

The Use of 3D Models and Extended Reality for Surgical Planning in Craniopagus Twins

Heron Werner¹, Gabriel Mufarrej², Owase Jeelani³, Jorge Lopes¹, Gerson Ribeiro¹, Vinicius Arcoverde¹, Pedro Castro¹, João Azevedo¹

1. Biodesign Lab Dasa/PUC-Rio, Rio de Janeiro, Brazil
2. Pediatric Neurosurgery, Instituto Estadual do Cérebro, Rio de Janeiro, Brazil
3. University College London Great Ormond Street Institute of Child Health, London, UK

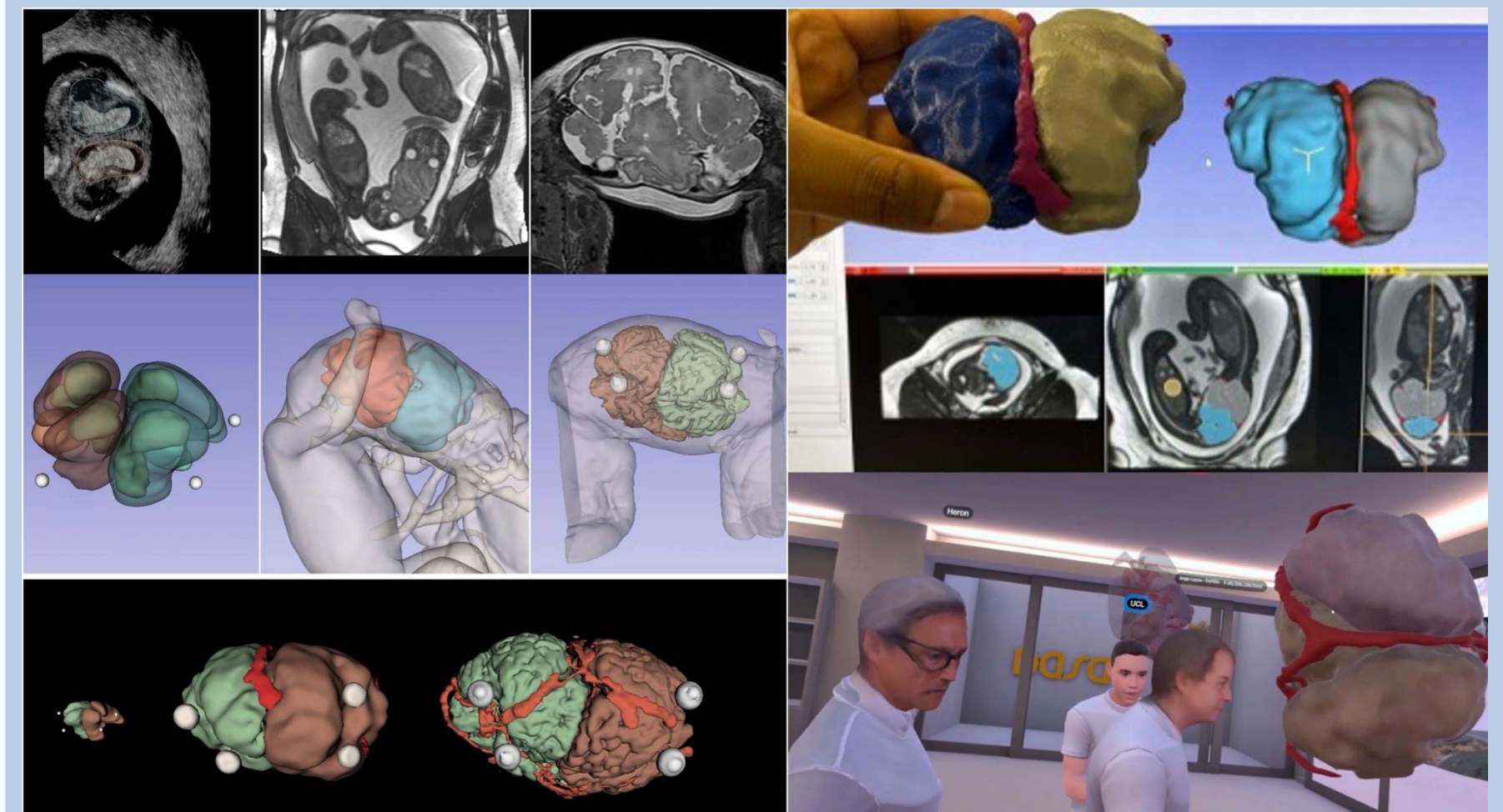
Objective: This study aims to describe the surgical planning of craniopagus twins (CPT) using 3D models and extended reality (XR) from the prenatal stage.

Methods: CPT was diagnosed at 13 weeks of gestation using 3D ultrasound (US), revealing also a single ventricle heart malformation in one fetus. Magnetic resonance imaging (MRI) at 30 weeks provided further insights for surgical planning. A multidisciplinary team across different regions of Brazil and England collaborated on postnatal separation. Postnatal surgery was planned utilizing 3D models and XR.

Results: After birth at 32 weeks, additional examinations with computed tomography (CT) and MRI were performed. The twins were successfully separated 52 days postnatally. While the neurosurgery was successful, the twin with the cardiac malformation did not survive. However, he donated meningeal tissue, bone, and skin to his brother, who had an excellent clinical outcome. 3D models provided a clear understanding of brain structures, while XR facilitated global expert discussions. The models also served as training tools, helping to mitigate potential complications.

Discussion: CPT is an extremely rare condition, occurring in approximately 1 in 2.5 million live births. Despite its high morbidity and mortality rates, advances in neuroimaging and neurosurgical techniques have improved separation success. The evolution of XR and 3D models generated from US, MRI, and CT has significantly enhanced surgical planning and served as crucial anatomical references during procedures.

Conclusion: The use of 3D models and XR was essential for pre-surgical planning, providing critical insights into complex anatomical variations. XR also played a key role in optimizing the surgical approach and facilitating expert collaboration worldwide.



Fetal brains at 13 weeks, 30 weeks, and postnatal. 3D virtual models. A 3D-printed model at 30 weeks was generated based on MRI data and multidisciplinary discussion in the metaverse.