Digital transformation in nose surgery

Kunica, Zoran; Poje, Gorazd; Mlivić, Denis; Knežević, Mario; Antunović, Bartol

Zoran **Kunica**, Gorazd **Poje***, Denis **Mlivić**, Mario **Knežević**, Bartol **Antunović**

Digital transformation in nose surgery

University of Zagreb Faculty of Mechanical Engineering and Naval Architecture

* University Hospital Centre Zagreb; Department of Otolaryngology, Head and Neck Surgery

Content

- **Aim and goals of work**
- **Inferior nasal turbinates surgery in CAD**
- **Rhinoplasty in Virtual Reality**
- **Future work**

Aim and goals of work[1][2]

- **Digital integration** of the whole nose surgery process:

  from the diagnosis and state of a specific patient, through surgery itself till wider health-care and social context.

- **better understanding – new knowledge**
- **normization – increased efficiency**
- **new tools, mechanization and automation**

[1] Towards virtualization and optimization of sinus surgery planning and execution
Kunica Zoran, Poje Gorazd, Mlivić Denis, Topolnjak Jan
Medica Jadertina 52 (Suplement 1), 17-17, 2022

[2] Conceptualisation of Virtual Reality Experiments for Optimised Sinus Surgery Planning and Execution
Kunica Zoran, Poje Gorazd, Mlivić Denis, Topolnjak Jan
International journal of industrial engineering and management 14 (1), 13-24, 2023

- Two surgery procedures observed in the work:
  - **inferior nasal turbinate surgery**[3]
  - **rhinoplasty**[4].

[3] Virtualizacija kirurških zahvata na nosu/Virtualization of nose surgery
Knežević Mario
University of Zagreb Faculty of Mechanical Engineering and Naval Architecture 2023

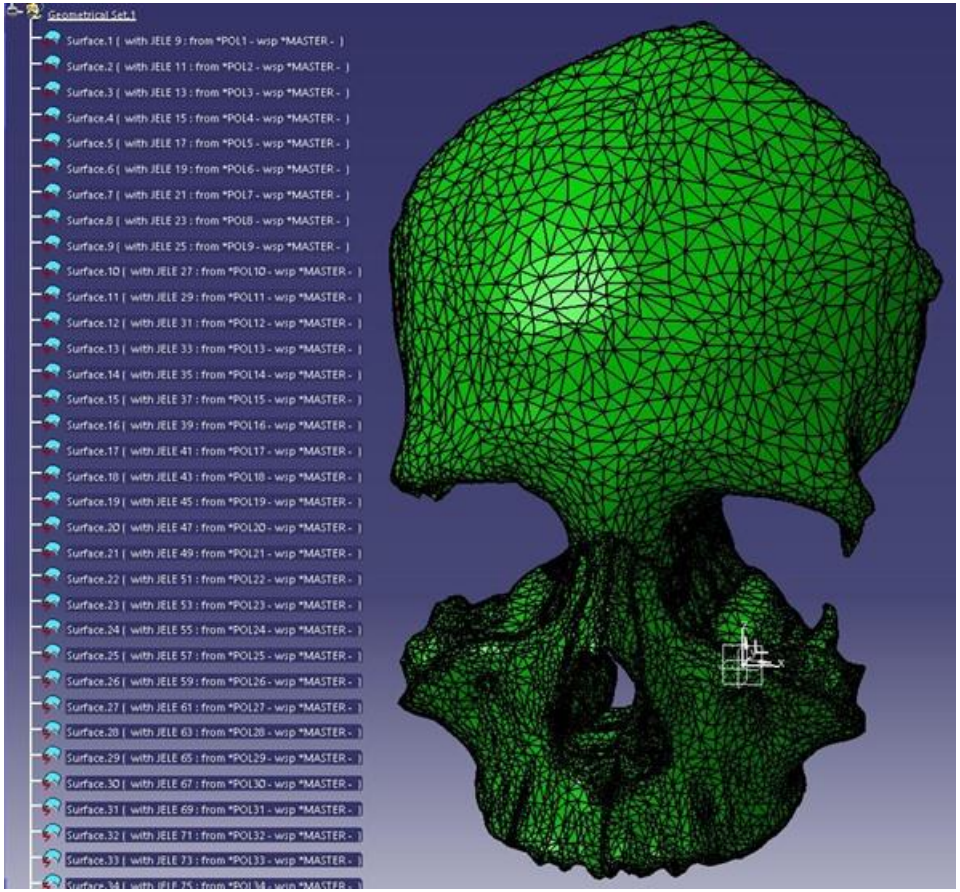
[4] Primjena virtualne stvarnosti u radnom okružju/Application of virtual reality in a work environment
Antunović Bartol
University of Zagreb Faculty of Mechanical Engineering and Naval Architecture 2023

Inferior nasal turbinates surgery in CAD

- designed and simulated in CATIA Delmia V5 software

- design stages:
  - head and tissue
  - tool and work environment
  - process

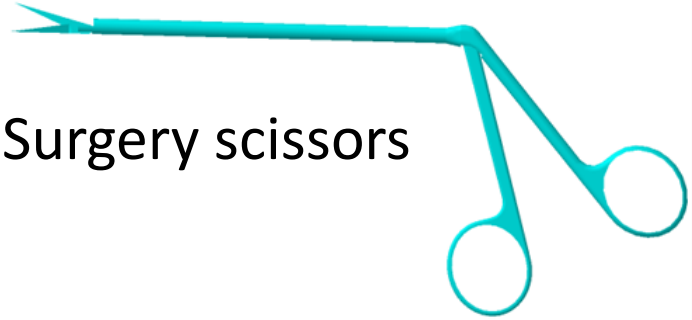
HEAD AND TISSUE design – complexity and simplifications



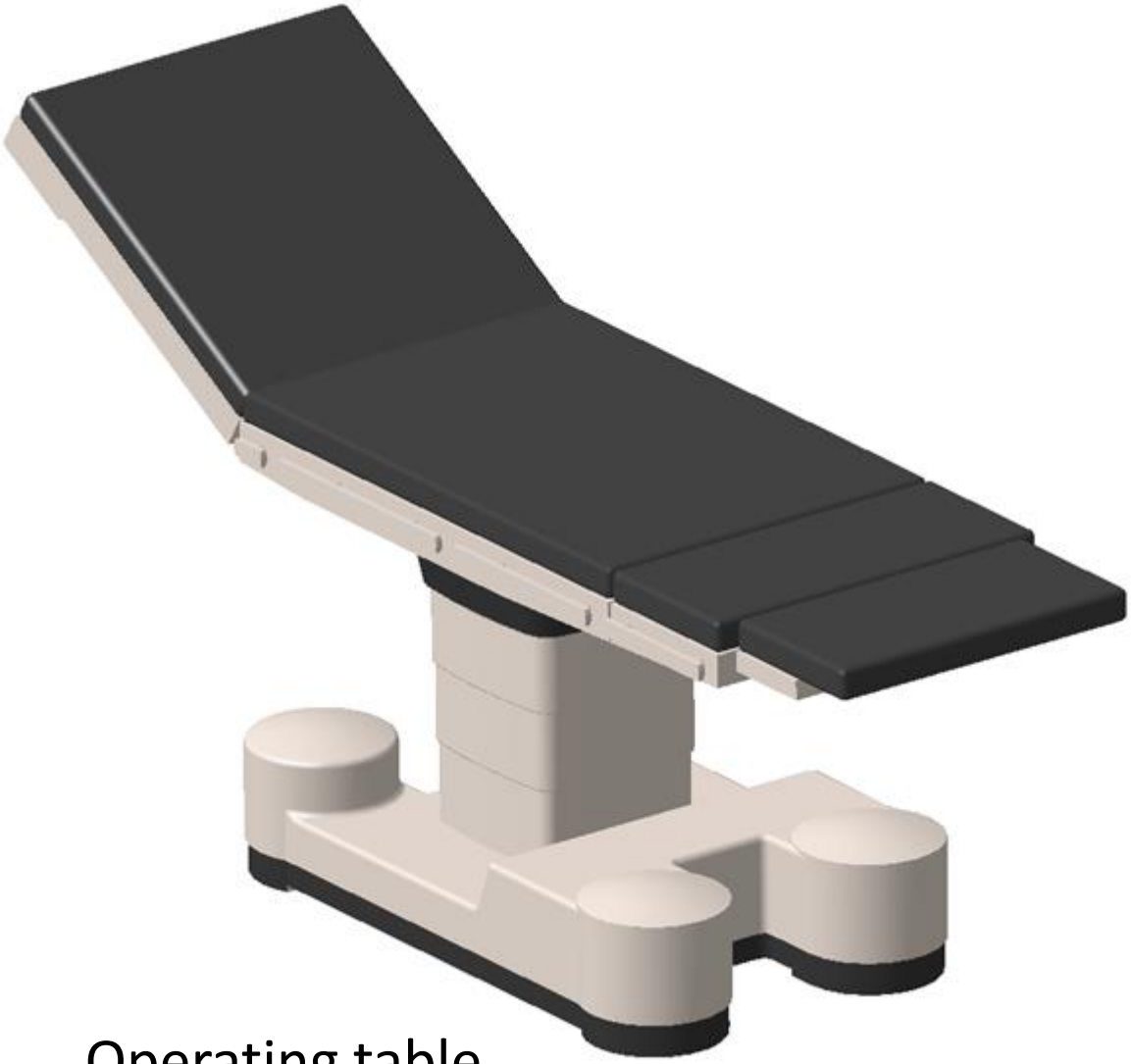
Preparation of the model of the head:

1. collecting CT scans
2. conversion into CAD models (STL format)
3. repairing with Blender

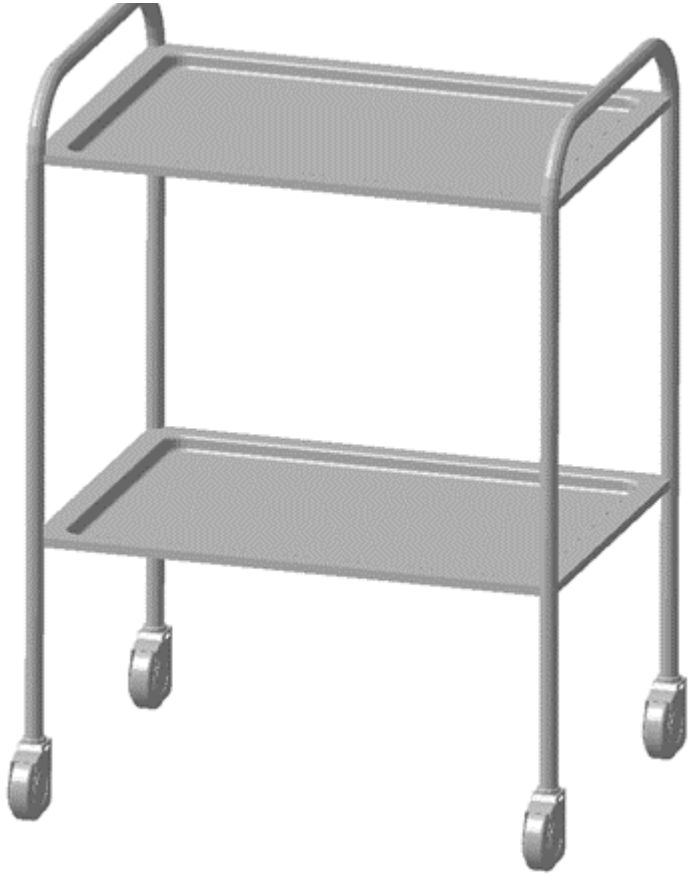
TOOL AND WORK ENVIRONMENT design



Surgery scissors



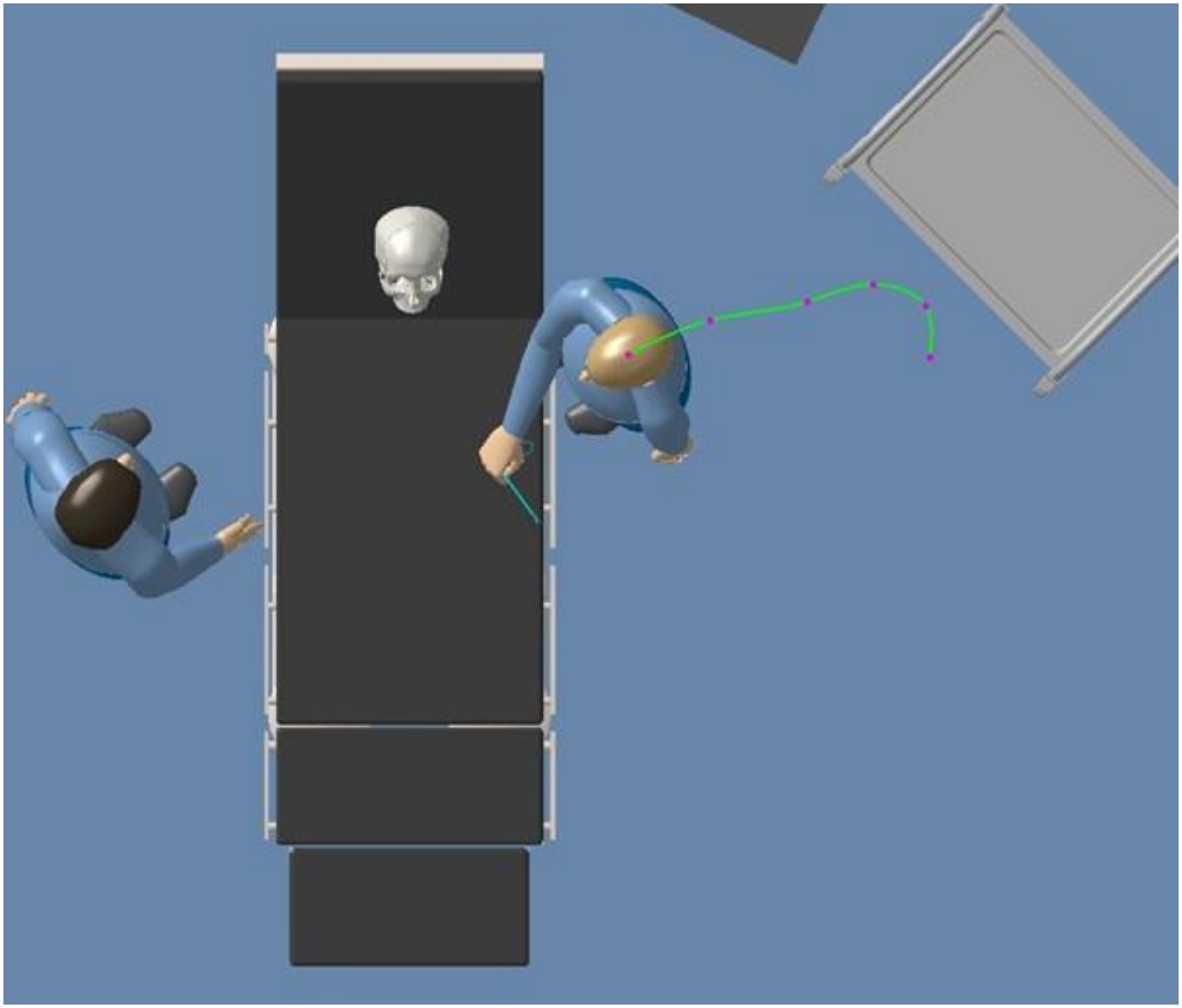
Operating table



Operating tray (cart)

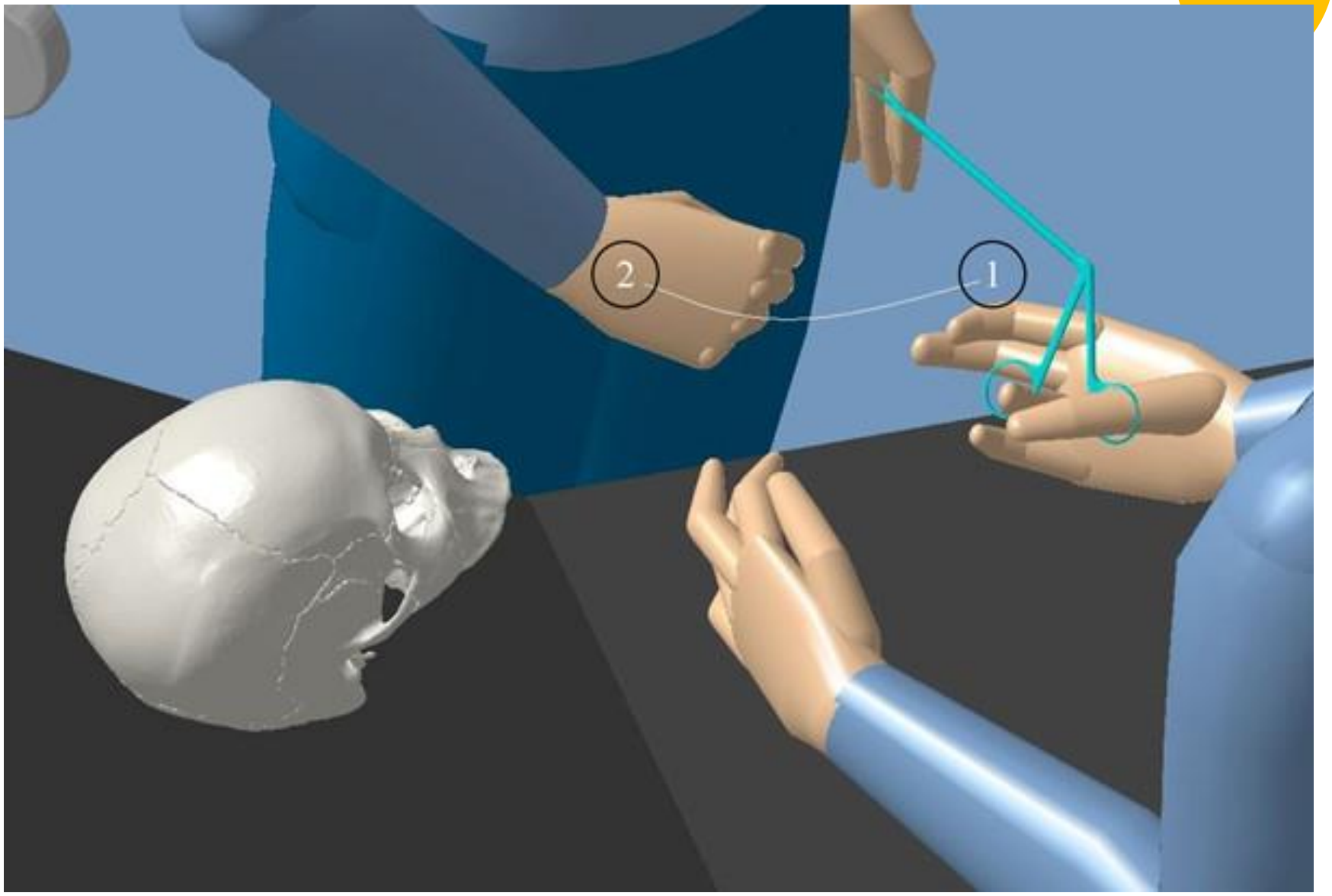
The real-world and virtual inferior nasal turbinate surgery

PROCESS design: work of the surgeon and the instrument technician



The path of the instrument technician shown

Stages of cutting process

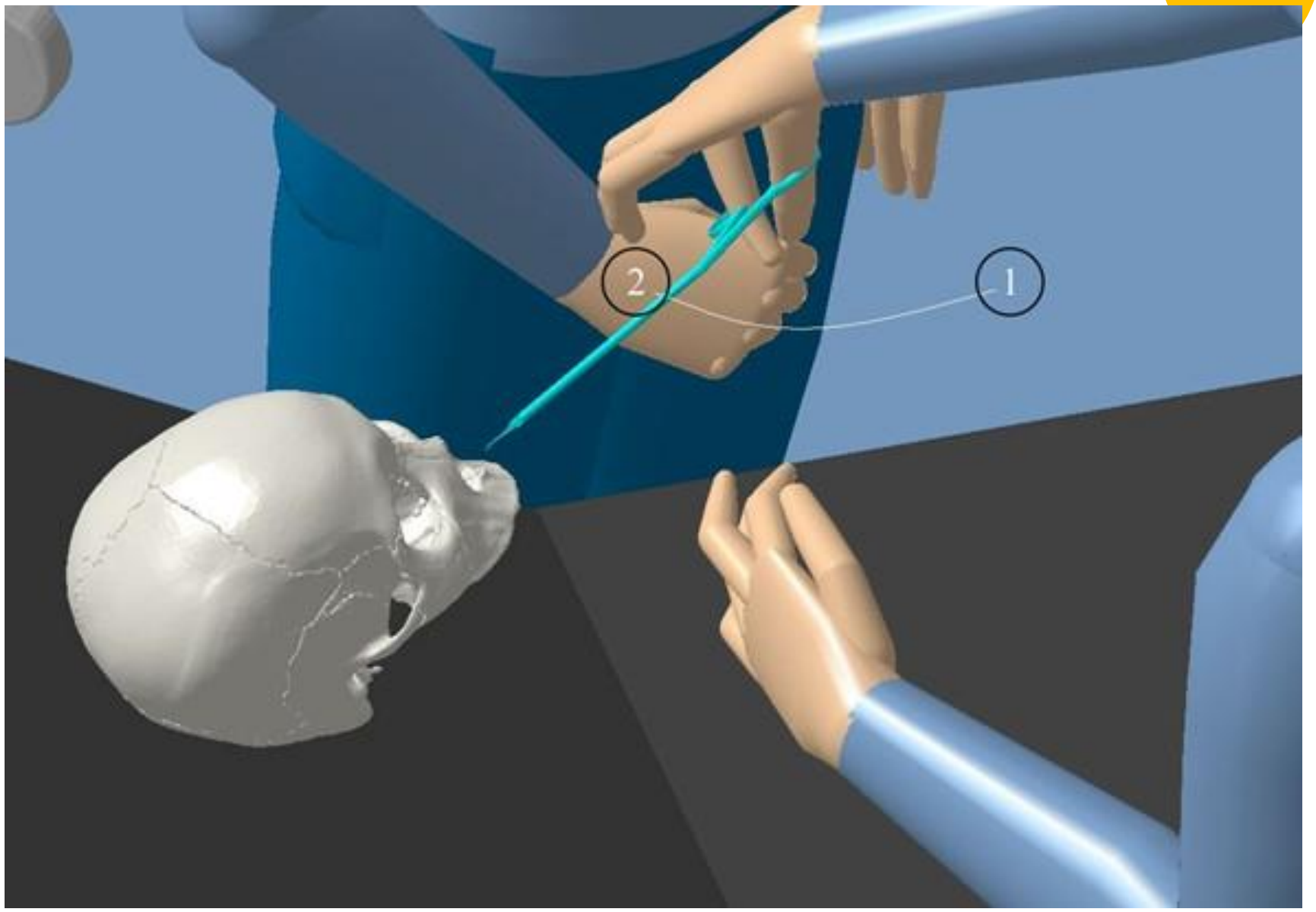


1 – starting position

2 – approaching the inferior nasal turbinate

3 – cutting

Stages of cutting process



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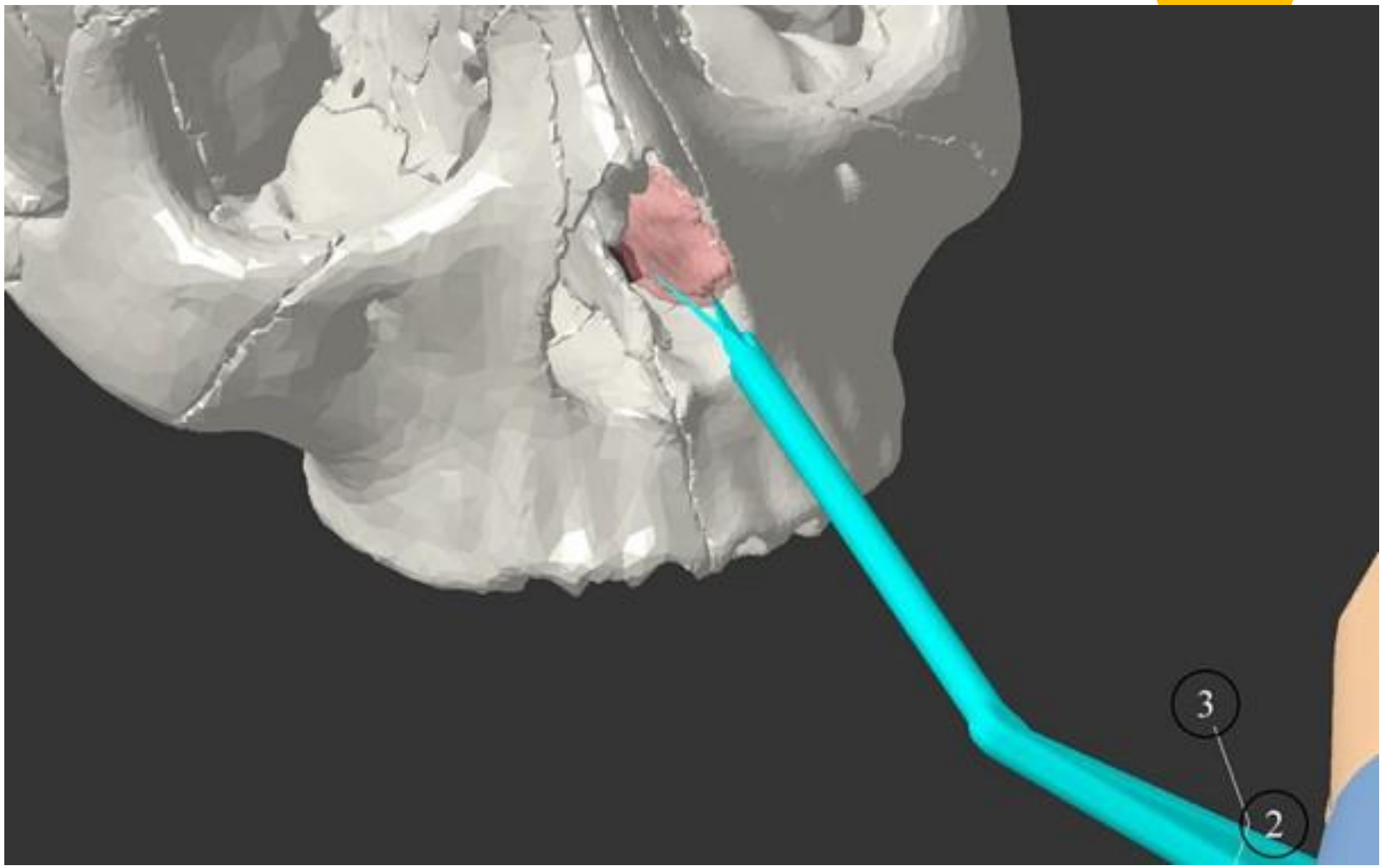

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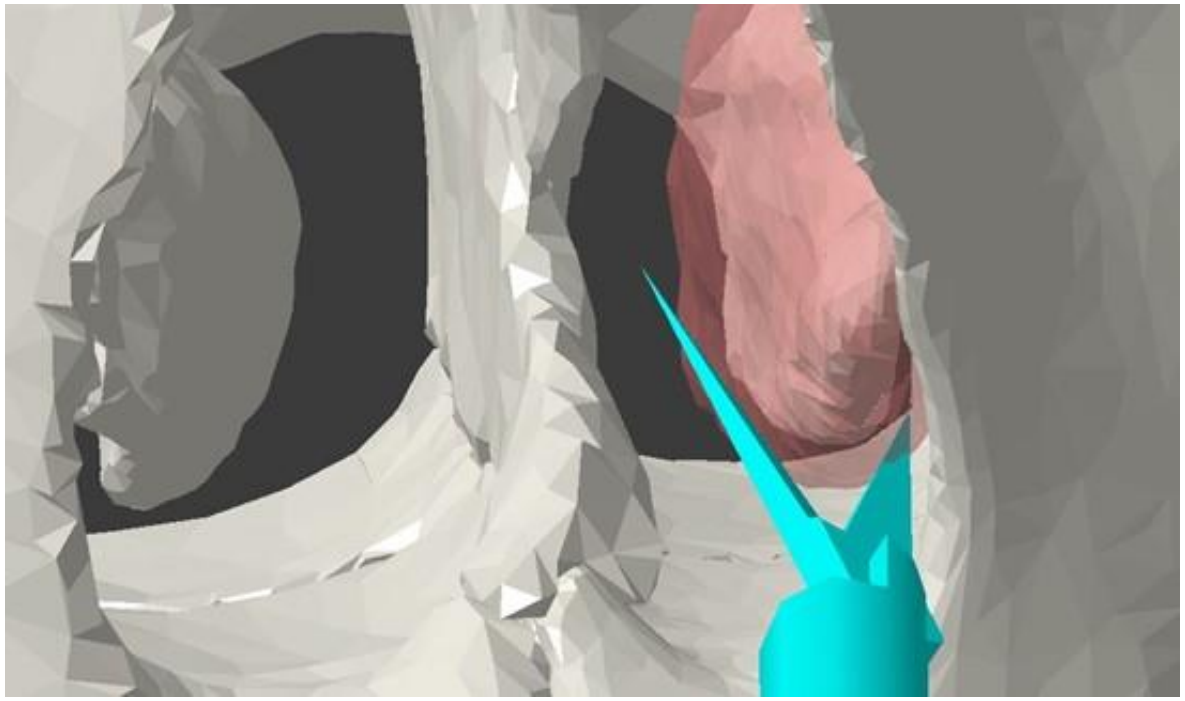
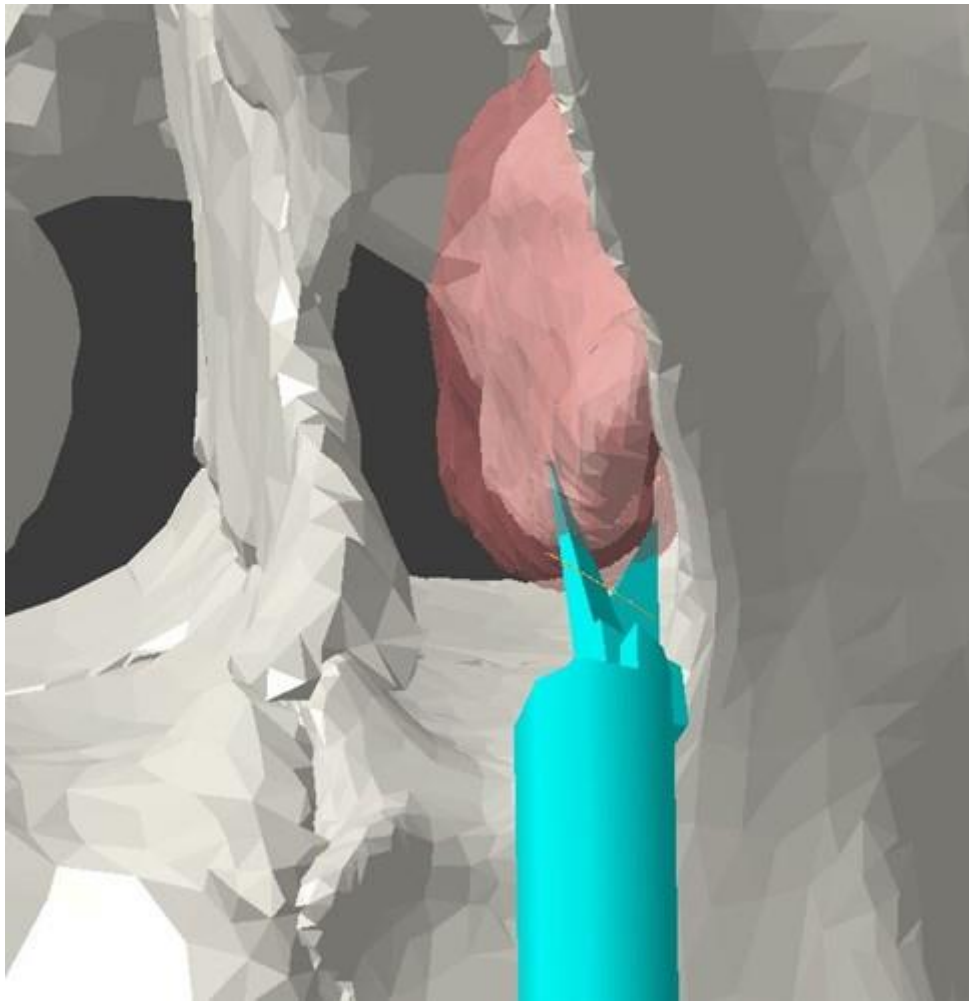
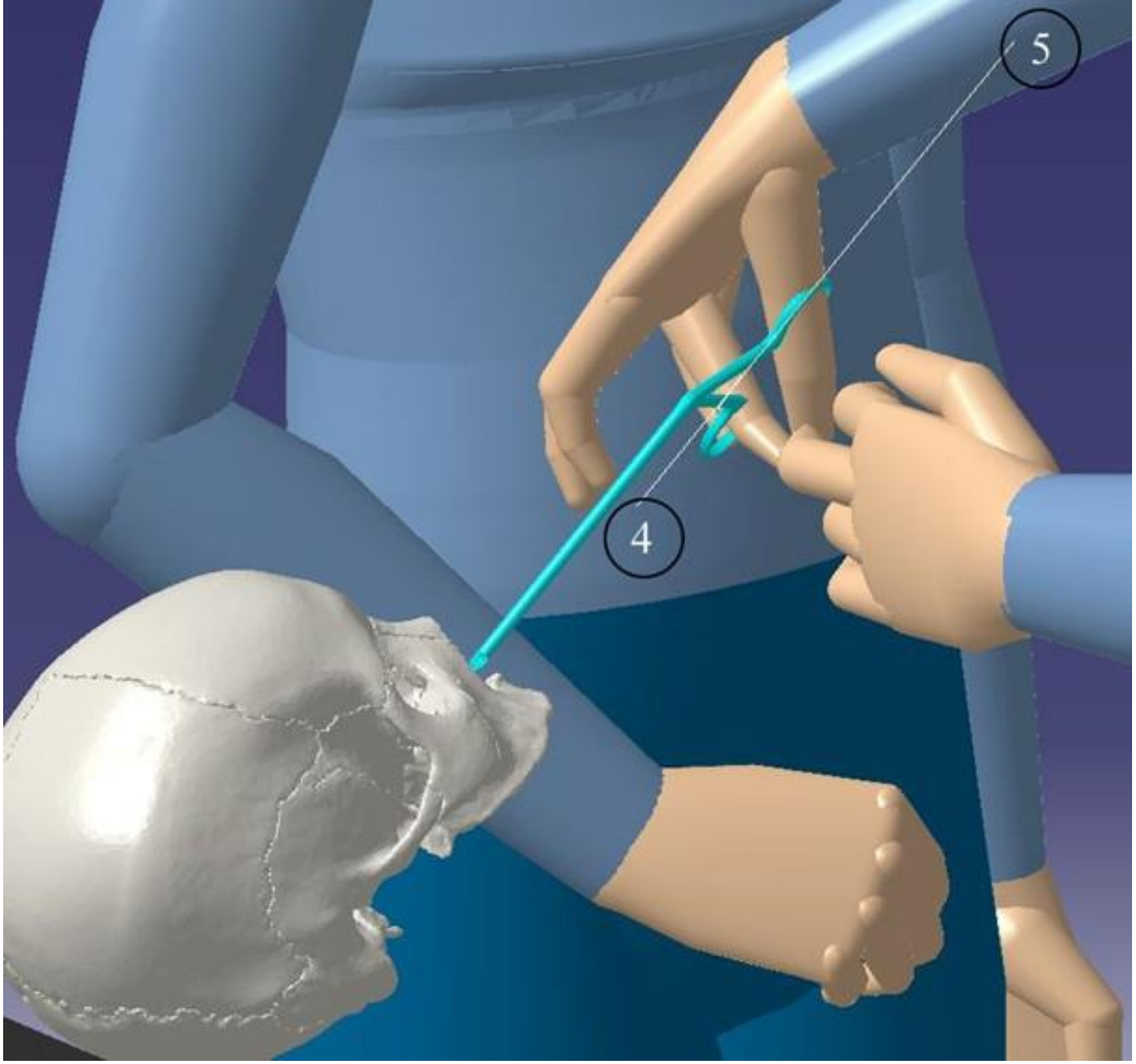




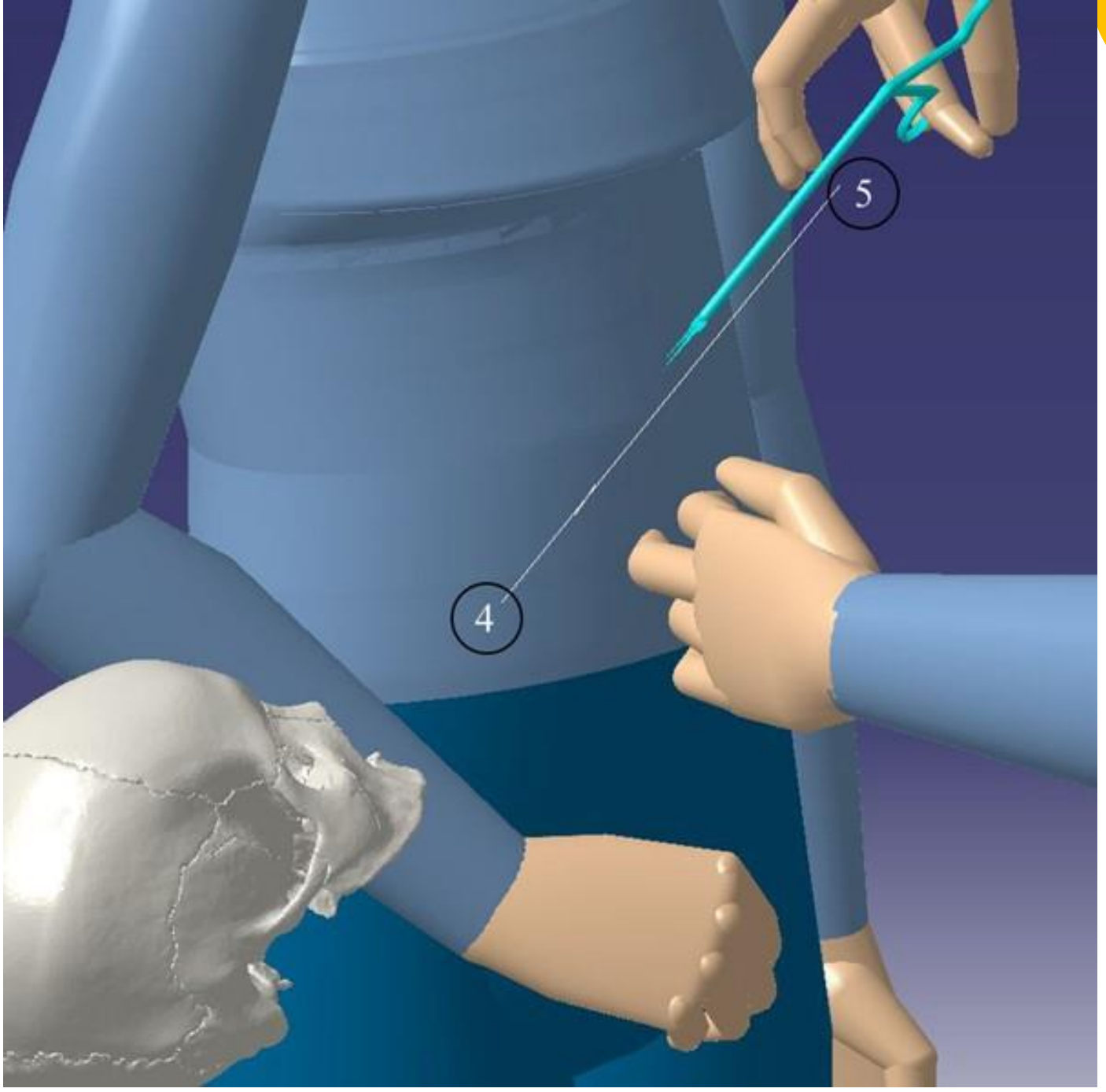
Virtual cutting (opening and closing of scissors) of the inferior nasal turbinate

Stages of cutting process



4 and 5 represent starting and final points of the extraction of tool

Stages of cutting process



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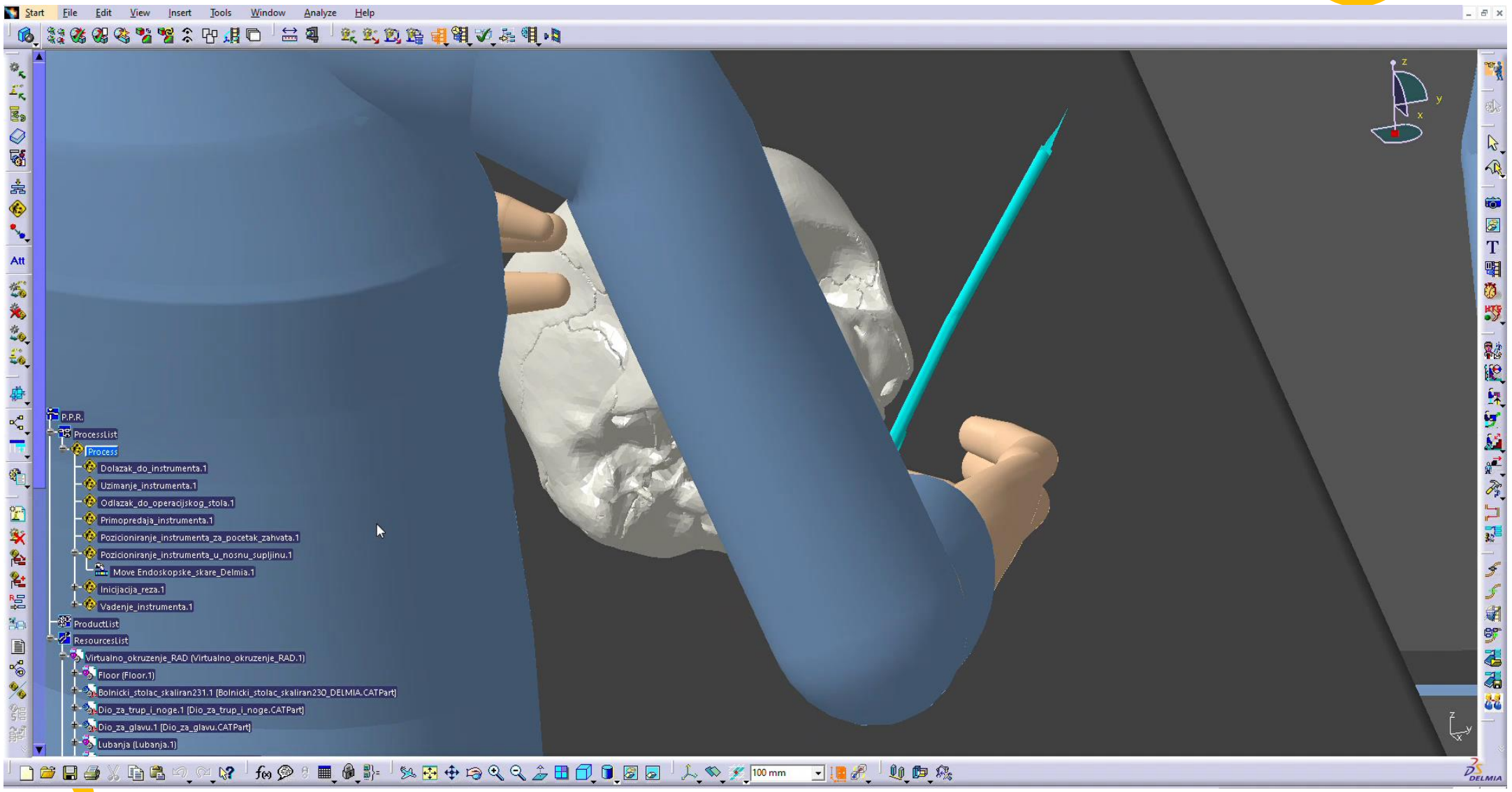
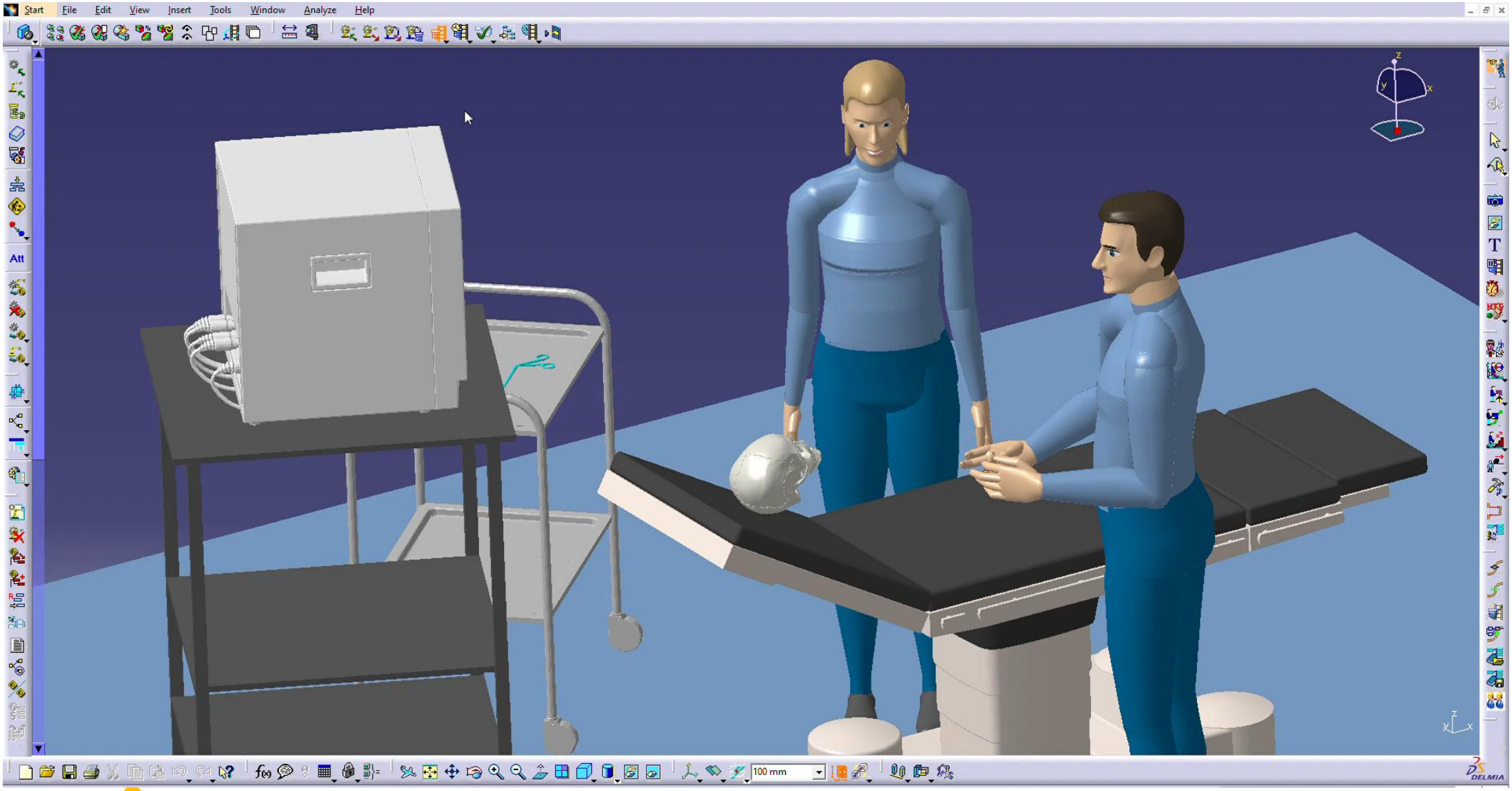


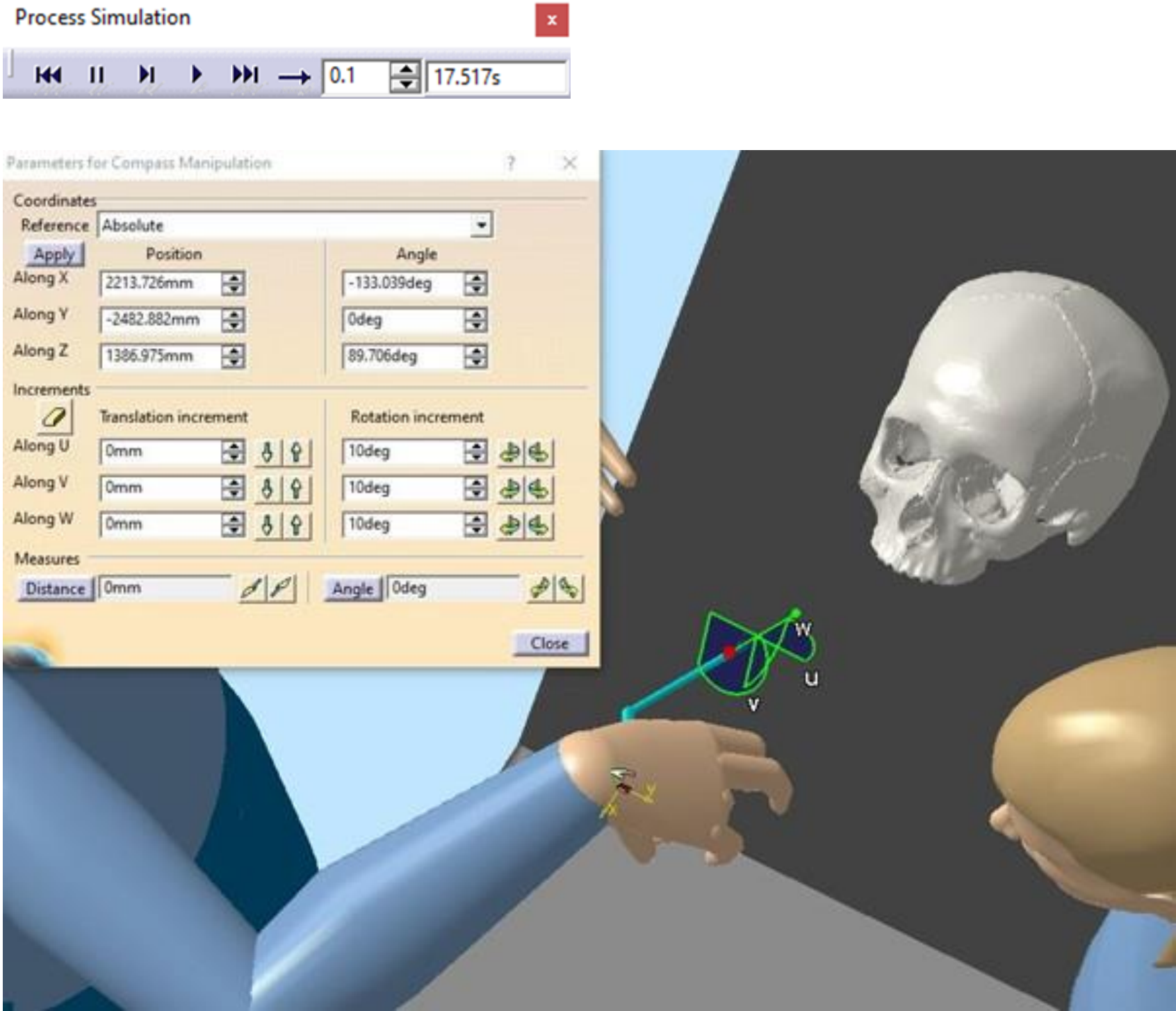
Cutting process



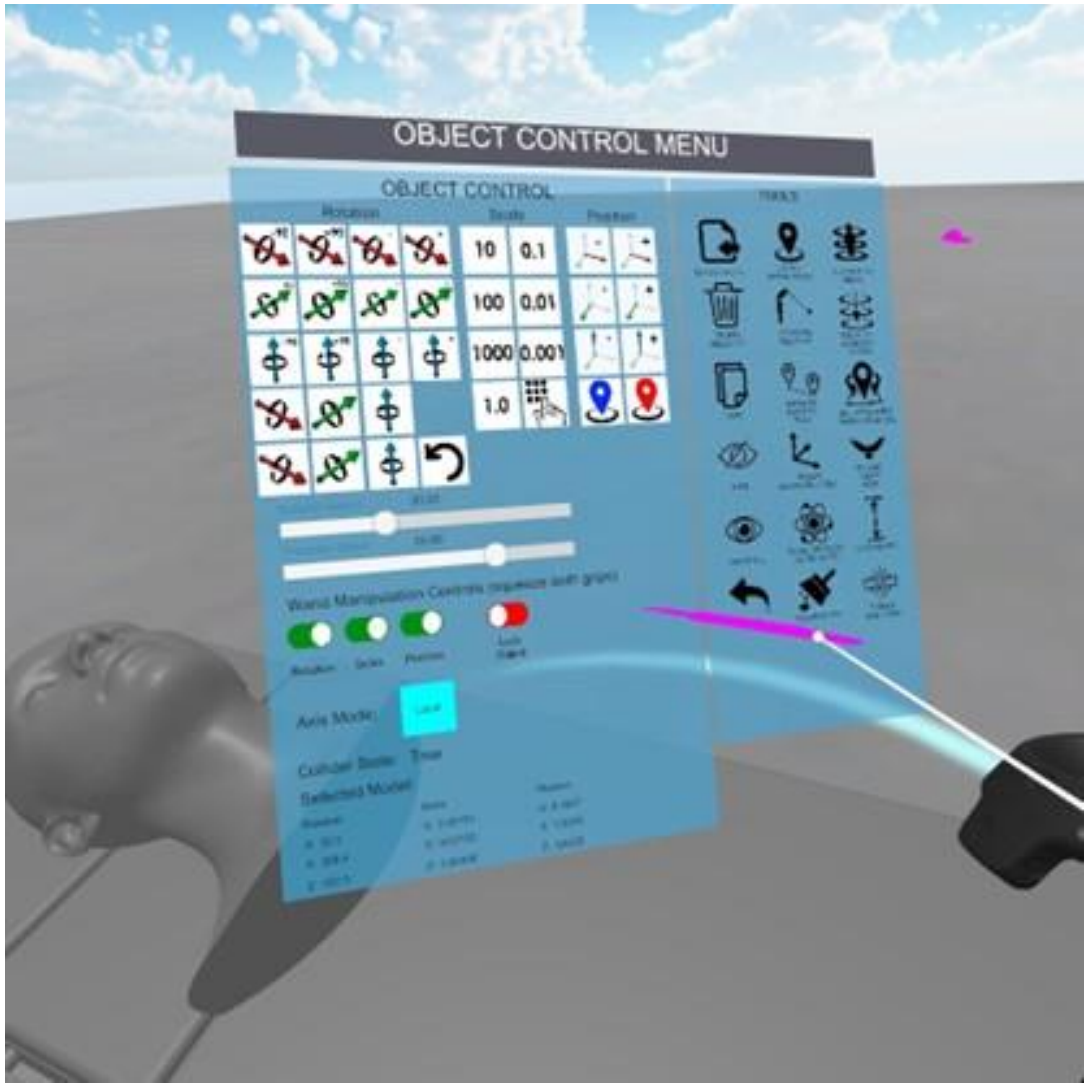
Simulation of the whole process

Results:

- time of process
- precise angles and lengths of movements
- RULA ergonomy analysis



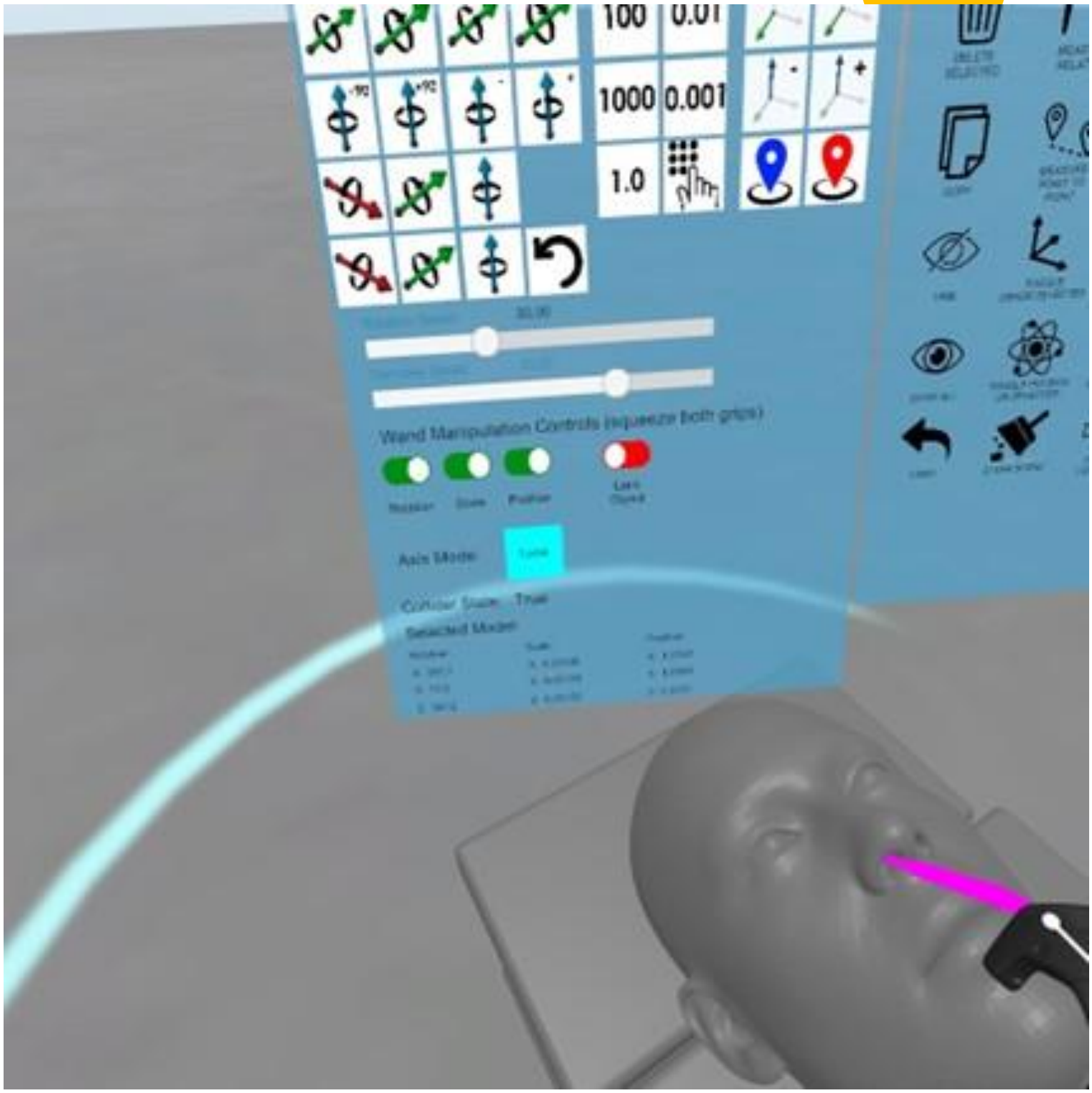
Rhinoplasty in Virtual Reality



- HTC Vive headset system
- Tool Center Point (TCP) represents the tip of scalpel

Results:

- precise angles and lengths of movements
- similar feel of control during movements
- delay up to 20 miliseconds



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Future work

Both cases of nose surgery digital twinning give basis for future work, that may include:

- digital encompassing of **further details** of mentioned surgical procedures
- recording of the **surgeon's actual movements** during the procedures and their transfer to a digital model
- motion capture and comparing the work of **several surgeons**
- implementation on a **larger sample of patients**
- the introduction of virtual reality into **training** of surgeons
- the introduction of **augmented reality** into surgical procedures.

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