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Scientific Foundations

Single-Stage Craniofacial Distraction Using Resorbable Devices

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We report on the use of a new type of internal bone distraction devices designed for craniofacial applications. These resorbable devices allow a single operative procedure for device placement, eliminating the need for a second open operative procedure for hardware removal. We report on three models of resorbable devices. The midface orbital frontal device was used for midface and monoblock advancement. The mandibular adolescent device was used in older children and adolescents. In neonates and young children, the mandibular infant device was used. Twenty-one patients (9 female, 12 male) aged 6 days to 15 years (mean = 53 months) underwent bony expansion of the craniofacial skeleton over a 2-year period. A total of 39 devices were implanted: 32 in the mandible, 3 in the maxilla alone, and 4 in the maxilla and frontal bones. Expansion distances ranged from 15 to 30 mm. Expansion took place at 1 to 2 mm/d. Latency periods ranged from 48 to 72 hours. There were no device structural failures and no major complications.

Key Words: Craniofacial distraction, biodegradable devices, poly L-lactic acid

There have been many advances in bone expansion of the craniofacial skeleton since McCarthy et al[1] reported on human mandibular distraction osteogenesis in 1992. Early external devices were cumbersome and were subject to external trauma and pin site infections. In addition, the pins tracking through the skin often resulted in scar disfigurement. Subsequently, several authors reported on buried maxillofacial distraction devices, which minimized external scars and wound care.[2–4,5] Although these internal devices were beneficial in terms of patient acceptance and decreased morbidity, they required a second open operative procedure for removal. Fibrous and sometimes bony ingrowth over the internal expansion devices made removal of these devices a formidable task.

Biodegradable hardware has largely replaced metallic and titanium implants in pediatric craniofacial applications.[6,7] Recently, Cohen et al [8] reported on a new partly biodegradable midface distraction device. This device requires a second operative procedure for partial removal and stabilization. Building on the advances in biodegradable plates and internal distraction technology, we began to investigate the possibility of developing a single-stage class of distraction devices in 1998. These efforts resulted in the development of three types of one-stage resorbable devices based on LactoSorb resorbable implant technology (Walter Lorenz Surgical, Jacksonville, FL). The first device we developed and used clinically was designed to allow distraction of the midface, orbits, and frontal bone (MOF device). The second device was a mandibular adolescent (MA device) suitable for older children and adolescents with adequate bone mass. The third device was specifically designed to allow for mandibular distraction in neonates, infants, and young children (MI device) having a relatively small amount of mandibular bone mass. We report on our experience with this new class of devices in 21 patients over 24 months.

MATERIALS AND METHODS

Twenty-one patients underwent bony expansion over a 24-month period. Table 1 gives detailed patient data and indications for bone expansion. Seventeen patients underwent mandibular expansion, 1 underwent maxillary expansion, 1 had unilateral

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Table 1. Patient Data and Indications for Bone Expansion

Diagnosis	*Number of Patients*	*Type of Expander*	*Distraction Mean (mm)*	*Distraction Range (mm)*	*Wound Complications*
Pierre Robin syndrome	7	MI	17 mm	15–20	—
Craniofacial Microsomia	6	MI, MA	17 mm	15–20	2
Midface hypoplasia	3	MOF	27 mm	25–30	1
Treacher Collins	2	MA	28 mm	25–30	—
Nagers	1	MA	25 mm	25	—
Mandibular hypoplasia	2	MI, MA	23 mm	20–25	1

MA = mandibular adolescent device; MI = mandibular infant device; MOF = midface, orbits, and frontal bone device.

mandibular expansion and maxillary expansion, and 2 had monoblock advancement of the midface orbits and frontal bone.

Each type of expander consists of three parts, which vary in size and shape according to their intended application (Figs 1–3). There is a proximal plate for anchoring the device proximal to the osteotomy, a distal plate attached to the segment that is to be distracted, and a drive screw that joins the two. The proximal plate contains a threaded housing through which the expansion screw passes to join the distal plate. The expansion screw has several features. The proximal end is attached to a plastic-coated flexible cable that has a hexagonal distal end, where the expansion driver fits. The cables are available in various lengths. The central segment is threaded from the cable attachment to the distal tip, which is of slightly smaller diameter than the threaded shaft. The distal tip fits into a smooth receptacle in the center of the distal attachment plate, allowing it to turn freely as it pushes the distal plate forward during the expansion process.

Patients underwent general endotracheal anesthesia, and a cephalometric radiograph was obtained. The midface was approached through a combination of temporal incisions and intraoral incisions as has been previously described.[3] The two patients who underwent monoblock osteotomies had a combination of coronal and intraoral incisions as has been previously described.[4] The same device was used for midface and monoblock distraction (see Fig 3). The distal U-shaped plate was modified by trimming the upper limb of the plate for midface distraction applications. In the monoblock application, the upper limb was attached to the lateral orbital rim and frontal bone, whereas the lower limb was attached to the lateral and anterior maxilla.

All mandibular osteotomies were performed through small external submandibular incisions (Fig 4). The neurovascular bundle and tooth buds were

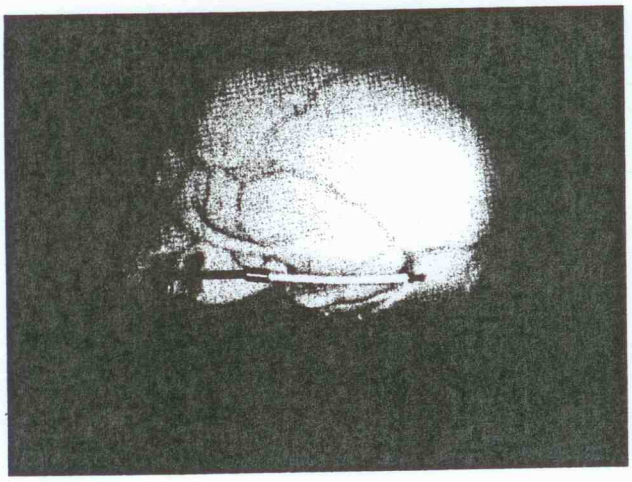

Fig 1 Mandibular infant device applied to skull model of neonate. Note narrow proximal and distal attachment plate design. The flexible expander cable (white) has been coupled to the drive screw.

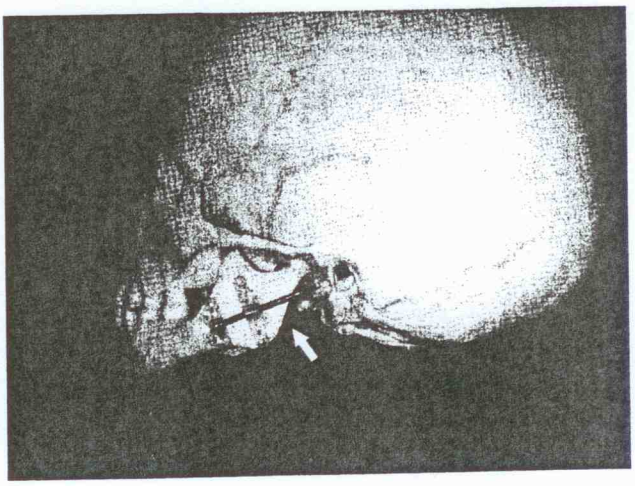

Fig 2 Mandibular infant device applied to skull model of 5-year-old child. Note wider plate design for proximal and distal attachment plates. The drive screw (arrow) has not been attached to the flexible cable.