InnovX Rapid Cranial Clamp
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Abstract
Rapid cranial clamps are proving to be the preferred technology to re-fixate bone flaps to the skull after craniotomies. Our objective is to improve and/or replace the INVISx cranial clamp produced by Medtronic Neurosurgery, Inc. Specific goals include minimizing creep and reducing application cost. The results of our efforts include an innovative shaft configuration, optimized material choices, versatile plate design, and a novel disposable applicator. The overall objective of our project is to deliver a proof-of-concept prototype design with realistic materials.

Results
1. Disposable applicator eliminates clamping tool
2. Inner gates of applicator will fail in shear at a predetermined clamping force
3. Threads allow torque-limiting application
4. Polymer plates produce no artifacts in radio-imaging
5. Tilting plate with clover design allows conformation to skull profile anomalies
6. Titanium shaft will not creep under clamping load
7. Ratchets provide quick and strong fixation

Key accomplishments:
• Met design goals by eliminating creep and costly separate application tool
• Potentially patentable novel design

Future Recommendations
• Modify applicator to allow for one-piece injection molding
• Size gates according to material choice and desired clamping force
• Add tab or knob on distal end of shaft for stability in application

Acknowledgements
Professor Laguette, Jeff Bertrand, Robert Citron, Kirk Fields, Dr. Duncan McBride, Jeff Hughes, Vijay Srinivasan, Craig Draiger, 3D-RPM, Korda and Gels Engineering

References
1) http://www.uspto.gov
2) http://www.medtronic.com
3) http://www.pubmed.com

Table 1. Market overview

<table>
<thead>
<tr>
<th>Product</th>
<th>Key Features and Benefits</th>
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</thead>
<tbody>
<tr>
<td>Aesculap CranioFix</td>
<td>Ratched shaft</td>
</tr>
<tr>
<td></td>
<td>• Fast application time</td>
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<tr>
<td></td>
<td>• No unratching</td>
</tr>
<tr>
<td></td>
<td>• Only need to engage one ratchet</td>
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<td>Lorenz RapidFlap Spindown</td>
<td>Threaded shaft</td>
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<td></td>
<td>• Allows for torque limiting application</td>
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<tr>
<td></td>
<td>Disposable applicator</td>
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<td></td>
<td>Tilt plate conforms to skull</td>
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<td>Synthes Tube Clamp</td>
<td>Clover cap design</td>
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<td></td>
<td>• Allow for anomalies in skull profile and craniotomy cut</td>
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Figure 1. Clamp application site

Figure 2. INVISx clamp and clamping tool
- Reduce the cost of the tools required for application
- Minimize shaft creep
- Retain low to zero interference with radio-imaging
- Maintain a repeatable clamping force

Design Development

Figure 3. Testing, prototyping, and clinical review
- Conducted patent review and market research
- Designed and performed tests to develop performance specifications
- Validated design through rapid prototyping and actual size proof-of-concept modeling
- Verified research and design efforts with industry sponsors and focus groups with UCLA neurosurgical team
- Addressed clinical needs with innovative design

Figure 4. InnovX Rapid Cranial Clamp

Competitor Review

Table 1. Market overview