Effects of Primary Periosteoplasty on Facial Growth in Unilateral Cleft Lip and Palate: 10-Year Follow-up

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Cephalometric radiographic assessment of facial growth was carried out in 35 10-year-old boys with complete unilateral cleft lip and palate, operated upon in childhood with the technique of primary periosteoplasty. They were compared with two matched series of boys with clefts; one group was treated with primary osteoplasty and the second with the technique of surgical repair without a bone graft or periosteal flap. Comparison of the three surgical techniques disclosed that subsequent jaw development was most advantageous after primary periosteoplasty and least satisfactory after bone grafting. Facial changes after periosteoplasty consisted of a milder retrusion of the upper jaw, a maintenance of the overjet, and a more satisfactory prominence of the upper lip. Analysis also revealed that orthodontic treatment appeared to play a major part in improving the facial configuration.

KEY WORDS: *cleft lip and palate, primary periosteoplasty, bone grafting, facial growth.*

The surgical bridging of the cleft alveolar process with a periosteal flap was initially described by Skoog (1965) as a means of stabilizing the separated segments of the upper jaw and providing support for the sunken nasal wing. Although the aim of the periosteal flap is similar to that of an implanted bone graft, its use helps to avoid the frequently observed adverse effect of bone grafting on subsequent growth of the upper jaw.

A slight modification of the Skoog periosteal flap method has been used since 1973 at the Department of Plastic Surgery in Prague. This modification employs a smaller flap (5 to 7 mm wide and 15 to 20 mm long) and, therefore, requires the exposure of a smaller area of bone (Hrivnáková et al, 1981). Evidence of ossification of the flap was recorded in about 75% of the patients (Hrivnáková et al, 1981), consisting mostly of the formation of narrow lamella.

The purpose of the present study was to assess the growth and development of the face at around age 10 in boys with unilateral cleft lip and palate treated simultaneously with lip suture and periosteoplasty, compared with boys who underwent the surgical procedures of primary osteoplasty or surgical repair without the use of a bone graft or a periosteal flap. These two procedures were compared in a separate study (Müllerová and Šmahel, in press). The only significant differences consisted of a more marked deficiency of vertical growth of the anterior upper face height and a more marked retroinclination of upper incisors in patients treated with primary osteoplasty compared with individuals without bone grafts.

Material and Method

Follow-up examinations were conducted in 35 boys, aged 9 to 11 years, with repaired complete unilateral cleft lip and palate without any other malformations. Primary cheiloplasty was carried out according to Tennison, or sometimes according to Veau, with the mean age at 8.4 months, and palatoplasty consisting of push-back and pharyngeal flap surgery, with the mean age at 5 years 1 month. Simultaneous with lip suture, the cleft alveolus was bridged over with a periosteal flap. At the time of the follow-up examination, mean age of the subjects was 9 years 11 months. All affected individuals were born between 1973 and 1976.

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For comparison purposes, two series of boys with the same type of cleft, without associated malformations, were used as controls. These boys were treated with the same methods but without the use of periosteoplasty. One series consisted of individuals who underwent primary bone grafting. The second group did not undergo periosteoplasty or a primary bone graft to the alveolar cleft.

The series of patients who underwent primary osteoplasty included 32 boys aged 10 to 11 years. The bone graft was obtained from a rib and was implanted into the alveolar process and did not extend into the hard palate. Primary cheiloplasty according to Tennison (only occasionally according to Veau) was performed with the mean age at 7.0 months, while palatoplasty with push-back and pharyngeal flap was performed with the mean age at 4 years 3 months. At the time of the follow-up examination, mean age of this group was 10 years 5 months; thus, these subjects were 6 months older than the boys in the other series. However, this difference was not considered to be of significance during the prepubertal period. The patients were born in the years 1966–1972.

The series without a bone graft or a periosteal flap included 30 boys. They were re-examined at age 10 years ± 3 months. Primary lip suture, according to Tennison (in a few cases according to Veau), was carried out at the mean age of 7.2 months and the closure of the palate with push-back and pharyngeal flap at a mean age of 4 years 6 months. All individuals examined were born in the years 1960–1968.

All individuals assigned into these three groups were operated on at the Department of Plastic Surgery in Prague and subsequently treated at our orthodontic department with removable appliances only. This treatment was predominantly aimed at creating some protrusion of the upper incisors in order to correct the anterior crossbite and establish a positive overjet. However, although the principles and methods of this treatment were similar in all three groups of patients, in the most recent group with periosteoplasty an attempt was made to restore an overjet as soon as possible. Anterior overjet was present at the age of 10 years in 51% of these patients, in contrast to 34% after osteoplasty and 27% in the series without a bone graft or a periosteal flap. If the numbers of patients with an edge-to-edge bite were added to these figures, the respective data would be 80% (flap), 53% (graft), and 63% (without flap or graft). Fixed appliances were used at a later age during the pubertal growth spurt. Preoperative jaw orthopaedics was not used. The differing ranges of age of these patients in individual series at the time of the follow-up examination exerted no effects on the mean values of measured characteristics.

The study was based on cephalometric assessment of lateral x-ray films obtained under standard conditions in centric occlusion. The cephalometric points and reference lines used in this study are presented in Figure 1. The measurements of perpendicular distances of a point from the reference line are designated as Ptm-VL, angles as Ss-N-Sm (i.e., ANB), or as a fraction of the pertinent reference lines (ML/NSL), and proportional characteristics as S-Go%N-Gn (S-Go in percent of N-Gn). Ls⊥Li shows the extent to which the upper lip is more prominent in the stated points than the lower lip (measured perpendicular to the connecting line N′-Pg′). Anterior overjet (Is-Ii) was measured between the edges of the upper and lower incisors parallel to the occlusal plane. The results were analyzed statistically with the *t* test.

Results

Numerous measures (Table 1 and Fig. 2) showed statistically significant differences between patients who had early periosteoplasty and those who had bone grafts. The most important difference between those two groups was that the periosteoplasty group showed a milder retrusion of the upper jaw (S-N-Ss, S-N-Pr). This was due to the more marked anterior displacement of the jaw (Ptm-VL, Pmp-VL) rather than to the larger length of the maxilla, which did not attain the significance level (Ss-Pmp). The mandible was displaced anteriorly as well (S-N-Pg, S-Ar) and showed a smaller posterior rotation (N-S-Pgn). In spite of the anterior displacement of both jaws, their anteroposterior relation was more favorable in individuals with periosteal flaps (Ss-N-Sm). These individuals showed a more marked retroinclination of the mandibular symphysis (CL/NSL), which fully compensated the anterior displacement of the mandible (there were no differences between S-N-Id). This was accompanied by an anterior overjet, in contrast to an anterior crossbite in the other two series (Is-Ii). The lower face (Sp-Pg, Ii-Gn), and thus the face as a whole (N-Gn), showed a greater elongation in individuals with bone grafts and thus contributed to an increased posterior rotation of the face (S-Go%N-Gn) with a steeper slope of the mandibular body (ML/NSL) and a more marked alteration of vertical jaw relations (PL/ML). The canting of the palatal plane (PL/NSL) in patients with grafts characterized the deficient

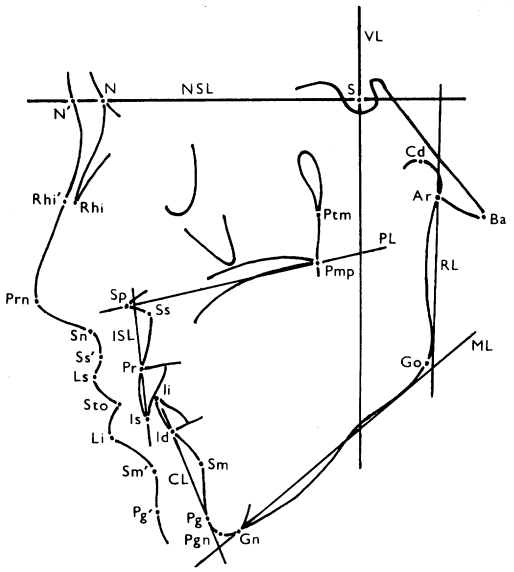

FIGURE 1 Cephalometric points and reference lines used in the present study: Ar (articulare) = intersection of inferior contour of the clivus and posterior contour of the ramus mandibulae; Ba (basion) = most posteroinferior point on the clivus; Cd (condylion) = most superior point on the condylar head; Gn (gnathion) = lowest point of the mandibular symphysis; Go (gonion) = point on the angle of the mandible determined by the axis of ML/RL angle; Id (infradentale) = point of the gingival contact with lower central incisor; Ii (incision inferius) = incisal tip of the lower central incisor; Is (incision superius) = incisal tip of the upper central incisor; Li (labrale inferius) = margin of the vermilion of the lower lip; Ls (labrale superius) = margin of the vermilion of the upper lip; N (nasion) = most anterior point on the frontonasal suture; N′ (soft nasion) = intersection between NSL and soft profile contour; Pg (pogonion) = most anterior point on the bony chin; Pg′ (soft pogonion) = most anterior point on the soft tissue chin; Pgn (prognathion) = point on the mandibular symphysis farthest from Cd; Pmp (pterygomaxillare palatinum) = intersection of palate line PL with the fissura pterygomaxillaris; Pr (prosthion) = point of gingival contact with upper central incisor; Prn (pronasale) = point on the top of apex nasi; Ptm (pterygomaxillare) = most inferior point of fossa pterygopalatina where fissura pterygomaxillaris begins; Rhi (rhinion) = most inferior point on the nasal bone; Rhi′ (soft rhinion) = point on the soft profile contour over Rhi; S (sella) = center of sella turcica; Sm (supramentale) = deepest point on the anterior contour of the mandibular symphysis; Sm′ (soft supramentale) = deepest point on the soft contour of the lower jaw; Sn (subnasale) = point at which columella merges with the upper lip; Sp (spinale) = tip of the anterior nasal spine; Ss (subspinale) = deepest point of the subspinal concavity, Ss′ (soft subspinale) = deepest point of the upper lip; Sto (stomion) = point of contact of the upper and lower lip; NSL = line through N and S; VL = perpendicular to NSL through S; PL = line through Sp and most posterior point of the palatal processes; CL = line through Pg and Id, ML = tangent to the mandibular body through Gn; RL = tangent to the mandibular ramus through Ar; ISL = line through Is and Pr.

growth of the anterior upper face height compared with its posterior height. The altered vertical proportion of the upper and lower face (N-Sp%N-Gn) confirmed this observation. The soft tissue profile showed a more satisfactory prominence of the upper lip after periosteoplasty (S-N′-Ss′), especially in relation to the lower lip (Ls⊥Li). This resulted in a more favorable anteroposterior relation between the middle and lower face (Ss′-N′-Sm′).

It was possible to observe much smaller differences in the development of the face between the series of patients with a periosteal flap and individuals operated upon without a bone graft or a flap. The single significant improvement after periosteoplasty consisted of a more satisfactory prominence of the upper lip (Ls⊥Li). However, a comparison of the mean values for most important facial characteristics, i.e., sagittal jaw relations (Ss-N-Sm) and the corresponding relations of the soft tissue profile (Ss′-N′-Sm′), occlusion at the incisors (Is-Ii), and the prominence of the upper lip (Ls⊥Li), showed the most satisfactory development in individuals with periosteal flaps and the most unfavorable development in individuals with bone grafts. The series of patients operated upon without bone grafts or periosteal flaps occupied an intermediate position.

Discussion

The cephalometric characteristics in individuals with periosteoplasty disclosed a definite growth improvement in the subjects at age 10 in contrast to those observed with bone grafts. The improvement included less retrusion of the upper jaw, the presence of a dental overjet relationship, and an improved prominence of the upper lip. The improvement was evident also during a comparison with the series operated upon without the use of a bone graft or of a periosteal flap, yet the differences were smaller. These results provided evidence of a favorable development of the jaw after primary periosteoplasty, whereas the most unsatisfactory situation was evident after primary osteoplasty among the groups studied.

Some questions remain as to the factors that contribute to the favorable changes seen after periosteoplasty. Certainly, an important part has been played by orthodontic therapy. The most significant result of this therapy was the restoration of a positive overjet, which was promoted by the less pronounced retrusion of the upper jaw. This milder retrusion in individuals treated with periosteoplasty was apparently not due to an improved growth of its depth but,

TABLE 1 Mean Values of x-ray Cephalometric Characteristics in Individuals with Complete Unilateral Cleft Lip and Palate with Primary Periosteoplasty (Flap), Primary Bone Grafting (Graft) and Surgery Without Graft or Flap (No G.F.)

	Flap	*Graft*	*No G.F.*	*Dif. F-G*	*Dif. F-N*
N-Sp	46.71	46.25	47.60	+0.46	−0.89
N-Gn	111.37	114.75	112.43	−3.38*	−1.06
Ii-Gn	39.31	41.44	40.03	−2.13†	−0.72
Sp-Pg	60.03	63.94	60.67	−3.91†	−0.64
Ss-Pmp	44.91	43.88	45.37	+1.03	−0.46
S-Ar	31.29	33.00	32.50	−1.71‡	−1.21
Ptm-VL	13.00	11.53	11.90	+1.47‡	+1.10
Pmp-VL	12.03	10.34	11.20	+1.69‡	+0.83
Is-Ii	0.67	−0.88	−0.78	+1.55‡	+1.45
N-S-Pgn	70.80	73.12	71.47	−2.32*	−0.67
S-N-Ss	75.66	73.62	75.67	+2.04‡	−0.01
S-N-Pr	76.26	74.31	76.07	+1.95‡	+0.19
S-N-Id	74.69	73.91	75.37	+0.78	−0.68
S-N-Sm	73.49	72.41	73.97	+1.08	−0.48
S-N-Pg	74.63	73.06	74.70	+1.57‡	−0.07
Ss-N-Sm	2.17	1.22	1.70	+0.95	+0.47
PL/NSL	7.43	5.75	8.23	+1.68‡	−0.80
ML/NSL	38.60	41.16	40.00	−2.56‡	−1.40
PL/ML	31.17	35.41	31.77	−4.24*	−0.60
CL/NSL	74.17	70.71	72.60	+3.46‡	+1.57
ISL/PL	77.89	75.81	79.17	+2.08	−1.28
S-N′-Ss′	81.29	78.97	81.47	+2.32‡	−0.18
Ss′-N′-Sm′	6.06	4.47	5.47	+1.59‡	+0.59
Ls ⊥ Li	2.69	0.47	0.97	+2.22†	+1.72*
S-Go%N-Gn	60.63	59.62	59.21	+1.01	+1.42
N-Sp%N-Gn	41.94	40.31	42.34	+1.63*	−0.38

* $p < 0.01$
† $p < 0.001$
‡ $p < 0.05$
Abbreviations: dif.f-g = difference between individuals with periosteal flap and with bone graft; dif.f-n = difference between individuals with periosteal flap and without flap or bone graft.

rather, to the anterior shift of the maxilla as a whole from its dorsal displacement (Šmahel and Brejcha, 1983). A similar inhibition of the growth of the maxillary depth after periosteoplasty and in the series treated without a bone graft or a periosteal flap suggests that the inhibition is effected by some other factors unrelated to periosteoplasty. In our opinion, the main factors include (1) scar tension after palatoplasty, (2) uninterrupted osseous closure of the hard palate after surgical repair, and (3) the primary impairment of the growth potential of the upper jaw, sometimes considered the most important factor (Jelínek et al, 1983). The first factor can be partially reduced by the applied techniques of palatoplasty. For these reasons, the problems associated with the diminished growth of the upper jaw will persist in the future as well. A more marked improvement of the prominence of the upper lip relative to the prominence of the maxilla after periosteoplasty (Fig. 2) is suggestive of the good quality of lip reconstruction.

Analysis of our data indicates that the soft tissue improvement after periosteoplasty is caused mainly by the restoration of dental overjet. Thus, these results confirm the importance of orthodontic therapy for improving the final configuration of the face in clefts (Šmahel, in press). However, the choice of the surgical technique used can provide a more or less favorable background for orthodontic treatment and thus, to a large degree, can determine both its success and its limitations. In this respect, the techniques included in our comparison showed primary periosteoplasty to be most advantageous. Nonetheless, it is necessary to take into account the steadily increasing changes and differences in surgical experience, as stated by Ross (1987c). The fact that our series of patients operated on without a bone graft or a periosteal flap was treated a decade earlier than those treated with periosteoplasty could explain some differences in the data obtained. We believe, therefore, that a less favorable facial development after osteoplasty could be attributed to this method, while a more satisfactory development recorded after periosteoplasty, compared with the series treated without graft or flap, was due to the restored overjet as well as

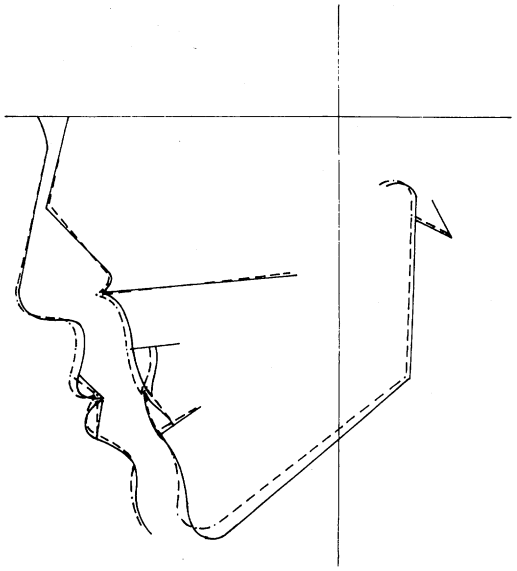

FIGURE 2 Faciograms in boys with complete unilateral cleft lip and palate operated upon with primary bone grafting (solid line) and with primary periosteoplasty (dashed line).

to the increased surgical experience rather than to the method itself. This statement is in agreement with the chronology of the applied methods, i.e., without graft or flap, with a graft, and, finally, with a flap.

The described improvement after periosteoplasty, or impairment after primary osteoplasty, was not remarkable in comparison to the results obtained in a series treated without a bone graft or periosteal flap. According to Ross (1987a), however, a large portion of individuals with clefts are functionally and esthetically classified as borderline cases and thus small changes could be biologically significant. Even a slight improvement can therefore be of substantial importance for the patient. Since the main developmental insufficiency of the maxilla occurred during the period of pubertal growth spurt, a further increase of the differences among the three series could not be excluded. Certainly, it is not possible to expect a developmental improvement during puberty and thus a less or more favorable development recorded before puberty indicates the final result of growth. Conceivably, this does not hold true in all individuals.

We find no other identical reports in the literature to allow comparison with our results. Hellquist and Pontén (1979) assessed the results of periosteoplasty at the age of 8 years in individuals with complete unilateral cleft lip and palate and reported that they were consistent with other Scandinavian findings in patients operated upon without a periosteal flap or a bone graft. The comparison of our mean values with Scandinavian data (Table 2) shows a good agreement between the main characteristics. In the series of subjects operated upon without a bone graft or a periosteal flap, the sagittal jaw relations (Ss-N-Sm) were in close agreement with the findings reported by Sidhu and Bergland (1972). However, Hellquist and Pontén (1979) reported sagittal jaw data for patients who had previously received periosteal flaps, and their subjects, who were observed at age 8 years, exceeded our 10-year-old patients by 0.6 degrees. Since the ANB angle decreased with increasing age (Hellquist and Pontén, 1979), it could be expected that at the age of 10 years the differences would prove very small. The most unfavorable results were recorded both in our series and especially in the series reported by Friede and Johanson (1974) in patients with bone grafts. The anteinclination of the palatal plane (PL/NSL) recorded in our patients and in the Scandinavian series of patients with bone grafts was due to the deficient growth of the anterior height of the upper face. The steep slope of the mandibular body (ML/NSL) was somewhat less marked in the Scandinavian series, which could be due to ethnic differences,

TABLE 2 Means for Cephalometric Radiographic Characteristics of Subjects Undergoing the Three Compared Surgical Techniques*

Variable	*Hellquist and Pontén (Periosteal Flap, 8 Years)*		*Friede and Johanson (Bone Graft,† 10 years)*		*Sidhu and Bergland (No Graft or Flap, 10.8 Years)*	
S-N-Ss	76.5	(75.7)	73.1	(73.6)	76.1	(75.7)
S-N-Pg	74.6	(74.6)	76.6	(73.1)	75.8	(74.7)
Ss-N-Sm	2.7	(2.2)	−2.4	(1.2)	1.7	(1.7)
PL/NSL	8.7	(7.4)	4.2	(5.8)	10.5	(8.2)
ML/NSL	37.8	(38.6)	35.9	(41.2)	38.8	(40.0)

* Data are reported for Scandinavian series and for the subjects in the current study (brackets).
† Plus vomer flap.

the applied therapeutic procedures, or both. Thus, the findings were in agreement with those of our experience.

In the international study, Ross (1987b) recorded a slight anteroposterior and more marked vertical growth deficiency of the maxilla after primary bone grafting. He also revealed a reduction of the vertical maxillary growth after soft tissue repair of the alveolar process. We failed to confirm the latter observation (N-Sp%N-Gn) possibly because of slight signs of the ossification of the narrow flap.

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