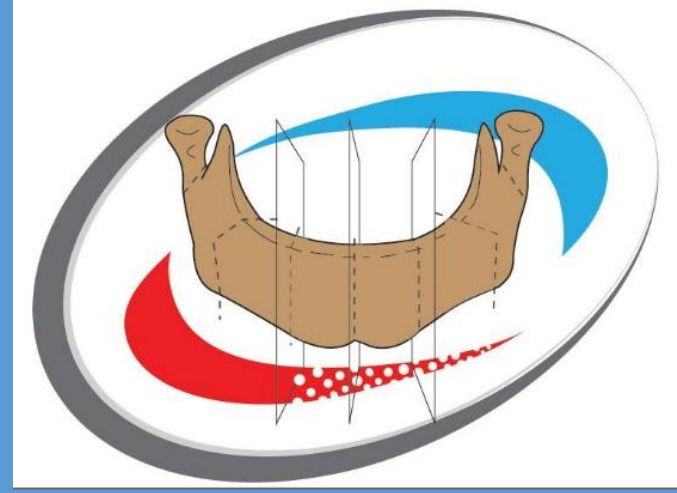


Slicer as a prototyping, versatile medical research software



BoneReconstructionPlanner: A 3D Slicer extension for virtual surgical planning of mandibular reconstruction with vascularized fibula free flap and generation of patient-specific surgical guides.

Corresponding paper:

<https://www.sciencedirect.com/science/article/pii/S2666964123000103>

2021: Initial development as final project: Mauro I. Dominguez, Supervision: Andras Lasso

2022-2023: Maintenance and Improvements: Mauro I. Dominguez,
Occasional recommendations: Andras Lasso

Eyeballing, the traditional paper-ruler method



1. Bend reconstruction plate according to resected mandible
2. Cut the rectangular paper ruler to pieces that match the reconstruction plate



3. Align the paper pieces along the grafted fibula and mark the closing-wedge osteotomies

Virtual Surgical Planning, the digital way

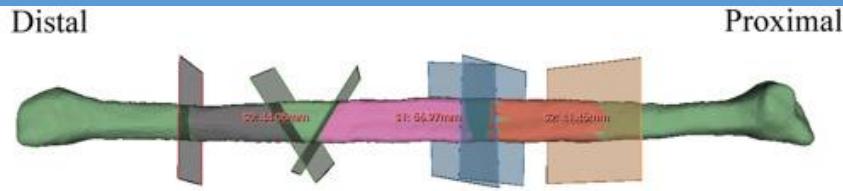
Virtual surgical planning (VSP) - segmentation and mandible reconstruction

- a) Segmentation of mandible. Noted mandible is separated from the midface and appear in a different colour.
- b) Tumour resection is done virtually.
- c) Placement of mandibular cutting planes and reconstruction
- d) Lateral view of mandible segmentation.
- e) Lateral view post-resection.
- f) Lateral view post-reconstruction.
- g) Bottom view of mandible segmentation
- h) Bottom view post-reconstruction.

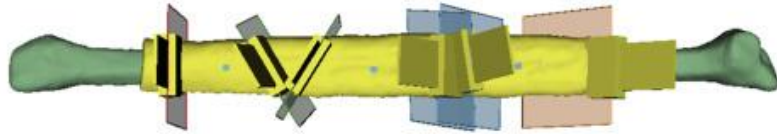
Virtual Surgical Planning, the digital way

VSP – fibula cutting guide generation

- a) Fibula bone segmentation with the placement of fibula planes.
- b) Generation of fibula cutting guide.
- c) Fibula cutting guide in STL format
- d) 3D printed fibula cutting guide using PLA materials.
- e) 3D printed reconstructed mandible.
- f) 3D printer.



(a)



(b)



(c)



(d)

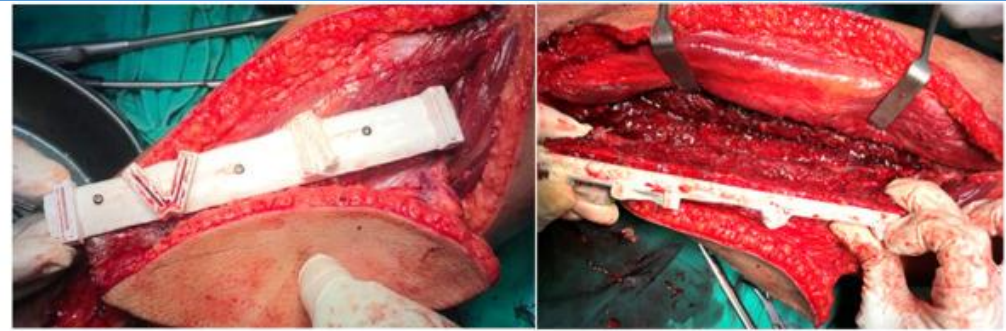


(e)



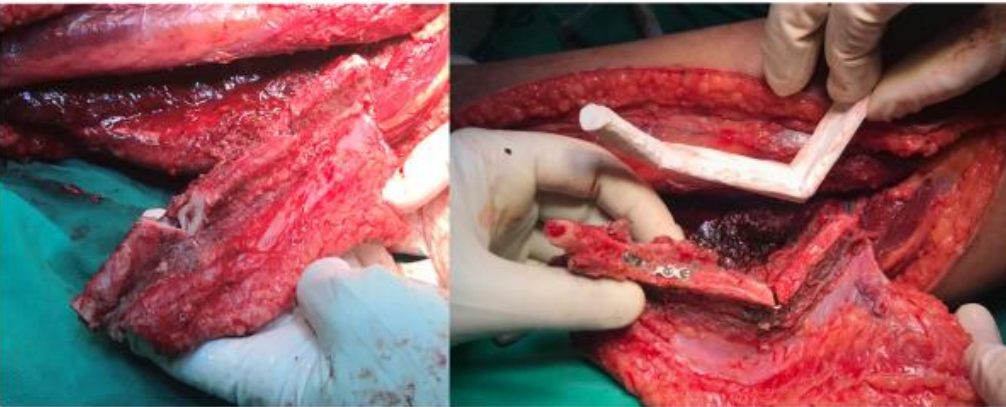
(f)

Virtual Surgical Planning, the digital way



(a)

(b)



(c)

(d)



(e)

(f)

Intra-operative photos (Case 1).

- a) Fibula cutting guide fixed on to the fibula
- b) Fitting of fibula cutting guide at the anterior and lateral aspect of the fibula.
- c) Osteotomy cuts made. The fibula bone is cut into 3 segments.
- d) Miniplates were fixed onto the fibula segments. Pedicles are still attached at this moment.
- e) The main tumour was resected.
- f) Fibula segments were fixed onto the native mandible to form neomandible.

Virtual Surgical Planning, the digital way



(a)

(b)

Clinical photos (case 1).

- a) Pre-operative facial appearance.
- b) 1-month post-operative facial appearance.
- c) Pre-operative orthopantomogram.
- d) 1-month post-operative orthopantomogram.

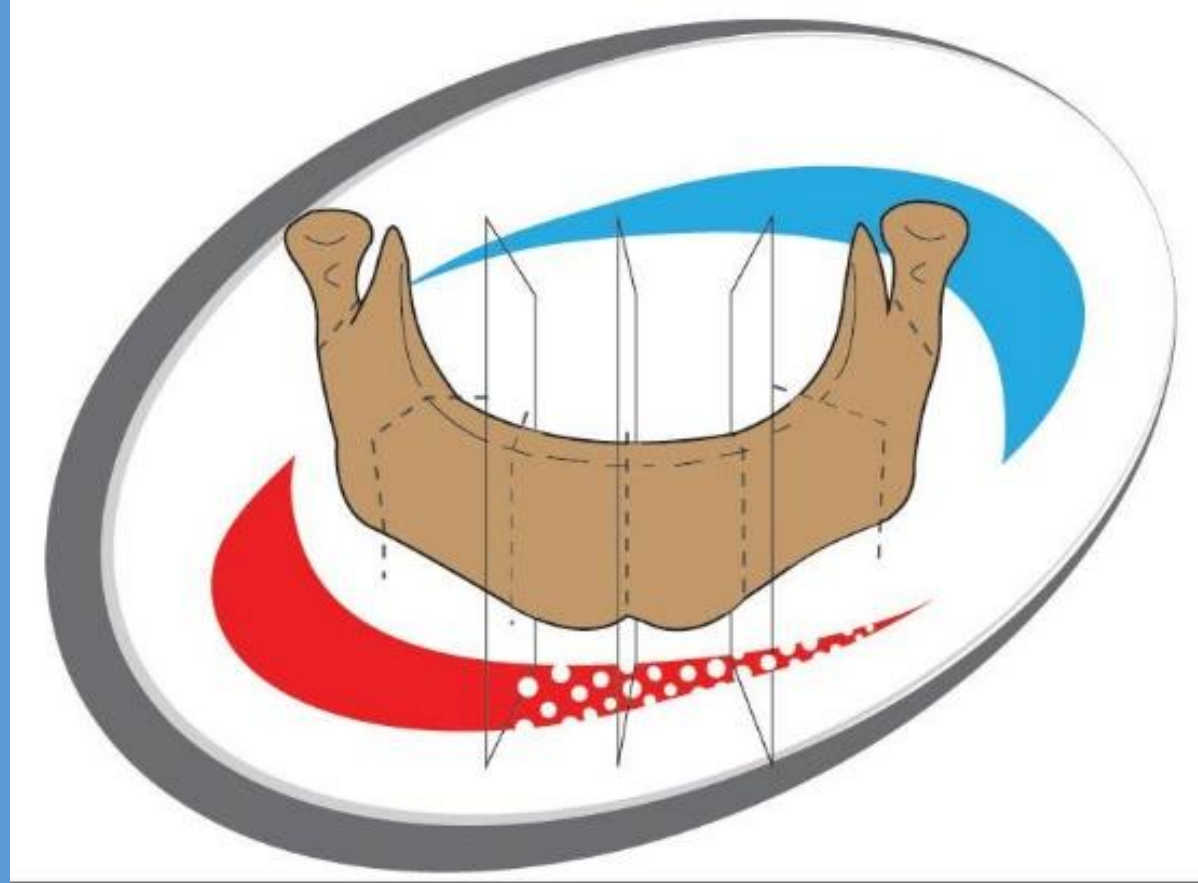


(c)



(d)

Virtual Surgical Planning, the digital way



Demo Video: <https://youtu.be/HRciwWEOAKk?t=1>

Virtual Surgical Planning, the digital way

Benefits:

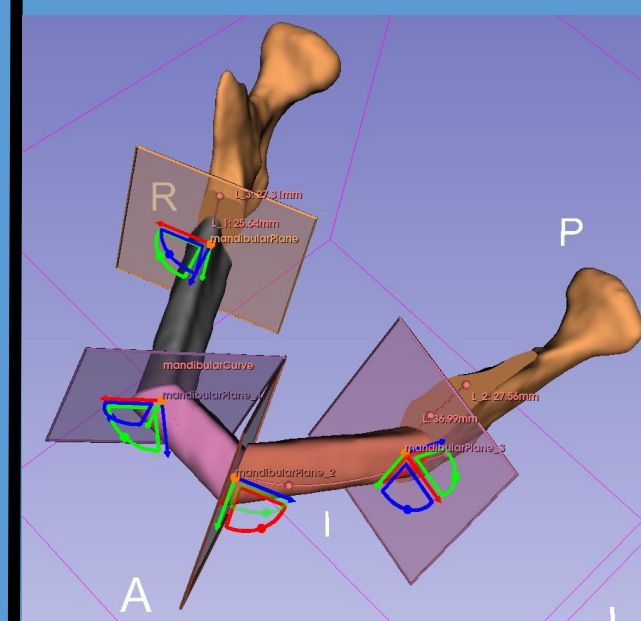
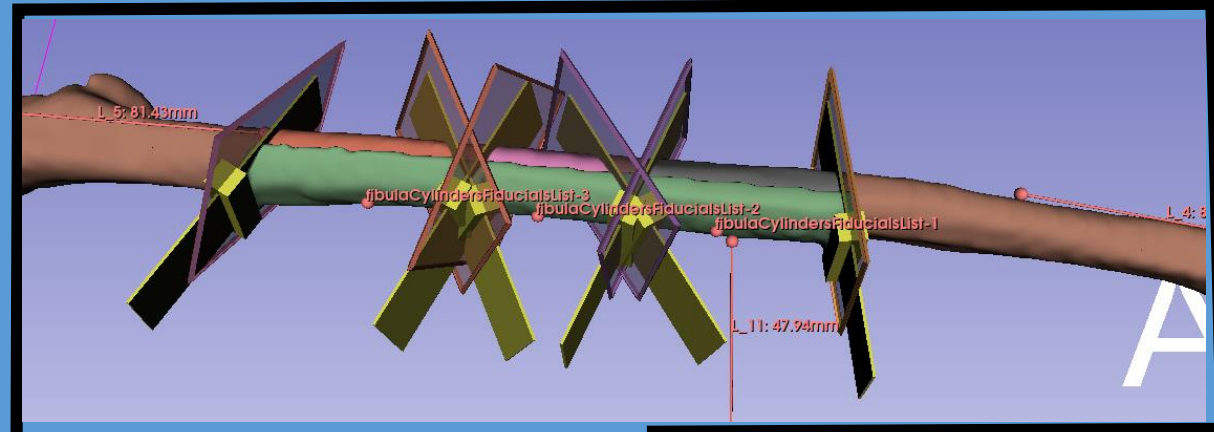
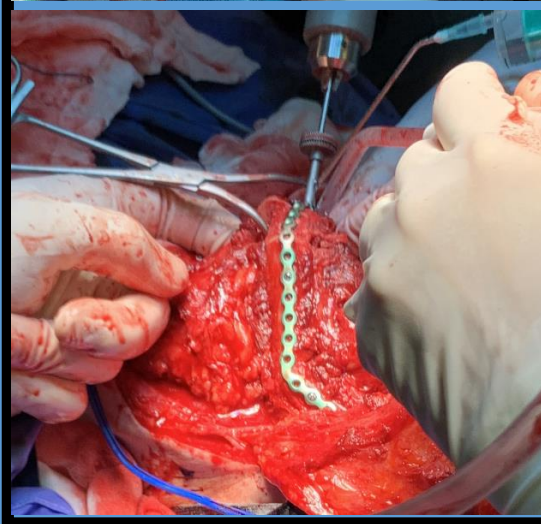
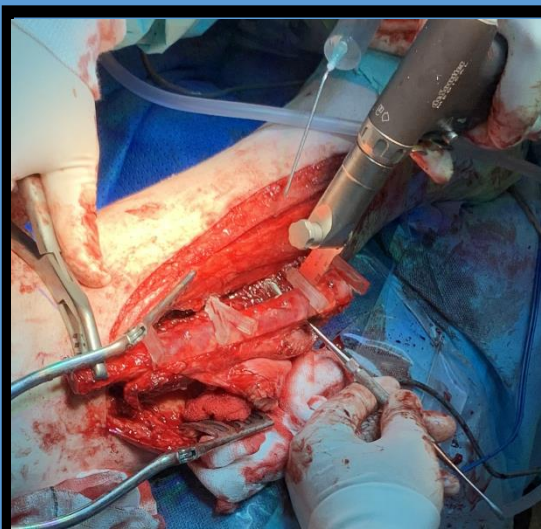
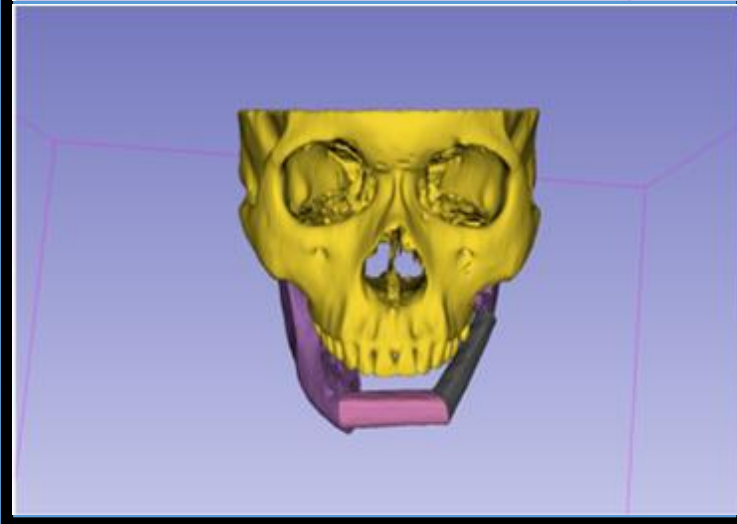
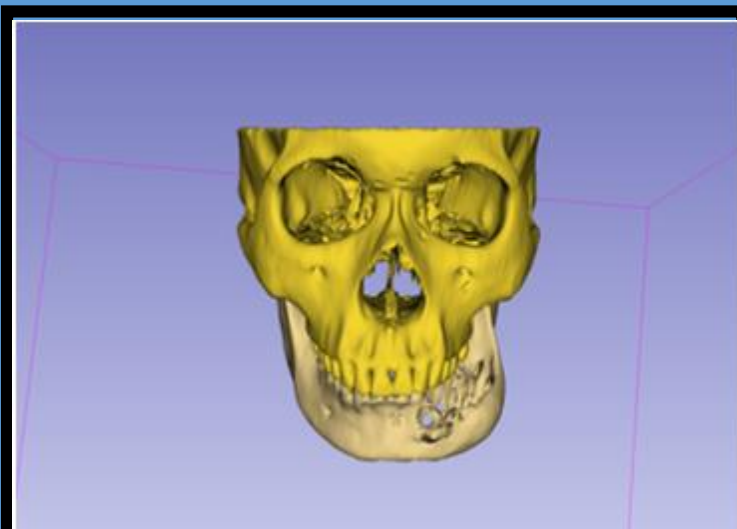
- less operation time
- less ischemic time
- less length of hospital stay after surgery
- better osteotomies accuracy
- better neomandible contour, more aesthetic

Cons:

- VSP software license (free if using BoneReconstructionPlanner, 15k USD annual license if using commercial software)
- 3D printer, biocompatible material, sterilization (can be done on an in-house 3D printing lab or outsourced)
- needs research-review-board or FDA approval
- half an hour preoperative plan (plenty net time is still saved)
- learning curve for new user or need of biomedical engineer or qualified technician

Virtual Surgical Planning, the digital way

Use cases: around 30 surgeries informally documented



Sources:

- <https://github.com/SlicerIGT/SlicerBoneReconstructionPlanner/discussions/58>
- <https://github.com/SlicerIGT/SlicerBoneReconstructionPlanner/discussions/62>
- <https://github.com/SlicerIGT/SlicerBoneReconstructionPlanner/discussions/40>
- <https://discourse.slicer.org/t/bone-reconstruction-planner/19289>

BoneReconstructionPlanner – Software Architecture

Used features currently available on Slicer:

- Markups (lines, curves, planes, points)
- Segmentations (created from the segment editor)
- 3D models
- 3D operations (algorithms, filters)
- Registrations (transforms)

In top of that:

- Virtual osteotomies and virtual reconstruction
- Generation of personalized surgical guides

Appendix:

The math behind it all

Source:

- Mauro I. Dominguez
- <https://www.linkedin.com/in/mauro-dominguez-77496211b/>
- <https://github.com/maugna06>

