

Right-Angle Dissector Scissors Hybrid Surgical Instrument

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Abstract

During deep-hole surgery, the surgeon operates using the right-angle forceps and sometimes has to cut tissue. However, his or her other hand is usually occupied with another instrument and an assistant often cannot see or reach in. A hybrid instrument incorporating scissors and the right-angle forceps has to be developed to allow the surgeon to perform delicate dissection and cut desired tissue without damaging surrounding regions.

Background

Latissimus Dorsi Breast Reconstruction Surgery

- Conducted following mastectomy due to breast cancer

Latissimus Dorsi Flap Reconstruction

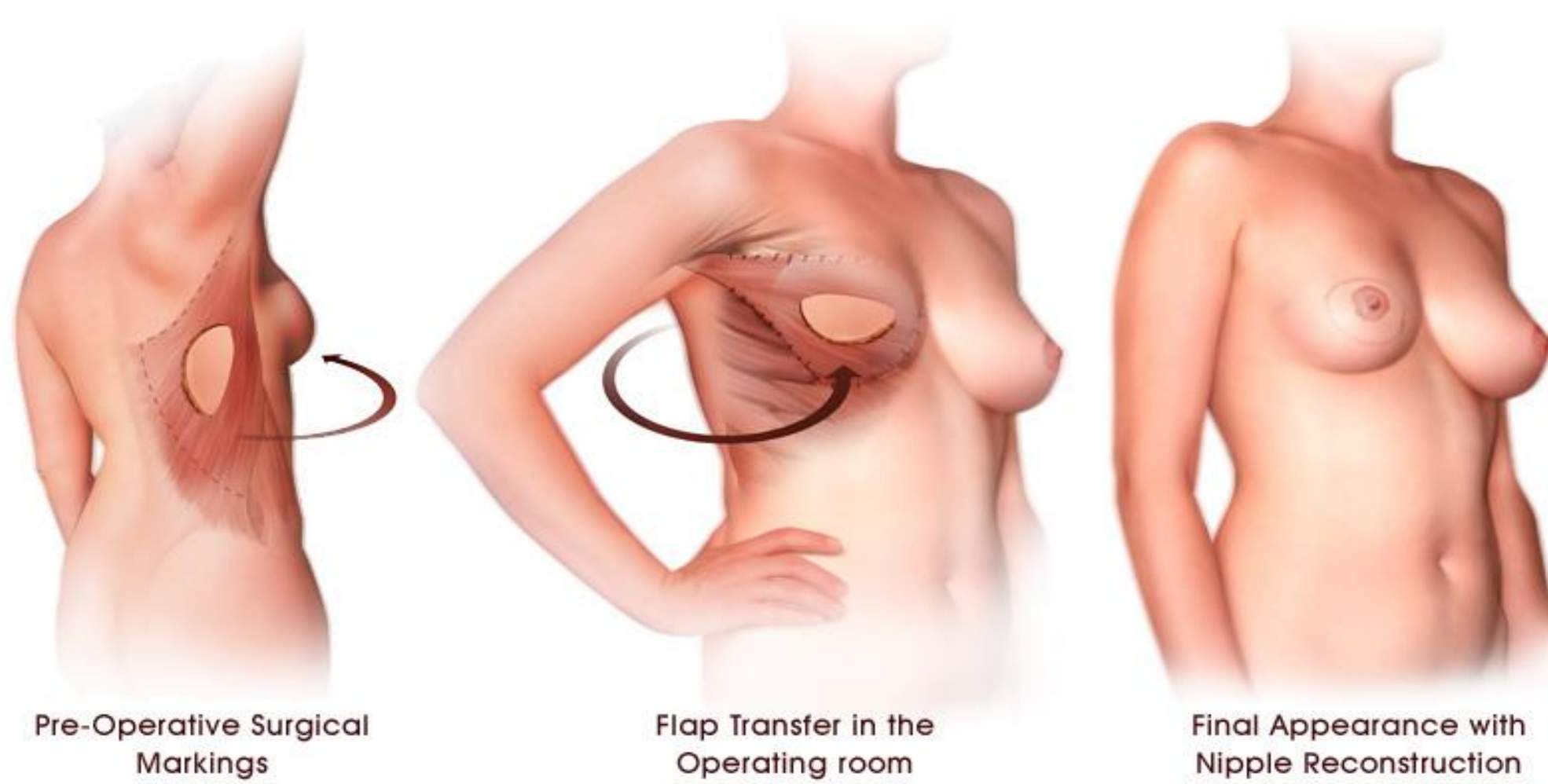


Figure 1: Latissimus dorsi flap breast reconstruction¹

Current Practices

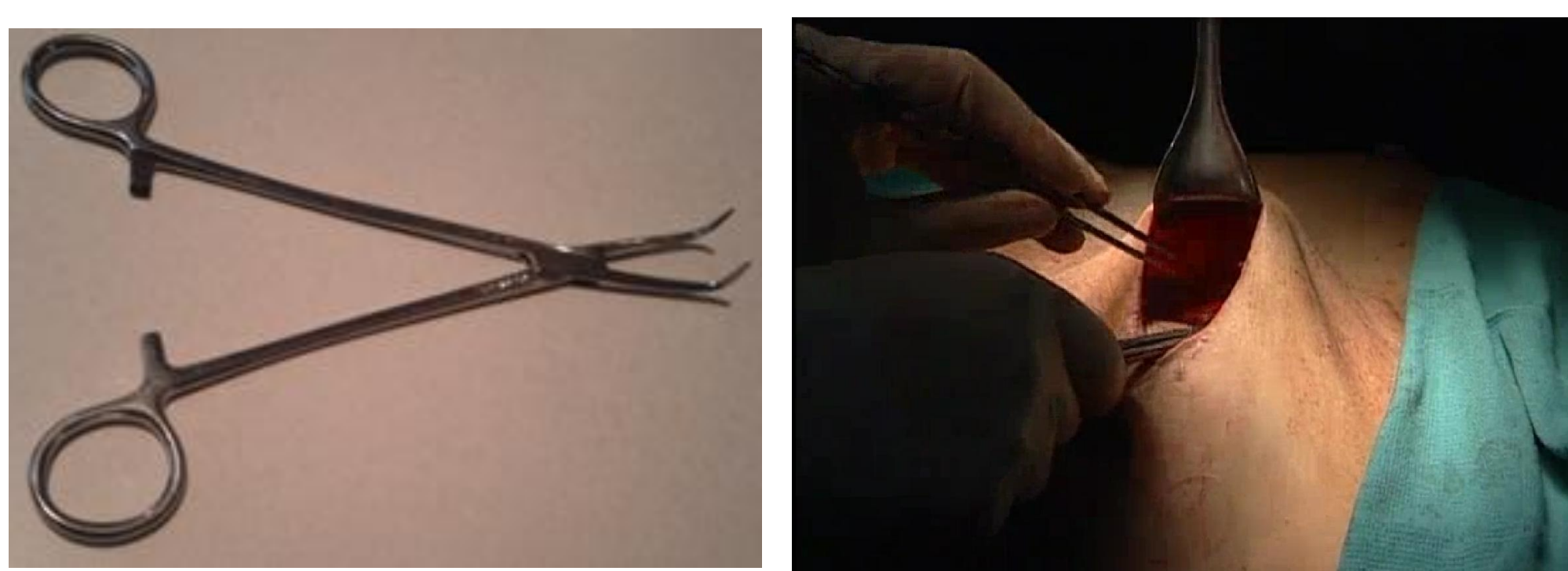


Figure 2: Right-angle forceps Figure 3: Right-angle forceps in deep hole surgery²

Difficulty operating in deep hole:

- Assistant cannot reach area
- Surgeon's other hand occupied

Dissecting around sensitive vascular structures difficult

Design Requirements

Incorporate dissector and scissors function

- Blunt outer edges and sharp inner edges
- One-handed use
- Maintain visibility while cutting

Surgery-compatible materials

- Surgical-grade stainless steel
- Autoclavable

\$200 budget

Trigger Scissor Prototype Design

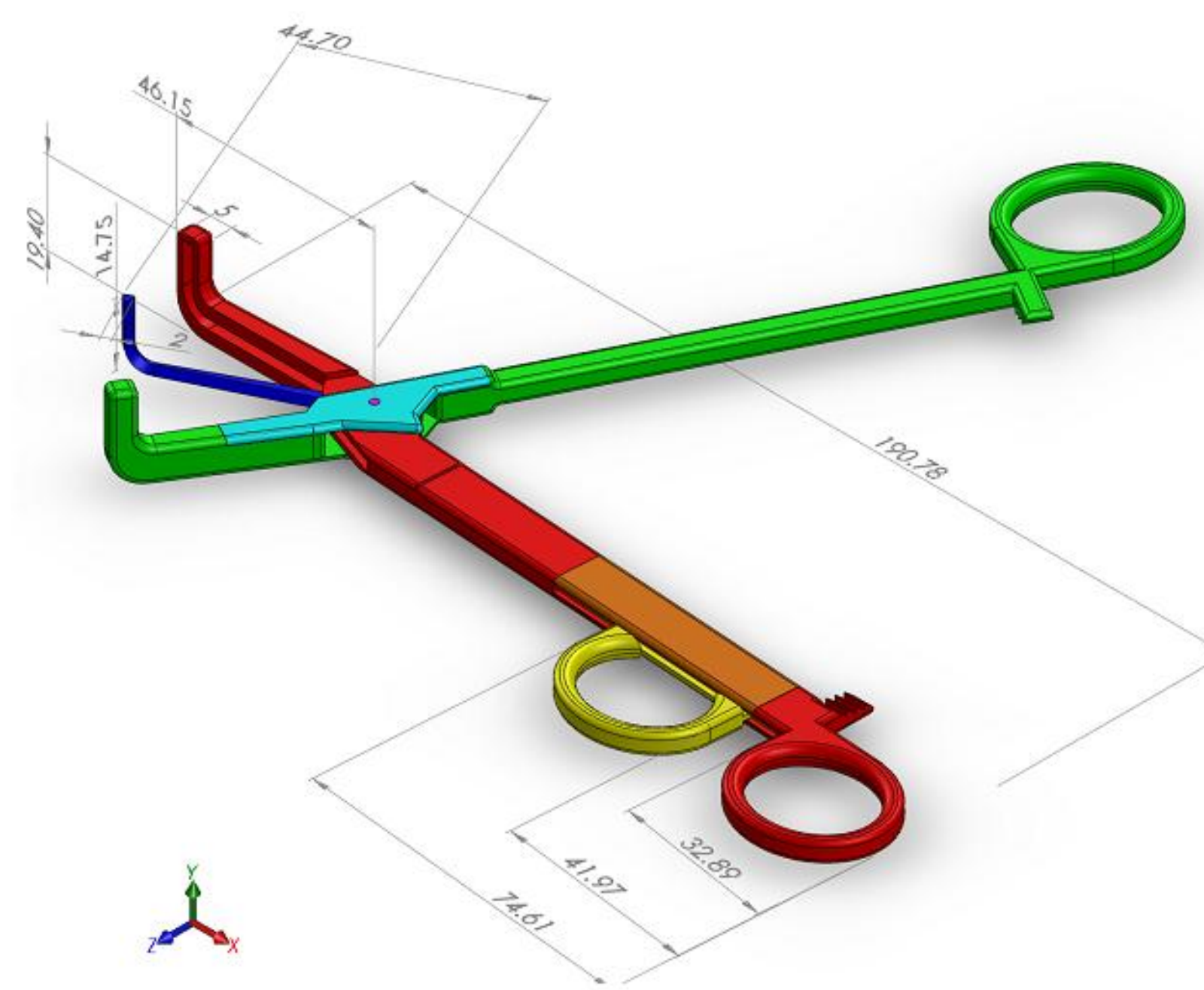


Figure 4: Seven parts, spring, wire assembled, tips open and blade exposed. Note: spring and wire are hidden. All dimensions are in mm.

Materials

- Thermoplastic acrylonitrile butadiene styrene (ABS)
- 4 Stainless steel springs
 - 2.82 mm outer diameter
 - 6.8 mm length
- Stainless steel wire
 - 0.4 mm diameter

Cutting blade (blue)

- Attaches at hinge
- Resistance through linear spring
- Swings between forceps halves (red, green)

Trigger (yellow)

- 20.5 mm track (groove in red)
- Ergonomic placement
- Attaches to arm via wire

KEY

- Red: digit 4
- Orange: attachment
- Yellow: trigger
- Green: digit 1
- Turquoise: attachment
- Blue: blade
- Pink: pin

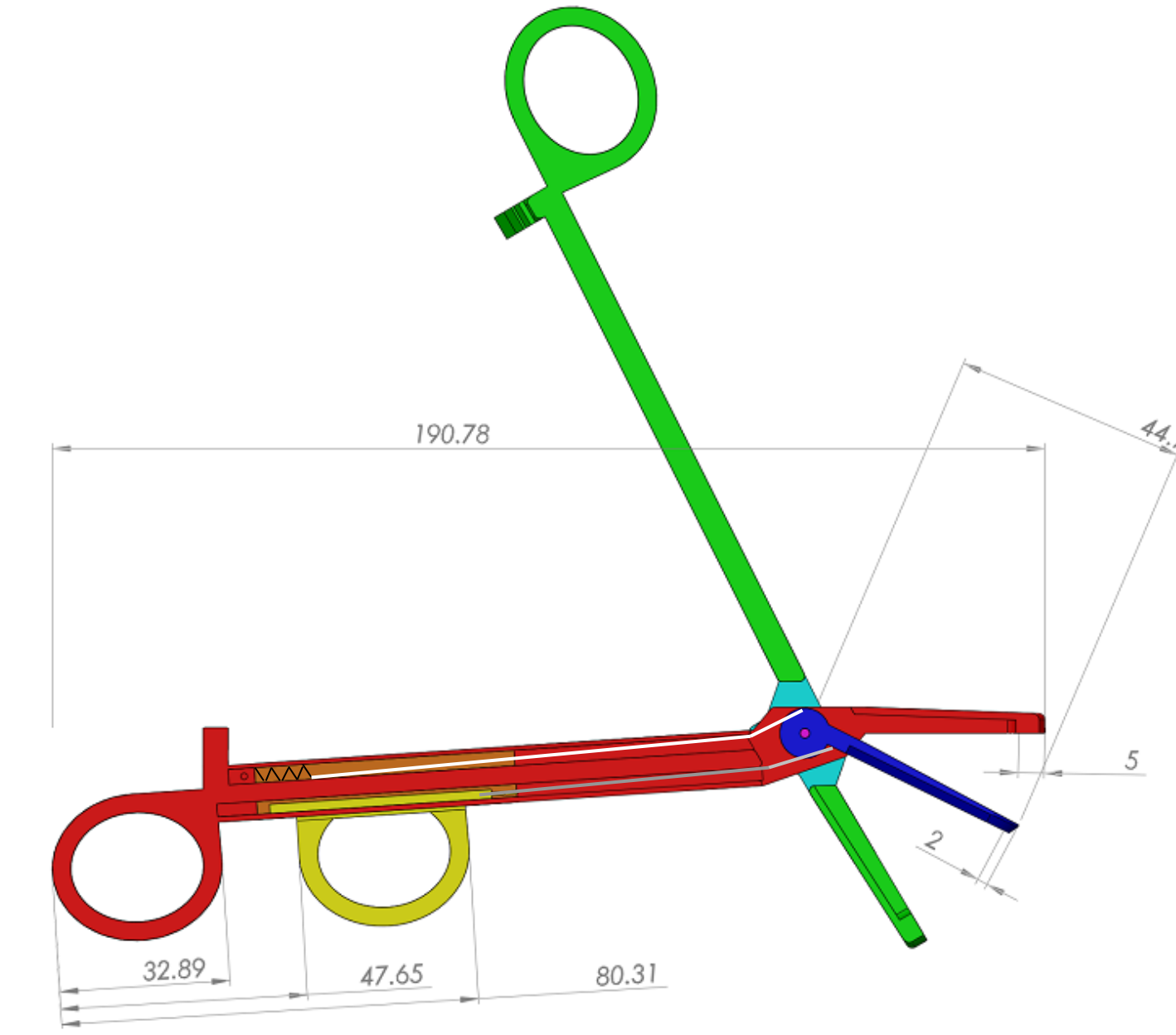


Figure 5: Bottom view of the prototype with top sectioned plane through the device. The assembled parts, spring, and wire are clearly seen. All dimensions are in mm.

Testing

Ergonomics

Table 1: Results of ergonomics survey. Categories were rated on a scale of one (bad) to ten (good), with five being considered average.

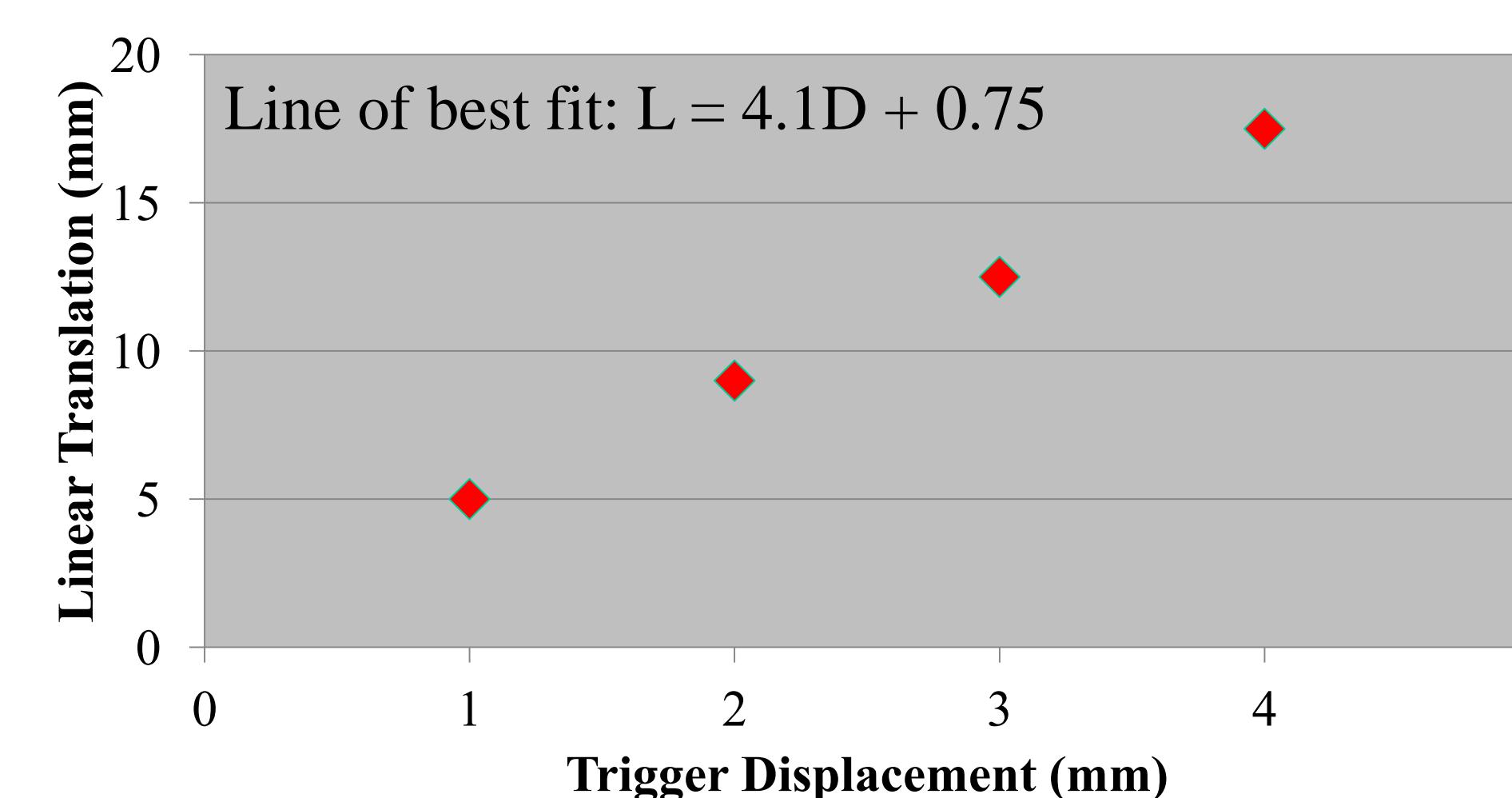
	Surgeon 1	Surgeon 2	Surgeon 3	Average ± Standard Deviation
Trigger location	9	8	9	8.67 ± 0.58
Ability to maintain visual	9	9	9	9.00 ± 0.00
Range of motion	9	9	8	8.67 ± 0.58
Control	9	8	8	8.33 ± 0.58
Additional effort required	7	8	9	8.00 ± 1.00
Comparison to current practices	8	7	8	7.67 ± 0.58
Overall ease of use	9	8	8	8.33 ± 0.58

Feedback

- Round off forceps tip
- Trigger is conveniently located
- Deploying blade requires force which causes jostling

Range of Motion

Linear Translation



Angular Displacement

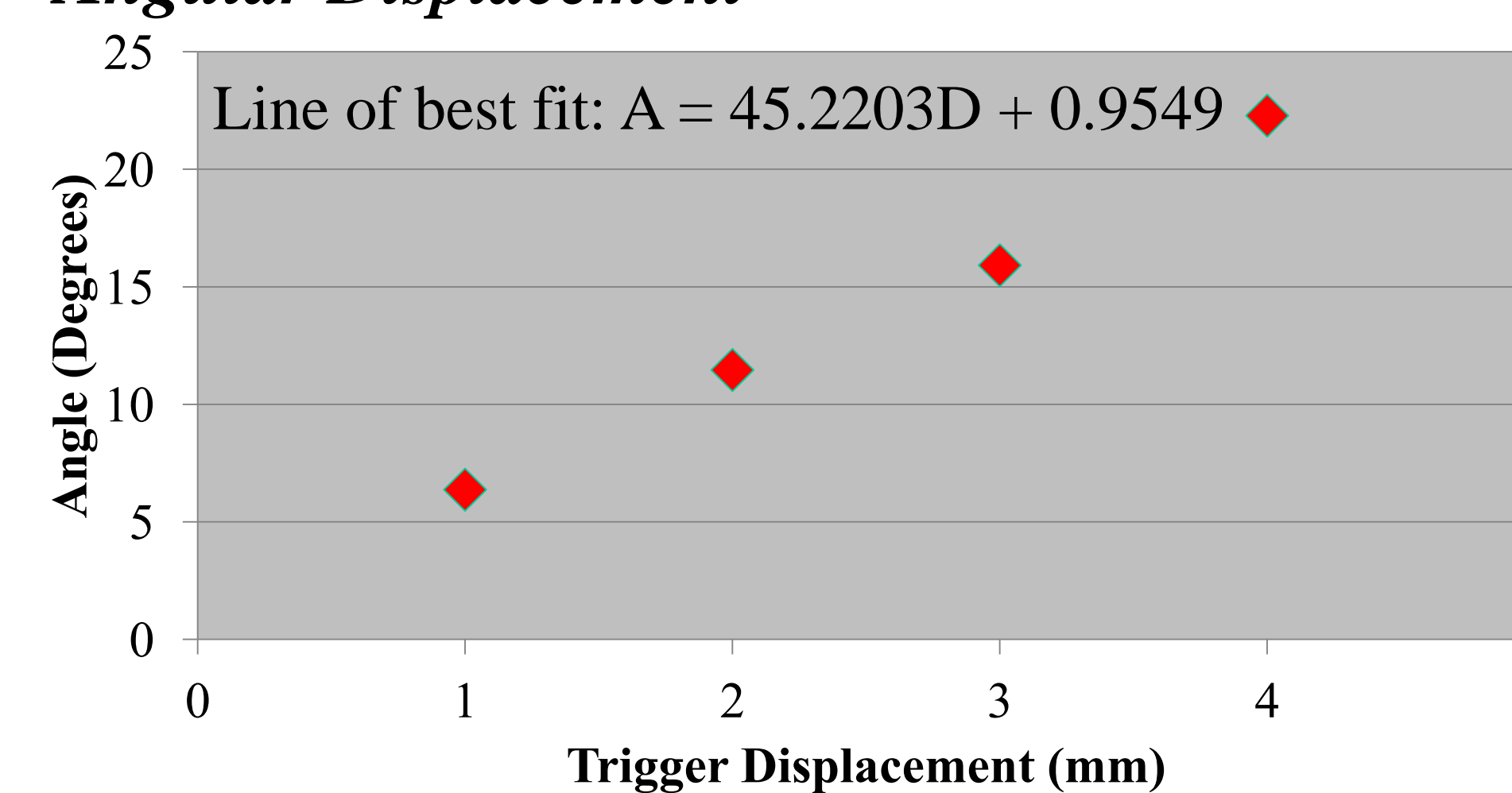


Figure 6: Results of range of motion testing

Budget

Current Expenses

Table 2: Current expenses breakdown

Expense	Price (\$)
Spray paint	8.48
Torsional springs	22.04
Compression springs	12.29

Future Expenses

Table 3: Future expenses breakdown

Expense	Price (\$)
Extension springs	17.00
Steel wires	5.00
Steel machining	200.00

Future Work

Design Modifications:

- Sharpen forceps tips
- Widen blade notch
- Extend trigger track
- Use extension springs instead

Manufacture prototype out of ABS

Perform testing on prototype

- Range of motion
- Precision of cut
- Smoothness of cut
- Ergonomics survey on residents (n ≥ 10)

Manufacture prototype out of stainless steel

Validate prior testing

- Perform force testing

Consider patent options

Acknowledgements

Tracy Puccinelli, Ph.D
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 Andrew Mikkelsen, Ph. D
 Residents who completed ergonomics survey

References:

- [1] Israeli, R., Feingold, R. S., & Korn, P. T. (2007, October 21). Latissimus Dorsi Flap. In *Breast Reconstruction*. Retrieved October 8, 2012, http://www.breastreconstruction.org/TypesOfReconstruction/dorsi_flap.html
 [2] St Ghorbani, N. (2011, August 28). *One Stage Breast Reconstruction- 5 of 7*. Retrieved October 13, 2012, <http://www.youtube.com/watch?v=uvq1hEqjMy4&feature=relmfu>