OEDK
Oshman Engineering Design Kitchen

Around the Kitchen Table

Presented by bp

Medical Technology Projects

October 18, 2011

5:30 – Meet and Greet

6:00 – Student Presentations

6:30 – Dinner Buffet

6:40 – Dinner Discussions

BAKER HUGHES

bp

BCM Baylor College of Medicine
Cullen Eye Institute

Chevron

KBR

NASA

Procyrion

Texas Heart® Institute
at St. Luke's Episcopal Hospital

Team tCoil:

Wirelessly Powering Procyrion's Ventricular Assist Device With Transcutaneous Energy Transfer

Wirelessly Powering Procyrion's Ventricular Assist Device With Transcutaneous Energy Transfer

Team tCOIL: Alexander Dobranich, Trevor Mitcham, Michael Torre, Hana Wang, Erin Watson, Tyler Young

Mentors: Michael Cuchiara, Maria Oden, Gary Woods

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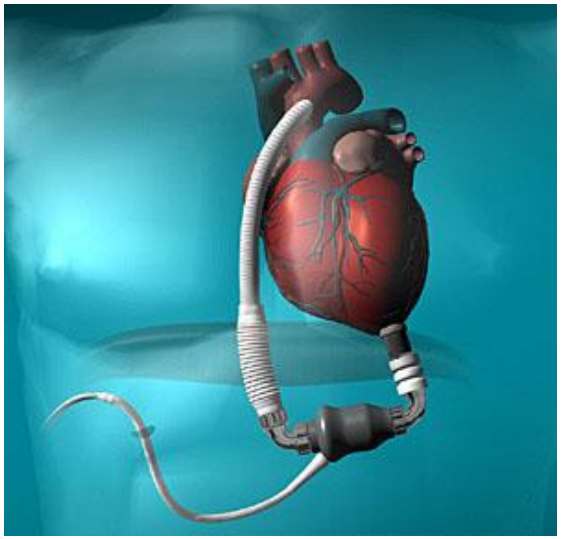
Procyrion

Ventricular Assist Devices (VADs)

- Heart Failure
  - Occurs in 1 in 5 people over 40[1]
  - Kills 60,000 people, costs > $40 billion per year in US



Left Ventricular Assist Device

- Common Heart Failure Treatment: VADs
  - Provide supplemental mechanical circulatory support
  - Procryion: catheter deployed VAD

1. Levy D., et. al. Long-term trends in the incidence of and survival with heart failure. N. Engl. J. Med. 347:1397-1402, 2002.

Issues with Percutaneous Wires

- Procyrion's VAD requires percutaneous wires
- Percutaneous wires cause infection
  - 30% left VAD patients with wire leads develop sepsis[2]

Percutaneous Wires

2. M. Jarvik, "LVAD power delivery: a percutaneous approach to avoid infection," The Annals of thoracic surgery, vol. 65, pp. 470-473, 1998.

Creating a Wireless Power Source

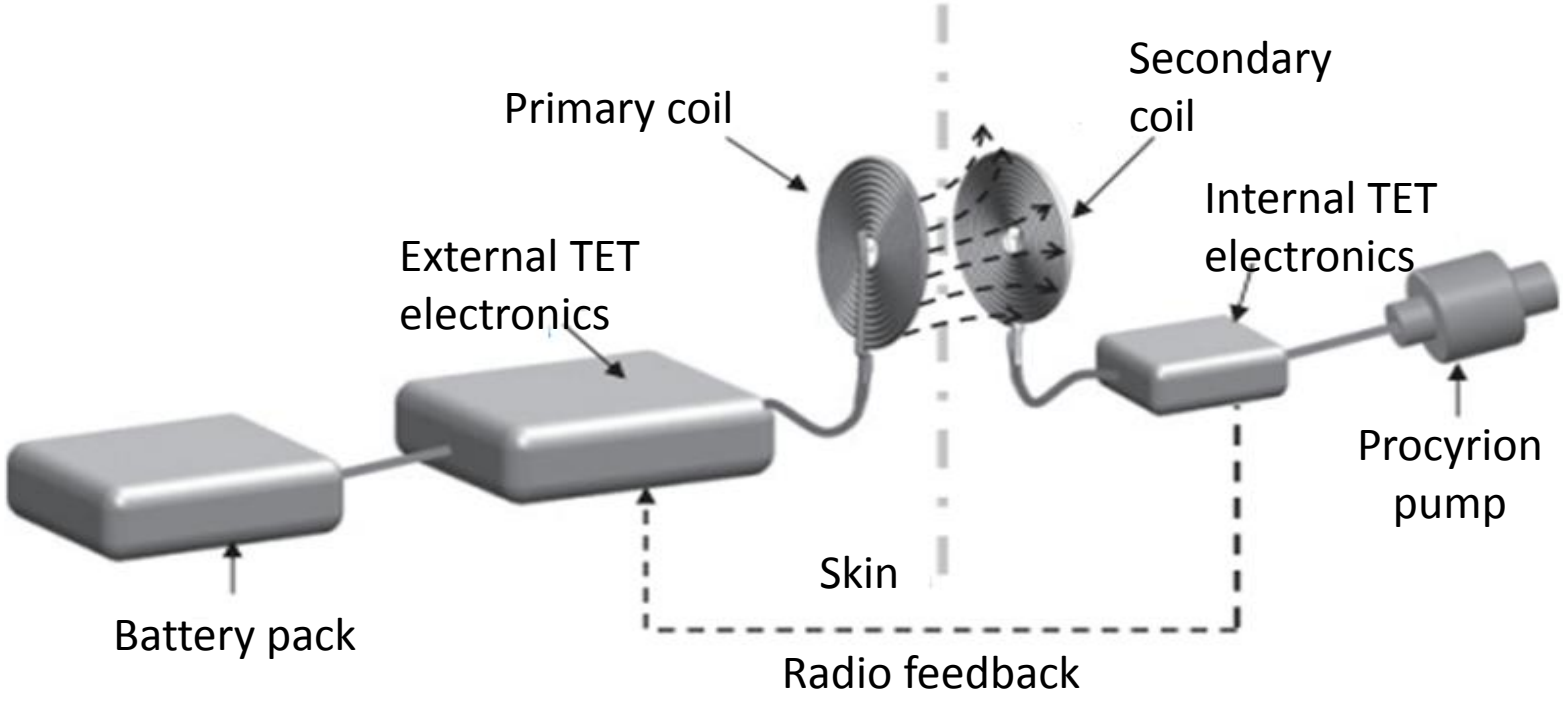
- Create a system that wirelessly powers Procyrion's catheter deployed VAD

- Key Device Requirements
  - Run >30 minutes without external power
  - Lifetime: 90 days
  - Size: <10 cm diameter
  - Distance: 1-2 cm
  - Biocompatible
  - Data up- and downlink
  - Power: 5 W

Procyrion's Catheter Deployed VAD

Transcutaneous Energy Transfer (TET)

- Inductive Coupling
  - Current in primary coil generates magnetic flux
  - Changing flux induces current in secondary coil



3. Thushari Dissanayake. Auckland Biogengineering Institute. A Novel Low Temperature Transcutaneous Energy Transfer System Suitable for High Power Implantable Medical Devices: Performance and Validation in Sheep

Using TET to Power Procyrion's VAD

- No infection risk from percutaneous wires
  - Viable for long term use
- Higher quality of life sans wires
- Applicable to many other implantable devices

Coils for TET

4. Hidetoshi Matsuki. Department of Biomedical Engineering, Tohoku University. Medical Applications for Implantable Devices Utilizing Electromagnetic Fields

Team OPTO:

Regulated Tube Shunt for Glaucoma

OPTO: Saving the Future's Vision

Felix Chang
Chris Fan
Karen Marsden
Kevin Perkins
Eva Thomas

The Burden of Glaucoma

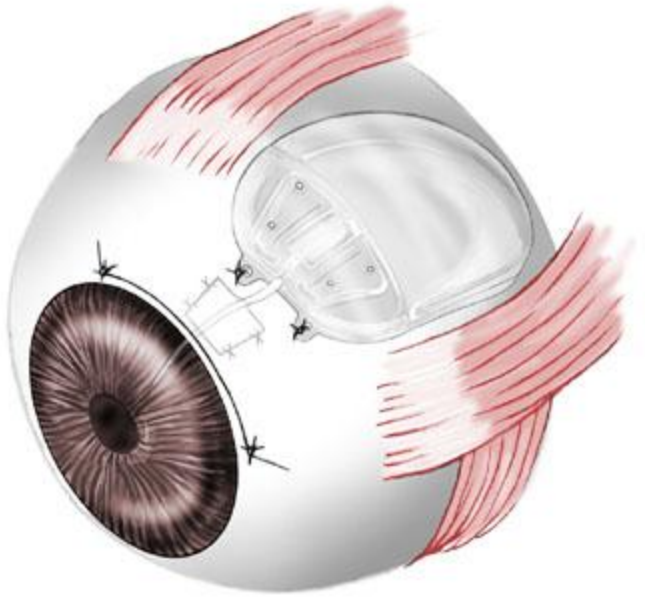
- Pathophysiology
  - Impeded flow of aqueous humor through the trabecular meshwork results in an increase in intraocular pressure (IOP)
  - Optic disc damage resulting in visual field loss
- Current problems
  - **2nd** leading cause of blindness worldwide
  - **60 million people** currently afflicted worldwide
  - **$1.5 billion** annually in U.S. Social Security

Tube Shunts: Problems and Potential

- Non-functional pressure regulation
  - Hypotony in first 6 weeks
  - Variable long term pressure

Variable fibrous encapsulation

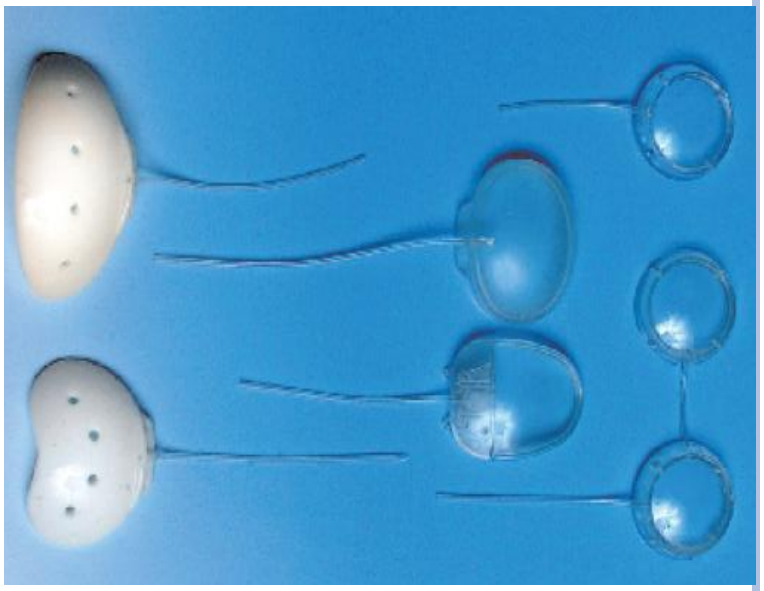
- Ideal tube shunts:
  1. Effective solution
  2. One time application
  3. Tunable to personal needs



Anterior Chamber (Driving Force) → Tube (Routing) → Valve (Regulation) → Plate (Dispersion) → Sclera (Reabsorption)

Shunt Design Criteria

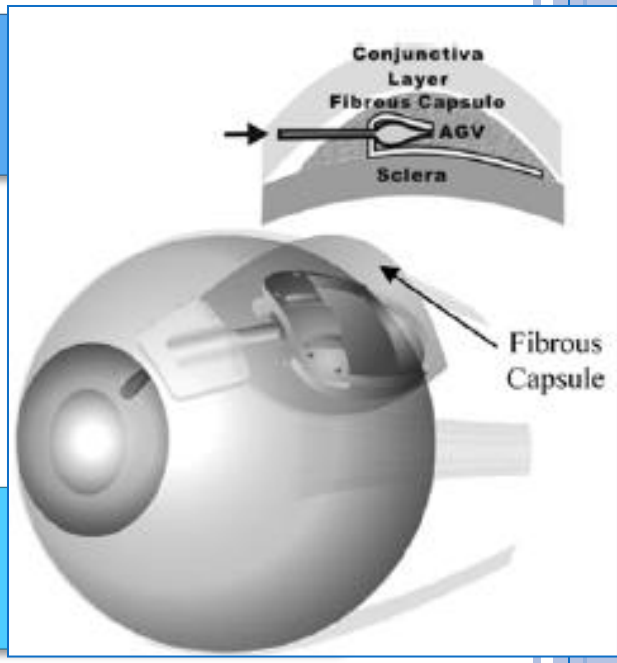
- Functionality: valves & drainage plates
  - Regulate pressure (8-14 mmHg)
- Size/Shapes (32 mm x 15 mm x 2 mm)
  - Permit easy implantation and patient comfort
- Cost (<$1000)
- Implantation complexity
- Durability



Design Challenges

Microscale

- Plate size limited to roughly 32x15 mm
- Thickness of < 2 mm
- Restricts design solutions
- Barrier to fabrication and testing



Role of the inflammatory response

- Affects long term function
- Variable degree of encapsulation
- Lack time and resources to test fibrous encapsulation

Lack of established precedents

- Most of our solutions have no existing analogue
  -At best, theoretical proof of concept

Preserving the Future's Vision

- 60 million suffer from glaucoma
- Current solutions are inadequate
  - Variable IOP
  - Hypotony
- Our aims:
  - Tight IOP control
  - Specific target IOP
- Improving quality of life
  - Fewer complications
  - Reduce glaucoma progression

References

- Image source: Modeling and characterization paper
- http://www.babble.com/CS/blogs/strollerderby/2009/01/grandparents.jpg

Team Break and Make:

Designing an Automated Linear Distraction Mechanism

Team Break and Make:
Designing an Automated Linear Distraction Mechanism

October 18, 2011

Alvin Chou, Mario Gonzalez, Stephanie Herkes,
Raquel Kahn, Elaine Wong

Advisor: Dr. Marcia O'Malley
Mentor: Dr. Gloria Gogola

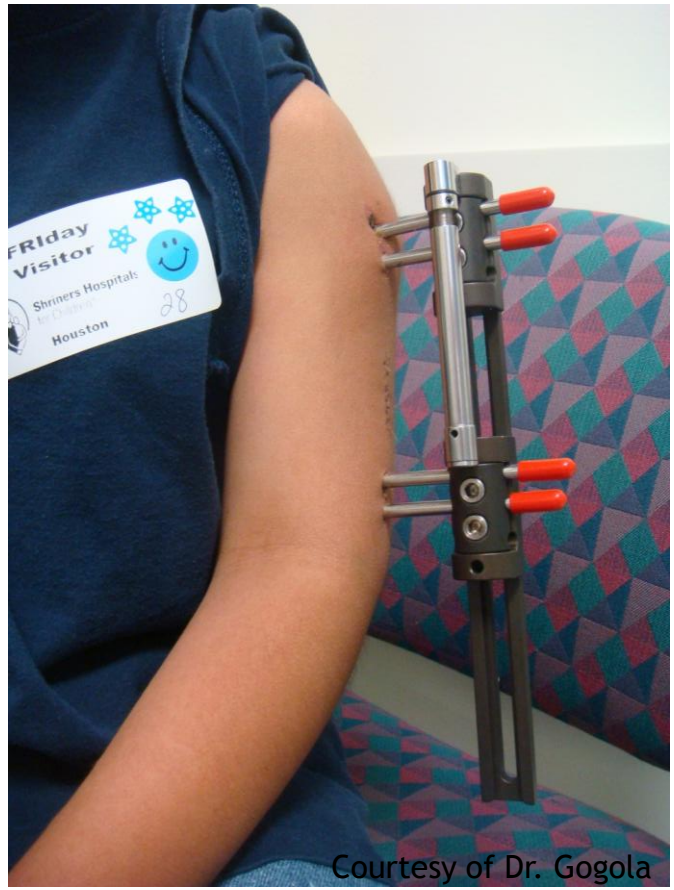
This project was sponsored by a gift from Chuck and Sharon Fox. The design work for this project was supported by the resources of the Oshman Engineering Design Kitchen.

Background

- Deformed bones
  - Trauma
  - Infection/Disease
  - Congenital Disorder

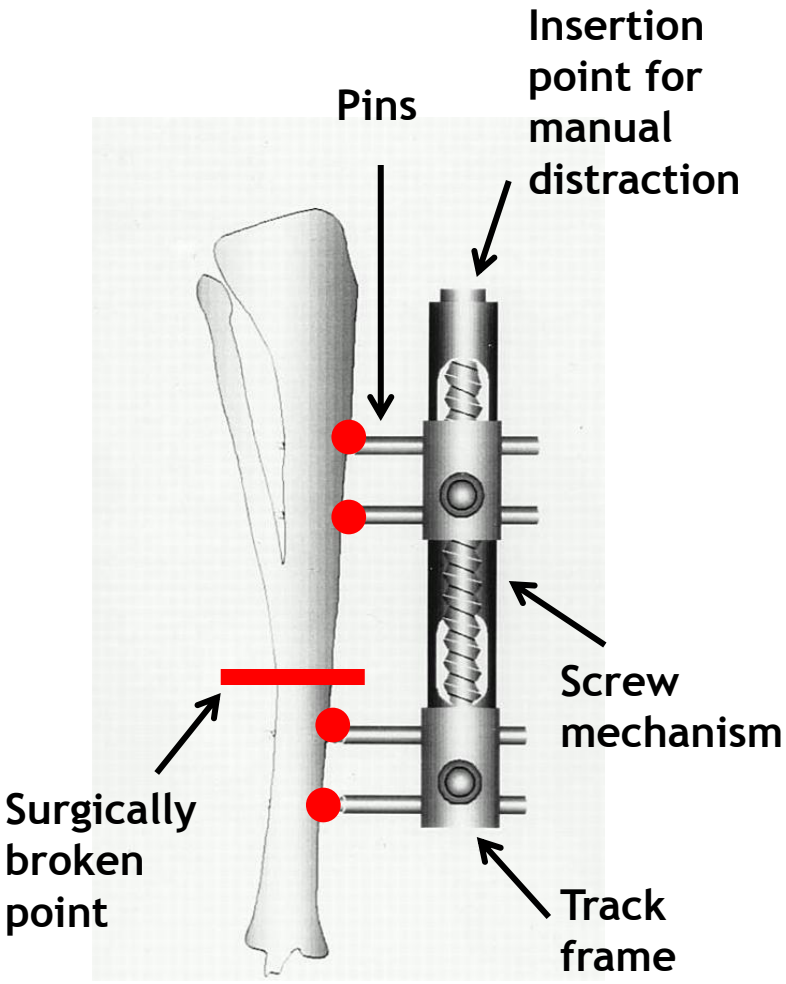
- **Solution:**

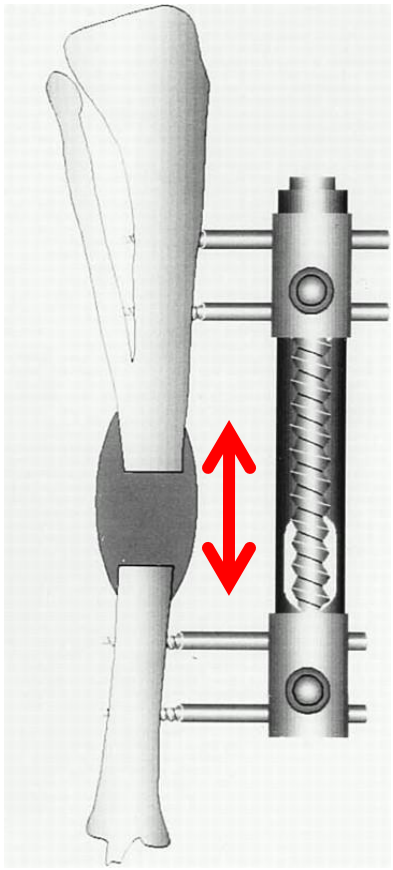
  Distraction Osteogenesis



Courtesy of Dr. Gogola

Current Devices

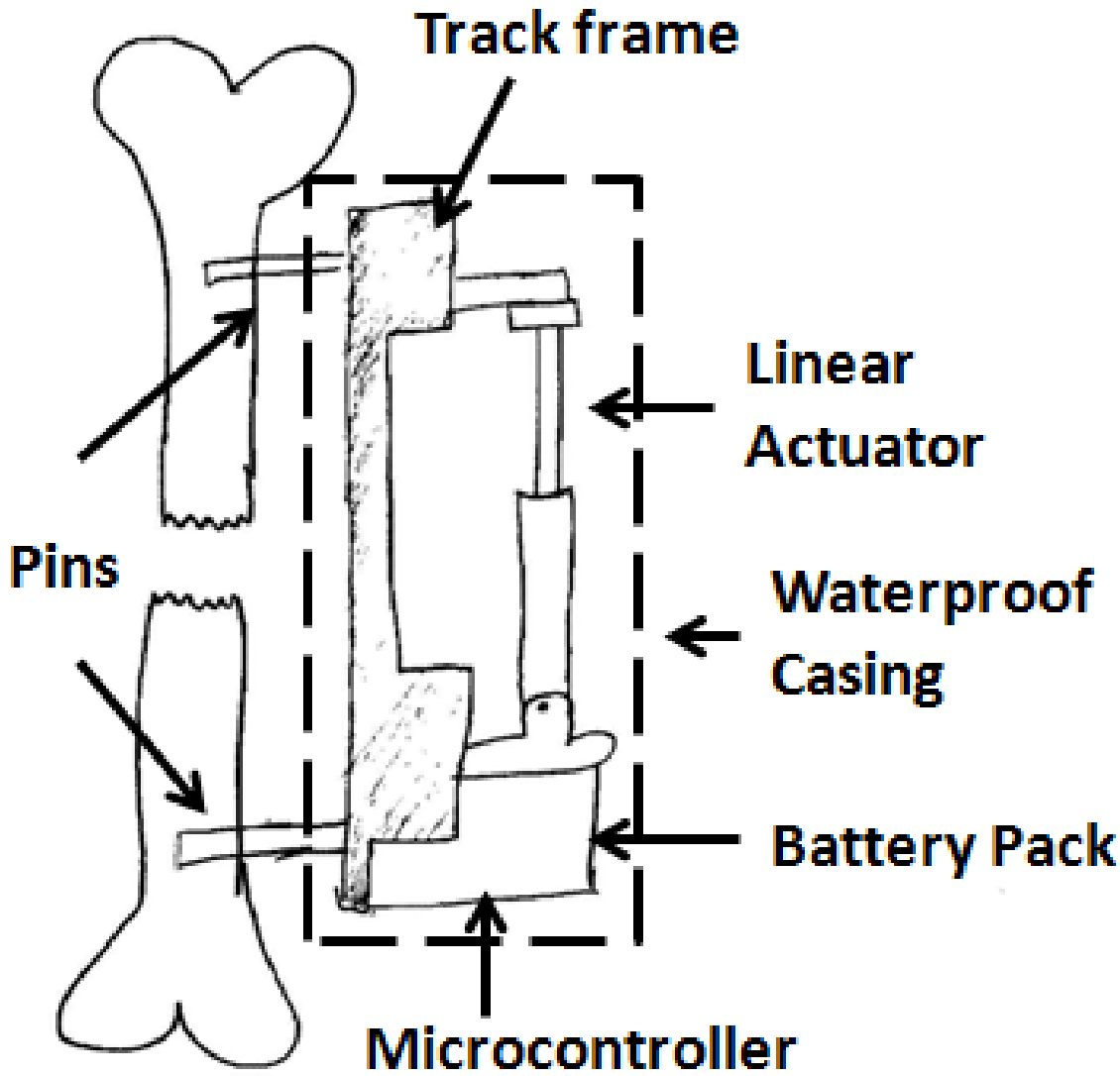




Courtesy of Dr. Gogola

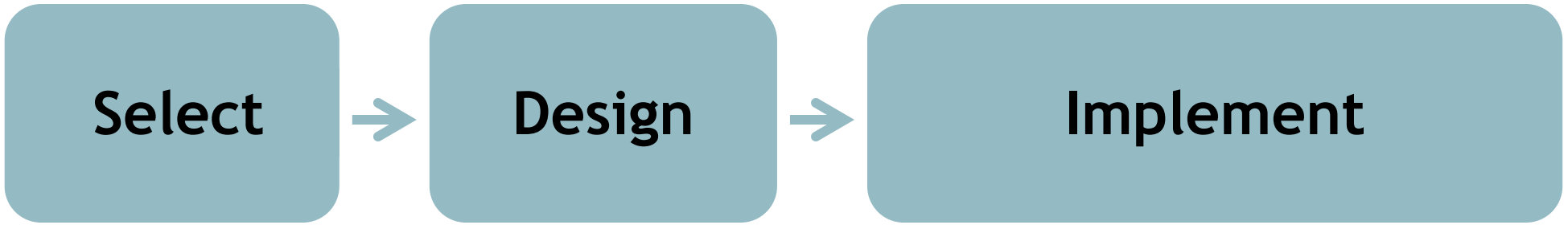
- Distraction controlled manually
- Purely mechanical
- Weekly clinic visits

Team BAM's Self-Adjusting Automated Distractor



- Safety
- Waterproof
- Durability
- Accuracy
- User Friendliness
- Dimensions
- Weight
- Cost of Prototype
- Feasibility

Moving Forward



October - November

- Select components
- Order parts

November - December

- Generate CAD model
- Run simulation
- Design and build prototype

January - April

- Refine design
- Run testing
- Modify prototype

Team CivSAFE & Team Collar ID:

Cervical Spine Immobilization

Cervical Spine Immobilization

Team CivSAFE

&

Team Collar ID

October 18, 2011

Presenters: Kelsey Horter and Kareem Ayoub

RICE

Cervical Immobilization Importance

- 30% of all trauma fatalities are caused by spinal cord injuries (SCI) [1]
- Improper immobilization causes 3,000 deaths per year [1]
- SCI account for 7.4% of military trauma cases [2]
  - Each year, 450 newly injured military members receive SCI rehabilitation [3]
- 25% of deaths from SCI occur from a secondary injury [1]

Problems with Existing Collars

- Spinal distraction [4,5,6]
- Incomplete immobilization
- Airway obstruction
- Pain and discomfort
- Environmental complications

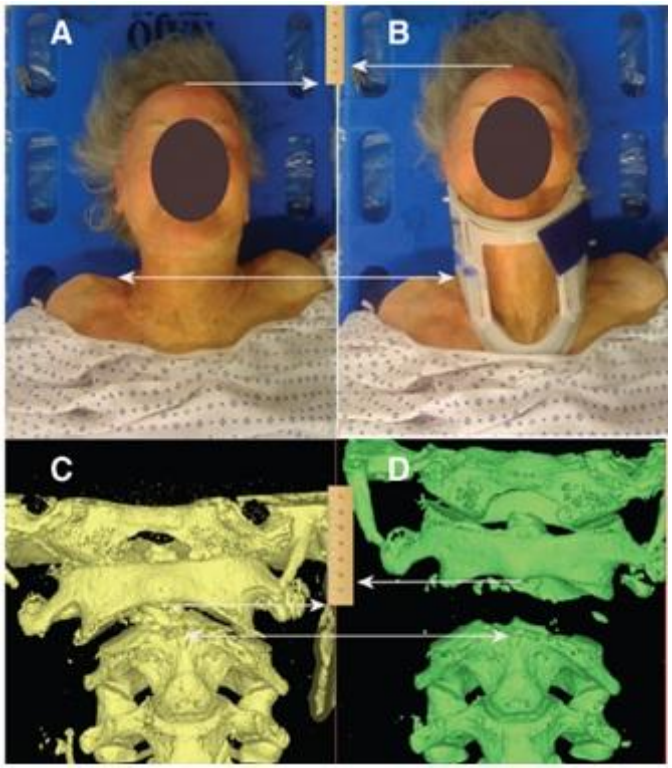
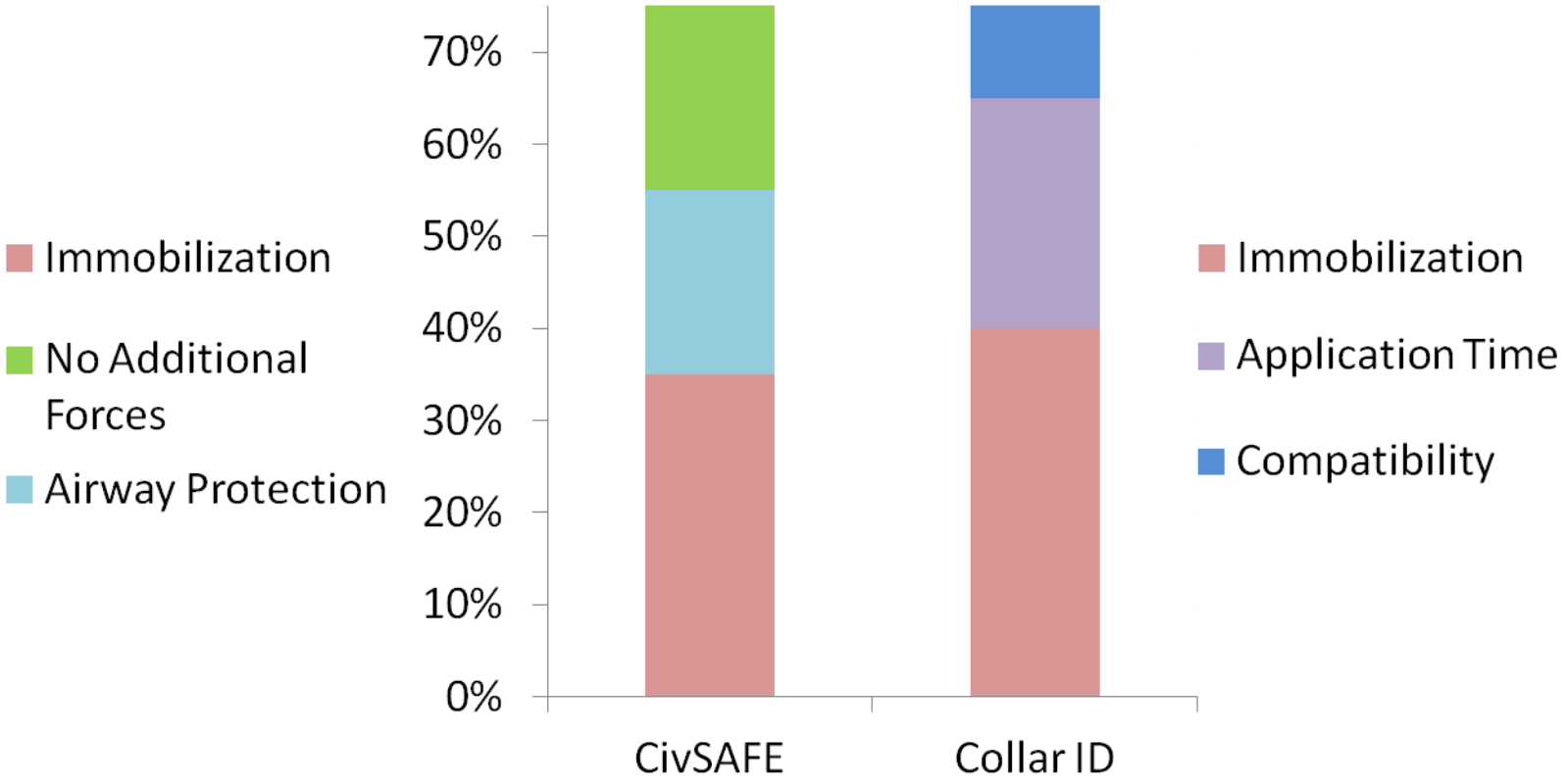


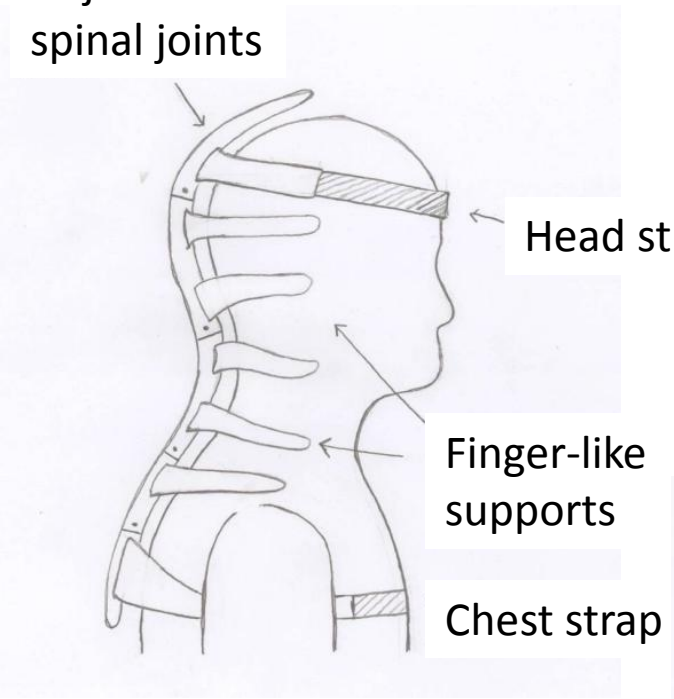
Photo credit: Ben-Galim, Peleg. "Extrication Collars Can Result in Abnormal Separation Between Vertebrae in the Presence of a Dissociative Injury"

Design Criteria



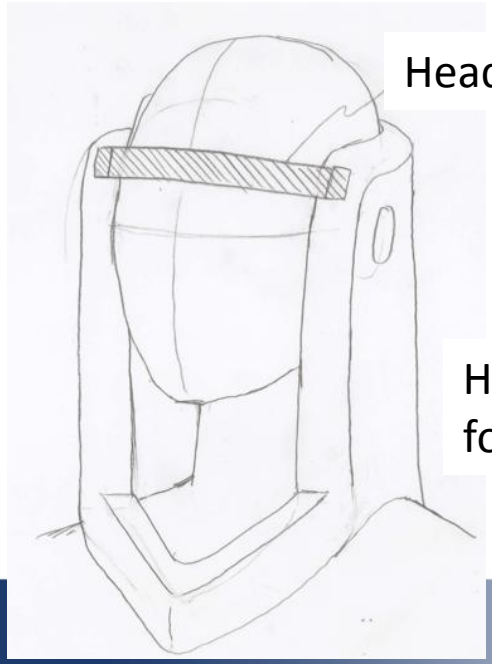
Civilian Immobilization Designs

Adjustable spinal joints

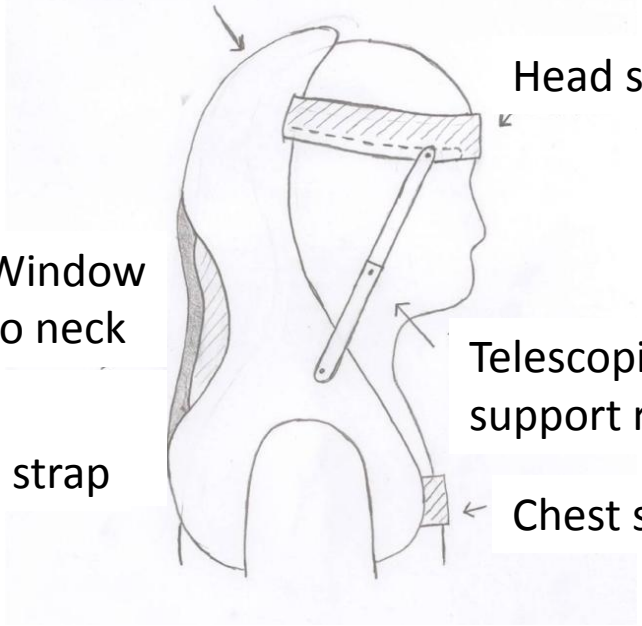


FINGERS OF LIFE

HEAD SPLINT



Hard plastic shell, foam interior

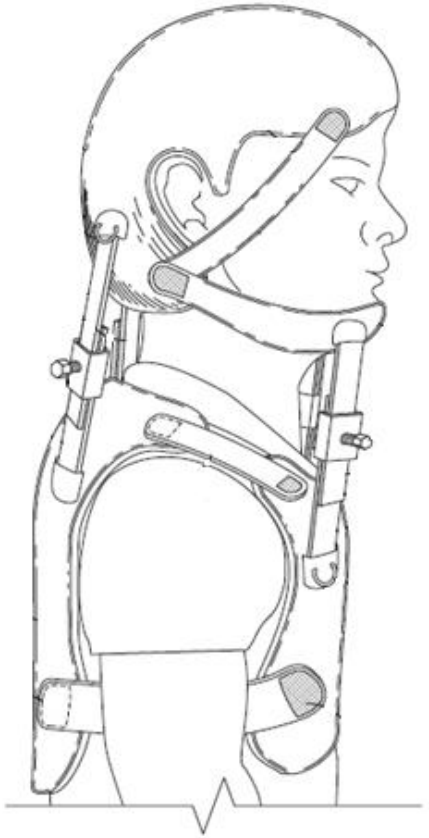


HEADCASE

Military Immobilization Design

Modified traditional suspension collar

- Integrates with military gear
- Attachment points between head and torso
- Suspension system isolates cervical spine from external forces



Acknowledgements

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Dr. Hipp
Dr. Oden
Dr. O'Malley
Dr. Persse
Dr. Wettergreen

And special thanks to our project sponsors:

BP and **Davis/Bucholtz**

References

[1] Ben-Galim, Peleg, Niv Dreiangel, Kenneth L. Mattox, Charles A. Reitman, S. Babak Kalantar, and John A. Hipp. "Extrication Collars Can Result in Abnormal Separation Between Vertebrae in the Presence of a Dissociative Injury." *The Journal of Trauma: Injury, Infection, and Critical Care* (2010): 1. Print.

[2] Schoenfeld, Andrew J. et al. "Characterization of Combat-Related Spinal Injuries Sutained by a US Army Brigade Combat Team During Operation Iraqi Freedom." *The Spine Journal*. 10 (2010). Print.

[3] "Fact Sheet:VA and Spinal Cord Injury."Department of Veterans Affairs. Jan 2009. Website. http://www1.va.gov/opa/publications/factsheets/fs_spinal_cord_injury.pdf

[4] USOCOM. "Tactical Combat Casualty Care Guidelines." Aug. 2010. Web. http://www.itstactical.com/wp-content/uploads/2010/10/TCCCGuidelinesAug2010.pdf

[5] Lunsford T, Davidson M, Lunsford B. "The Effectiveness of Four Contemporary Cervical Orthoses in Restricting Cervical Motion." *J Prosthet Orthot.* 1994; 6: 93–99.

[6] James, Colleen et al. "Comparison of Cervical Spine Motion During Application Among 4 Rigid Immobilization Collars." *Journal of Athletic Training*. 2004; 39(2): 138–145.

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