Future Applications of Lasers in Gynecology and Reproduction

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Introduction

When attempting to predict future developments, one should bear in mind the ancient Talmudic proverb: “Since the temple was destroyed, prophecy has been taken from prophets and given to fools and children” [3]. However, in an era when embryos are frozen in “banks” and lasers are “fired” into the pelvis to reopen blocked fallopian tubes, it appears that the present can actually be regarded as “the future”, and further clinical developments can be extrapolated from recent advances in the basic sciences.

After its introduction, conventional surgery underwent no fundamental changes until the middle of the twentieth century. At that time, scissors and scalpel were still the main surgical instruments in use. Recent advances in endoscopic technology that enable detailed visualization of almost every cavity in the human body and the adaptation of various lasers with suitable delivery systems offer an optimal surgical/therapeutic combination. The developments have paralleled rapid progress in other innovative imaging technologies such as ultrasonography (US), computerized tomography (CT), and magnetic resonance imaging (MRI) – all enabling early, precise, and noninvasive detection of pathological lesions. The combination of these diagnostic and therapeutic modalities demands considerable flexibility in adapting new treatment protocols for daily clinical purposes. The introduction of in vitro fertilization (IVF) as a routine clinical service has similarly provoked the development of several other therapeutic modalities, generally defined as artificial reproductive technologies (ART). As a result, the clinician, as well as the patient, has to face a situation where different protocols may be offered to treat the same pathological condition, and, therefore, an individualized approach is sometimes mandatory [32]. The availability of these new technologies, in turn, underscores the importance of a well-informed approach to decision-making in gynecology and reproductive medicine.

Laser-tissue Interaction

The effect of the laser beam on tissue is primarily thermal, since the absorbed photons can be converted into heat. Thermodynamic calculations indicate that the radiant energy density re-
required to raise the temperature of living tissue from 37 °C to 150 °C is roughly 488 J/cm³ and approximately 3200 J/cm³ is required to vaporize a given volume element of tissue [2]. Of course, these values are dependent on the wavelength of light, the tissue absorption coefficient (at the incident wavelength), and the temporal characteristics of the laser (i.e., whether a pulsed- or continuous-wave laser is used). Although the heating effect may be harmful if not carefully monitored, it can be beneficial to several aspects of reproductive surgery and ART when properly applied (Fig. 1).

In fact, selective cell destruction is possible with careful choice of laser parameters which permit targeting of pigmented, structurally defined tissue types (Fig. 2). Similar effects can be achieved via photochemical mechanisms discussed below.

The carbon dioxide (CO₂) laser, operating at 10.6 μm in wavelength, is the