Design of an Endonasal Graft Placement Tool for Repair of Skull Base Defects

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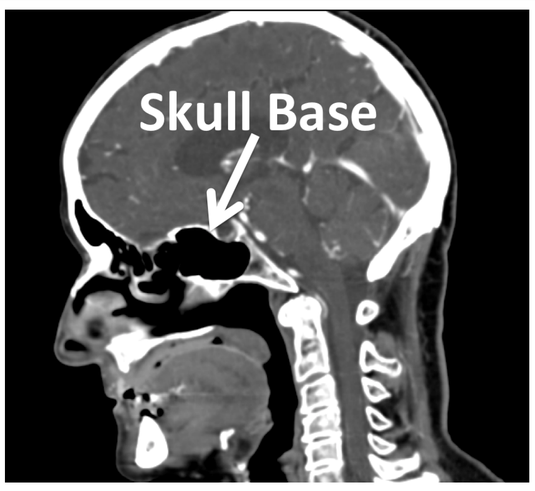
Endonasal Skull Base Surgery

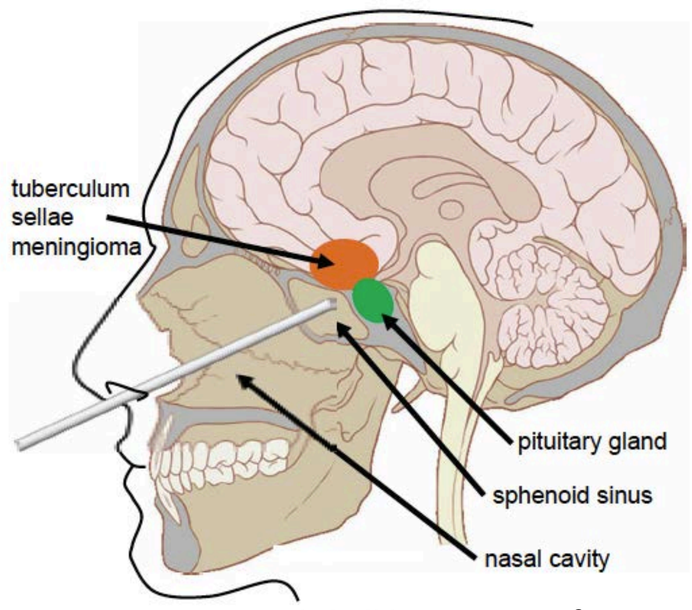
Causes of Skull Base Injury
- Trauma
- Inevitable during some procedures



Endonasal Approach
- Minimally invasive
- Limited tool manipulability
- Graft placement can add up to 30 minutes

Inadequate Graft Placement Complications
- CSF leaks that lead to meningitis, brain hemorrhage, neurological deficits, or death[1]

Current Surgical Tool Problems



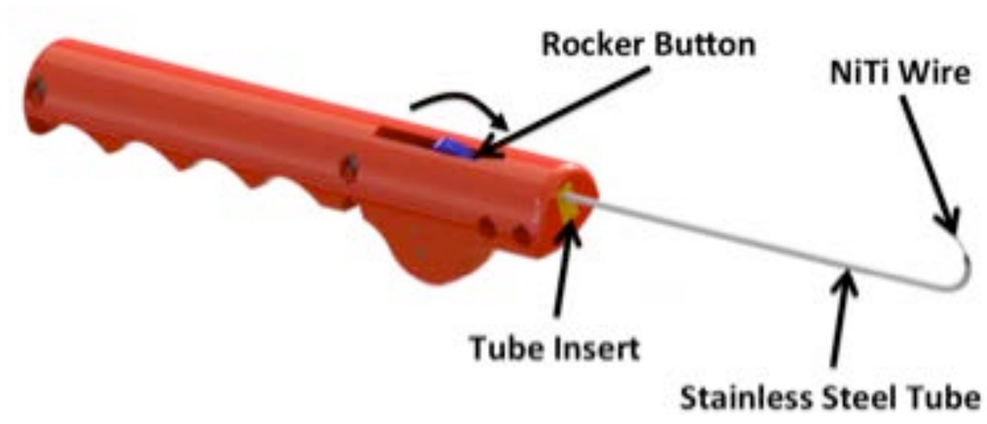
Transnasal skull base surgery[2]

Poor tools lead to dropped grafts, decreased surgeon confidence, increased operating time

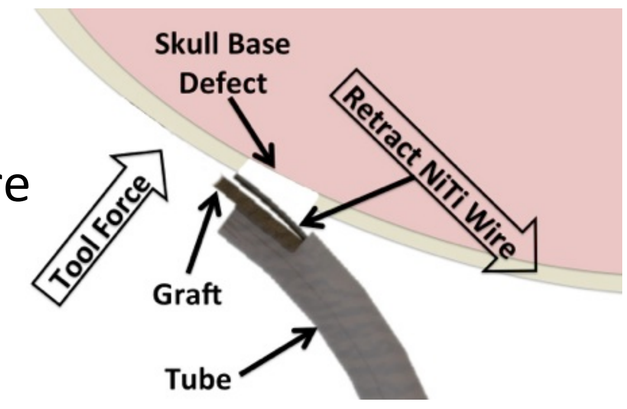
Forceps:
- cannot reliably open and close in tight spaces
- good grip
- poor force application

Blunt Tools:
- good force application
- poor grip
- difficulty handling varying graft size, shape, rigidity

Novel Tool Design

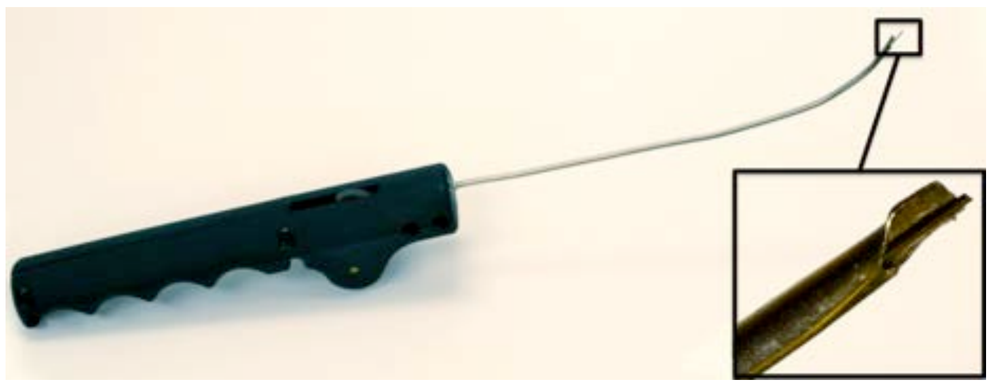


- Surgeon actuated rocker button
- Extends/retracts wire
- Shelf at tube tip
- Graft held by bent wire and shelf

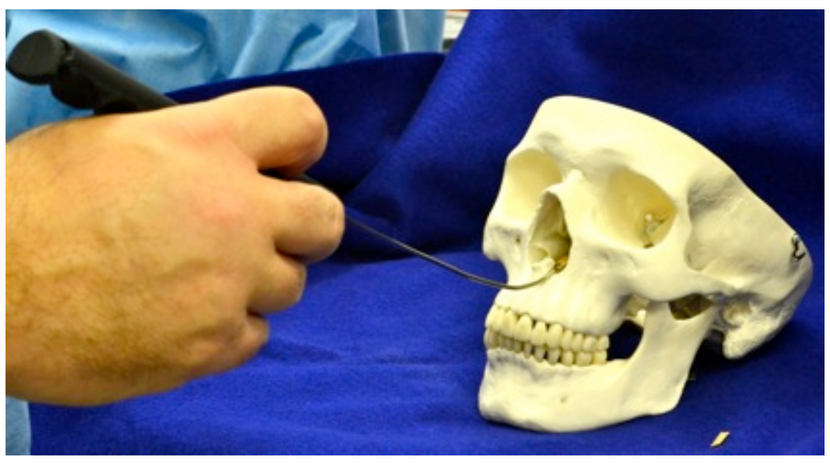


- Excellent gripping, control, force application

Prototype & Testing



- 3D printed handle in two pieces
- Laser cut acrylic rocker button, tube insert
- Bent 2.15mm stainless steel hypotube



- Benchtop simulated graft placement experiment
- Surgeon noted better control and force application, and expects this design to decrease operating time

References

[1] Kim, E., and Russell P., 2010, “Prevention and Management of Skull Base Injury,” Otolaryngol. Clin. N. Am., **43**, pp. 809-816.
[2] J. Burgner, P. J. Swaney, D. C. Rucker, H. B. Gilbert, S. T. Nill, P. T. Russell III, K. D. Weaver and R. J. Webster III, “A Bimanual Teleoperated System for Endonasal Skull Base Surgery,” IEEE/RSJ International Conference on Intelligent Robots and Systems, pp. 2517-2523, 2011.