

Pediatric Mandibular Resection and Reconstruction: Long-Term Results with Autogenous Rib Grafts

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ABSTRACT

Reconstruction of mandibular defects following tumor resection in infants is a particular challenge. Although autogenous rib grafts have no relevance in the restoration of mandibular bone defects occurring after ablative tumor surgery due to limited bone stock and the availability of other donor areas, they are a useful surgical alternative following tumor surgery in infants. We here report on a 2, 5, 8, and 15-year follow-up of four children who were diagnosed with benign tumors of the mandible with osseous destruction at the age of 4, 6, 15, and 18 months, respectively. Histologic diagnoses were melanotic neuroectodermal tumor ($n=2$), hemangioendothelioma of the mandible ($n=1$), and ameloblastoma ($n=1$). Following continuity resection of the mandible, lateromandibular bone defects were restored using autogenous rib grafts. Both clinical and radiologic follow-up visits were performed for all children to assess growth of the facial skeleton and the mandible. One child was already further reconstructed using bone augmentation at the age of 15 years. Cephalometric measurements on panorex films and three-dimensional computed tomographic scans revealed a slight vertical growth excess and transversal growth inhibition of the reconstructed mandible compared with the nonoperated side. Although further growth of rib grafts is difficult to predict and occlusal disharmony may occur due to physiologic maxillary growth and growth of the unaffected mandible, we believe that autogenous rib grafts can be ideally used for the restoration of mandibular continuity defects in newborns and young children. Clinical follow-up visits on a yearly basis and orthodontic controls are useful for early orthodontic treatment of growth deficits. Further corrective surgery with bone augmentation or osseous distraction is required following completion of growth of the facial skeleton.

KEYWORDS: Mandibular reconstruction, rib graft, facial growth, bone graft, pediatric maxillofacial tumor

Mandibular tumors requiring continuity resection have a relatively low incidence during infancy and childhood.¹⁻³ Therefore, only few publications on mandibular restoration and reconstruction of the growing

facial skeleton are available and, in particular, clinical data on long-term follow-up of patients are limited.⁴⁻⁸ Restoration of mandibular continuity defects following ablative surgery in infants is a particular surgical challenge

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Craniomaxillofac Trauma Reconstruction 2010;3:25-32. Copyright

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Received: August 9, 2009. Accepted after revision: September 26, 2009. Published online: March 11, 2010.

DOI: <http://dx.doi.org/10.1055/s-0030-1249371>.

ISSN 1943-3875.



Figure 1 (A, B) Six-month-old infant with a progressively growing tumor of the left mandible. Incisional biopsy revealed a melanotic neuroectodermal tumor.

because all those donor areas routinely used in adults (iliac crest, fibula) are not available in young infants. Furthermore, there is general consensus that micro-surgically revascularized bone transplants are not indicated in infancy, in particular due to unknown or unpredictable growth inhibition or uncompleted ossification at the time of surgery. In this situation, autogenous rib grafts, although they do not play a role in mandibular reconstruction in adults due to limited bone stock, offer an ideal possibility of mandibular bony restoration in infants in view of functional and aesthetic aspects. This report describes the surgical challenge of treatment of mandibular defects in four infants and the successful mandibular restoration using autogenous rib grafts. In particular, two clinical long-term results at 8 and 15 years underline the usefulness of rib grafts as a surgical alternative for the restoration of large mandibular defects.

CASE REPORTS

Case No. 1

A progressively growing tumor of the left mandible with osseous destruction was diagnosed in a 6-month-old female infant (Fig. 1A and B). Extraorally, a tumor of the left buccal and paramandibular region was present (Fig. 1A). Intraorally, a large reddish tumor mass of the left lower alveolar crest with a dislocated primary molar was visible (Fig. 1B). Biopsy revealed a melanotic neuroectodermal tumor with infiltration of the left mandible. Following complete diagnostic evaluation, tumor resection with mandibular continuity resection and exarticulation was performed using a submandibular approach.

The bony defect of the mandible was primarily reconstructed using two autogenous rib grafts (Fig. 2). Fixation of the rib grafts was performed using resorbable Vicryl sutures. The postoperative course was completely uneventful, and the infant recovered quickly from surgery. Up to now, regular clinical and radiologic follow-up visits for mandibular growth assessment took place over a 15-year period. Panorex films taken yearly, starting from the age of 2 years, revealed a slight vertical overgrowth of the reconstructed left mandible and a slight transversal growth inhibition. For comparative analysis, the distances condyion–gonion, gonion–gnathion, gonion–midline, and condyion–gnathion were measured (Fig. 3A–C). The calculated ratio of these distances can be interpreted as an indication of growth

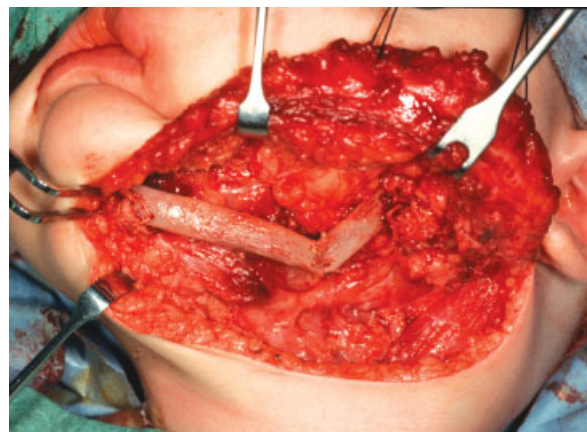


Figure 2 The tumor was completely resected with exarticulation of the left condyle using a combined transoral–submandibular approach. The large mandibular defect was reconstructed with two rib grafts.

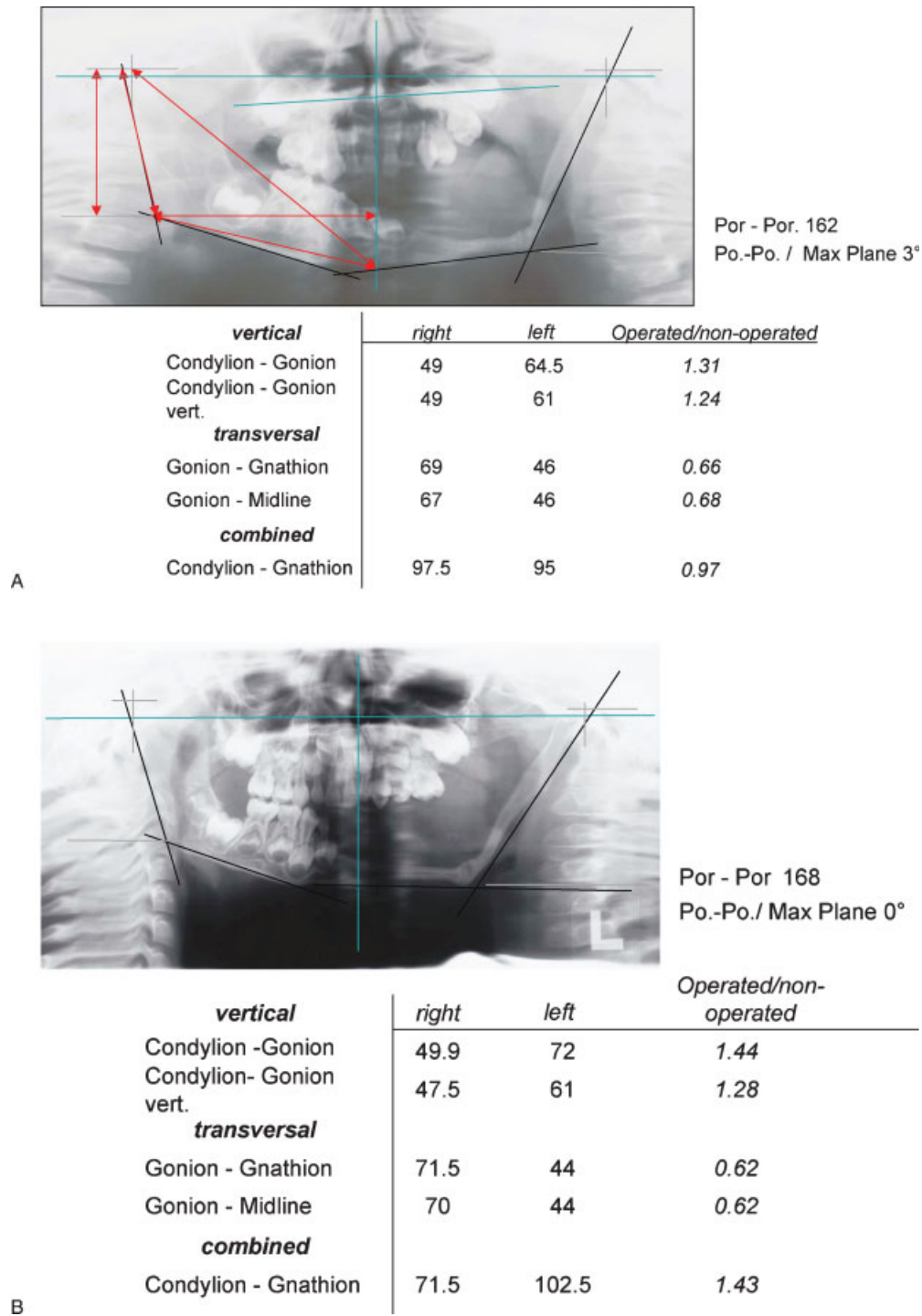
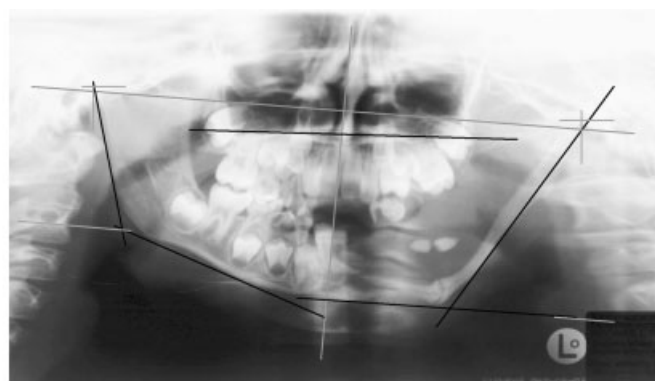


Figure 3 (A–C) Panorex films taken at 2, 3, and 6 years postoperatively and cephalometric analysis show good bone healing of the rib grafts with a tendency to vertical overgrowth of the reconstructed left mandible and transversal growth inhibition.

excess or growth inhibition (ratio > 1 = growth excess, ratio < 1 = growth inhibition). Cephalometric analysis revealed some vertical growth excess and transversal growth inhibition at 2 (Fig. 3A), 3 (Fig. 3B), and 6 years (Fig. 3C). Active ongoing orthodontic treatment started at the age of 9 years. At present, at the age of 15 years, the child presented with markable facial contour deficit

(Fig. 4A) and returned for lateral mandibular bone augmentation. Following initial preoperative virtual planning of the left mandibular bone defect, bone augmentation was performed from a submandibular approach. Intraoperatively, the rib graft was still in place with perfect bone healing and no signs of resorption. Exact placement of the autogenous bone grafts was



Por - Por 174
Po.-Po./Max Plane 3°
Operated/non
operated

	<i>right</i>	<i>left</i>	
vertical			
Condylion - Gonion	53	81	1.52
Condylion - Gonion vert.	51	72	1.41
transversal			
Gonion - Gnathion	71	40.5	0.57
Gonion - Midline	68	40.5	0.59
combined			
Condylion - Gnathion	108	105	0.97

C

Figure 3 (Continued)

achieved using intraoperative navigation (Fig. 4B and C). Compared with the preoperative facial appearance (Fig. 4A), an improved left facial contour was achieved (Fig. 4D). Further dental rehabilitation with implants will follow.

Case No. 2

A 4-month-old male infant was diagnosed with a rapidly growing tumor of the right mandible. Radiologic diagnosis showed an extensive osteolytic tumor of the right horizontal mandibular ramus (Fig. 5). Incisional biopsy revealed the rare diagnosis of an intraosseous heman-gioendothelioma of the mandible. With regard to the unpredictable biological behavior of this tumor, radical tumor resection with continuity resection of the mandible was performed. Intraoperatively, the right condyle did not show tumor infiltration and could be preserved. The mandibular bone defect was primarily reconstructed using two autogenous rib grafts. The postoperative clinical course was completely uneventful. Both rib grafts were taken without any problems. Parallel to yearly clinical follow-up visits, computed tomographic (CT) scans of the reconstructed mandibular region were taken. At the age of 5 years after mandibular resection and reconstruction, the child shows a good cosmetic and functional result with undisturbed growth of the facial skeleton (Fig. 6A and B). In addition, orthodontic care has been initiated for continuous assessment of the

growth of the mandible and facial skeleton. Further mandibular bone augmentation will be required on complete growth of the facial skeleton.

Case No. 3

A 2-year-old girl from Algeria was referred to our institution for further diagnosis and treatment of a slowly growing tumor of the right mandible. The girl had a 2-year history of a slowly growing mandibular tumor. According to her parents, an incisional biopsy was taken in a local hospital in Algeria more than a year ago without further advice for additional surgical treatment. On clinical examination, a firm tumor of the right mandible extending from the lower right incisor to the mandibular angle was diagnosed. Intraorally, an exophytic tumor mass of the right horizontal mandibular ramus was seen (Fig. 7A). Radiologically, CT scans showed extensive bony destruction of the right mandible extending up to the coronoid process (Fig. 7B and C). Surgical biopsy revealed an ameloblastoma of the right mandible. Subsequently, a radical tumor resection with mandibular continuity resection was performed using a combined submandibular/transoral approach (Fig. 8A and B). For restoration of mandibular bone continuity, two rib grafts were harvested and graft fixation to the remaining mandible was performed using 1.5 mm titanium miniplates. An immediate postoperative CT scan showed adequate anatomic reconstruction of the

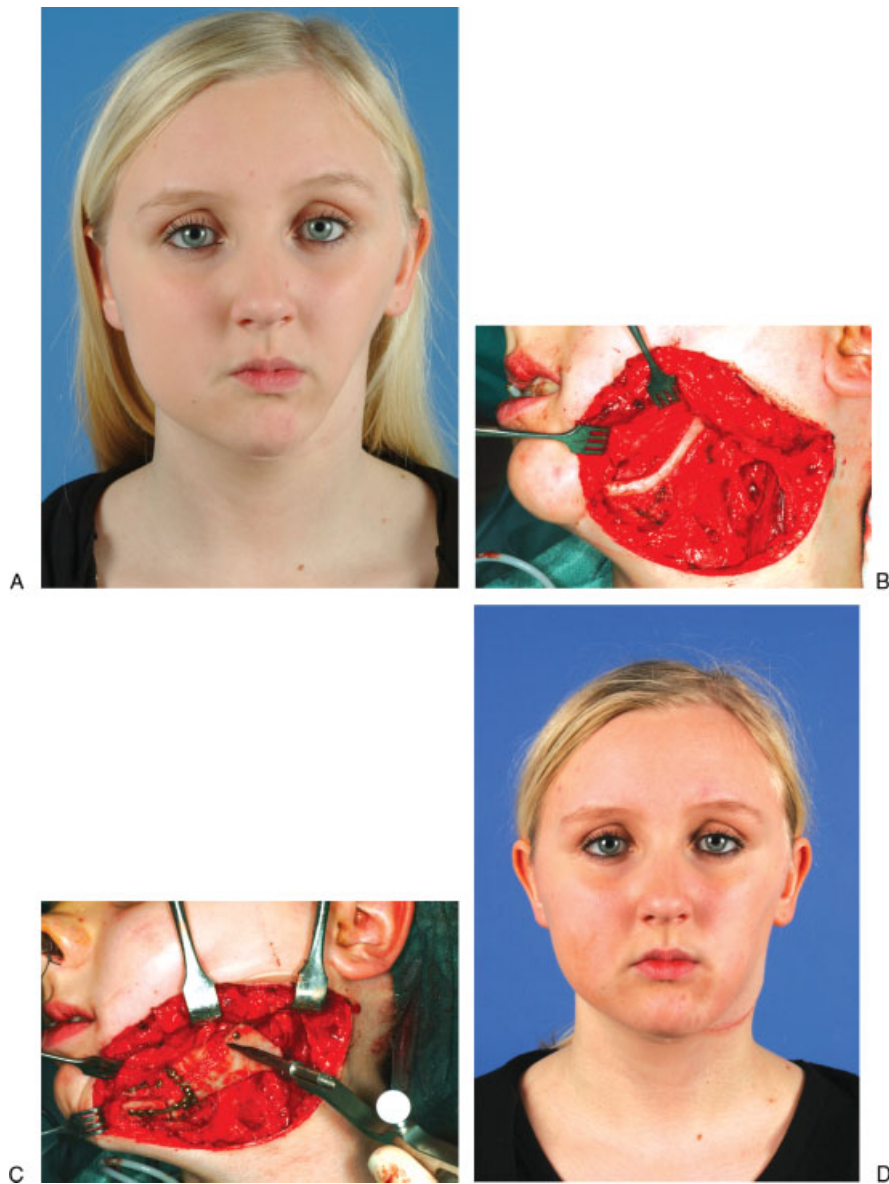


Figure 4 Preoperative frontal photo shows some facial contour deficit of the patient at the age of 15 years (A) compared with an improved facial contour shown on the postoperative photo (D). Intraoperative view demonstrates good incorporation of the rib graft after 15 years (B). Left mandibular contour restoration and augmentation using autogenous bone grafts from the iliac crest (C).

mandibular bone defect (Fig. 9A). With an uneventful postoperative course, the girl was discharged from hospital on the 10th postoperative day. A follow-up visit 4 weeks postoperatively showed good cosmesis and facial symmetry (Fig. 9B). A follow-up after 5 years showed stable results of the reconstructed mandible; the girl is also under regular orthodontic control.

Case No. 4

A 15-month-old boy from Russia was referred to our institution. He was diagnosed with a rapidly growing tumor of the right mandible (Fig. 10A); intraoral incisional biopsy revealed a melanotic neuroectodermal tumor of infancy. Three-dimensional CT scans showed

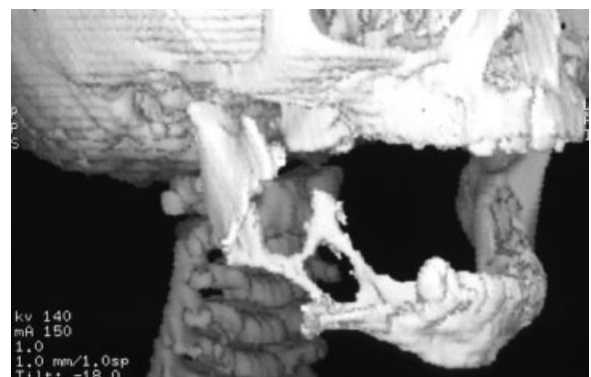


Figure 5 Three-dimensional computed tomographic (3D-CT) scan of a 4-month-old boy with extensive bony destruction of the right mandible.



Figure 6 Frontal photograph of the boy at the age of 5 years showing good cosmesis and facial symmetry (A). Corresponding three-dimensional computed tomographic (3D-CT) scan shows good bone healing of the rib graft (B).

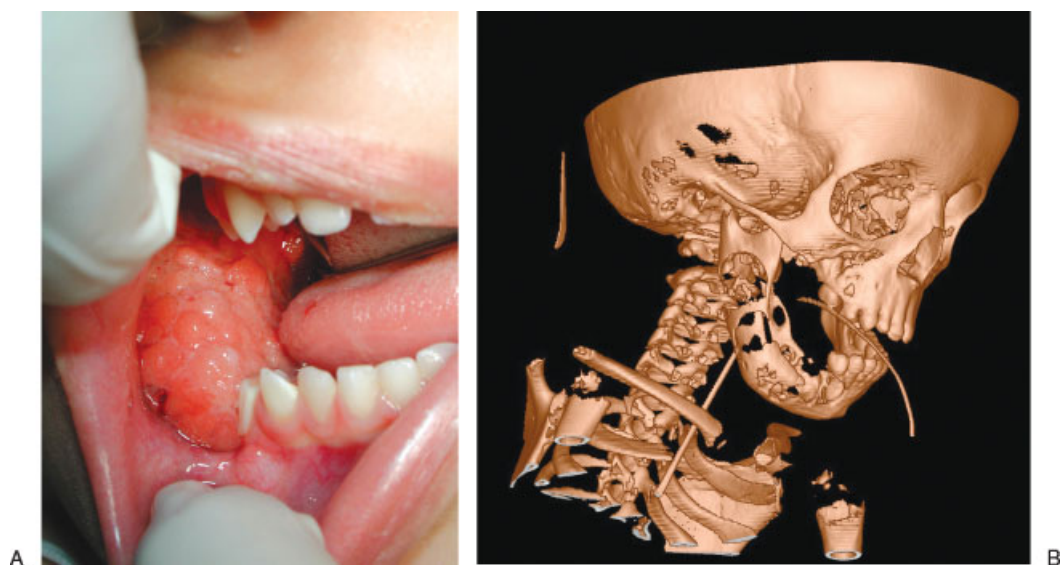


Figure 7 Intraoral view of a slowly growing mandibular tumor (A) in a 2-year-old girl with extensive bony destruction of the right mandibular body and ascending ramus (B). Histology revealed mandibular ameloblastoma.

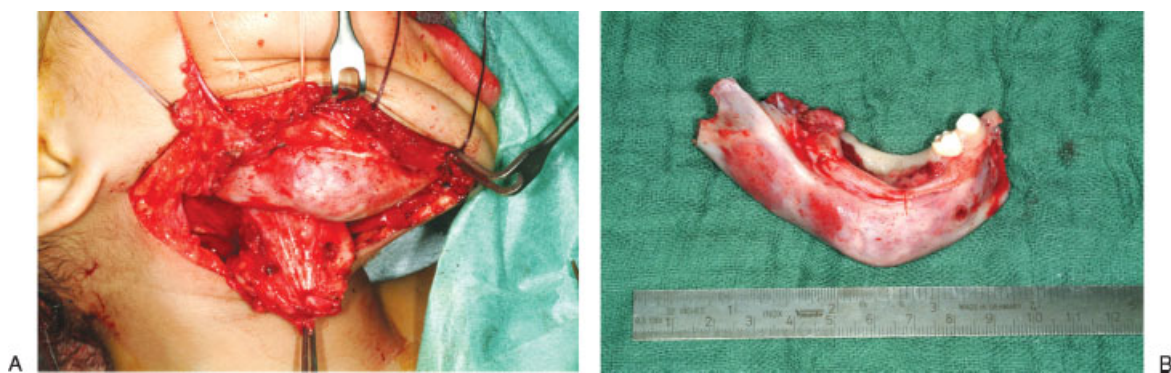


Figure 8 The tumor was completely resected using a combined transoral–submandibular approach (A). (B) The resection specimen; the right condyle was left in place. Two rib grafts were harvested and used for mandibular reconstruction; fixation was performed using titanium miniplates.



Figure 9 Three-dimensional computed tomographic (3D-CT) scan on postoperative day 1 shows good projection and anatomic reconstruction of the rib grafts used for reconstruction of a large mandibular defect (A). Good facial symmetry and cosmesis at a 4-week follow-up visit (B).

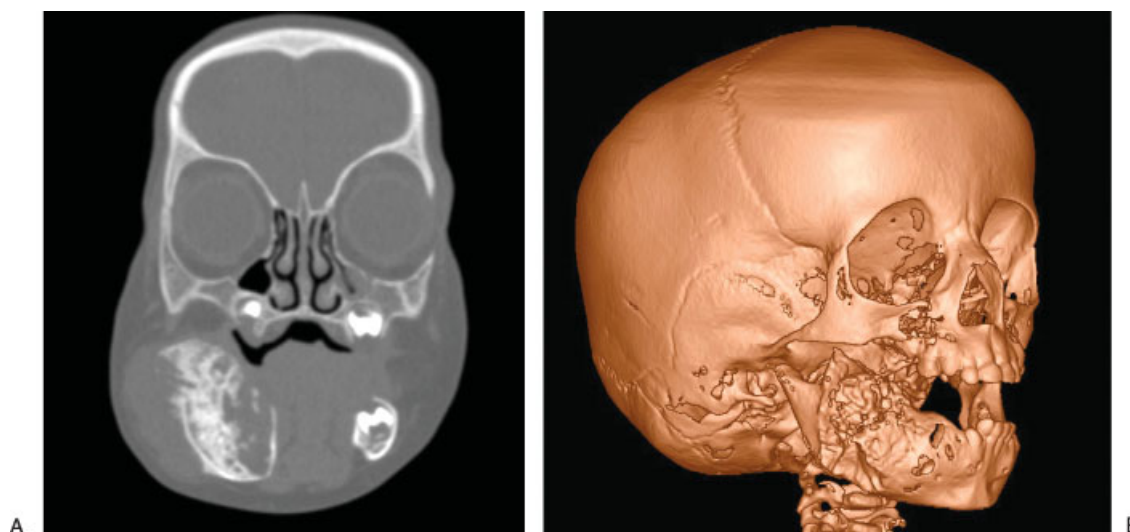


Figure 10 (A, B) Extensive bony destruction of the right mandibular body and ascending ramus in a 15-month-old boy.

extensive bony destruction of the right mandible (Fig. 10B). Subsequently, the tumor was explored using a transoral/submandibular approach (Fig. 11A) and partial mandibular resection was performed with imme-

diately defect restoration using two autogenous rib grafts. Graft fixation was performed using titanium micro-plates. Following an uneventful postoperative course, the child returned 6 months after initial surgery and

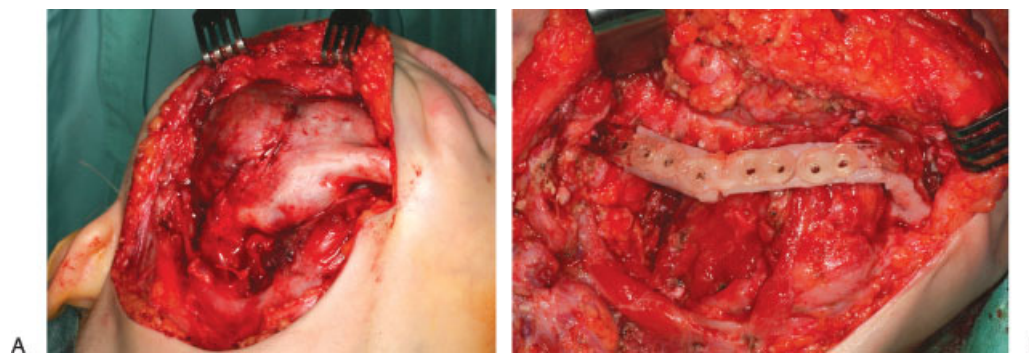


Figure 11 Intraoperative exploration of the extensive mandibular tumor using a submandibular/transoral approach (A). Following tumor resection, rib graft fixation was achieved using resorbable plate system (Sonic Weld) (B).

presented with local tumor recurrence. The boy underwent immediate surgery with resection of the tumor recurrence together with the reconstructed mandible. The resulting defect was primarily reconstructed with two autogenous rib grafts; graft fixation was achieved with resorbable plates (Sonic Weld; KLS Martin, Tuttlingen, Germany) (Fig. 11B). With an uneventful postoperative course, the patient returned to his home country, where further follow-up visits by referring physicians are being organized.

DISCUSSION

With regard to time point, size, and localization, acquired mandibular defects may result in various asymmetries of the mandible and irreversible functional deficits can be expected.⁹ Reconstructive surgery in the growing facial skeleton is challenging, because particular parts of the facial skeleton have to be replaced by transplants that do not grow in the same fashion as the remaining normal-growing bone. Because of the biological behavior of particular tumors, such operations cannot be postponed and require some surgical alternatives,¹⁰ which need to be discussed in view of growth-related changes of the mandible. There is general agreement that alloplastic materials for the restoration of mandibular bone defects are not indicated during the active growth phase in infancy and childhood.¹¹ In general, various donor sites (rib graft, free and revascularized iliac crest, revascularized fibula) are available for the restoration of mandibular continuity defects. Requirements for particular bone grafts have to take into account patient's age at the time of reconstruction and the amount of bone for complete restoration of the defect.¹² Although spontaneous bony regeneration has been reported if the adjacent periosteum remains intact,¹³ this condition cannot always be realized if radical ablative surgery is required. The main selection criteria for a rib graft as donor site in our four patients were the young age and the expected morbidity of other donor site areas like iliac crest and fibula. An intact cartilaginous apophysis of the iliac crest is required during the first decade of life to prevent local ossification disturbances after bone harvesting. With regard to an optimal age for successful revascularized bone transfer, there is no general agreement. Although Posnick et al¹⁴ reported on fibula transfer in children at the age of 5.5 to 9 years, an early partial resection of the fibula carries the risk of deformity of the ankle joint.¹⁵ We are convinced that the selection of autogenous rib grafts in infancy has a solid foundation and respects all biological properties of the various donor sites in this early phase of life. Although the rib graft has a limited bone stock and will not grow in the same fashion as the

normal remaining mandibular bone, we were able to demonstrate that severe deformities and dysfunction can be prevented. Our four patients clearly demonstrate that autogenous rib grafts for mandibular restoration in infancy are reliable and a useful surgical alternative. The rib graft was stable with minimal or no signs of resorption even after 15 years. Further bone augmentation was successfully performed in one child as a next step toward dental rehabilitation. Such results can be achieved within coordinated interdisciplinary approach between the orthodontist and the maxillofacial surgeon.

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