NanoStitch
A Nanoshell Assisted Laser Tissue Welding System

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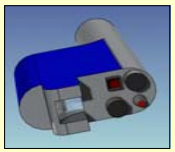
Introduction

Current methods of wound closure, such as sutures and liquid adhesives, lead to increased scarring, cost, inconvenience, and possibility for infection. A new approach that combines nanoshell technology with laser tissue welding[1] appears promising. However, the problem of user variability remains to be solved. ***Team Lazer has designed and built a prototype of an easily applicable device and a user-friendly software to address the concerns of safety and consistency arising from the variables of laser distance, angle, and motion along with the surface temperature of the skin.***

NanoStitch Concept

Prototype Requirements

- Easily Portable
- Maximum Safety
- Cost < $5 per use
- Cost < $1500 per device
- Operable with minimal training
- Highly Consistent & Repeatable
- Operator friendly computer interface
- Size of Wound: 2-5cm
- Volume < 2m³
- Sensing Distance: 2-10cm



Safety Concerns Addressed

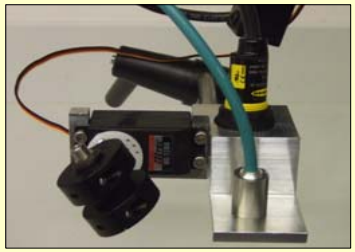
Patient Safety

- Temperature monitoring prevents damage to skin
- Modulated laser intensity to prevent burns
- Reduced manipulation of wound → Less opportunity for infection
- Motorized angle adjustment allows for consistent application to skin

Operator Safety

- Alarms when critical temperature is reached
- Proximity to skin determined in real-time
- Automatic Shut-off system

NanoStitch



How it Works

Set Up

- Laser adjusted to desired conditions
- **Distance** and **temperature** sensor calibrated

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Sample Preparation

- Chicken samples isolated
- Nanoshell solder applied directly to wound

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Commence Annealing Process

- Laser shined over wound to begin closure
- Motor adjusts angle of laser to maintain surface exposure

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Safety Feedback Mechanisms

- If **temperature** becomes too high, alarms trigger operator and **laser intensity ramped down**
- Operator notified of **distance** to wound in real-time to ensure consistency

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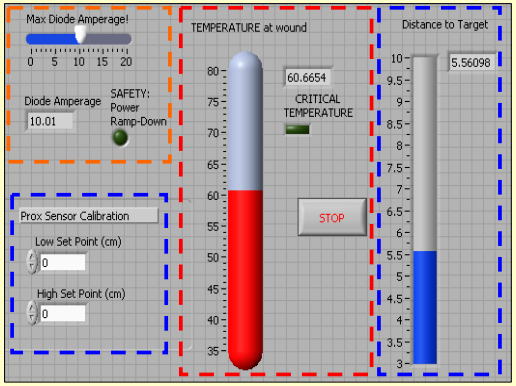
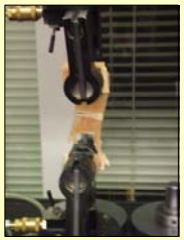
Safe, Successful Wound Closure!!

User Interface



Safe and Effective Solution



- Mechanical tensile failure tests were implemented to determine efficacy of NanoStitch
- **No significant difference between tensile strength of NanoStitch and Suturing Technique** (two-sample t-test, $\alpha<0.05$)
- **NanoStitch exhibits significantly greater Young's Modulus over Handheld technique** (two-sample t-test, $\alpha<0.05$)
- Qualitative analysis illustrate more frequent failure at grip site, rather than welding site, during NanoStitch testing

Method of Wound Closure	Young's Modulus	Yield Point	Ultimate Tensile Stress
NanoStitch (n=5)	**0.044 ± 0.009 N/mm²**	0.019± 0.027 N/mm²	**0.013 ± 0.0038 N/mm²**
Handheld (n=5)	**0.028 ± 0.016 N/mm²**	0.013± 0.022 N/mm²	0.008 ± 0.0055 N/mm²
Suture (n=5)	0.030 ± 0.016 N/mm²	0.012 ± 0.006 N/mm²	**0.015 ± 0.011 N/mm²**

Conclusions

- NanoStitch goes one step further than conventional hand-held laser tissue welding technology.
- The incorporation of real-time feedback controlled distance and temperature sensors into a user-friendly software program results in a safer and more consistent wound closure.

Acknowledgments and References

1. Gobin AM, O'neal DP, Watkins DM, Halas NJ, Drezek RA, West JL. Near infrared laser-tissue welding using nanoshells as an exogenous absorber. *Lasers Surg Med*. 2005 Aug;37(2):123-9.

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