Femoral Corrective Osteotomy Using a Patient-Specific 3D-Printed Guide

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Purpose: Surgical treatment of complex multiplanar deformities might result in multiple failed surgeries. Complications may generate conditions such as diminished bone quality, increased infection risk, or affect the adjacent joints. Management of these disorders represent a challenge in the attempt to offer an adequate outcome. The use of 3-dimensional (3D)-printed devices can result in a better understanding of the deformity correction and, in consequence, may produce a more accurate intervention. Our objective is to demonstrate that the use of 3D models and custom-made osteotomy guides improve preoperative planning and provide a more precise correction angle for the osteotomy with the benefit of enhanced surgical training techniques, improving the surgeon's confidence during the definitive surgical procedure and thereby decreasing the risk of inappropriate correction osteotomies.

Methods: A 25-year-old male patient had a severe multiplanar deformity of the femur secondary to a hip fracture as a 9-year-old child. Through the years, two valgus and one derotation osteotomy were performed, complemented by femur lengthening with an external fixator. Four years after the last surgical procedure he suffered a distal third femoral fracture treated initially with a pelvipodalic cast, resulting in a femoral angular deformity. He came to the orthopaedic trauma surgery clinic because of limb shortening, varus plus recurvatum deformity of the femur, and knee rigidity. An alignment osteotomy fixed with a retrograde femoral nail was performed. The site and configuration of the osteotomy was selected using finite element analysis, determining the site of highest stress, and a 3D-printed cutting guide was made. The surgery was first performed in the biomechanics laboratory in a 3D-printed model of the femur and the femoral analysis was performed by calculating a closing wedge of 43.68° to achieve the desired alignment in the coronal and sagittal planes. During surgery, a quadricipital shortening was evident, so a quadriceps tendon reconstruction was performed using an autograft from the gracilis and semitendinosus tendons.

Results: Correction was achieved obtaining an alignment in the coronal plane from a varus of 46.9° to 4.3°. The anterior deformity was corrected from 47.4° to 2.7°. This procedure corrected the length discrepancy from 6.9 to 1.3 cm. Knee flexion was recovered from 10° to 100°. The patient is now completely functional and walks without crutches.

Conclusion: Preoperative planning assisted with 3D-printed models is useful for replicating the procedure in the laboratory before the definitive surgery. This helps to prevent complications, efficiently improves the osteotomies, and provides precise cuts with the use of prefabricated 3D guides. It is a low-cost resource that diminishes the possibility of failure. These models were used initially for complex cases only but nowadays they are being used more frequently. Novice surgeons may benefit from this technology since it can be used as an innovative training tool.