Nasal Reconstruction with a Forehead Flap in Children Younger than 10 Years of Age

Carlos Giugliano, M.D., Patricio R. Andrades, M.D., and Susana Benitez, M.D.

Santiago, Chile

Nasal reconstruction has been analyzed extensively in adults but not in children. The purpose of this article is to review the authors' experience with the forehead flap for nasal reconstruction in 10 children under the age of 10 during a 10-year period. Outcomes were assessed by an objective grading system for cosmetic surgical results. Subjective criteria were also applied by an assistant surgeon and by the patients' relatives. Appropriate results were obtained by the following principles: (1) A modified approach that considers three subunits consisting of the dorsum, tip, and ala was used; (2) a forehead flap is the best option for an entire subunit or a full-thickness defect repair; (3) the forehead flap design should be paramedian, oblique, and opposite to the major defect to avoid the hairline and allow better caudal advancement; (4) ear or costal cartilages are good options for structural support (the septum is a nasal growth center that should not be touched); (5) infundibular undermining of vestibular mucosa, turnover flaps, and skin grafts are good options for internal lining; (6) reconstruction is a three-stage procedure (an intermediate operation is added to thin the flap and perform secondary revisions for lining and support); (7) reconstruction should be completed before the child is school aged, to achieve good aesthetic results immediately and avoid psychosocial repercussions; and (8) the reconstructed nose, with skin, lining, and support, will grow with the child (no final surgery should be planned at the age of 18, other than revisions of late complications). (*Plast. Reconstr. Surg.* 114: 316, 2004.)

Many articles have been written about the history, techniques, and outcomes of nasal reconstruction with a forehead flap.[1–12] Burget and Menick's book published in 1994 has become the standard for nasal reconstruction, and the results obtained by following their principles are self-evident.[13]

In adults, the forehead flap has become a reliable, aesthetic, and versatile way to reconstruct the nose, as opposed to children, in whom nasal restoration with the forehead flap has not been studied thoroughly. We reviewed the literature, finding very few reports mentioning the use of a forehead flap in the pediatric population. Most are case reports with short-term follow-up and a diversity of surgical techniques.[14–19] Pediatric nasal reconstruction raises specific questions. When should reconstruction be initiated? Will the rebuilt portions grow in proportion to face development? Must a definitive reconstruction be planned in adulthood? Therefore, the purpose of this article is to review our experience with the forehead flap for nasal reconstruction in children under 10 years of age in an effort to answer some of the unsolved questions in this group of patients.

Patients and Methods

Patients

A total of 10 patients with nasal defects underwent reconstruction with a forehead flap between 1992 and 2002. Their clinical charts were reviewed, and all patients were last seen in January of 2003. Digital photographs were taken and results evaluated during last control. Objectively, cosmetic results were assessed by a grading system according to the method described by Strasser.[20,21] It uses four grade levels: excellent (0 points), good (1 point), mediocre (5 points), and poor (15 points). A grade level is assigned to one of five headings: malposition, distortion, asymmetry, contour deformity, and scar. The addition of each level will show a final excellent (0 points), good (1 to 4 points),

From the Plastic Surgery Unit, Pediatric Surgery Department, Dr. Roberto del Rio Clinical Hospital for Children, and J. J. Aguirre Clinical Hospital, University of Chile, School of Medicine. Received for publication February 10, 2003; revised September 11, 2003.

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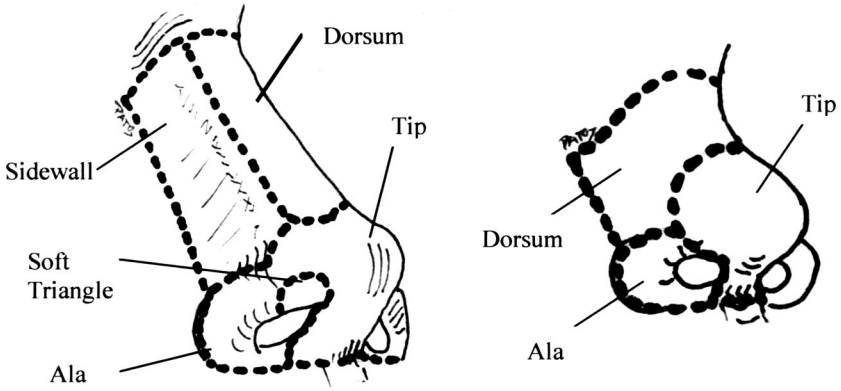

FIG. 1. The modified subunit approach for pediatric nasal reconstruction. Only three convex subunits are used: tip, dorsum, and ala (*left*, adult; *right*, child).

mediocre (5 to 14 points), or poor result (more than 15 points). Subjective criteria using a scale from 1 to 10 (in which 1 means a poor result and 10 the best) were also applied by an assistant surgeon and then by the patients' relatives.

Surgical Technique

Under general anesthesia and antibiotic prophylaxis, a thorough surgical cleansing was performed. The defect was measured and a modified three-subunit approach applied considering the tip, dorsum, and ala (Fig. 1). If the subunit had over 50 percent damage, the defect was enlarged to the size of the complete aesthetic unit. If it was less than 50 percent, the defect was not enlarged for reconstruction. The forehead flap was based on one supratrochlear artery (paramedian), with its pedicle just below the level of the eyebrow, oblique and contralateral to the major defect. Tissue expansion was used in special cases only. The distal third of the flap was elevated with skin and subcutaneous tissue and the donor site always closed primarily. The internal lining was achieved in most cases by a 360-degree infundibular undermining of the vestibular mucosa advanced to the nostril margin (Fig. 2). A folded forehead flap and turnover flaps were applied in only two cases. No skin grafts or septal, extranasal, free, or prefabricated flaps were used. When nasal support was needed, an auricular cartilage graft was used for ala and tip reconstruction. Costal cartilage was applied for dorsum or columella reconstruction only. We did not work with septal cartilage, bone graft, or alloplastic implants. In the nasal reconstruction sequence, the first step consisted of flap rotation, internal lining restoration, and structural support. The second step, in the first five cases, was the pedicle section. In the last five cases, an intermediate operation was added 3 weeks after the first, to thin the forehead flap. The final pedicle section in these cases was performed 2 weeks after this second procedure. Patients were discharged from the hospital 2 days after surgery and readmitted 1 day before the next operation.

RESULTS

In terms of the different causes of injury and layer involvement, each specific problem required a modified surgical technique based on the forehead flap described. Layer and subunit compromise included a combination of partial-

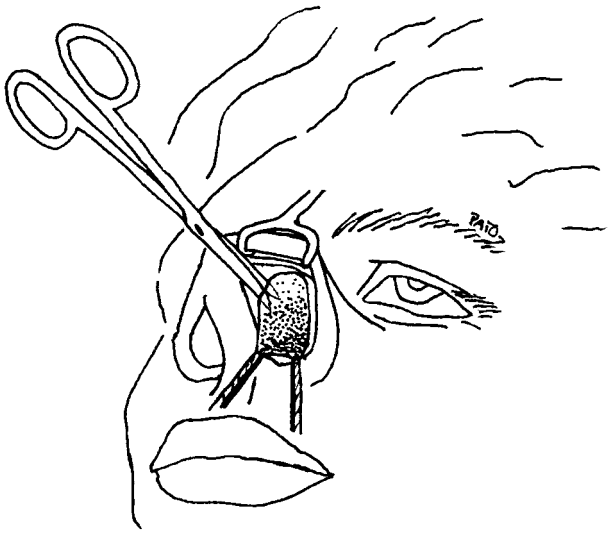

FIG. 2. A drawing demonstrating 360-degree undermining. The residual mucosa is freed completely around the vestibule and advanced to the nostril margin, leaving no internal defect.

thickness or full-thickness destruction, with tip, dorsum, and ala involved in variable amounts between patients. General surgical results include no donor-site morbidity and only one partial brow flap necrosis as an immediate complication. As late complications, we found mild to moderate nostril stenosis in three patients and hypertrophic scars in two. One was lost from follow-up; therefore, late complications for this patient were unknown. Average follow-up was 5 years (range, 6 months to 10 years). Cosmetic objective scoring went from 4 to 12, and subjective data from the assistant surgeon and relatives went from 4 to 8 and 8 to 10, respectively. Patient characteristics are summarized in Table I and cases are illustrated in Figures 3 through 8.

TABLE I
Patient Characteristics

Patient	Sex/Age (yr)	Cause of Lesion	Layers (thickness)	Subunits	Follow-Up (yr)	Morbidity	Evaluation*		
							Cosmetic	Assistant Surgeon	Relatives
1	Female/4	Dog bite	Full	Tip, left ala, partial dorsum	10	Moderate nostril stenosis	12	4	8
2	Female/2	Dog bite	Full	Tip, right ala, partial dorsum	10	Mild nostril stenosis and hypertrophic scars	8	6	9
3	Female/8	Electrical burn	Full	Left ala, partial dorsum	Lost†	Unknown	5	8	?
4	Female/1	Craniofacial malformation‡	Full	Left ala, partial tip	6	No	?	?	?
5	Female/9	Hemangioma sequela	Partial	Tip, ala, partial dorsum	6	No	5	7	9
6	Male/1	Dog bite	Full	Right ala, partial tip	4	Mild nostril stenosis	4	8	10
7	Female/5	Hemangioma	Partial	Tip	4	No	3	8	9
8	Female/7	Congenital nevi	Partial	Dorsum	3	Partial brow flap necrosis	3	8	10
9	Female/6	Dog bite	Full	Partial tip	1.5	No	4	8	9
10	Female/4	Congenital half nose	Full	Left dorsum, left ala, left tip	0.5	No	4	8	10

* From left to right, cosmetic, assistant surgeon, and relatives' evaluation.
† Lost 1 month postoperative. Scores applied at this time.
‡ Unclassifiable and scores not applicable.
F, full thickness; P, partial thickness; T, tip subunit; A, ala subunits; D, dorsum subunit; R, right; L, left; P, partial involvement (<50%).

Discussion

We believe that there are four major differences between a child and an adult when it comes to analyzing the need for nasal repair: development, anatomy, injury causes, and the psychosocial factor. During the first 10 years of life, the entire face is changing.[22,23] According to Farkas and colleagues,[24] during this period of time the nose changes from a small, flat, and undefined structure in newborns, to a more prominent and globe-shaped tip at the age of 5. Surgical nasal development is considered finished at the age of 16, when it finally becomes a risen pyramid with a triangular base. The midface growth center is an unsolved topic. Some authors believe that the septum plays an important role in midface development,[13,25] but others claim that a functional matrix of nonskeletal composition is the controlling element of midface growth.[25] We believe the septum should not be touched until solid evidence exists to demonstrate the safety of septum manipulation in children.

From an anatomic viewpoint, the child is not a little adult. Some subunits described by Burget and Menick[9] can hardly be observed in the child. The dorsum and sidewalls are fused in one convex subunit. The tip and columella form the most prominent and large subunit, and both alas are tiny lobules that can also be considered subunits. The soft triangles are just shadow valleys in the child's nose. This is why we tried to apply a simple approach with only three subunits (Fig. 1).

Injuries that require nasal repair are also different between children and adults. Trauma, benign tumors, and malformations

FIG. 3. Patient 2. (*Above*) Tip and right ala subunits were affected in more than 50 percent. Dorsum was affected in less than 50 percent. Her complete tip and ala were reconstructed. Her dorsum was also completely reconstructed, not following the 50 percent rule. Results after 2 (*center*) and 10 years (*below*). See text for detailed information.

are the most relevant in children.[25–27] In our work, 40 percent of the injuries were caused by dog bites,[28–30] two cases had nasal malformation,[18,31,32] and three patients had skin tumors.[33–35]

The psychosocial aspect is one of the most important in pediatric nasal reconstruction. At approximately the age of 5, a child becomes self-conscious, developing self-image and self-esteem. Therefore, complete reconstruction is necessary before this age to provide the child with the closest to normal aesthetic appearance.[13,17] We do not agree with the concept of performing a final operation at the age of 18.[17] The fact is that there will be a long period of time during which the child will live with a partial, insufficient repair and an always-present deformity. This makes secondary surgery undesirable unless late complications are present.

As stated by many authors,[4,6,36–40] the forehead skin is acknowledged as the best donor

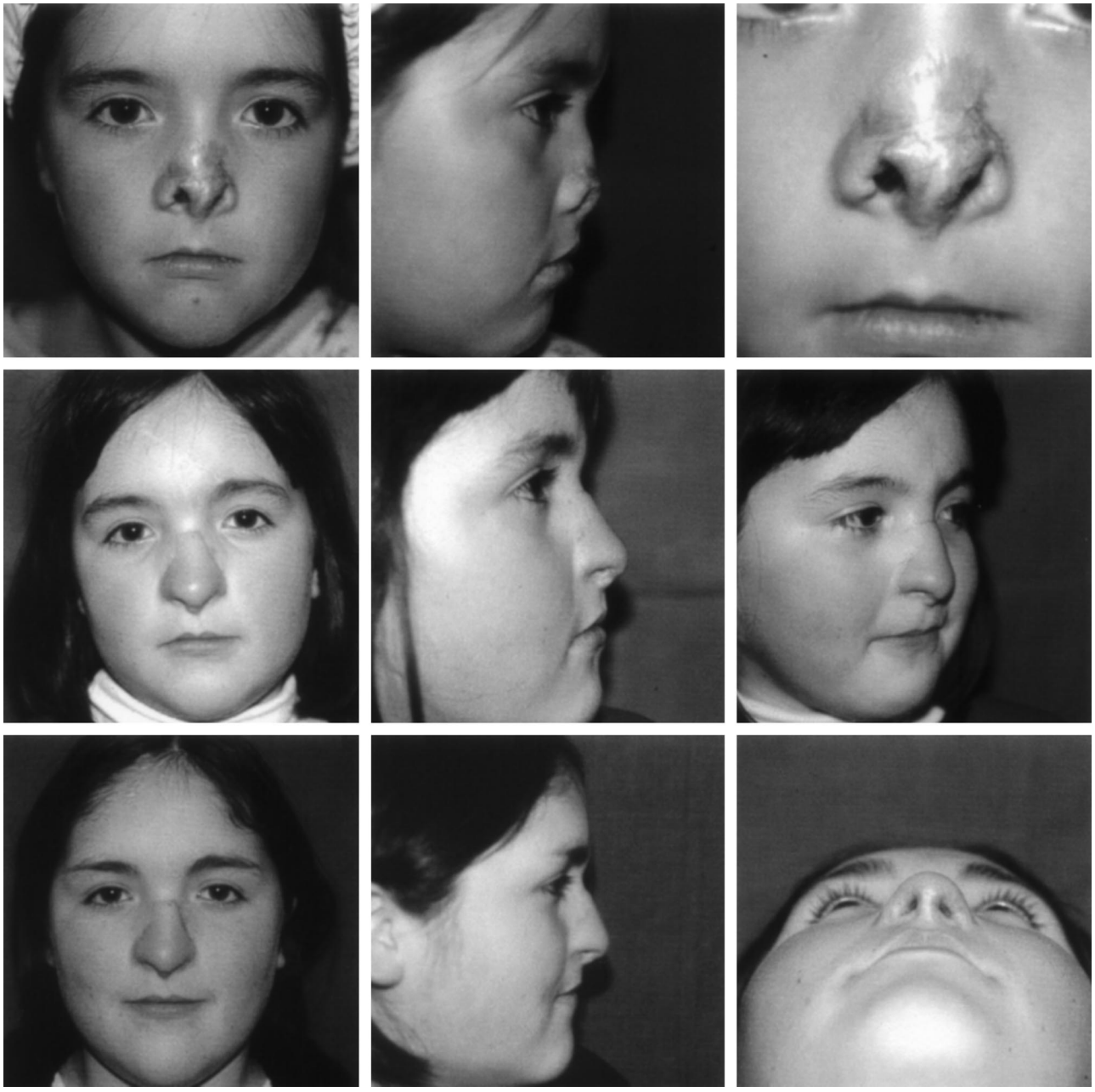

FIG. 4. Patient 5. (*Above*) Tip and right and left alas were affected in more than 50 percent. Dorsum was affected in less than 50 percent. Complete tip and alas and partial dorsum were reconstructed. Results after 1 (*center*) and 6 years (*below*). See text for detailed information.

site with which to resurface the nose. Lately, some reports have noted better aesthetic results with nasolabial flaps,[41,42] but this has not yet been demonstrated in children. The forehead flap in children is the best choice when at least one of the three subunits needs to be repaired entirely or when a full-thickness injury with cartilage or internal lining exposure is present. This is the most difficult and important decision during reconstruction, considering the small nose size and sometimes-undefined subunit limits.

The opposite paramedian oblique forehead flap was performed based on the child's short forehead, to avoid the hairline and to obtain a larger flap with better caudal advancement.[43] We use tissue expansion only in special cases in which a large defect with a proportional small donor site needs to be covered (cases 4, 8, and 10).[44,45] Despite the controversy,[37] we believe

FIG. 5. Patient 6. (*Above*) The tip was affected in less than 50 percent and the right ala in more than 50 percent. Complete ala and partial tip were reconstructed. (*Below*) Results after 4 years. See text for detailed information.

expansion provides a safe flap in difficult cases.[46]

The main concern with support is its growth capacity after grafting. Burget and Menick outlined that nonvascular transplantation will result in flap growth over the underlying support growth.[13] However, the use of bone and cartilage grafts have been used for cleft lip rhinoplasty, with excellent immediate and long-term results and no growth alterations.[47] Studies in framework growth after microtia reconstruction have also demonstrated that grafted cartilage grows with rates that are very similar to normal ears.[48–50] Consequently, there should be no differences with cartilage grafts placed on the nose. These findings enhance the idea of complete reconstruction before the child is school aged.

The many techniques for internal lining when applied to children will damage growth centers, leaving only a few options for reconstruction.[37] Nostril stenosis in two patients with a folded forehead flap in the absence of an intermediate operation became a major concern. We performed a 360-degree undermining of the vestibular mucosa, preserving perichondrium (Fig. 2), with one mild stenosis in the second group of patients. We did not use skin grafts, but they may be considered as a good alternative if placed in a vascularized bed.[38]

CONCLUSIONS

Our results show no donor-site morbidity and no flap necrosis. In patient 8, in whose case a double expanded forehead flap[51] was used, a partial distal necrosis was observed on the flap for eyebrow coverage. The learning curve is obvious when reviewing our results. Our poorer results in the first patients consistently improved with time. The main reasons for these improvements were the elimination of the folded forehead flap for internal lining and the intermediate procedure added to thin the flap.[38] The surgeon's score shows a demand for better outcome

FIG. 6. Patient 7. (*Above*) The tip was affected in 100 percent. No other subunits were affected. The complete tip was reconstructed. (*Below*) Results after 4 years. See text for detailed information.

despite objective evaluation and subjective data from patients and relatives that demonstrate good results. However, we will have to wait until these children become adults to see the definitive results.

Carlos Giugliano, M.D.
Avenida Kennedy 4917, D.1702
Las Condes, Santiago, Chile
doctor@carlosgiugliano.cl

REFERENCES

1. Calderón, W. Historia de la Cirugía Plástica Mundial. In W. Calderón and A. Yuri (Eds.), *Cirugía Plástica*, Vol. 1, 1st Ed. Santiago: Sociedad de Cirujanos de Chile, 2001.
2. McDowell, F., Valone, J. A., and Brown, J. B. Bibliography and historical note on plastic surgery of the nose. *Plast. Reconstr. Surg.* 10: 149, 1952.
3. Mazzola, R. F., and Marcus, S. History of the nasal reconstruction with particular emphasis on the folded forehead flap technique. *Plast. Reconstr. Surg.* 72: 408, 1982.
4. Boyd, C. M., Baker, S. R., Fader, F. D., Wang, T. S., and Johnson, T. M. The forehead flap for nasal reconstruction. *Arch. Dermatol.* 136: 1365, 2000.
5. Kazanjian, V. N. The repair of nasal defects with a median forehead flap: Primary closure of the forehead wound. *Surg. Gynecol. Obstet.* 83: 37, 1946.
6. Quatela, V. C., Sherris, D. A., and Rounds, M. F. Esthetic refinements in forehead flap nasal reconstruction. *Arch. Otolaryngol. Head Neck Surg.* 121: 1106, 1995.
7. Millard, D. R. Aesthetic reconstructive rhinoplasty. *Clin. Plast. Surg.* 8: 169, 1981.
8. González-Ulloa, M., Castillo, A., Stevens, E., Alvarez Fuertes, G., Leonelli, F., and Ubaldo, F. Preliminary study of total restoration of the facial skin. *Plast. Reconstr. Surg.* 13: 151, 1954.
9. Burget, G. C., and Menick, F. J. The subunit principle in nasal reconstruction. *Plast. Reconstr. Surg.* 76: 239, 1985.
10. Burget, G. C. Aesthetic restoration of the nose. *Clin. Plast. Surg.* 12: 463, 1985.
11. Burget, G. C., and Menick, F. J. Nasal support and lining: The marriage of beauty and blood supply. *Plast. Reconstr. Surg.* 84: 189, 1989.
12. Menick, F. Aesthetic refinements in use of forehead for nasal reconstruction: The paramedian forehead flap. *Clin. Plast. Surg.* 17: 607, 1990.
13. Burget, G. C., and Menick, F. J. (Eds.). *Aesthetic Reconstruction of the Nose.* St. Louis, Mo.: Mosby Year Book, 1994. Pp. 463-524.
14. How, X. K., Lui, Y. Y., Luo, S. J., et al. Repair of severe tissue loss and deformity of maxillofacial area. *Ann. Plast. Surg.* 15: 501, 1985.
15. Zuker, R. M., Capek, L., and de Haas, W. The expanded forehead scalping flap: A new method of total nasal reconstruction. *Plast. Reconstr. Surg.* 96: 155, 1996.

FIG. 7. Patient 8. (*Above*) Only the dorsum subunit was affected in more than 50 percent. Complete dorsum was reconstructed. (*Below*) Results after 3 years. See text for detailed information.

16. Meyer, R. Total external and internal construction in arhinia. *Plast. Reconstr. Surg.* 99: 534, 1997.
17. Pittet, B., and Montandon, D. Nasal reconstruction in children: A review of 29 cases. *J. Craniofac. Surg.* 9: 522, 1998.
18. Nagase, T., Kobayashi, S., and Ohmori, K. Achieving natural shading of the nostril in the reconstruction of a half nose. *Br. J. Plast. Surg.* 51: 131, 1998.
19. Miller, P. J., Hertler, C., Alexiades, G., and Cook, T. A. Replantation of the amputated nose. *Arch. Otolaryngol. Head Neck Surg.* 124: 907, 1998.
20. Strasser, E. J. An objective grading system for the evaluation of cosmetic surgical results. *Plast. Reconstr. Surg.* 104: 2282, 1999.
21. Strasser, E. J. Application of an objective grading system for evaluation of cosmetic surgical results. *Plast. Reconstr. Surg.* 109: 1733, 2002.
22. Millard, D. R. Hemirhinoplasty. *Plast. Reconstr. Surg.* 40: 440, 1967.
23. Enlow, D. H. (Ed.). *Handbook of Facial Growth*. Philadelphia, Pa.: Saunders, 1982. Pp. 10-50.

FIG. 8. Patient 10. (*Above, second row, and third row*) Tip, dorsum, and left ala were affected in more than 50 percent. Complete tip, dorsum, and left ala were reconstructed. (*Below*) Results after 6 months of follow-up. See text for detailed information.

24. Farkas, L., Posnick, J., Hreczko, T., et al. Growth patterns of the nasolabial region: A morphometric study. *Cleft Palate Craniofac. J.* 29: 318, 1992.
25. Dufresne, C. R., and Manson, P. Facial trauma in the child. In J. McCarthy (Ed.), *Plastic Surgery: The Face*. Vol. 1, 2nd Ed. Philadelphia, Pa.: Saunders, 1990.
26. Ortiz-Monasterio, F., and Olmedo, A. Corrective rhinoplasty before puberty: A long-term follow-up. *Plast. Reconstr. Surg.* 68: 381, 1981.
27. Manson, P. Facial trauma. In J. McCarthy (Ed.), *Plastic Surgery: The Face*, Vol. 1, 2nd Ed. Philadelphia, Pa.: Saunders, 1990.

28. Pinckney, L., and Kennedy, L. Traumatic deaths from dog attacks in the United States. *Pediatrics* 69: 193, 1982.
29. Avner, J., and Baker, D. Dog bites in urban children. *Pediatrics* 88: 55, 1991.
30. Rohrich, R., and Reagan, B. Man's best friend revisited: Who is watching the children? *Plast. Reconstr. Surg.* 103: 2067, 1999.
31. Beg, M. H. Half nose. *J. Laryngol. Otol.* 98: 915, 1984.
32. Gifford, G. H., Swanson, L., and MacCollum, D. Congenital absence of the nose and anterior nasopharynx. *Plast. Reconstr. Surg.* 50: 5, 1972.
33. McCarthy, J., Buroud, L., and Schreiber, J. Hemangiomas of the nasal tip. *Plast. Reconstr. Surg.* 109: 31, 2002.
34. Warren, S., Longaker, M., and Zide, B. The subunit approach to nasal tip hemangiomas. *Plast. Reconstr. Surg.* 109: 25, 2002.
35. Gur, E., and Zucker, R. Complex facial nevi: A surgical algorithm. *Plast. Reconstr. Surg.* 106: 25, 2000.
36. English, J. M., and Barton, F. Nasal reconstruction. *Select. Read. Plast. Surg.* 8: 1, 1997.
37. Muzzaffar, A., and English, J. M. Nasal reconstruction. *Select. Read. Plast. Surg.* 9: 1, 2000.
38. Menick, F. A 10-year experience in nasal reconstruction with the three-staged forehead flap. *Plast. Reconstr. Surg.* 109: 1839, 2002.
39. Park, S. Reconstruction of nasal defects larger than 1.5 centimeters in diameter. *Laryngoscope* 110: 1241, 2000.
40. Burget, G., and Menick, F. Nasal reconstruction: Seeking a fourth dimension. *Plast. Reconstr. Surg.* 78: 145, 1986.
41. Uchiama, E., Matsui, K., Shimakura, Y., et al. Evaluation of the median forehead flap and the nasolabial flap in nasal reconstruction. *Aesthetic Plast. Surg.* 21: 86, 1997.
42. Arden, R., Nawroz-Danish, M., Yoo, G., et al. Nasal alar reconstruction: A critical analysis using melolabial island and paramedian forehead flap. *Laryngoscope* 109: 376, 1999.
43. Friduss, M., Dagum, P., Mandych, A., et al. Forehead flap in nasal reconstruction. *Otolaryngol. Head Neck Surg.* 113: 740, 1995.
44. Adamson, J. Nasal reconstruction with the expanded forehead flap. *Plast. Reconstr. Surg.* 81: 12, 1988.
45. Fan, J. A new technique of scarless expanded forehead flap for reconstructive surgery. *Plast. Reconstr. Surg.* 106: 777, 2000.
46. De Filippo, L., and Atala, A. Stretch and growth: The molecular and physiologic influences of tissue expansion. *Plast. Reconstr. Surg.* 109: 2450, 2002.
47. Ortiz-Monasterio, F., and Ruas, E. Cleft lip rhinoplasty: The role of bone and cartilage grafts. *Clin. Plast. Surg.* 16: 177, 1989.
48. Tanzer, R. Microtia: A long term follow up of 44 reconstructed auricles. *Plast. Reconstr. Surg.* 61: 161, 1978.
49. Brent, B. Auricular repair with autogenous cartilage grafts: Two decades of experience with 600 cases. *Plast. Reconstr. Surg.* 99: 355, 1992.
50. DellaCroce, F., Green, S., and Aguilar, F. Framework growth after reconstruction for microtia: Is it real and what are the implications. *Plast. Reconstr. Surg.* 108: 1479, 2001.
51. Furuta, S., Hayashi, M., and Shinohara, H. Nasal reconstruction with an expanded dual forehead flap. *Br. J. Plast. Surg.* 53: 261, 2000.