Knee Traction Device

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Overview

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- Problem Motivation
- Current Technology
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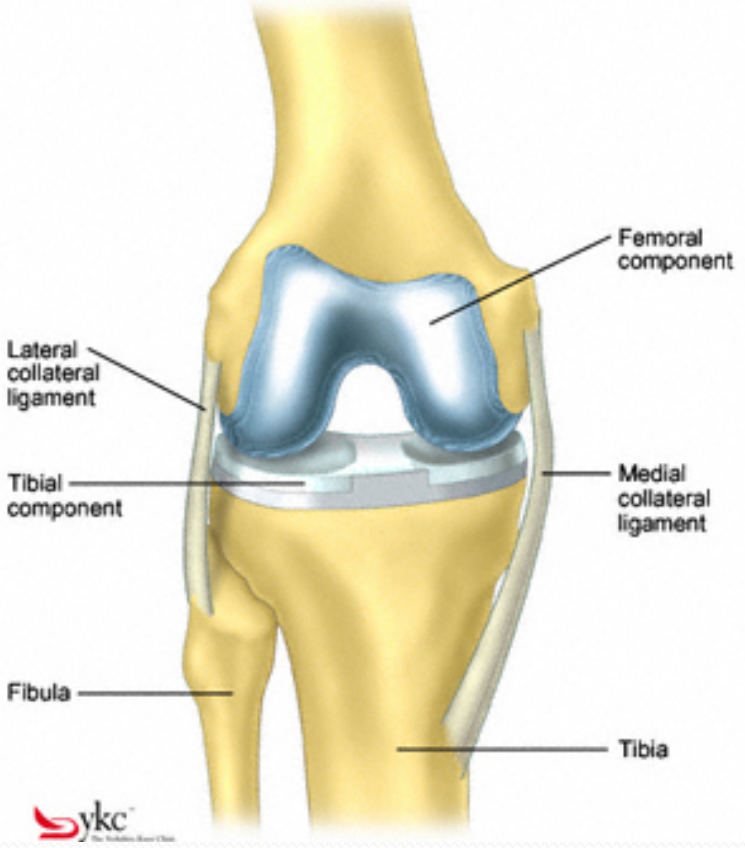
Background

- Osteoarthritis (OA)
  - Progressively degenerative joint disease
  - Affects ≈ 14% of US population[1]
  - Medical expenses for individuals and insurers reach ≈ $185.5 billion annually[2]

Picture from:
http://www.myflatfeet.com/wp-content/gallery/related-conditions/osteoarthritis.jpg

Background

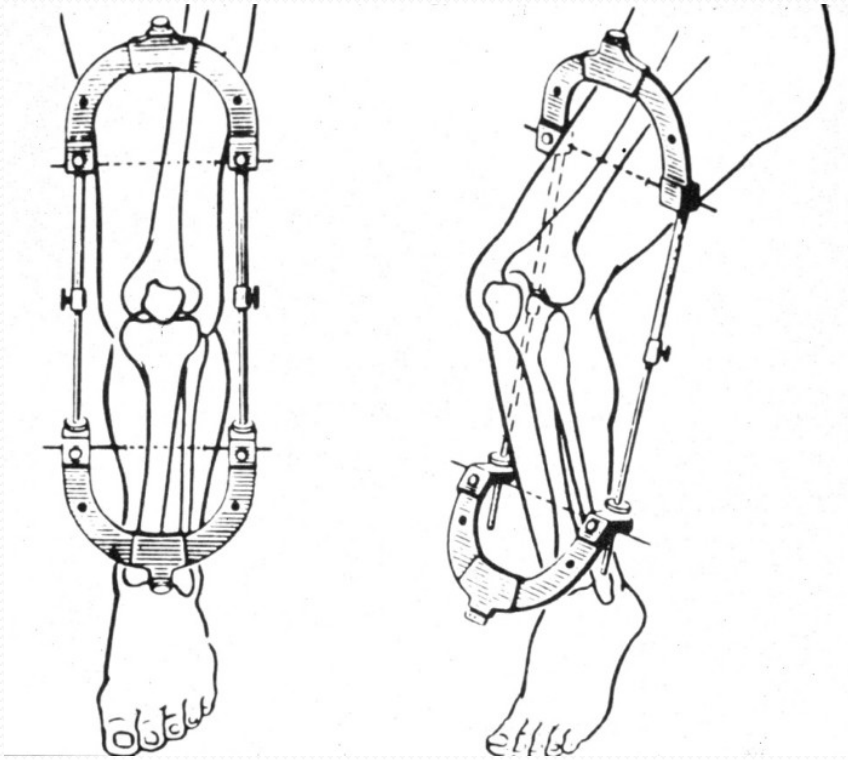
- No true cure widely available
- NSAIDs recommended for pain and swelling
- Total joint replacement is typical
  - Temporary fix lasting only about 10 years
  - Repeated surgeries may be necessary



Picture from: *The Yorkshire Knee Clinic - Arthritis & Knee Rreplacement*. Retrieved October 7, 2012, from http://www.yorkshireknee clinic.com/knee-surgery/arthritis-knee-replacement/

Background

- Possible alternative: distraction
- Ilizarov surgical distraction (proof of concept)
  - Increases joint space
  - Reduces joint pressure
  - May reverse damaging effects of osteoarthritis[3]



Picture from:
http://www.aaos75th.org/images/library/story_photos/ilizarov_EarlyFixator1_opt.jpeg

Problem Motivation

- Osteoarthritis is increasingly prevalent
  - Results in diminished quality of life[4]
  - Great impact on economy
- Current treatments do not solve the problem
- Goal: design device to provide nonsurgical knee distraction
  - Non-invasive therapeutic treatment option
  - Individualized regiment provided by physical therapist
  - In-home use

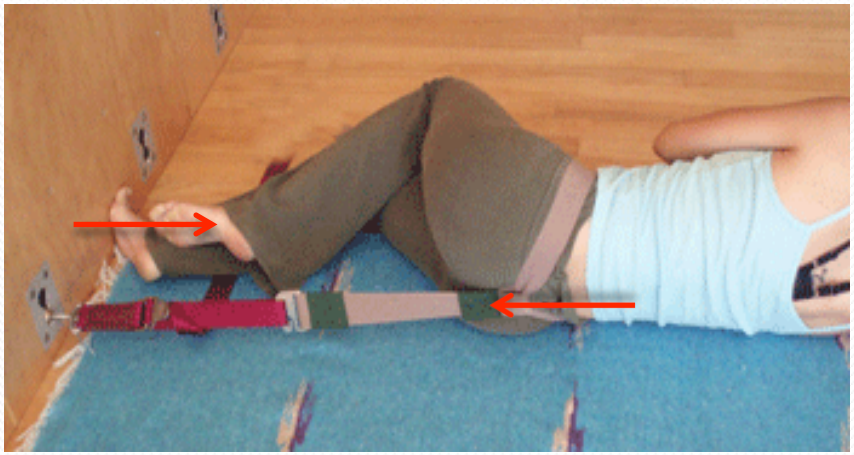
Analogous Technology

- Cervical Traction
  - User fills bag with water
  - Weight creates traction force to separate the cervical vertebrae
  - Easy, affordable, in-home application

Picture from http://www.physiosupplies.com.au/fitness/A_Traction_300.jpg

Analogous Technology

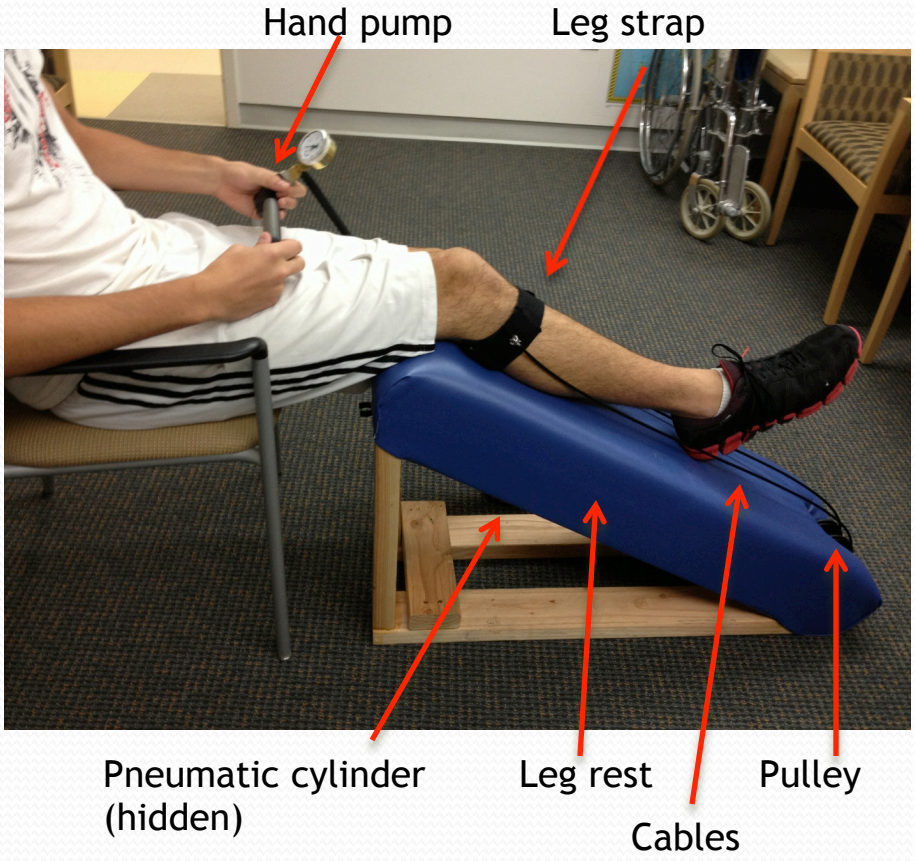
- Lumbar Traction
  - User fastens band around the waist
  - Band attaches to wall
  - User presses feet against wall, creates tension
  - Easy, cost effective traction device



Picture from: http://www.burtonreport.com/images/Spinal%20Stretch.jpg

Current Technology

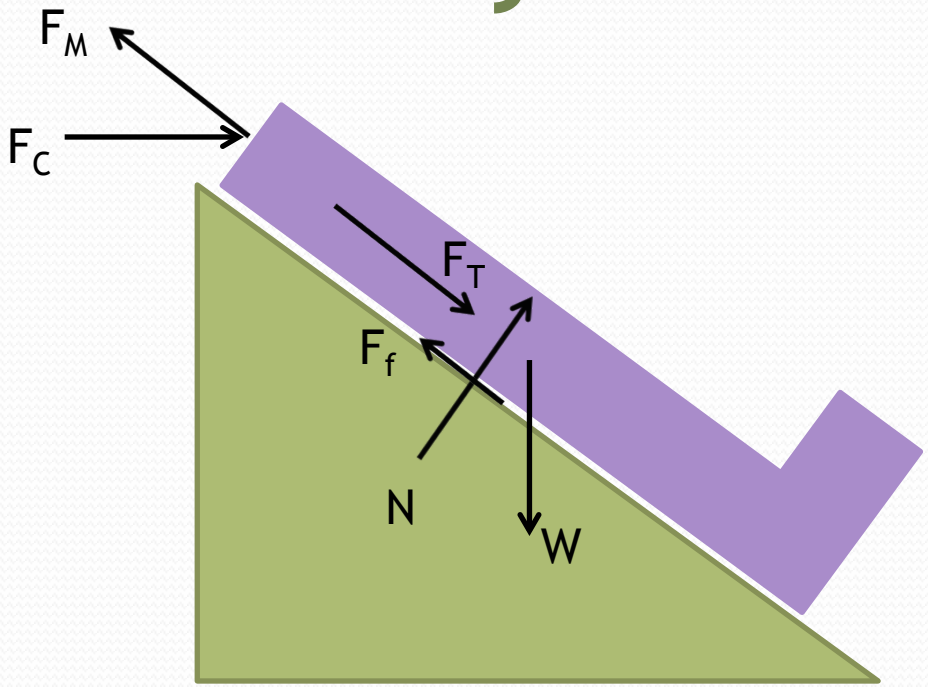
- Previous Design Group Prototype
  - User sits on chair of appropriate height
  - Knee flexion angle fixed at 30°
  - Strap attaches directly below knee
  - Pneumatic pump induces traction force
  - Pros: easily operated, cost effective
  - Cons: bulky, heavy, non-adjustable



Design Requirements

- Adjustable height and force
- Maintain angle around 30°, i.e. “open-pack” position
- Lightweight – easily maneuverable
- Intended for daily home use
- Inexpensive - $400 budget
- Easy to operate
  - Suitable for wide range of patients

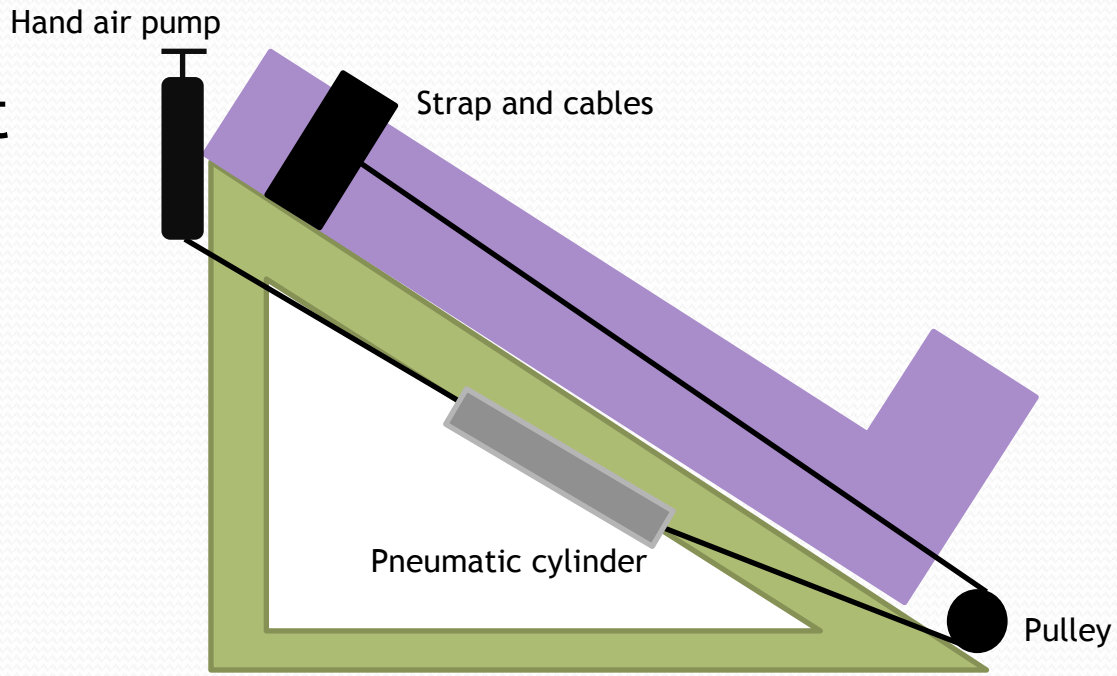
Force Analysis



F_T = Force of traction
F_M = Force of tendons, muscles, and ligaments in knee
F_C = Internal joint contact force
F_f = Friction force
N = Normal force
W = Weight of leg

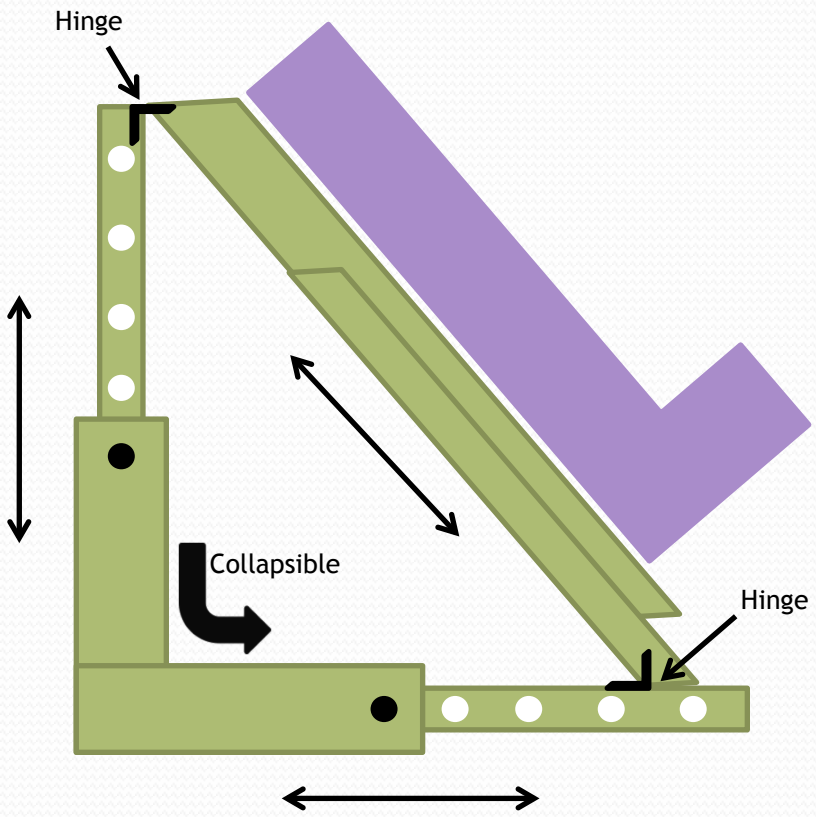
Overall Design Concept

- Collapsible
- Height adjustment
- Pneumatic force applicator
- Pulley system



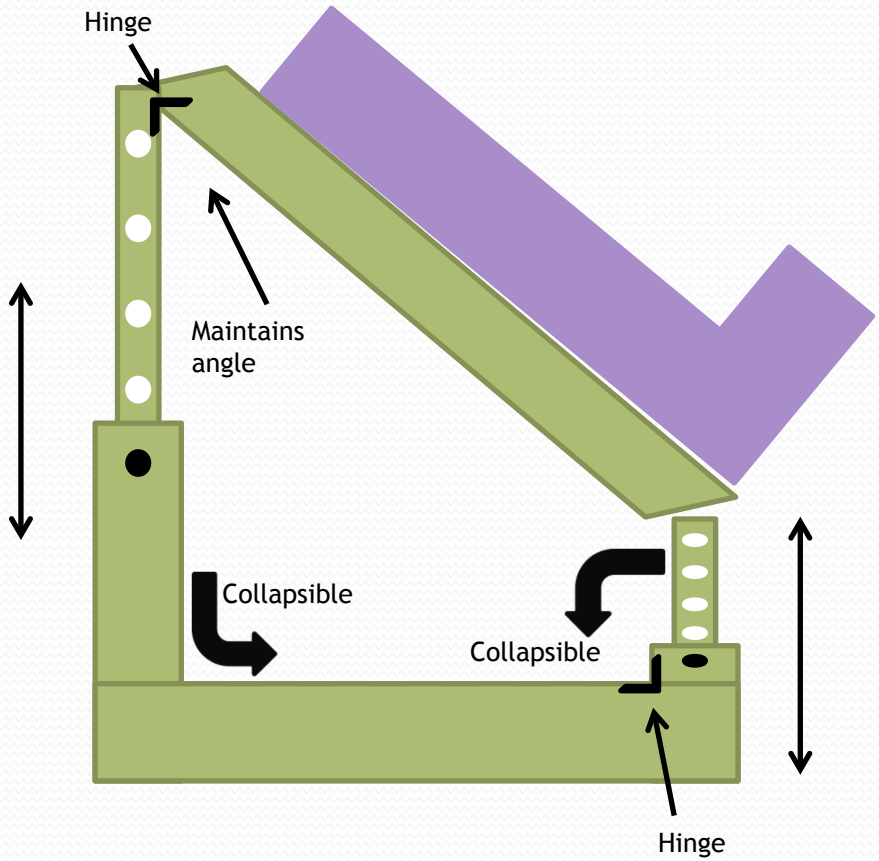
Design 1: Three-Sided Adjustment

- Sliding channel apparatus for leg rest
- Walker/crutch mechanism
  - Adjustable height and length by set intervals
  - Numbered alignment system with reference chart
- Fully adjustable
  - Height, length, and angle



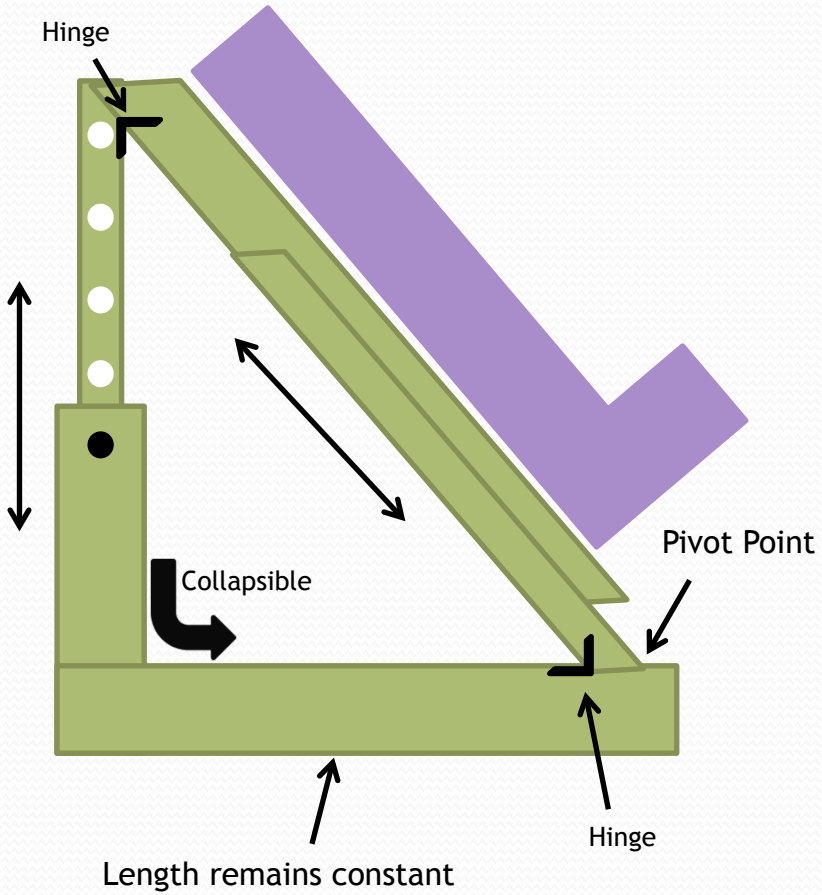
Design 2: Fixed Platform

- Fixed leg rest angle
  - 30° from horizontal
- Both ends vertically adjustable
  - Accommodates many chair heights



Design 3: Pivoting Platform

- Two adjustable sides, coupled system
  - Allows for variable height **or** angle
- Average chair height (19”) will correspond to angle of 30°



Design Matrix

Category	Weight	Three-Sided Adjustment	Fixed Platform	Pivoting Angle
Height Adjustability	30	30	30	25
Ease of Use	25	10	20	25
Portability	20	15	10	15
Ease of Fabrication	15	0	5	10
Angle Adjustability	10	10	0	5
TOTAL	100	65	65	80

Future Work

- Build device
  - Cost of project to date: $0
  - Estimated cost of final prototype: $350*
- Subject testing
  - User feedback
  - Force consistency
- Marketability
  - FDA approval

Acknowledgments

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Questions?

References

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2. Pearle, A. D., Warren, R. F., & Rodeo, S. A. (2005). Basic science of articular cartilage and osteoarthritis [Abstract]. *Clinics in Sports Medicine, 24*(1) 1-12.
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4. http://www.jrheum.org/content/31/12/2433.full.pdf