

SUMMARY

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The present work is aimed to study the effect of argon laser, of the same intensity and duration as that used during retinal treatment, on the structure and function of the chicken eye by the use of some biophysical techniques. It consists of four chapters.

Chapter I contains the introduction and review of literatures for essential and recent work in the field of retinal electrical activity, molecular structure and histology in addition to the different laser duration effects on the whole eye.

Chapter II includes the theoretical aspects of the used physical techniques while the material and experimental techniques are illustrated in chapter III.

Chapter IV demonstrates the obtained results accompanied by comments and discussion. It is divided into four main parts:

- 1- Electroretinographic records (ERG),
- 2- Dielectric parameters of the chicken eye,
- 3- Infrared (IR) spectroscopic measurements and
- 4- Retinal histological study.

The following results were obtained :

- 1- The ERG, records (especially its b-wave) were found to be affected by the chicken age, state of adaptation and temperature change. The b-wave of the ERG has reached approximately a constant value at 2-3 weeks. Accordingly, the age, in this work, was fixed at this range. It was more sensitive to temperature variations than the a-wave and this sensitivity was altered during light (photopic) and dark (scotopic) adaptation.
- The photopic curve of the b-wave amplitude-temperature relationship behaved in quite opposite manner than the scotopic curve and this is because most of the retinal cells behave with opposite manners in case of light and dark adaptation. So, it is of great important to take the state of adaptation and the temperature at a suitable value, into consideration during the retinal treatment. Chicken eyes exposed to a laser beam of intensity 1 mW/cm^2 and durations 0.12 & 0.25 sec at a temperature range of $10-30^\circ\text{C}$ showed pronounced variations in their ERG records before, immediately and after 1-5 days of laser exposure. These variations depend on the eye temperature, state of adaptation as well as on the laser dose (intensity \times duration).
- In case of laser exposed light adapted eyes, the amplitude of the b-wave (A_b) of the ERG showed a fluctuated decrease, from their normal values, in the first three

recovery days and then they approached the complete recovery in the fourth and fifth recovery day for laser durations of 0.12 & 0.25 sec respectively. This recovery was more significant when the eye temperature was maintained at 10 °C.

- In case of laser exposed dark adapted eyes, similar variations of A_b with temperature were found but they were more regular than those of the light adapted ones.
- 2- The dielectric measurements showed an accurate method for studying the structural and functional states of the eye. The impedance components (real Z_R and imaginary Z_I), the dielectric losses ϵ'' and the relaxation time τ were found to change with temperature and after laser exposure.
- A set of semicircles, demonstrating the relation between Z_R & Z_I , of dark adapted chicken eyes, before and after laser exposure at a fixed temperatures of 10, 20 and 30 °C, indicated pronounced variations of Z_R and Z_I , with respect to temperature in the frequency range of 0.5 - 50 KHZ. Their values changed at the first recovery days and then approached the normal value in the fourth or fifth recovery day.
- The relation between dielectric loss ϵ'' and the logarithmic values of the frequency $\log f$ for dark and light adapted chicken eyes, before, immediately and at the fourth recovery day at temperature 10, 20 & 30 °C, indicated a maximum value of dielectric loss ϵ''_{\max} at the frequency range of 900-2000 HZ.

- This value of ϵ''_{max} was found to increase in the immediate exposure and then decreased, approaching to normal value, in the fourth recovery day especially at 10°C so that we may expect that this temperature is more suitable in decreasing the laser damage and hence decreasing the time for complete recovery.
 - On comparing the results of the laser effects on the eye, in both cases of adaptation, we found that the variations of ϵ''_{max} in the five recovery days, and so, the repairing processes, in case of dark adaptation, were more regular and pronounced than those in case of light adaptation.
 - The relation between the natural logarithm of the dielectric relaxation time ($\ln \tau$) and the reciprocal of temperature ($1/T$), for both cases of adaptation, represented two approximate parallel lines which have a slope provided the enthalpy ΔH and two interceptions indicated two values for the entropy ΔS . The obtained values of ΔS , which describe the local disorder, indicated that ΔS is more pronounced in case of light adaptation than that in dark adaptation. This confirmed the idea that the processes of recovery are more pronounced in case of dark adaptation in addition to that the temperature of the eye must be maintained at 10 °C. This is in good agreement with our previous finding in case of ERG records and the dielectric methods results.
- 3- The obtained IR spectra of the total retina confirmed the obtained results by the polarized IR studies of visual

purple membrane which conclude that the rhodopsin has an α - helix structure with special orientation with membrane normal.

- Retinaii exposed to a laser beam of constant intensity ($1\text{mW}/\text{cm}^2$) and different durations (0.12 & 0.25 sec) at fixed temperatures (10, 20 & 30 °C) showed no detectable frequency change, indicating that there is no change in the main helical structure of membrane protein. The changes were in the orientation angle of rhodopsin as indicated from the ratio of amide II (1540 cm^{-1}) and amide I (1662 cm^{-1}).
- The sensitivity of chicken retina for the recovery of the reorientation of rhodopsin was more pronounced after laser exposure of duration 0.12 sec than that of 0.25 sec, and the decreasing in the chicken eye temperature (10°C) which compensate the heating effect due to the increase in laser duration.
- 4- The histological structure of the chicken retina, before and after laser exposure was studied by using light and electron microscopes.
- The light microscopic studies, of the exposed retina indicated pronounced changes in the pigment epithelium and the photoreceptor layers and these changes, in case of laser duration 0.25 sec, were more clear than those in case of 0.12 sec.

- The electron microscope studies were concentrated on the normal and exposed pigment epithelium and photoreceptors layers to investigate more of their structural details.
- The results of the present work, obtained due to the application of the different biophysical techniques were very useful in constructing a simplified schematic model summarized the possible mechanism of laser damage /repair processes and suggesting the best suitable conditions for laser retinal treatment.