Volume 1 Issue 1
www.escientificlibrary.com
ES Journal of Surgery

# Hundred Times on the Business

## Case Report

**Yves Cirotteau***
*Neuilly Sur Seine Hospital, Courbevoie, France*

**Received:** Apr 22, 2020; **Accepted:** May 15, 2020; **Published:** May 20, 2020

***Corresponding author:** Yves Cirotteau, Neuilly Sur Seine Hospital, Courbevoie, France



## Abstract

Following a car accident, this patient is hospitalized for a complex fracture of the lower third of the femur. The non union confirmed, a re-intervention with removal of the material, anatomical reduction, new osteosynthesis with a screw-plate plate [1-2] and grafting of a biomaterial [3-5] is practiced. Consolidation is achieved in four months. The femoral shaft is anatomically reconstructed in one year. There were no sequelae. Follow-up is three years. The essential role of vascularization is underlined. This result supports more than 300 femoral fractures treated using the same modus operandi.

## Keywords

Femur, fracture, non-union, graft, bone-marrow, natural coral, screw-plate, diaphyseal vascularization, B.M.D.,[Bone Mineral Density], B.M.U.[Basic Multicellular Unit]

## Clinical History

Miss Hélène G ... aged 20, was operated in emergency when she arrived at the hospital on August 12, 1999. The femur was osteosynthesized using a long screw-plate. The reduction of the focus, very approximate, results 4 months later in a non union. A second surgeon offers a reoperation. The patient refuses. Despite the practitioner's insistence and against the family's advice, she persisted in her refusal. It is only after seven months that she accepts a new intervention.

## Method and Technique

The operation takes place on march 7, 2000. After the material has been removed, the surgeon dissects the non-union area according to the technique described by Robert Judet [6] and wraps it in a natural coral biomaterial [7,8] placed in the shell. The anatomical reduction of the fracture zones is temporarily maintained by forceps and fixed firmly by a plate blade [1,2]. A short antibiotic therapy [5 days] was prescribed. The operating suites were simple : no fever, a partial support with two crutches was authorized from the 12th day. There were a few rehabilitation sessions. The abandonment of a crutch with full support was done after three months and the abandonment of the two canes after four months. During the three-month clinical examination, the femur was painless, knee mobility normal, and there was no more lameness. Muscle mass returned to normal within eight months. Unrestricted sporting activity was allowed after one year. The follow-up of this case was two years.

## Equipment

- The plate blade is made of stainless steel. [1-2]. The blade is bent at 95°. It has a length of 6.5 cm. The plate is pierced with 9 holes. The screws are 5 mm in diameter. The three upper screws take six cortices above the most proximal fracture line.

- The natural coral [8] is porites, with an open porosity of 50%. Pores all communicate with each other. The average pore size is between 150 to 500 microns. The volume, the thickness of the walls and the structural regularity allow the circulation in the heart of the bone marrow cells [blood fluids, proteins, anions, cations]. The skeleton is made up of 98% calcium carbonate. It is used in the form 1.5 to 2 mm diameter spheres. The architecture of natural coral is conducive to bone growth. Natural coral has remarkable qualities of resistance to compressive stress, even when the pore volume approaches 50, which is identical to that of a cancellous bone. On the other hand, the mechanical resistance in bending and in torsion is low. Biocompatibility : the biomaterial is perfectly tolerated by the human body without risk of contamination and is compatible with the structural requirements of bone growth. Bioresorbable [9,10]: it is perfectly integrated with a total absorption between 2 and 6 months. The resorption of the skeleton of calcium carbonate is due to the carbonic anhydrase which it contains and which releases H + ions by the osteoclasts. Bioactive: Due to its mineral and architectural characteristics [Aragonite Crystal and Porosity], natural coral is rapidly impregnated with autologous blood and bone marrow cells as soon as it is placed in the bone site. Calcification begins on the 9th day. Osteoconductivity: The porosity allows a rapid invasion of bone marrow and integration of newly formed bone. The coral resets the process of mineralization of the bone. It is rapidly vascularized and gradually absorbed by the osteoclasts [11], then replaced by the osteoblasts [12] in order to direct the neoformation of bone identical to the recipient's bone. This cell invasion is the first step in the bone restoration process characterized by the development of neovascularization. Porites has a striking resemblance to cancellous bone [Figure 4].

- Bone marrow: Using a Mallarmé trocar, the surgeon took three to six cc of bone marrow from the Iliac crest. They are mixed immediately with biomaterial and heparin. The figured elements are absorbed by the biomaterial to the center of the coral spheres. A composite resembling frog spawn is thus formed. This compact amalgam is easy to put between the femoral shaft and the cortical decortication.

## Evolution of vascularization of a long bone

Over time, the vascular supply changes [13]. In the newborn, the vascular supply to the cortex comes exclusively from the bone marrow. The richly vascularized periosteum does not penetrate. It is perfectly integrated into the cortex.

In this angiographic section of a cross section of a 42-year-old femur, the medullary arteries are robust and supply the entire cortex. [enlargement x3] with the exception of the right part of the posterior cortex where traces of periosteal arteries are detected.

The vascularization of the diaphysis of a long mammalian bone is longitudinal traversing the large axis of the bone in the middle of the bone marrow. Here there are two systems, one proximal, the other distal (Figure 1).

**Figure 1:** Angiograph of a transverse section of a femur (2 years old) perfused in vivo.

**Figure 2:** Angiograph of a transverse section of a femur (42 years old)

## Resorption of natural coral grafts

### Role of vascularization

The role of vascularization is essential. In a necrotic bone or in contact with inert metallic material [plate, screw, nail], no vascularization can develop in the pores [Figure 2]. In the example below, there is no modification of the biomaterial which remains in the mineral state, surrounding the spheres [Figure 3] by an avascular fibrous sleeve: F [Figure 4].

On contact with the well vascularized bone, on the contrary, the biomaterial is absorbed under the action of the double mechanism (Figure 5 & 6): demineralization [osteoclasts], then remineralization [osteoblasts] and newly formed bone appears [Figure 7].

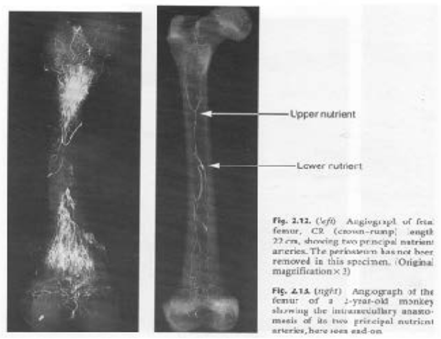


**Figure 3:** The main artery has a longitudinal direction

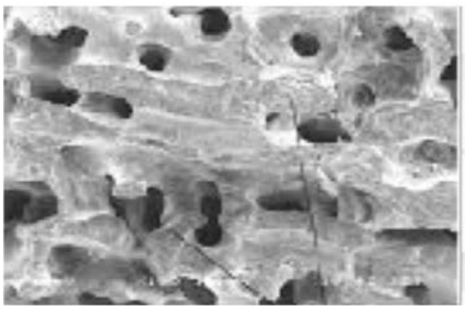

**Figure 4:** Porites pores

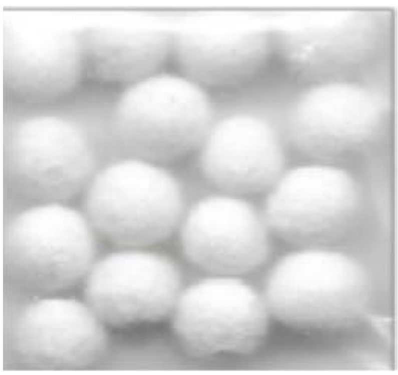

**Figure 5:** Porites spheres


**Figure 6:** The coral spheres have remained intact. They were surrounded by fibrous tissue F without vessels


**Figure 7:** the coral spheres ( in brown) in contact with the bone and the vessels which pass through it have been colonized by the bone cells which have undertaken the resorption of the biomaterial. (Biomatech laboratory)

## Methodology of the mechanical development of the coral graft

On the front and strict profile radiographs [photos taken at a distance of one meter, by the same operator and with the same machine], the coral spheres impregnated with bone marrow clearly individualized on a visual scale were counted at the level of the anterior and posterior surface [lateral radiography] external and internal [frontal radiography] of a young man's femoral shaft [non-union 8 months after injury]. They were written down on a sheet of millimeter paper. They were counted at different stages of consolidation. There are five phases of reconstruction. In phase III and IV, it can be observed an alignment of the external spheres along the long axis of the diaphysis. This suggests the beginning of the organization of the Haversian system.

It can be seen that the absorption is identical at the level of the four faces. By plotting the number of the remaining spheres as a function of time on a graph, we obtain a logarithmic plot in geometric degression, [Figure 8 & 9] suggesting an identical and coherent physiological resorption process.

## Radiographic evolution of the femur of the young patient

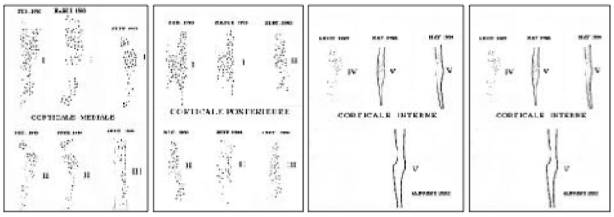

**Figure 8:** The points represent the visible biomaterial spheres. They are reported on a millimeter paper

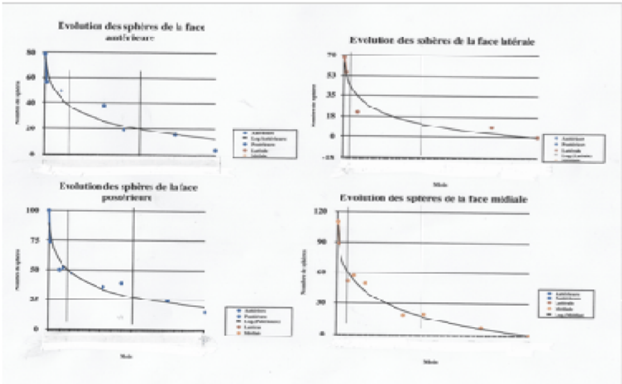

**Figure 9:** Young patient, 19 years old, with pseudarthrosis of the femur treated by two external fixators. (anterior and lateral), thus allowing the counting of the spheres of coral on the four faces. Diseappearance of the biomaterial according to a logarythmic curve.

- Pre op: The femoral fracture is located in the lower half of the femur. The shft is broken in 4 large fragments and a few small shards.
- At 7 Months: The reduction of the focus is very approximate. The osteosynthesis by plate lets persist an axial deviation and a stable inter-fragmentary big gap preventing consolidation.
- At Day 1: The recovery restores the diaphyseal axis and anatomically restores the diaphysis. The coral graft is distributed in contact with the shelled femoral sleeve.
- At three months the spheres are no longer visible on a visual scale and an inhomogeneous bone callus surrounds the focal point of the fracture.
- At four months the outbreaks are joined. The diaphysis is reconstructed. The callus is hypertrophic and the spinal canal is dense on the front X-ray.
- At 20 months, the diaphysis is anatomically reconstructed. The medullary canal is permeable.

### Evolution of the b.m.d over time

There is a regular decrease in the D.M.O. This reduction begins as soon as the subject has reached bone maturity, that is to say, on average in young adults, around 23 years of age. This is well known. This natural evolution of the bone stock also occurs in people whose fracture has been treated by combining osteosynthesis and graft of biomaterial (Figures 10 & 11).

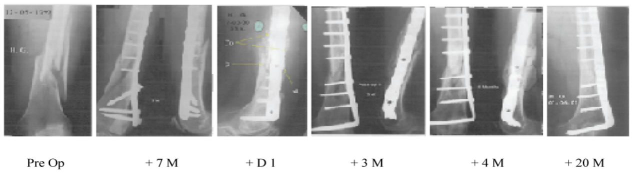


**Figure 10:** Radiographic evolution of the femur of the young patient.

| Name | Age. | Date of. Clin. Exam. | B.M.D. gr/cm² | 3.M. | 6.M. | 1.Y. | 2.Y. | 5.Y. |
|---|---|---|---|---|---|---|---|---|
| M.O. | 80 | 07/24/1992. | 0,853 | 0,853 | 0,852 | 0,742. | 0,667 | 0,536 |
| G.A. | 94. | 07/27/1992. | 0,806 | 0,773 | 0,691. | 0,668. | 0,541 | |

**Figure 11:** Examination of the B/M.D carried out by the same operator, the same machine and the same technique.

## Discussion

A fractured bone whose fracture site is stabilized by osteosynthesis, while allowing a minimal gap between the fragments to persist, can consolidate provided it is placed in a well vascularized area. Likewise, very minimal mobility in the home is not an obstacle to consolidation. On the other hand, nonunion is inevitable when the inter-fragmentary gap is large, the focus mechanically stable [very or too much] and the vascularization precarious. To avoid this formidable complication, it is necessary to anatomically reduce all the broken fragments and to maintain them firmly. This stabilization is moreover essential for the resorption of the graft.

Likewise, it is fundamental, while respecting bone physiology, not to destroy the central medullary vascularization. Due to the longitudinal arrangement of the medullary arterial system, it is necessary to reestablish this course throughout the diaphysis interrupted by fibrosis located at both proximal and distal ends of the pseudarthrosis. This re-sealing restores blood circulation. It provides blood and the figurative elements necessary for bone metabolism.

Bone decortication », according to the technique of R. Judet, is not essential for consolidation. It was practiced widely before the use of biomaterials. In this case, the surgeon, convinced of the effectiveness of the method, combined the two techniques.

The biomaterial prevents the taking of an autologous bone graft [15] and removes painful or infectious complications. This choice was adopted by many surgical teams [16-20]. Professor L'Hocine Yaya published an exhaustive review on coral grafting [21].

## Conclusion

This technique was used in the treatment of multiple pseudarthrosis of variable etiologies: delay in intervention, technical error in the majority of cases, chronic osteitis, unsuitable material etc. The fractures treated reached all the long bones of the human body both in level of upper limb than lower limb. The biomaterial graft acts as an autologous [ cancellous or compact ] bone as confirmed by the complete resorption of it, the vascular supply necessary for its absorption, the alignment of the spheres [from phase III and IV] resembling the disposition of the cortical haversian system, the absence of immunological reaction and restitution of bone stock [3-23]. There was no failure in the 25 cases of pseudoarthritis treated with this method. A process that reproduces the metabolism of a bone - considered normal - cannot fail. No treatment of this kind was proposed for congenital malformations.

**Citation:** Cirotteau Y. Hundred Times on the Business. ES J Surg. 2020; 1(1): 1006.