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CORR Insights®: Periosteal Fiber Transection During Periosteal Procedures Is Crucial to Accelerate Growth in the Rabbit Model

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Where Are We Now?

We know that excessive compressive forces across a physis can inhibit growth [1, 5], while tensile forces may cause growth stimulation. The role of

the periosteum as a potential “tether” to the adjacent growth plate has been speculated in previous studies [8, 11]. Furthermore, clinical investigators have implicated the torn (“untethered”) periosteum as a contributor to limb overgrowth following a pediatric femoral shaft fracture and asymmetric medial physal growth leading to genu valgum after certain proximal tibial fractures in young children [2, 3, 9]. Although studies have shown that leg-length discrepancy can be addressed by transecting or stripping the periosteum of the shorter limb in young patients [4, 6, 8, 10], I believe that few surgeons currently apply these principles in clinical practice. Perhaps due to the reported unpredictability [10] and the lack of robust basic-science support, this seemingly straightforward method of growth stimulation of the short leg has not gained the popularity

enjoyed by surgical alternatives, such as gradual lengthening or a contralateral epiphysiodesis. Additionally, it is currently unknown whether the various purported methods of untethering the periosteum are equally effective in inducing and sustaining growth stimulation of the affected extremity.

In this well-designed animal study, Halanski and colleagues have dug deeper and studied the effects of four distinct methods of periosteal release on the growth rates and lengths of tibiae in skeletally immature rabbits. They found that simply stripping the periosteum around the proximal tibial metaphysis without transection of the longitudinal fibers did not enhance growth, while circumferentially transecting the periosteum, (with or without its removal) does stimulate growth at the proximal and distal tibial physes, as noted 2 weeks postoperatively. Although this growth stimulation was not sustained 8 weeks after surgery at the proximal tibial physis in the animals undergoing a one-time release, repeat transection at 4 weeks postoperatively seemed to reignite the physis. This latter group of

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animals with a periosteal rerelease demonstrated the most enhanced growth rates and gain in tibial lengths at 8 weeks.

While it was not specified whether the rabbits had reached skeletal maturity at 8 weeks postoperatively (the end point of the study), previous investigators [7] have noted that the histologic closure of the proximal tibial physis does not occur until 25 weeks to 32 weeks-of-age. Since the experimental limbs actually grew slower than the contralateral control limbs at 8 weeks postoperatively, followup to skeletal maturity would be prudent and further clarify the role of one-time periosteal release on the final gain in tibial length by adulthood. Given this limitation, skeptics may wonder whether that the “additional” tibial length gained with a one-time periosteal release might eventually disappear, or worse, that the affected physis could close prematurely. Therefore, the well-intentioned method of growth stimulation may instead cause the opposite effect, that is, overall growth inhibition.

Where Do We Need To Go?

In terms of building on the results of this important animal study, future researchers can further quantify the magnitude and duration of growth

stimulation for the physes around the skeletally immature knee, so that treating physicians can accurately predict the timing of the appropriate periosteal release procedure(s) in children with leg length discrepancy. Is it feasible to address angular deformities in children by selectively untethering the periosteum on the concave side of the deformity and allowing for intentional asymmetric growth stimulation to help realign the extremity by skeletal maturity? Is there a role for combining a periosteal release with an osteotomy or extraperiosteal implant on the opposite side to address limb length discrepancy and/or angular deformity in children and adolescents? If so, does the unrepaired periosteum impair new bone formation at the osteotomy site? While there are anecdotal reports of enhanced growth with a second release procedure [10], can this effect be better quantified for clinical use?

How Do We Get There?

As suggested by the authors, we must first validate the findings presented here in a large-animal model. Additionally, the relationship of the proximity of the periosteal release to the physis with the magnitude and longevity of growth stimulation can be further elaborated. If the results of

large-animal model experiments remain promising, investigators can then corroborate their findings using well-designed prospective case-control studies for addressing leg-length discrepancy and angular deformities in pediatric patients, with regular follow-up through skeletal maturity. Given the enhanced effect on the growth rate seen with repeated periosteal transections, investigators can also explore the viability of less invasive, reliable, safe, and cost-effective means of untethering the periosteum, so that the biologic effects of such physeal manipulation can be harnessed for the affected child without resorting to repeated trips to the operating room.

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