Challenging the norm with smart implant algorithms

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Introduction

- Early jaw fracture stabilization with bandages was often ineffective.
- Plate osteosynthesis introduced in 1886 provided better stability.
- Less invasive miniplates introduced in 1970s have since been used.
- Plates still require careful bending to fit the bone & implant stability still often remains a concern.

Our aim:

- **Develop next-gen custom fracture plates using topology optimization for better fit and stability.**
- **Transform bone plate design and production with point-of-care 3D printing.**
- **Challenge and outperform traditional implants.**

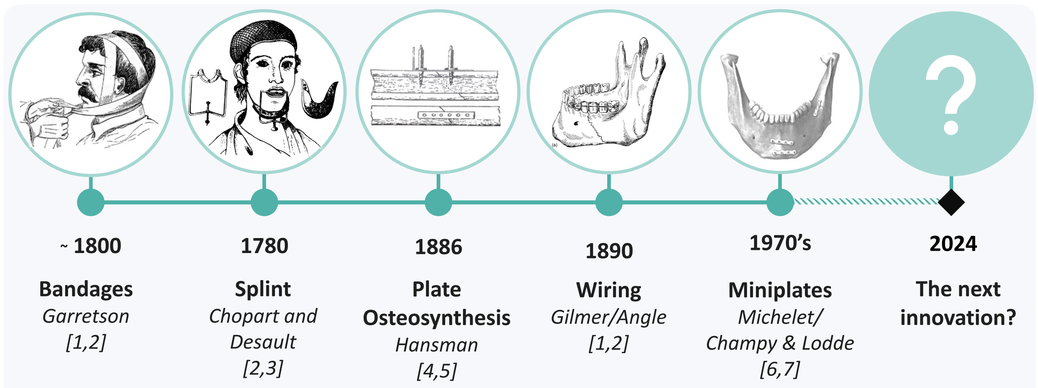


Figure 1. Timeline of key innovations in treatment of maxillofacial fractures. *Figure sources: [2,5,7]*

Methodology

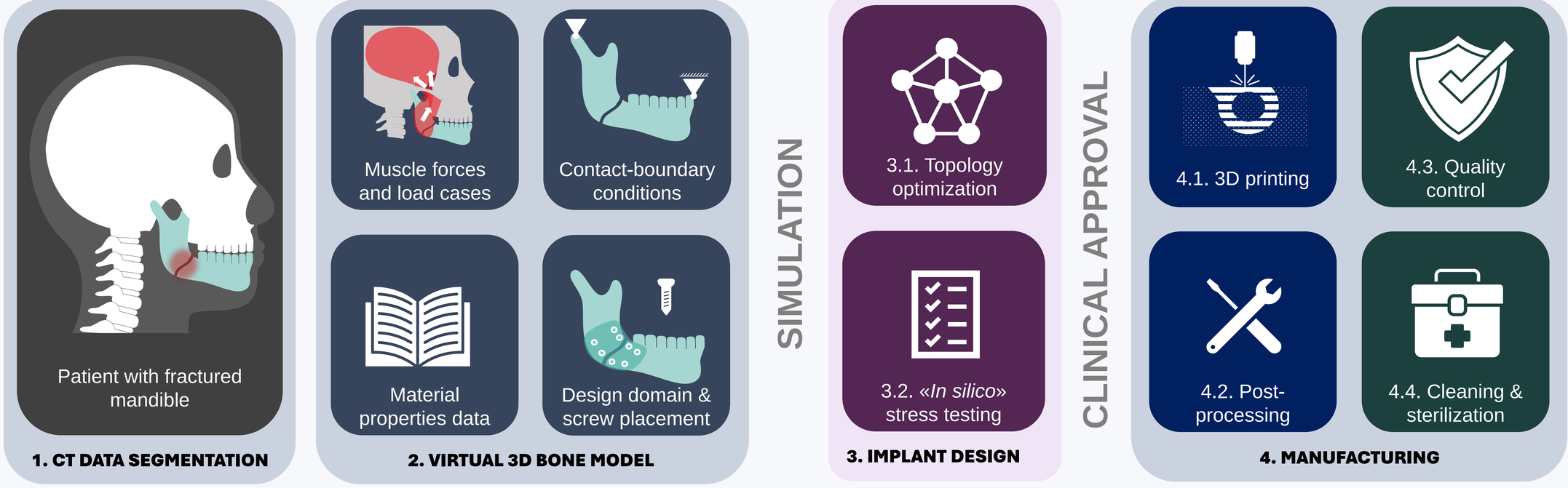


Figure 2. Our methodology for automatic mandibular fracture plate design and production. Material choice and manufacturing method affects the implant shape and is considered in design process. [8, 9]

Results

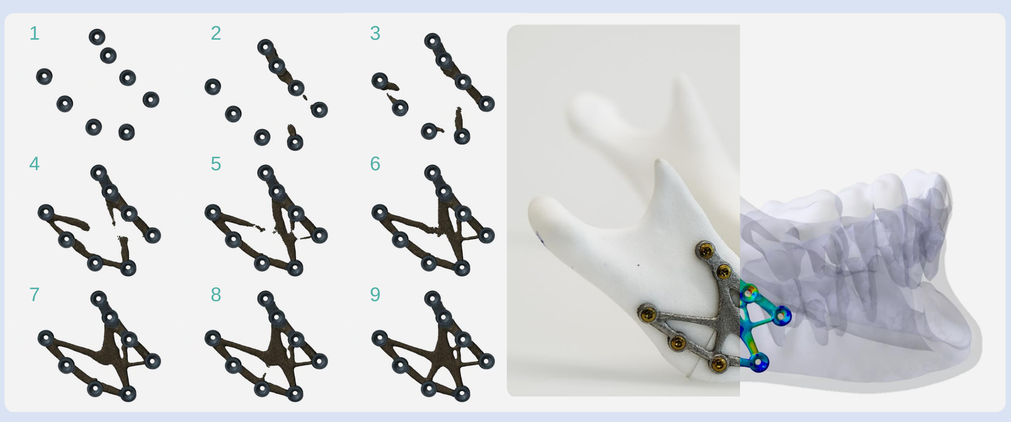
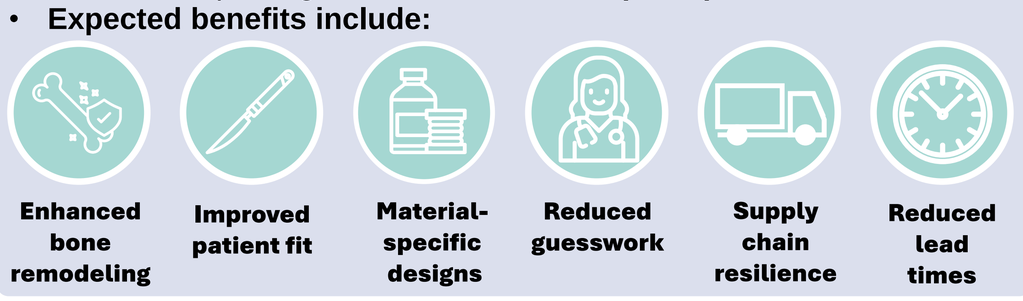


Figure 3. (Left) Example of the topology optimization process for a titanium mandibular fracture plate. **(Right) "***In silico"* model shows stress distribution in the implant under masticatory force, overlaid with a photo of a laser-melted titanium implant fixed to a synthetic mandible.

Discussion

- Use of a **patient-specific** design algorithm to create custom implants.
- Implants conform to unique anatomy and fracture patterns, **optimizing strength & stability**.
- The simulation incorporates **material properties** in the design process.
- Future simulations and manufacturing could occur **directly at the point-of-care**.
- Certified 3D printing will allow **in-house implant production**.
- **Expected benefits include:**



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References:

Acknowledgements:

This project is financially supported by the Werner Siemens Foundation through the MIRACLE II project and the University of Applied Sciences and Arts Northwestern Switzerland School of Life Sciences (HLS ResearchPROJECTS, Stiftung**FHNW**)