Vertebral Body Distraction Device

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Overview

- Introduction
- Problem Statement
- Current Designs
- Product Design Specifications
- Proposed Designs
- Design Matrix
- Final Design
- Future Work
- Acknowledgements

Client

Dr. Nathaniel Brooks

http://images.search.yahoo.com/images/view

- Neurological surgeon in Madison.

- Distraction alleviates pressure, helps with alignment, as well as provides more room to work.

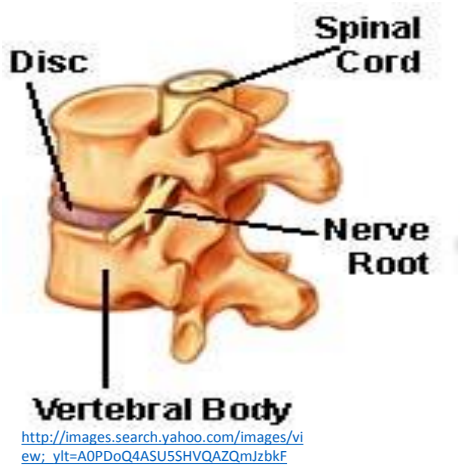
Background – The Spine

Anatomy:

- ❖Vertebral Body
- ❖Disc
- ❖Spinal Cord
- ❖Nerves

Function:

- ❖Structural support
- ❖Protect spinal cord



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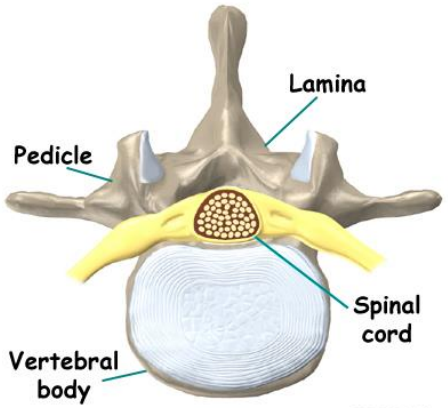

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Figure 1: Images depicting the anatomy of the spine.

Background-Collapsed Discs

www.google.com/search?q=collapsed+disc&source=lnms&tbm=isch&sa=X&ei

Figure 2: Visual comparison of healthy and unhealthy discs.

Typical Surgical Procedure:

1. Extraction of disc
2. Insertion of distractor
3. Placement of permanent cage
4. Retraction of distractor

Problem Statement

- The goal of this project is to design and fabricate a vertebral body distractor for the lumbar portion of the spine that can be easily manipulated and will not cause spinal fractures.

Current Designs

Figure 3: Cobb Elevator paddle distractor

Figure 5: Spine Wave StaXx

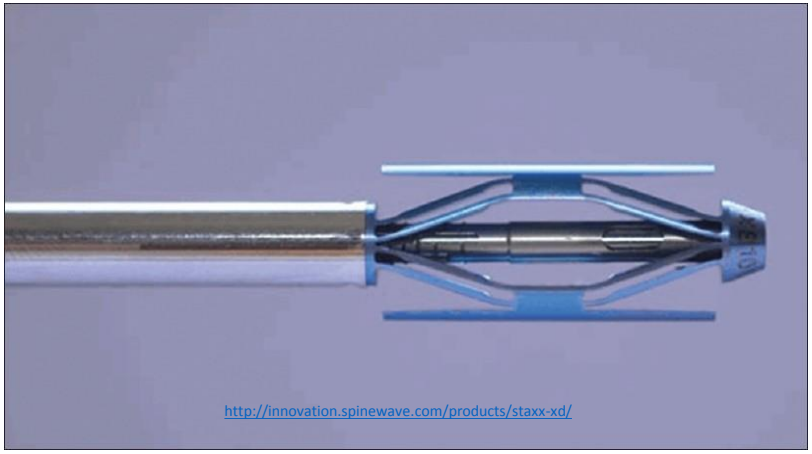

Figure 4: Scissor Jack system

These designs are…

- Stainless steel
- Too bulky
- Apply concentrated loads

Product Design Specifications

- Provides sufficient distraction force
- Avoids bone fractures
- Not bulky
- Provides proper feedback mechanism
- Biocompatible
- Cost Effective

Our Design Alternatives

- Mechanical System
- Inflation System
  - One Balloon
  - Multiple Balloons

Mechanical System

Components:

- Removable insertion rod
- Wire based distraction
- Feedback mechanism
- Mechanical distractor
- Removal technique

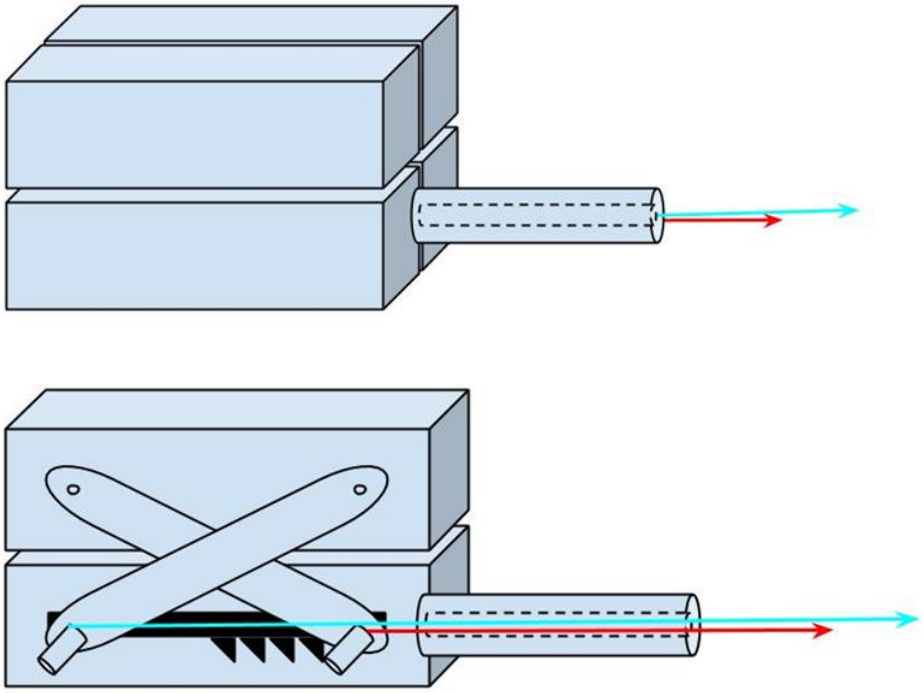

Figure 6: External (above) and internal (below) views of mechanical design

Inflation method

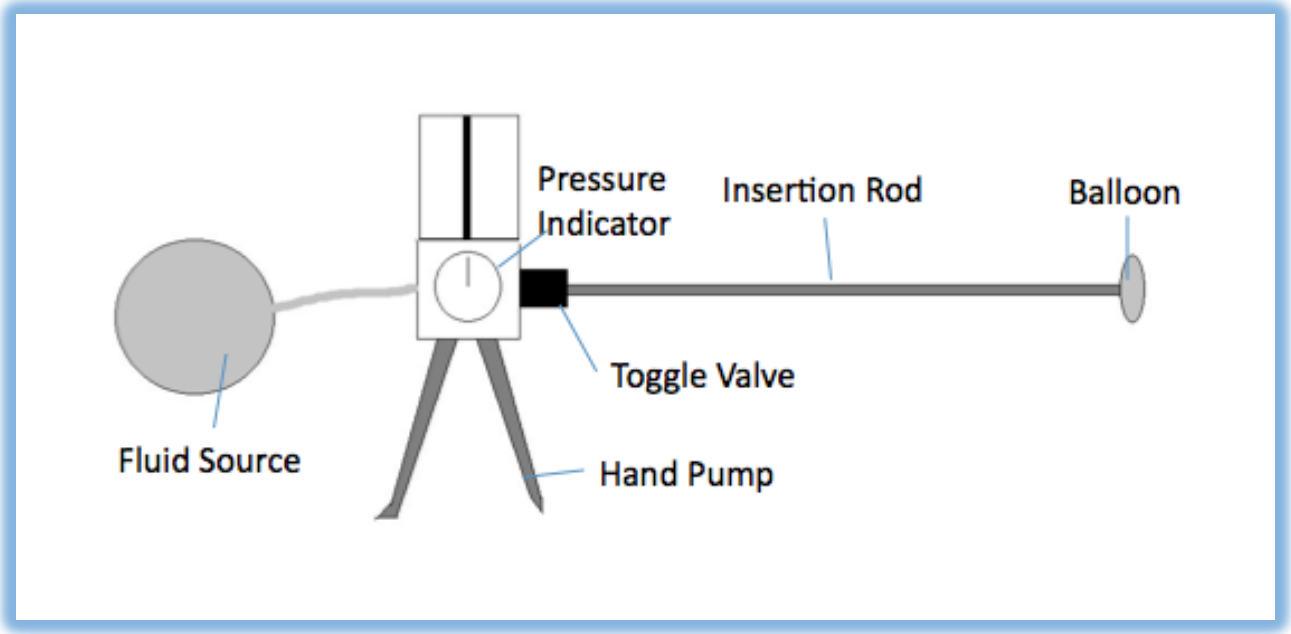

Figure 7: Inflation method schematic

- Balloon on tip of rod is inserted and inflated to distract the spine
- Toggle valve is closed so pump and rod can be detached after insertion
- Toggle valve is opened during removal to deflate the balloon

Inflation Method cont'd

Rod Properties:

- Covers fluid tube
- Provides insertion stability
- Removable

Balloon Properties:

- PET or Nylon
- Directed expansion
- Pneumatic or hydraulic

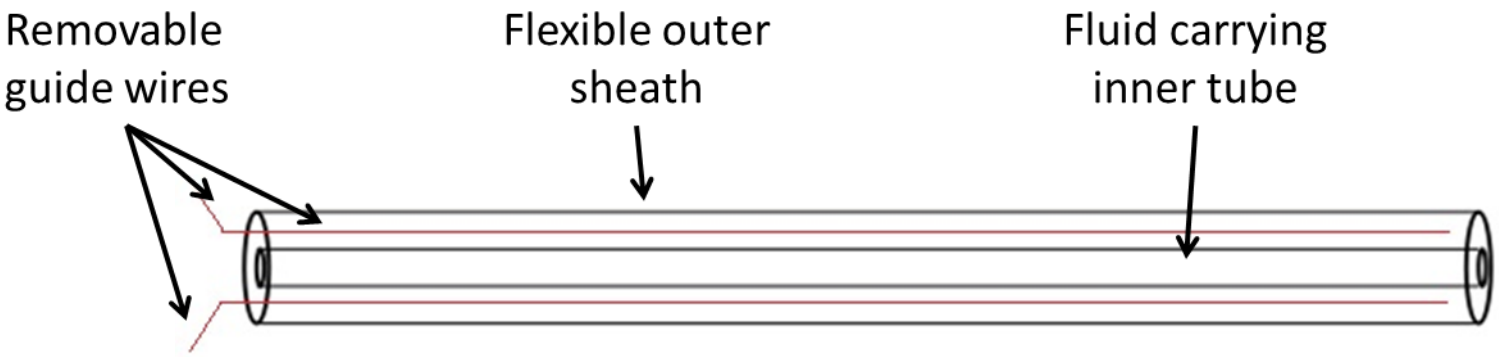

Figure 8: Rod design with guide wires and flexible outer sheath.

One Structured balloon

- Single balloon inflated for distraction
- Simple design, fewer points of failure
- Very easy placement

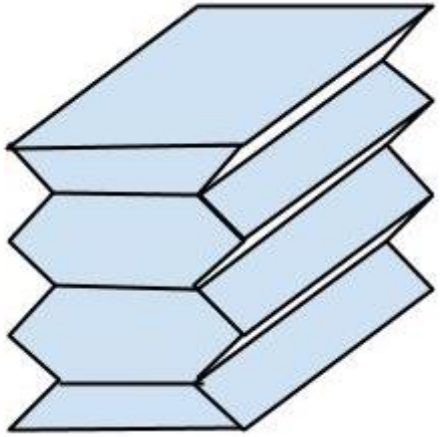

Figure 9: Accordion-shaped inflatable balloon.

Multiple Balloons

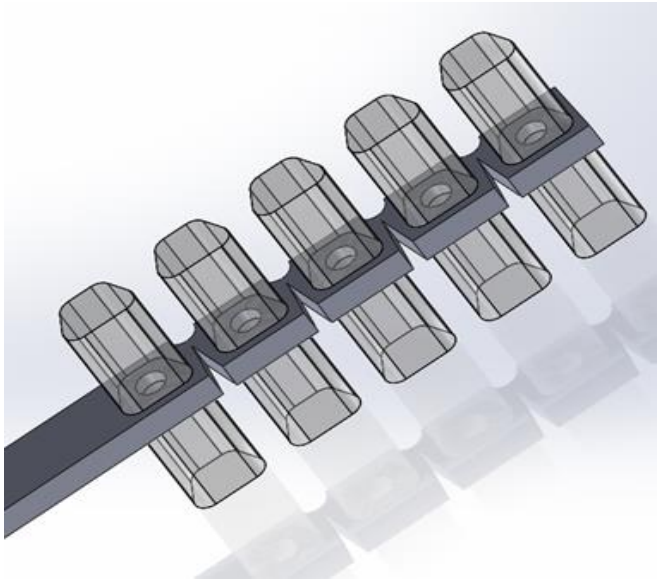

Figure 10: Zoomed in version of multiple balloon design.

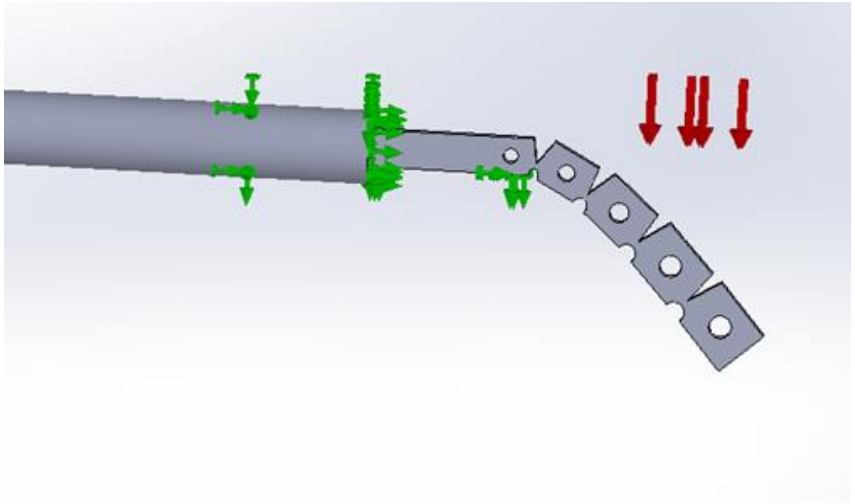

Figure 11: Zoomed out version of multiple balloon design showing flexibility.

- Multiple balloons
- Segmented shaft

- Flexibility
- Directional pressure

Design Matrix

	Mechanical		Inflatable			
	Expanding Platforms		One Balloon		Multiple Balloons	
Functionality (25)	4	20	4	20	5	25
Safety (25)	3	15	4	20	4	20
Size / Shape (15)	2	6	4	12	5	15
Feedback supplied (15)	3	9	3	9	3	9
Ease of use / Bulkiness (15)	3	9	4	12	3	9
Cost effectiveness (5)	2	2	3	3	3	3
TOTAL (100)	61		76		**81**	

Table 1: Design matrix. Scores are out of 5. Displayed as: score | weighted score.

Final Design

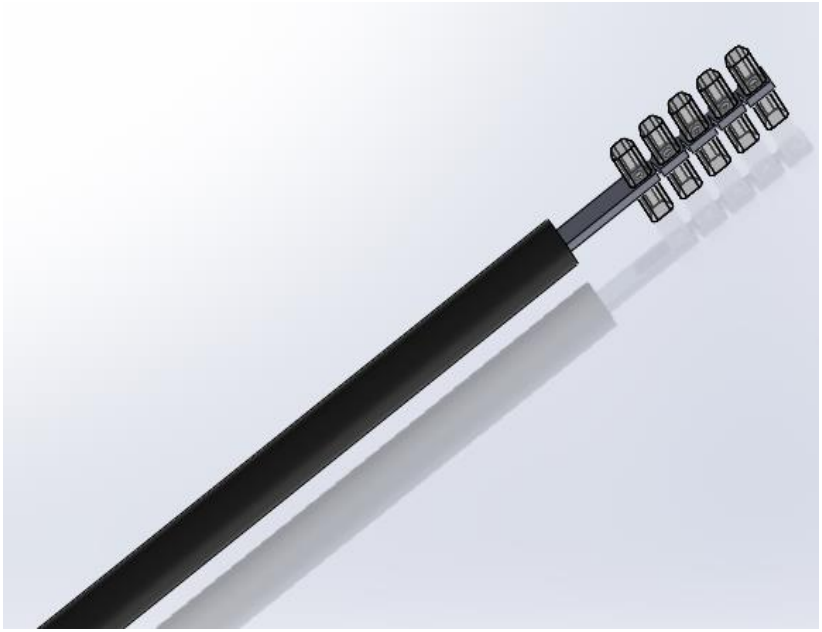

Figure 12: Final design of multiple balloons on flexible rod

- Uses multiple balloons, instead of just one
- Conforms to disc space
- Allows device versatility, flexibility, and maneuverability

Future Work

- Calculate required distraction force
- Determine balloon shape
- Finalize delivery method
- Fabrication
- Testing

Acknowledgements

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- Dr. Brooks' other vertebral groups

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Questions???

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