The Annals of the "Ştefan cel Mare" University of Suceava.
Physical Education and Sport Section. The Science and Art of Movement
eISSN 2601 - 341X, ISSN 1844-9131 Volum XV issue 2/ 2022

ANALYSIS OF THE CALLUS PROCESS IN TIBIA AND FIBULA FRACTURES REDUCED WITH OSTEOSYNTHESIS MATERIAL

Author(s)[1] Mihai Constantinescu
Institutional affiliation [1] Ștefan cel Mare University of Suceava, Romania
Email adress [1] mihai.constantinescu@usm.ro

Keywords: fracture, osteosynthesis material, casting, recovery.

Abstract This paper aims to present some aspects accompanying the process of callus healing of a tibia and fibula fracture reduced by the application of osteosynthesis material. Also in the same context we will describe a case in which fracture reduction can evolve viciously due to clinical or post-surgical approach variables. Timely identification of possible conflicts in the callus processes will allow the bone and soft tissue alignment to be reshaped in order to achieve a functional recovery of the traumatized segment.

Introduction

The literature clearly specifies the stages of bone remodelling following trauma and fractures. Studies and analyses of both etiopathogenic factors and methods of approach from the point of view of fracture reduction on the clinical side and on the medical recovery side are being carried out..

We will therefore present some general aspects of fracture reduction but also the physiological processes that accompany the process of callus. In order to carry out the proposed analysis we will present some anatomical and pathophysiological aspects of tibia and fibula fractures.

Fig.no.1 types of tibia fractures, a. transverse fracture; b. Spiral fracture with shortening; c. comminuted fracture; d. segmental fracture [6]

After a fracture, the body responds with a set of adaptive changes (vascular and tissue), which lead to repair and healing of the bone through a formation called a callus. This is achieved through a process of neo-osteogenesis, the bone being the only organ to heal through the formation of tissue similar or even identical to that which existed before the trauma. There are differences between tubular and cancellous bone repair that should be noted. [8]

Tubular bone repair It is performed by indirect ossification, most commonly when the fractured bone has not been rigidly fixed, and by direct ossification when there has been rigid fixation of the bone.

Indirect ossification In this case, the appearance of mature bone occurs only after the completion of intermediate preparatory stages. These phases correspond to the gradual development of connective, fibrous and cartilaginous tissues from which young bone tissue will be built. This remodelling finally leads to mature bone tissue, structured in the same way as before the fracture.

1. Inflammatory stage (hemorrhagic-hyperemic or fracture hematoma stage): begins immediately after the fracture, when bleeding occurs between the fractured bone ends, originating in the medullary, periosteal and muscular vessels. The hematoma thus formed coagulates, with the appearance of a network of fibrin in the mesh of which there are at first figurative blood elements. This stage lasts about 7 days.

2. The temporary callus phase The healing process continues with this reparative phase, which is carried out in two phases: The fibrous callus phase - continues and completes the changes begun previously. The ground substance is enriched with mucopolysaccharides and becomes a favorable environment for the deposition of mineral salts, thus being a pre-osteoid ground substance. The ground substance is unevenly populated with three types of cells: fibrous, cartilaginous and bone. At the end of this stage, which lasts about 14 days, the focus stabilises by anchoring the fractured bone ends by collagen fibres.

The primitive bone callus phase - is characterized by the miniaturization of the ground substance.At this stage about 80% of the mineral material in the bone is deposited. This stage also lasts 14 days.

Final, remodelling phase - in which the indirect ossification healing process is completed by remodelling the primitive bone callus.

Direct ossification. This is a type of healing that occurs when, after anatomical reduction, the fracture site has been stabilised by firm osteosynthesis. In these cases, the preliminary steps are not necessary. Under the protection provided by osteosynthesis, the body forms mature bone tissue from the outset, following the biomechanical pattern of the original lamellar bone, and restores bone continuity.

In the case of direct ossification there are two histological variants:

- In the first variant, also called gap healing, the small spaces remaining after reduction of a diaphyseal fracture are filled by neocapillary and bone-forming cells ("drill cone" composed of capillaries, osteoclasts and osteoblasts).

- In the second variant, the voids are filled from the beginning with immature bone which is then remodelled and transformed by the same drilling cones into mature lamellar bone. .[2, 5, 7, 8]

Delay in healing, is a term that attempts to define the slow healing process through the calcification of the fracture site, which in some cases exceeds the universally accepted optimal time period for fracture healing.

The causes are many and varied: insufficient vascularisation, in the case of a fracture on a bone without muscle insertions or poorly vascularised, which presents an increased risk of necrosis; open fracture by removal of the fracture haematoma, the matrix of the future callus; infection, even clinically inapparent (torpid sepsis in the focus); insufficient immobilisation or excessive traction.

Pseudarthrosis, occurs when the delay in healing is not recognised and the fracture is not properly treated. The causes are numerous, but tissue interposition between fragments and interfragmentary diastasis by excessive distraction in the focus are the most common causes.

Vicious callus, occurs when fractured fragments consolidate in a non-anatomical position with persistence of focal displacement such as angulation, offset, buckling or shortening that is functionally or aesthetically unacceptable. [8, 10]

The causes are multiple, but the vicious consolidation may be mainly due to:

- failure to properly reduce the fracture;
- loss of reduction quality during consolidation or secondary displacement by telescoping or gradual collapse of a comminuted or pathological bone fracture.

Clinically, the deformity is usually obvious, but the extent of the vicious consolidation can only be correctly estimated on X-ray. A fracture may be represented by a discontinuity in the bone axis caused by an overload, it is unstable, requiring osteosynthesis for temporary stabilisation. [1, 3, 9]

In this regard we present some types of osteosynthesis used in current practice:

- osteosynthesis with screwed metal plate;
- osteosynthesis with centromedullary rod;
- screw osteosynthesis;
- Kirschner wires;
- metal wires;
- staples.

In this case, the centro-medullary rod was used.

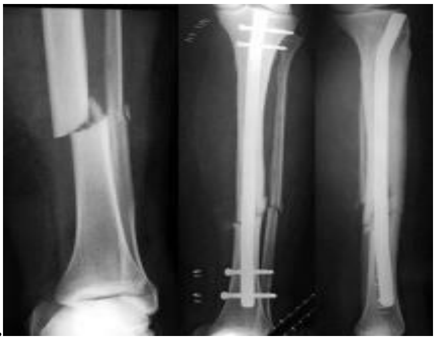

Fig. no. 2 reduced tibia and fibula fracture with centro-medullary rod[4]

Purpose and objectives of the study:

Aim of the work is to identify in a timely manner the factors that can disrupt the recovery process following a tibial fracture injury.

Research objectives:

- analysis of the specialized literature regarding the physiological mechanisms accompanying the post-fracture healing process;
- to carry out an investigative analysis throughout the post-operative recovery process in which the fracture was achieved using osteosynthesis material.

Materials and methods: In order to understand the mechanisms that accompany the healing and recovery process of a fracture, we present a case study of a 21 year old girl who, following a road accident, suffered several traumas including a tibia and fibula fracture. It should be noted that the polytrauma was particularly aggressive and surgery was required on both lower limbs to reduce the fractures and restore the physiological alignment of the lower limbs.

Imaging investigations also revealed fractures of the costovertebral and upper limbs and a cranial hematoma.The patient is hemodynamically stabilised, successfully withstands the surgery that took place and is discharged with the recommendation of specialist supervision and recovery at home.

For the analysis proposed we present the control X-ray taken 28 days after reduction of the tibia and fibula fracture. For ethical reasons we will not name the institutions or physicians who performed the surgery or any other personal data. However, we will mention that after the imaging analysis the patient will decide to have another surgery in another medical center in another town. The control imaging investigation was carried out due to the fact that during the assessments carried out by the physiotherapist the following was found:

- unevenness of the lower limbs with a difference of 2-3 cm;
- the osteosynthesis material causes pain and discomfort,

- the injured segment had edematous, painful tissue with detectable trophic disturbances, paresthesia and increased temperature.

As a result, the patient requires specialist assessment and consultation.

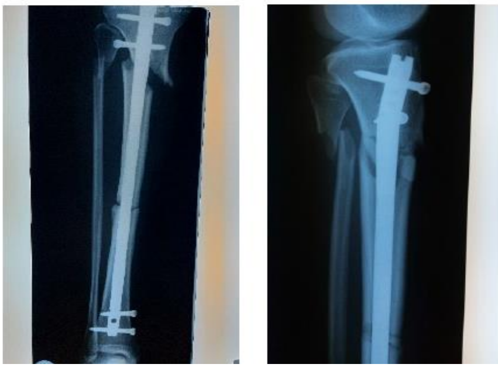

Fig. no. 3 reduced tibia and fibula fracture with centro-medullary rod at the first control

After the investigations carried out by the second team of doctors, the decision is made to perform a new surgical intervention that will remove the rod, reposition the fractured segments and proceed to the application of osteosynthesis material.On discharge, the patient is taken over by the team that will carry out the therapeutic route for recovery.

Fig. no. 4 reduced tibia and fibula fracture with centro-medullary rod after second surgery

Results and discussions: Following the second surgery performed, the patient responds favourably to the recovered treatment and has good dynamics. From the point of view of the post-operative clinical picture, the patient presents a good morphofunctional status with a favourable prognosis for an ad integrum recovery. The causes leading to this incident can be attributed to violent polytrauma but also to the application of osteosynthesis material in less good conditions. The aim of this approach is to make the patient as well as the therapist aware of the posttraumatic symptoms and of the clinical/paraclinical investigations necessary to be performed during the postoperative recovery process.

Conclusions:

- Complications that may accompany the postoperative status are often ignored and lead to irreversible functional sequelae;
- Regular assessment and imaging investigations after fracture reduction with osteosynthesis material can ensure a favorable recovery;
- Timely identification and management of possible complications considerably reduces the potential for functional disability;
- From the analysis carried out, it appears that imaging investigation is obligatory in order to achieve a therapeutic recovery.

Bibliography:

[1]. Corneliu Petru Zaharia, Elemente de patologie a aparatului locomotor, Ed. PAIDEIA, București 1994 pag 127-128;
[2]. Dan George Goția, Chirurgie, ortopedie și traumatologie clinică, Iași 1996;
[3]. Dinu .M. Antonescu, Patologia aparatului locomotor, ed. Medicală București 2008, pag.378-379;
[4]. http://www.lectiadeortopedie.ro/traumatologia-membrului inferior/fractura-diafizei-tibiale/;
[5]. Mihai Constantinescu, Kinetoterapia în afecțiuni ortopedico-traumatice cu aplicații în sport, Caiet de lucrări practice, Ed. Universității Ștefan cel Mare, Suceava 2018;
[6]. NETTER’S CONCISE ORTHOPAEDIC ANATOMY, SECOND EDITION, Copyright © 2010, 2002 by Saunders, an imprint of Elsevier Inc;
[7]. Pasztai Zoltan, Kinetoterapia în recuperarea funcțională posttraumatică a aparatului locomotor, ed. Universității din Oradea, 2001;
[8]. Paul Botez, Ortopedie, ed. Casa de editură Venus, Iași 2008, pag.32-44;
[9]. T Duckworth, C M Blundell, Lecture Notes: Orthopaedics and Fractures, Fourth edition, ed. Wiley-Blackwell, A John Wiley & Sons, Ltd., Publication, 2010 pg. 41-42;
[10]. Tudor Zbenghe, Recuperarea medicală a sechelelor posttraumatice ale membrelor, ed. Medicală, București 1981, pag 81-83