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CORR Insights

CORR Insights®: Reamed Intramedullary Nailing has an Adverse Effect on Bone Regeneration During the Distraction Phase in Tibial Lengthening

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Where Are We Now?

How does periosteal and endosteal blood supply contribute to bone healing? It is a question posed by philosophers and scientists as far back as the 17th and 18th centuries—from Jean-Baptiste Du Hamel, to John Hunter, and Bernhard Heine.

The problem of new bone formation in fracture healing has been well evaluated: 70% to 75% of the centrifugal blood supply of the cortex derives from the nutrient artery and the epiphyseal arteries and 25% to 30% from the periosteum, as long as the muscle coverage is intact. Intramedullary reaming will destroy the intramedullary arterial network of vascularization. Cortical defects will be filled with 70% bone formation from the medullary cavity and 30% from the periosteum. An endosteum does not exist. The periosteal bone healing appears with a delay of 5 days to 7 days [3–5, 9, 10]. The conclusion is clear: Any lengthening without intramedullary reaming will result in earlier bone formation. The amount of biomechanical load transfer, however, remains unclear.

Where Do We Need To Go?

The question that still needs to be answered is quite obvious: How can we combine the most biomechanically stable fixation with the least traumatization of the vascular network? But there are other gaps in the knowledge as well. What is the best fixation for the bone after having made the osteotomy? How can we achieve a stable fixation of the fragments allowing at the same time load transmission inducing bone formation? How can we avoid destroying the vascularization?

Fracture fixation interaction and its mechanical and biological consequences are complicated and not yet fully understood. Alternative treatments include principle external fixation and intramedullary nailing. The external fixation diminishes the

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axial load acting on the mesenchymal tissue, leaves, however, the intramedullary vascularization intact. Nailing allows axial loading, but destroys the intramedullary vascular network. Therefore, one important question remains: Is intramedullary reaming in a more atraumatic way [6]—such as including the material of the implant, titanium, or stainless steel—a viable option [1, 2, 6]. The transcutaneous nailing technique might offer a way to achieve a stable fixation by a minimal invasive osteosynthesis even in open fracture treatment, a situation comparable to the osteotomy [7].

How Do We Get There?

We have to combine different methods, based on a profound knowledge on the effects of each therapy. We should: (1) Study all possibilities for the osteotomy, as opposed to cutting the nutrient artery of the bone; (2) avoid reaming in the first phase of bone formation during lengthening; (3) study bone formation dependent on the revascularization using polychromatic fluorescent labels; and (4) define the first phase for revascularization and the second phase for axial loading.

In terms of biomechanics, we can study all phases of load transfer by a gait analysis and choose the osteosynthesis appropriate to guarantee stability. One option, developed by Labitzke [8], is a spiral intramedullary nail, called the Endo-Helix, which can be introduced percutaneously by a stich incision and a drill hole in the tibial bone. The nail would find its way along the compact bone of the tibial tube and will not destroy any vasculature.

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