Acta Scientific Orthopaedics

Volume 2 Issue 3March 2019

Case Study

The Masquelet Technique with RIA Bone Graft for Treatment of Bone Loss

GC Salvo*, S Bonfiglio, S Milazzo, R Ortuso and G Longo

Orthopedic and Trauma Care Unit, "Cannizzaro" Emergency Hospital, Catania, Italy

***Corresponding Author:** GC Salvo, Orthopedic and Trauma Care Unit, "Cannizzaro" Emergency Hospital, Catania, Italy.

Received: January 31, 2019; **Published:** February 23, 2019

Abstract

The authors explain their experience about a rare case of post-traumatic acute bone loss after a road accident. The patient came to hospital showing a type III B G.A. open fracture of the distal tibia with acute loss of the talus and distal tibia comminution.

Anatomic reconstruction with stable and biological ostheosynthesis is the goal of a trauma surgeon, but in case of very comminuted articular tibial plafond fractures with inadequate skin coverage, associated to bone defects or high contamination index, it will be unlikely to restore every time the articular motion, therefore among the therapeutic options it could be useful to consider an acute bone resection, followed by an autograft bone implant which was applied, in this specific case, with Masquelet technique using RIA. (Reamer Irrigator Aspirator).

The combination of arthrodesis and autograft bone to fill the gap left by the removal of the meta-epiphyseal component which was damaged by the trauma and the subsequent debridement and of the fracture, is a valid therapeutic alternative of treatment. A previous antibiotated spacer application would be necessary to bridge the dead gap created and clear the surgical site of potential septic problems.

Keywords: Masquelet technique; RIA; Bone Loss

Introduction

Bone defect treatment after a major trauma represents one of the main issues to face. It is essential to consider the damage of soft tissue, the etiopathogenetic defect and location before the application of a therapeutic strategy.

A bone gap can be the result of a septic or aseptic nonunion; it can be caused by osteomyelitis, or by acute treatment with bone tissue loss at the moment of trauma.

There are various treatment options and all of them show advantages and disadvantages as well as guidelines oriented not only by the dimension of the bone gap but also by the orthopedic surgeon's experience.

It is intuitive to understand how a therapeutic approach to periarticular gap can be quite difficult, as functional recovery with anatomical reconstruction is much more complicated.

If it is true that grafts can be autologous or heterologous, or that we have various scaffolds and bone replacements available, with bony transposed methods and microsurgery techniques as valid as ever, the opportunity to use an autologous graft with high biological capacity, represents a valuable alternative in many cases. The polytherapy approach ensures high concentration of growth factors and low index of infection compared to a heterologous graft.

Case Study

The patient arrived at the emergency room after a trauma caused by a road accident while driving his motorcycle, showing a sub-amputated limb to the ankle, and a wide semicircular wound on the ankle joint. He was 21-year-old male.

Clinical aspect: Bony matter loss from the distal tibia. Talus not present. Suprasyndesmotic fibula fracture. Open fracture Type III B according Gustilo-Anderson classification.

No peripheral vascular deficiency, no peripheral neurological deficiency.

No other associated injury. Patient was vigilant and sharp.

Figure 1: Emergency surgery: Damage Control for Limb Salvage. Irrigation, soft tissue and bone debridement, with bone resection. Excision of comminuted distal tibia and talus fragments. Application of external fixator and wound suturing.

The limb salvage procedures were activated; with the collaboration of the vascular and the plastic surgeons the patient was taken to the O.R. and began the broad-spectrum antibiotic therapy.

After an assessment of the local status of the tissue and the absence of articular surfaces, the patient and his family were informed that the articular function of the ankle would be lost and that there were severe risks of infection associated with the high probability of local and general complications: the suggested surgical indication during the informed surgical consent was irrigation, cleansing and the application of a bridging external fixator, to salvage the limb which was severely compromised by the trauma and since the MESS SCORE (Mangled Extremity Severity Score) < 5. It was also explained to them that it complications may occur anyway and lead to a necessary amputation of the limb, which was excluded as an option during the emergency treatment, and a future arthrodesis was planned if the conditions allowed it.

The following CT study, allowed to plan the subsequent surgery.

There was a bone gap of approximately 7 cm.

An autologous bone graft was planned in order to prevent the limb shortening, by taking the necessary part from the femoral canal by using the RIA (Reamer Irrigator Aspirator) method, and Masquelet technique, and taking advantage of the biological chamber principle, which would form by using a cement spacer placed on the bone gap.

Figure 2: CT Scan.

2nd time: Wound revision and an additional debridement with cement spacer apposition was applied after ten days. The Ex Fix was left in situ (Figure 3).

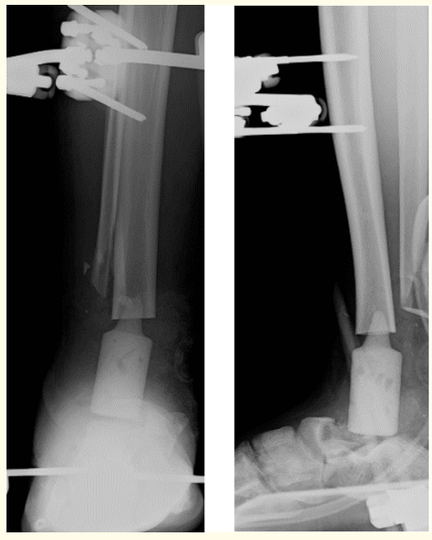

Figure 3: Debridement and cement spacer.

3rd time: Spacer substitution, removal of the Ex Fix, and stabilization through retrograde nail were done after five weeks (Figure 4).

4th time: The wound healed through microsurgery after two months (Figure 5).

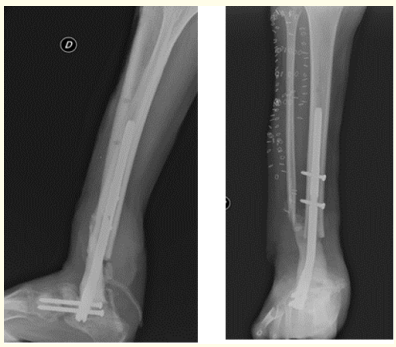

Figure 4: Ex Fix removal, retrograde nail, and new cement spacer.

Figure 5

5th time: 4th month, in view of the appropriate soft tissue conditions, the negativity of inflammation indexes and growing swabs performed during the tibio-tarsic arthrodesis treatment through retrograde nail, autologous bone sampling from the femoral canal through RIA and graft inside the formed chamber were carried out (Figure 6a-6e).

The patient was left to drain for 30 days, followed by the permission to gradually increase weight bearing.

Follow-up was arranged 30, 60, 90 and 150 days afterwards. Check-up at 8, 12 and 18 months.

6a

6b **6c**

6d **6e**

Figure 6

a- Autologous collection from medullary femoral canal using the RIA device.
b- X-ray image checking the device in medullary canal.
c- Opening the dedicated container.
d- Preparation of grafting.
e- Insertion of the graft to filling the bone gap, inside the biological chamber.

Patient can walk unassisted and slightly limping but with no pain.

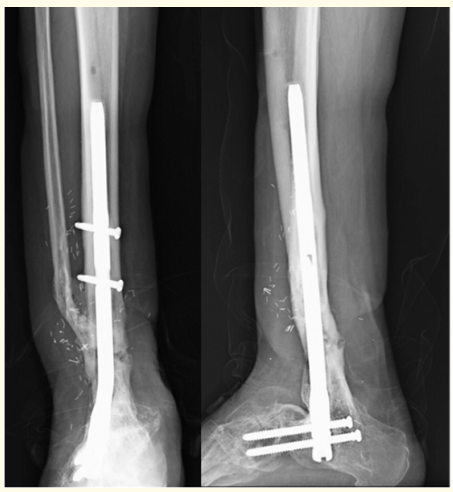

Figure 7: X-ray after 18 months.

Figure 8: Clinic check-up after 18 months.

Discussion

Treatment of bone defects represents an issue with no simple solution.

A bone defect can be caused by chronic infections, severe traumas, or non-unions.

The therapeutic options mainly depend on the gap size and the surgeon's experience.

Bone transport techniques, vascularized and not vascularized fibula autografts, autologous grafts of the iliac crest, heterologous grafts, and bone substitutes of different types can be planned.

The Masquelet method represents a valid therapeutic option, based on Giannoudis' diamond theory, which stresses the importance of vascular contribution and a valid mechanic stability associated with scaffolds, stem cells and growth factors, in order to create the best environment possible for bone regeneration [2-5].

Therefore, with a stable synthesis performance and the bone graft embedded into a biological chamber to enhance and accelerate osteogenic capacity, the healing rate increases significantly [6-13].

Many different studies compare the osteogenic capacity of bone grafts through the RIA method, to the capacity of the iliac crest bone sample, with overlapping outcomes but with less morbidity at the sampling site, despite major iatrogenic type complications associated with the RIA method [1-4].

Another limit of the autologous graft of the iliac crest is the limited size of the samples that can be taken [2-7]. The Masquelet induced membrane technique is based on the principle that the body reacts to the cement spacer in that it is a foreign object, thus filling the void of the defect [9,13,14]. This membrane presents high concentrations of growth factors and is highly vascularized, making it an ideal place thanks to its osteogenic and osteo-inductive factors [8-10]. The presence of the spacer prevents the formation of fibrous tissue and maintains a space for the subsequent bone graft [9,13,14]. If an infection were to arise, the cement would be able to eradicate it as a consequence of the constant flow of antibiotics. For a more successful outcome, suggestions can be found in the literature regarding the addition of demineralized bovine bone to increase the volume of the graft by 30%, as the sample is limited [13,14]. Another solution could be the use of an allograft, although the mechanical quality of the bone union would not be improved.

The type of bone defect, the bone segment involved, as well as the type of defect are not at all correlated with the time it takes for the bone to heal. Bone union has no direct correlation with the severity of the defect in regards to this technique [15-17].

Conclusion

The Masquelet method combined with RIA graft represents a valid therapeutic option considering the bone defect size and applying a rigorous surgical technique. In specific anatomical areas with thin soft part cover defects, the use of the autologous bone graft confined into a semi-rigid shell and an intramedullary synthesis, is an aid for the healing of bony and soft tissue.

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