DOI: 10.7860/JCDR/2015/15561.6955

Letter to Editor

Dentistry Section

# Energy and Power Density: A Key Factor in Lasers Studies

JACEK MATYS[1], MARZENA DOMINIAK[2], RAFAL FLIEGER[3]

To the editor

I read with interest, three articles in subject of laser studies published in JCDR in last few months. The authors in their researches used different types of lasers devices: Niranjani et al., (diode laser), Murthy et al., ($CO_2$ laser), Kanumuru and Subbaiah (diode and Nd:YAG lasers) [1-3]. Unfortunately the authors have not presented in their researches a value of energy density (fluency) of lasers which is key factor to measure a dose of energy absorbed by treated tissues [Table/Fig-1].

Different types of lasers with same or different wavelength have been utilized in medical market, but the varied inbuilt technology in these devices provides divergent results in energy density (amount of light) which is absorbed by the tissue.

The total energy delivered, divided by the area (energy per unit area) is called fluency or energy density. In a number of examples, fluency is the most important parameter for laser therapy [4].

Aside from energy density, a second important parameter in lasers measurement is a power density. The power density (irradiance) is a ratio of power (P) in Watt (W) to the cross section area (I=W/$cm^2$). The importance of this will be clarified when we consider the interaction of laser beams with different materials [5].

**Example:** A pulsed laser emitting a beam with repetition rate f =1 pulse per second (1Hz), with energy of 50mJ (0.05J), for two diameters of a laser tip, the results in fluency ($J/cm^2$) are divergent:

- 200μm tip, $E=J/\varpi r^2$, r=0.5d, r=0.01cm; $0.05J/3.14*0.01^2= 159.2J/cm^2$ per pulse
- 400 μm tip, $E=J/\varpi r^2$, r=0.5d, r=0.02cm; $0.05J/3.14*0.01^2= 39.8J/cm^2$ per pulse

As the example showed that doubling of tip diameter implicates in 4 times energy density growth. It is very important in all studies that a data which can help to repeat each experiment by other researchers should be provided. Thus, all the studies should include the important parameters which allow comparing different kinds of lasers [4].

In Niranjani et al., Murthy et al., and Kanumuru and Subbaiah studies it is not possible to calculate and compare energy or power density [1-3].

In the author's opinion, it is important that researchers and clinicians using lasers be educated in laser science. Without doubt, the principal knowledge of laser physics is unquestionably important to utilize lasers in good and safe manner.

## Advance in Knowledge

It is strongly recommended to provide, in scientific laser-assisted studies, all parameters for evaluating the energy and power density of laser devices. The energy absorbed by tissue is strictly connected with laser technical parameters listed below:

- energy and power of laser.
- pulse duration and repetition rate.
- time of irradiation
- size of tip
- distance to the target
- tip angulation
- beam profile (Gaussian or Flat-top)

| Parameters / Study | Niranjani et al., (2015) Diode 810nm | Murthy et al., (2015) $CO^2$ 10600nm | Kanumuru and Subbaiah (2015) | | |
|---|---|---|---|---|---|
| | | | Diode 810nm | Diode 980nm | Nd:YAG 1064nm |
| Power (W) | 1.5 | 3 | No data | No data | No data |
| Energy (J) | No data | No data | No data | No data | No data |
| Repetition rate (Hz) | No data | 1000 | No data | No data | No data |
| Pulse duration (sec.) | No data | 160 ms | 100 μsec | 100 μsec | 100 μsec |
| Mode | No data | Pulse | Pulse | Pulse | Pulse |
| Distance (mm) | No data | 1 | No data | No data | No data |
| Angulation (°) | No data | 90 | No data | No data | No data |
| Tip size (m) | No data | No data | 200 | 200 | No data |
| Irradiation time (sec.) | 2 | No data | 10 | 10 | 10 |
| Energy density ($J/cm^2$) | No data | No data | No data | No data | No data |
| Power density ($W/cm^2$) | No data | No data | No data | No data | No data |

**[Table/Fig-1]:** Comparison of studies
Abbreviations-
cm – centimeter
d – diameter
f – repetition rate
Hz – Hertz
J – joule
$J/cm^2$– joule per square centimeter
mm –millimeter
sec. – second
μm – micrometer
W – watt
$W/cm^2$–watt per square centimeter
$\varpi$ – pi number
°– grades

## REFERENCES


[1] Niranjani K, Prasad MG, Vasa AAK, Divya G, Thakur MS, Saujanya K. Clinical evaluation of success of primary teeth pulpotomy using mineral trioxide aggregate®, laser and biodentine™- an invivo study. *Journal of Clinical and Diagnostic Research.* 2015;4(9):35-37.

[2] Murthy V, Balaji M, Livingstone D. Effect of four surface treatment methods on the shear bond strength of resin cement to zirconia ceramics- a comparative invitro study. *Journal of Clinical and Diagnostic Research.* 2014;8(9):65-68G.

[3] Kanumuru NR, Subbaiah R. Bacterial efficacy of ca(oh)$^2$ against *E.faecalis* compared with three dental lasers on root canal dentin- an invitro study. *Journal of Clinical and Diagnostic Research*. 2014;11(8):135-37.

[4] Katzir A. Medicals lasers. In Katzir A:Lasers and Optical Fibers in Medicine, Avademic Press, San Diego, Calif, 1993, pp.15.

[5] Star WM. Light dosimetry in vivo. *Phys Med Biol.* 1997;42(5):763-87.

Reply from author of "Effect of Four Surface Treatment Methods on the Shear Bond Strength of Resin Cement to Zirconia Ceramics- A Comparative invitro Study. *Journal of Clinical and Diagnostic Research.* 2014;8(9):65-8G"

With regard to our cited article I would like to bring to the kind notice of author that since lasers was one of the four methods we compared more details could not be included because of word limitations.

We have mentioned the company and model details about the LASER used in our study. Readers interested in finding the details/ pursuing further studies can visit the site and get the necessary details. We understand that all the information included in the article should be sufficient to replicate the methodology of the article. But sometimes due to the limitation of words and number of figures, it is not possible to include all the details in the text therefore we found it useful to mention the company of the LASER used in our study and relevant data pertaining to our study.

**PARTICULARS OF CONTRIBUTORS:**
1. Private Dental Healthcare, Wschowa, Lipowa 18, Poland.
2. Professor, Departament of Dental Surgery, Wroclaw Medical University, Poland.
3. PhD, Departament of Dental Surgery, Poznan Medical University, Poland.

**NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:**
Dr. Jacek Matys,
NZOZ Ka-Dent, Lipowa 18, 67-400 Wschowa, Poland.
E-mail: jacek.matys@wp.pl

**FINANCIAL OR OTHER COMPETING INTERESTS:** None.

Date of Submission: **Jul 05, 2015**
Date of Peer Review: **Aug 07, 2015**
Date of Acceptance: **Aug 10, 2015**
Date of Publishing: **Dec 01, 2015**