

CO₂-Laser Irradiation Affects Positively Surface Energy of Rough Titanium Surfaces

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INTRODUCTION

Osseointegration of implants is significant in determining implant success. Factors influencing osseointegration include the wettability of the implant surface.

OBJECTIVE

The purpose of this study was to investigate the free surface energy before and after CO₂ irradiation.

METHODS

Two groups of implant surfaces were used for this experiment: (A) sandblasted, large grit, acid-etched (SLA) and (B) machined. Contact angle evaluations were performed for saline, albumin, and artificial blood using a contact angle goniometer (Ossila, Sheffield, UK).

Each group consisted of 120 droplet measurements: 20 saline at 25°C, 20 albumin at 25°C, 20 artificial blood at 25°C, 20 saline at 37°C, 20 albumin at 37°C, 20 artificial blood at 37°C. The titanium disks were then irradiated with a CO₂ laser (10,600 nm, Lutronic® LS-1005, GPT Dental, Fairfield, NE) using a non-contact, defocused, 2W continuous wave for 30 seconds. Contact angle measurements for saline, albumin and artificial blood were evaluated before and post-laser irradiation on both A- and B-implant surfaces. Paired t-test using SPSS was performed for 5% statistical significance level.

RESULTS

There is a decrease of the contact angles in all the groups of the SLA surfaces after laser, showing an increase in wettability of the surfaces and surface energy. Changes in contact angles after CO₂-laser irradiation were statistically significant ($p < 0.05$) for all groups excluding albumin at 25°C on SLA titanium surfaces. In contrast, contact angles on the machined surfaces showed no statistically significant differences pre and post laser, except for albumin at 37°C on the machined surfaces where the contact angles after irradiation were decreased ($p < 0.05$), showing an enhancement of the surface wettability.

SLA	Pre-CO ₂	Post-CO ₂	p-value
Saline@25°C	111.97° ±13.673°	79.29° ±10.829°	$p < 0.001$
Albumin@25°C	89.04° ±12.022°	83.291° ±20.713°	$p = 0.297$
Blood@25°C	97.79° ±14.445°	86.29° ±10.826°	$p = 0.020$
Saline@37°C	104.12° ±13.138°	92.66° ±4.777°	$p = 0.001$
Albumin@37°C	83.09° ±14.073°	65.20° ±15.729°	$p < 0.001$
Blood@37°C	80.42° ±19.007°	58.62° ±24.345°	$p = 0.012$

Machined	Pre-CO ₂	Post-CO ₂	p-value
Saline@25°C	86.53° ±17.410°	91.88° ±3.489°	$p = 0.204$
Albumin@25°C	71.55° ±15.908°	76.13° ±13.537°	$p = 0.404$
Blood@25°C	52.58° ±27.394°	60.86° ±16.376°	$p = 0.254$
Saline@37°C	72.54° ±17.831°	72.52° ±13.800°	$p = 0.995$
Albumin@37°C	60.49° ±16.374°	45.31° ±10.292°	$p = 0.001$
Blood@37°C	62.96° ±19.417°	49.57° ±22.010°	$p = 0.101$

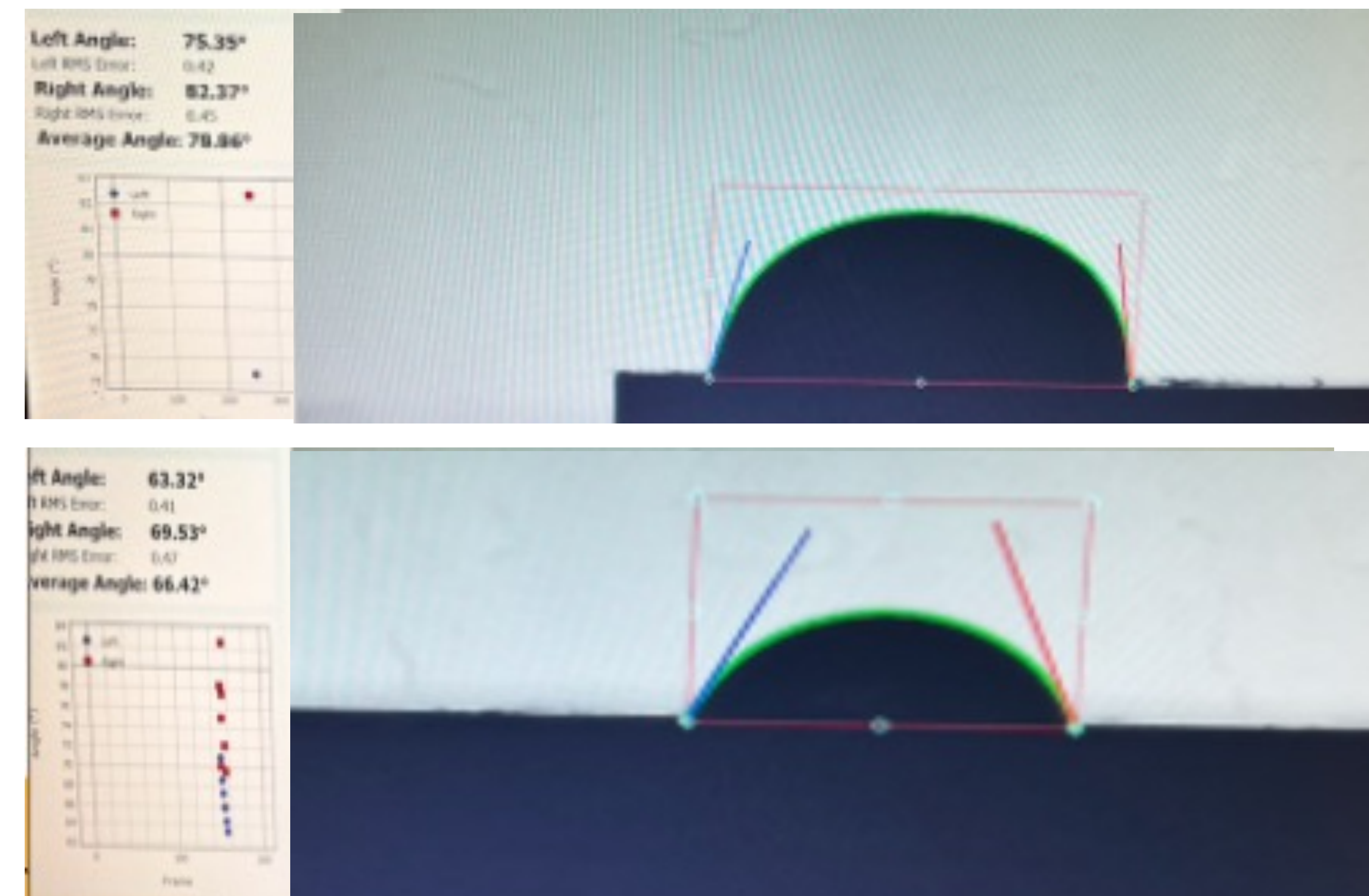


Figure 1. Contact Angle Evaluation of Artificial Blood at Blood (25°C) on SLA surface - Pre CO₂ Laser Irradiation

Figure 2. Contact Angle Evaluation of Artificial Blood at Blood (25°C) on SLA surface - Post CO₂ Laser Irradiation

CONCLUSION

The CO₂ laser irradiation positively affected, in general, the wettability and hydrophilicity of SLA surfaces improving positively the surface energy and therefore the biological properties of the titanium surface. In addition, the wettability of machined surfaces with blood proteins in body temperature is significantly enhanced.