Motorized Internal Limb Lengthening: International Perspectives

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The remote-controlled, motorized, intramedullary lengthening nail is a disruptive technology that has fundamentally changed the approach to limb lengthening and reconstruction surgery globally. This new paradigm for limb reconstruction, marked by a decreased need for external fixation, has ignited a fervor among limb deformity surgeons. Although the origins of the Ilizarov method of distraction osteogenesis are deeply entwined with circular external fixation, the disadvantages of external fixators are well known and include pin track infections, skin pain, soft-tissue tethering, and joint stiffness. Integrated fixation techniques were developed combining internal and external fixation such as lengthening over a nail, lengthening and then nailing, lengthening and then plating, and bone transport over a nail to minimize the treatment time in external fixation. Building on these incremental advances, bone lengthening with a fully implantable device has enabled us to entirely avoid external fixation in most cases. Early designs of the internal lengthening nail (ILN) were telescopic and lengthened through a ratchet mechanism requiring mechanical rotation of the limb. Issues with mechanical integrity and accurate control of distraction by these implants have vastly improved over the last decade with the latest remote-controlled ILN delivering a predictable outcome.

The remote-controlled ILN is available in different nail types with varied mechanics, material properties, and surgical indications. One design employs an electric motor imbedded into the telescopic rod, activated by intermittent transcutaneous transmission of radiofrequency waves to an implanted antennae/receiver which converts these waves into an electrical impulse discharged via a connecting cable. The second design, now most widely used in the United States, is a telescopic rod with a magnetic drive mechanism, activated by a hand-held external electromagnetic actuator. Furthermore, in addition to the functional mechanism differences, there are nails made from titanium or from stainless steel, and these have different biomechanical properties. The indications range by bone and nail orientation. The femur can be approached antegrade through a piriformis or greater trochanteric entry or can be entered retrograde. A short residual femur after amputation can be lengthened with a specially designed nail. The tibia is approached antegrade. Although the ILNs are primarily used for distraction osteogenesis bone lengthening, the magnetic ILN can also be used for compression of nonunions. In the last several years, there has been some experience with bone transport nails but recently, a motorized magnetic bone transport nail for treatment of segmental bone defects up to 10 cm has been launched, and the early experience is currently being accumulated. Creative, off-label uses of the commercially available nails have included humerus lengthening, retrograde tibia through an ankle/subtalar arthrodesis, extramedullary lengthening with a nail, and bone transport over a plate. Additional internal lengthening designs are in development including humerus nails, ankle fusion/retrograde tibia nails, and internal lengthening plates.

In the absence of angular deformity, lengthening of a long bone with the ILN is an ideal surgical indication. Rotation may be corrected over the nail. Blocking screws may be needed to prevent predictable deformities that occur during lengthening. In the presence of preoperative angular deformity, adjuvant techniques such as fixator assisted nailing and blocking screws may be utilized in many, but not all cases, to acutely correct deformity and then gradually lengthen with the ILN. With increased periosteal disruption, latency and distraction may need to be modified. In addition, a staged approach may be used where deformity correction is performed and then at a second surgery, lengthening with the ILN is done. Furthermore, a bifocal approach may be used where deformity correction is performed at one end of the bone and lengthening with the ILN is done at the other end of the bone.

The ILNs have created excitement among surgeons from separate sub specialties and diverse nationalities. Both pediatric and adult patients share common pathologies that require bone lengthening and deformity correction including congenital and posttraumatic deformity and leg length discrepancy. These pathologies have inspired global collaboration between orthopedists trained in pediatrics, trauma, foot and ankle, oncology, sports, knee/hip reconstruction, or limb deformity. Through annual meetings and a common body of literature, we all come together to teach and learn from each other.

The motorized ILN is an ingenious technology has encouraged us to build new paradigms for limb reconstruction surgery. Although there is continued need for external fixation in selected cases, the modern limb deformity surgeon will use the ILN when possible. The ILN is, however, not available yet in many developing countries. In this edition of Techniques in Orthopedics, dedicated to internal limb lengthening, we have gathered an international panel of experts to discuss specialized applications of this most recent evolution of the Ilizarov method.

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S.R.R.: with Nuvasive, Orthospin, Smith and Nephew, Stryker. A.T.F.: with Nuvasive, Depuy/Synthes.