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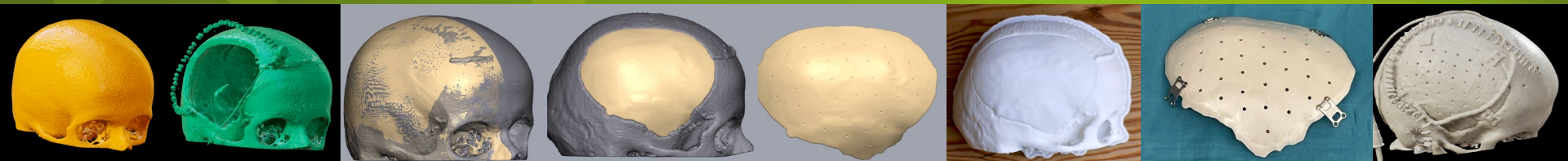
CHRISTIAN-DOPPLER-KLINIK

PEEK printing at the POC: A 6-month clinical review

J. Pöppe
Department of Neurosurgery, University Hospital Salzburg

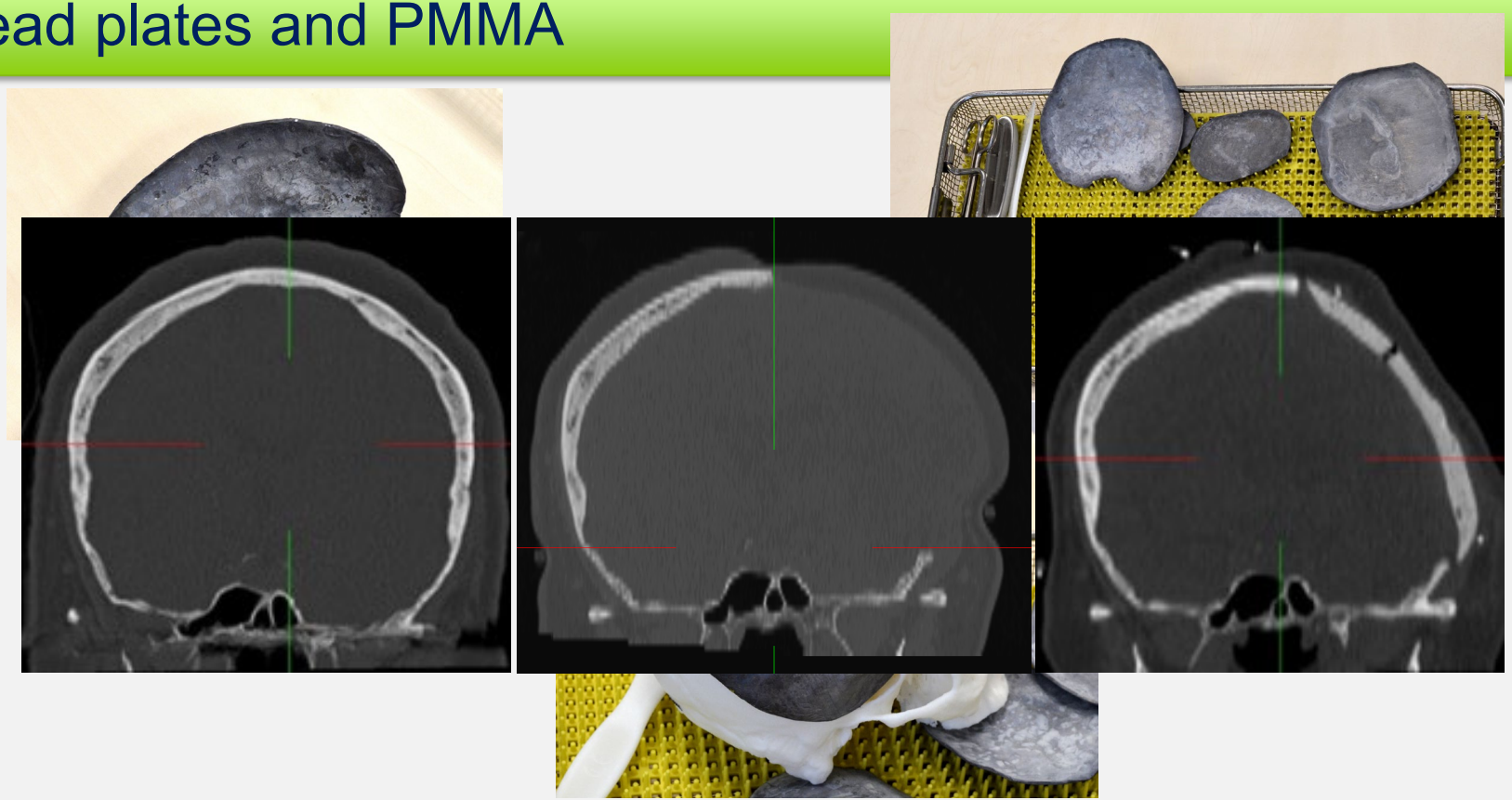


A neurosurgeons point of view...

No disclosures

1. **Historical aspects**
2. **The Salzburg workflow**
3. **Surgery**
4. **Clinical data**
5. **Case report**
6. **Conclusion**

Lead plates and PMMA



First experiences with 3D printing - The Springform Technique

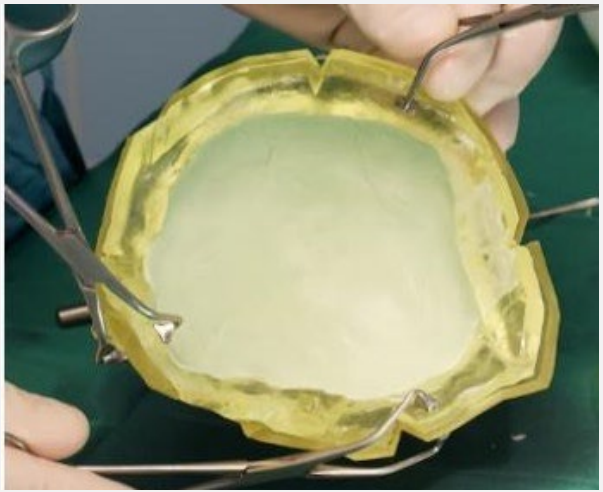
Acta Neurochirurgica (2022) 164:679–688
https://doi.org/10.1007/s00701-021-05077-7

TECHNICAL NOTE - NEUROSURGICAL TECHNIQUE EVALUATION

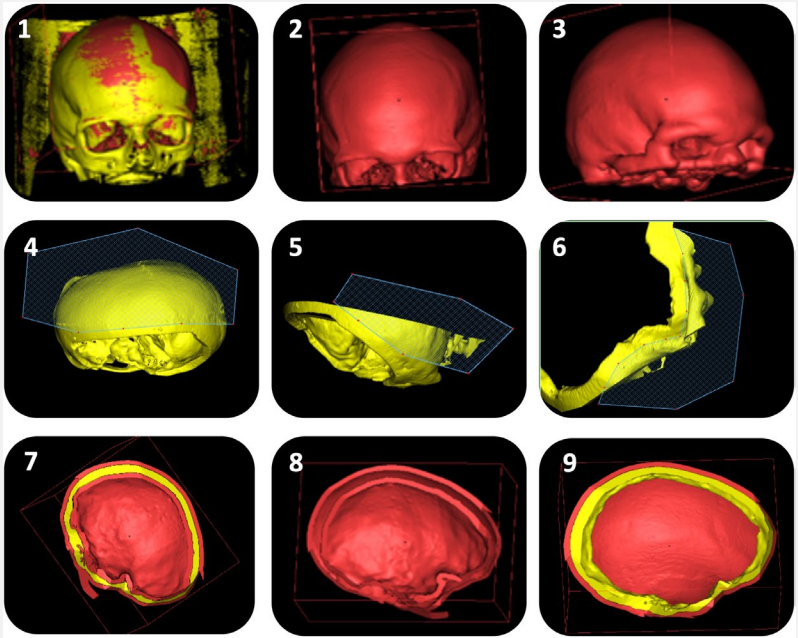
Check for updates

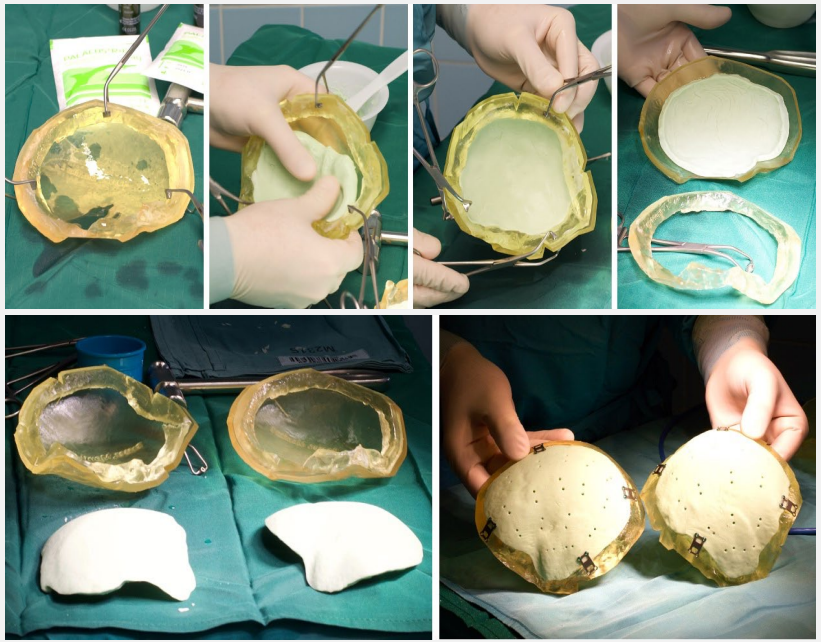
The "springform" technique in cranioplasty: custom made 3D-printed templates for intraoperative modelling of polymethylmethacrylate cranial implants

Johannes P. Pöppe[1] · Mathias Spendel[1] · Christoph Schwartz[1] · Peter A. Winkler[1] · Jörn Wittig[2]



The Springform Technique



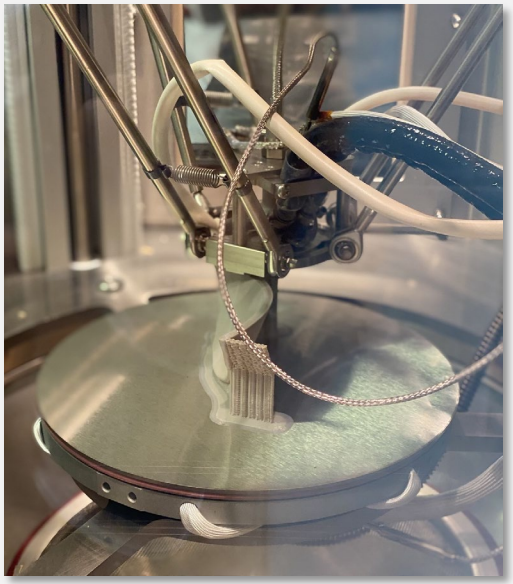


What about in-house 3D printed Implants....?

Polyetheretherketon (PEEK) → Fused Filament Fabrication (FFF)

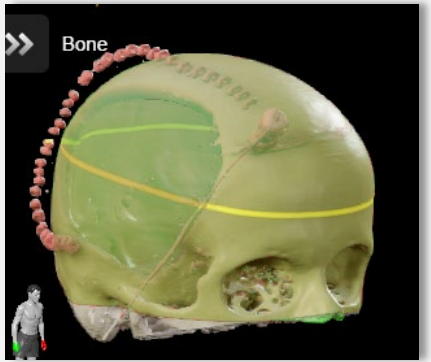
EXT 220 MED (Kumovis F

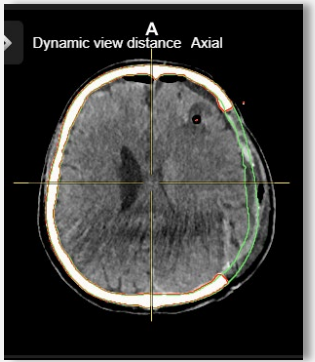
3D SYSTEMS
KUMOVIS

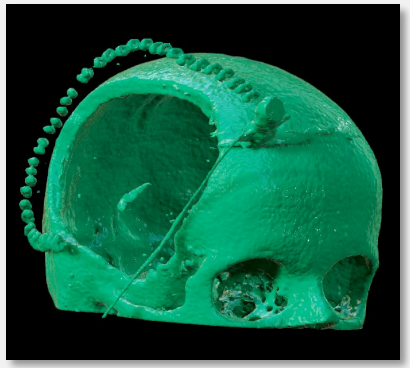


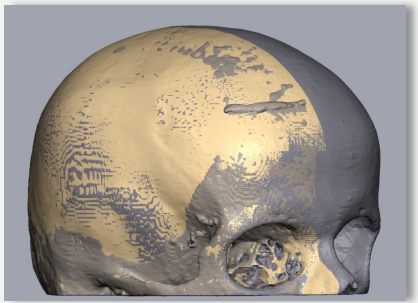
3D printed Implants: Design

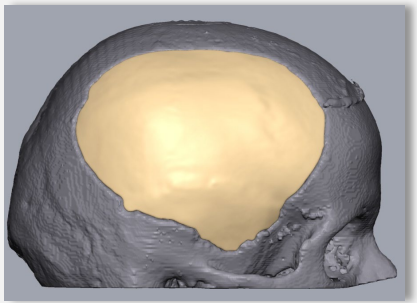
BRAINLAB

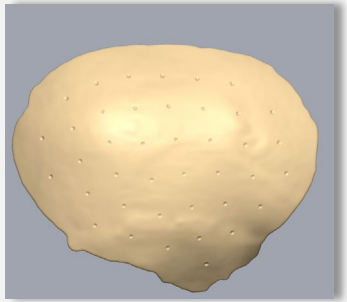


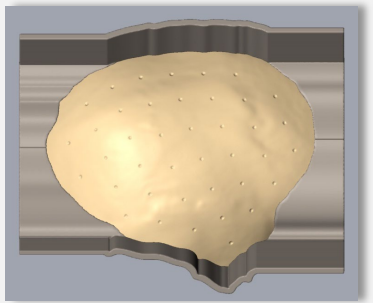






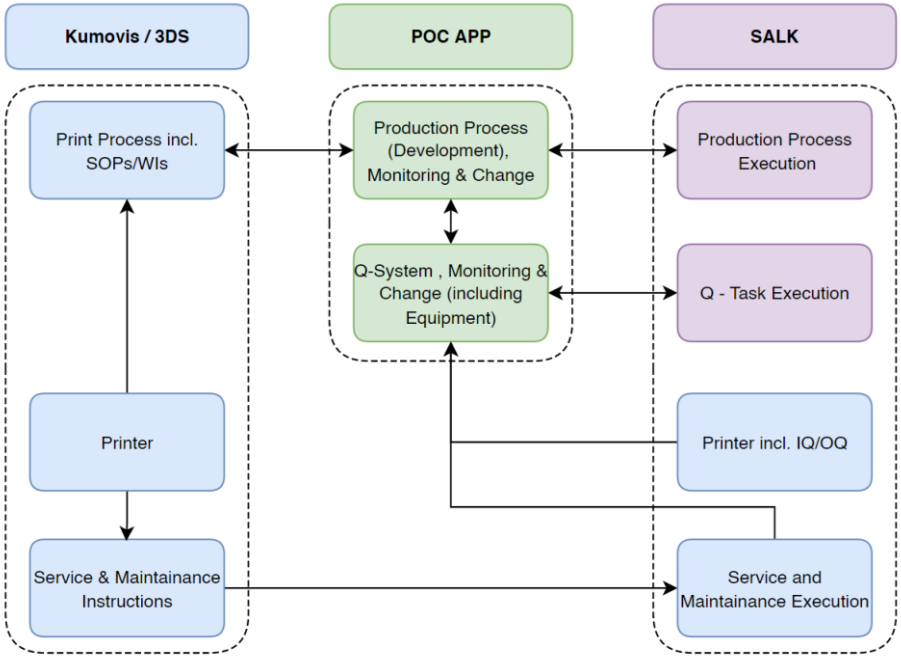






And now...

Verordnung (EU) 2017/745 über Medizinprodukte



Neurosurgeon

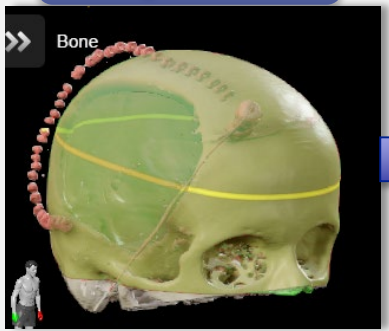
Printing Expert

Case Manager

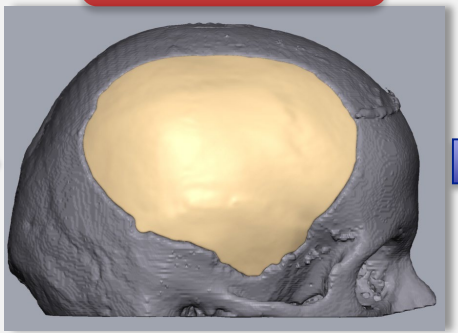
The Salzburg workflow

3D printed Implants: The formal Process

Data acquisition & Segmentation



Implant design



Printing of template

Clearance

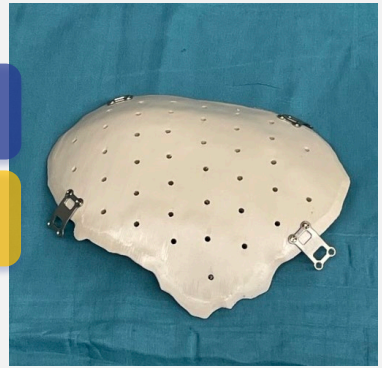
Clearance

Printing of implant

Post Processing & Sterilization

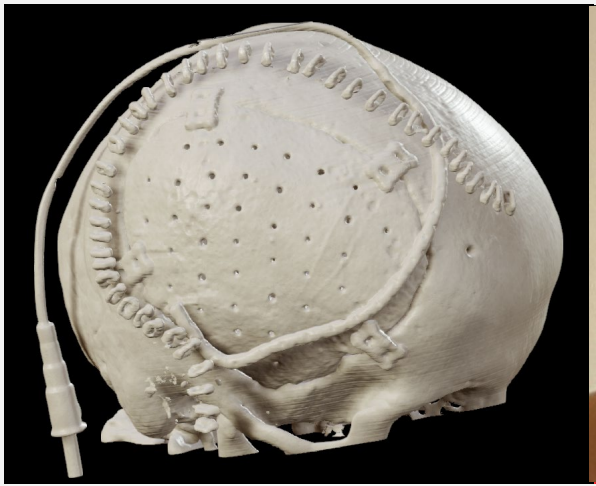
Clearance of final implant

Clearance of final implant



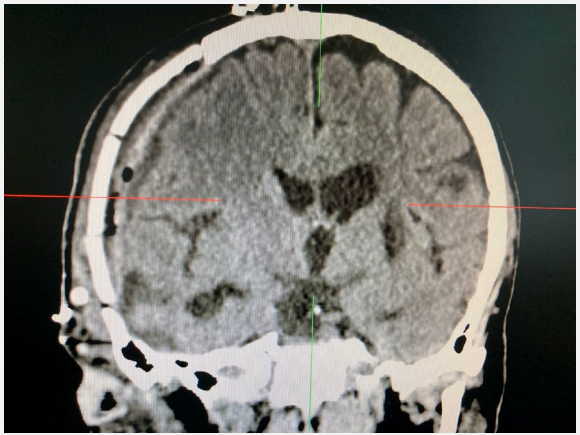
Premiere 09/12/2023

Pat. 63 J., TBI with right sided aSDH, decompressive craniectomy
Good clinical recovery, residual left sided hemiparesis

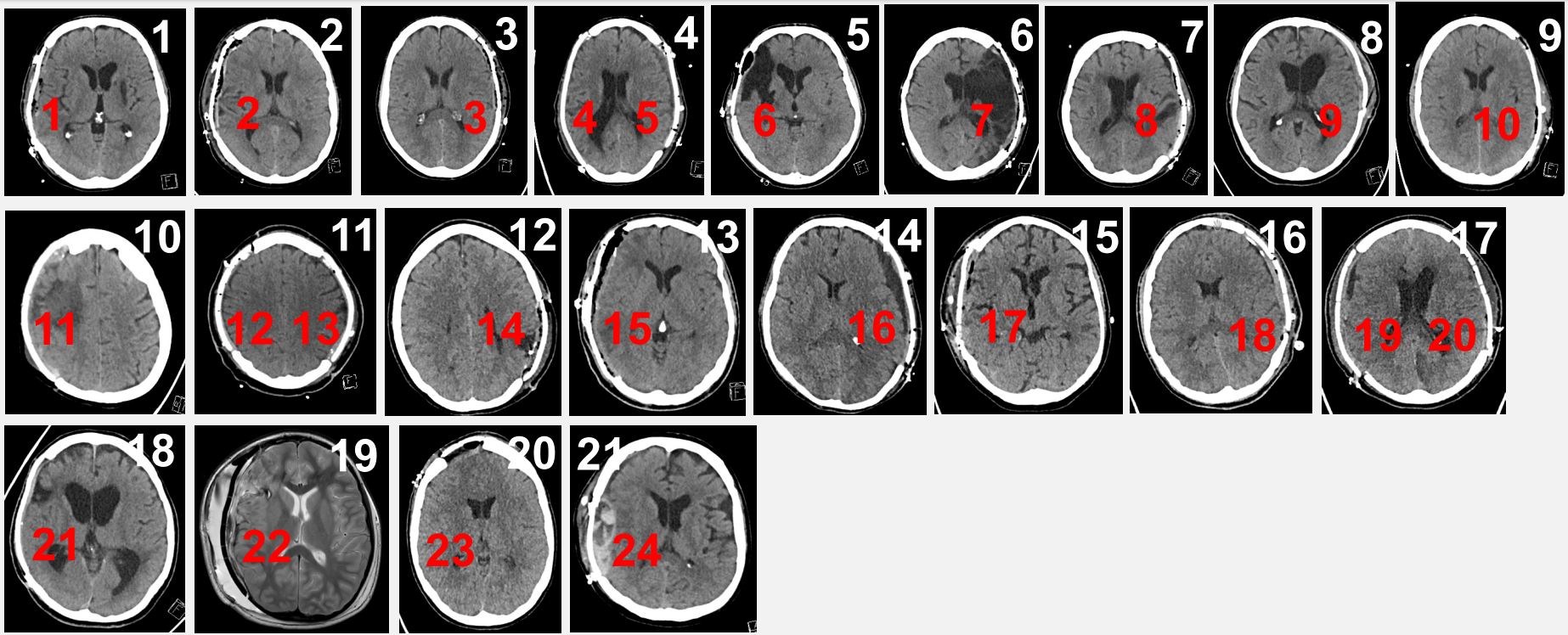



Premiere 09/12/2023

Good clinical recovery
Very satisfied patient
No complications



3D printed Implants: Implementation



Clinical data

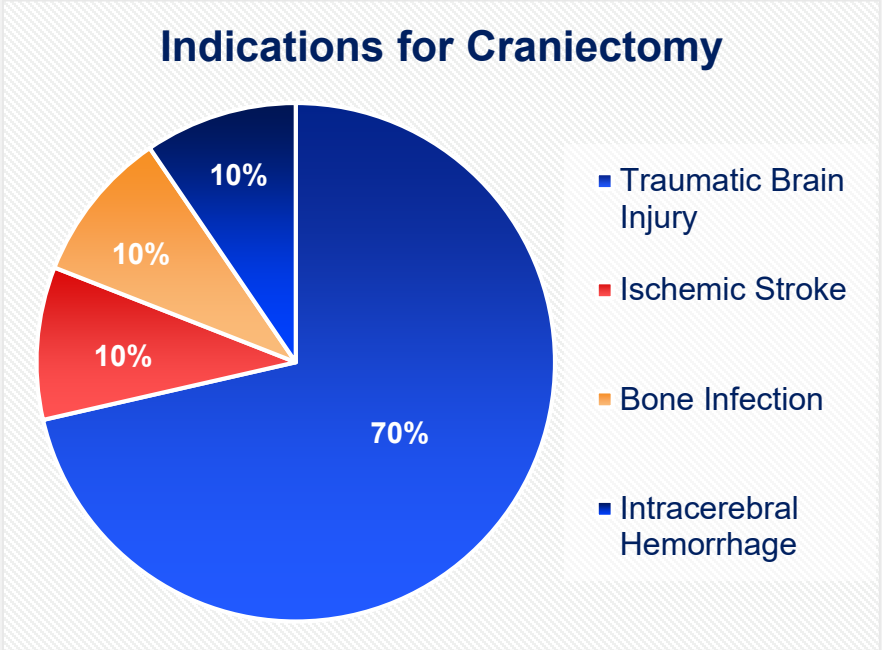
21 patients

24 implants

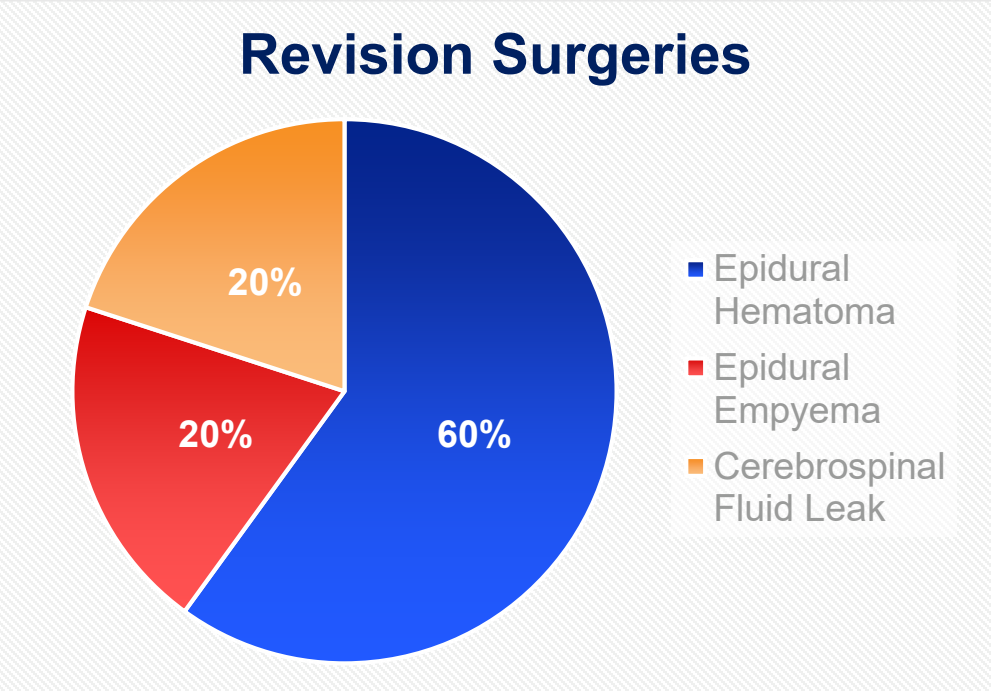
No persistent neurological morbidity

Perfect reconstruction of pre-craniectomy skull shape

5 revision surgeries....



Complications EDH

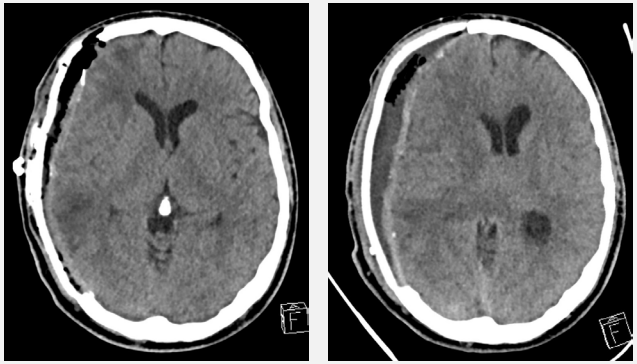


Revision Surgery
Explant of PEEK implant
Re-Sterilization
Reimplantation on day 17
No neurological deficits

Complications Infection

Epidural Empyema
4 weeks Post OP

19.12.23 **16.01.24**



- Revision Surgery
- Explant of PEEK implant
- Antibiotic therapy
- No Reimplantation up to date
- No novel neurological deficits

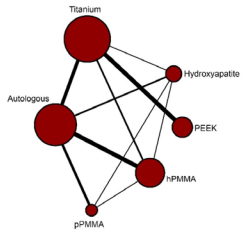
Complications discussion

Complications of Cranioplasty in Relation to Material: Systematic Review, Network Meta-Analysis & Meta-Regression

Review Design

Studies reporting rate of infection, implant exposure or revision in PEEK, PMMA, hydroxyapatite, titanium or autologous bone were eligible for inclusion

Frequentist network meta-analysis performed for each complication



Results

31 studies

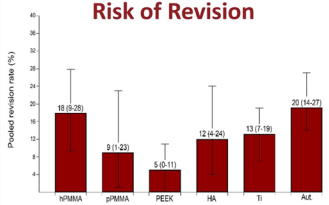
5345 cranioplasties

8% infection rate

6% exposure injuries

14% re-operation rate

Risk of Revision

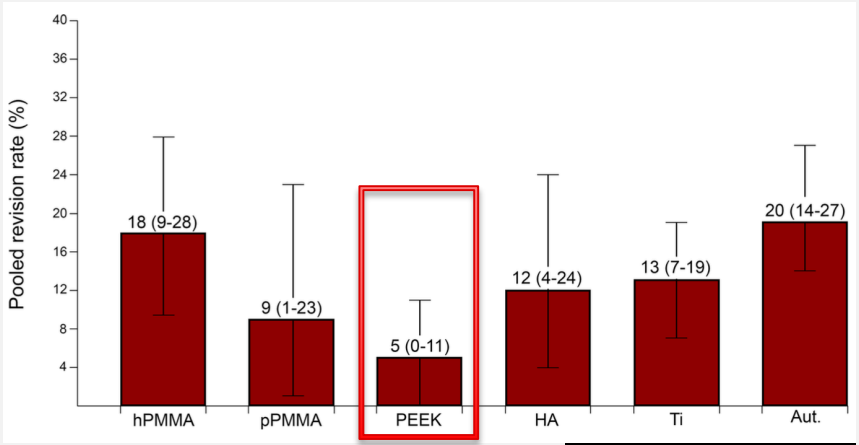


PEEK had the lowest risk of revision surgery (5%: 95%CI 0-11)

- **PEEK = HA** (RR 0.45, 95%CI 0.15-1.36)
- **PEEK > Autologous** (RR 0.20, 95%CI 0.07-0.57)
- **PEEK > Ti** (RR 0.39, 95%CI 0.17-0.92)
- **PEEK > pPMMA** (RR 0.14, 95%CI 0.04-0.51)
- **PEEK > hPMMA** (RR 0.20, 95%CI 0.07-0.60)

Henry et al. *Neurosurgery*. June 2021

NEUROSURGERY



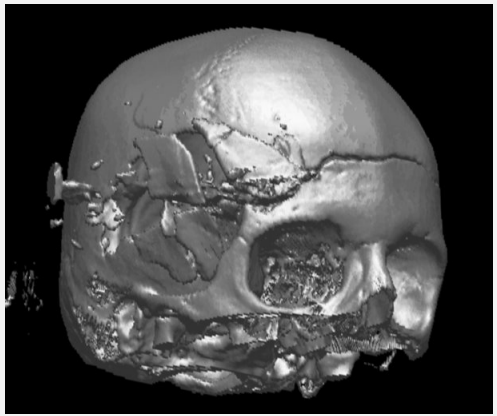
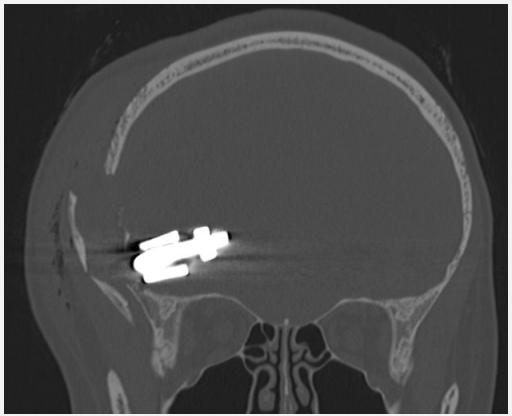
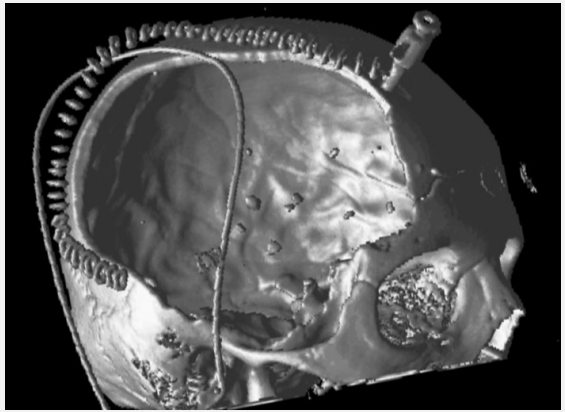
Indication for revision surgery?

Surgical aspects? Drainage?

Implant design?

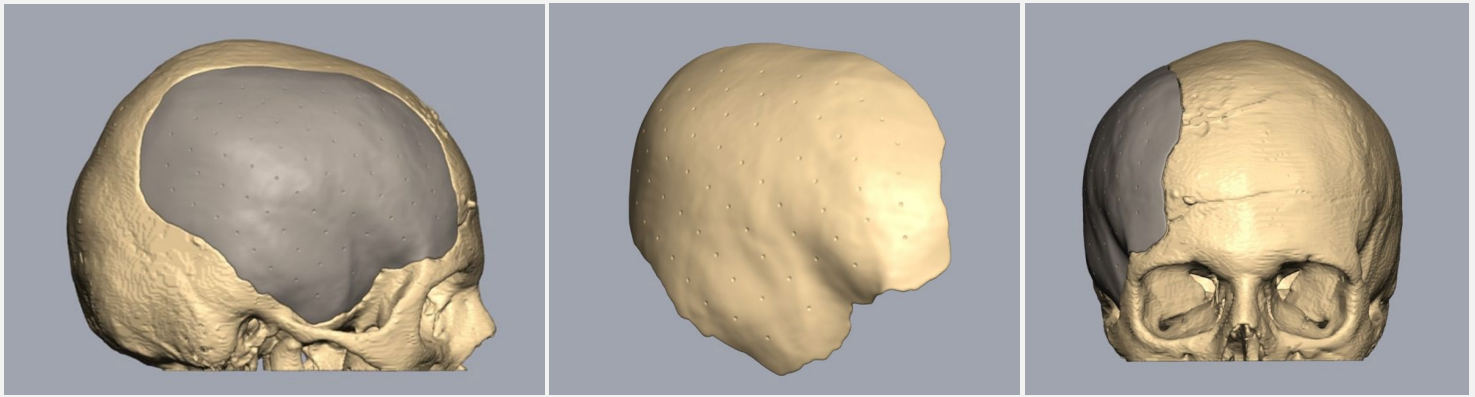
Illustrative case report

10 year old boy....

28th of Dec.

Illustrative case report



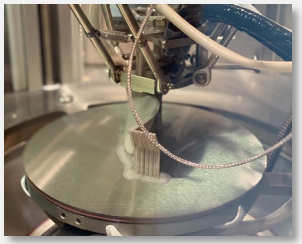
09th of January

Illustrative case report

Discharge home, No deficits

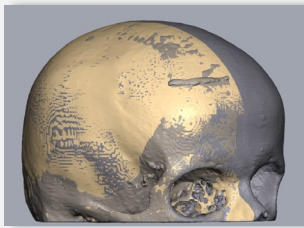
22nd of January

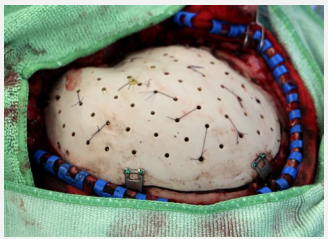
Conclusion



3D printing of cranioplastic PEEK implants can be routinely performed at the point-of-care in accordance with the EU MDR

The close interaction between medical and technical personel can be used to drive innovation in medical 3D printing of patient specific implants





3D printing of CP implants at the POC enables for very early cranioplasty after craniectomy with precise PSIs

Point-of-care 3D-printed Polyetheretherketone (PEEK) customized implants for cranioplastic surgery of large skull defects

Objective

To 3D print patient specific PEEK cranioplastic implants for large skull defects at the point of care.

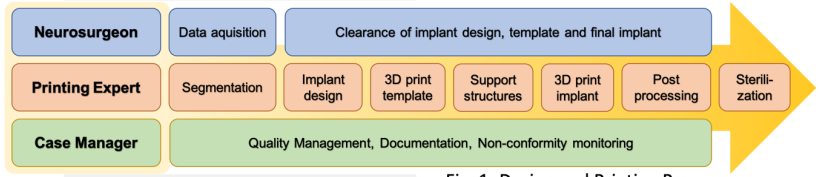


Fig. 1: Design and Printing Process

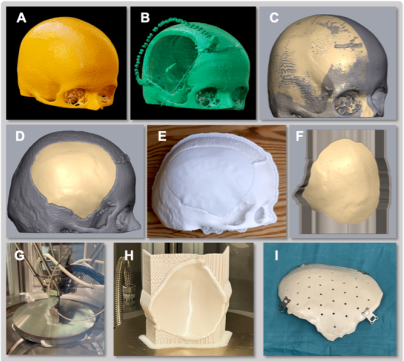


Fig. 2: Steps from CT segmentation to 3D printing of a cranioplastic implant

Methods

A design and 3D printing process im complicance with medical device regulations was established [Fig. 1,2].

Results

First implantation of a 3D printed cranioplastic PEEK implant was successfully performed in a patient after decompressive craniectomy [Fig. 3].

Conclusion

This novel 3D printing workflow facilitates to 3D print patient specific cranial implants from Polyetheretherketone (PEEK) at the point of care in accordance with medical device regulations.

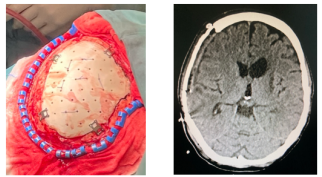


Fig. 3: Fixed implant and post OP CT scan

OPERATIVE Neurosurgery
Pöppe et al
Published by Wolters Kluwer on behalf of the Congress of Neurological Surgeons

Thank you for your attention!

Werner Wurm
Mark György
Marco Leukermoser

Alexander Gaggl
Simon Enzinger

Dr. med. Johannes Pöppe

Universitätsklinik für Neurochirurgie
Uniklinikum Salzburg
Christian-Doppler-Klinik
Paracelsus Medizinischen Privatuniversität
Ignaz-Harrer Straße 79, A-5020 Salzburg

Tel.: +43 (0)5 7255-56155
Mail: j.poeppe@salk.at

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3D SYSTEMS
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POC APP