Inflatable Vertebral Body Distractor

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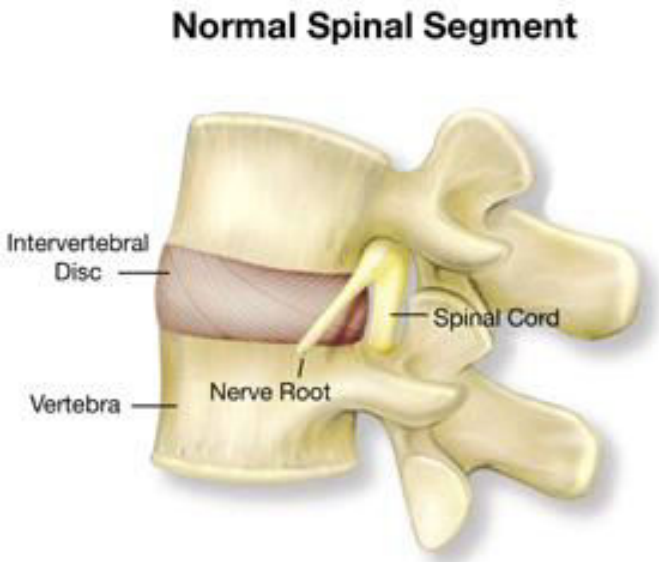
Presentation Overview

- Introduction
- Problem Statement
- Previous Devices
- Design Specifications
- Design Alternatives
- Design Matrix
- Future Work

Background - The Spine

Anatomy

- Vertebral body
- Intervertebral disc
- Spinal cord
- Nerve roots



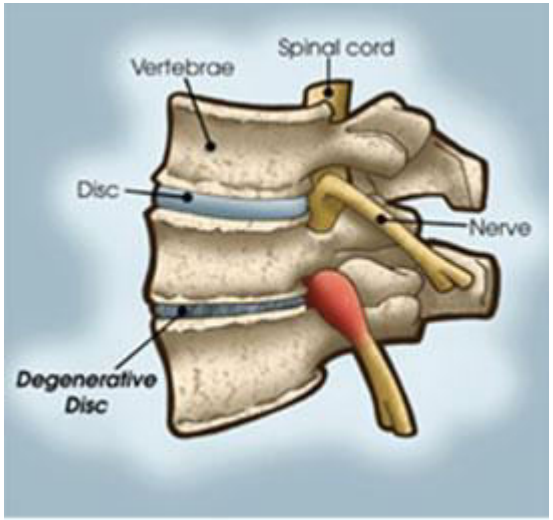
http://www.zimmer.com/content/images/en-US/pc/spinal-segment.gif

Problems

- Discs are soft, degenerate over time

Background - Surgery

- Lumbar intervertebral fusion procedure
  - disc space opened, entered below nerve root
  - disc space is distracted
  - degenerated disc is removed
  - cage inserted in disc space
  - removal of distractor

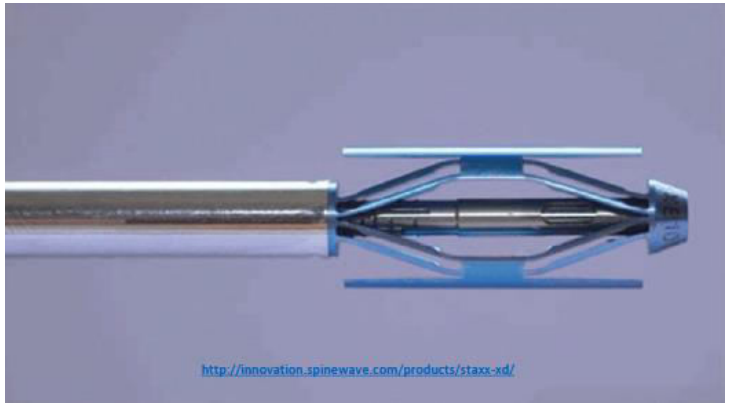


http://www.spinehealth.com/images/degenerated-disc-disease.jpg

Problem Statement

- Device to distract the vertebrae during spinal surgery
  - allows for removal of intervertebral disc
- Current devices fracture bone or are ineffective
- Pursue an inflatable device

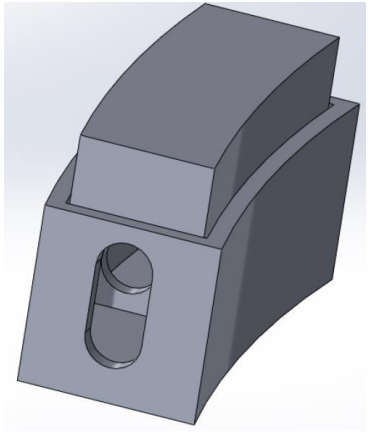
Current Designs



Design Issues:

- Too bulky
- Hard to maneuver
- Small surface contact area applies large pressure to vertebrae

Last Year's Design



Design 1: Box

- Internal balloon
- Box limits horizontal expansion
- Rigid design

Design 2: Catheter

- Pre-inflated catheter
- Stabilizing frame

Design Specifications

- **Mechanics**:
  - 431 N (compressive)
  - 1720 kPa
    - Required for 3-5 mm distraction
- **Size**:
  - 10x25mm (anterior ⅓ of disk space)

- **Safety**:
  - Biocompatible
  - Yielding edges
  - Maximum contact surface

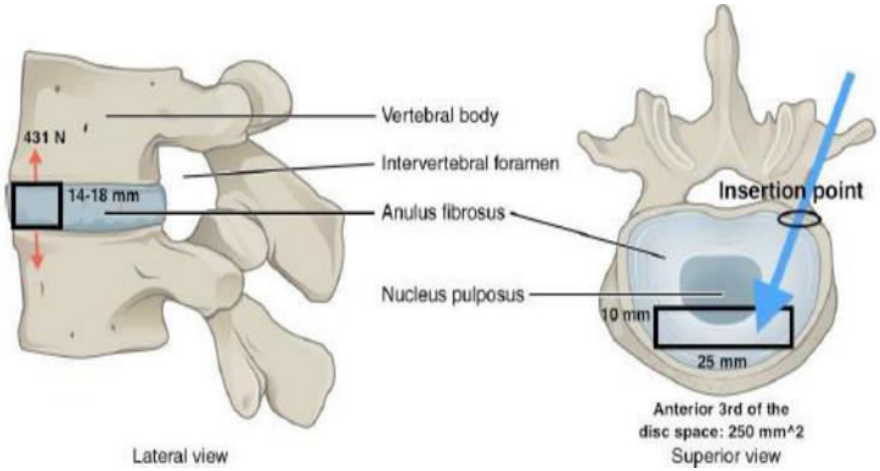
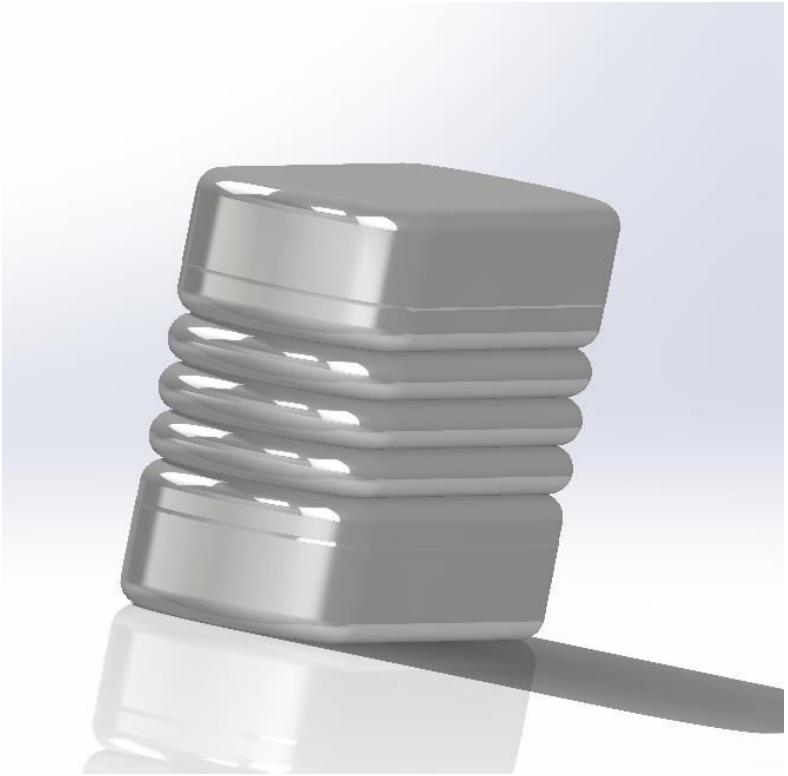


*Image Source: Inflatable Vertebrae Distractor Team (Spring 2014 Mid-Semester Report)

Design Features

- Pressure Gauge
- Axial Inflation
- Tactile Feedback System
- Manipulable

Design 1: Reinforced Inflator



- **Materials:**
  - Butyl rubber
  - Wire or polyester mesh
  - High-strength elastomer
- **Dimensions (mm):**
  - Deflated: 10x25x7
  - Inflated: 10x25x16

Design 2: MatJack

- Inspired by existing inflation product MatJack
- Neoprene rubber reinforced with steel/aramid

Dimensions

- 7 mm(width) x 3 mm(height) x 25mm(length) uninflated
- Increase height inflation to 16mm

Design 2: MatJack

Design:

- Polycarbonate balloon
  - flat prior to insertion
- Air valve
- Ultimately connect to air supply

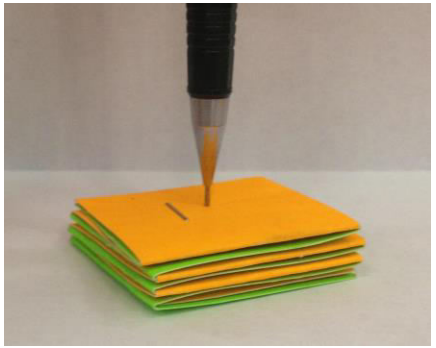
Design 3: Accordion

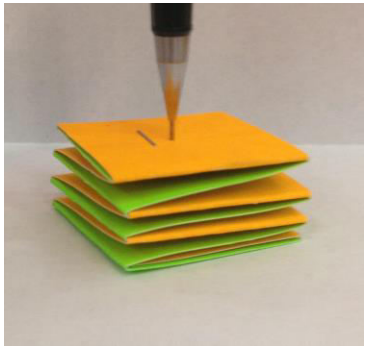
Design

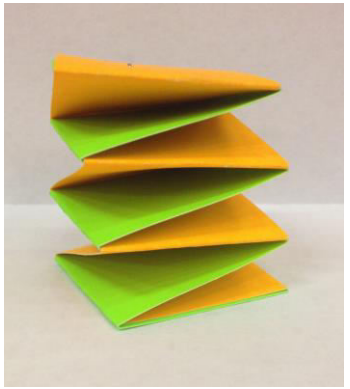
- Woven structure
- Consists of multiple stacked balloons to
- Polycarbonate balloons

Dimensions

- 7mm(height) x 7mm(width) x 25mm(length) uninflated







Design Matrix

Criteria	Weight	Disc		Matjack		Accordian	
Safety	30	2	12	5	30	3	18
Axial Inflation	25	5	25	4	20	4	20
Ease of Use	15	3	9	3	9	4	12
Durability	15	2	6	5	15	3	9
Feasibility	10	3	6	4	8	2	4
Size	5	2	2	5	5	3	3
Total	100	60		87		66	

Future Work

- Develop tactile feedback system
- Create proof of concept
- Research material costs
- Start fabrication

Acknowledgments

- Dr. Brooks
- Professor Murphy
- Spring 2014 Team

References

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[2] "Gasket, Aramid Fiber, 1/16 In T, 30 X 30 In." *GARLOCK SEALING TECHNOLOGIES Gasket,Aramid Fiber,1/16 In T,30 X 30 In*. N.p., n.d. Web. 25 Sept. 2014.

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[4] "Item # 103K, 3.3 Ton Matjack High Pressure Air Lifting Bag." *On Matjack-Indianapolis Industrial Products*. N.p., n.d. Web. 25 Sept. 2014.

Questions?