# Ideal treatment protocol for cleft lip and palate patient from mixed to permanent dentition

**Roberto Rocha,[a] Daltro Enéas Ritter,[b] Arno Locks,[a] Leonardo Koerich de Paula,[c] and Regis Meller Santana[c]**
*Florianópolis, Santa Catarina, Brazil*

A girl with an Angle Class III malocclusion, anterior and posterior crossbites, a concave profile, and cleft lip and palate sought orthodontic treatment. She was treated with a multidisciplinary therapeutic protocol including orthodontic and surgical procedures. The proposed objectives of occlusion, normal function, and balanced profile were achieved, and these results remained stable 4 years after the treatment. (Am J Orthod Dentofacial Orthop 2012;141:S140-8)

Cleft lip and palate (CLP) is the most frequent congenital facial abnormality. Its incidence varies according to studied populations but is usually between 1 and 1.82 for each 1000 births. The etiology is related to genetic heritage or environmental factors.[1] CLP patients might suffer from unfavorable smile esthetics and low self-esteem, leading mainly to difficulties in social interactions.[2-5] Patients with CLP have typical characteristics, such as deficiency in midface development, orthodontic Class III tendency, significantly smaller ANB angle, oronasal fistulae in some cases, alterations in shape and number of the lateral incisors, and, occasionally, supernumerary teeth.[6-12]

The multidisciplinary therapeutic protocol frequently extends over many years, starting with primary surgeries up to the end of adolescence.[4] Treatment might start around 3 to 6 months of age with a labial repair or at 10 to 12 months of age with palatoplasty.[6,8,13,14] Secondary alveolar bone grafting is indicated for most patients with an alveolar cleft, and the best stage for the procedure is when the canine adjacent to the cleft has completed half to three quarters of its root formation.[6,8,13,15-18] Orthodontic treatment before bone grafting might be performed, aiming to improve the maxillary relationship and the facial profile, as well as to aid positioning of cleft alveolar segments, leading to a more favorable graft prognosis.[8,9,11-13,19-21] If successful, this surgery enhances the dental alveolus for eruption and periodontal support of the teeth adjacent to the cleft, usually the canine and the lateral incisor.[10] Surgical protocols might use several areas as bone donors, such as the mandibular symphysis and the iliac crest, which are the most used.[6,9,16-18]

The purpose of this report was to show that an interdisciplinary treatment protocol, after adequate diagnosis and planning, significantly improves the alterations resulting from a bilateral CLP deformity. The proposed objectives of occlusion, normal function, and balanced profile were achieved, and these results remained stable 4 years after the treatment.

## DIAGNOSIS AND ETIOLOGY

A girl, aged 9 years 8 months, with a complete bilateral CLP, sought care at the Care Facility for Patients with Facial Deformity at the Federal University of Santa Catarina in Brazil. The facial assessment showed a functional mandibular deviation to the right side and vertical balance among the facial thirds. The facial profile was concave with a retrusive upper lip (Fig 1). She was at the end of the mixed dentition and had an anterior crossbite and Class III molar and canine relationships. Her soft and hard palates had been repaired successfully at 1 year of age. She had an atresic maxilla in the premolar and canine areas, overjet of −2 mm, and 50% overbite. The dental cast discrepancies were −5 mm for the maxilla and −0.5 mm for the mandible. The mandibular midline deviated 2 mm to the right and was related to the postural mandibular deviation resulting from the posterior crossbite. The maxillary midline was deviated 2 mm to the left (Fig 2).

Panoramic and periapical radiographs showed the presence of all permanent teeth, and the maxillary lateral incisors adjacent to the cleft were malpositioned. Four

From the School of Dentistry, Federal University of Santa Catarina, Florianópolis, Brazil.
[a]Adjunct professor, Department of Orthodontics.
[b]Associate professor, Department of Orthodontics.
[c]Postgraduate student.
Reprint requests to: Daltro E. Ritter, Rua Nereu Ramos, 69-512, 88015-010, Florianópolis, Santa Catarina, Brazil; e-mail, daltroritter@hotmail.com.
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**Fig 1.** Pretreatment facial and intraoral photographs at age 9 years 8 months.

supernumerary teeth (precanine type) were additionally diagnosed as 2 deciduous teeth accompanied by their successors. They were bilaterally positioned at the distal ridge of the alveolar clefts. The lateral cephalometric radiograph showed skeletal maxillomandibular horizontal balance (ANB, 3.5°; NAPog, 5.0°; AO-BO, 1.0 mm) (Table). The facial growth vector was predominantly vertical (GoGn.SN, 33°; FMA, 32°; y-axis, 63.5°) (Fig 3). The maxillary incisors had accentuated vertical angulation (1.NA, −4°; 1-NA, 0 mm), whereas the mandibular incisors were well positioned (1.NB, 23°; 1-NB, 5 mm; IMPA, 92°). The maxillary incisor retroclination led to buccally positioned roots, influencing the contour of the anterior maxillary vestibule; this produced an increased ANB angle and masked the retrusive maxillary position. Her hand and wrist radiographs were compatible with a bone age of 10 years. The thumb abductor sesamoid was present, indicating that the pubertal growth spurt had already started (Fig 4).[22]

## TREATMENT OBJECTIVES

The main goals of the treatment were to correct the anterior and posterior crossbites, perform a bilateral secondary bone graft, and perform dental alignment and leveling to achieve adequate intercuspation. In addition to the occlusal alterations, balancing of the patient's profile was also desired.

## TREATMENT ALTERNATIVES

Anterior and posterior crossbites are better corrected early in treatment. Thus, maxillary expansion and protraction were planned for the initial stages of orthodontic therapy. Maxillary surgical advancement or mandibular setback in adulthood would be another option, if the mandibular or maxillary growth did not respond favorably.

If the bone graft of the maxillary cleft were successful, the first option would be to move the supernumerary

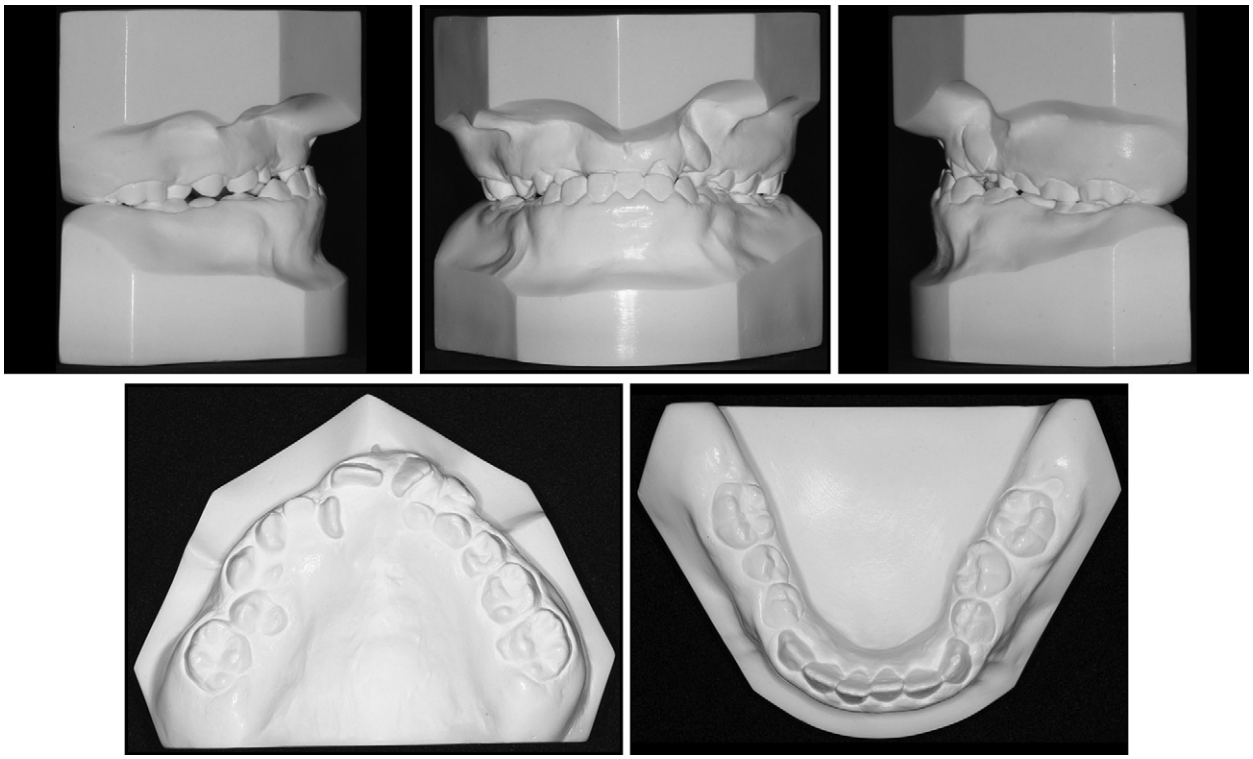

**Fig 2.** Pretreatment study models.

**Table.** Cephalometric measurements

| *Measurements* | *Normal* | *Pretreatment* | *Posttreatment* | *Difference* |
|---|---|---|---|---|
| Skeletal pattern | | | | |
| SNA (°) | 82 | 80 | 83 | 3 |
| SNB (°) | 80 | 76.5 | 82 | 5.5 |
| ANB (°) | 2 | 3.5 | 1 | −2.5 |
| Facial convexity (°) | 0 | 5 | 0 | −5 |
| Y-axis (°) | 59 | 63.5 | 65 | 1.5 |
| Facial angle (°) | 87 | 81 | 81 | 0 |
| SN.GoGn (°) | 32 | 33 | 35 | 2 |
| AO-BO (mm) | 0 | 1 | 3.5 | 2.5 |
| FMA (°) | 25 | 32 | 33.5 | 1.5 |
| Dental pattern | | | | |
| IMPA (°) | 90 | 92 | 82 | −10 |
| 1.NA (°) | 22 | −4 | 35 | 39 |
| 1-NA (mm) | 4 | 0 | 5 | 5 |
| 1.NB (°) | 25 | 23 | 17 | −6 |
| 1-NB (mm) | 4 | 5 | 4 | −1 |
| 1.1 (°) | 130 | 156 | 133 | −23 |
| Profile | | | | |
| Upper lip-S line (mm) | 0 | −1.5 | −1 | 0.5 |
| Lower lip-S line (mm) | 0 | 3 | 3 | 0 |

teeth into the lateral incisor positions. The lack of bone and gingival support for the existing lateral incisors favored their extraction. Other options could have been (1) mesial movement of posterior teeth with closure of the space distal to the central incisors, (2) implants when the lateral incisors or supernumerary teeth were lost, (3) surgical mesial positioning of the posterior maxillary segments if the grafts failed, and (4) partial or fixed prostheses between the central incisors and the canines if other alternatives including grafting failed.

## TREATMENT PROGRESS

The first procedure consisted of maxillary expansion at age 9 years 11 months to improve the maxillary arch shape and provide better conditions for future bone grafting. A modified Haas expander was anchored to the maxillary first molars and the deciduous canines. Two daily screw activations were performed for 15 days. After stabilization was achieved, maxillary protraction was initiated with a force of 220 g. Protraction was prescribed for at least 12 hours per day to correct the anterior crossbite and improve the profile.

Complete fixed appliances were bonded or cemented on all erupted teeth at age 10 years 7 months. The protraction was stopped, and the palatal expander was removed 3 months after bracket bonding. During this phase, the goals were alignment and leveling, anterior and posterior crossbite correction, and improvement of

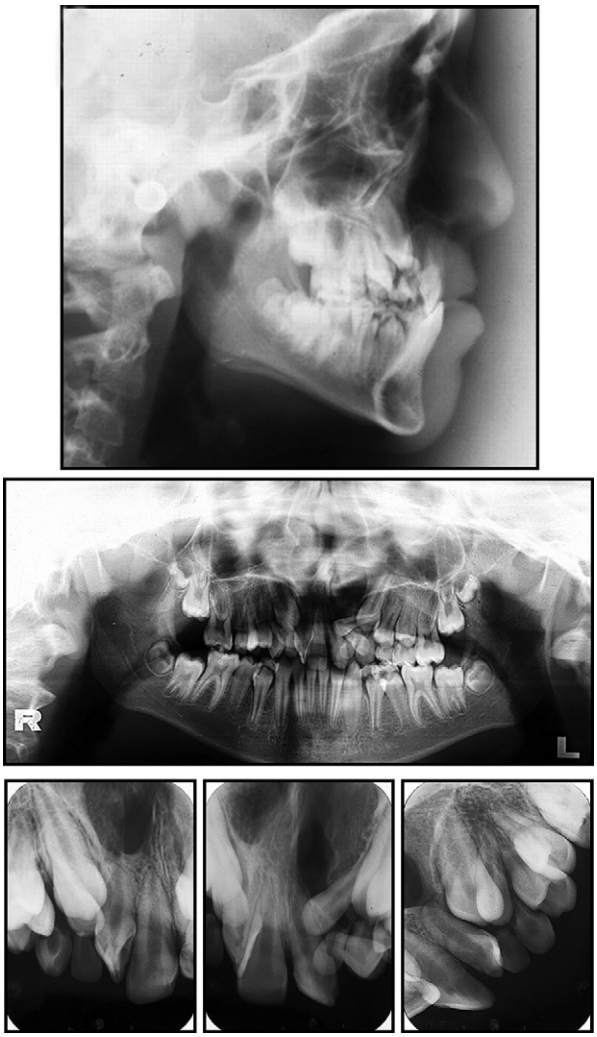


**Fig 3.** Pretreatment cephalometric, panoramic, and periapical radiographs.

the maxillary incisor angulation. The alveolar bone graft was performed at age 11 years 5 months to promote the bony union of the alveolar segments and closure of the bilateral clefts. This procedure improved the nasal base and enhanced the stability of the expansion. The maxillary lateral incisors were extracted, because they were near the cleft, had exposed root cementum, and were excessively mobile. The donor site for the bone graft was the mandibular symphysis.

After determining that the alveolar bone graft was successful, we moved the supernumerary teeth in the cleft area into the lateral incisor positions. During this phase, maxillary protraction was again used to improve the dentoskeletal relationships. Class III elastics were also used during this phase to increase the overjet and compensate for additional mandibular growth.

**Fig 4.** Pretreatment hand-wrist radiograph.

## TREATMENT RESULTS

At 15 years 7 months of age, this patient's expected orthodontic outcomes had been achieved, so the active phase of orthodontic treatment was concluded, and the fixed appliances were debonded (Fig 5). A fixed palatal arch was installed to prevent relapse of the maxillary expansion. A mandibular lingual bonded retainer was also placed. The posttreatment dental casts showed good intercuspation (Fig 6). The patient was referred to the restorative department of the dental school of the Federal University of Santa Catarina to have her maxillary anterior teeth restored. The final radiographs showed no root resorption (Fig 7).

The maxillomandibular relationships at the end of the treatment maintained their balance (ANB, 1°; NAPog, 0°; AO-BO, 3.5 mm) and showed a slight increase of the vertical measurements (GoGn.SN, 35°; FMA, 33,5°; y-axis, 65°) (Table). This represents greater vertical growth of the mandible. The angulation of the maxillary incisors changed from −4° to 32.5° (1.NA) and from 0 to 5 mm (1-NA). The pretreatment and posttreatment cephalometric superimposition demonstrated vertical mandibular growth, improvement of the profile, and maxillary incisor proclination (Fig 8).

Minor plastic surgery of the upper lip was performed 1 year after removal of the orthodontic appliances to enhance esthetics and function. At 4 years posttreatment, the orthodontic results were relatively stable (Fig 9).

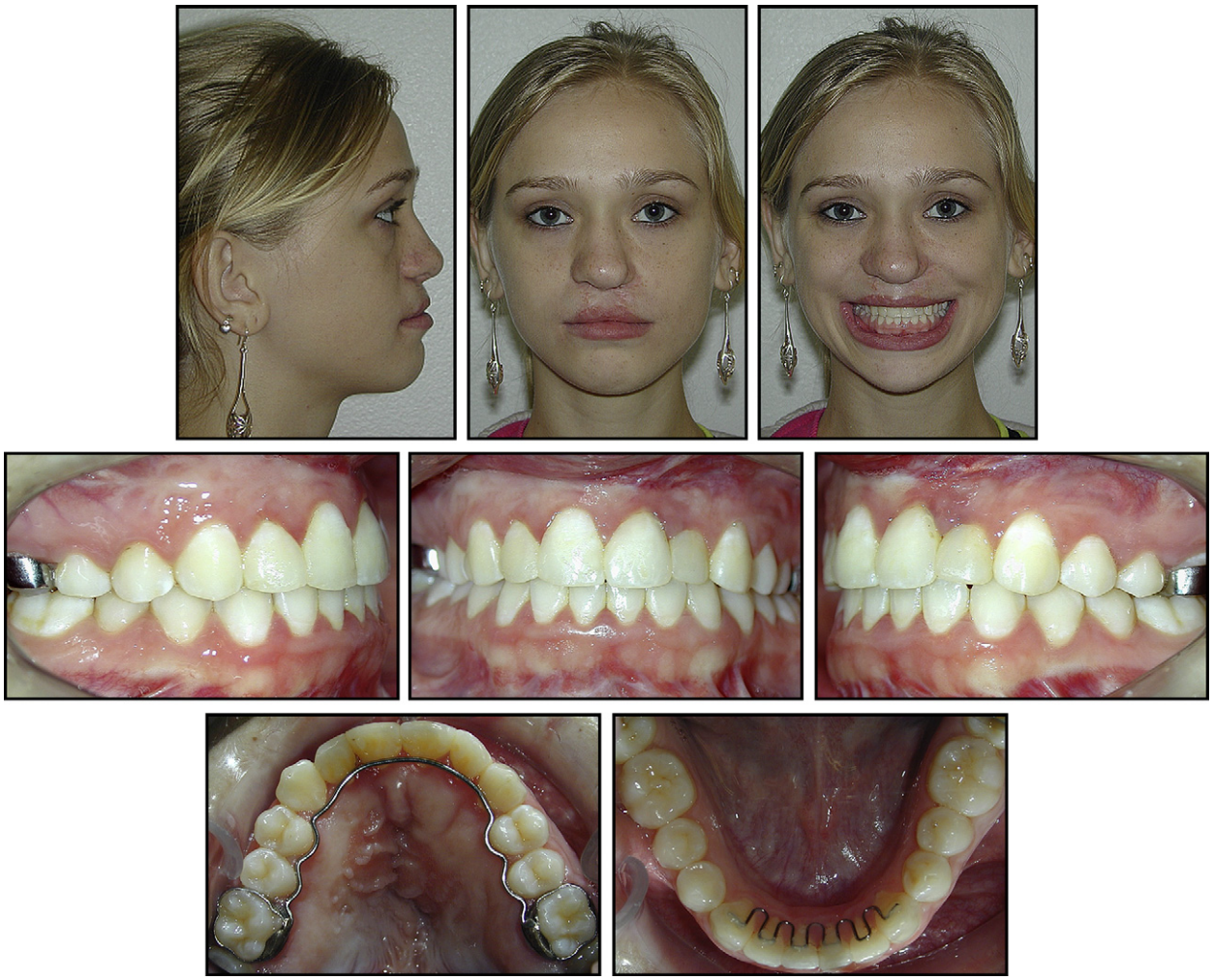

**Fig 5.** Posttreatment facial and intraoral photographs at age 16 years 7 months.

## DISCUSSION

The treatment for patients with CLP is challenging because of the difficulties inherent in the deformity, the necessity of interdisciplinary involvement, and the need for good patient cooperation. The results might still be limited even if all of these challenges can be overcome.

Our patient came with the initial lip and palate reparative surgery already performed. Patient and parent cooperation was obtained during orthodontic treatment, allowing the use of all necessary orthodontic resources. The advantage of performing maxillary expansion before the alveolar bone graft is the ability to achieve expansion with better positioning of the cleft arch segments, thus permitting a more favorable outcome of the bone graft.[23,24] Although the ANB angle (3.5°) at the beginning of treatment did not resemble a skeletal Class III relationship, maxillary protraction was used to correct the anterior crossbite, compensate for any further mandibular growth, and enhance the patient's profile.[23,25,26]

Fixed appliances were used to obtain dental alignment and leveling, and to correct the retroclined maxillary incisors. According to Long et al,[23] the preservation of thin alveolar bone surrounding the dental roots close to the cleft is the main obstacle to anterior tooth movement and crossbite correction. So, in our patient, we prevented any root movement toward the bilateral clefts before bone grafting. This was accomplished primarily through the positions of the central and lateral incisor brackets.

Secondary alveolar bone grafting was proposed by Boyne and Sands[15] in 1972 and documented extensively by Bergland et al.[27] Problems can occur during the graft procedure. These include loss of the graft, difficulty in

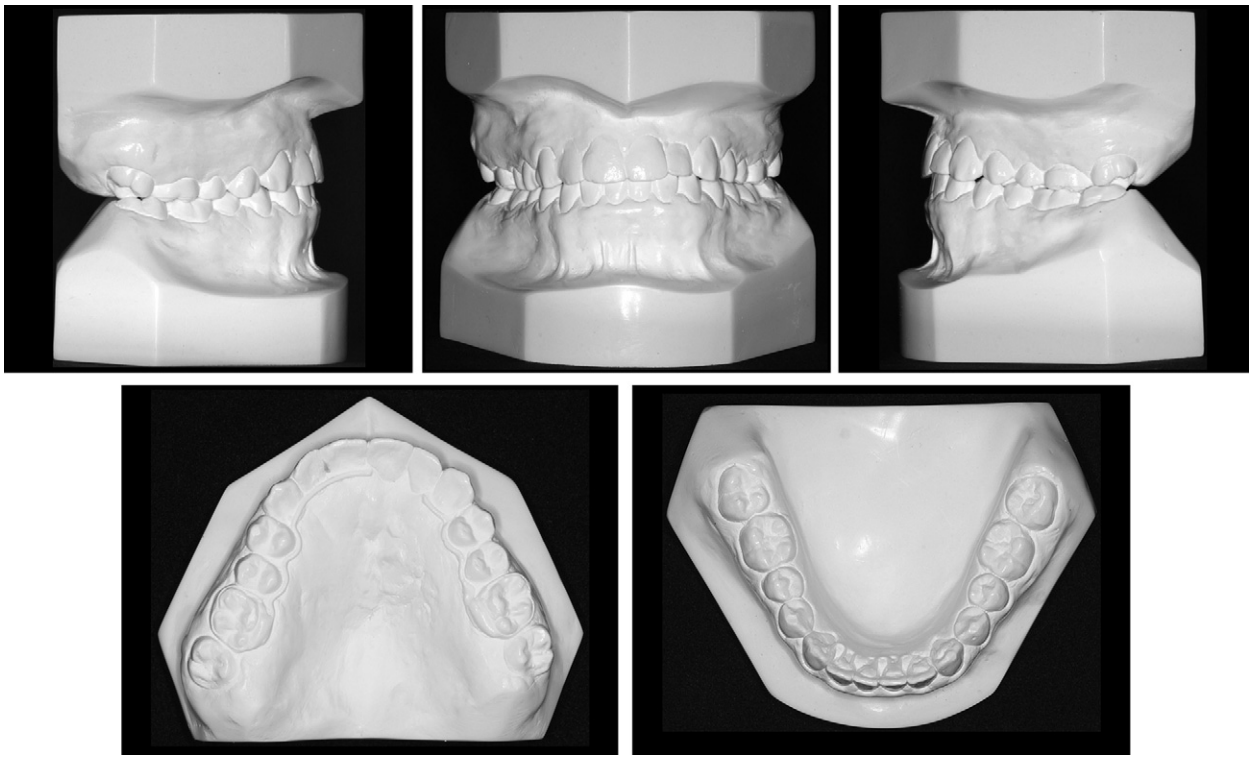

**Fig 6.** Posttreatment study models.

establishing a bony bridge, problems with adjacent tooth eruption, and lack of nasal support. However, better results are reported when the procedure is performed before permanent canine eruption and, more specifically, when these teeth have formed between half and three quarters of their roots.[15,23,27] The graft can be performed before the eruption of the permanent lateral incisors to maintain a bony framework for these teeth.[23] Secondary alveolar bone grafting does not interfere with vertical and horizontal maxillary growth.[28,29]

The donor site for the alveolar bone graft in our patient was the symphysis of the mandible. When bone is harvested from the chin, the patient's recovery is improved, hospital time is decreased, blood loss during surgery is diminished, and postoperative pain is less compared with bone harvested from the iliac crest. Although the risk is small, if bone were harvested from the iliac crest, this could result in a minor alteration in the growth of the hip. In addition, scar tissue and a slight bone depression are common when the donor site is the hip. On the other hand, an important advantage of an iliac bone graft is that more trabecular bone can be harvested.[30]

The supernumerary teeth were moved into the lateral incisor positions. The actual lateral incisors were extracted because of lack of bone and gingival support. Once we noted that the bone grafting had been successful, the supernumerary teeth were positioned as substitutes for the extracted lateral incisors. The supernumerary teeth had favorable periodontal support, and the root and crown anatomies were acceptable. This treatment decision permitted natural alveolar growth and decreased the movement of adjacent teeth. Between 90 and 120 days after grafting, the supernumerary teeth were moved slowly into the graft area. These teeth are commonly found in patients with CLP distally to the cleft, with a frequency of 47.4%.[31] The supernumerary teeth were restored after orthodontic treatment, and their esthetic appearance was acceptable.

At the end of treatment, normal overjet and overbite were achieved, and the molar and canine relationships were Angle Class I. Adequate dental alignment and leveling, as well as maxillary and mandibular midline symmetry, were also established. Postorthodontic treatment can be as difficult as the therapeutic portion of the treatment in patients with CLP depending on the type of cleft. In some patients, the treatment often seems endless. This postorthodontic phase of treatment is fundamental, and patients should be aware of its importance. Our patient was cooperative, and the treatment results have been maintained for 4 years (Fig 9).

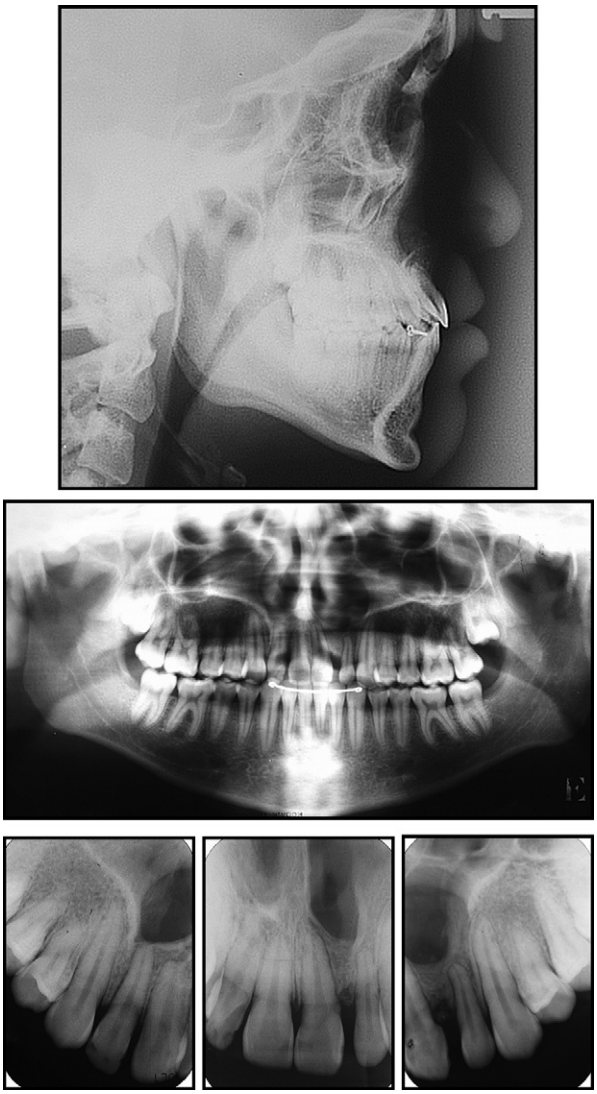

**Fig 7.** Posttreatment cephalometric, panoramic, and periapical radiographs.

## CONCLUSIONS

The treatment of patients with CLP is challenging for both the orthodontist and the multidisciplinary team. However, satisfactory results regarding functional occlusion, dental esthetics, and facial esthetics can be achieved with a well-established diagnosis and treatment plan. As with all orthodontic treatment, long-term follow-up is necessary to maintain the results.

## REFERENCES


1. Derijcke A, Eerens A, Carels C. The incidence of oral clefts: a review. Br J Oral Maxillofac Surg 1996;34:488-94.
2. Thornton JB, Nimer S, Howard PS. The incidence, classification, etiology, and embryology of oral clefts. Semin Orthod 1996;2: 162-8.


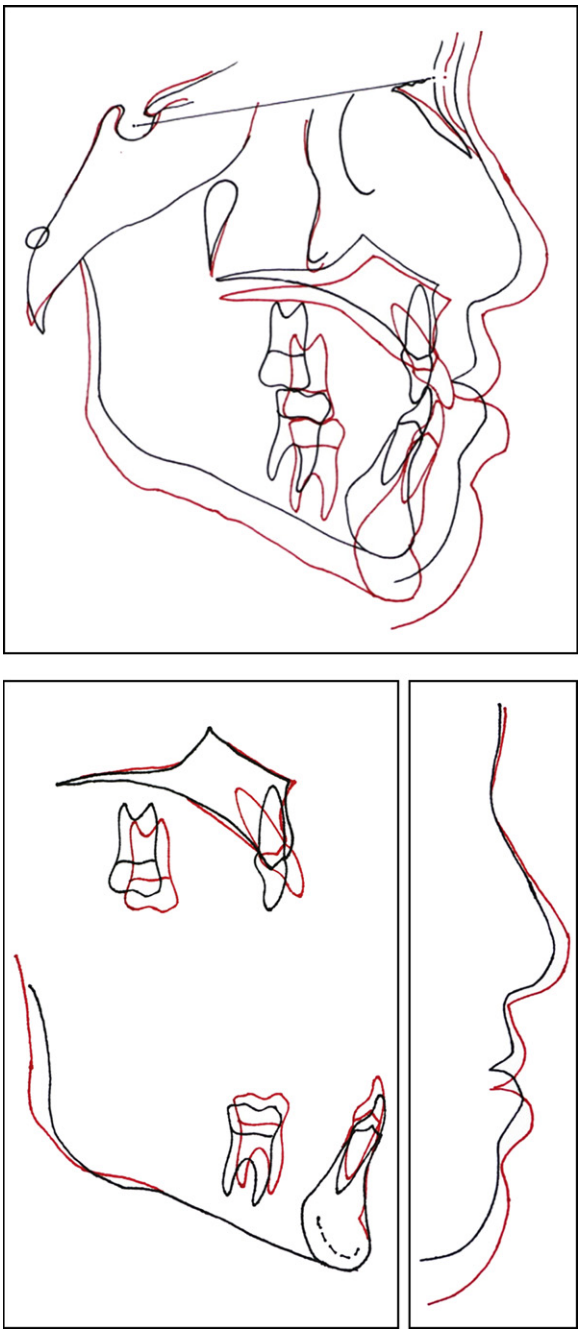

**Fig 8.** Pretreatment (*black*) and posttreatment (*red*) cephalometric tracings, superimposed on sella-nasion at sella; maxilla best fit; mandible plane at menton; and sella-nasion at nasion.


3. Landsberger P, Proff P, Dietze S, Hoffmann A, Kaduk W, Meyer FU, et al. Evaluation of patient satisfaction after therapy of unilateral clefts of lip, alveolus and palate. J Craniomaxillofac Surg 2006;34: 31-3.
4. Aljohar A, Ravichandran K, Subhani S. Pattern of cleft lip and palate in hospital-based population in Saudi Arabia: retrospective study. Cleft Palate Craniofac J 2008;45:592-6.

**Fig 9.** Long-term stability at the 4-year follow-up, with maintenance of adequate overbite and overjet.


5. Kramer FJ, Gruber R, Fialka F, Sinikovic B, Schliephake H. Quality of life and family functioning in children with nonsyndromic orofacial clefts at preschool ages. J Craniofac Surg 2008;19:580-7.
6. Tan AE, Brogan WF, McComb HK, Henry PJ. Secondary alveolar bone grafting—five year periodontal and radiographic evaluation in 100 consecutive cases. Cleft Palate Craniofac J 1996;33:513-8.
7. Gaggl A, Schultes G, Karcher H. Aesthetic and funcional outcome and orthodontic correction of bilateral cleft of lip, palate and alveoulus. Cleft Palate Craniofac J 1999;36:407-12.
8. Kajii TS, Alam MK, Iida J. Orthodontic treatment of cleft lip and alveolus using secondary autogenous cancellous bone grafting: a case report. World J Orthod 2009;10:67-75.
9. Cavassan AO, Albuquerque MA, Capelozza Filho L. Rapid maxillary expansion after secondary alveolar bone graft in a patient with bilateral cleft lip and palate. Cleft Palate Craniofac J 2004;41:332-9.
10. Russell KA, McLeod CE. Canine eruption in patients with complete cleft lip and palate. Cleft Palate Craniofac J 2008;45:73-80.
11. Tindlund RS, Rygh P, Boe OE. Orthopedic protraction of the upper jaw in cleft lip and palate patients during the deciduous and mixed dentition periods in comparison with normal growth and development. Cleft Palate Craniofac J 1993;30:182-94.
12. Tindlund RS, Rygh P. Maxillary protraction: different effects on facial morphology in unilateral and bilateral cleft lip and palate patients. Cleft Palate Craniofac J 1993;30:208-21.
13. da Silva Filho OG, Teles SG, Ozawa TO, Filho LC. Secondary bone graft and eruption of the permanent canine in patients with alveolar clefts: literature review and case report. Angle Orthod 2000;70:174-8.
14. Rosenstein SW, Grasseschi M, Dado DV. A long-term retrospective outcome assessment of facial growth, secondary surgical need, and maxillary lateral incisor status in a surgical-orthodontic protocol for complete clefts. Plast Reconstr Surg 2003;111:1-13.
15. Boyne PJ, Sands NR. Secondary bone grafting of residual alveolar and palatal clefts. J Oral Surg 1972;30:87-92.
16. Eppley BJ, Sadove M. Management of alveolar cleft bone grafting—state of the art. Cleft Palate Craniofac J 2000;37:229-33.
17. Rawashdeh MA, Al Nimri KS. Outcome of secondary alveolar bone grafting before and after eruption of the canine in Jordanian patients with cleft lip and palate. J Craniofac Surg 2007;18:1331-7.
18. Rawashdeh MA, Telfah H. Secondary alveolar bone grafting: the dilemma of donor site selection and morbidity. Br J Oral Maxillofac Surg 2008;46:665-70.

19. McIntyre GT, Devlin MF. Secondary alveolar bone grafting (CLEFTSiS) 2000-2004. Cleft Palate Craniofac J 2010;47: 66-72.
20. Kindelan J, Roberts-Harry D. A 5-year post-operative review of secondary alveolar bone grafting in the Yorkshire region. Br J Oral Maxillofac Surg 1999;26:211-7.
21. Peamkaroonrath C, Manosudprasith M, Godfrey K. Assisted eruption of impacted teeth into an alveolar bone graft in a patient with cleft lip and palate. Aust Orthod J 2008;24: 149-55.
22. Greulich WW, Pyle SI. Radiographic atlas of skeletal development of the hand and wrist. Palo Alto, Calif: Stanford University Press; 1959.
23. Long RE, Semb G, Shaw WC. Orthodontic treatment of the patient with complete clefts of lip, alveolus, and palate: lessons of the past 60 years. Cleft Palate Craniofac J 2000;37:1-13.
24. Silva Filho OG, Boiani E, Cavassan AO, Santamaria M Jr. Rapid maxillary expansion after secondary alveolar bone grafting in patients with alveolar cleft. Cleft Palate Craniofac J 2009;46: 331-8.
25. Trotman CA, Ross RB. Craniofacial growth in bilateral cleft lip and palate: ages six years to adulthood. Cleft Palate Craniofac J 1993; 30:261-73.
26. Heidbüchel KLWM, Kuijpers-Jagtman AM, Freihofer HPM. Facial growth in patients with bilateral cleft lip and palate: a cephalometric study. Cleft Palate Craniofac J 1994;31:210-6.
27. Bergland O, Semb G, Abyholm FE. Elimination of the residual alveolar cleft by secondary bone grafting and subsequent orthodontic treatment. Cleft Palate J 1986;23:175-205.
28. Levitt T, Long RE Jr, Trotman CA. Maxillary growth in patients with clefts following secondary alveolar bone grafting. Cleft Palate Craniofac J 1999;36:398-406.
29. Daskalogiannakis J, Ross RB. Effect of alveolar bone grafting in the dentition on maxillary growth in complete unilateral cleft lip and palate patients. Cleft Palate Craniofac J 1997;34:455-8.
30. So L, Lui WWK. Alternative donor site for alveolar bone grafting in adults with cleft lip and palate. Angle Orthod 1996;66:9-16.
31. Halpern RM, Noble J. Location and presence of permanent teeth in a complete bilateral cleft lip and palate population. Angle Orthod 2010;80:591-5.