3D printed rodent skull for animal-free approach for neurosurgical training
Optimizing the 3R's within rodent stereotaxic surgery

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Introduction

In research, stereotaxic surgery is a critical technique for allowing exploring of the brain in live animals. Stereotaxic brain surgery requires sufficient and proper training. There is currently no animal-free training option. Stereotaxic techniques are learned and practiced on dead animals. We aim to introduce and implement 3D printed skulls to create rodent like brain models for training. We will do this in collaboration with Marie Bainier from Roche Innovation Center in Basel, who has already implemented this technique.

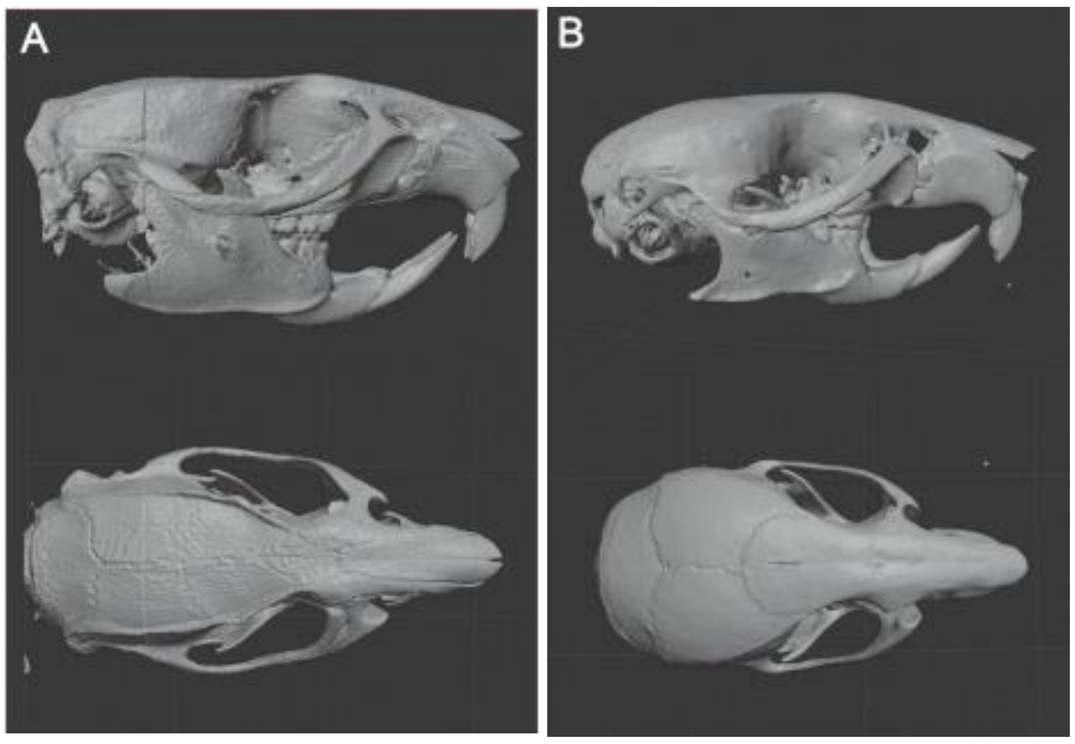

Fig 1. 3D printed models of rat (A) and mouse (B)

Aim

To train a surgeon takes many surgeries and much practice. Using 3D printed skulls, the surgeon can train without using real rodents. The training can be repeated as much as needed. This will reduce the number of live animals from approximately 5 to 0 animals depending on the type of surgery. Training possibilities will include; fixation in stereotaxic frames, craniotomies and cranial windows, screw placements, brain injections, electrode/ probe implantations and long-term suturing techniques.

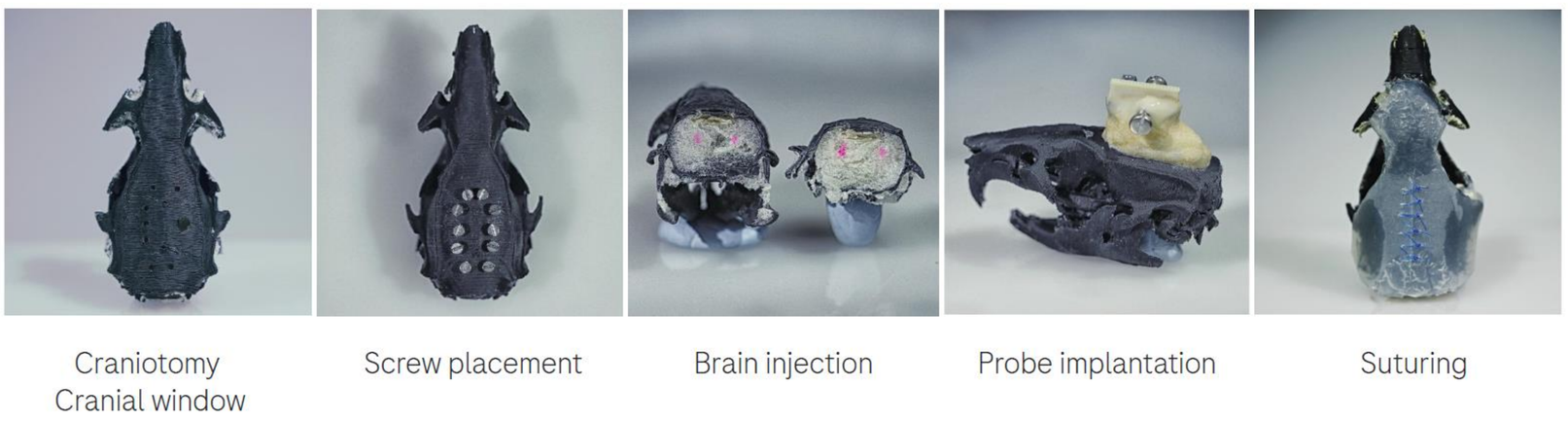

Fig 2. Various techniques that can be trained using the 3D printed skulls

Focus on the 3R's

Proper surgery techniques are fundamental for animal welfare and for securing high-quality data. Animals are typically used, under specific animal care licenses, to practice stereotaxic surgeries. But with the 3D printed skulls we can have an animal-free option for neurosurgery training. The benefits are therefore threefold.

Replace: **Replacement of rodents for all types of stereotaxic brain surgery training**

Refine: **Higher success rate and shorter surgery times, reduce animal distress and allow better recovery**

Reduce: **Better implant stability allowing us to reuse animals for several experiments**

Conclusions

- It is crucial to have the right 3D printer and resin to print the skulls to the necessary quality and detail
- Once printed to correct quality, initial piloting trials with these replicas will be needed to familiarize the surgical trainers
- Surgery trainings will be possible without use of live animals

What is next?

Beyond the basic 3D printed skulls, it is also possible to create artificial brain tissue and skin to practice deep brain electrode placements as well as suturing techniques. Furthermore, you can practice drilling and screw electrode placement.

Cost/resources

3D printer:	40.000 DKK
Printing material (20k skulls):	2.000 DKK
Repair maintenance:	5.000 DKK

Acknowledgements

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Marie Bainier; Roche Innovation Center Basel provided support and images shown here. *Ref. 3D printed rodent skin-skull-brain model: A novel animal-free approach for neurosurgical trainingMarie BainierID1 *, Arel Su2 , Roger L. Redondo1 1 Roche Pharmaceutical Research and Early Development (pRED), Neuroscience and Rare Diseases, Roche Innovation Center Basel, F. Hoffmann-La Roche Ltd, Basel, Switzerland, 2 Roche Pharmaceutical Research and Early Development (pRED), Pharmaceutical Sciences, Roche Innovation Center Basel, F. Hoffmann-La Roche Ltd, Basel, Switzerland*