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Repair of a resistant tibial non-union with a recombinant bone morphogenetic protein-7 (rh-BMP-7)

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In the review article: “Orthopaedic applications of osteogenic protein-1 (BMP-7)” published in *International Orthopaedics* [5], we presented two patients with resistant non-union who healed after application of a recombinant bone morphogenetic protein-7 (rh-BMP-7). Now we present a very rare patient with a pre-amputation non-union of the distal tibia who was healed with rh-BMP-7 and external fixator by Ilizarov after 14 years of unsuccessful treatment.

The morbidity and mortality associated with impaired/delayed fracture healing remain high. About 10% of fractured bones heal slowly (delayed union) or fail to heal (non-union), requiring additional costly medical intervention to repair the fracture [1]. The discovery of bone morphogenetic proteins (BMPs) [4, 5] has increased our understanding of the cascade of events that take place during fracture healing. Several clinical studies demonstrate the capability of these proteins to induce and facilitate this process [2, 3]. Here we report the use of an rh-BMP-7 bound to a collagen carrier (osteogenic protein-1 device) in combination with autologous bone marrow to treat a patient with a resistant, pre-amputation tibial non-union.

The patient fell and fractured the distal tibia at age of 49 and was since unsuccessfully treated 11 times over a period of 14 years. Failed treatments included: plate and screws (three times); plate, screws and autologous cancellous bone (three times), gastrocnemius muscle graft (one time), skin graft (one time), conservative immobilisation (two times), and external fixator (one time). The

patient refused amputation, and an orthosis was applied in combination with two crutches. In our department, during the 12th procedure, the fibula was resected and tibial non-union fragments removed. Due to extremely compromised soft tissues and vascularization, bone marrow cells were simultaneously prepared from the left iliac bone according to a standardised procedure and were mixed with a BMP (OP-1) device (Stryker Biotech, Hopkinton, MA, USA). The mixture was applied between tibial ends, and bone fragments were stabilised by Ilizarov external fixator (Fig. 1A and B). To prevent dispersion of the mixture, the fixator was compressed 48 h following surgery. After discharge the patient walked with two crutches and slowly advanced to full weight bearing during the next 12 months (Fig. 1C). The external fixator was removed 18 months post-operatively after a complete radiographic healing was observed (Fig. 1D). After abandoning crutches, the patient now walks with a 4 cm elevated shoe.

We conclude that a combination of an rh-BMP as a signalling molecule, and implanted bone marrow cells, were capable of healing a pre-amputation tibial non-union.

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Fig. 1 Distal tibia non-union (A) was stabilised by external fixator and a recombinant bone morphogenetic protein (rh-BMP) was applied in combination with autologous bone marrow (B). After a complete bridging of the defect (C), external fixator was removed. The patient slowly advanced to full weight bearing after a complete radiographic healing was observed (D)

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