Influence of Argon laser on retina of diabetic patient

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Abstract:

Photocoagulation therapy is a method of treating detachments of the retina (the layer of light-sensitive cells at the back of the eye) with an argon laser. The high-intensity beam of light from the laser is converted into heat, which forces protein molecules in the affected tissue to condense and seal the tissue. So photocoagulation bleeding of retina with Argon laser of a diabetic patient is considered one of the modern method for searching ofa relationship between the energy of laser beam and spot area of bleeding retina.The aim of the research is the choice of the energy needed for space required, leading to reduced patient stay under the laser device and reduce the fear factor of the patient.The quality information that has been obtained can be used in future as database which can be embedded into a laser device can work automatically.

تأثير ليزر الاركون على شبكية مريض السكري

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ملخص البحث:

العلاج بالتخثر الضوئي هو وسيلة لعلاج انفصام الشبكية (وهي طبقة من الخلايا الحساسة للضوء في الجزء الخلفي من العين) ومع ليزر الاركون يتم تحويل شعاع عالي الشده من ضوء الليزر إلى حرارة، الأمر الذي يؤدي الى تكثف جزيئات البروتين المتضررة والتحامها، لذلك التخثير الضوئي لنزيف الشبكية لمريض السكري وباستخدام ليزر الاركون يعتبر احدى الطرق الحديثة لعلاج انفصام شبكيه العين لمرضى السكر. في هذا البحث نراعي طريقة حديثة لبحث العلاقة بين الطاقة من شعاع الليزر الساقط المستخدم في هذه الحالة مع مساحة البقعة النازفة للشبكية. هدف البحث هو اختيار الطاقة اللازمة للمساحة المطلوبة ، مما يؤدي الى تقليل مكوث

المريض تحت جهاز الليزر وتقليل عامل الخوف للمريض. كما ويمكن استخدام المعلومـــات التـــي حصلنا عليها وذلك من خلال تحويلها الى النظام الحاسوبي أي قاعـــــده بيانات ، حيـــث يمكـــن التحكم من خلال الحاسوب لتقدير مقدار الطاقة للمساحة المراد علاجها للشبكية اوتوماتيكيا.

Introduction:

The term thermal interaction stands for a large group of interaction types, where the increase in local temperature is the significant parameter change. Thermal effects can be induced by either continuous or pulsed laser radiation. While photochemical processes are often governed by a specific reaction pathway, thermal effects generally tend to be nonspecific (1).However, depending on the duration and peak value of the tissue temperature achieved, different effects like coagulation, vaporization, carbonization, and melting may be distinguished.

Another example of an important thermal effect, where water strongly absorbs the laser wavelength leading to vaporization within the layers. The inducedincrease in pressure – water tries to expand in volume as it vaporizes – leads to localizedmicro explosions (2-3).

Argon laser photocoagulation has long been the standard of care for several retinopathies.(4-5).Laser pulse durations havetypically been in the range of 100–500 ms, with spot sizesvarying from 50 to 500 µm. Although successful in coagulatingthe photoreceptor layer, pulses of these durations arethe photoreceptor layer, pulses of these durations areknown to produce collateral thermal damage to the innerretina(6).Patterned scanning laser photocoagulation, a new method of retinal phototherapy, departs from these traditional

parameters by using a scanning laser to apply patterns of 4 to50 lesions, with pulse durations in the range of 10–30 ms (7).The number of pulses applied in each pattern is limited by the eye fixation timeon the order of half a second. Clinical studies have shown that this regime is less painful and as efficacious as traditional retinal photocoagulation, reported to date over short periods of follow-up (7-8).Moreover, shortduration pulses appear to target the photoreceptor layer more selectively, reducing unintended damage to the neural retina (9) .

However, shorter pulses require higher peak powers and retinal for photomechanical injury and rupture of Bruch’s temperatures for coagulation, thus increasing the potential membrane (10).Consequently, it has been observed that the safetherapeutic window (defined as the ratio of threshold powersfor rupture and mild retinal coagulation)decreases with decreasingpulse duration. The safe therapeutic window for10-ms pulses

has been reported to be between 2.5 and 3,showing an increase for larger spot sizes (11).

Photocoagulation with shorter pulses enables an increase in the number of lesions in a pattern applied during a single treatment and improves spatial confinement of the thermalspread in the retina. At the same time, pigmentation in human eyes varies by about a factor

of 2 (12-13),and the safe therapeutic window should not be smaller than this(11).In order to balance these considerations, it is useful to understand the dynamics of retinal photoco- agulation and rupture, as well as the factors that determine the thresholds of theseprocesses.

Thermal modeling can play an important role in furthering this understanding as it provides a quantitative estimate of temperatureelevation within the retina during the laser pulse. Couplingheat conduction and thermal damage models allows for theprediction of damage zone size for arbitrary laser parameters.This enables calculation of the number of lesions required fordifferent treatment parameters to affect the same total area of the retina, which is an important factor for clinical efficacy. Italso provides guidance for optimization of the laser parametersin order to improve safety of photocoagulation at shorterpulses.

THEORY

In order to get a basic feeling for typical laser parameters, the followingvery simple calculations might be very useful. We assume that a pulse energyof 3 μJ is absorbed within a tissue volume of 1000 μm^3 which contains 80%water. The amount of water in the specified volume is equal to 8×10^{-10} cm−3or 8×10^{-10} g, respectively.

There are now three steps to be taken into accountwhen aiming for a roughapproximation

of the final temperature. First, energyis needed to heat the tissue up to 100◦C.Second, energyis transferred tovaporization heat. And third, the remaining energy leads to a furtherincreasein temperature of the water vapor.

Last operating temperature is very important for getting energy needed for treatment the diseased area of the retina that have been discovered (14-15), which is very important in our research to get the less possible energy in a shorter time and using the graph that we got it for several cases. Which is modern and new in this research, compared with the previous references according to the following table, which shows the different areas with energy.

Retina	A (s^{-1})	∆ E (J/mol)	Reference
Retina	1×10^{44}	2.9×10^{5}	(16)
Retina (T< 50 C^{O})	4.3×10^{64}	4.2×10^{5}	(17)
Retina (T> 50 C^{O})	9.3×10^{104}	6.7×10^{5}	(18)
Skin	6.3×10^{95}	6.3×10^{5}	(18)
Liver	1×10^{70}	4×10^{5}	(19)

Assuming a body temperature of 37◦C, no measurable effects are observedfor the next 5◦C above this.The first mechanism by which tissue isthermally affected can be attributed to conformational changes of molecules. These effects, accompanied by bond destruction and membrane alterations,are summarized in the single term hyperthermia ranging from approximately42–50◦C.Beyond 50◦C, a measurable reduction in enzyme activityis observed, resulting in reduced energy transfer within the cell andimmobility of the cell. Furthermore, certain repair mechanisms of the cell aredisabled. Thereby, the fraction of surviving cells is further reduced.The possibility of localized tissue coagulation has formed the basis of a novel tumor treatment technique called laser-induced interstitial thermotherapy**(LITT).** It was recently introduced to the treatment of various types of tumors such as in retina, brain, prostate, liver, or uterus.Detailed descriptions and first clinical results are found in the papers by (20), (21), (22), (23), and (24), respectively.The principal idea of LITT is to position an appropriate laser applicator inside the tissue to be coagulated, e.g. a tumor, and to achieve necrosis by heating cells above 60◦C.

EXPERIMENTAL AND METHOD

It has been provedthat the laseris useful forthe treatment diabetic retinopathy, which is a beam of lighthigh energy, which, when projectedon the retinaturns intoheatandthe purpose of the laser treatment in cases of diabetic retinopathyNonwidespreadpreventslaserinfiltrationof blood vessels and after the lasercannoseethe patientpointssmallbecause of the impact thelaser, which will disappearwiththe passage of timeand become less bothersome and leakage can occuragain in the future which requires conducting sessions for other laserin the case of retinopathy widespread, the laser beamdestroysthe damaged partof the retinato stop theproliferationabnormal blood vesselsand laserinthis caseis the bestknown treatmentto preventloss ofnewdamage in this such cases,the treatment ison the perimeter ofthe retinato protect the center and this means that the peripheral vision will be reducedas well asnight visionandsidevisionis sacrificedto savecentral visionandthe eye itself, andislaser therapy on an outpatient basis using local anesthesia drops after the session which normally takes 15 minutes back to thepatient's home is the cover of the eye.Areas in which the temperature reaches values higher than

60◦C are coagulated, and irradiated tissue cells become necrotic. Areas with maximum temperatures less than 60◦C are treated hyperthermically only, and the probability of cells staying alive depends on the duration and temporal evolution of the temperature obtained. The experimental side was performed in the Republican Hospital in the city of Mosul, in the Department of Laser. Where they were taking readings listed below according to the following equation:

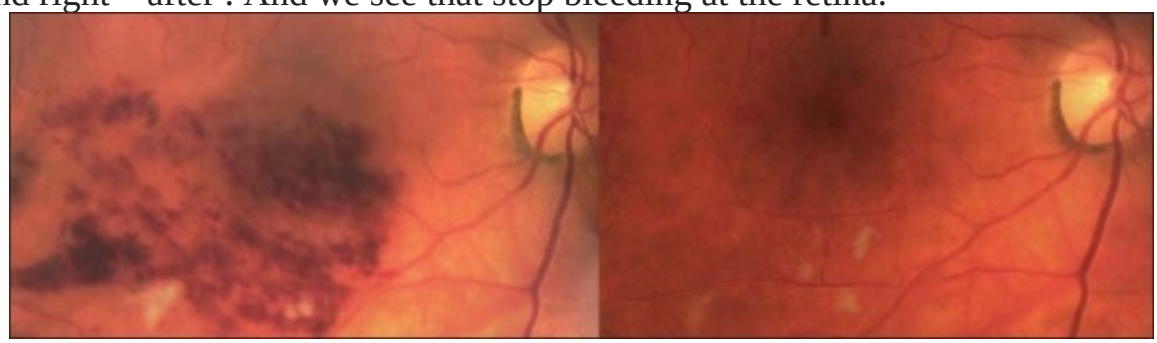
Radiation =

RESLTS AND DISSCUSION:

1- Wehave used the device NIDEK as shown in figure (1) , with maximum energy 1700 mW and spot area between (50-500 µm).

Figure (1) showsthe device NIDEK.

2-Figure (2)show the result of treatment (BEFORE and AFTER) , left before and right after . And we see that stop bleeding at the retina.



- Figure (3) show the result of treatment (BEFORE and AFTER) , left before and right after .

3- After taking readings for several cases of diabetics we got the following chart: which we will discuss in the following paragraph.

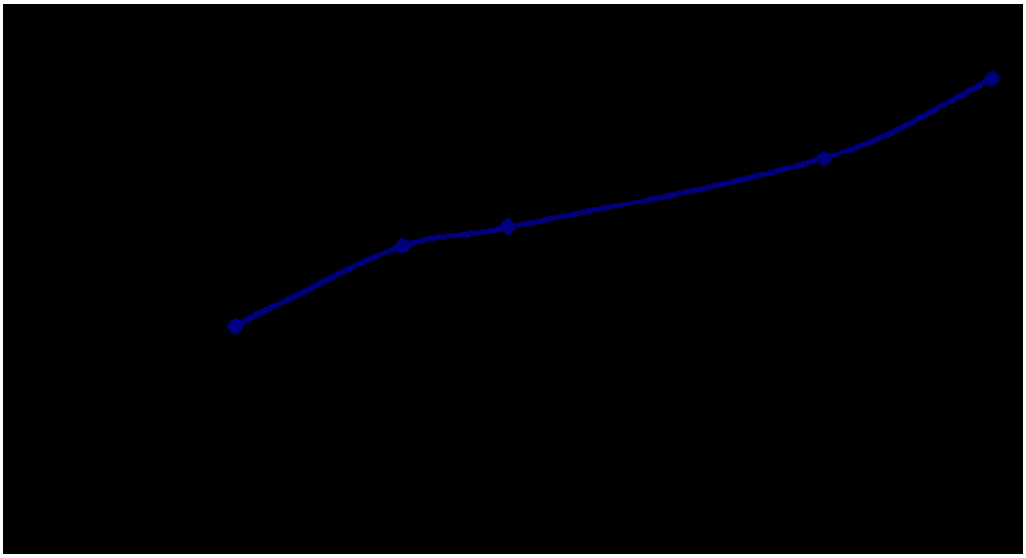


Figure (3)shows the relationship between the power output of the laser beam with Area of the injured retina.

CONCLUSION:

We have noticed through the graph as follows: -

1- The energy needed to treat the damage caused by diabetes is directly proportional to the area of damage.

2-In order to take advantage of the search , the damage area can be known through the use of the graph in which we can use less laser energy . Higher laser energy can cause theprobability of patient feeling pain. That will minimize the feeling of fear factor ,especially when patient is treated first time as well as to reduce laser treatment time.

3- The quality information that has been obtained can be used in future as database which can be embedded into a laser device can work automatically.

4- Figure (3) show the result of treatment (BEFORE and AFTER) , left before the treatment with laser beam where we note the presence of bleeding, after the treatment withlaser beam we see that stop bleeding at the retina.

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