



EpiNex

A Needle-free Injector for Epinephrine Delivery

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The Opportunity: A Safer Treatment for Anaphylaxis

Most Reported Issues with Current Products:

- Accidental Exposure
- Device Failure
- Drug Ineffectiveness
- Expired Product Administered
- Soft Tissue Infections & Lacerations
- Cost

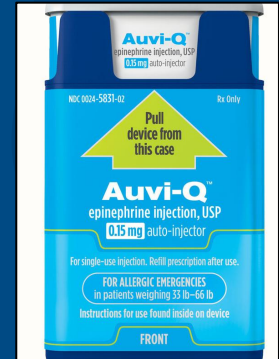
Current Products on the Market



EpiPen



Symjepi



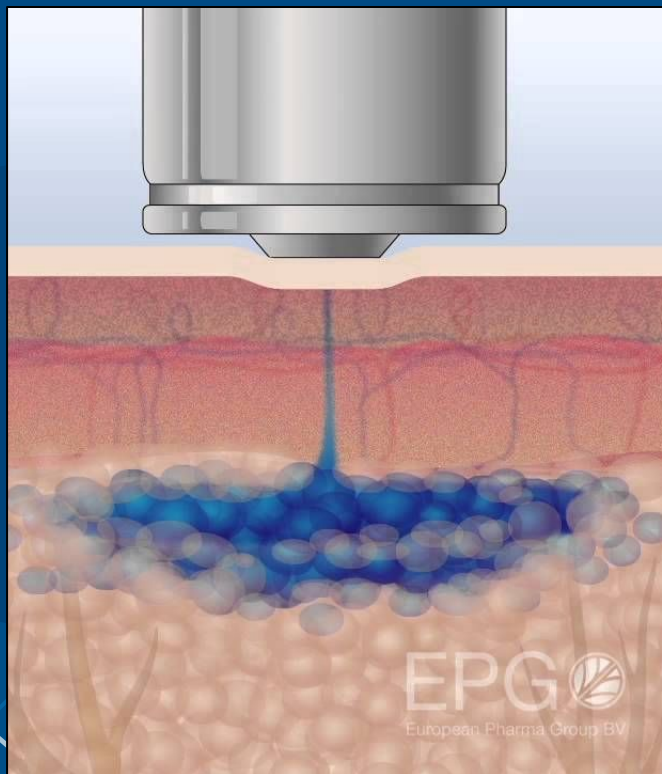
Auvi-Q

Needs & Specifications: Considerations to Address the Opportunity

01	Administers Epinephrine	<ul style="list-style-type: none">• Painless or mildly painful• Easy and accessible controls• Administers rapidly
02	Reliable	<ul style="list-style-type: none">• Reduces any device failure• Survives normal wear and tear• Prevents accidental use
03	Affordable	<ul style="list-style-type: none">• Reusable• Last long-term• Capable of being refilled
04	Easy to Operate	<ul style="list-style-type: none">• Accommodates all age groups• Simple controls• Few steps
05	Portable	<ul style="list-style-type: none">• Hard to lose• Easily transported• Durable

From Needs to Concept (Our Solution):

EpiNex - A Reusable Needle-Free Injector



Device administers epinephrine

- Spring powered injection within seconds
- Effective for regular insulin injections
- Capable of delivering up to 0.3 mL

Device is affordable

- Reusable injector body → lower cost refills
- Cartridge system decreases waste material
- Delivery method allows multiple users per device



From Needs to Concept (Our Solution):

EpiNex - A Reusable Needle-Free Injector

Device is easy to operate

- Minimal steps before injection
- Compression of spring before use eliminates accidental injections
- Easily deconstructed for easy cleaning

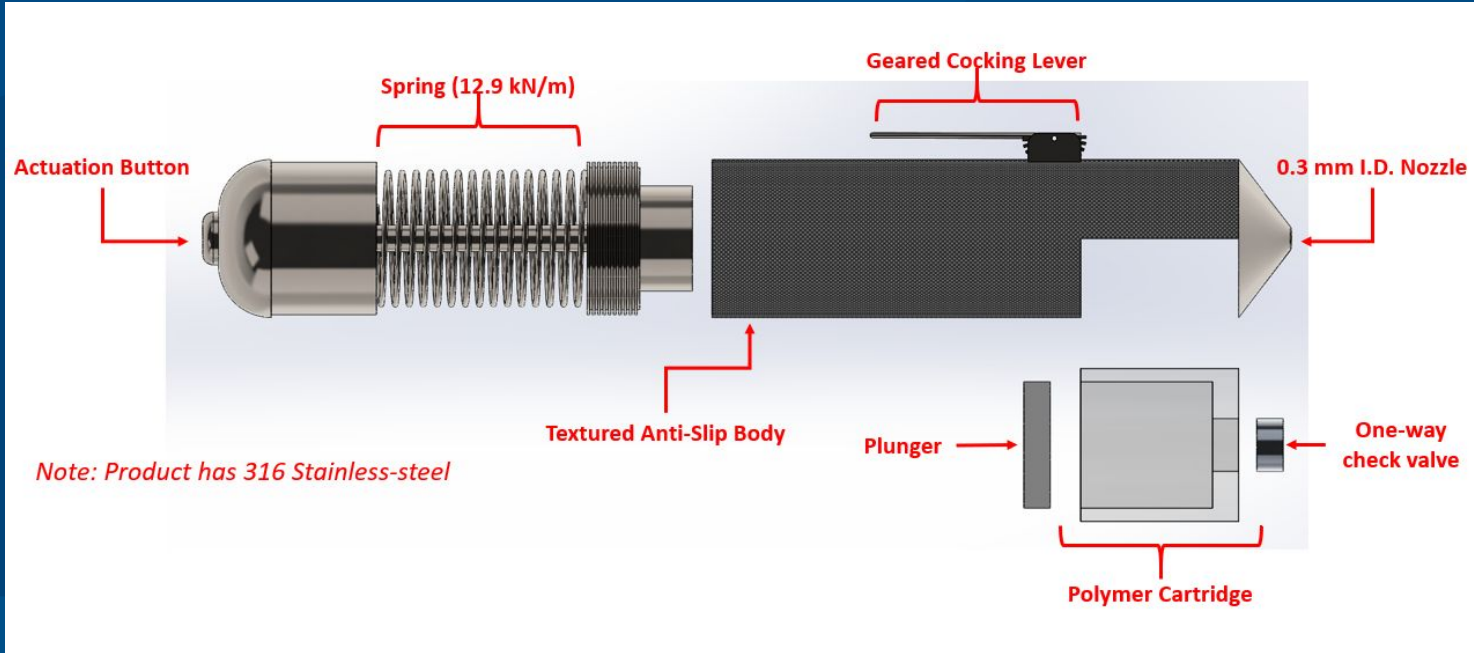
Device is portable

- Approximately the size of an EpiPen
- Durable shell protects cartridge
- Superior material strength opens possibility for slimmer body design

Device is reliable

- Injection powered by operator
- Sturdy case material resists corrosion and wear
- Electronic free and shockproof

Our Initial Model



Overview of Prototyping Projects

Prototype 1

Stress Analysis
via
SolidWorks



Prototype 2

Mathematical Models
+
COMSOL



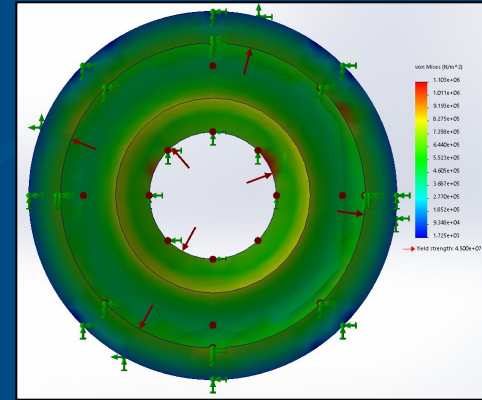
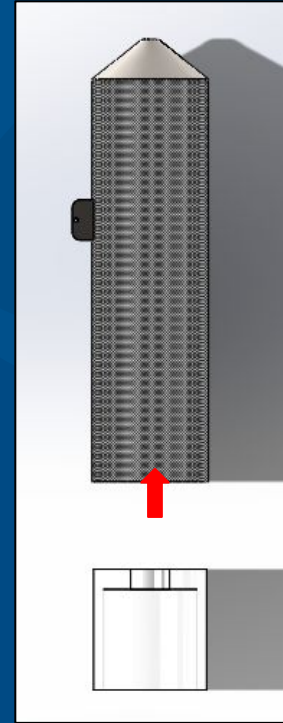
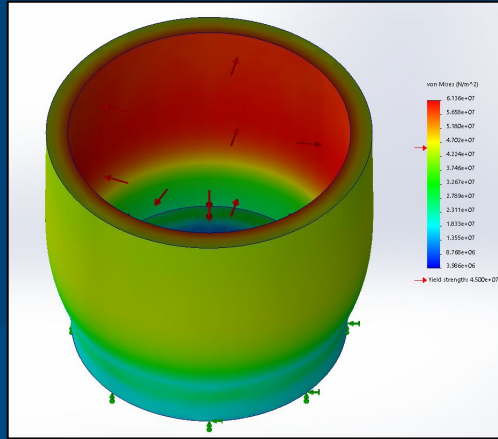
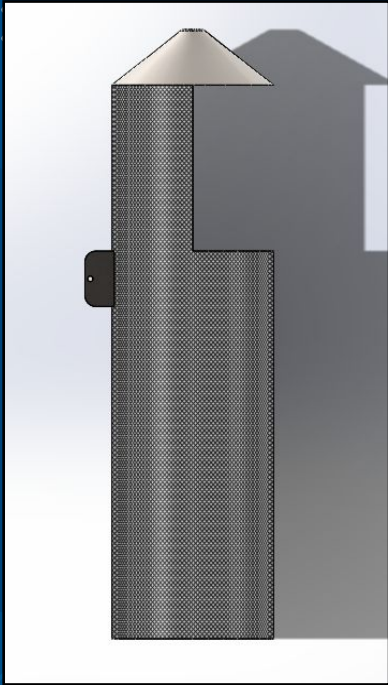
Prototype 3

Physical testing on tissue
analogs with
EpiNex 1.0

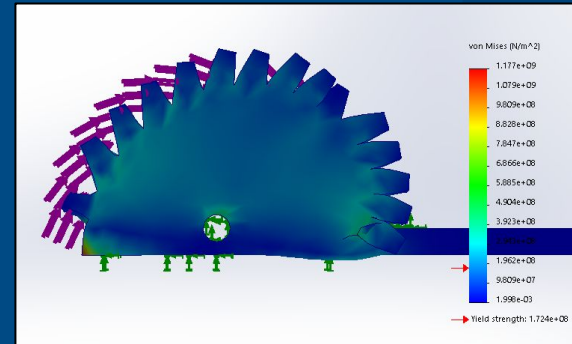
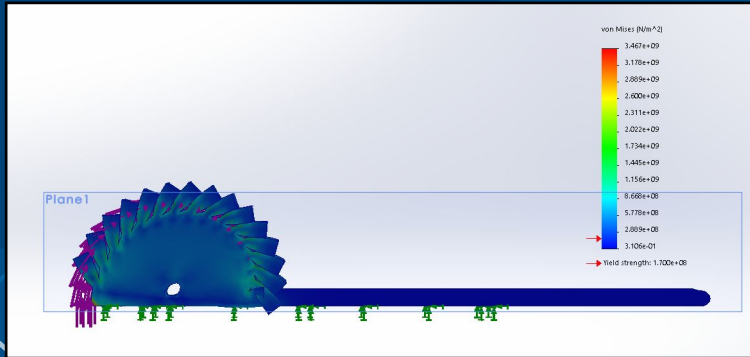
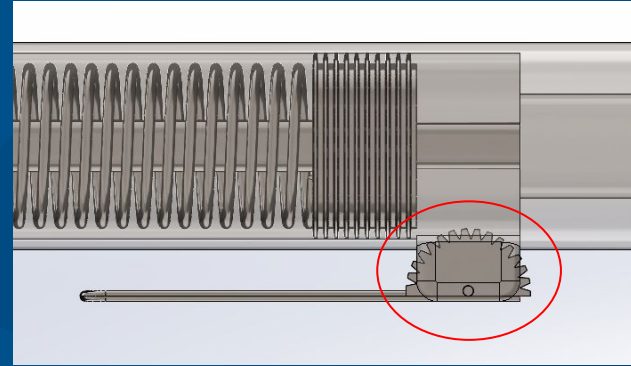
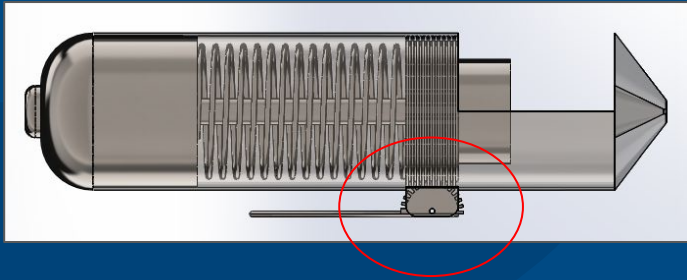


Analytical Modelling: Prototype 1 and 2

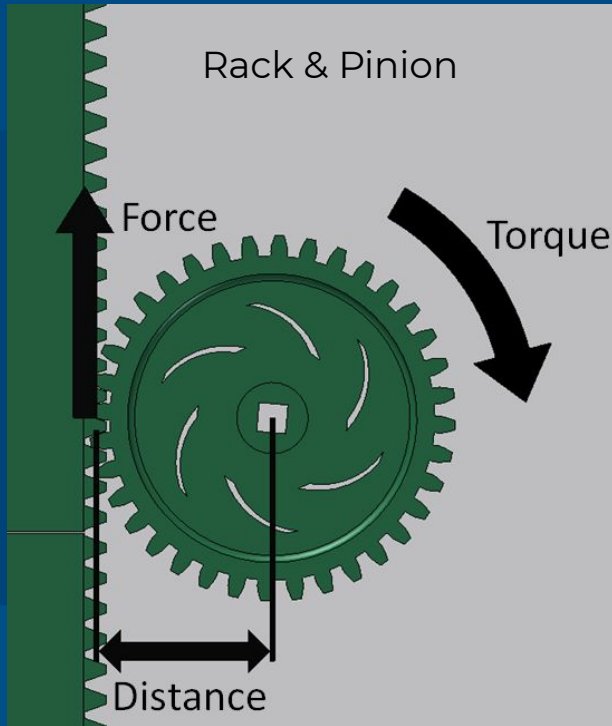
Our Refinements: End Cartridge Loading



Our Refinements: Angled Gear Teeth



Can the Spring be Cocked?



- Torque = Force * Distance
- 1,000N of Force by Spring
- Gear Distance = 7.5mm
- Torque on Gear = 7,500N-mm
- Lowest Squeeze Force (Elderly Woman) = 200N
- Lever length of 3.75cm - Feasible!



Model Revision → Comsol Representation

Model 1: Depth of Penetration

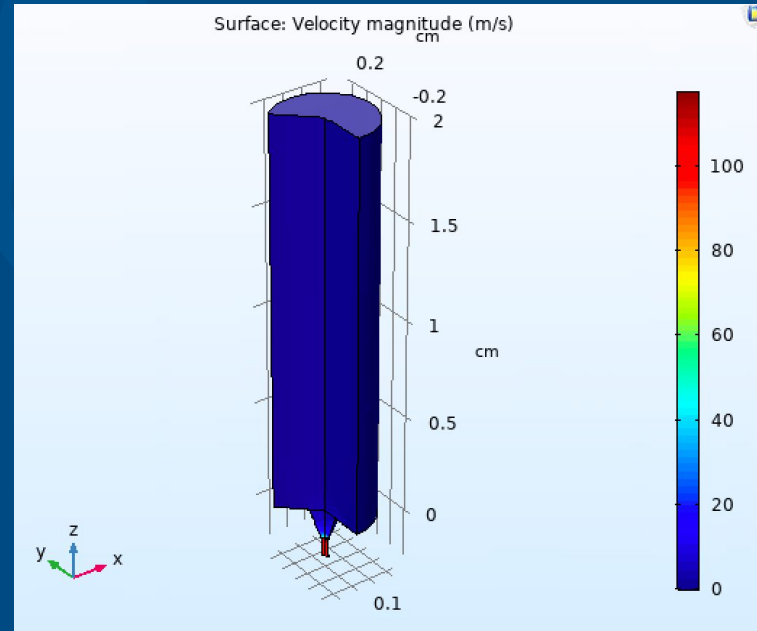
- Altered model to correlate correct type of jet injection

Model 2: Stream Exit Velocity

- Analytical model evolved into system representation Comsol Model

Model 3: Spring/Plunger Force

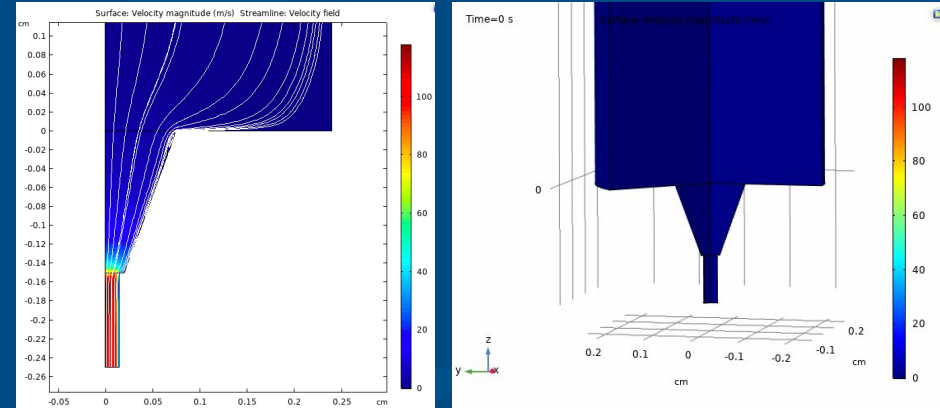
- Final determination of spring parameters



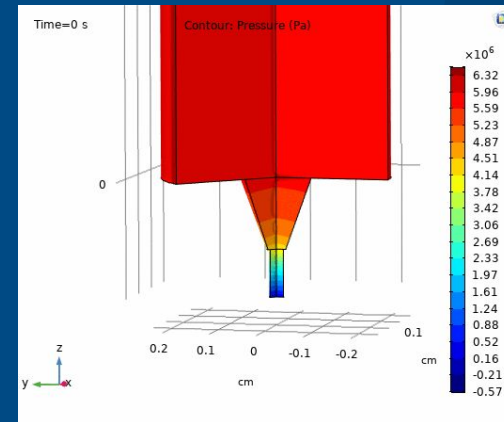
Comsol Cartridge Modeling

- System reaches equilibrium in $60 \mu\text{s}$
- Requisite force of approximately 103N
- Reduction in cartridge dimension to return more realistic input force

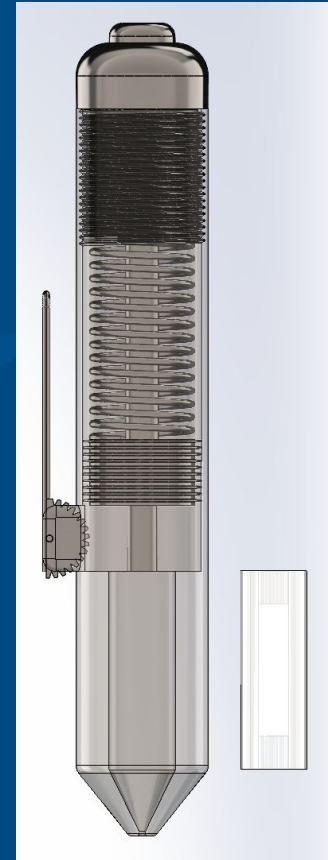
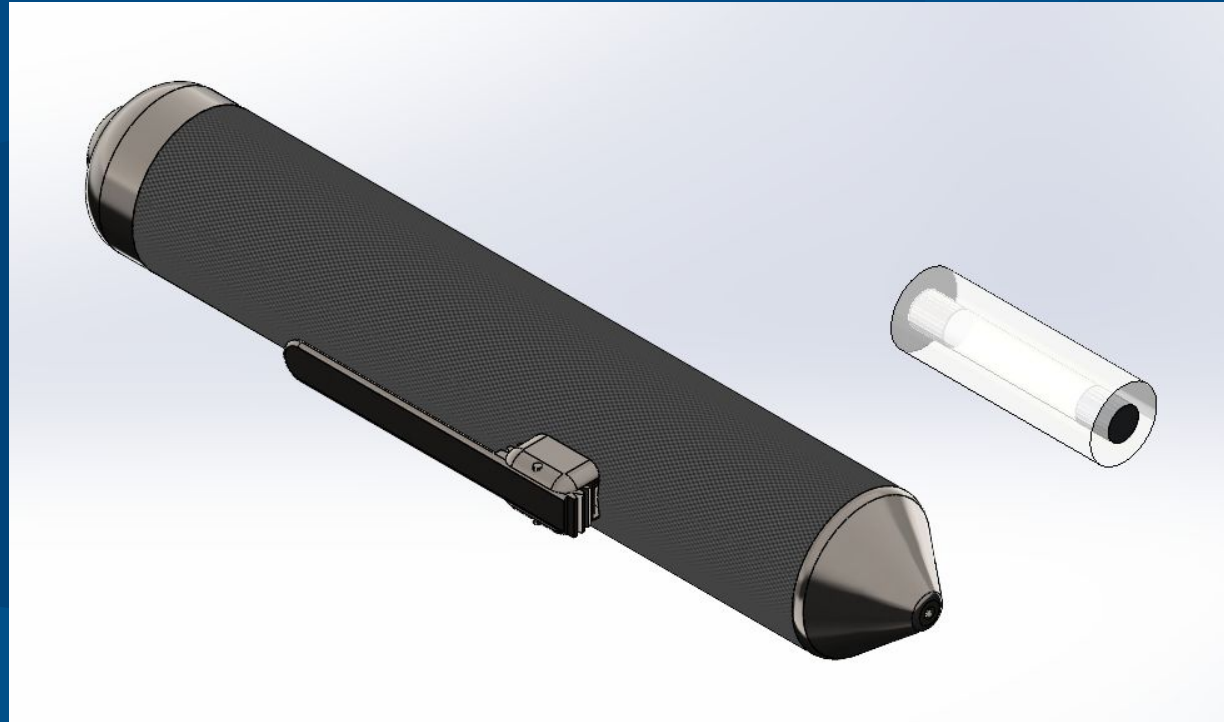
Exit Velocity (m/s)



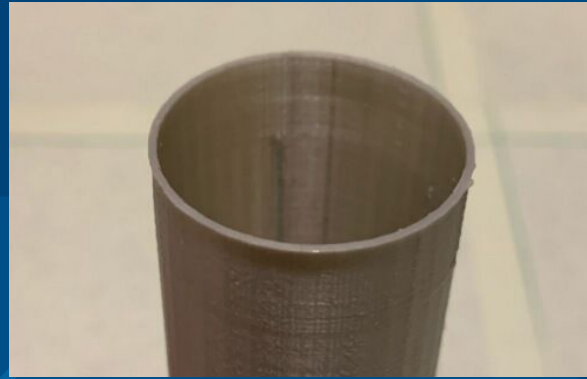
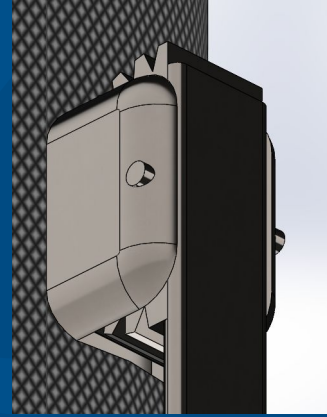
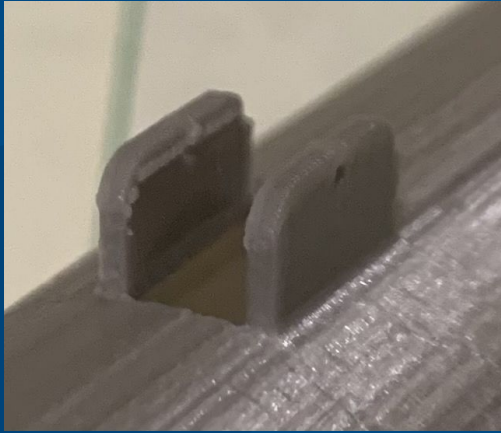
Pressure (Pa)



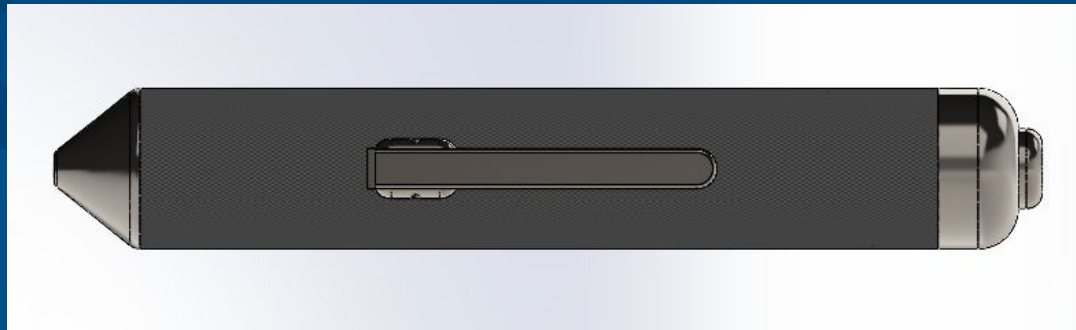
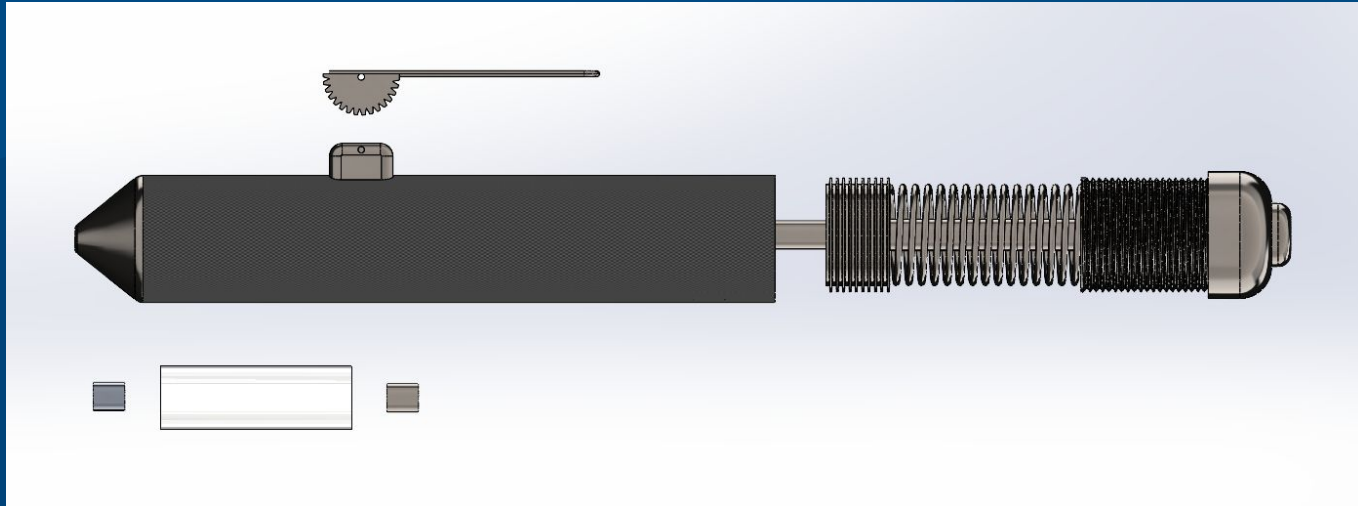
Refined CAD Model: Thinner Overall Diameter



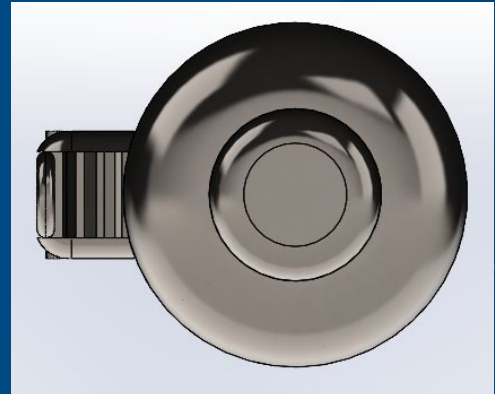
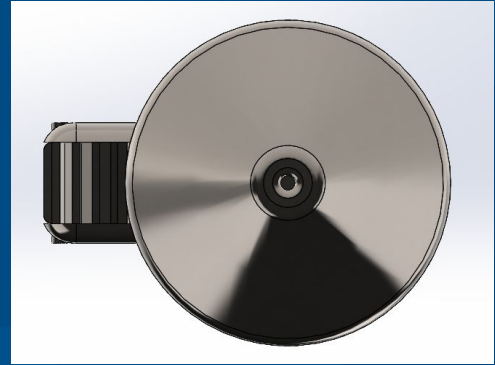
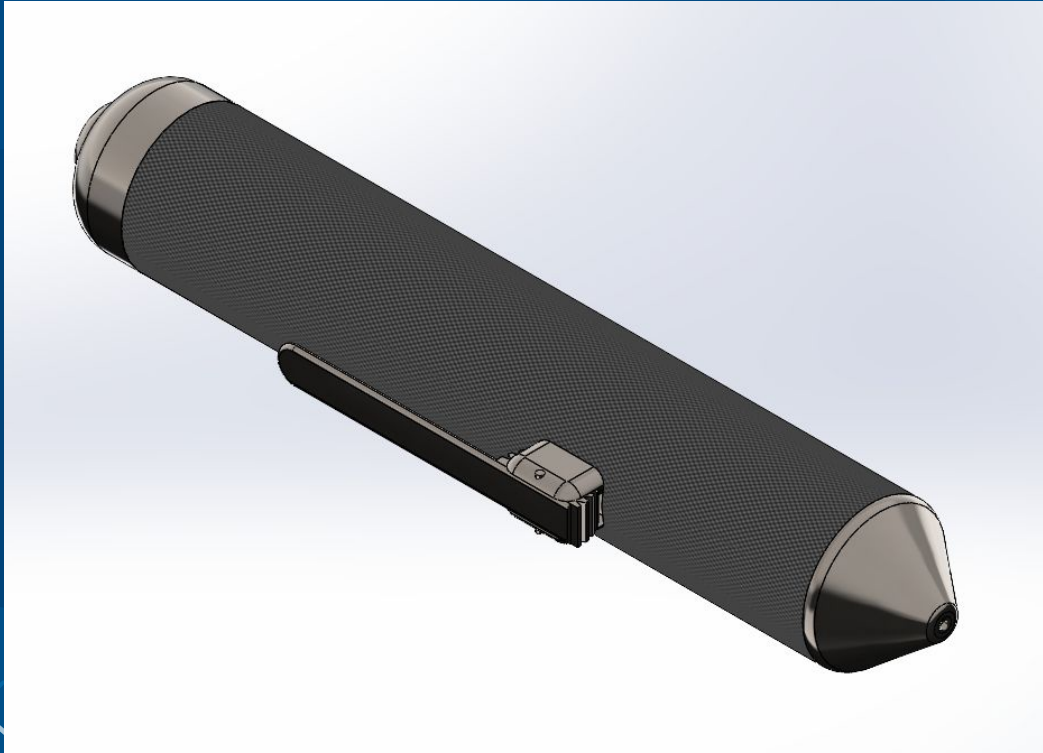
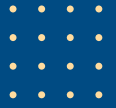
Finishing Touches from 3D Printing: Increased Housing Wall Thickness, Smoothed Edges, and Threads



Final CAD Design



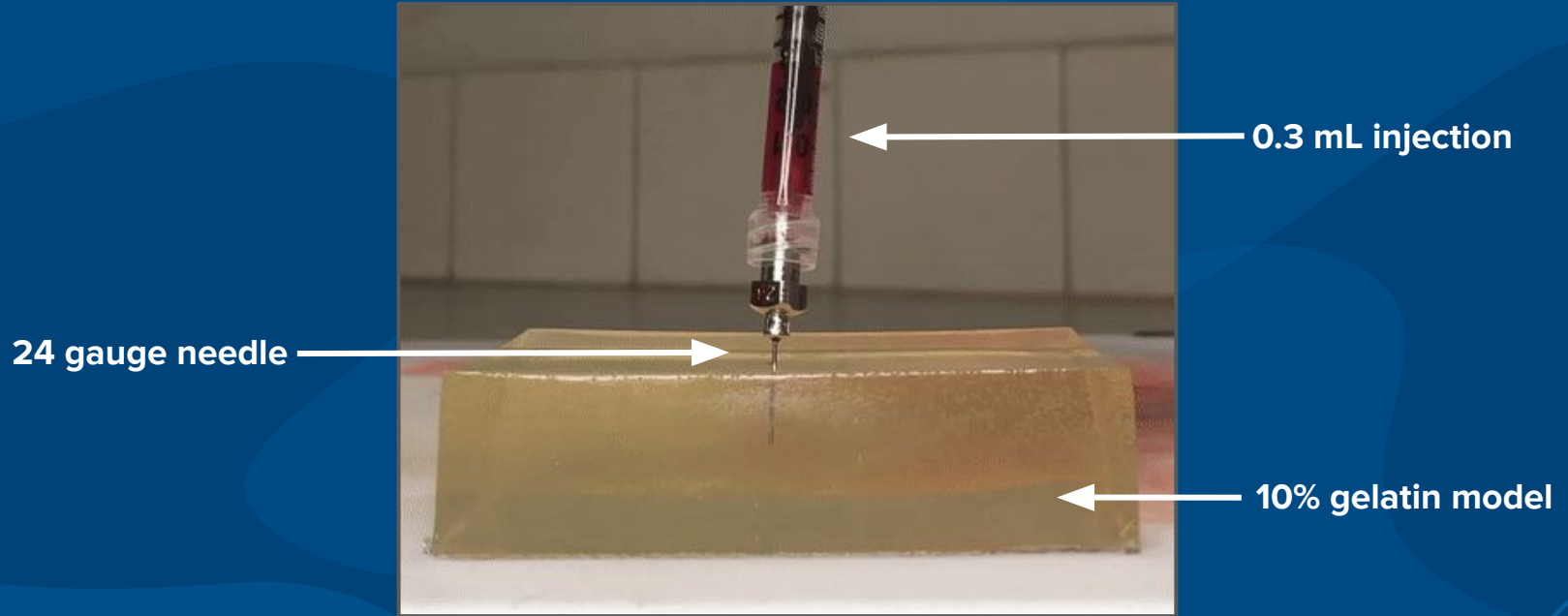
Final CAD Design (cont.)



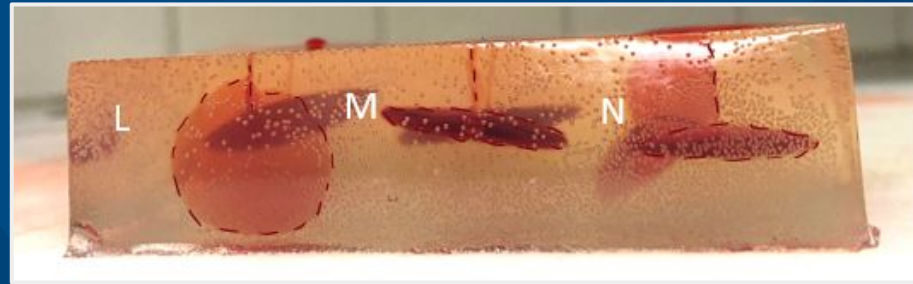


Physical Testing: Prototype 3

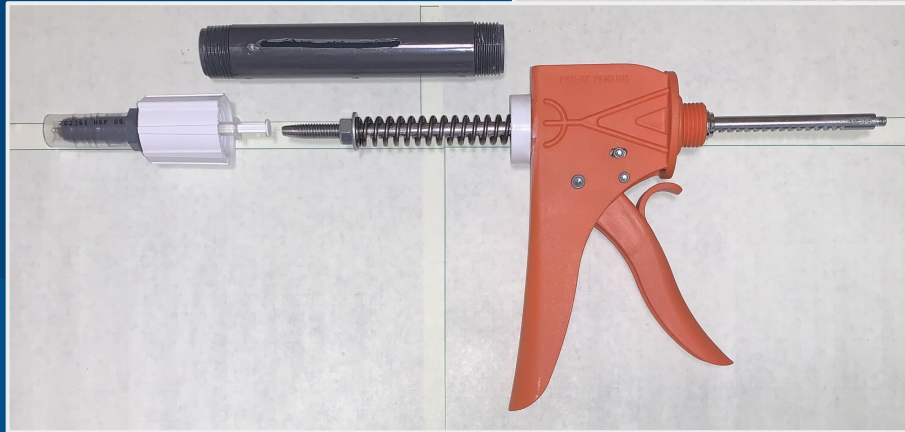
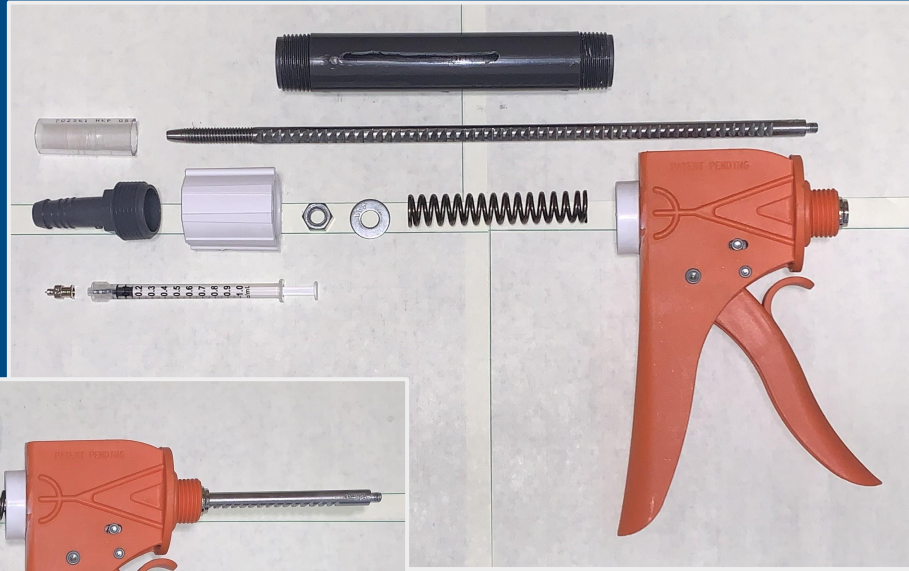
Tissue Analog Testing



Qualitative Analysis of Tissue Analogs



EpiNex 1.0 - Humble Beginnings



Velocity Analysis Slow Motions



Injection Slow Motions



Injection Results



Insights From Physical Testing



- **Friction**

- Ram sliding through cocking/locking mechanism
- Between the plunger and walls of the syringe
- Fluid resistances

- **Recoil/Kickback**

- Maintaining injection site and proper standoff distance
- Releasing the spring

- **Spring Toughness**

- Large lever required to cock back the spring
- Likely contributes to kickback

- **Consistent Injections/Reliability**

- Injection volume and in general



Potential Improvements:

- Wider syringe (Less travel distance)
- Lubricants
- Smoother cocking mechanism
- Eliminate of standoff distance
- Button release instead of twisting/turning
- Shorter device provides more control
- Redesign for a single spring and nozzle





Questions?