LASER PHOTOMEDICINE - AN OVERVIEW: PAST, PRESENT, AND FUTURE

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I. INTRODUCTION

The Directors of this NATO-A.S.I. on "Laser system for photobiology and photomedicine" have asked us to provide some opening remarks, as we are the only two foreign faculty members of the previous Laser Photomedicine course held in Erice in 1983. It does not seem to us that seven years have passed since that last summer school, but there have been many new developments in laser applications in medicine and surgery. Nevertheless, most fundamental concepts remain unchanged and the basic lectures on lasers, tissue interactions and applications remain current. For this reason, many of the students (readers of the proceedings) may be interested in reviewing the proceedings (edited by S. Martellucci and A. N. Chester) of the previous school. In the previous school, emphasis was placed firstly upon tissue interactions, then studies at the cellular level, the photochemistry, photobiology, surgery, safety and diagnostics1-26.

One of the fundamental difficulties encountered in any multidisciplinary field is the lack of effective communication due to a lack of common knowledge and common terminology. For example, the physicists concentrate only upon the initial events in laser-tissue interactions: absorption, transmission and scattering of energy, fluorescence, heat transfer and acoustic transients and ablation or vaporization. Design engineers were interested in providing safe, reliable lasers and practical delivery systems, and generally were enthusiastically hopeful that "their laser" could find more medical applications. The life scientists and clinicians were interested in primarily the morphological (structural) changes and the biological sequelae following laser exposure. In other words, physicists must be careful not to ignore the chain of biochemical and biological events that occur after energy absorption and dissipation, and the life scientist and clinicians must recognize the important optical and thermal properties of tissue and the variations of tissue vaporization and coagulation that can be achieved by varying wavelength (penetration depth, etc.) and exposure duration. J. A. Parrish and A. J. Welch emphasized these points in the previous school2-4.

Seven years ago, there was an increasing number of physicians, surgeons and basic scientists who had achieved a sufficient level of multidisciplinary knowledge to communicate effectively on laser-tissue interac-
tions. Although several investigators produced evidence for photobiological reactions induced by red light, the consensus remained that low-power ("soft") laser effects referred to as "laser biostimulation", were most likely placebo effects.

The photophysical and photochemical interactions at the atomic and molecular level were a point of interest as photochemotherapy was a new subject of interest. The photobiological effects of short-wavelength light and ultraviolet radiation (UVR) were well accepted. Clinical experience in laser surgery was also a major point of interest.

In the previous course, attention was paid to the use of proper radiometric terminology and interaction mechanisms. Unfortunately, the misuse of radiometric terms such as fluence (for radiant exposure) and fluence rate (for irradiance) continue in the literature. These two terms should only be used for flux densities in tissue.

Laser safety was not ignored in the previous course. At that time, specific standards for laser safety were predicted, but had not been developed. Since then, medical laser safety standards are now an accepted fact.

Several papers concerned new technologies, such as light-emitting diodes, and fiber optics in laser medical applications. The previous proceedings provide an excellent insight into the state of progress of laser applications in medicine and surgery at that time. Since that time, a far better insight into the limits of laser applications in surgery has been realized. It should now be evident that optimization of a laser surgical procedure requires a tradeoff between maximizing the competing, undesired interactions that produce unwanted side effects. For example, phototoxicity may often be present during coagulation, and destructing shock or acoustic warts may occur during ablative surgery. For example, phototoxicity may be present even during coagulation.

II. FUTURE CONSIDERATIONS

There will be a great host of new applications of lasers in medicine and surgery. However, it is our fervent hope that the new applications will be developed with an eye toward what tissue interactions are really needed, and do not continue as in the past depending only on a hit or miss empirical approach; in other words, design a laser with a specific wavelength and exposure characteristics rather than "Here is a laser - What can we do with it?" approach.

REFERENCES

2. J. A. Parrish, "Photobiology and Photomedicine", in Reference 1, pp. 3-16
3. J. A. Parrish, "Effects of lasers on biological tissue: options for specificity", in Reference 1, pp. 17-28
4. A. J. Welch and M. Motamedi, "Interaction of laser light with biological tissue", in Reference 1, pp. 29-56
5. T. I. Karu and V. S. Letokhov, "Biological action of low-intensity monochromatic light in visible range", in Reference 1, pp. 57-66
6. S. Passarella, E. Casamassimi, E. Quagliarello, I. M. Catalano and A. Cingolani, "Certain aspects of He-Ne laser irradiation on biological systems in vitro", in Reference 1, pp. 67-74