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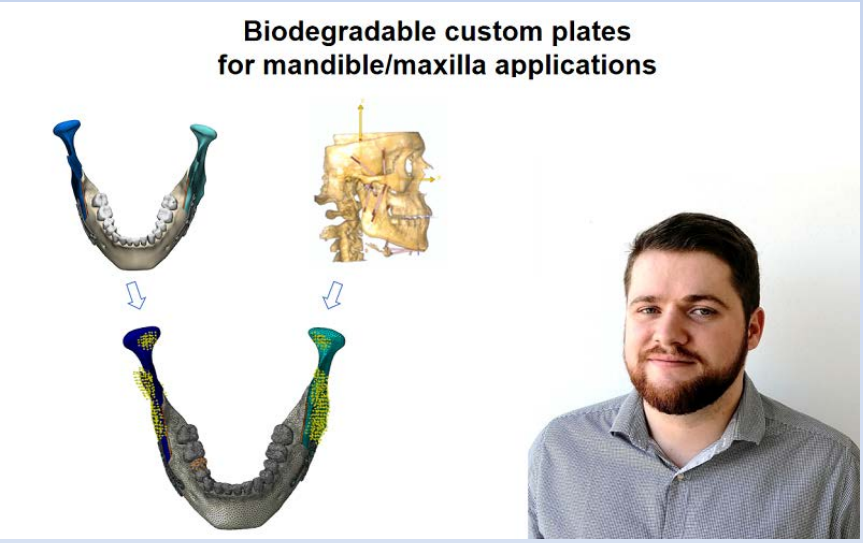
July-December 2020

CURABONE

Predictive models and simulations in bone regeneration: a multiscale patient-specific approach

1. WELCOME TO ANTOINE VAUTRIN, NEW ESR



We are very happy to introduce Antoine Vautrin as a new member of the Curabone team since August 2020. He obtained his Bachelor's degree in Materials Engineering and his Master of Science in Biomechanics at the University of Lorraine in France. He completed his master's thesis internship at the University of Zaragoza in the M2BE (multiscale in mechanical and biological engineering) research group and worked on patient-specific Finite Element models incorporating bone regeneration models. He has done a great job in Curabone so far. Welcome, Antoine!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 722535.

2. THE EXPERIENCE OF THE ESRS IN CURABONE

Some of our PhD students have finished their time at Curabone, and they have shared with us what their time at this ITN has meant to them. Despite having finished their contracts, they are still part of the team. In fact, they will participate in the **Curabone Final Event** on 11th February 2021, an online celebration of the project's completion, where they will disseminate the results of their research and their personal experience as Early Stage Researchers.

My experience in Curabone as an Early Stage Researcher: Jonathan Pitocchi

When I started my Marie Curie experience in the Curabone ITN project, I felt it could represent a once in a lifetime chance, not only for the development of my scientific career, but also for my life in general. In three years, thanks to the high mobility of the fellowship, I had the opportunity to participate in many international events including top-tier conferences, workshops, training and meetings around the world (Canada, Austria, Ireland, Spain, Belgium…).

The Marie Curie grant gave me the opportunity to develop my own research project with a large degree of autonomy. In particular, the main goal of my project was to define a method to optimize long-term fixation of shoulder implants, using patient-specific information to personalize the surgical management. Computer Aided Tools, supported by experimental validation, were used to optimize screw parameters and prosthesis design and position, eventually providing novel tools to the surgeon to support their clinical decisions. In this way, the pre-operative planning for shoulder implants could be improved by decreasing planning time and ensuring a better surgical outcome.

The mixed blend of industry-academia, a unique feature of ITN networks, gave me the possibility to contribute with my project to bridge the gap between fundamental research at the university and product development in a medical device company. The main outcomes of my research not only underwent a scientific evaluation, resulting in three publications in peer-reviewed journals, but most of them were also transferred into commercial software or used as supporting tools in specific company processes.

Today, thanks to the Marie Curie fellowship, I am confident that my improved professional profile will open new opportunities in the competitive scientific job market.

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My experience in Curabone as an Early Stage Researcher: Gabriele Nasello

The CuraBone project may sound like just another Innovative Training Networks grant for an outsider. For me, it has been an unvaluable doctoral training and a life changing experience. During my 3 years as Early Stage Researcher, I lived in four European countries (Spain, Ireland, United Kingdom and Belgium) and worked in five world-class academic and non-academic institutions (University of Zaragoza, NUI Galway, Robert Jones and Agnes Hunt Orthopaedic Hospital, Materialise NV and KU Leuven). From a research perspective, I experienced different working environments and learned hard skills both in computational and experimental research, which ended up with two scientific research papers published in peer-reviewed journals. The computational research investigated whether the regenerative potential depends on both the scaffold and the host mechanical environment. The experimental research focused on the development of a micro-engineered platform to assess the osteogenic activity of primary osteoblasts isolated from single donors. Overall, I gained experience on different aspects of scientific research, such as finite element simulation, scientific programming with Python, microscopy image acquisition and analysis and in vitro culture of human cells. This a mix of interdisciplinary skills that I could learn only because I collaborated with several researchers.

Moreover, partners involved in the project offered several trainings on transferable and soft skills, which I feel that are guiding my career progression. From a personal point of view, the international collaborations I established have enriched my cultural background and my feeling as European citizen. At the end of the project, I realized how much I grew both as a researcher and as an individual. To be honest, I did not expect it.

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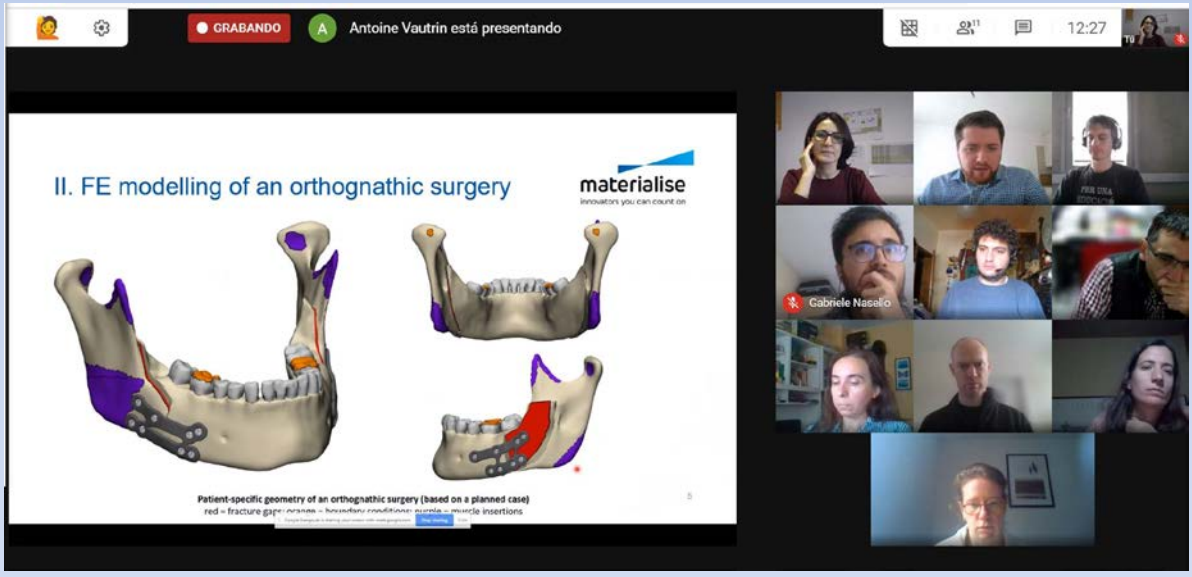
3. VIRTUAL CONSORTIUM MEETING



We held our biannual **Consortium Meeting** online on October the 28th. It was great to have the chance to share, catch up, discuss, plan new activities and listen to our ESRs, who made great presentations on their research work. It was also very nice to have Jonathan Pitocchi and Gabriele Nasello, who despite having finished their time as ESRs in Curabone joined the meeting and presented the conclusions of their experience in the project.

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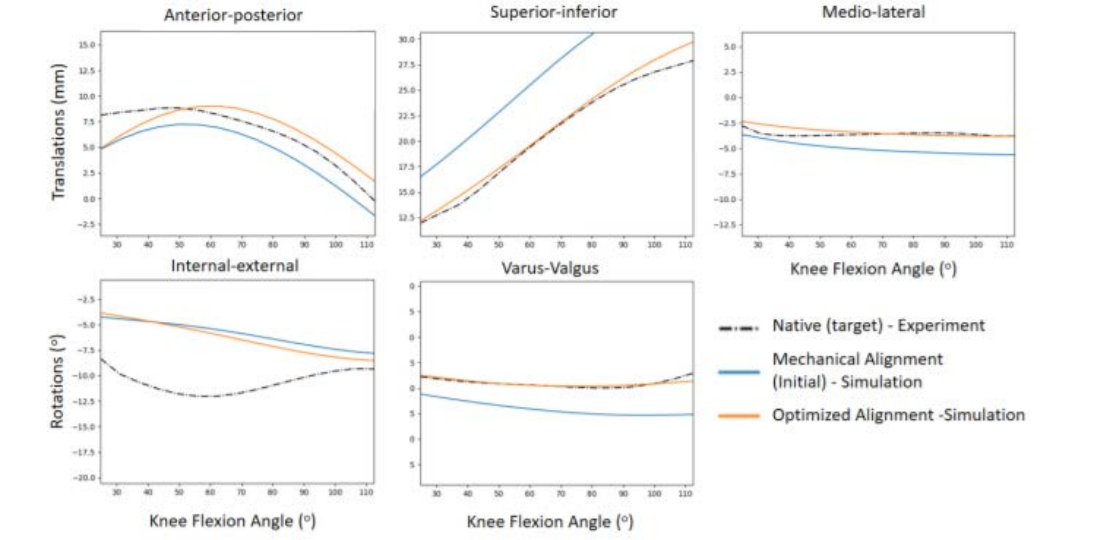
4. DISSEMINATION: PUBLISHED ABSTRACTS - CAOS 2020

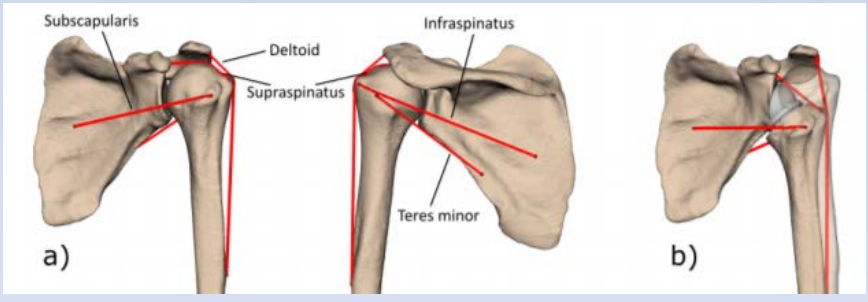
The 20th Annual Meeting of the International Society for Computer Assisted Orthopaedic Surgery (CAOS 2020) was finally held online due to the pandemic restrictions, but the abstracts sent by our ESRs David and Jonathan were published:

Standard Cruciate-Retaining Total Knee Arthroplasty Implants can Reproduce Native Kinematics. EPiC Series in Health Sciences Volume 4, 2020, Pages 61–64
David Leandro Dejtiar, Laura Bartsoen, Mariska Wesseling, Roel Wirix-Speetjens, Jos Vander Sloten and Maria Angeles Perez



Tibiofemoral kinematics during a squat from 20 to 120 degrees of knee flexion for specimen 1

Automatic muscle elongation measurement during shoulder arthoplasty planning. EPiC Series in Health Sciences Volume 4, 2020, Pages 237-239
Jonathan Pitocchi, Katrien Plessers, Mariska Wesseling, G. Harry van Lenthe and Maria Angeles Perez



(a) Shoulder muscles. (b) Reverse shoulder implant: pre (transparent) vs post-op model.

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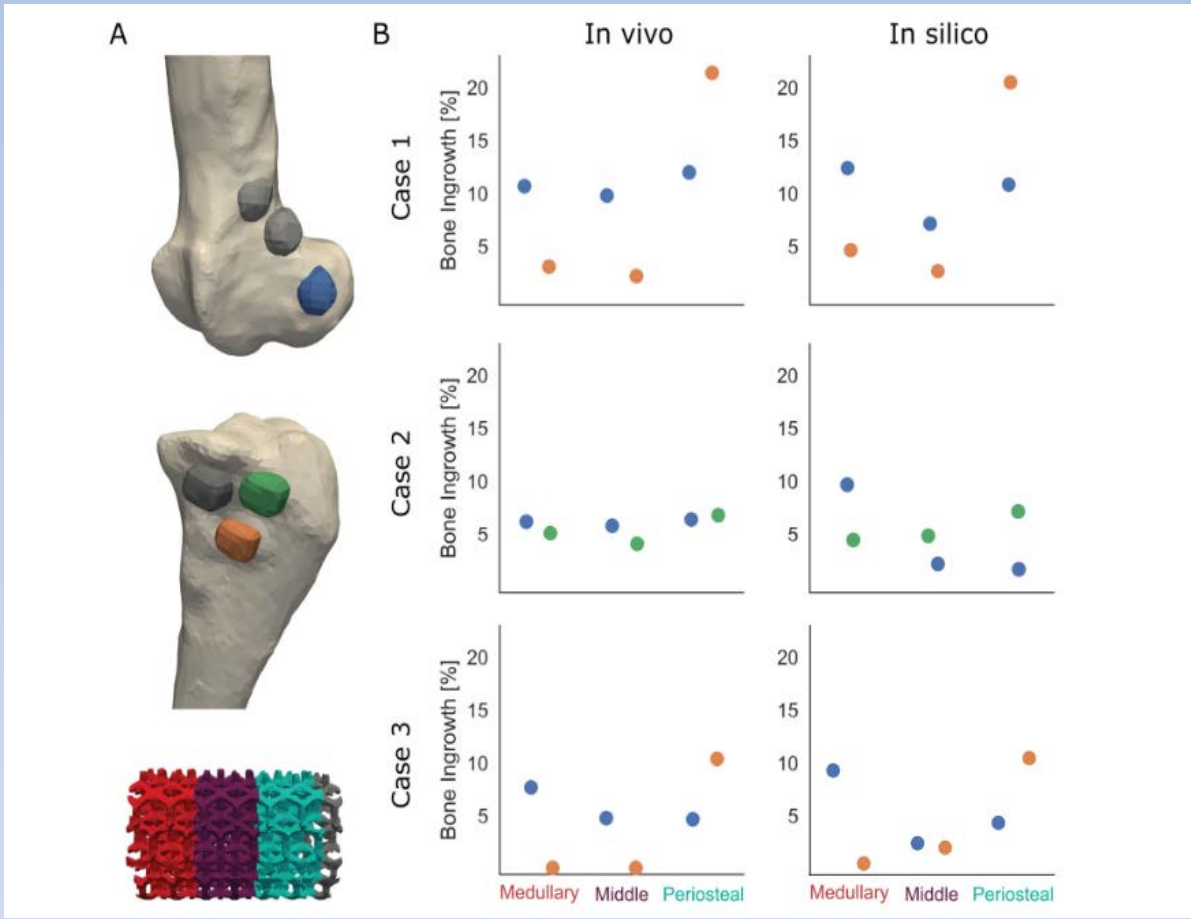
5. DISSEMINATION: NEW PUBLICATIONS IN SCIENTIFIC JOURNALS

Mechano-driven regeneration predicts response variations in large animal model based on scaffold implantation site and individual mechano-sensitivity Bone
Gabriele Nasello, Antoine Vautrin, Jonathan Pitocchi,Mariska Wesseling, Jan Herman Kuiper, María Ángeles Pérez, José Manuel García-Aznar



Mechano-driven regeneration predicted bone ingrowth distribution in different scaffold locations. Bone ingrowth was assessed in six different scaffolds inserted into the left femurs and the tibiae of three different goats (cases) after 12 weeks from implantation. (A) Representative femur and tibia models showing the epiphyseal (blue, green) and diaphyseal (orange) locations of the titanium bone scaffolds. The scaffolds were individually simulated with the finite element model of mechano-driven bone regeneration. Three-dimensional view of the porous titanium scaffolds (gray) with the medullary (red), middle (purple) and periosteal (light blue) subregions highlighted. (B) Comparison of bone ingrowth quantification between in vivo and in silico models. (

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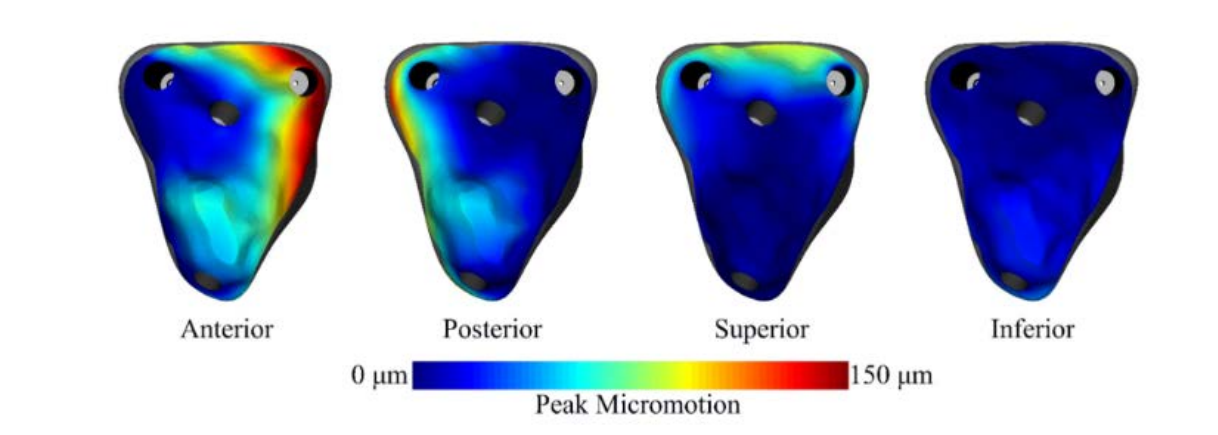
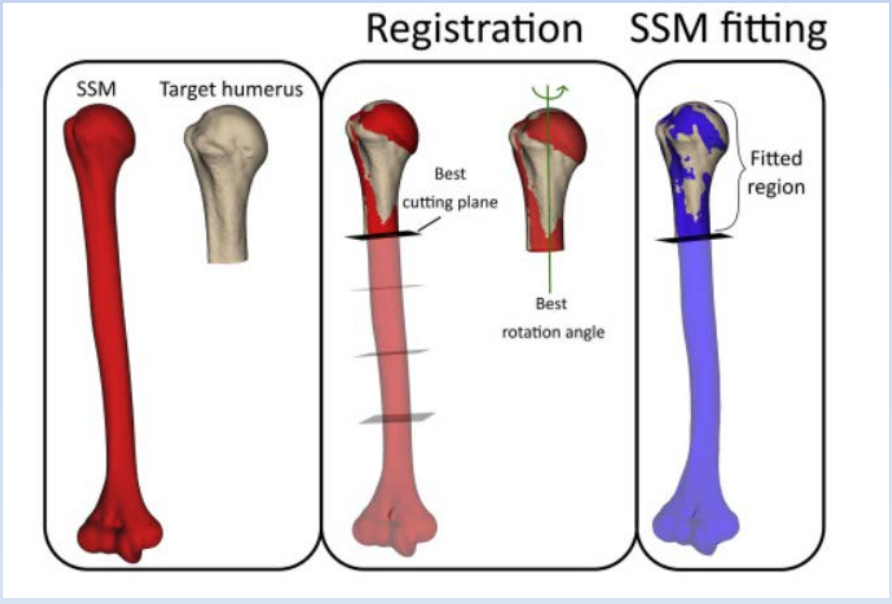
Finite Element Analysis of Custom shoulder Implants Provides Accurate Prediction of Initial Stability Mathematics
Jonathan Pitocchi, Mariska Wesseling, Gerrit Harry van Lenthe and María Angeles Pérez



Back view of the implant. Peak micromotion map at the bone-implant interface for all the loading directions.

Automated muscle elongation measurement during reverse shoulder arthroplasty planning
Journal of Shoulder and Elbow Surgery
Jonathan Pitocchi, Katrien Plessers, Roel Wirix-Speetjens, Philippe Debeer, G. Harry van Lenthe, Ilse Jonkers, Maria Angeles Pérez, Jos Vander Sloten



Workflow for registration and fitting of humeral statistical shape model (SSM) to target humeral shape. The target humeral shape can contain the complete humerus or only the proximal part (left). First, the best cutting plane and best rotation angle are selected to register the SSM to the target humeral shape (middle). Second, the SSM is fitted to the target humeral shape while all SSM points that are below the selected cutting plane are ignored (right).

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Leading institutions:

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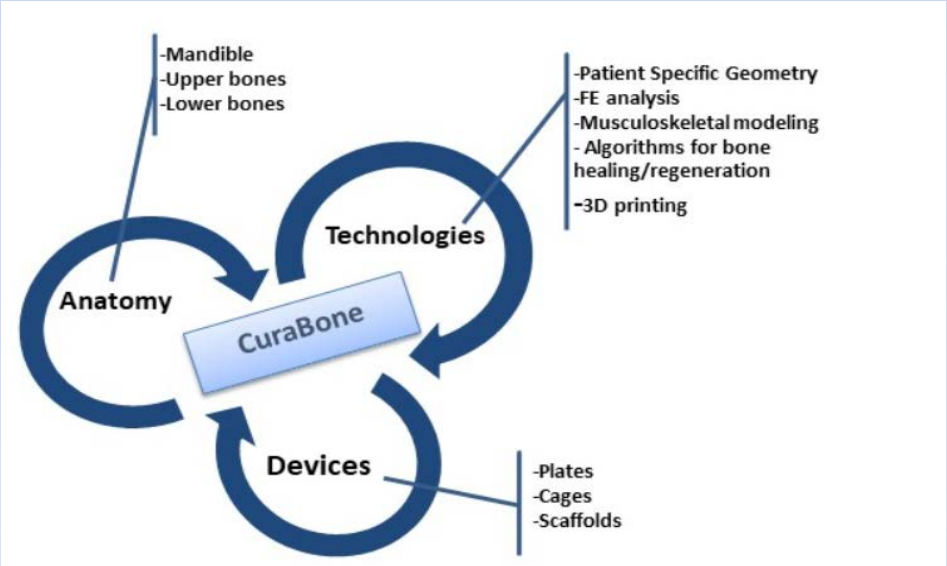

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