Laser and Its Hazard Potential

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Abstract

Laser-induced eye injuries have been reported more and more often in the past years, yet the laser is not a modern invention. Based on stimulated emission, the wavelength, energy dose and pulse duration of the laser are the determining factors for its possible hazard potential. The eye, which is the most vulnerable body part for laser radiation, can be affected. As medical treatment is discussed controversial, a great demand has been put on developing laser protection gear. The present review summarizes the physical basics, clinical findings and therapeutic options of laser-induced eye injuries.
Laser-induced eye injuries – morphologic findings and therapy

Laser radiation is graded into different groups according to its risk exposure. Laser until class 2 are known to be "safe," due to the sufficient protection by the normal lid closure. In higher classes, the normal ocular protection mechanisms fail and serve eye injuries can be induced (accident prevention regulation BGV B2, [Lasersstrahlung], 01.04.1988, version 01.01.1997 with instructions from April 2007 status: January 2010 (print: 2011-01)). The victims of laser injuries typically report decreased visual acuity and visual field defects [19]. Corneal structures can be disrupted, reaching form photokeratitis until perforation [8,29,30]. The extent of intraocular damage however, is dependent on pupil size [31]. Vitreous [32], subretinal [33] or chorioretinal hemorrhages [32], as well as retinal edema or scars can also occur [34], and hypopigmentation [35], pigment clumps [36] and choroidal neovascularization [37] can develop. Even one month after an injury, macular holes may arise [38]. Macular pucker or epiretinal membranes were observed in some patients [39,40]. Beside the testing of visual acuity, measurements of the visual field (e.g., with perimeter, Bagolini test [41,42]) should be performed by clinicians. Additional information can be received by measuring of the Spectralis Domain OCT, as it offers the possibility to visualize the exact retinal damage [19,20]. Spectralis Domain OCT measurements are also recommended in clinical follow-up examinations.

The therapeutic procedure for laser damage has been discussed controversially. Administration of local and systemic anti-inflammatory drugs (e.g., glucocorticoids, indomethacin) [43,44], as well as Nd:YAG hyalodiotomy or vinctrectomy [45] have been the medical or surgical options, yet recovery of visual acuity has not been consistent. Reports of an increase [46] as well as a missing of visual acuity after vitrectomy [47] can be found in literature. Even laser-induced macular holes do not require an immediate operation as they can close spontaneously [48]. However, there is no evidence-based recommendation for the treatment of laser-induced eye injuries. Several approaches were done using growth factors [49,50] or neuroprotective substances (e.g., MK-801 in animal model [51]; PN-277 in animal model [52]), however some of them are toxic for humans. Research on new medical treatment is ongoing with a focus on the aforementioned target structures.

Conclusion

Although there is a guideline of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) for the exposure of laser [5], several accidents were reported accidentally or even tightly focused. It is recommended that laser radiation is totally encased. If this is not possible, a restriction of entrance, laser protection glasses and specific training courses should be offered. It is also recommended that the civil international trading of laser equipment via the internet be restricted for laser (≥ class 3) to prevent any inappropriate use.
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