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Clinical and Radiological Features of the Formation of Distraction Regenerate During Elongation of the Lower Leg According to Ilizarov

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Annotation: The main attention is paid to the x-ray features of the distraction regenerate formation with elongation of the tibia in the proximal part. There are possible three types of regenerate formation: normotrophic, hypotrophic, hypertrophic. The main problems associated with the features of regeneration and possible ways of their correction are presented. The description of the picture of the gradual regenerate formation at various times during the stages of distraction and fixation is presented. The radiographic signs are described in detail, which allow us to conclude that the external fixator can be removed. This is the density of the regenerate. The presented material is of interest to orthopedists, radiologists and medical experts.

Key words: Ilizarov apparatus, bone osteotomy, limb lengthening.

Introduction

The possibility of limb lengthening by gradual distraction is an outstanding achievement of Russian orthopedics and is based on the discovery of G. A. Ilizarov "General biological property of tissues to respond to stretching growth and regeneration (effect Ilizarov) [1]. Developing this topic, it should be noted that this possibility is realized not so much due to the design of the external ring retainer, but due to the above effect. Designs change, but the principle itself remains unchanged for many decades [2, 3]. By gradual distraction at a daily rate of 1 mm in the area of pre-performed osteotomy, segment lengthening occurs. The resulting diastasis occurred between the proximal and distal zones and there were no structural changes in bone tissue in the elongation zone. In all cases, lengthening was performed in the upper third of the lower leg. The operation consisted of several elements. First, the fibula was crossed at the border of the middle and lower third. Then a machine was placed on the shin Ilizarov from 3 rings. After that, the tibia was crossed. In all cases, osteotomy was performed in the upper third of the lower leg with an osteotome (chisel) 7-12 mm wide, which was inserted from front to back in various directions (fan-shaped) by hammer blows. After the formation of several such channels, the osteotome was inserted as deeply as possible and rotated, which led to osteoclasia of the bone. The criterion that the bone was crossed was mobility in this zone in all directions (angular, rotational, and transverse). This type of crossing of the tibia is known as a corticotomy by Ilizarov [10].

Scheme of the final moment of corticotomy (according to B.Golyakhovsky). A – Cross-section of the bone and direction of insertion of the osteoma. B-side view of the same bone with temporarily disconnected rings of the apparatus. Using pliers or a wrench, the osteotome is rotated, resulting in a crack in the posterior cortical wall [10]. In the postoperative period, distraction was started on day 5-7 at a rate of 1 mm per day (0.25 mm every 6 hours). Radiography was performed every 2 weeks during distraction, then monthly until fusion occurred.

After the fact of bone fusion in the osteotomy area was established and the regenerate formation was completed, the device was dismantled. Additional immobilization with plaster bandages or orthoses after removing the devices was not performed. Results When lengthening the lower leg, you have to solve many problems and find answers to numerous questions that arise during a long and complex treatment. And the main one of these questions is whether it's time to remove the device Ilizarova Street. this question is constantly asked by patients in the hope of completing a painful procedure, putting on normal clothes, washing up, and going to work. The answer to this question is the key to a new stage of improving the quality of life. And it depends on the doctor's correct assessment of the degree of maturity of the distraction regenerate. After completing the fixation, the doctor gradually fills the bone fragment with the newly formed bone, which is called distraction regenerate, based on X-ray data. Features of regenerate formation, concomitant changes in surrounding tissues, and many other factors were comprehensively studied using a wide variety of morphological and physiological methods [4,5,6]. these studies are certainly extremely valuable. But in the work of a practical orthopedic doctor, clinical and radiological diagnostic methods are still the main ones, both for fractures of the limb bones and for their elongation.

Among surgical reconstructive interventions aimed at correcting the length of the limbs, lengthening of the lower leg is the most common. This is due to the relative simplicity of the surgical technique and a fairly high level of quality of life of patients during treatment. At the same time, it is necessary to note several factors that have a significant impact on the organization of the treatment process and largely determine the relevance of this work. First, external osteosyn thesis is used less frequently every year, giving way to internal structures, including those used for limb lengthening [7, 8, 9].

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Therefore, at present, there is a certain lack of information about the biological processes that occur during distraction in the brain. Conditions of external osteosyn thesis. Secondly, the modernization of healthcare has led to the widespread introduction of digital X-ray machines, which produce a qualitatively different image of the studied structures than on the previous equipment.

At the same time, many additional elements are visualized (cracks, cysts, etc.), the assessment of which requires knowledge and experience. Third, in recent years, the question of conducting an expert examination of the quality of medical care has been increasingly raised. It should be said here that when the lower leg is lengthened, the formation of regenerate really has features that some experts may interpret ambiguously and even erroneously. Fourth, and most importantly, the degree of maturity of the regenerate determines the possibility of functional load on the segment and justifies the most important decision – to remove or not to remove the external retainer.

The aim of this study was to study the X-ray features of the formation of distraction regenerate and their relationship with the clinical possibilities of providing an adequate load when lengthening the lower leg by. It is necessary to evaluate the mechanical characteristics of the regenerate, first of all, the adequacy of the strength of the regenerate to the recommendations that will be given to the patient. At the same time, it is necessary to rely on objective criteria that characterize the regeneration at various stages of limb extension and fixation after its completion. There are three types of regenerate: normotrophic, hypertrophic, and hypotrophic [10,13,15]. to the fact that the duration of treatment increases significantly. A prerequisite for achieving consolidation is the cessation of distraction and the convergence of bone fragments. Otherwise, the regenerate formation process may stop or be significantly delayed. To a certain extent, this condition is analogous to the formation of a false joint. As with the treatment of false joints, optimal conditions must be created to stimulate fusion. Such conditions include reduction of inter-fragmental diastasis, stable fixation, and functional load. The normotrophic type of regenerate is characterized by a uniform filling of the zone between the proximal and distal tibial fragments. If we draw an analogy with the formation of a bone callus in a fracture, then this option is analogous to the primary type of fusion. this is the best option, in which you should not be afraid of slowing down the time of fusion or, on the contrary, constantly monitor the rate of distraction in order to avoid the progression of deformation in the lateral projection (such as antecurvation) associated with increased resistance to tensile forces. Hypertrophic type of regenerate is manifested by the formation of pronounced periosteal formations on the posterior surface of the tibia. this significantly increases the mechanical strength of the regenerate. On the one hand, this is a favorable variant of the course of reparative treatment. Osteogenesis that involves fusion in the shortest possible time. On the other hand, the asymmetric distribution of loads on the external apparatus associated with increased resistance to stretching along the posterior surface of the lower leg is a frequent cause of secondary displacement of bone fragments, requires constant monitoring and, if necessary, correction of the position of fragments in relation to each other. The amount of expected lengthening is determined at the preoperative planning stage. Usually we are talking about elongation by a specific amount, defined in units of length (centimeters, millimeters). However, it is correct to determine the relative length of elongation based on an estimate of the initial bone length. Functionally permissible and limiting elongations are distinguished [11]. Functionally acceptable lengthening — lengthening by the maximum percentage of the original segment length at which it is possible to restore function in the distal joint. This value is determined by the response of the neuromuscular system to distraction, its reparative and functional-restorative capabilities. Maximum elongation – an elongation that exceeds the functional limit. Its achievement is accompanied by pronounced disorders of the neuromuscular system, and clinically-by switching off the function of the underlying joint. Based on clinical and electromyographic studies, it has been shown that the functionally acceptable one-stage elongation is 20-30% of the initial segment length, and the limit is 40-50% [25,26,27].In order to differentiate various deviations from the normal course of the consolidation process, it is necessary to understand how this process proceeds normally. Correction begins 5-7 days after surgery and consists of two stages: distraction and fixation. In the process of distraction, it is necessary to assess the type of forming regenerate, adjust the pace if necessary, and make an additional correction of the position of the limb axis. Figures 4 and 5 show radiographs of the right lower leg of a 27-year-old patient who had both lower legs lengthened by 7 cm and varus deformity corrected in order to increase his height.

Density is the decisive factor. The main sign of sufficient regenerate density is a state where a clear boundary can be defined along the entire perimeter of the external contour. At the final stages of maturation, the regenerate already acquires a sufficiently high density. But if there are indistinct boundaries along its contour, then its mechanical strength is low. If a thin pencil or needle can be drawn around the contour of the regenerate, then this is the main sign of its final formation and an indication for dismantling the external retainer. It is enough if we see such a picture only in one plane. Figure 6 shows close-up radiographs of the same patient as in Figures 4 and 5 at 20, 24 and 27 weeks after the start of distraction.

Premature removal of the device may cause the regenerate to deform. The peculiarity of such deformities is that the pain syndrome is poorly expressed and the first thing that patients notice is the curvature of the segment. At the same time, the load is a factor that stimulates rapid fusion and, as a result, in order to correct such a deformity, a second osteotomy is required. Conclusion Limb extension by the method ofIlizarova is one of the most difficult areas of modern orthopedics. Our experience of lengthening almost a thousand shins did not allow us to identify the influence of factors such as age or initial diagnosis on the time of fusion. The only factor that directly affects the rate of regenerate formation and determines the overall duration of treatment is the lengthening time. At the same time, in each specific case, it is impossible to predict the duration of this process in advance. Despite the fact that this technique has been used for more than 70 years, the main methods for assessing the degree of regenerate formation, as before, are X-ray signs.

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