

# BIOMECHANICAL EVALUATION OF GENERATIVELY DESIGNED PATIENT-SPECIFIC HIGH TIBIAL OSTEOTOMY PLATE FIXATIONS

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## Introduction

High Tibial Osteotomy (HTO) is an effective joint preserving treatment for knee osteoarthritis (OA), offloading the affected area within the medial compartment to relieve pain and optimise joint movement [1]. The one-size-fits-all approach adopted in HTO results in major plate related complications such as delayed or incomplete healing, skin irritation, implant prominence, stress shielding, lateral hinge fractures, construct instability, eventually requiring a revision surgery, all of which diminish post-operative clinical outcomes and hinder the ultimate potential of HTO [2]. The authors have developed a novel design framework to produce patient-specific HTO plates from a CT scan using Generative Design (GD) [3]. Unlike conventionally designed HTO plates, the application of GD allows plate designs to simultaneously integrate patient factors, surgical planning, and patient specific biomechanics with the aim to reduce plate stiffness and profile on soft tissue.

## Methods

A surrogate left tibia (Sawbones model 3401-1) with 10-degree varus deformity was used for virtual simulation of HTO. A biomechanical model of the HTO construct with the gold standard plate was developed and validated through finite element modelling, to attain plate design requirements. Subsequently, the clinical and biomechanical requirements were replicated within the GD domain to explore titanium (Ti-6Al-4V) fixation plates for HTO. The novel patient-specific plate designs (Figure 1) were comprehensively analysed through biomechanical assessment under physiologic loading, to attest their construct stability, healing efficacy, stress shielding effect, lateral hinge stability, and the risk of implant failure.

## Results

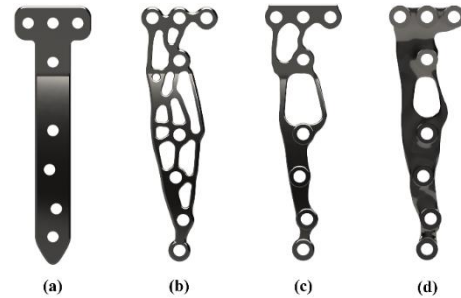


Figure 1: HTO plate designs (a) Gold standard plate (b) GD plate A (c) GD plate B (d) GD plate C

## Discussion

GD approach to HTO increases the patient-specificity of plate designs by creating personalized fixation conforming to both patient anatomy and biomechanics, minimising surface area, plate prominence and stiffness whilst maintaining construct stability, and thus improving mechanobiological performance and post-operative surgical outcomes.

## References

1. M. O'Malley et al., *Arthrosc. Tech.*, 5, pp. e769–e774, 2016.
2. T. Woodacre et al., *Knee*, 23, pp. 276–282, 2016.
3. S. Kanagalingam et al., *Prog Addit Manuf*, 2022.

## Acknowledgements

This work is supported by the UK's Engineering and Physical Sciences Research Council (EPSRC) National Productivity Investment Fund (EP/R512436/1)

