetics, or orofacial function had no effect on the postoperative distress of patients and their parents. However, with the exception of symmetry, these parameters were statistically significantly worse in children who were themselves, or their parents, were concerned about the deformity (p(scar width) parents addressed = 0.0231, p(scar width) child addressed = 0.013; p(NSc) parents addressed = 0.027, p(NSc) child addressed = 0.03). Patients from group b) were more often approached by the social environment about the malformation (66.67 %) than those from group a) (50 %). This difference was only slightly pronounced when parents were interviewed. However, parents in group b) felt significantly more stressed preoperatively than in group a) (p = 0.0017).

Table 4
Cleft width, scar width, scar score (NSC) and function score (FSC) with measured values in millimeters (mm).

Demographics					
			Minimum	Maximum	Median
Cleft width (in mm)	Lip red white border	right	4	20	12.22 ± 3.75
		left	1	22	12.31 ± 4.61
	Nasal inlet left	right	0	16	8.49 ± 4.17
		left	0	19	8.12 ± 5.17
Scar width (in mm)			0.96	11.48	3.77 ± 2.03
Scar score (NSc)			0	50	12.75 ± 12.77
Function score (FSc)			0	80	26.11 ± 22.2

There was no difference in leisure time behaviour. The satisfaction of patients and their parents correlated statistically significantly with lip aesthetics (p = 0,009) and lip function (p = 0,007), but not with symmetry (p = 0.056) or cleft or scar width (p = 0,299). Surprisingly, satisfaction in group b) was even slightly higher despite more severe involvement preoperatively. Overall, the satisfaction of patients and their parents was 95 %.

4. Discussion

Our results in terms of prevalence of CLP, sex and side distribution are in accordance with the data in the literature.[1,2] However, the international literature data regarding function and aesthetics are difficult to compare due to different surgical and assessment procedures. The midface and the lip are crucial for the aesthetic self-perception and the perception by others.[9] Symmetrical faces - independent of malformations - are known to be perceived as particularly aesthetic.[9] Known aesthetic problems after lip closure include discontinuities in the lip between skin and mucosa, red-white, with medial subsidence and vertical lip length that is too short or too long on the cleft side. In particular, wide conspicuous scar ratios, hypertrophic scars, or scars at the suture insertion sites, due to knots that are too tight or suture material left in-situ too long, are very noticeable and are most likely to cause dissatisfaction in affected individuals.[10] In addition to superficial deformities, muscular deficits, some due to inaccurate reconstruction, result in further problems.[11]

Surgical intervention, according to Delaire's basic principle, should aim to normalize the musculature and overlying tissues and thus function, which then leads to minimization of the scar. Otherwise these scars can compress the upper jaw in the lip area and thus hinder the growth of the midface. This may subsequently lead to retrognathia, as evidenced by a tendency toward flattening of the facial profile and rather elevated facial contour angles (nasolabial and facial contour angles) in both patient groups.[12,13] However, group b) shows better results than group a).

The software used was integrated into the proven ivoris® (Dental-SoftwarePower) clinical program. As a result, the measurement system and the collected indices are easy to use and comprehensible at all times for everyday clinical practice and the inexperienced user. The measurement can be used individually, objectively and quickly for assessment. It is thus very user-friendly and efficient despite its high level of detail. This also opens up a multitude of new assessment and comparison options through automatic interfaces, such as to X-ray and statistics, etc. This applies to diagnostics and planning as well as to the evaluation of surgical interventions. The same applies to the use of NSc and Fsc. The individual iris calibration of each image also allows interdisciplinary, repeatable and comparative surveying. This ensures complete and consistently structured documentation of findings, regardless of the survey location. This leads to a high quality of treatment for the patient and to new scientific examination possibilities.

Our results support the impression of patients and their parents that there is a positive correlation between cleft expression and aesthetic and functional impairment preoperatively. There is also evidence in the literature of such a dependence in adult patients.[15–17] In contrast, our results show a high postoperative satisfaction of patients and parents (95 %) especially in the aesthetically and functionally more impaired group b), which can be explained by an obviously good surgical outcome with a predominantly pleasing aesthetic appearance. This is also evidenced by the largely symmetrical CLCSI measurements of both groups. The objectively measured deficits of lip length, cleft and scar width as well as visual and palpatory functional deficits are important in their totality for subjective perception and satisfaction. Therefore, isolated use and evaluation of symmetry indices is not recommended because every face has asymmetries to a small degree. In this context, slight asymmetries have no influence on attractiveness.[8,9]

The largely symmetrical surgical results of patients with CLP suggest that it is a muscular dislocation deformity rather than a tissue deficit,

which should be accordingly surgically repositioned and reconstructed symmetrically.[12–14]

5. Conclusion

With the presented measurement system and the symmetry indices we would like to contribute to the continuous and interdisciplinary development of cleft surgery and its results.[18] This objective system can be used excellently and effectively in clinical routine, especially for the inexperienced examiner, for fast and yet detailed, objective recording of findings. The measurement results can be analyzed comparatively and interpreted predictively for diagnostics, planning and therapy. It also opens up a multitude of new assessment and comparison options through automatic interfaces, such as to X-ray and statistics, etc. regardless of the survey location. This ensures complete and consistently structured documentation, leads to a high quality of treatment for the patient and to new scientific examination possibilities.

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Conflict of interest declaration

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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