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UNION OF OPEN TIBIAL SHAFT FRACTURE WITH BONE DEFECT USING STEM CELLS: CASE REPORT

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ABSTRACT

Open tibial shaft fractures are usually challenging to treat and they have a high rate of complications and non-union, up to 10%. Treatments with nail dynamization, compression plating, or the use of rhBMP-2 and BMP-7 are often used to promote the union of these fractures. We present the case of a patient with an open tibial shaft fracture and bone defect treated successfully with intramedullary nailing and autologous stem cells. The patient sustained an open tibial shaft fracture Gustillo IIIA with a 2cm bone defect at the fracture site. It was decided a 2-stage treatment where in the first stage of therapy the wound was irrigated, debridement was performed and the fracture was stabilized with external fixation for 1 month. At the second stage, the external fixation was replaced by an intramedullary nail and the defected fracture site was filled with heterologous bone grafts infused with homologous stem cells, harvested from the bone marrow of the healthy tibia. The post-operation follow-up was free of complications, the patient was ambulatory within the first 40 days and complete fusion of the fracture was radiologically recorded after 8 months. The fusion of tibial shaft fractures, simple or complicated, usually requires both mechanical stabilization and biological stimulation. The role of mesenchymal stem cells in delayed or non-union fractures is currently on research without any level 1 trials or studies. In this presented case, though, with this high risk for non-union fracture, the use of stem cells with the bone grafts led to a clinically and radiologically excellent result.

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INTRODUCTION

Tibial shaft fractures are the most common long bone fractures. They are often associated with soft tissue injury and bone loss. This type of fracture has a 2-10% incidence of nonunion. The main risk factors for nonunion are open fracture, cortical contact <50%, transverse fracture pattern and smoking. The usual treatment options for tibial non-unions are reamed intramedullary nailing and later nail dynamization, compression plating, fibular osteotomy, bone grafting, augmentation with Bone Morphogenetic Protein (BMP) -2 or rhBMP-7, to elicit new bone formation. The use of stem cells shows significant potential for the treatment of bone nonunion. Mesenchymal stem cells are extracted from bone marrow samples and are either cultured ex-vivo or collected with higher concentration by centrifugation of the bone marrow. The stem cells are introduced to the fracture site with a scaffold, like autologous or heterologous bone grafts. This case report is about a 57-year-old man, worker in a storage facility. According his medical history he is smoker and takes medication for hypertension, high levels of cholesterol, hyperuricemia and angina pectoris

METHODS AND MATERIALS

The patient had a work accident where a heavy box fell on his right leg and suffered an open tibial shaft fracture Gustillo IIIa with 2 cm bone defect and bipolar fracture of fibula. There was administered immediate intravenous antibiotics and tetanus prophylaxis in reducing high risk of infection at the emergency department. Due to the complication of the injury, bone defect, soft tissue contamination and many risk factors for nonunion there was decided a 2-stage treatment. At the first stage of therapy, the patient was transferred to the operation room within 6 hours where the wound was irrigated, debridement was performed and the fracture was stabilized with external fixation. The patient was hospitalized for 7 days to continue his intravenous antibiotic therapy. After that he was discharged with instructions for non-weight bearing, regular care of wound and external fixation device, per os antibiotics and subcutaneous anticoagulant therapy for 1 month. At the second stage of therapy, the external fixation was removed. There was performed closed reduction and internal fixation with tibial intramedullary nail. During the operation, harvest of bone marrow from the healthy tibia and extraction of mesenchymal stem cells with centrifugation were performed. The bone defect was filled with heterologous bone grafts (freeze – dried bone allografts) infused with the extracted stem cell solution.

RESULTS

The patient was hospitalized for 3 days after operation to continue his intravenous antibiotic therapy. After that he was discharged with instructions for non-weight bearing for a month. The patient was submitted on post-op x-rays the first month without mechanical complication of internal fixation device so he was able to partial weight bearing after that period. The post-operation follow-up was free of complications or infection of the wound and the patient had often post operative x-rays. At the post-operation follow-up the second, the third and the fourth month the patient was ambulatory without pain or discomfort and the post-op x-rays had no mechanical complication of internal fixation device and but there was still no significant bone fusion. He submitted also post-op x-rays the fifth month which revealed gradual fusion of the fracture. The complete fusion of the fracture was radiologically recorded after 8 months when the fracture was fused and new bone formation was visible. The patient had a complete rehabilitation in his daily life 9 months after his injury.

CONCLUSIONS

This case report demonstrated the strategy for the treatment of a tibial fracture with many risk factors for nonunion. The fusion of tibial shaft fractures, simple or complicated, usually requires both mechanical stabilization and biological stimulation. Apart from the mechanical stabilization of the intramedullary nailing technique that was chosen, special consideration was given for the biological stimulation of the bone formation. The role of MSCs in the treatment of nonunion does not appear to be fully understood. The appropriate concentration of mesenchymal stem cells, the ideal introduction of the stem cells to the fracture site, the need for ex vivo culture or process of the extracted bone marrow stem cells is currently under investigation.

DISCUSSION

In this presented case, the dual staged approach and the combination of both nailing and bone grafting infused with mesenchymal stem cells led to clinical and radiological excellent result. The role of mesenchymal stem cells in delayed or non-union fractures is currently on research without any level 1 trials or studies.

Figure 1. At Emergency Department Day 0

Figure 2. First X-ray Day 0

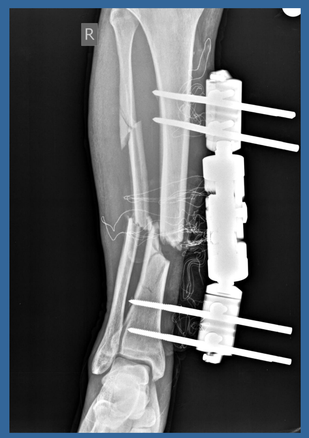

Figure 3. External Fixation Day 2

Figure 3. Post-op x-ray 1 month

Figure 5. Post-op x-ray 4 months

Figure 6. Post-op x-ray 8 months