Tibial stent

Designing a novel fixation device for pediatric orthopedic tibia fractures

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Abstract

In order to stabilize severe adult tibial fractures, titanium rods are inserted through the proximal face of the tibia into the intramedullary canal. This method does not work for pediatric patients as the rod would damage the growth plate distal to the epiphysis. Therefore, current pediatric procedures insert two elastic nails through drilled openings in the lateral and medial sides of the bone directly distal to the metaphysis. However, this mechanism does not always lead to proper stabilization and surgical complexities can result. In order to create a novel device to fixate pediatric tibial fractures, three different designs were considered and a device that expands laterally through compression was deemed the best design to replace the current flexible pediatric nails for stabilization.

Background

Tibial Fractures

- 5% of all fractures in children
- Caused by falling, trauma, sports, abuse, or overuse
- Load bearing bone necessitates correct alignment

Growth Plate

- Growth plates important for growth
- Located between epiphysis and metaphysis on distal and proximal ends of the bone
- Damage to the growth plate can lead to stunting of tibial growth

Current Practices

Adult Intramedullary Stent

- Titanium rod
- Insertion through proximal face of tibia
- Spans entirety of break
- Does not work for pediatric patients due to growth plate

Pediatric Intramedullary Stent

- 2 Flexible nails
- Insertion on lateral and medial sides of tibia
- 3 points of contact
- Limited optimization dependent on break location

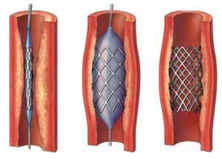
Design Requirements

- Must span tibial break
- Must have enough stability to align bone
- Must be implantable at distal or proximal location
- Must have a diameter of less than 1 cm
- Must be biocompatible

Alternative Designs

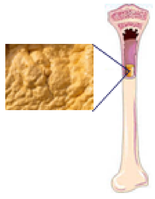
Balloon Stent

- Mesh cylinder inserted into intramedullary canal
- Inflated by removable balloon



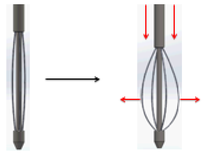
Expanding Foam Stent

- Foam activation within intramedullary canal
- Contained in bladder for directed shape



Compressive Expanding Stent

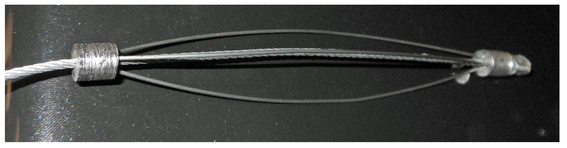
- Series of solid and flexible units
- Flexible units expand laterally from vertical compression



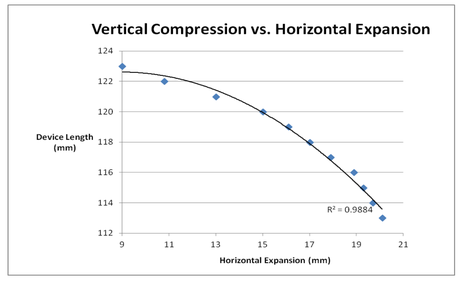
Design Matrix

Criteria	Balloon Stent	Expanding Foam	Compressive Expansion
Fixation (30)	20	15	25
Client Preference (15)	10	10	15
Ease of Implantation (15)	5	10	10
Feasibility (15)	10	5	15
Safety (15)	15	5	15
Cost (10)	10	5	10
Total (100)	70	50	90

Final Design



Testing



Testing

Future Work

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References: