PATIENT-SPECIFIC 3D-PRINTED REGISTRATION AND CUTTING GUIDES FOR HEMICORTICAL RESECTION AND RECONSTRUCTION OF METAPHYSEAL TUMORS AROUND THE KNEE

SEGURA FM*, PEDEMONTE F**, SEGURA FP*, SEGURA FV*

*2ª. Catedra de Ortopedia y Traumatología – Facultad de Medicina – Universidad Nacional de Córdoba – Córdoba – República Argentina

** Raomed S.A.

INTRODUCTION

Some benign aggressive tumors and low grade malignant tumors can be resected with close margins without compromising the patient´s oncological evolution.

When these tumors are located in the distal femur or proximal tibia, they compromise the knee joint.

Hemi cortical resection, instead of intercalary or osteoarticular allows to save the articular surfaces, the bone stock and the opposite cortical continuity.

Intra-surgical navigation has improved precision of the cuts performed in a tridimensional space. In this paper, we explore the combined use of Surgical Navigation with 3D-printed registration and cutting guides

The objective of this paper is to report the use of surgical navigation, registration and cutting guides for hemi cortical marginal resection and allograft reconstruction of metaphyseal tumors around the knee.

MATERIAL AND METHODS

MATERIAL

3 patients were treated during the study, 2 presenting parosteal osteosarcoma in the distal femur and 1 presenting a peripheral chondrosarcoma in the proximal tibia.

The patients presenting parosteal osteosarcoma were females aged 18 and 29 years old and the patient with peripheral chondrosarcoma was a 24-year-old male.

CT and MRI images were fused and processed and 3D-models were created. They served as a basis for the virtual simulation of the surgery, which was performed in the Mimics Innovation Suite (Materialise NV). Once the simulation was satisfactory, the results were used to digitally compare and select the optimal allograft. After this, two guides were designed and 3D-printed: a patient-specific and an allograft-specific registration and cutting guide. The cutting planes derived from the planning, as well as the CT and MRI images were loaded into a Stryker Intellect Computer-Assisted Surgical Navigation System.

The registration and cutting guides were fully matched with the coordinate system and landmark points generated inside the Navigation System´s software.

METHOD

In all the cases a virtual planning was performed through CT and MRI images fusion and 3D modelling of the lesion.

The guides were designed based on the virtual planning giving the possibility to cut 5 mm and 10 mm away from the tumor margin. Prior to the surgery, 3D printed biomodels were used to physically perform the surgery on them. That allowed to check the performance of the guides regarding margins accuracy and integration with the Surgical Navigation System.

The tumor is reached by a conventional approach. Once the guide is properly positioned, five (5) landmarks are touched with a smart pointer in order to match specially the Navigation System´s reference frame with the bone reference frame. Once this was performed, it was possible to navigate the femur or the tibia and locate the resection planes. The jigs contain, grooves located so as to guide the blade along the resection planes.

After the tumor resection, the same procedure was repeated in the allograft. The reconstruction was made with the allograft, stabilized by means of conventional plates and screws.

RESULTS

In the three cases the margin was free of tumor, both at macro and microscopic level and never less than 1 mm, according to the original plan.

There were no postoperative complications registered and the patients were allowed to walk with full load in the treated limb 4 months after the procedure.

At the assessment time every graft showed integrated and the functional MSTS score average was 28.

DISCUSSION

The current challenge in bone tumor surgery is to resect the least amount of tissue of the host in order to preserve the maximum function possible.

In some tumors marginal resection is a good option without compromising the oncological evolution.

In low grade malignancies near the knee is possible the resection of only one cortex, preserving the articular cartilage, bone stock and the continuity of the opposite cortex.

The use of navigation in this situation has allowed planned bone cuts with better precision. The medical images and 3D reconstruction models allow the surgeon to do cuts according to what was previously planned.

In hemicortical resections the use of cutting guides allows a resection according to the planning with a precision of 1mm.

In addition the guides allow a more exact matching when the reconstruction is made with allograft bone.

CONCLUSIONS

The use of Patient-Specific Custom-Made cutting guides in tumor resection and allograft reconstruction around the knee allows marginal resections, with optimal morphological matching between the allograft and host bone.