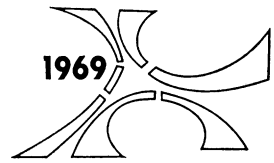
Long-Term Postoperative Results of Primary and Secondary Bone Grafting in Complete Clefts of Lip and Palate



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In our opinion, reports of good preliminary results (*7, 8, 12–14, 16–22*) of primary and secondary bone grafting (*5, 11, 15*) in complete clefts of lip and palate are not sufficient to state a final decision about this method. The question under discussion is whether the grafted bone might interfere with the subsequent growth of the maxilla and/or if the growing maxilla may influence the form and size of the transplanted bone respectively. To our knowledge, there exists no answer from the literature to this date. The maxillary growth after the primary dentition is particularly remarkable and has to be noticed more than heretofore. Therefore the long-term results have to be looked upon as a guide for definitive statements. One of us stated in 1964: "The final decisions about bone grafting in cleft palate repair will be made in the future" (*7*).

Evaluation of two comparable series of treated children

As shown in Tables 1 and 2, for a period of 14 years in the Westdeutsche Kieferklinik, total clefts have been closed with or without osteoplasty alternatively. The oldest 100 children, operated between 1955 and 1962, have been selected and investigated, 50 of them with an average age of 10.5 years with bone grafting and 50 with an average age of 9.6 years without bone grafting.

Methods of surgical repair

1. Primary osteoplasty was performed at a mean age of 8.0 months. The bone bed was created in 34% with a tilted vomer flap according to Stellmach (*21, 22*) (Figure 4, center). In the remaining 66% of the cases,

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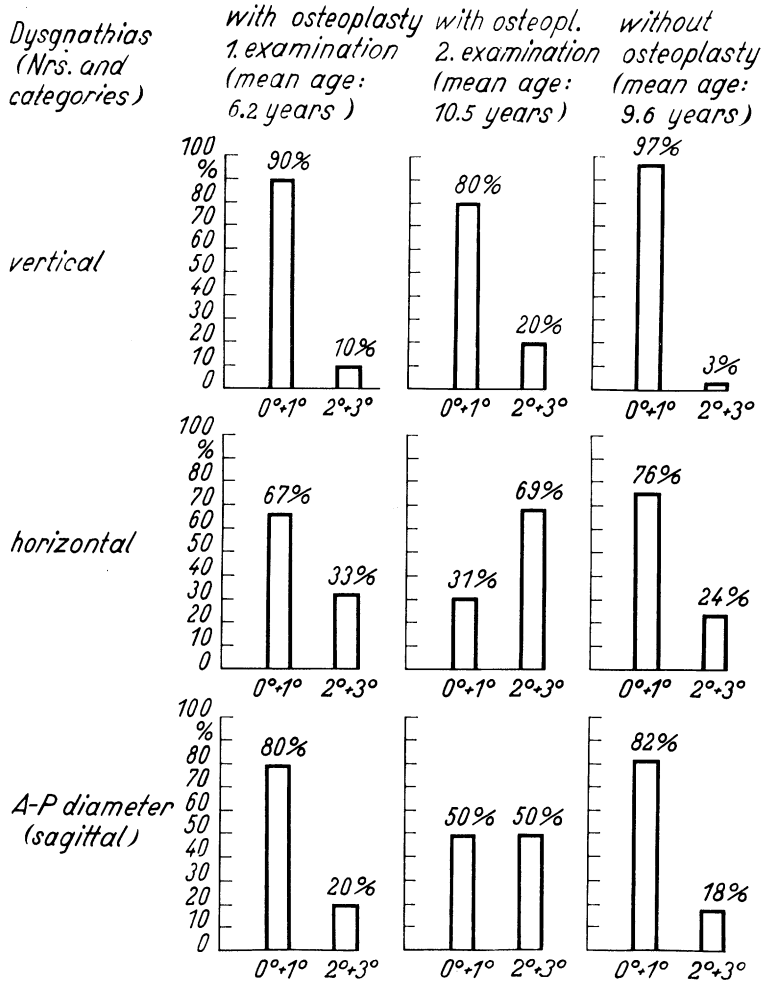
This paper was presented at the 1969 International Congress on Cleft Palate, Houston.

TABLE 1. Results after plastic closures of alveolar cleft with or without bone grafting in relation to postoperative intervals.



the nasal lining was performed up to the dorsal border of the alveolar arch according to Veau-Axhausen, the oral lining according to Burian-Trauner. The lip repair was done at the same stage (Figures 1 and 2). The secondary osteoplasty was done at an average age of 4.5 years in the same manner through an incision in the labial sulcus between the edges of the segments. The hard palate in these two groups was closed at an average age of four years.

2. In the control group, on 84% only the alveolar cleft was closed according to Veau-Axhausen, and in 16% the hard palate was closed additionally utilizing a Pichler-flap at the same time (Figure 5, center). In the remaining 84%, the hard palate was closed at a mean age of 4.5 years.

TABLE 2. Summary table.

	with bone grafting (osteoplasty)									*without bone grafting*			*difference*
	primary			*secondary*			*total*						
	uni-lat.	*bi-lat.*	*tot.*	*uni-lat.*	*bi-lat.*	*tot.*	*uni-lat.*	*bi-lat.*	*tot.*	*uni-lat.*	*bi-lat.*	*total*	
no. of cases	20	20	40	5	5	10	25	25	50	37	13	50	ϕ
no. of plastic closures of alveolar cleft	20	36	56	5	9	14	25	45	70	37	26	63	+7
division of sex (male: female)	29:11			3:7			32:18			37:13			−10% (males)
localization: N(%)													
right	24 (43)			8 (57)			32 (46)			29 (46)			ϕ
left	32 (57)			6 (43)			38 (54)			34 (54)			ϕ
age at operation (months)	8.0			(4.5 years)			not sig.			7.8			+0.2
age at: (years)													
1. reexamination	5.9			7.2			6.2			not sig.			not sig.
2. reexamination	10.0			12.4			10.5			9.6			+0.9
difference (years) between:													
op. and 1. reexam.	5.2			2.7			not sig.			not sig.			not sig.
op. and 2. reexam.	9.3			7.9			not sig.			8.9			+0.4
1. and 2. reexam.	4.1			5.2			4.3			not sig.			not sig.
orthodontic treatment in clefts: N(%)	23 (40)			10 (71)			33 (47)			30 (48)			−1%

3. In all cases mentioned above, the cleft lip repair was performed according to Le Mesurier (Figure 3, bottom left, and Figure 4, center) applied at that time.

4. Orthodontic treatment was administered in 47% of the cases which were grafted and in 48% of the control group. The different results of this treatment in dependancy on the surgical methods used will be discussed later.

In all cases the repaired lip was, according to the technique applied, without undue tension, so that noxious pressure to the frontal parts of the maxillary arch was not present. In the control group, one case needed a second intervention for the closure of the soft palate. In one case, the whole palatal cleft was not yet closed due to familiar reasons. In the remaining 98 cases, healing was obtained by primary intention. Interference with growth due to the interventions on the lip and on the palate can therefore be estimated as minimal as possible.

In contrast to this, the trauma to the anterior ends of the alveolar segments, in those cases in which a denudation by the stripping of the periosteum is inevitable, and in which the tooth germs sometimes may be

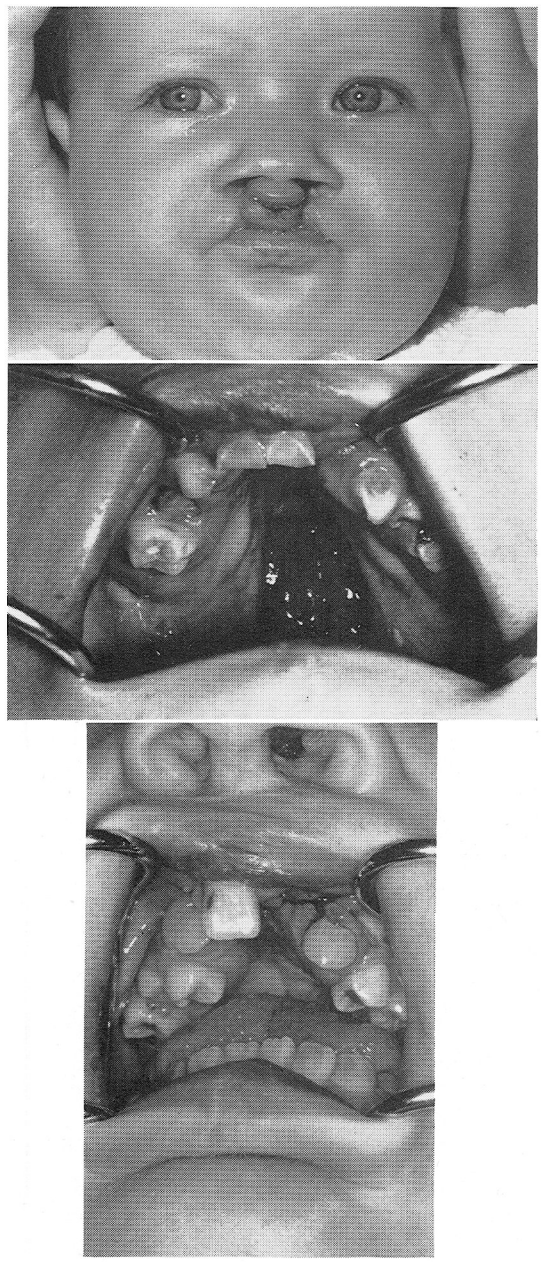


FIGURE 1. *Top:* Patient S. S., female, age: 6 months. Bilateral complete cleft of lip and palate with congenital fistulas of the lower lip. Floating premaxilla. *Center:* The same patient at an age of 5½ years. Primary osteoplasty was performed at an age of 8 months on the left side and of 11 months on the right side. Well-developed arch of upper jaw without any orthodontic alignment. *Bottom:* The same patient at an age of 10 years. Severe malformation of the upper jaw. Horizontal deviation to the midline of 3rd degree left and 2nd degree right. Also dysgnathias in vertical and sagittal plane. Orthodontic treatment is needed.

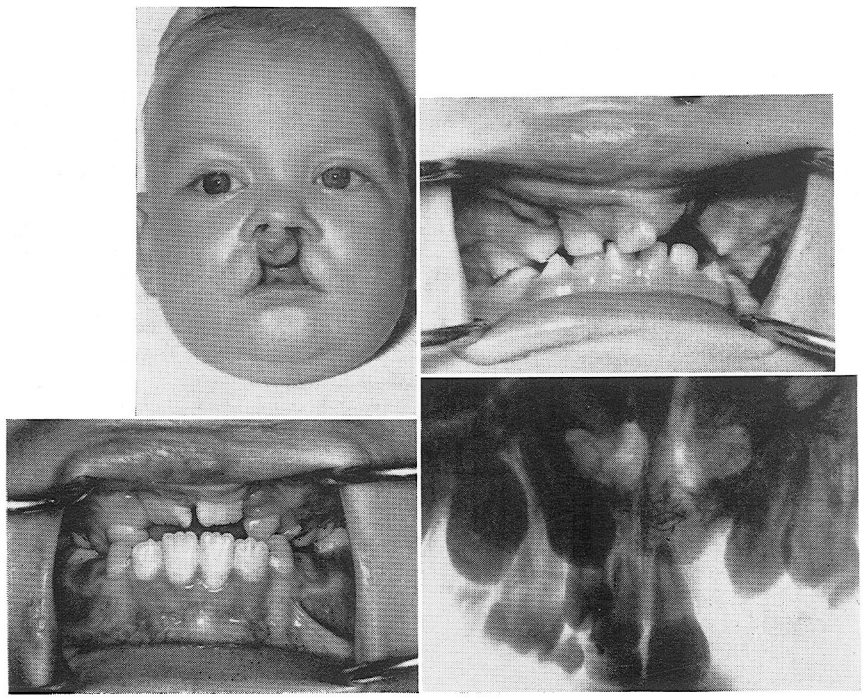


FIGURE 2. *Top Left:* Patient T. R., male, age: 5 months. Bilateral complete cleft with floating premaxilla. *Top Right:* The same patient at an age of 2 years. Primary osteoplasty on the right side at an age of 7 months, on the left side at an age of 10 months. Normal dental overjet and normal interarch relationship. No orthodontic treatment. *Bottom Left:* The same patient at an age of 9½ years. Upper dental arch inside lower dental arch. Mandibular pseudoprognathism of 2nd to 3rd degree. Also transverse constriction of 2nd degree. Orthodontic treatment is needed. *Bottom Right:* X-ray film to Figure 3, Bottom Left. Bony bridge after grafting decreased in length about 50% in the following 9 years.

damaged, plays an important role in further growth. This conclusion can be derived from those of our cases which are not on the two series and in which the bone bed was made in the same way mentioned above but a bone graft was not inserted or in those exceptional instances where the bone graft did not take.

Success or failure of alveolar cleft repair besides achieving anatomical closure is mixed up with the possible development of malocclusions. We subdivided the malocclusions into groups of vertical, horizontal, and sagittal (A-P diameter), further subdividing them into three degrees of malformation for the left and the right side respectively. Missing malocclusion is labeled as zero degree (0°).

Results

UNILATERAL COMPLETE CLEFTS. Table 3 shows the results obtained in unilateral clefts. It is apparent that at a second follow-up examination

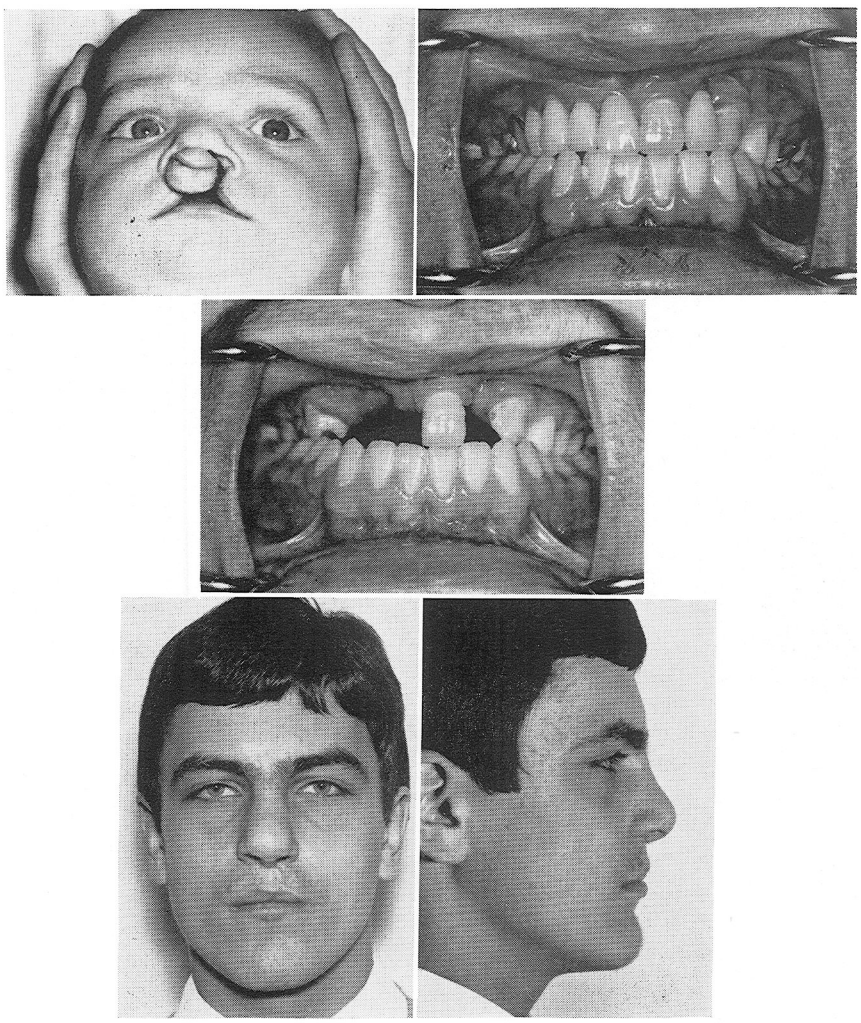


FIGURE 3. *Top Left:* Patient B. M., male, age: 5 months. Bilateral complete cleft with floating premaxilla. *Top Center:* The same patient at an age of 15 years. Teeth 323/2 missing because of caries; premaxilla little mobile; no bone grafting. No dysgnathia in any dimension. Orthodontic treatment not needed. *Top Right:* After prosthetic substitution of missing teeth. Very good cosmetic appearance. *Bottom Left:* Frontal view at same age. Closure of cleft lip was performed according to Le Mesurier technique. *Bottom Right:* Profile view after lengthening of columella with forked flaps. Normal shape of the middle third of the face.

at the age of 9.0 years a significant rise of horizontal and sagittal malocclusions was found in the group that was grafted (Figure 4, bottom). In comparison to the control group (Figure 5), there was a substantial decrease of normal bites and an increase of two and three degree malocclusions up to 40%.

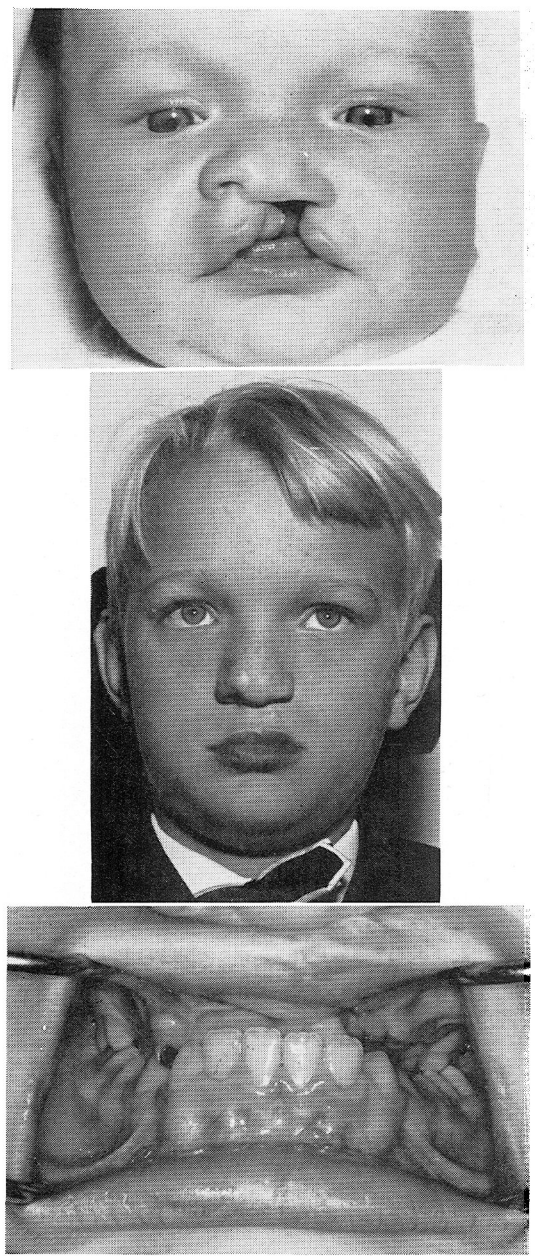


FIGURE 4. *Top:* Patient M. H.-G., male, age: 5 months. Complete cleft of lip and palate on the left side. *Center:* The same patient at an age of 11 years, 10½ years after primary osteoplasty of the alveolar gap, using a tilted vomer flap after Stellmach for covering the solid bone transplant. Closure of cleft lip according to Le Mesurier. Note the retroposition of upper lip in regard to lower lip. *Bottom:* Severe malocclusion in all three dimensions. The whole frontal part of upper dental arch inside lower dental arch. Mandibular pseudoprognathism of 3rd degree. Orthodontic treatment is needed.

TABLE 3. Comparison of postoperative results (unilateral complete clefts).

	with bone grafting (osteoplasty)						*without bone grafting*	*statistics*	
	primary		χ^2	*secondary*		χ^2			
no. of cases	20			5			37	χ^2 for comparison	
examination	1.	2.		1.	2.			primary contra no graft	secondary contra no graft
number of clefts: N (%)	7 (100)	20 (100)		2 (100)	5 (100)		37 (100)		
mean ($\bar{x}$) age (years) of examinees	5.5	9.0		6.0	6.6		9.1		
type of malocclusions									
1. vertical: N (%)									
0°	5 (71)	6 (30)		1 (50)	3 (60)		20 (54)		
1°	2 (29)	11 (55)	not sig.	1 (50)	1 (20)	not sig.	15 (40)	not sig.	not sig.
2°	0	3 (15)		0	1 (20)		1 (3)		
3°	0	0		0	0		1 (3)		
2. horizontal: N (%)									
0°	4 (57)	2 (10)		0	0		10 (27)		
1°	2 (29)	7 (35)	sig. at 5%	1 (50)	2 (40)	not sig.	16 (43)	not sig.	not sig.
2°	1 (14)	6 (30)		1 (50)	3 (60)		8 (22)		
3°	0	5 (25)		0	0		3 (8)		
3. sagittal: N (%)									
0°	1 (14)	7 (35)		0	1 (20)		18 (49)		
1°	5 (72)	1 (5)	sig. at 1%	2 (100)	1 (20)	not sig.	10 (27)	sig. at 5%	not sig.
2°	1 (14)	7 (35)		0	2 (40)		6 (16)		
3°	0	5 (25)		0	1 (20)		3 (8)		

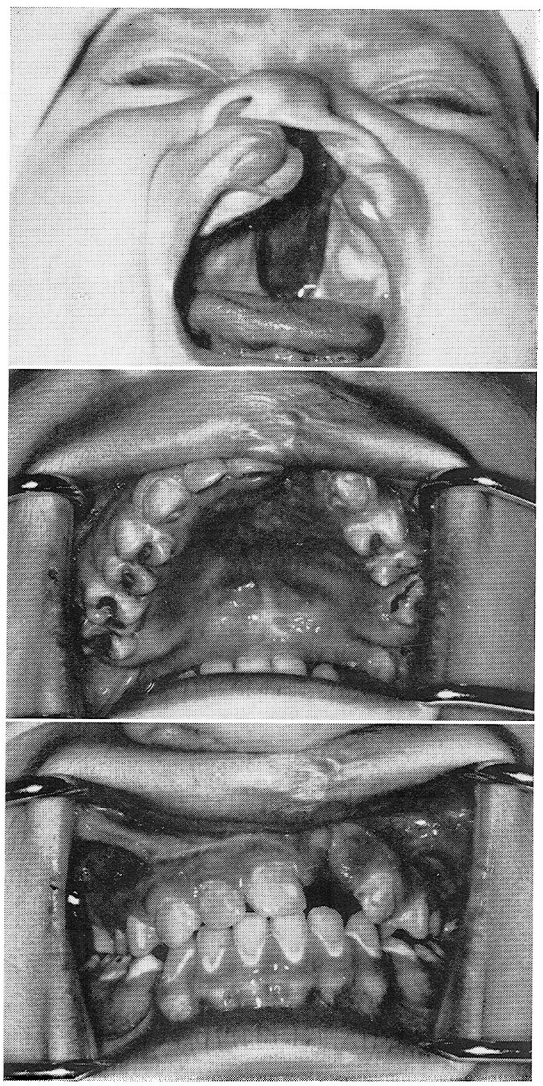


FIGURE 5. *Top:* Patient E. M., female, age: 5 months. Unilateral total cleft with hypoplasia of the smaller segment of the alveolar arch on the left side. *Center:* The same patient at an age of 14½ years. Well developed upper dental arch; $\frac{1}{}\frac{2}{}$ were lost due to caries. The gap of the hard palate was closed at an age of 5 months after Pichler. *Bottom:* Normal dental and alveolar arch relationship without any deviation. No bone grafting was performed. Orthodontic treatment is not needed.

BILATERAL COMPLETE CLEFTS. In bilateral complete clefts, a highly significant increase of horizontal deviations to the midline was existing after primary osteoplasty (Figure 1, bottom) (Table 4). In comparison to the control group, the increased percentage of dysgnathias in all dimensions was up to 60%.

TABLE 4. Comparison of postoperative results (bilateral complete clefts).

	with bone grafting (osteoplasty)						*without bone grafting*	*statistics*	
	primary		χ^2	*secondary*		χ^2			
no. of cases	20			5			13	χ^2 for comparison	
no. of plastic closures of alveolar cleft	36			9			26	primary contra no graft	secondary contra no graft
examination	1.	2.		1.	2.				
number of clefts: N (%)	23 (100)	36 (100)		7 (100)	9 (100)		26 (100)		
mean ($\bar{x}$) age (years) of examinees	6.0	10.6		7.6	15.6		10.2		
type of malocclusions									
1. vertical: N (%)									
0°	16 (70)	17 (47)		3 (42)	4 (44)		19 (73)		
1°	5 (22)	9 (25)		2 (29)	5 (56)		7 (27)		
2°	2 (8)	10 (28)	not sig.	2 (29)	0	not sig.	0	sig. at 5%	not sig.
3°	0	0		0	0		0		
2. horizontal: N (%)									
0°	5 (22)	4 (11)		0	2 (22)		10 (38)		
1°	12 (52)	3 (8)		2 (29)	2 (22)		12 (46)		
2°	6 (26)	19 (53)	sig. at 0.1%	5 (71)	3 (34)	not sig.	3 (12)	sig. at 0.1%	not sig.
3°	0	10 (28)		0	2 (22)		1 (4)		
3. sagittal: N (%)									
0°	16 (70)	14 (38)		0	4 (44)		18 (69)		
1°	4 (17)	6 (17)		3 (42)	1 (12)		6 (23)		
2°	3 (13)	10 (28)	sig. at 5%	4 (58)	2 (22)	not sig.	2 (8)	sig. at 1%	sig. at 5%
3°	0	6 (17)		0	2 (22)		0		

Total Number of Uni- and Bilateral Complete Clefts. In combining uni- and bilateral clefts, one can make the following conclusions. In the period between primary and permanent dentition, vertical, horizontal, and sagittal bite relationships deteriorated heavily after primary bone grafting (Figure 1, center and bottom, and Figure 2, top right and bottom left) (Table 5). After secondary bone grafting at the age of 4.5 years, however, a clinically striking impression of a trend toward malocclusion was observed, but this impression could not be substantiated statistically. In contrast to the control group, use of a χ^2-test for comparing primary grafting, contra no grafting, gave a significant difference between vertical and sagittal bite relationships and a much higher significance in the horizontal bite relationship. A comparison between secondary bone grafting contra no grafting shows a significance for horizontal and sagittal malocclusions.

Table 6 exhibits a comparison of all primary and secondary osteoplasties in one category and of all alveolar arch repairs without inserting bone, respectively. Missing and low-degree malocclusions as well as malocclusions of second and third degree have been compared, each group subdivided into vertical, horizontal, and sagittal dysgnathias. Thereby, the χ^2-test revealed significant differences in the vertical plane. A high significance was found in the group covering the horizontal and sagittal malocclusions (Figure 1, bottom, and Figure 2, bottom left).

These results correspond to the so-called mean difference of upper lip in regard to lower lip in lateral view. Measurements for the group with bone grafting were -2.3 mm, and for the control group, $+0.6$ mm.

In the grafted cases, mentioned above, which underwent orthodontic treatment, there is evidence that the primary realignment of the maxillary arch led to very good results. In the period up to the permanent dentition, however, there was an evident increase of malocclusions of major degrees (Table 5). This means that, very few cases excepted, the bony bridge must not necessarily warrant a further normal development of the maxilla, leading to a normal size at the adult age. On the other hand, there could be evaluated from both the series that orthodontic treatment up to the permanent dentition was more effective in the control group. We feel that the bridging bone connecting the segments impedes the extension of the maxillary arch very considerably. Due to the small number of the cases in these series treated orthodontically, this impression could not be substantiated statistically as yet.

In contrast to this, secondary bone grafting is in our opinion of great value in adult patients after orthodontic extension of the maxilla and/or the surgical correction of deviated segments for definitive stabilization.

In the evaluation of the cases with uni- and bilateral alveolar cleft repair utilizing a tilted vomer flap, both series reveal that bite relationships in all three dimensions are not worse than when utilizing the method according to Veau-Axhausen. These clinical findings let us conclude that

TABLE 5. Comparison of postoperative results (uni- and bilateral complete clefts).

	with bone grafting (osteoplasty)						*without bone grafting*	*statistics*	
	primary		χ^2	*secondary*		χ^2		χ^2 for comparison	
no. of cases	40			10			50		
no. of plastic closures of alveolar cleft	56			14			63	primary contra no graft	secondary contra no graft
examination	1.	2.		1.	2.				
number of clefts:									
N (%)	30 (100)	56 (100)		9 (100)	14 (100)		63 (100)		
mean ($\bar{x}$) age (years) of examinees	5.9	10.0		7.2	12.4		9.6		
type of malocclusions									
1. vertical: N (%)									
0°	21 (70)	23 (41)		4 (45)	7 (50)		39 (62)		
1°	7 (23)	20 (36)		3 (33)	6 (43)		22 (35)		
2°	2 (7)	13 (23)	sig. at 5%	2 (22)	1 (7)	not sig.	1 (1.5)	sig. at 1%	not sig.
3°	0	0		0	0		1 (1.5)		
2. horizontal: N (%)									
0°	9 (30)	6 (11)		0	2 (14)		20 (32)		
1°	14 (47)	10 (18)		3 (33)	4 (29)		28 (44)		
2°	7 (23)	25 (44)	sig. at 0.1%	6 (67)	6 (43)	not sig.	11 (17)	sig. at 0.1%	sig. at 5%
3°	0	15 (27)		0	2 (14)		4 (7)		
3. sagittal: N (%)									
0°	17 (57)	21 (37)		0	5 (36)		36 (57)		
1°	9 (30)	7 (13)		5 (56)	2 (14)		16 (25)		
2°	4 (13)	17 (30)	sig. at 1%	4 (44)	4 (29)	not sig.	8 (13)	sig. at 1%	sig. at 5%
3°	0	11 (20)		0	3 (21)		3 (5)		

TABLE 6. Comparison of postoperative results.

	with bone grafting	*without bone grafting*	*difference*	χ^2
type of malocclusions				
1. vertical: N (%)				
0° + 1°	56 (80)	61 (97)	−17%	sig. at 1%
2° + 3°	14 (20)	2 (3)	+17%	
2. horizontal: N (%)				
0° + 1°	22 (31)	48 (76)	−45%	sig. at 0.1%
2° + 3°	48 (69)	15 (24)	+45%	
3. sagittal: N (%)				
0° + 1°	35 (50)	52 (82)	−32%	sig. at 0.1%
2° + 3°	35 (50)	11 (18)	+32%	
mean ($\bar{x}$) difference (mm) of upper lip in regard to lower lip in lateral view	−2.3 mm	+0.6 mm	−1.7 mm	

the use of a very great part of the septal mucosa does not influence the forward directed development of the maxilla. Similar findings could be derived when a septal mucosa flap after Pichler was utilized (Figure 5, center).

As Tables 3 to 5 and Figure 2 show, the results of the first reexamination, 6.2 years after osteoplasty, are equivalent to the results of the control group, 9.6 years after plastic closure of lip and alveolar process. In contrast, data concerning malocclusions 10 years after grafting reveal a substantial increase of malocclusions of 2nd and 3rd degree, whereas missing or low-degree dysgnathias decreased considerably. These results indicate that, first dentition being completed, sequelae of early bone grafting are little manifest yet. The dysgnathias as described develop progressively in between primary and secondary dentition (Figure 1, center and bottom, and Figure 2, top right and bottom left).

Discussion

Very many studies approve of primary or early secondary bone grafting in complete clefts on the basis of preliminary results. On the other hand, only a few authors were skeptical, such as Ritter (*9*), Johanson,[1] Hollmann (*2*), Longacre (*4*), and Derichsweiler (*1*). Only recently, Robertson and Jolleys (*10*) report about deterioration in the dental base relationship. Kling (*3*) and Pickrell, Quinn, and Massengill (*6*) comment on the phenomenon of increasing lateral crossbite after osteoplasty. Stenstroem and Thilander (*23, 24*) experimentally provoked disturbances of the growth of the maxillary bone consecutive to osteoplasty. Our measurements were taken from children with the largest chronological inter-

[1] Personal communication, 1961.

val between surgery and reexamination reported so far. No similar reports for comparison with our results are available from the literature.

The evaluation of both groups of children with or without grafting suggests the following conclusion. Bone grafting in the area of alveolar processes does not bring about permanent stabilization of the segments. Lengthening of the bony bridge was never observed. This was not to be expected because any growth-center is lacking. Contrarily, the inserted bone does become shorter over the years (Figure 2, right). This bony transformation may be due to scar traction and pressure to the bony bridge by means of the growth of the lateral segments, the direction of which is altered towards the bony bridge. The bone furthermore does not show any apposition at the frontal site, according to influences on the basis of functional stimuli in normal frontal bite of the deciduous incisors. The frontal ends of alveolar processes conjugated by bone are rather retarding in their development in all three dimensions. This reminds us of the old experience that a too early touch of the bony cleft is contrary to growth. The resulting bony bridge, disregarding the type of autogenous bone transplantation, keeps these ends of alveolar segments together comparable to a claw. The development of the little bud of baby-jaw toward a sufficiently wide adult-jaw is not enhanced but rather interfered with.

The results indicate to us that the practice of primary and early secondary bone grafting of the alveolar cleft should be abandoned. The secondary grafting after permanent dentition is completed has been resorted to for the purpose of stabilizing the premaxillary bone, apart from bone grafting in surgical correction of the upper alveolar arch. The definitive integration of bone grafting during the process of rehabilitation of cleft palate patients is to limit bone grafting to the time after secondary dentition.

Summary

After 10 years of performing primary and secondary bone grafting in infants and small children, the long-term follow-ups have been evaluated and analyzed statistically. Two groups, consisting of 50 children each, one with and one without bone grafting, have been compared. The early expectations on the basis of preliminary results connected with bone grafting to the alveolar process have not been fulfilled, when the further development of the maxilla is considered. Malocclusions of grades 2 and 3 in the sagittal and horizontal planes were prevalent in the grafted group in high significance in comparison with the ungrafted group. Therefore, it must be concluded that early bone grafting in nearly all of our cases provokes retardation in development of the maxillary arch and local growth arrest of the maxillary bone. For that reason, we have abandoned primary and

early secondary bone grafting and limit osteoplasty to the time after secondary dentition.

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Acknowledgment. The authors wish to acknowledge and appreciate the help of Prof. H. Klinger, Director of the Institution for Statistics and Documentation of the University Duesseldorf.

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