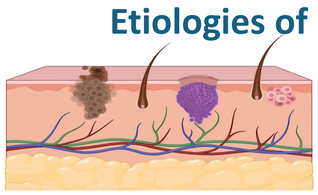
Optimization and personalization in total nasal reconstruction through digital planning and surgical, biomechanical and psychological insights.

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Redefining Nasal Reconstruction

Etiologies of Nasal Amputation



1st Oncologic resection

2nd Trauma :

- Bite (human or animal)
- Road traffic accident
- Explosion…



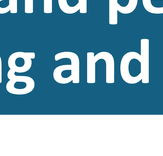


Other : infections, congenital malformations, immune diseases, vascular malformations…

Nose:

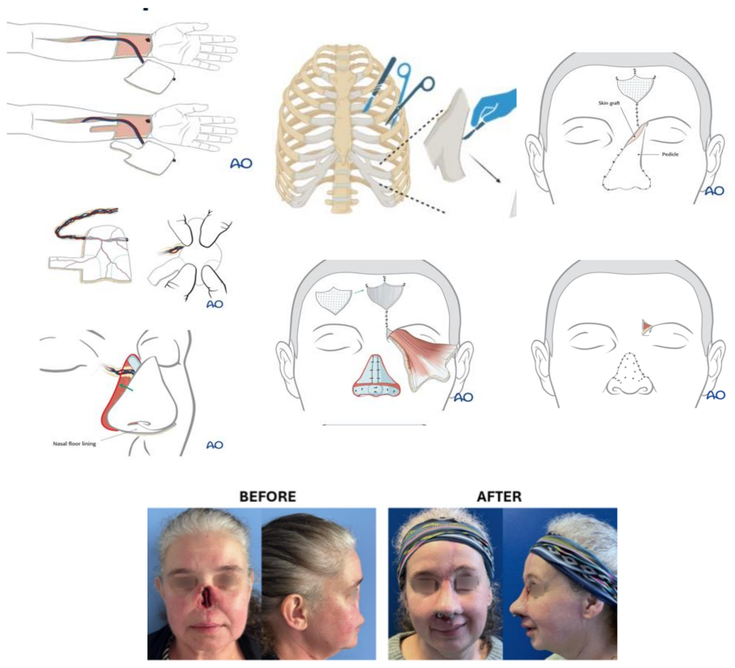


Critical component of the upper airway & Central feature of facial identity

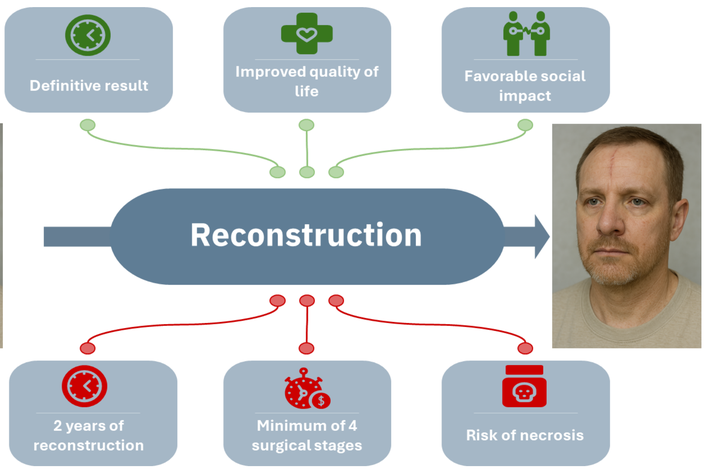


Demands reconstructive approaches that address both form and function.

Gold Standard (C. Burget, F.J. Menick)



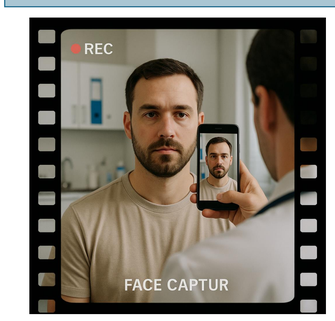




Limitations :
- Highly complex, multistage surgery
- No anatomical guidance for surgeons
- Reconstructed nose ≠ original nose

Aim of Digital planning

3D acquisition and modeling of the patient's native facial morphology





Achieving a patient-specific result tailored to the morphology of the original nose

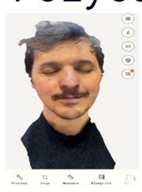
Assist the surgeon at each harvesting step to personalize the procedure to the patient.



Approach



Polycam



blender



Step 1
Acquisition of a clinical video recording showing the patient's facial features

Step 2
Patient face capture and nasal region extraction

Step 3
Patient-specific 3D modeling and printable cartilaginous substitute

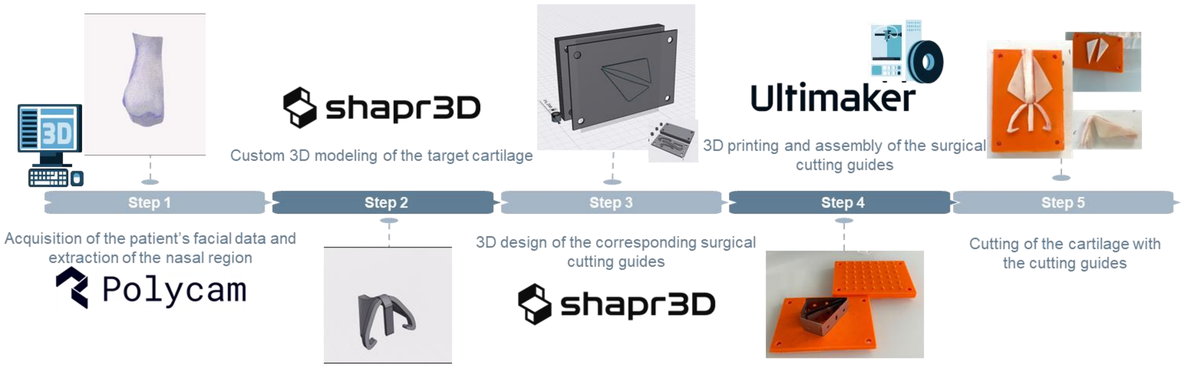
3D facial models generated using:
- Structured-light
- LiDAR-based photogrammetry
- Standardized image acquisition

Next step:
Recruitment of patients requiring total nasal reconstruction with combined flap reconstruction with available pre-injury facial references.

Results

Cutting Guides

For costal cartilage sculpting



For skin flap design

This approach uses virtual simulation, 3D printing, and patient-specific guides to improve accuracy, reduce variability, and streamline nasal reconstruction.

Biomaterials

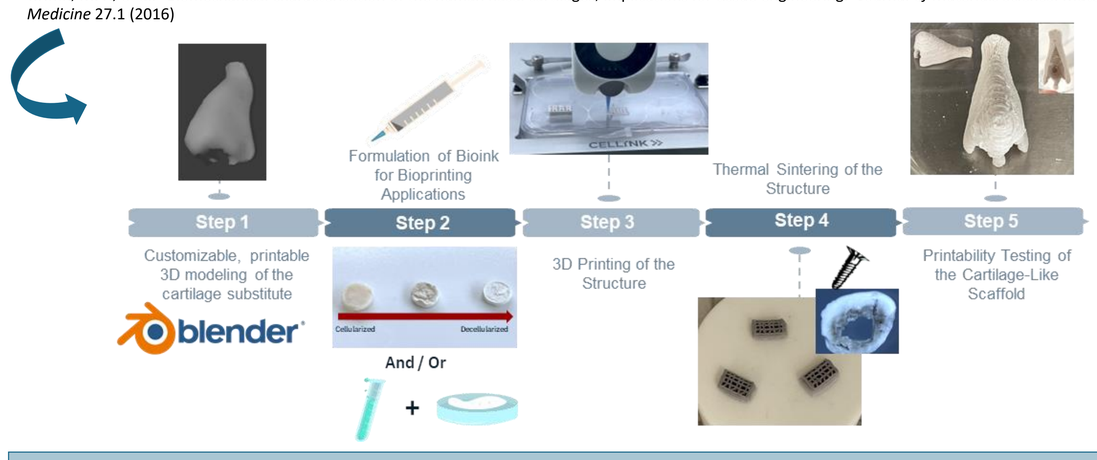
In parallel with digital optimization strategies, this work research to develop a biomaterial alternative to costal cartilage, inspired by the mechanical properties of native nasal cartilage described below.

Table 1 Compressive and viscoelastic properties of the nasal cartilages based on anatomical structure of the nasal cartilages (MPa)

Mechanical property	Type of nasal cartilage (average, standard deviation)					
	Septal posterior	Septal middle	Septal anterior	Alar lateral	Alar medial	Lateral
Compression Young's elastic modulus (MPa)	3.47 ± 0.26	2.74 ± 0.37	2.50 ± 0.32	2.12 ± 0.50	2.06 ± 0.50	0.98 ± 0.29
Final stress relaxation rate (MPa 10^{-5})	1.6 ± 0.40	1.33 ± 0.09	1.63 ± 0.42	3.4 ± 0.13	3.26 ± 0.15	1.46 ± 0.06
Final absolute relaxation rate (MPa)	0.23 ± 0.04	0.23 ± 0.05	0.21 ± 0.03	0.42 ± 0.06	0.41 ± 0.04	0.22 ± 0.03

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Griffin, M. F., et al. "Biomechanical characterisation of the human nasal cartilages; implications for tissue engineering." *Journal of Materials Science: Materials in Medicine* 27.1 (2016)



3D-printed scaffolds based on bio-inks represent a promising approach for creating patient-specific, mechanically adapted substitutes, paving the way for more advanced and less invasive nasal reconstruction techniques.

Conclusion

The integration of these biomaterials into a comprehensive digital workflow, combined with automated 3D imaging, paves the way for truly personalized, accurate, and biomimetic nasal reconstruction

References

(1) Faris C. et al, 2020, 10.1002/lary.28480,
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