

# Use of 3D printed personalized osteosynthesis material for knee osteotomy

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## PURPOSE

In recent years the use of customized surgical material manufactured by 3D printing has been growing in the field of orthopedic surgery.<sup>1,2</sup> New developments in osteotomy techniques and methods of fixation have caused a renewed interest in wedge osteotomies of the tibia and femur in the treatment of knee osteoarthritis. In this work we describe and evaluate a **new customized guidance and osteosynthesis system for tibia and femur wedge osteotomies**.

## METHODS

A prospective observational study was performed in 12 patients who required knee osteotomy. **Seven were high tibia closing wedge osteotomies, 4 low femur opening wedge osteotomies and 1 double closing wedge osteotomy** (femur and tibia at the same time). DICOM images from a CT study and the Mimics Medical software were used to perform the **surgical planning** (Figure 1). The personalized guides and plates used in this study were designed by the Unigraphics NX11 software and **manufactured by additive manufacturing** using SLM technology with PA2200 material for the guides and EBM technology with Ti6Al4V material for the osteosynthesis plates (Figure 2). To analyze the accuracy obtained, a comparative study was made between surgical planning and a radiological study performed one month after surgery.

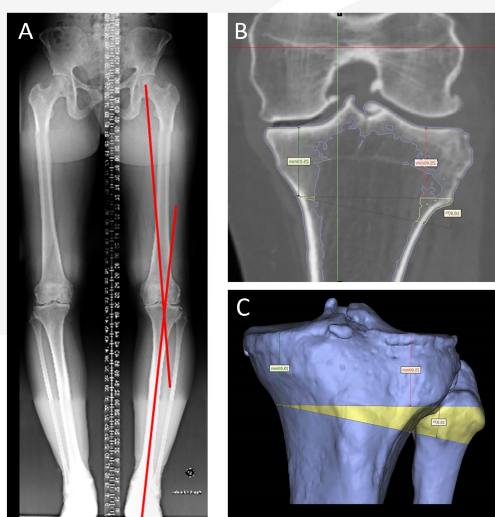


Figure 1. surgical planning using radiographies (A), CT scan images (B) and subsequent 3D reconstruction (C).

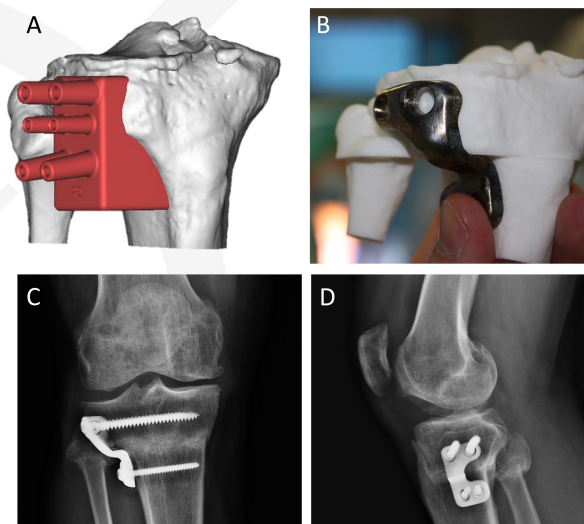


Figure 2. Design of the personalized guide (A), 3D printing of the plate (B) and X-ray of the surgical intervention (C, D).

## RESULTS

Six months after surgery, **the accuracy was 1,4° (0°-4°) of hypercorrection, with only 1 bad result due to osteosynthesis material failure**, and patient had to be re-operated (Table 1). **No intolerance to the material** was reported in any case. Surgical **time was reduced markedly** by facilitating surgery. In addition, thanks to this technique, the tibial/femoral **bone cut height could be calculated in the presurgical planning**.

Age	Sex	Limb	Type	Varus/valgus	Result
21	Man	Limb (Right)	Subtraction	10° varus	3,5°(valgus)
43	Man	Tibia (Right)	Subtraction	10° varus	1,5°(valgus)
47	Man	Tibia (Left)	Subtraction	15° varus	2,5°(valgus)
54	Woman	Tibia (Right)	Subtraction	10° varus	0,5°(valgus)
54	Woman	Tibia (Left)	Subtraction	12,5° varus	1°(valgus)
58	Man	Tibia (Right)	Subtraction	6° varus	0°(valgus)
59	Man	Tibia (Left)	Subtraction	7° varus	4°(valgus)
62	Man	Tibia (Left)	Subtraction	7° varus	0°(valgus)
52	Woman	Femur (Left)	Addition	8° valgus	0,5°(varus)
54	Man	Femur (Left)	Addition	7° valgus	0,5°(varus)
56	Man	Femur (Left)	Addition	9° valgus	No Data
30	Man	Femur (Left)	Sustraction	8° valgus	Failure

Table 1. Patients undergoing osteotomies with personalized plates and guides.

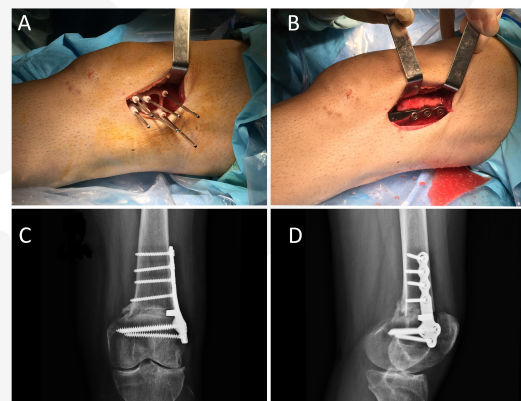


Figure 3. Femur osteotomy using guides (A) and personalized plates (B), and control X-ray (C, D)

## CONCLUSIONS

The surgeries performed with **personalized 3D guides and osteosynthesis plates allow surgical planning**, facilitate the intervention, **reduce surgical time** and possible complications, and **increase the precision** of the osteotomy.

## REFERENCES

- Fiz N et al. Application of 3D technology and printing for femoral derotation osteotomy: case and technical report. Ann Transl Med. 2017 Oct;5(20):400.
- Lal H et al. 3D printing and its applications in orthopaedic trauma: A technological marvel. J Clin Orthop Trauma. 2018 Jul-Sep;9(3):260-268.