

# A NEW DESIGN FOR A LAPAROSCOPIC KIDNEY CLAMP

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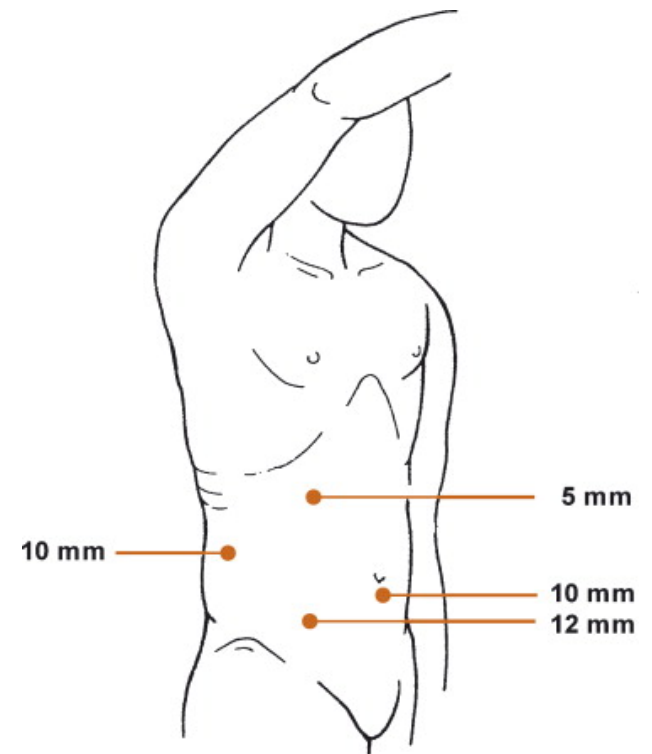
# Overview



- Background
- Requirements
- Previous Design
- Modifications
- Fabrication Methods
- Force Calculations
- Testing
- Expected Results

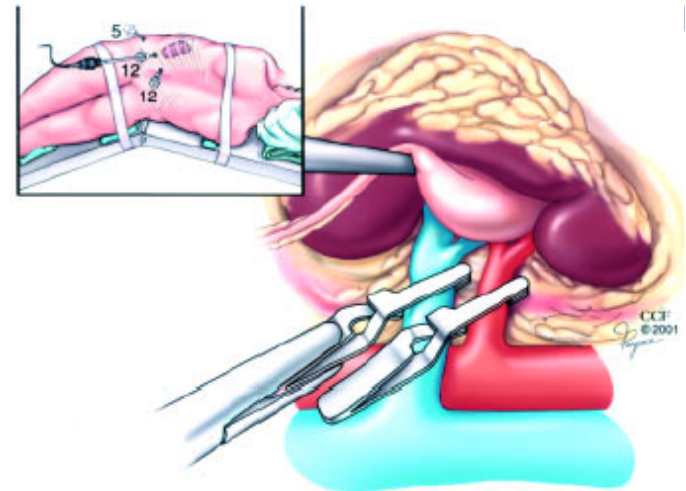
# Laparoscopic Partial Nephrectomy

- ❑ LPN involves removal of only diseased tissue from kidney.
- ❑ Small incisions
- ❑ Kidneys filter ~ 20% of blood/minute
- ❑ Clamping needed to control blood loss and keep operating view clear.



# Current Methods

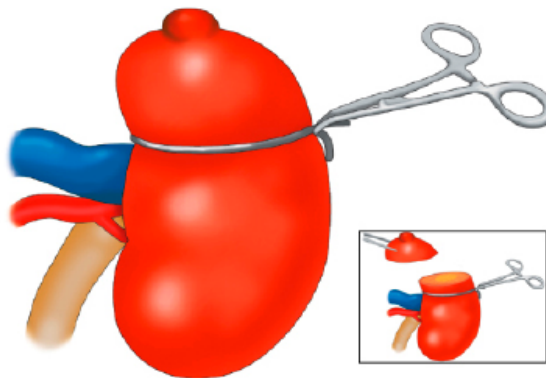
- Blood flow occluded during Partial Nephrectomy (PN)
  - ▣ Currently clamped at renal artery and vein
  - ▣ Create global ischemia to kidney
  - ▣ Potential long term damage



<http://www.kidneycancerinstitute.com/PDFs/Aesculap-Nader-partialnephrectomy%20manuscript.pdf>

# Proposed Methods

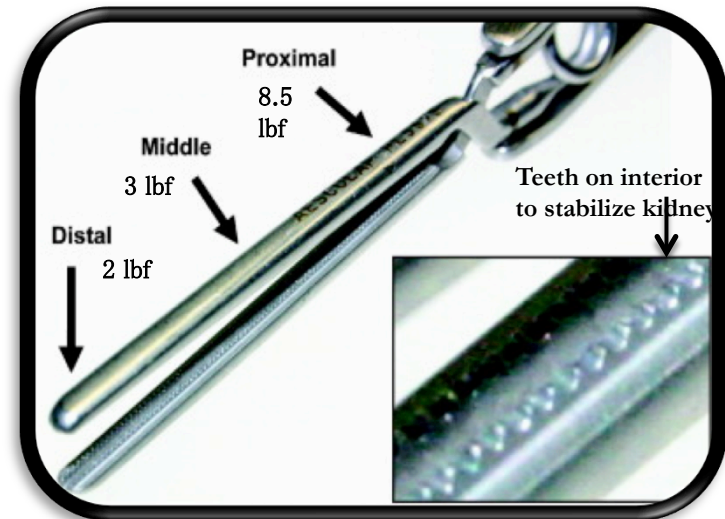
- Create a surgical clamp that will clamp across the kidney
  - ▣ Selectively occludes blood flow to the portion of the kidney being removed
  - ▣ Does not disrupt blood flow to healthy tissue



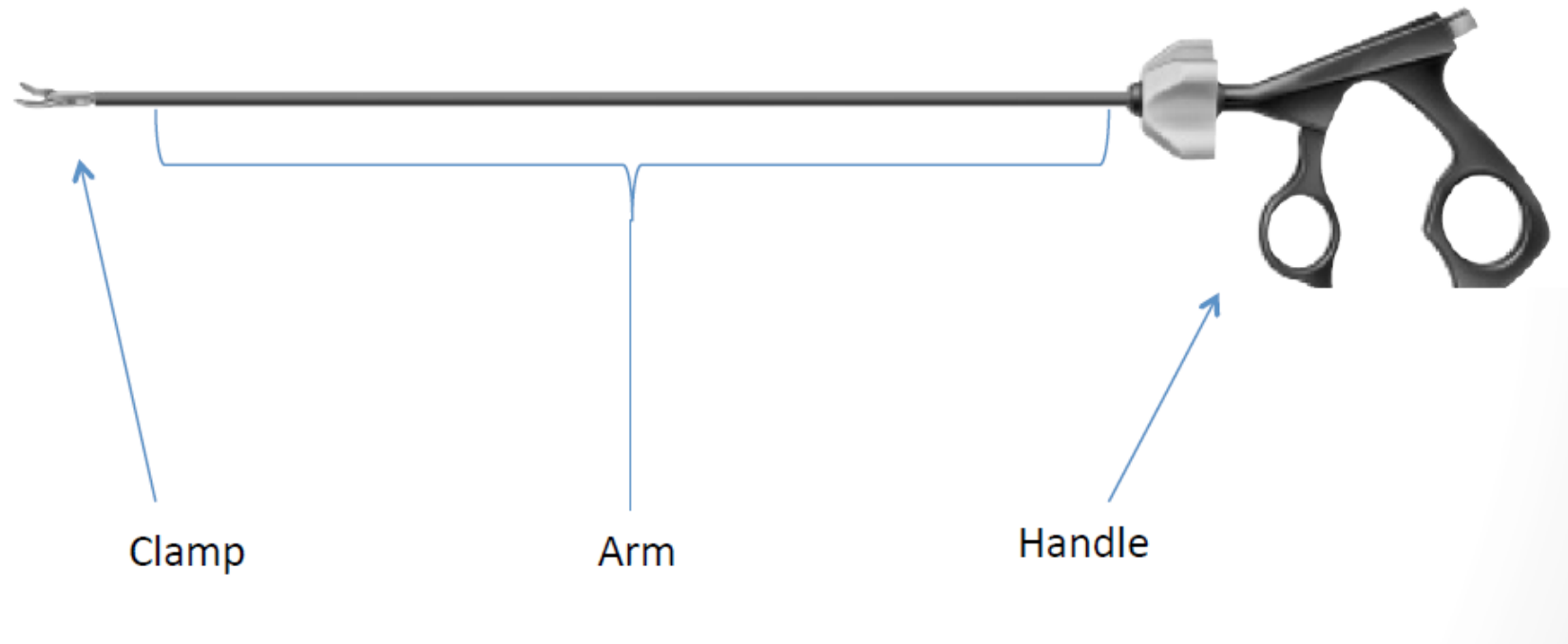
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# Requirements

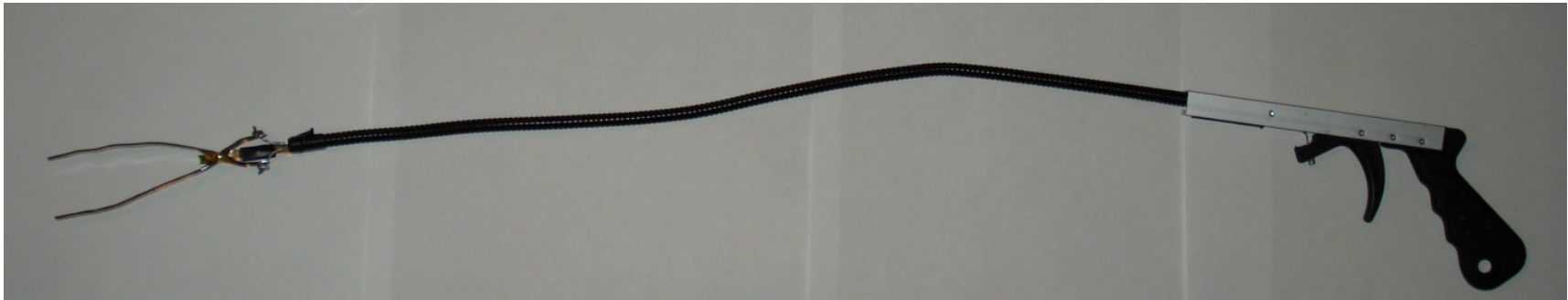
- Laparoscopic instrument
  - Must be able to fit through a 12 mm trocar
- Provide enough strength to occlude renal blood flow
  - 5 N
  - Without causing harm to kidney
  - Force applied evenly
- Reusable, sterilizable
- Able to operate with one hand
- Flexible shaft



# Clamp Components



# Previous Design



## Issues:

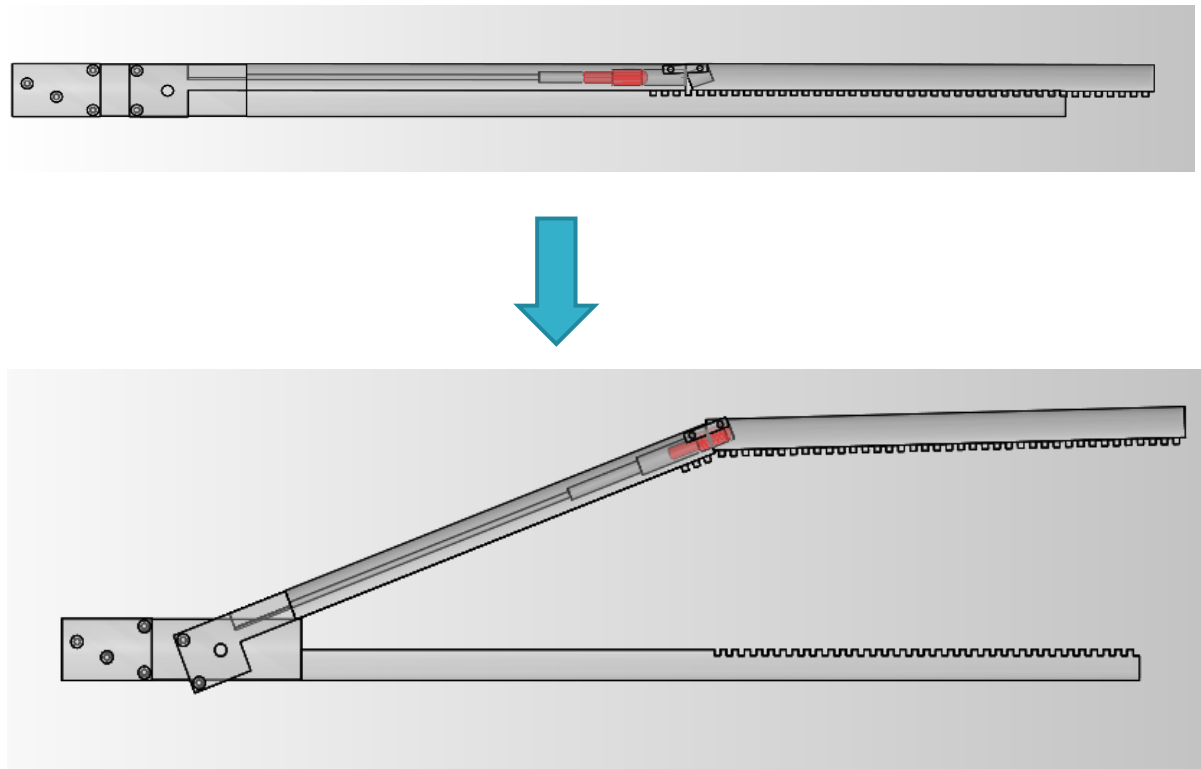
❑ Fabrication

❑ Even force application



# Design Modifications: Clamp

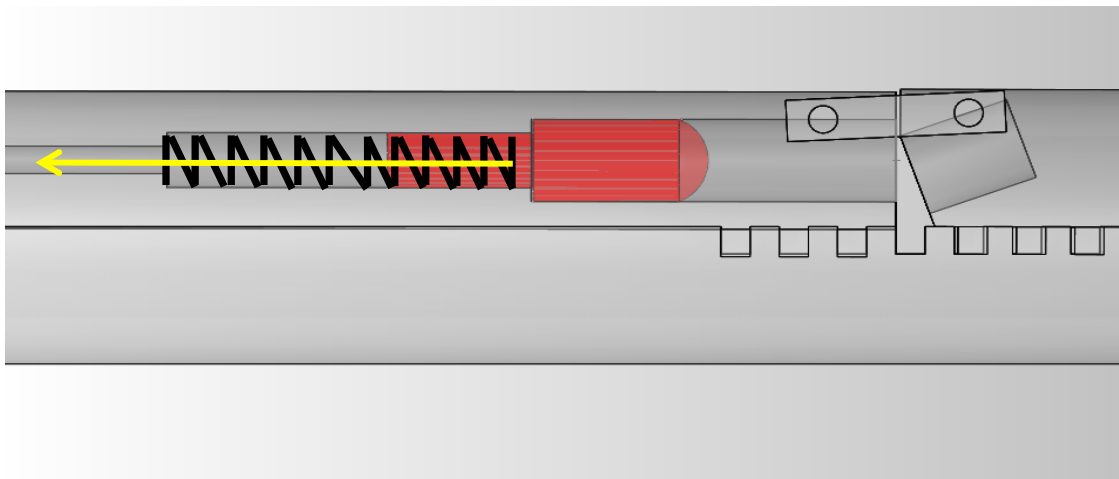
- Two-stage design
- Locks into place
- Applies force evenly
- Easily fits into trocar



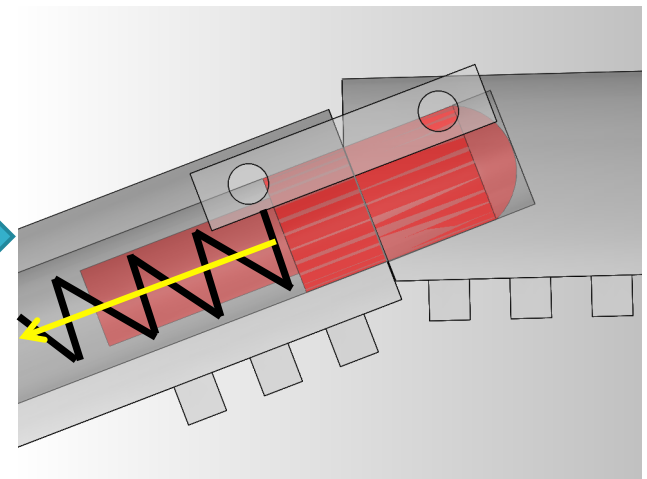
# Clamp Mechanism

- Plunger with spring
  - ▣ When closed, spring retracted, plunger restricted
  - ▣ After least  $20^\circ$ , spring released, plunger deployed
  - ▣ Two pieces become one part

**Closed**

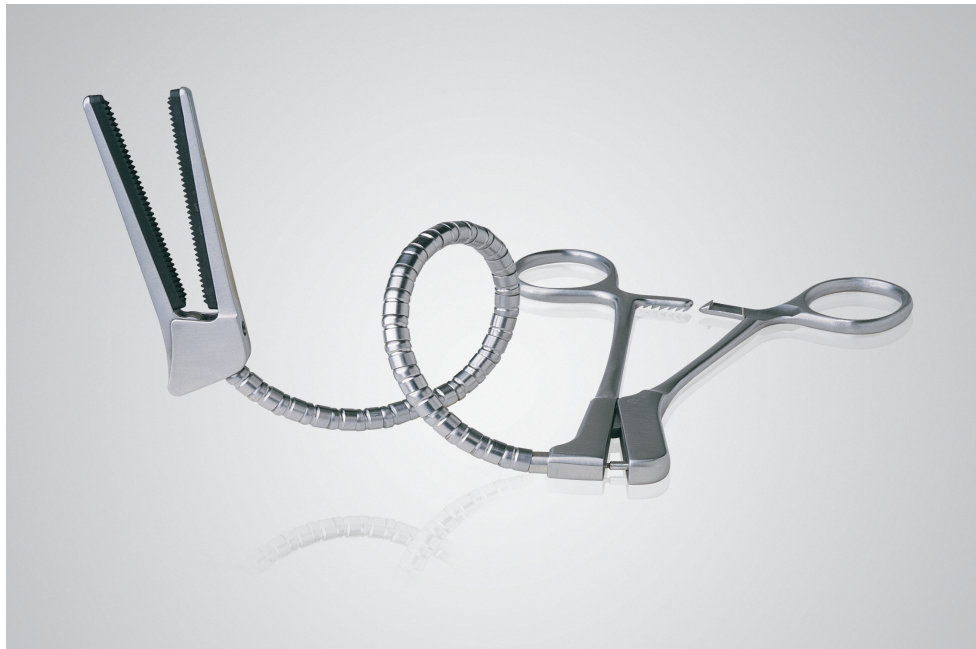


**Open**



# Design Modifications: Shaft

- Modeled off current flexible shafts
  - Provides more flexibility
- Plastic sheath inside shaft protects wires



[http://www.carefusion.com/pdf/Surgical\\_Instrumentation/VM1823\\_Cosgrove\\_Flexclamp\\_lit\\_sheet%20final%20090210.pdf](http://www.carefusion.com/pdf/Surgical_Instrumentation/VM1823_Cosgrove_Flexclamp_lit_sheet%20final%20090210.pdf)

# Design Modifications: Handle

- Model off current laparoscopic handles
- Three main components
  - ▣ Slide to retract/deploy plunger
  - ▣ Trigger to open clamp to at least  $40^\circ$  to fit around kidney
  - ▣ Handle to apply gradual force to kidney
    - Includes ratchet to maintain previously applied force



[http://en.wikipedia.org/wiki/File:Laparoscopic\\_Hand\\_Instruments\\_001\\_JPN.jpg](http://en.wikipedia.org/wiki/File:Laparoscopic_Hand_Instruments_001_JPN.jpg)

# Fabrication Methods



- Material : Delrin
  - ▣ Acetal homopolymer
  - ▣ Can withstand 11,000 psi and temperatures of 180 degrees F
  - ▣ 12" x 12 " x 0.5" sheet costs \$43
- Manufactured via another company
- Cable : Steel wire rope
  - ▣ Flexible, breaks at 110 lbs
  - ▣ \$9 for 50 ft

# Force Calculations

- Maximum force of female hand ~200 male hand ~300 N
- Force necessary to compress kidney a substantial amount = 5N
- Force needed at handle to provide 5 N of clamping force ~ **100N**

# Safety Calculations

- 20 N of force will rupture kidney
- ~400 N of force at handle

# Testing



- Can find force and stress in clamp with FBD and stress analysis in SolidWorks

## Questions to Answer



- How much force does it actually apply?
- Will the clamp occlude blood?
- What is the actual force needed to occlude blood?

# Expected Results



- Compressive tests of kidney using MTS
  - Is 5N enough to compress entire kidney?
- Pig lab to assess occlusion force as well as ergonomics of clamp



# Next Steps



- Send clamp design out to be fabricated
- Design and fabricate handle with ratchet
  - ▣ Must have a trigger to open the clamp, close the clamp, and release the plunger
- Order steel cable
- Assemble clamp components
- Testing

# References

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Questions?