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POST-FRACTURE ANALYSIS OF THE TIBIA AND FIBULA DIAPHYSEAL WITH SPIROID TRAJECTORY, DISPLACEMENT AND ANGULATION, REDUCED WITH TIBIAL INTRA-MEDULLARY NAIL

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Abstract: The presented study is based on an analysis of the post-fracture pathophysiological status of the tibia and fibula diaphysis with a spiral trajectory, displacement, and reduced angulation with a tibial intramedullary nail in a 30-year-old patient. We consider that the mechanisms of its production and the method of its reduction present specific aspects for study. The fact that some lower limb injuries need to be reduced with osteosynthesis material requires a detailed analysis of all the elements that make up the clinical picture of the post-traumatic patient. Through the proposed approach, we aim to identify and analyze the factors that may impede the callus formation process at the site of injury, as well as the elements that may facilitate and optimize the recovery process.

Introduction:

Bone has the ability to change its size, shape, and structure in response to mechanical needs.

In accordance with Wolff's law on bone remodeling in response to stress, bone resorption occurs when pressure decreases, bone hypertrophy occurs when pressure increases, and areas of increased pressure follow the orientation of the main trabeculae.[11]

After a fracture occurs, the body responds with a series of adaptive changes (vascular and tissue) that lead to repair and healing through a formation called callus. This is created through a process of neo-osteogenesis, bone being the only organ that heals by forming tissue similar or even identical to that which existed before the trauma.

Inflammatory stage (hemorrhagic-hyperemic stage or fracture hematoma stage). It begins immediately after the fracture occurs, when bleeding originating in the medullary, periosteal, and muscular vessels appears between the fractured bone ends (7 days).

Provisional callus stage: Fibrous callus phase (14 days). Primitive bone callus phase (14 days).

The final phase, remodeling in which the healing process through indirect ossification is completed by remodeling the primitive bone callus. Immature bone tissue is replaced by mature bone tissue.

Thus, bone remodeling occurs in a variety of circumstances that alter normal pressure patterns. From a clinical perspective, altered pressure patterns caused by osteosynthesis implants or joint prostheses have raised concerns about long-term bone architecture. Bone base and body weight are closely correlated, especially for weight-bearing bones. Thus, immobilization or lack of gravity (as experienced by astronauts) decreases bone strength and hardness. Bone loss is caused by the absence or alteration of normal pressures. However, bone mass is regained once normal pressures are restored. [1, 2, 5, 6, 8]

Bone loss in response to immobilization or lack of gravity is a direct consequence of Wolff's law. Bone resorption in response to orthopedic implants can be disastrous for bone healing. While plates provide support for fractured bone, the altered pressures associated with rigid metal plates cause resorption of the bone adjacent to the fracture or beneath the plate, which is why plate removal can cause another fracture. Bone resorption in response to a rigid implant, which alters the pressure pattern of the supporting bone, is called stress shielding. The degree of stress shielding is not dependent on the elasticity of the prosthesis but rather on the degree of reduction in the elasticity of the implant relative to that of the bone.[3]

Stress shielding is the reduction in bone density (osteopenia) as a result of removal of typical stress from the bone by an implant. [10]

From a clinical point of view, stress shielding can be disastrous for the longevity of implant fixation. Therefore, in an effort to reduce stress shielding, implant designers use materials with a modulus of elasticity close to that of bone (e.g., titanium).

In the case of closed intramedullary osteosynthesis, peripheral callus formation is largely due to the pushing of medullary substance through the interfragmentary fracture zone as a result of drilling maneuvers. If the fracture is not immobilized, fibrocartilaginous tissue usually forms in the interfragmentary space, which, if immobilization is resumed, can be transformed into bone through a lengthy process of enchondral ossification.

Delayed consolidation is a term that attempts to define the slowness of the healing process through callus formation at the fracture site, which in some cases exceeds the unanimously accepted optimal time period for fracture healing.[9]

The causes are many and varied: insufficient vascularization, in the case of a fracture on a bone without muscle insertions or poorly vascularized, which presents an increased risk of necrosis; open fracture through the removal of the fracture hematoma, the matrix of the future callus; infection, even if clinically unapparent (torpid sepsis in the focus); insufficient immobilization or excessive traction.

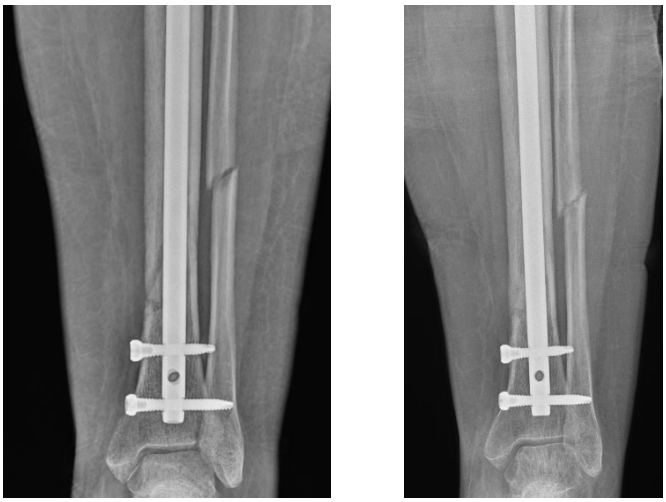
Aim and objectives of the study:

Aim of the study: to analyze the physiopathological factors involved in the post-fracture status of the tibial and fibular diaphysis with a spiral trajectory, displacement, and reduced angulation with a tibial intramedullary nail.

Research objectives:

- analysis of the specialized literature regarding of the post-fracture at the level of ½ of the tibia and fibula diaphysis;
- identifying and understanding the pathophysiological mechanisms leading to tibia and fibula diaphysis fracture recovery;
- the realization of a therapeutic pathway tibia and fibula diaphysis; fracture recovery.

Materials and methods: To understand the post-fracture status and the physiotherapeutic approach to the recovery of tibial and fibular diaphysis fractures with a spiral trajectory, displacement, and reduced angulation with a tibial intramedullary nail, we will conduct a case study of a 30-year-old patient.[4]



2 a 2 b

Fig.2 a; b. rgf. 6 weeks and at 18 weeks after fracture

Post-fracture status at the level of ½ of the diaphysis of the left tibia and fibula, with spiral trajectory, displacement, and angulation. Reduction by osteosynthesis with tibial intramedullary nail.

No callus is visible at the time of the first X-ray taken 6 weeks post-fracture.

Non-homogeneous osteopenic bone structure at the talar and distal tibial/fibular levels. The patient presents an open wound in the medial area of the calcaneus, with a complicated infectious vasculotrophic status.

Knee joint locked in extension, ankle joint also locked, hypotonic muscles in the thigh and calf, walking and standing impossible. A kinetic program is initiated with the following objectives:

- management of the vasculotrophic status, i.e., wound care.
- increase joint mobility in the knee and ankle joints;
- increase muscle strength in the affected muscle groups;
- regain proprioceptive abilities, i.e., recover walking.

At 18 weeks post-fracture, an imaging examination is performed and the following is observed:

- The tibial trajectory is almost completely consolidated;
- The fibular fracture trajectory is in the process of healing – callus present, sclerotic and poorly defined edges of the bone ends;
- Non-homogeneous osteopenic bone structure at the talar and tibial/fibular level – more pronounced than at the last examination.

The patient can walk without support, is able to perform basic ADLs, has reduced exercise capacity, and is advised to avoid uneven terrain, prolonged walking, handling bulky objects, and lifting heavy weights. At the same time, it is recommended to continue an exercise program to consolidate the results obtained from the kinetic program.

Results and discussions: Therefore, based on the findings of the analysis of all factors included in the patient's therapeutic pathway, we will present several aspects that were decisive in the recovery program.

This case emphasizes the value of dynamization as a strategy to enhance fracture healing, particularly in cases of delayed union or non-union.[7]

The patient's clinical status at 6 weeks shows a complicated, which causes a slowdown and sluggish dynamics in the callus formation processes. This is due to the fact that the fracture at the fibula level could not be reduced properly, the bone ends were not aligned and did not have sufficient contact to initiate the callus formation process.

At the first imaging check of the tibia, which was reduced with osteosynthesis material, we have callus, but at the level of the fibula, the temporary callus is missing.

After starting the recovery program, the vasculotrophic processes in the post-traumatic focus area accelerate, and mechanical stress causes the bone structure to organize in a way that favors the initiation of physiological callus formation processes. Thus, after 12 weeks of recovery, imaging shows complete callus formation at the tibia and ongoing callus formation at the fibula. (fig. 2 a, b)

Conclusions:

- Spiral fracture of the tibia and fibula diaphysis, with displacement and reduced angulation, treated with a tibial intramedullary nail, may be accompanied by complications: lack of or delayed callus formation; osteopenia;
- Medical control through imaging investigations such as X-rays is mandatory in order to prevent possible complications;
- Initiation of an immediate recovery program in order to maintain functional capacity and optimize vascular and callus formation processes.

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