Laser in Reproductive Medicine

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PHOTOMEDICINE - BME 135

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Milestones in Medicine

The growing divergence of rich and poor is now arguably the greatest challenge. The future cannot be predicted, but the potential of physics and engineering to improve medicine has never been greater.
32 Years of Laser Laparoscopy

22 Years of Laser in A.R.T.

(Assisted Reproduction Technologies)
Endoscopy.

The potential use of various wavelengths in laparoscopy

The Electro-magnetic Spectrum

Beckman Laser Institute and Medical Clinic (UCI)
Laser Beams spot sizes

- **MM non-contact Laser beam IVF & Chromos.** (0.5-3 µm)
- **MM contact Laser fiber / glass pipette IVF.** (3-5 µm)
- **MM contact Laser fiber IVF.** (20 µm)

**CO2 Laser Laparoscopy** (500-800 µm)

**Microspot** (Op. Mi.)
- For Gynecology (400-600 µm)
- For E.N.T. (125-150 µm)

**MM = Micromanipulation, Op.Mi. = Operating Microscope.**

Laser MM: Basic and clinical trials
Cutting & Coagulation

THE IMPORTANCE OF HIGH POWERS

EXPOSURE TIME = 9 Secs.
Total Energy = 90 Joules

EXPOSURE TIME = 3 Secs.
Total Energy = 90 Joules

EXPOSURE TIME = 1 Secs.
Total Energy = 90 Joules
32 Years of Laser Laparoscopy
CO2 Laparoscopy: Delivery system and Coupler.

Figure 3-1.  A. A 5-mm straight diagnostic laparoscope. B. A 10-mm diagnostic laparoscope. C. Angled laparoscopes.
CO2 Laser Laparoscopy for Endometriosis
Video Clips on laparoscopic Surgery

**Laser laparoscopy – Hysterectomy:**

**Laparoscopic Myomectomy:**

**Laser Laparoscopic Hysterectomy Part 1**

As more gynecological procedures move to endoscopic or laparoscopic surgery, the use of lasers continues to increase. Lumenis has kept pace with this expanding field by cooperating with endoscope, microscope and colposcope manufacturers to ensure that gynecologists have access to the most advanced and compatible surgical lasers available. For example, Lumenis was the first and only laser company to modify its lasers for use with CO2 insufflation gas. Lumenis CO2, holmium and dual-wavelength lasers with special gynecologic accessories are widely used to perform laparoscopy, colposcopy and hysteroscopy procedures. For more information, please visit [www.surgical.lumenis.com](http://www.surgical.lumenis.com).
SwiftLase™ - Operating Principle
Detection of peritoneal endometriotic lesions by autofluorescence laparoscopy.


Buchweitz, et al. **Conclusion**: Combination of white light illumination and autofluorescence is significantly superior to white light illumination alone in detecting nonpigmented endometriotic lesions.
ART: IVF, Micromanipulations, and other modern techniques.
1987: SuZI & PZD

Figure 7.

a. Zona Drilling (Acid Tyrode)
b. Sub Zonal Insertion (SuZI)
c. Intra cytoplasmatic sperm injection
d. Partial Zona Dissection (PZD) [Mechanical]
e. Non-contact Laser Zona Drilling (LZD)
f. Contact Laser Zona Drilling (C-LZD)
The Electromagnetic Spectrum: Absorption in Water, DNA and Proteins

- Absorption spectrum of DNA
- Absorption spectrum of Protein (BSA)
- Absorption spectrum of Water

1480 nm Diode Laser

The Visible Range

Optimal "window" for non-contact laser MM

WL-(nm) used for micro-manipulations

U.V.  P.  I.R.  →
1. No heat exposition of the oocyte or the embryo.
2. Wavelength distant from the DNA absorption maximum.
3. Low ablation threshold and power to ensure precision and minimize vibration.
4. Avoid extensive additional equipment or special training.

**Contact Laser Micromanipulation**
- Disposable fibers
- Need for sterilization
- Added to the conventional MM set-up (holding pipette, mechanical fixation and oocyte manipulation)
- Limited ability to reduce spot size.
- Require special training.
- No intra cellular application.
- Heat exposition!

**Non Contact Laser (free beam) Micromanipulation**
- No need for fibers
- No need for sterilization
- No need for conventional MM set-up (no holding pipette, no mechanical fixation and oocyte manipulation)
- Spot size can be reduced to 0.5 µm.
- No Requirement for special training.
- Intra cellular application.
- Heat exposition?

**Microscope stage**

Figure 2.
LASER CRATER in the Z.P. for Assisted Hatching
Various hole size performed in a mouse oocyte.

Duration: Variable

Hamilton Thorne Biosciences
ZILOS-tk
Zona Infrared Laser Optical System
The “Smiley Embryo”, sculpted with a laser beam.
Fertilization: ICSI takes over...

No need for PZD or SuZI

Figure 7.

a. Zona Drilling
   (Acid Tyrode)

b. Sub Zonal Insertion
   (SuZI)

C. Intra cytoplasmatic sperm injection

d. Partial Zona Dissection
   (PZD) [Mechanical]

e. Non-contact Laser Zona Drilling
   (LZD)

f. Contact Laser Zona Drilling
   (C-LZD)

c. Intra cytoplasmatic sperm injection
Applications of Laser Computerized System

- Laser Assisted Hatching
- Embryo Biopsy
- ICSI
- Nuclear Transfer
- Stem Cell Research
- Polar Body Biopsy

Watch videos:
http://www.hamiltonthorne.com/research/xyclone/apps.htm
Laser Assisted Hatching and Embryo Biopsy

http://www.hamiltonthorne.com/documentation/videos.htm

- Hamilton Thorne, Inc. is a leading provider of advanced laser systems and instruments for in-vitro cell applications in the regenerative medicine research and fertility clinic markets.
- Hamilton Thorne's ZILOS-tk and XYClone laser systems attach to standard inverted microscopes and operate as robotic micro-surgeons, reducing time and increasing efficiency in key stem cell, embryo and living cell procedures. Hamilton Thorne's CASA systems are designed to bring quality, efficiency and reliability to studies of reproductive cells in the animal, human infertility and reproductive toxicology fields.
- The Company's novel laser systems are rapidly emerging as the dominant products to facilitate precise micro-surgical procedures with stem cells and other living cells in the laboratory. Specific applications include the reduction from nine months to six weeks to develop transgenic animal models, dramatic reductions in cell damage during micro-surgical procedures and 50% higher yields for many cell procedures.

**OBJECTIVE:** To determine whether laser-assisted hatching can improve clinical outcome of assisted reproductive techniques in patients with advanced female age, with recurrent implantation failure, or who are using frozen-thawed embryos.

**CONCLUSION(S):** The laser-assisted hatching improved the pregnancy and implantation rates in patients with frozen-thawed embryos.
Preimplantation genetic aneuploidy screening performed by polar body biopsy has become a frequently used method, especially as in several countries only preconceptional genetic diagnosis is allowed.

To penetrate the zona pellucida, mechanical, chemical and laser-assisted techniques have been introduced.

In this paper, the advantages, disadvantages, efficacy and safety of these techniques are elucidated.
Abstract

Intracytoplasmic sperm injection (ICSI) is the method of choice for the in vitro production (IVP) of equine embryos. However, conventional ICSI has been associated with mechanical damage to the oocyte caused by the deformation of the zona pellucida (ZP) and exposure of the oolemma to negative pressure during injection. Introduction of the less traumatic and more efficient piezo drill-assisted ICSI (PDAI) yielded higher cleavage rates and more consistent results. Nevertheless, PDAI is also associated with disadvantages such as the use of mercury and possible DNA damage. This led us to explore an alternative method avoiding oocyte trauma, namely laser-assisted ICSI (LAI), which involves creating a hole in the ZP prior to ICSI.

Conclusion: In this pilot study, PDAI and LAI were compared for ICSI in the horse. No significant influences on subsequent embryonic development were observed.
Clinical Mode

- Three preset power and pulse combinations
  - Low
  - Medium
  - High
- Automatic laser shutoff timer for safety
- Choice of arrow or circle targets
Measurement Utility

• Store 5 separate sets of measurements

• Automatically calculates mean and standard deviation

• Transferred to report at touch of a button
Built-in Data Management

- Storage of individual images
- Integrated report generation
- Add pre- and post-treatment images to report
- Choose 2 or 4 image format
- Export data to ASCII (.txt and .mer)
• The Computerized Laser System is a Safe, Accurate, and Fast Modality for Gamete Manipulations.

* Real-Time Documentation of Clinical and Research Data gathered in the IVF lab offers an added value.
Don’t fall in love with your project

• Watch closely what’s going on?
  • and who is doing what?
• For the same application or need !!!
Gracias

شكراً

תודה

Merci

Bedankt

Vielen Dank

Teşekkürler

Hvala