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Review Article

Laser Therapy for Treating Tuberculosis

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ABSTRACT

For a start, as a preamble, here are some excerpts from various sources on the problem of Tuberculosis (TB), which are quite strange to read at the beginning of the third millennium, since many people confidently believed that there has been enough time to solve this problem during the past two millennia:

Tuberculosis symptoms and signs: cough, loss of weight, chest pain, fever, night sweats. If untreated, 50 percent of patients die within five years.

More than any other infectious disease, TB kills approximately 1 million women per year. Each year, TB kills 100 000 children. Tuberculosis is the most common cause of orphanage.

Untreatable bacteria can destroy the progress of TB control achieved in the last 50 years. There are no drugs to combat some resistant TB bacteria (in developed countries 50 million people may be infected).

Keywords: Tuberculosis; Immune system; Mycobacteria; Laser treatments

INTRODUCTION

The majority of people infected with TB never become sick because their immune system prevents the development of TB mycobacteria. Only 5 to 10 percent of those infected develop TB. Scientists today do not know exactly why some infected people develop TB and die, while others do not.

At least one person is infected with TB every second, 1 percent of the world's population are infected each year. Untreated persons infect on average 10–15 neighbors during a year. For major cities, this figure is considerably higher. The most susceptible to infection are prisons, the Army and the Navy, where the concentration of people living together for a long time is the greatest [1-4].

According to the WHO over the past two centuries, TB killed about a billion people. The WHO warns that unless we take urgent action, in the next 10 years, TB will kill an estimated 30 million people and infect 90 million people. Further, by the end of 2020 a billion people will have been already infected: 200 million people will be sick and 70 million people will die. So much for the White Plague.

LITERATURE REVIEW

Amulet semiconductor laser apparatus

An Amulet semiconductor laser apparatus with a fiber for introducing radiation in the affected area through an injection needle is intended for the treatment of destructive forms of pulmonary and bone TB that are resistant to conventional medical treatment, as well as to shorten the treatment of common forms of TB by topical exposure of the infected surface to Ultra Violet Radiation (UVR) with a wavelength of 266 nm, which has very strong bactericidal and bacteriostatic effects. UV radiation in this case has low intensity and only affects the micro flora without any damage of the living tissues of the human body. The typical time of UV irradiation of the affected area is 5 to 15 min. In this case, the traumatic effect is absent [5-8].

The Amulet apparatus (Figure 1) is designed to treat patients with tuberculosis affecting lungs, bronchi, bones and joints, to cure diseases associated with suppurative infections and other inflammatory processes, with the abnormal healing process, with the immune system variations and instability of the capillary circulation. In addition, the apparatus can be used in

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endosurgery, phthisiology, otolaryngology, traumatology, stomatology, treatment of burns, gynecology, therapy, surgery, urology, proctology, and dermatology (Table 1) [9-11].

Emission wavelength (nm)	266
Average output power (mW)	2.5, 5, 10
Pulse repetition rate (kHz)	10 – 20
Pulse duration (ns)	5 – 7
Beam diameter (mm)	<0,5
Radiation out coupling	Fiber
Fiber diameter (μm)	400 – 800
Power consumption (220V/50Hz) (W)	<200
Service life (h)	>2000
Cooling	Air
Dimensions (mm)	450×165×290
Weight (kg)	<12

Table 1: The main technical characteristics of the Amulet apparatus.

Clinical trials of the Amulet apparatus

In accordance with the decision of the Commission on Tools, Instruments, Apparatus and Materials used in General Surgery of the Committee on New Medical Technology of the Ministry of Health of the Russian Federation (Protocol No. 3 dated 22 March 2001) and relevant orders of the Main Military Medical Directorate of the Ministry of Defence (Department of endoscopy and surgical department for treatment of patients with complicated forms of TB of the lungs), the Director of the Research *Institute* of *Phthisiopulmonology*, *I.M. Sechenov* Moscow Medical Academy (Department for the treatment of patients with bone and joint tuberculosis) and the Director of the *Central Research Institute* of *Tuberculosis* of Russian Academy of *Medical Sciences* (Department of pulmonary tuberculosis), we performed clinical trials of a prototype of a therapeutic UV solid-state diode-pumped laser (Amulet), produced by LLC Energomashtehnika. The laser emits middle-level low-energy UV radiation with a wavelength of 266nm and intensity of up to 10mW/cm2 at the fiber output [12].

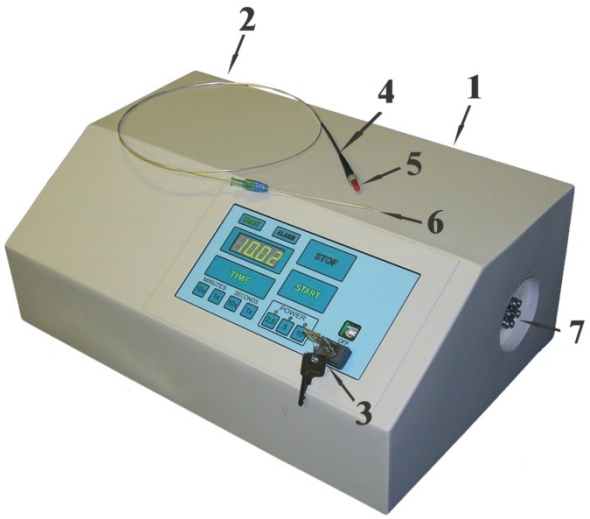

Figure 1: General appearance of the Amulet apparatus.

The use of low energy laser radiation in medicine is very beneficial in the treatment of TB patients because of its ability to cause an analgesic, an anti-inflammatory and an anti-edema effects, as well as physiological and reparative regeneration of tissues (Figure 2).

The effectiveness of the therapeutic UV solid state diode pumped laser was tested in 7 patients with bronchial tuberculosis, 4 patients with laryngeal tuberculosis, 7 patients with chronic tuberculous empyema, 14 patients with osteoarticular tuberculosis complicated by surface wounds [13].

During the clinical trials, we improved the optical fibers which made it possible to increase the area of laser radiation scattering both in the case of endobronchial and transthoracic introduction of the fiber. Pathologically altered tissues were irradiated as a part of complex therapy of TB, including 4–5 anti-tuberculosis medications. In the process of clinical trials we monitored the presence of TB mycobacteria in abnormal tissues and performed histological studies of inflammatory changes. The TB-affected tissues of the patients were irradiated through a bronchoscope. The TB process in these patients had the following localization and character:

- Bronchial TB in the middle lobe, fistula;
- Bronchial TB in the middle lobe, ulcer;
- Bronchial TB at segmental (B6) bronchi, infiltration;
- Laryngeal TB with the destruction of epiglottis;
- Pulmonary TB, cavern and thoracic fistulas;
- Mycobacterium TB was found in all the patients.

Exposure conditions

- The intensity of the radiation is constant.
- The distance of the distal end of the optical fiber from the irradiated surface is 1-2cm.
- The exposure time is 30s.
- The number of laser treatments is 8-12.

The use of therapy solid state diode pumped laser UV radiation together with specific and intensive health-improving restorative treatment at the end of clinical trials showed that the oronasal fistula was free of cheesy masses. In the course of the microscopy

of bronchoalveolar lavage fluids, TB mycobacteria were net found. Besides, a decrease in inflammation of the bronchial mucosa was visually ascertained. The histological examination of biopsy material revealed rapid healing, formation of fibrosis in the bronchial mucosa with signs of hyalinization, and narrowing of the bronchial lumen. In patients with laryngeal TB, a decrease in swelling and redness of the mucous larynx above the vocal cords as well as the healing of erosive and ulcerative lesions were visually observed. During laser irradiation of TB empyema (10–12 laser treatments for each patient) the volume of purulent discharge and increased bleeding were observed, which we attribute to the reduction of inflammatory changes and improvement of local blood circulation [14].

In the case of bone TB, application of UV radiation leads to copious and purulent discharge of necrotic masses, which clearly demonstrates the bactericidal and bacteriostatic effect of UV radiation on flora. In all cases, after 6–12 irradiation sessions held daily, the wound surface was cleaned, and a pink granulation tissue covered the wound bed and its edges. Examination of swabs and inoculations from the wounds demonstrated a drastic decrease in the presence or growth of the colonies. This allows the surgical treatment of wounds and placement of secondary sutures, which greatly accelerates the healing of wounds.

Figure 2: Treatment of TB by laser.

CONCLUSION

Thus, the clinical trials performed allow us to make a conclusion that a therapy UV solid state diode pumped Amulet laser is effective in the treatment of TB affected tissues and bones due to the bactericidal and bacteriostatic effect and stimulation of reparative processes. It could be used for many other applications in the practical medicine.

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