Case Report

Secondary Bone Graft and Eruption of the Permanent Canine in Patients with Alveolar Clefts: Literature Review and Case Report

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Abstract: This paper emphasizes the important role that secondary bone grafting plays on the treatment of patients with alveolar clefts. The authors present a literature review and, based on panoramic radiographs, retrospectively and longitudinally analyze the behavior of permanent canines after completion of secondary bone grafting in 50 patients at the Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo, Brazil. Twelve patients with unilateral cleft lip and alveolus and 38 patients with complete unilateral cleft lip and palate (n = 50) had undergone bone grafts to repair their residual alveolar clefts before the eruption of their permanent canines. These patients were observed over an average period of 3 years. In 94% of the sample (47 patients), the permanent canines presented intra-alveolar movement toward the oral cavity. In 72% of those 47 patients (36 patients), the permanent canines spontaneously erupted through the grafted area. In 6% of the 47 patients (3 patients), the permanent canines required orthodontic traction. (*Angle Orthod* 2000;70:174–178.)

Key Words: Cleft lip and palate; Alveolar cleft; Bone graft; Secondary bone graft

INTRODUCTION

Bone grafting has become a common procedure in the treatment of cleft lip and palate patients. The main difference in the treatment protocol of the various rehabilitation centers is the timing of the bone graft. According to its time of occurrence, the bone graft may be considered as primary, secondary, or tertiary (late).[1,2] When performed during early childhood, at the same time as the primary repair surgeries, bone graft is called primary.[3] Some authors state that this early procedure can cause impairment of maxillary growth.[4,5] Because of its controversial and counter-productive aspect, this technique has been abandoned by most rehabilitation centers that used to perform it.[6,7]

Bone grafting is called secondary when performed later, at the end of the mixed dentition. It is the most accepted procedure and has become part of the treatment protocol at the Hospital for Rehabilitation of Craniofacial Anomalies (HRCA), University of São Paulo, in Bauru, Brazil.[1] A secondary bone graft is performed preferably before the eruption of the permanent canine in order to provide adequate periodontal support for the eruption and preservation of the teeth adjacent to the cleft.[2,8–17]

When a bone graft is performed in the permanent dentition after completion of orthodontic treatment, it is called a tertiary or late graft.[18–21] Tertiary grafts are performed to enable prosthodontic and periodontal rehabilitation and to assist in the closure of persistent bucconasal fistulae. A tertiary or late bone graft cannot repair bone loss to teeth adjacent to the cleft.[22] Occasionally, tertiary grafts cause progressive root resorption on the cervical third of roots of teeth adjacent to the cleft, especially canines.[23,24] Such root resorption is caused by the contact of the grafted bone to the exposed root surface.

Studies show that secondary bone grafting can repair the cleft alveolus without increasing the already known iatrogenic effect of primary surgeries on maxillary growth.[8,11,16,25–29] Secondary bone grafting has been extensively reported in the literature, mostly by the Oslo cleft lip

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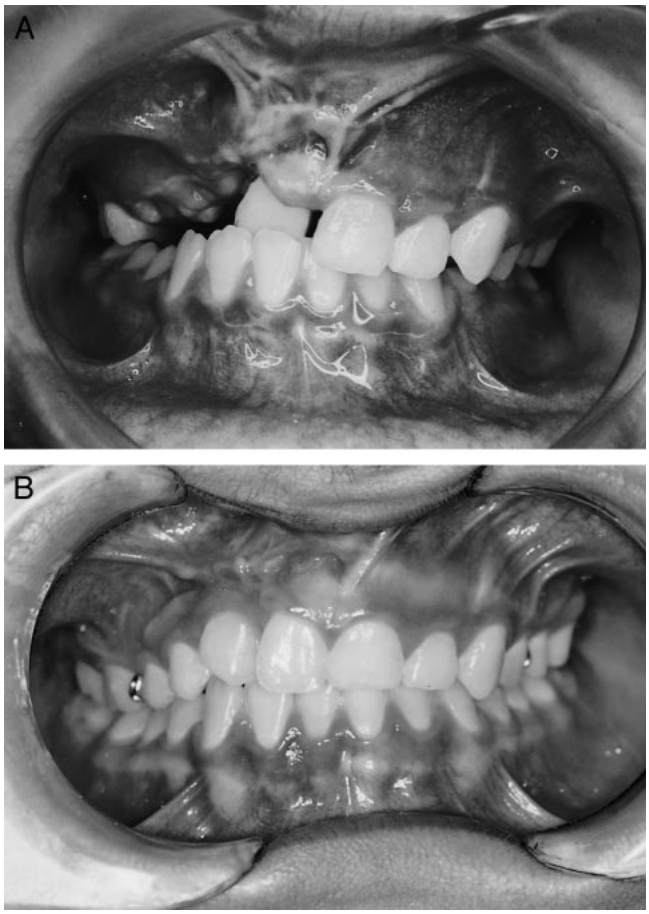

FIGURE 1. (A) Secondary bone graft with cancellous bone taken from the iliac crest was performed during the mixed dentition, before the eruption of the permanent canine. Patient's age: 10 years old. (B) Complete permanent dentition with full eruption of the right upper canine through the grafted area. Gingival contour reflects the excellent periodontal condition.

and palate (CLP) team,[25] and is based on the biological and technical principles described by Boyne and Sands[9] and Boyne.[30] Grafted cancellous bone fills in the residual alveolar cleft and is anatomically joined to the adjacent bone, becoming indistinguishable in radiographic images after an average period of 3 months. This structural incorporation has been histologically proved in young Rhesus monkeys[30] and seems to occur more rapidly in younger patients.[25]

From an orthodontic point of view, the most important benefit of secondary bone grafting is that the newly grafted bone acts as the alveolar bone, allowing for spontaneous migration of the adjacent canine toward the alveolar ridge as shown in Figure 1. When the canine does not erupt spontaneously, it is necessary to perform orthodontic traction.[7,10,14,31–36] When the canine eventually erupts, it creates a periodontium of support and protection that usually maintains an interdental bone septum of good height.[8,11,25,32,34,37,38] Thus, periodontal conditions are better when bone graft is performed before the eruption of the permanent canine.

Therefore, bone grafting has become mandatory in the

Table 1. Distribution of the Patients

	UCL and Alveolus	Complete UCLP
Male (n = 32)	03	29
Female (n = 18)	09	09
Total (n = 50)	12	38

UCL indicates unilateral cleft lip; UCLP, unilateral cleft lip and palate.

Table 2. Distribution of the Patients of Secondary Bone Graft

Age at Time of Bone Graft (years)	Follow-up Period					
	1 year	2 years	3 years	4 years	5 years	Total
8	—	1	1	1	—	3
9	1	5	2	2	—	10
10	4	2	3	—	1	10
11	4	6	7	2	—	19
12	1	1	2	2	—	6
13	—	1	—	—	—	1
14	—	—	1	—	—	1
Total	10	16	16	7	1	50

treatment protocol of cleft patients, establishing 2 well-defined stages for orthodontic mechanotherapy (pre- and post-secondary bone grafting). During the prebone graft orthodontic treatment, the upper dental arch is prepared for the graft and the permanent incisors are aligned whenever necessary.[11,33] The pregraft orthodontic treatment also results in better access for the surgeon at the time of the grafting procedure. The presurgical orthodontic preparation involves predominantly transverse mechanics with the use of orthodontic or, preferably, orthopedic expansion during the mixed dentition in order to reposition the palatal segments.[39] Occasionally, some patients are subjected to maxillary protraction in addition to the expansion in order to correct maxillary antero-posterior deficiencies. Three months after the bone graft procedure, and depending on the radiographic image of the area, orthodontic treatment is restarted to correct the position of the permanent teeth.[8,25] This phase involves movement of the teeth through the grafted area.

In this report, the movement of the permanent canines through the cleft area after completion of the secondary bone graft was followed longitudinally. We analyzed panoramic radiographs of 50 patients (32 males and 18 females) ranging in age from 8 years 10 months to 15 years. Twelve patients had unilateral cleft lip and alveolus and 38 patients had complete unilateral cleft lip and palate (Table 1). All patients received a secondary bone graft before the eruption of their permanent canines, and were longitudinally observed over a period of 1 to 5 years (Table 2). The patients were selected based on the availability of suitable radiographs, including images obtained immediately before

Table 3. Data Extracted from the Literature Regarding Canine Eruption Through Secondary Bone Graft

Authors	Year	Cleft Type and Sample Size	Number of Patients	Gender	Age at Bone Grafting	Spontaneous Eruption	Forced Eruption
Amanat N, Langdon JD[31]	1991	BC: 13 UC: 21	34	23 males 11 females	7–24 y	97%	3%
Bergland O, et al[25]	1986	BC: 49 UC: 291	340	218 males 122 females	8–17 y	85%	15%
Bergland O, et al[42]	1986	BC: 41	41	25 males 16 females	8y 9m to 17y 4m	95%	5%
Boyne PJ, Sands NR[9]	1972	—	10	—	8 pat.: 9–11y 2 adult pat.	80%	—
El Deeb M, et al[10]	1982	BC: 18 UC: 28 CLA: 4 CLAP: 42	46 (64 canines)	32 males 14 females	7–14 y	27%	47 canines (73%)
El Deeb M, et al[32]	1986	BCLP: 18 UCLP: 8	26 (44 canines)	17 males 9 females	7–13, 9y	41%	59%
Enemark H, et al[34]	1985	UCLP	62	—	12 y	31 patients	5 patients
Hinrichs JE, et al[13]	1984	UC: 18	18	10 males 8 females	10.5 y (7.3–13.9 y)	—	100%
Kwon JH, et al[40]	1981	BC: 35 UC: 64	99 (134 canines)	62 males 37 females	7–11 y	73%	27%
Paulin G, et al[14]	1988	BC: 13 UC: 54	67	—	37 pat.: 8–14 y 30 pat.: 10–20 y	93%	7%
Troxell J, et al[15]	1982	BC: 4 UC: 26	30 (34 canines)	14 males 16 females	13.2 y 7–26 y	95%	5%
Turvey TA, et al[16]	1984	UC: 15 BC: 9	24 (33 canines)	13 males 11 females	13.6 y 11.7 to 35.4 y	95%	5%

BC indicates bilateral cleft; UC, unilateral cleft; CLA, cleft lip and alveolus; CLAP, cleft lip, alveolus, and palate.

the bone graft and a minimum of 1 year after the surgical procedure.

DISCUSSION

All patients of the HRCA currently undergo the same treatment protocol: (1) primary surgeries performed during childhood (lip repair after 3 months of age and palate repair after 12 months of age); (2) no early pre- and post-surgical maxillary orthopedics; (3) orthodontic treatment during the mixed dentition; (4) secondary bone graft at the end of the mixed dentition; and (5) fixed orthodontic treatment during the permanent dentition. Secondary bone graft was included in our treatment protocol in the early 1990s.

The current radiographic, retrospective study allowed for longitudinal assessment of the behavior of the permanent canines in relation to secondary bone graft over an average period of 3 years, with a follow-up period ranging from 1 to 5 years (Table 2).

Radiographic follow-up demonstrated dramatic adaptation of the cancellous bone of the iliac crest to the host area, making it impossible to distinguish the mesial and distal limits of the cleft.[12] In addition, it was radiographically apparent that canines migrate toward the occlusal plane through the grafted bone and create good periodontal condition. Our findings agree with other studies in which teeth erupted through the grafted bone.[2,7–17,31–35,40,41]

Our results were considered satisfactory. In the follow-up, 36 of the 50 patients (72%) had canines spontaneously erupt through the grafted bone, indicating a strong tendency for spontaneous tooth eruption after the secondary bone graft. The success rate in our group of 50 patients (72%) was higher than that reported by other authors but is equivalent to the average percentages found in the literature (75%). Reported percentages for spontaneous canine eruption through bone graft are 27%,[10] 41%,[32] 50%,[33] 73%,[39] 80%,[9] and 95%.[15,16] Data are shown in Table 3.

Cancellous bone graft is quickly incorporated and vascularized and, most importantly, does not interfere in the formation of the teeth adjacent to the cleft.[25,30] This statement has been proved histologically[30] and radiographically.[10] The presence of the tooth contributes to the preservation of the grafted bone and to the differentiation of the periodontal support. This fact is shown in the radiographs of the patient in Figure 2.

Although the therapeutic perspective of dentists, especially orthodontists, with regard to alveolar cleft repair has improved with the secondary bone grafting techniques, the problem of canine eruption should not be considered

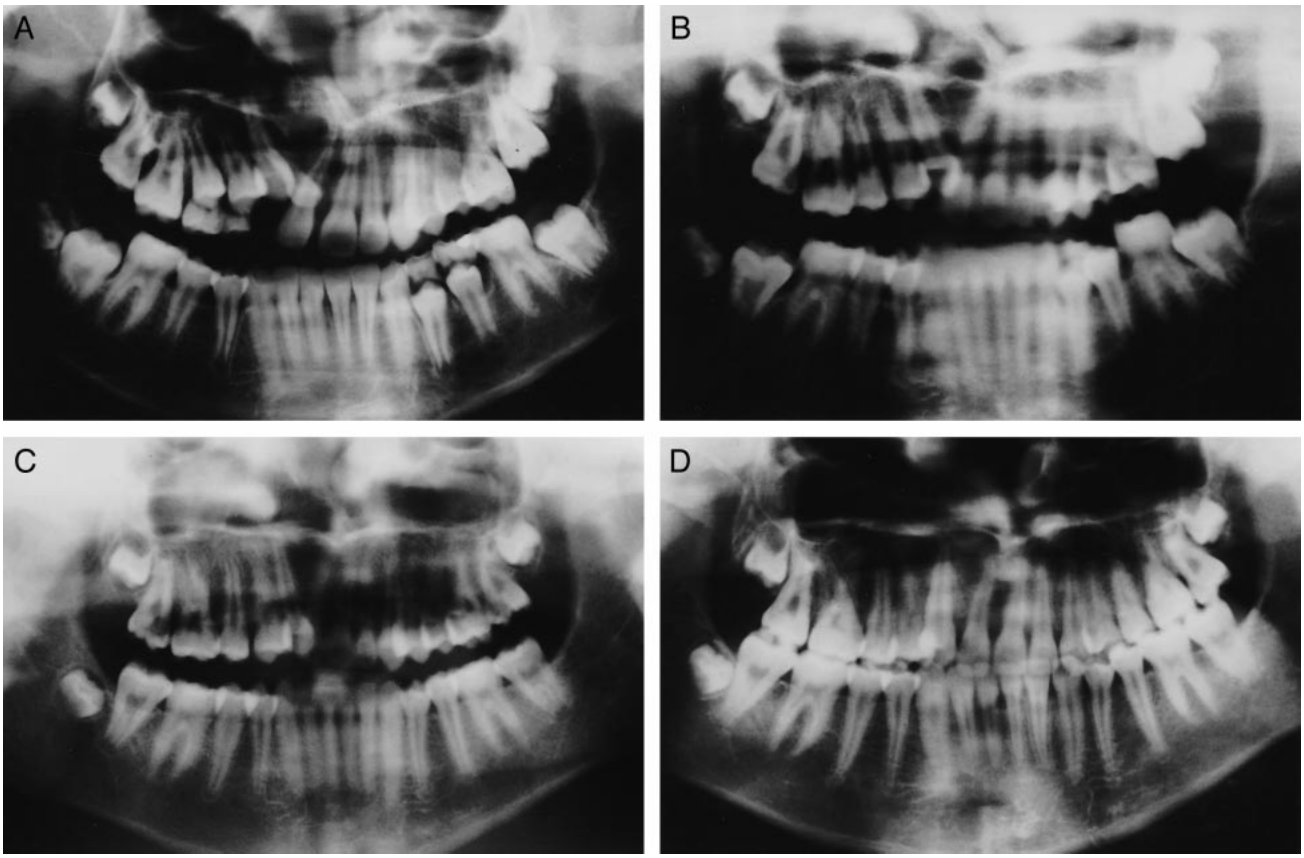

FIGURE 2. Panoramic radiographs. (A) One month before the secondary bone graft; (B) 3 months following the bone graft; (C) seventeen months after the bone graft; (D) 2 years and 4 months after the bone graft.

solved. As stated, 72% of the canines in our sample spontaneously erupted. Occasionally, however, canines need extrabiological stimuli for their eruption. Several authors have mentioned the possibility of surgical procedures, with or without subsequent orthodontic intervention, that aim to stimulate teeth to erupt through the grafted area. These procedures include exposure of the canines, with literature data ranging from 9%[32] to 17%,[10] and orthodontic traction, with percentages of 5%[40], 7%,[14] 50%,[32] and 56%.[10] In our study, 3 patients (6%) had orthodontic traction of their canines through the grafted area. Although the remaining 11 patients (22%) still present signs of tooth movement inside the bone, their canines have not yet erupted. So far, these teeth have not been subject to orthodontic traction because they are still within the accepted time limit for spontaneous eruption.

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