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Title: In Vitro Evaluation of the Effects Of Er,Cr:YSGG and Diode Lasers Used on Titanium Cylinders

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Author Questionnaire

1. We have marked your project as author-provided footage, meaning you film the video yourself and provide JoVE with the footage to edit. JoVE will not send the videographer. Please confirm that this is correct.

√ Correct

2. Microscopy: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **NO**

3. Software: Does the part of your protocol being filmed include step-by-step descriptions of software usage? **YES, all done**

4. Proposed filming date: To help JoVE process and publish your video in a timely manner, please indicate the proposed date that your group will film here: **07/02/2025**

When you are ready to submit your video files, please contact our Content Manager, Utkarsh Khare.

Current Protocol Length

Number of Steps: 21
Number of Shots: 48 (9 SC)

Introduction

NOTE: The filming was done using the draft script

NOTE: Use the interview videos with the file names ending with "horizontal"

1.1. **Mükerrem Hatipoğlu: This study evaluates the use of two different types of lasers on titanium surfaces to treat peri-implantitis, investigating the impact on implants.**

1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

What are the current experimental challenges?

1.2. **Mehmet Büyüktarakcı: One of the challenges of the experiment was to replicate the intra-oral environment into a on controllable in-vitro model.**

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.3.1*

What significant findings have you established in your field?

1.3. **Mehmet Büyüktarakcı: Studies on the use of laser in the treatment of peri-implantitis should be conducted as extensive clinical trials**.

1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.5.1*

Protocol

2. Laser Application and Imaging Analysis of Titanium Cylinders

Demonstrator: Mehmet Büyüktarakcı

2.1. To begin, launch the Rhinoceros 3D graphics and design program **[1]**. Draw a circle with a diameter of 10 millimeters **[2]**. Then reduce the circle by 50% along one axis to create an ellipse **[3]**. Use the **Extruder** function to raise the ellipse in the third dimension **[4]**.

2.1.1. SCREEN: NEW-SCREENSHOT_1.MKV 00:00-00:03.
SCREEN: NEW-SCREENSHOT_1.MKV 000:04-00:10

2.1.2. SCREEN: NEW-SCREENSHOT_1.MKV 00:11-00:16.

2.1.3. SCREEN: NEW-SCREENSHOT_1.MKV 00:27-00:35.

2.2. Draw another circle for finger support **[1]**. Use the **Extruder** function to raise the second circle in the third dimension, ensuring it is shorter than the first shape **[2]**.

2.2.1. SCREEN: NEW-SCREENSHOT_1.MKV 00:17-00:20.

2.2.2. SCREEN: NEW-SCREENSHOT_1.MKV 00:37-00:41.

2.3. Now, drill a 10-millimeter hole in the elliptical drawing using the Boolean command **[1]**. For thermocouple support, create an L-shaped line using the Sweep 1 command and extrude it into the third dimension **[2]**.

2.3.1. SCREEN: NEW-SCREENSHOT_1.MKV 01:30-01:45.

2.3.2. SCREEN: NEW-SCREENSHOT_1.MKV 02:05-02:20.

2.4. Draw a square and extrude it into the third dimension to create the base **[1-TXT]**. ~~After printing the design **[2]**, apply silicone around the hole where the titanium cylinder will be positioned and let it to dry **[3-TXT]**~~.

2.4.1. SCREEN: NEW-SCREENSHOT_1.MKV 004:40-04:52 **TXT: Apply silicone around the hole where the titanium cylinder will be positioned**

~~2.4.2. Shot of the printed design.~~ **NOTE**: Not filmed, VO moved as on -screen text

~~2.4.3. Talent applying silicone around the designated hole. **TXT: This will secure cylinder in place during laser application**~~

2.5. Set a closed room with air conditioning to a temperature of 27 degrees Celsius **[1]**. Fix the stand in the center of a plastic tub using double-sided tape **[2]**.

2.5.1. Talent adjusting the room temperature to 27 degrees Celsius.

2.5.2. Talent securing the stand with double-sided tape inside the plastic tub.

NOTE: Show step 2.8 before 2.6

2.6. Insert the thermocouple of the thermometer into the hollow section of the titanium cylinder positioned in its slot on the stand **[1]**. Prepare a chronometer to monitor application time **[2]**. Assign a third observer to record temperature changes and operate the stopwatch **[3]**.
  2.6.1. Talent placing the thermocouple into the titanium cylinder slot.
  2.6.2. Talent setting up a chronometer.
  2.6.3. Talent instructing the third observer to track temperature and time.

2.7. Wear protective glasses before beginning laser application for safety **[1]**. Insert the tips for the lasers **[2-TXT]**.
  2.7.1. Talent wearing protective glasses.
  2.7.2. Talent inserting the tips for the lasers. **TXT: RPTF5-14 tip for Er,Cr:YSGG laser; E3 tip for diode laser**

2.8. Spray air into the titanium cylinder before starting the experiment **[1]**. Position the titanium cylinder on the fixing stand **[2]**. **NOTE**: Show step 2.8 before 2.6
  2.8.1. Talent spraying air onto the titanium cylinder.
  2.8.2. Talent placing the titanium cylinder onto the stand.

2.9. Turn on the Er,Cr:YSGG *(E-R-C-R-Y-S-G-G)* laser and select **Perio Closed Mode [1-TXT]**. Apply 1.5, 2.5, and 3.5 watts of laser energy for 20 seconds and 40 seconds each **[2]**.
  2.9.1. Selecting Perio Closed Mode for the Er,Cr:YSGG laser. **TXT: Er,Cr:YSGG : Erbium, Chromium-doped Yttrium-Scandium-Gallium-Garnet**
  2.9.2. The laser energy levels are being adjusted to 1.5 W, 2.5 W, and 3.5 W for designated durations.

2.10. Then turn on the diode laser and select **Perio Pocket Mode [1]**. Apply 0.8 watts, 1.3 watts, and 1.8 watts of laser energy for 20 seconds and 40 seconds each **[2]**.
  2.10.1. The Perio Pocket Mode is being selected for the diode laser.
  2.10.2. The laser energy levels are being adjusted to 0.8 W, 1.3 W, and 1.8 W for designated durations.

2.11. Have the third observer start the timer when the laser application begins **[1]**. Notify the observer when the time is up **[2]**.
  2.11.1. Talent instructing the observer to begin timing.
  2.11.2. Talent alerting the observer when the time has elapsed.

2.12. Now, apply the laser tip at a 15-degree angle to the surface, maintaining contact, and moving in a zigzag pattern across the entire surface for the planned duration **[1]**.
  2.12.1. Shot of the laser tip at 15° angle to the surface, zig-zagging across the entire surface. **Author's NOTE**: Two separate videos are provided:
  2.12.1: Application using diode laser
  2.12.2: Application using Er,Cr:YSGG laser

2.13. Record the initial and final temperature values during laser application **[1]**. Subtract the start temperature from the final value to calculate the temperature change **[2]**. Store samples in transparent bags labeled with group numbers **[3]**.
   2.13.1. Talent recording initial and final temperatures.
   2.13.2. Temperature data before and after laser application.
   2.13.3. Talent placing samples into labeled transparent bags.

3. Imaging Analysis of Titanium Cylinders Using SEM, AFM and Profilometer

3.1. For 2 and 3-dimensional imaging, do not coat samples before placing them in the scanning electron microscope **[1-TXT]**. Randomly select one cylinder from each of the 13 study groups **[2]**. Insert them into the SEM device, recording their location and sample code to avoid mix-ups **[3]**.
   3.1.1. Shot of uncoated samples being placed in the SEM. **TXT: Groups: 1 control; 6 diode laser; 6 Er,Cr:YSSG**
   3.1.2. Talent selecting samples
   3.1.3. Talent inserting the sample into the SEM and documenting placement locations and sample codes.

3.2. Place the titanium cylinder in the SEM device with the flat surface facing upward **[1]**. Perform analyses using **Low Vacuum Mode [2]**. Set the chamber pressure to **60 Pa** *(pascals)* during analysis **[3-TXT]**.
   3.2.1. Talent positioning the titanium cylinder for SEM analysis.
   3.2.2. Selecting Low Vacuum Mode in the SEM software.
   3.2.3. Adjusting chamber pressure to 60 Pa. **TXT: Capture images at 250x, 1000x, and 5000x magnification**

~~3.3. Once the device is fully ready, capture images at 250X, 1000X, and 5000X magnification from a random point on the flat surface **[1-TXT]**.~~
   3.3.1. ~~SEM capturing images at multiple magnifications.**TXT: Repeat image capture for all samples**~~ **NOTE**: Not filmed, VO moved as on -screen text

3.4. For atomic force microscopy measurement, randomly select one titanium cylinder from each study group **[1]**. Perform measurements in Tapping Mode **[2]**.
   3.4.1. Talent selecting a titanium cylinder from each study group.
   3.4.2. Tapping mode is being used to perform measurements.

3.5. Transfer the cylinder into the instrument **[1]**. Capture a 5 by 5-micrometer digital image for each sample and record at a slow scan rate of 1 hertz **[2-TXT]**.
   3.5.1. Talent transfers the sample into the instruments.

3.5.2. AFM scanning and capturing a 5 µm × 5 µm digital image at 1 Hz. **TXT: AFM instrument visualizes 25 μm^2 area** **NOTE:** Ignore 3.5.3

3.6. For the measurement of surface roughness, first fix the titanium roller with a holder [1]. Place the needle of the profilometer in contact with the titanium surface **[2]**.

3.6.1. Talent securing the titanium roller for profilometer analysis.

3.6.2. Talent adjusting the profilometer needle to touch the surface.

3.7. Set the resolution to 0.01 millimeters, the transverse length to 3.0 millimeters, and the diamond recording pin tip diameter to 5 micrometers [1]. Adjust the measurement speed to 0.5 millimeters per second to determine the mean roughness or Ra *(R-A)* value **[2]**.

3.7.1. The resolution of the profilometer is being set to 0.01 mm, the transverse length to 3.0 mm and the diameter of the diamond recording pin tip to 5 µm.

3.7.2. The measurement speed is being set to 0.5 mm/s.

3.8. Press Start to begin the measurement [1]. Once measurement is complete, save the recorded Ra value [2]. Repeat measurements five times in different directions on the flat surface of each cylinder **[3-TXT]**.

3.8.1. Start is being pressed.

3.8.2. The Ra value is being saved.

3.8.3. Repeated Ra values in different directions is being seen. **TXT: Repeat for the entire length of the cylinder**

Results

4. Results

4.1. The temperature change on the 40-second laser-applied cylinder surfaces was greater than that on the 20 -second laser-applied **[1]**.

4.1.1. LAB MEDIA: Figure 3 *Video editor: Please emphasize the box corresponding to 40s*

4.2. The temperature change in titanium cylinders using a diode laser was significantly greater than in those using the Er,Cr:YSGG laser [1]. Within the diode laser groups, the 40-second application resulted in significantly higher temperature changes compared to the 20-second application across all power levels **[2]**.

4.2.1. LAB MEDIA: Figure 4. *Video editor: Please emphasize the boxes corresponding to Diode and Er,Cr:YSGG*

4.2.2. LAB MEDIA: Figure 4. *Video editor: Please emphasize the boxes corresponding to Diode, Diode 20 s and Diode 40s*

4.3. The temperature range of the diode laser groups with 1.8 Watts applied to the cylinder surfaces was markedly greater than that in the diode laser groups with 0.8 Watts applied **[1]**.

4.3.1. LAB MEDIA: Figure 5. *Video editor: Please emphasize the orange points corresponding to 1.8Wx20s, 1.8Wx40s, 0.8Wx20s, 0.8Wx40s.*

4.4. SEM *(S-E-M)* images showed a porous structure in all groups, characteristic of sandblasted, acid-etched implant surfaces [1]. At 5000X magnification, laser-treated titanium surfaces showed visible enlargement of micron-sized pores compared to the control group **[2]**.

4.4.1. LAB MEDIA: Figure 6.

4.4.2. LAB MEDIA: Figure 6. *Video Editor: Please emphasize the areas marked by red circles in the 5000X image rows*

4.5. At 250X and 1000X magnifications, surfaces exposed to the Er,Cr:YSGG and diode lasers for 40 seconds exhibited more surface melting than those treated for 20 seconds **[1]**.

4.5.1. LAB MEDIA: Figure 6. *Video editor: Please emphasize the 250X and 1000X images.*

4.6. AFM images revealed that surface indentations were uniformly distributed in the control group compared to laser-treated samples **[1]**.

4.6.1. LAB MEDIA: Figure 7, Figure 8. *Video editor: Please show Figure 7 first and then figure 8*

4.7. The roughness parameter did not show a significant difference in laser type, Watt, time, or in combined evaluations **[1]**.

4.7.1. LAB MEDIA: Figure 9. *Video editor: Please sequentially emphasize the "Roughness Analysis by Laser type", "Roughness Analysis by Watt" and "Roughness Analysis by Time" graphs*

Pronunciation guides:

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1. **Rhinoceros**
   Pronunciation link:
   https://www.merriam-webster.com/dictionary/rhinoceros (Word Panda, Merriam-Webster)
   IPA: /raɪˈnɑ.sə.rəs/
   Phonetic Spelling: rahy-NOH-suh-ruhs

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2. **Thermocouple**
   Pronunciation link:
   https://www.merriam-webster.com/dictionary/thermocouple (Merriam-Webster)
   IPA: /ˈθɜr.məˌkʌp.əl/
   Phonetic Spelling: THUR-muh-kuh-puhl

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3. **Profilometer**
   Pronunciation link:
   https://www.merriam-webster.com/dictionary/profilometer (Merriam-Webster)
   IPA: /ˌproʊfəˈlɑmɪtər/
   Phonetic Spelling: proh-fuh-LOM-uh-tur

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4. **Erbium**
   Pronunciation link:

https://www.merriam-webster.com/dictionary/erbium (Merriam-Webster)
IPA: /ˈɜr.bi.əm/
Phonetic Spelling: UR-bee-uhm

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5. **Pascal** (unit of pressure)
   Pronunciation link:
   https://dictionary.cambridge.org/pronunciation/english/pascal (Cambridge Dictionary)
   IPA: /ˈpæs.kəl/
   Phonetic Spelling: PAS-kuhl
