PP-069

Biological skeletal reconstruction after sarcoma resection. Histological evaluation and CT scan analysis of retrieved cases

M. Manfrini, A. Beraudi, A. Roncari, D. De Pasquale, M. Gambarotti, F. Taddei
Istituto Ortopedico Rizzoli, Bologna, Italy

Aim: Massive bone allografts (MBA) are a worldwide biological solution for reconstructing skeletal sarcomas but the risk of mechanical failure of the allogenic bone remains high in the follow-up (f-up) because of the slow resorption without revascularization. On the other hand, vascularized fibula autotransplants (VFA) are effective solutions to reconstruct radius, ulna or humerus but do not have the right size to reconstruct femur or tibia. In order to add the mechanical characteristics of MBA to the biological activity of VFA, an original combination of a vascularized fibula placed inside a bone allograft was used at Istituto Ortopedico Rizzoli since 1989, as primary reconstruction in lower limb skeleton in a consecutive series of 96 young patients (mean age 13, range 4-38) affected by lower limb bone sarcomas The patients had an intercalary segment (mean length 16cm , range 8-30 cm) of the tibia (71 cases) or femur (25 cases) reconstructed at the time of tumor resection. VFA was inserted into the MBA, that was molded and adapted to receive the fibular bone in an intramedullary fashion. At a mean follow-up of 100 months (range 6-280 mo), 69 patients (72%) are continuously disease-free (CDF) and 10 are disease-free after treatment of a relapse (10%). During f-up, the biological implant was harvested in 16 children because of: Local recurrence (7 cases), Infection (4 cases), Mechanical failure (5 cases). The authors present the results of the multimodal analysis performed in these 16 cases.
Method: All retrieved specimen were histologically processed (7 decalcified and paraffin embedded and 9 undecalcified and polymethylmethacrylate embedded). In 10 patients a pre-harvest CT dataset densitometrically calibrated to obtain quantitative information from the gray levels of the images was available (with at least 3 serial CTs performed in the f-up: the first in the first postop month and the last in the last pre-harvest month). For each of these 10 cases, an electronic folder was created with the use of specialised software in order to identify repeatable reference systems in each reconstruction and monitor the densitometric evolution in selected regions before follow up. In particular the evolution in time of density and thickness of the allograft, of the fibular autograft and of the host original bone was performed. 6ix of these 10 patients had the implants embedded in methylmethacrilate. The slices were processed for Paragon staining and Circular Polarized Microscopy, to detect bone and soft tissues structures, and collagen orientation. The same sections used in the histological analysis were identified in the CT dataset done before the surgical harvest. On residual embedded bone, microhardness test was performed to measure bone mechanical competence.
Results: VFA was found viable in the 6 out of 7 cases harvested for LR and in the 4 infected implants. Four out of 5 cases that failed mechanically showed a necrotic VFA. In the 11 viable cases a complete fusion of MBA and VFA was observed in at least one position of the selected slices both on the CT analysis and in the histology. In the cases embedded in methylmethacrilate, In the inner boundary of the allograft the microscopic structure showed a change from mainly lamellar and transversally oriented in newly formed osteon-organized bone. At the same level, fibula loosed its structure in the region opposite to fusion area. Micro hardness in fusion area (both in allograt and VFA side) had a value comparable to the mean typical value (50HV) of a cortical diaphysis, while this value decreased sharply in the remaining part of fibula, to signify a remodeling process related to the lack of mechanical stress. The morphological changes clearly correlated on the CT dataset (figure).
Conclusion: Multimodal histological and CT analysis describes the intense remodeling between the MBA and VFA used in a concentric fashion with new osteons forming into the allograft bone and confirming the bone-inductive activity of VFA on the endosteal surface of MBA.

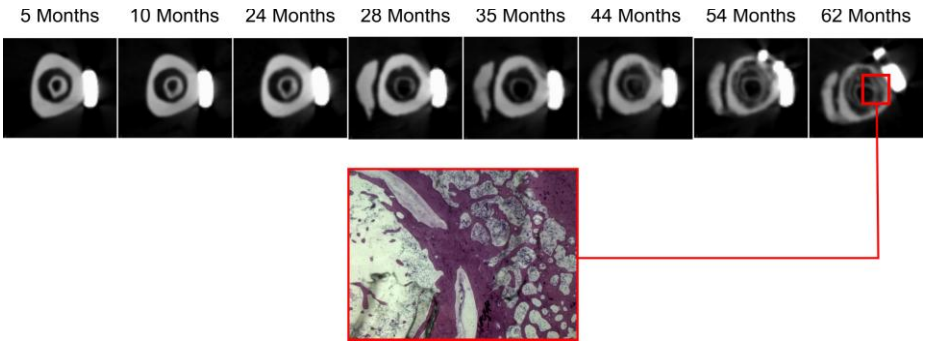
5 Months
10 Months
24 Months
28 Months
35 Months
44 Months
54 Months
62 Months

Figure 1.