

## Long-term outcome of secondary alveolar bone grafting in patients with various types of cleft

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### Abstract

**Objective:** To evaluate the results of secondary alveolar bone grafting in patients with various types of cleft.

**Design:** One hundred and seventy patients were classified as cleft lip and alveolar process alone (CLAP), complete unilateral cleft lip and palate (UCLP), and complete bilateral cleft lip and palate (BCLP). The Bergland criteria were used to assess the long-term outcome of alveolar bone grafting.

**Results:** In the UCLP and BCLP groups, the success rate was significantly better ( $P < 0.05$ ) when the cleft was grafted before the eruption of canines. When the operation was done after the eruption of canines, there was a significant difference in the success rate between CLAP and BCLP ( $P < 0.05$ ).

**Conclusion:** The timing of the operation was the critical variable that affected the outcome in patients with complete cleft lip and palate. The severity of the deformity influenced the success rate when alveolar bone grafting was done after the eruption of canines.

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**Keywords:** Alveolar bone graft; Cleft lip and palate; Canine eruption; Interdental alveolar bone

### Introduction

The treatment of patients with cleft lip and palate requires prolonged multidisciplinary effort. Since secondary alveolar bone grafting was first described in the 1970s,<sup>1,2</sup> it has become an accepted treatment for these patients.<sup>3</sup> The objectives of secondary alveolar bone grafting have been well documented.<sup>1,3–6</sup> Successful grafting is important, particularly in orthodontic treatment of patients with cleft lip and palate. From the orthodontic perspective, the main advantage of alveolar bone grafting is that it allows orthodontic movement of teeth into previous cleft sites. The iliac crest is the preferred donor site in most centres.<sup>3,7–10</sup>

Dental development at the time of the bone grafting, which is thought to be one of the important factors affecting the outcome of secondary alveolar bone grafts, has been discussed

in various publications. The best results have been achieved if the graft was inserted at the age of 9–11 years before the eruption of the canines.<sup>6,7,11,12</sup> A recent study showed a significant association between monthly increase in age at bone grafting and poor outcome in white children with unilateral cleft lip and palate.<sup>13</sup> The type of cleft lip and palate may also affect the outcome of alveolar bone grafting. In evaluating its effect, most investigators have focused on unilateral and bilateral cleft lip and palate.<sup>7,9,10,14,15</sup> The cleft sites were counted and interdental septal height was measured after secondary alveolar bone grafting.<sup>7,15,16</sup> In only a few studies was the outcome of secondary grafting investigated separately, by dividing the types of cleft into unilateral cleft lip and alveolar process alone (CLAP), unilateral cleft lip and palate (UCLP) and bilateral cleft lip and palate (BCLP).<sup>6,8</sup> Some studies have indicated that the morbidity of bone grafting is greater in patients with bilateral cleft lip and palate.<sup>7,8</sup> The relation between various cleft types and the outcome of secondary alveolar bone grafting requires further investigation.

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The main purpose of our study was to examine the relation between different types of cleft and the long-term results of secondary alveolar bone grafting.

### Patients and methods

The records of 202 patients with clefts who had secondary alveolar bone grafting at the Peking University School of Stomatology by the same surgeon between 1992 and 2001 were reviewed. Thirty-two patients were excluded because there was no follow-up or the cleft canine had not erupted at the time of the research. That left 170 patients with clefts whose canine on the side of the cleft had fully erupted after the secondary alveolar bone grafting. The patients were classified in three groups according to the type of cleft. The CLAP group comprised 40 patients (19 male and 21 female) with cleft lip and alveolar process alone. Their ages when they had the alveolar bone grafts ranged from 8 to 33 years (mean 14) and the canine on the side of the cleft had erupted in 24 patients and not in 16. The UCLP group comprised 102 patients (60 male and 42 female) with complete unilateral cleft lip and palate. At the time of alveolar bone grafting, their ages ranged from 8 to 35 years (mean 15). The canine on the side of the cleft had erupted in 58 patients and not in 44. The BCLP group comprised 28 patients (18 male and 10 female) with complete bilateral cleft lip and palate. Their ages at the time of alveolar bone grafting ranged from 8 to 24 years (mean 14). The canine had erupted at 34 sites and not at 22 (Table 1).

### Operation

In all patients, alveolar bone grafting was done by one surgeon by a standardised method that was first described by Boyne and Sands.<sup>1,2</sup> The surgeon made a vestibular gingival marginal incision and elevated a wide mucoperiosteal flap including at least one tooth lateral and mesial to the cleft. In the area of the cleft itself, the incision was taken vertically into the vestibular sulcus. When the perforation extended into the nasal cavity, the nasal mucosa was elevated allowing for a tension-free repair of that layer. After the nasal layer and palatal flaps had been repaired, copious amounts of cancellous bone harvested from the anterior iliac crest were pressed in small chips over the cleft on both the vestibular and palatal sides so that they extended over the cortical part of the border-

ing alveolar process. Finally, the grafted alveoli were covered by redraping the mucoperiosteal flaps on the vestibular and palatal aspect before the wound was closed.

Anterior occlusal radiographs were used to evaluate the long-term results of the alveolar bone grafting. The follow-up period was from 1 to 8 years (mean 1.9). Interdental septal height was assessed by the criteria of Bergland et al.<sup>11</sup> (Fig. 1), as follows:

- Type I: The interdental septal height was roughly normal.
- Type II: The interdental septal height was at least 3/4 of normal.
- Type III: The interdental septal height was less than 3/4 of normal.
- Type IV: Failure; there was no continuous bony bridge across the cleft.

The results of treatment were evaluated statistically by the chi-square test.

### Results

The distribution of interdental septal heights of each type of cleft in patients operated on before and after eruption of canines is shown in Table 2. When secondary alveolar bone grafts were inserted before the eruption of canines the success rates for CLAP, UCLP, and BCLP were 94, 95, and 91%, respectively. However, after the eruption of canines the corresponding success rates were 96, 83 and 68% (Table 2). The difference in the success rates before and after eruption of canines in the CLAP group was not significant, but the differences in the success rates before and after eruption of canines in the UCLP and BCLP groups were significant (Table 2).

There was no significant difference in success rates among CLAP, UCLP, and BCLP groups when the clefts were grafted before the eruption of the cleft canines. However, when the clefts were grafted after eruption of the canine, there was a significant difference in success rates in the CLAP and BCLP groups (Tables 3–5).

### Main complications

Four patients with unilateral cleft lip and palate and two patients with bilateral cleft lip and palate developed chronic infection of the grafts, resulting in complete failure. Five of these six patients had erupted canines, and one (with UCLP)

Table 1  
Distribution of the types of cleft

Cleft canine	Cleft lip and alveolar process alone (n = 40)	Cleft lip and palate		Total sites of cleft (n = 198)
		Unilateral (n = 102)	Sites of cleft in bilateral (n = 56 sites)	
Not erupted	16 (8)	44 (22)	22 (11)	82 (41)
Erupted	24 (12)	58 (30)	34 (17)	116 (59)

Figures are number (% out of 198).

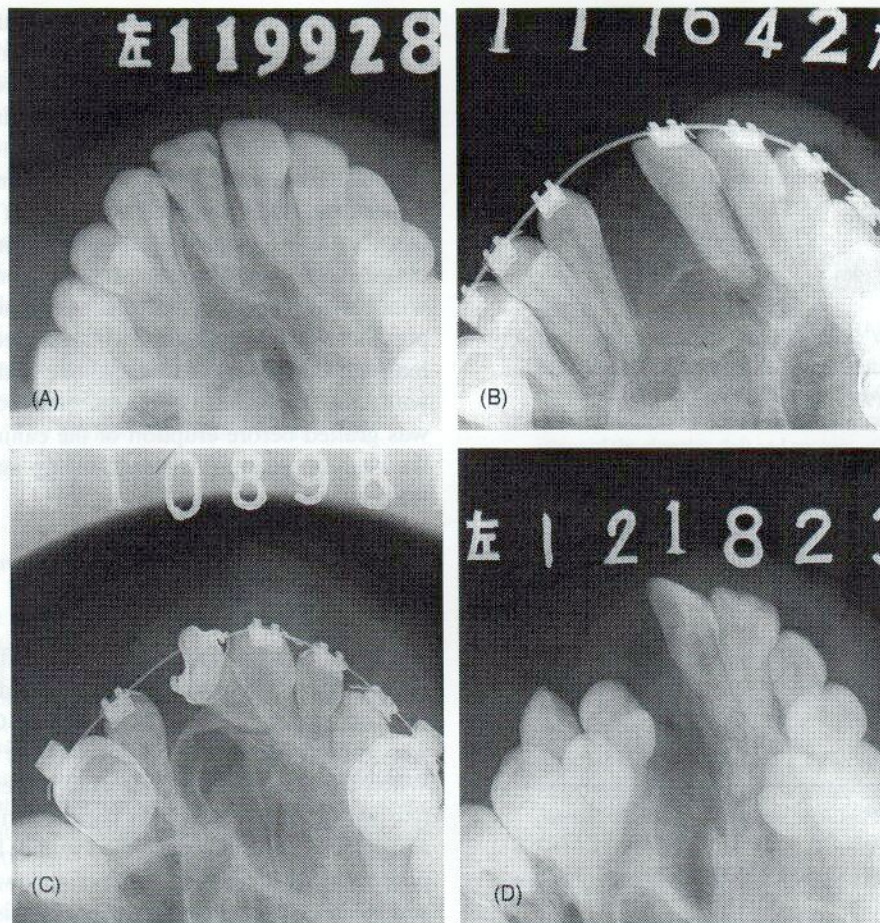


Fig. 1. Criteria of Bergland et al. were used for the evaluation of the bone grafting. Type I (A) and type II (B) were considered successes. Type III (C) and type IV (D) were considered failures.

had an unerupted canine. The postoperative oral hygiene of these patients was poor. Minor wound dehiscences developed at the sites of three grafts, resulting in partial loss of small bone fragments, and these were also associated with poor oral hygiene.

## Discussion

Secondary alveolar bone grafting in patients with cleft palates is now common practice. Successful grafting allows

eruption of teeth into the cleft and the achievement of orthodontic movement of teeth adjacent to the cleft site, to obtain non-prosthetic rehabilitation.<sup>2,5,11,17</sup> The height of the interdental septum after the operation was the main indication of successful bone grafting. Because patients with cleft lips and palates require prolonged interdisciplinary treatment, long-term follow-up is needed to establish the final condition of the bone associated with fully erupted canines. The healing of bony transplants shown on intraoral radiographs may be regarded as finished within 6 months after the operation in 80% of the patients.<sup>17</sup> In our study, the

Table 2  
Eruption of canines and outcome of alveolar bone grafting

Bergland scale	Cleft lip and alveolar process alone (n = 40)	Cleft lip and palate Unilateral (n = 102)	Cleft lip and palate Bilateral (n = 56 sites)
<b>Success (I and II)</b>			
Erupted	23 (96)	48 (83)*	23 (68)#
Not erupted	15 (94)	42 (95)*	20 (91)#
<b>Failure (III and IV)</b>			
Erupted	1 (4)	10 (17)	11 (32)
Not erupted	1 (6)	2 (5)	2 (9)

Figures are number (%).

\* Chi-square = 3.89,  $P = 0.049$ .

# Chi-square = 4.06,  $P = 0.044$ .

Table 3  
Long-term results of cleft lip and alveolar process and unilateral cleft lip and palate

Cleft canine	Bergland scale	Cleft lip and alveolar process alone (n = 40)	Cleft lip and palate Unilateral (n = 102)
Not erupted	Success (I and II)	15 (94)	42 (95)
	Failure (III and IV)	1 (6)	2 (5)
Erupted	Success (I and II)	23 (96)	48 (83)
	Failure (III and IV)	1 (4)	10 (17)

$P > 0.05$ . Figures are number (%).

Table 4  
Long-term results of unilateral and bilateral cleft lip and palate

Cleft canine	Bergland scale	Cleft lip and palate Unilateral (n = 102)	Cleft lip and palate Bilateral (n = 56 sites)
Not erupted	Success (I and II)	42 (95)	20 (91)
	Failure (III and IV)	2 (5)	2 (9)
Erupted	Success (I and II)	48 (83)	23 (68)
	Failure (III and IV)	10 (17)	11 (32)

$P > 0.05$ . Figures are number (%).

minimum observation period was 1 year after alveolar bone grafting.

#### *Eruption of the canine at the cleft and long-term results of alveolar bone grafting*

Alveolar bone was secondarily grafted at the stage of mixed dentition.<sup>18</sup> Several studies have shown that dental development at the time of bone grafting is important and have suggested that secondary alveolar bone grafting should be done before the eruption of canines.<sup>6,11,19–21</sup> In our study, each type of cleft was divided into two subgroups according to whether the canine at the cleft had erupted when the secondary alveolar bone grafting was done. We analysed the correlation between the success rate and eruption

Table 5  
Long-term results of cleft lip and alveolar process and bilateral cleft lip and palate

Cleft canine	Bergland scale	Cleft lip and alveolar process alone (n = 40)	Cleft lip and palate Bilateral (n = 56 sites)
Not erupted	Success (I and II)	15 (94)	20 (91)
	Failure (III and IV)	1 (6)	2 (9)
Erupted	Success (I and II)	23 (96)*	23 (68)*
	Failure (III and IV)	1 (4)	11 (32)

\*  $P = 0.01$ . Figures are number (%).

of the canine at the cleft. Our results suggest that in unilateral and bilateral cleft lip and palate, the success rate was higher when the cleft was grafted before the eruption of the canine at the cleft (Table 2). Similar results have been found in other studies.<sup>11</sup> However, in patients with cleft lip and alveolar process alone there was no significant difference between the erupted and unerupted subgroups (Table 2). We found that the timing of alveolar bone grafting was more critical in unilateral and bilateral cleft lip and palate than in patients with cleft lip and alveolar process alone. Our findings support those of Enemark et al. who reported significantly better long-term results of secondary bone grafting among patients with UCLP and BCLP with marginal bone level if the bone was grafted before eruption of the canine.<sup>6</sup> The changes in the healing potential with increasing age also contribute to the reduced success rate.<sup>8</sup>

#### *The relation between the type of cleft and the outcome of alveolar bone grafting*

We found that the success rate was different in the various types of cleft. There was no significant difference in the success rate among CLAP, UCLP, and BCLP when the cleft was grafted before the eruption of the canine at the cleft. When the grafting was done after the eruption, the success rate was greatly reduced in patients with bilateral cleft lip and palate. Previously published studies have also shown that poor results were achieved in patients with bilateral cleft lip and palate. Åbyholm et al. explained this by the fact that the premaxilla was not immobilised.<sup>4</sup> The shortage of tissue to cover the transplant is one of the variables that affected the success of bone grafting.<sup>8,12</sup> Loss of the graft is usually the result of dehiscence of the wound and breakdown of the flap in the area of the cleft, leading to exposure and contamination of the graft.<sup>9</sup> In patients with bilateral cleft lip and palate, fistulas are common and oronasal communication often causes gingival inflammation in the area of the cleft as a result of secretions from the nasal cavity.<sup>10</sup>

#### *Other variables that influence the outcome of alveolar bone grafting*

In our series, and in other reports, about one-third of the patients with failed grafts had local infection or wound dehiscence.<sup>18</sup> Poor oral hygiene is one of the most important causes of infection and postoperative infection leads to a greater incidence of absorption of the graft.<sup>17,18</sup>

#### *Long-term results of alveolar bone grafting and orthodontic treatment of patients with clefts*

In patients with cleft lip and palate, the residual alveolar cleft is considered to be the main obstacle to obtaining the best results.<sup>11</sup> Before starting orthodontic treatment, the grafted area must be examined carefully. Occlusal radiographs should be taken regularly. When the graft is successful

(types I and II), orthodontic treatment can be started. If the graft is unsuccessful (types III and IV), the tooth cannot be moved orthodontically into the site of the cleft unless a second operation is successful. Because of the severity of the deformity in patients with bilateral cleft lip and palate, more attention should be paid to them. It is generally thought that osseous healing of transplants is finished 6 months after the operation.<sup>17</sup> In patients who had bone grafts in the stage of permanent dentition after eruption of the canine, we follow the patients for 3–6 months before resuming orthodontic treatment. In the patients who have grafts at the optimal age, orthodontic treatment is usually initiated or resumed when the canine can be bonded after either spontaneous eruption or surgical exposure. The grafted site is also monitored carefully during orthodontic treatment.

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