Nd : YAG LASER CAPSULOTOMY

Essay

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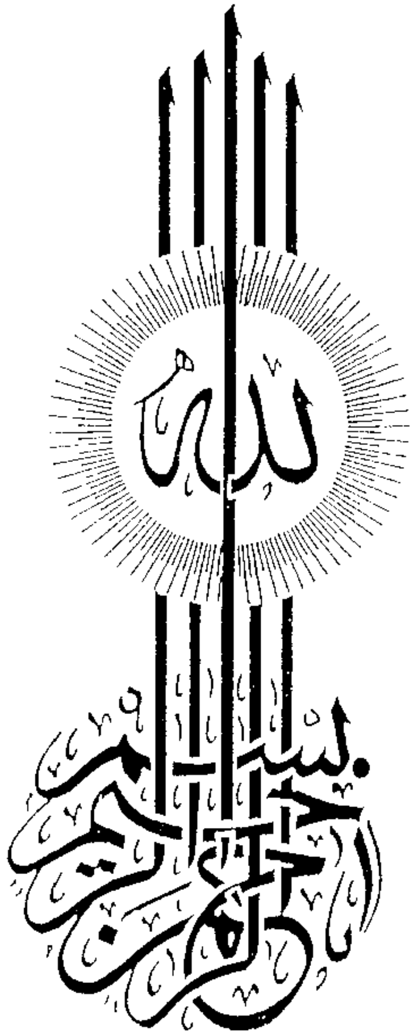
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DEDICATION

TO
MY PARENTS

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HISTORY AND INTRODUCTION

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HISTORY

In 1960 Maiman produced the optical master (or laser as it was eventually called) , using a ruby crystal to produce a 200 microsecond pulse of intense red light energy . This monochromatic light had a wavelength of 694.3 nanometer and provided the ophthalmic world with an intense , pure beam of light that could produce extremely small burns of varying intensities . In 1961 , Zaret began experimentation with ruby laser photocoagulation in animals (Zaret , 1961) , and both Campbell and Zweng treated human patients the following year (Campbell , Rittler and Koester , 1963) (Zweng , 1964) . The ruby laser was found to be highly effective in producing an adhesive chorioretinitis but was not useful in the treatment of vascular diseases . A series of laser sources , each with different characteristics , have been considered , investigated , and used clinicaly for varied durations during the quarter century that has followed .Table (1) shows ophthalmic lasers , with their date of clinical introduction , and the investigator most closely associated with their first use .

OPHTHALMIC LASERS : FIRST CLINICAL USE

1963	Ruby	Campbell , Zweng
1968	Argon	L'Esperance
1971	Frequency-doubled ND:YAG	L'Esperance
1972	Krypton	L'Esperance
1972	Carbon dioxide	L'Esperance
1973	ND:YAG (cw)	Beckman
1979	Dye (Q switched)	Bass
1981	Dye (cw)	L'Esperance
1981	ND:YAG (Q switched)	Frankhauser
1981	ND:YAG (mode-locked)	Aron - Rosa
1985	Excimer	Wollensak , Seiler

Table (1)

In 1971 , clinical trials were conducted concerning the photocoagulation potential of crypton (L'Esperance , 1971) and the frequency - doubled neodymium : yttrium - aluminum - garnet (ND : YAG) (L'Esperance , 1972) lasers in a series of patients. Although the laser radiations from these particular sources were more highly absorbed by the pigments of the eye , the technologic difficulties in producing the laser beam militated against their immediate use for therapeutic photocoagulation . During recent years the yellow (568.2 nm) and especially the red (647.1 nm) krypton laser beams have been used particularly in the treatment of macular disease where transmission through the xanthophyll pigment is desirable . Commercially available krypton lasers , designed to operate at certain wavelength , or krypton - argon combinations have been used as photocoagulation systems with great benefit in certain diseases . Because of the inconsistent reproducibility of the nonlinear crystal necessary for the frequency - doubling with the ND : YAG laser , the pea - green (532.0 nanometer) beam emitted for this laser was not available commertially for photocoagulation until recently . The creation of the potassium -titanium - phosphate (KTP) crystal has made photocoagulation with the frequency - doubled ND : YAG laser practical because of the high power available at 532.0 nanometer .

The pulsed ND : YAG laser was introduced in 1980 by Frankhauser (Frankhauser , 1981) and Aron Rosa (Aron - Rosa , 1980) with excelent results for the lysis of transparent ocular membranes and tissues , particularly opacified posterior capsules and vitreous strands .

ND : YAG LASER - TISSUE INTERACTIONS

The interaction of a specific laser emission or wavelength with various ocular tissues can be divided into six distinctly different tissue changes associated with :

(1) Photocoagulation therapy .

(2) Photodynamic therapy .

(3) Photovaporization therapy .

(4) Photodisruption therapy .

(5) Photoablation decomposition therapy .

(6) Phototherapy .

We are here concerned with the 4th type of interactions .

Photodisruption therapy :

the fourth ophthalmic laser tissue interaction , photodisruption , leads to a microscopically localized temperature rise from 37 to 15000 C . The photodisruption laser now presently used in various parts of the world are the pulsed ND : YAG laser, the erbium : yttrium - lithium - flouride (Y L F) laser , and the ruby laser . The action of the photodisruption laser depends on optical breakdown where electrons are stripped from the atoms of the target tissue and a plasma field and bubble are established , leading to a hydrodynamic and acoustic shock wave , and mechanical stress factors that tear the impact tissue apart on a microscopic level .

Atypical posterior capsular membrane behind an intraocular lens can be cleaved following laser photodisruption . The lyses of vitreous strands can also be accomplished with pulsed ND : YAG lasers reducing severe traction on areas of the retina or other areas of the posterior segment .

ND : YAG LASER SOURCES

The most common solid - state laser is the neodymium laser . The active element in a neodymium laser is a triply ionized neodymium ion that is incorporated in small fractions in a glass or in a crystal structure .

The most succesful host for neodymium lasers is the yttrium - aluminum - garnet crystal - Y3 AL5 O2 , common known as YAG . This ND : YAG crystal is brittle , but it has good thermal properties that make it easy to produce even a contineous - wave (cw) output at room temperature .

The ND : YAG laser is optically pumped either by a flash lamp , for pulsed operation , or by a contineous arc lamp for cw operations . The pump lamps emit radiation over a broad range of wavelengths , however , neodymium ions absorb in some limted bands that then act as the uppermost level of a four level system , as shown in simplified schematic form in fig. (1) From these upper

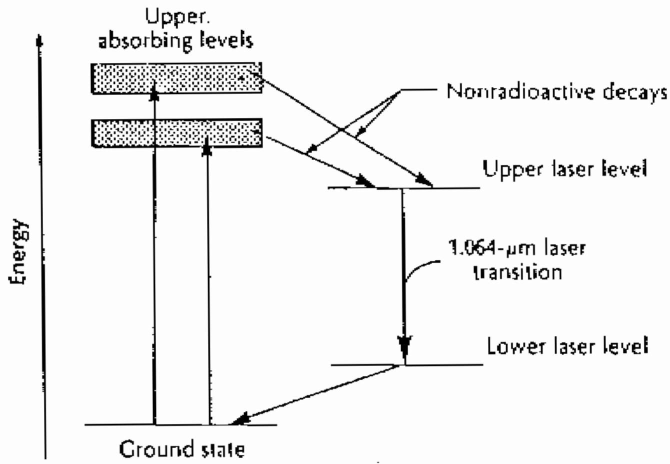

Fig. (1) Energy levels of the Nd:YAG laser.