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Comment on the Article „«Ischemic» Distraction Regenerate: Interpretation, Definition, Problems and Solutions“

E.A. Shchepkina

Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation

One of the complications in the lengthening of long bones and the defect repair by distraction osteogenesis is the formation of a distraction regenerate of the hypotrophic type. Other complications associated with this – deformations and fractures in the zone of regenerate after removal of the external fixators [1, 2]. The initial Ru Li's classification identifies 5 shapes of distraction regenerate: the predominance of the regenerate zone over the interfragmentary diastasis, the correspondence of the regenerate zone and interfragmentary diastasis, the 'hourglass' type, the edge defect and the formation of a thin regenerate only in the central portion. In the subsequent study of this problem, the variants for the formation of a thin edge regenerate and a fragmented regenerate in the central portion were added [3]. The last 3 shapes are clearly associated with compromised distraction osteogenesis and the inability of self-remodeling. Such a regenerate is usually defined as 'ischemic'. At the same time, a regenerate of the 'hourglass' type is often formed when the rate of distraction is exceeded or the magnitude of elongation is beyond 20% of the segment length. With timely distraction rate correction or cessation of further distraction, such a regenerate is, in some cases, capable of self- remodeling and may have a satisfactory network of vessels [4].

The multi-aspect assessment by X-ray and ultrasound imaging [3, 5] plays a large role in clarifying the state of the regenerate. This takes into account not only the predominance of the interfragmentary diastasis area over the regenerate zone, but also the formation of cortical plates, the ratio of the regenerate growth zone to other zones, and other parameters. On the basis of a combination of radiological and clinical signs, the authors of the article were able to describe an 'ischemic' distraction regenerate requiring a surgical solution to the problem.

The technique for repairing the existing bone defect by performing additional osteotomy with subsequent bone transport and mechanical compression in the zone of the 'ischemic' regenerate was addressed by the authors in greater detail. In this zone, open adaptation or osteoplasty may be needed. The advantage of this technique is the ability, in most cases, to restore the true length of the segment, and the surgical strategies comply with the principles of long bone de-

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Elena A. Shchepkina; e-mail: shchepkina_elena@mail.ru

fect repair by Ilizarov non-free osteoplasty. Simultaneous or discrete compression at the level of hypotrophic or 'ischemic' regenerate is considered as a solution to the problem, but is used in only in few cases [6, 7]. The beneficial effect of axial compression on bone formation is also confirmed in experimental studies [8, 9]. Due to the small sizes of groups studied, including these authors, a clear comparison cannot be made between this technique and other surgical approaches. However, the problem of subsequent segment length restoration persists.

Meanwhile, a timely assessment of compromised distraction ostogenesis makes it possible to use various techniques of stimulating the bone tissue formation. Experimentally and clinically, the positive effect of using various growth factors, bone morphogenetic proteins, stimulation with ultrasound, electromagnetic field, use of shockwave therapy, and systemic therapy with bisphosphonates was noted [3,7,10]. A positive effect was obtained in the graft of autogenous bone, demineralized bone matrix, bone marrow, and multipotent mesenchymal stromal cells, used both as a cell suspension and impregnated into various matrices [11, 12].

Special attention should be paid to the techniques of combined and sequential use of external and internal fixation. When lengthening and repairing long bone defects over an intramedullary nail, both clinically and experimentally, there was no bone tissue deficit during the formation of the regenerate. Thus, the possibility of deformation or fracture in the regenerate zone after the removal of the external fixator is completely excluded [13,14]. In clinical practice, when installing an intramedullary nail after lengthening or repairing a defect, activation of bone formation in the periosteal zone and more intensive formation of cortical plates [15,16] are noted and these allow to increase the axial load and begin active rehabilitation measures. Bone lengthening over the intramedullary nail has been studied in detail experimentally. Unfortunately, in contrast, sequential lengthening using an external fixator with the subsequent transition to intramedullary fixation is not sufficiently studied experimentally from the distraction regenerate remodeling perspective. Nevertheless, the available clinical data allow us to consider this technique promising for compromised distraction osteogenesis [17].

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INFORMATION ABOUT AUTHOR:

Elena A. Shchepkina — Cand. Sci. (Med.), Senior Researcher, Vreden Russian Research Institute of Traumatology and Orthopedics; associate professor, Department of Traumatology and Orthopedics, Pavlov First Saint Petersburg State Medical University, St. Petersburg, Russian Federation