Mathematical Design of The Removal Process of Warts by the ND:YAG-Laser

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***Abstract* – Results of the optimization of parameters ND:YAG-laser beaming and conditions of the irradiation are presented for effective warts removal.**

***Keywords* – Wart, Laser, Mathematical design**

I. INTRODUCTION

Recent years lasers are using as newest removal of warts and other skin neoplasm method. The basic mechanisms removal of neoplasm is epidermis evaporation (erbium laser) or evaporation and coagulation (CO_2-laser) of skin cell at the use of the surgical lasers. Such removal method of neoplasm is surgical procedure and here is a high risk of scarring and development of hyper- and hypopigmentation in place of treatment.

In this work the removal modes of the warts are optimized by the Nd:YAG-laser radiation. This laser radiation with wavelength 1064 nm can get deeply to skin tissue (to 7–8 mm) without the lesion of their integrity. There is coagulating operating on the blood vessels of warts root that stopped its nutrition. In this situation wart gradually, during a few weeks passes to reverse way of development and disappears. Anaesthesia here is not needed; complications are not at such treatment.

II. RESULTS OF THE NUMERIC EXPERIMENTS

The mathematical model and software interaction of the laser radiation with the biotissues is proposed. Software has been developed on basis of Monte-Carlo method [1]. The heterogeneous properties of the biotissues, features of the absorption and scattering in individual layers, nature of the heat-removing from surface are taken in account in calculations.

The design processes of the radiation distribution in skin and calculation of the temperature distributing in the skin structure with neoplasm under Nd:YAG laser radiation were conducted by the developed software. The temperature in the layer of warts blood vessels must be provide within the limits of 60-70^{o}C for the painless removal of the wart. The temperature on the surface must not exceed 44-46^{o}C for avoidance of destruction in the superficial skin layers. The parameters of laser radiation and modes of the superficial skin cooling are optimized by developed software for achievement of such temperature conditions. Optical parameters of skin with wart are presented in the Table 1.

The curves of the temperature distribution at the through skins depth with wart at laser pulse centre with Gaussian beam spatial distribution and rectangular time distribution are presented on the fig. 1.

Table 1

Skin optical parameters (λ=1064 nm) [2]

Tissue	μ_a, sm^{-1}	μ_s, sm^{-1}	g	n	d, μm
Wart	2	100	0,87	1,5	3000
Dermis	2,2	150	0,86	1,4	300
Vasculature	10	655	0,98	1,35	100

The laser radiation has follow parameters: pulse duration is 100 ns, energy density 2.5 J/sm^2, number pulses is 4, action duration 700 ns.

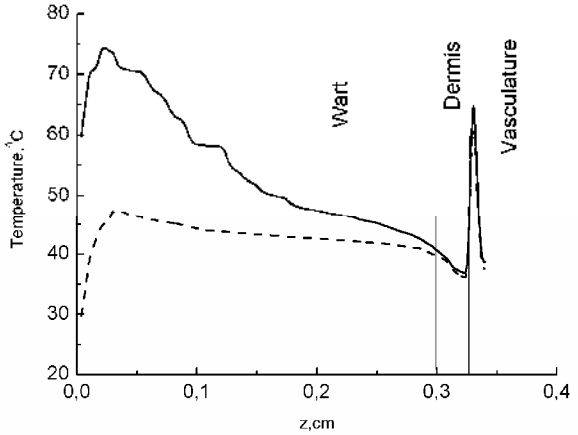

Fig.1. The temperature distribution at the through skins depth with wart at laser pulse centre: solid is without surface cooling, dash-dot is with surface cooling by ice for 15 s

III. CONCLUSION

These calculations demonstrate the effectiveness of Nd: YAG-laser radiation of with wavelength of 1064 nm to remove the wart by actions directly on the blood capillaries that nutrition it, without the destruction of skin tissue and the need for anesthesia. However, such a procedure requires prior short-term cooling of the skin surface to achieve the optimum temperature at the through skins depth.

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