Measurement of Radii of the Irradiated Red Blood Cells using He-Ne laser

قياس أنصاف اقطار كريات الدم المشعة باستخدام ليزر هيليوم - نيون

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Abstract :-

In this research, we have studied the effect of radiation on blood cells that were irradiated by Gamma rays, Beta particles and Alpha particles by means of determination their radii before and after radiation caused by the diffraction of Laser from the blood cells. A comparison has been made with the biological technique for measuring the radii of red blood cells. We found that there is good agreement between the biological and interference techniques, for the non-radiated cells. But, for the radiated cells. We found a clear different between these radii, i.e., measurement of the radii before and after the radiation about (100-1500 A^o) were increased to [O,AB,A] types, but it was decreased to [B] type.

Keywords :- blood cell, Dose , alpha particles, beta particles, Laser .

الملخص : -

يهدف بحثنا إلى دراسة تأثير الأشعة على كريات الدم التي تم تشعيعها بأشعة كاما ودقائق بيتاو دقائق ألفا من خلال قياس أنصاف أقطارها مقارنة بأنصاف أقطار كريات الدم غير المشعة.حيث تم قياس أنصاف أقطار الكريات من خلال قياس أنصاف الأقطار للموجات الناتجة عن الحيود لأشعة الليزر بوجود كريات الدم الحمر. و تم إجراء المقارنة أيضا مع الطريقة البايولوجية في حساب أنصاف أقطار كريات الدم.ووجدنا أن القيم المستحصلة تقترب من القيم البايولوجية فيما يخص كريات الدم غير المشعة. و اتضح جليا الفرق بين أنصاف أقطار كريات الدم المشعة مع غير المشعة بمقدار ($100-1500A^o$) للفصائل (O) و (AB).و(A) وقلت لفصيلة(B).

وتم استعمال ليزر الهيليوم- نيون كمصدر للقياس و ذلك لما له من مواصفات مميزة و منها (الاتجاهية، التشاكه، و السطوع) لتظهر الأهداب بشكل واضح و مميز.

Introduction :-

1-Laser

There are many medical applications of lasers, and there are different ways to classify them into groups:

- According to the organ to be treated by the laser, such as: eye, general surgery, dentistry, dermatology, blood vessels, cardiac, etc.
- According to the type of laser used for treatment, such as: CO_2, Nd:YAG, and Argon.
- According to the type of treatment, such as diagnostic, surgery, connecting blood vessels [1].

In medicine there are three main areas in which lasers have successfully established themselves, in surgery as a cutting tool, in ophthalmology and dermatology. As far as surgery is concerned, the CO_2 laser has proved the most successful all-rounder, although Nd-YAG lasers can also be used. The 10.6 μm output of the CO_2 laser is strongly absorbed by the water molecules present in tissue and the subsequent evaporation of the water leads to the physical removal of the tissue [2].The Laser diffraction method is very rapid and simple technique so it used in study on Size and Shape of red cell of cancer patients [3],and it used in measurement the radii red blood cell[4].

1- The Blood :-

Blood is the fluid constituent of the body that flows through the vascular channels and transports the vital requirements and waste products of the body. Other functions of the components of blood include defending the body through immunologic reaction, stoppage of bleeding and maintenance of body temperature .The blood has two major components-cellular and fluid. The cellular component consists of erythrocytes leukocytes and thrombocytes (platelets). These formed elements float in the fluid component of blood, called plasma and the clear fluid left behind is called Serum [5].

In an adult man, the blood is about 1/12 of the body weight and this corresponds to (5-6) liters. Blood consists of 55% Plasma and 45% by cells called formed elements.

The blood performs a lot of important functions by means of the hemoglobin contained in the erythrocytes; it carries oxygen to the tissues and collects the carbon dioxide (CO_2). It also conveys nutritive substances (e.g. amino acid, sugars, mineral, salts) and gather the excreted materials which will be eliminated through the renal filter .The blood also carries hormones, enzymes and vitamin [6].

2-1 Blood Cells :-

Erythrocytes (erythros= red, cytos=cell) are non-nucleated cells contain hemoglobin and are the heaviest of all formed elements of blood. The shape of the erythrocytes is that of biconcave disc, attached back to back on top sides, thus making it thicker at the end thinner at the center (fig 1)[5]the hemoglobin is responsible for carrying oxygen from the lungs to the tissue cells , brings back on its return to the lungs the gaseous waste products (carbon dioxide) of cellular metabolism. Internal fluid concentration of the erythrocytes is equivalent to about 0.85% sodium chloride. If the erythrocytes are dropped in water, they will swell due to endosmosis (water moving into the cell) which leads to the rapture of the membrane. This is called haemolysis (haem= blood, lysis= destruction). Conversely, if erythrocyte are dropped in concentrated solution of sodium chloride (e.g. 2% NaCl), they will shrink due to exosmosis (water moving out of the cell. this is why physiological saline injected into the body through the intravenous route (Iv) has a concentration of 0.85%NaCl. this is also called normal saline because it is equal to the normal solute concentration of the body [5,6, 7].

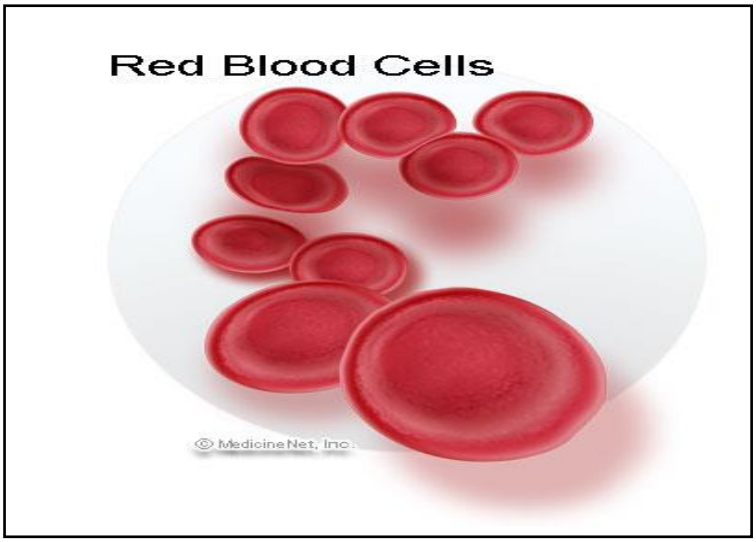


Figure (1): The Shape of Red Blood Cells [8].

The average number of red blood cells for cubic millimeter of blood is about 5 millions which are the same as a microliter [μl] of blood; women have a few percent below this value, as average about 4.8 million per cubic millimeter, and men a few percent above it (nearly about 5.4 million per cubic millimeter). The normal red blood cells (i.e. mature red cell) are a biconcave disk with a mean diameter of 8 microns and thickness of the thickest point of 2 microns and in the center of 1 micron. The erythrocytes volume of red blood cell is (80-100) fl, human red blood cells (RBCs) in the blood stream live for 110-120 days. Each of RBC is estimated to travel about 1145 km in the blood vessels during its short life span [9]

2- Experimental part3-1 Equipments:

1- Laser source (He-Ne laser with λ=6328 A^o& power 1mW).
2- Metal holder.
3- Glass slides.
4- Blood Cell:- fresh blood samples of normal human of 3ml was collected from the student.
5- Display screen.

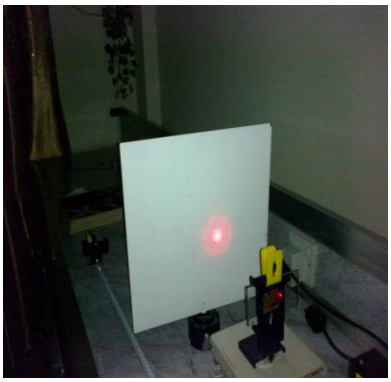
3-2 Procedure:-

1. We arrange the equipments as shown in figure (2).
2. Apply the laser beam on the slide (that contains the blood cells), the beam will allowed to incident on the screen. The ring fringes will be made on the screen because of the diffraction of laser beam from the blood cells. Then we have many dark and bright ring fringes.
3. We put the holder at specific distance from the glass slide and we focus on the first dark ring fringe, we specify the distance between the holder and the screen (D) and we measure the radius of the first dark ring fringe.
4. Repeat step (3) many times (by changing the distance (D)) and measuring the radius (r) at every distance.
5. We plot a graph between the radius (r) blood cells and the distance (D), then we have a direct proportional relation as shown below [10]:

$$\frac{r}{D} = \frac{1.22\lambda}{d} \ldots\ldots\ldots (1)$$

Where:
r: radius of the fringe.
D: distance between the slide and the screen.
λ: laser wavelength(= 6328A^o).
d: radius of blood cells.

6. Repeating steps (1-4) by irradiating the blood cells using three types of irradiative sources((^{60}Co),$t_{1/2}$=5.24yr,emitted Gamma rays ,(^{90}Sr),$t^{1/2}$=28yr ,emitted Beta particles and (^{210}Po),$t_{1/2}$=138.4d)emitted Alpha particles) at a distance about (2cm) with dose (D(^{60}Co)=0.317mrad), (D(^{90}Sr)= 1.674 mrad) and (D(^{210}Po)=4.13mrad) respectively for (2-12 minutes) [11].
7. Plotting a graph between the radius (r) of the fringe and the distance (D).
8. We were measured the Radii of red blood by (ocular lenses) the biological method.



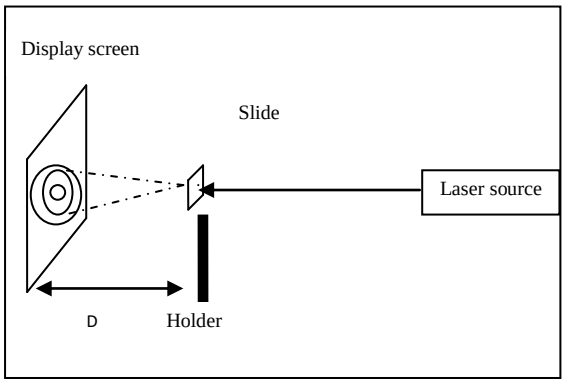


Figure (2): Equipments of the experimental part

3- Results :-

Arrange the results achieved from eq. (1) .in the figures as shown below:

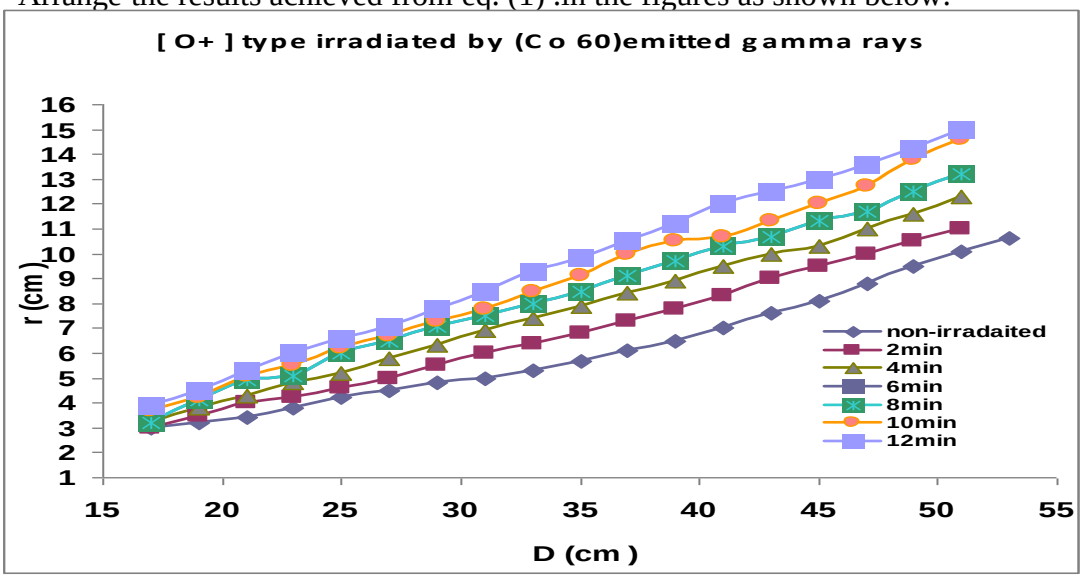


Figure (3-a): shows the relation between the distance (D) and the radius of the fringe (r) for (O) type

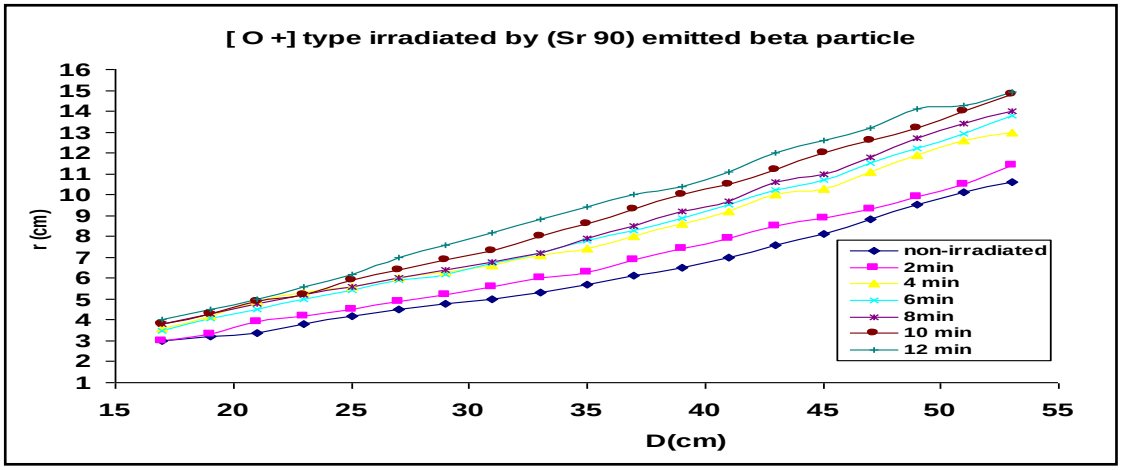


Figure (3-b): shows the relation between the distance (D) and the radius of the fringe (r) for (O) type

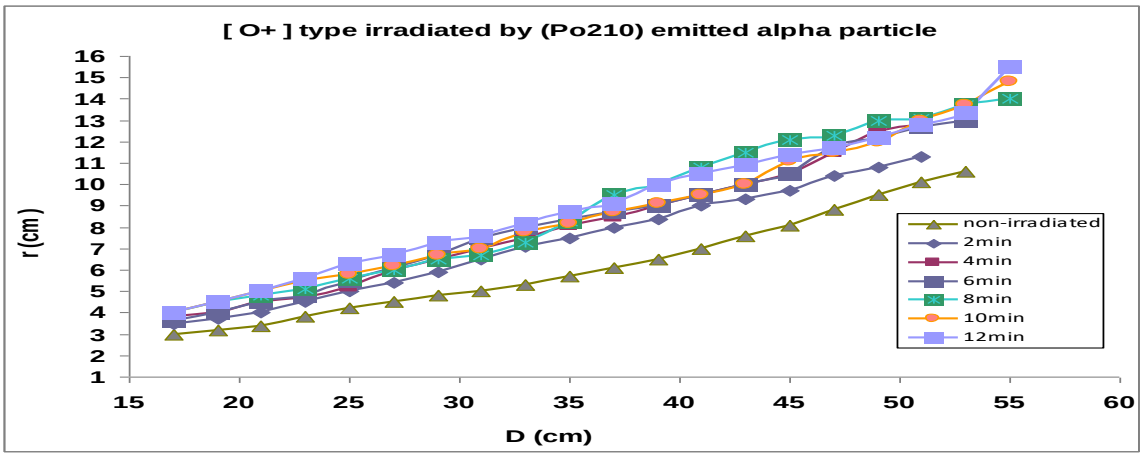


Figure (3-c): shows the relation between the distance (D) and the radius of the fringe (r) for (O) type

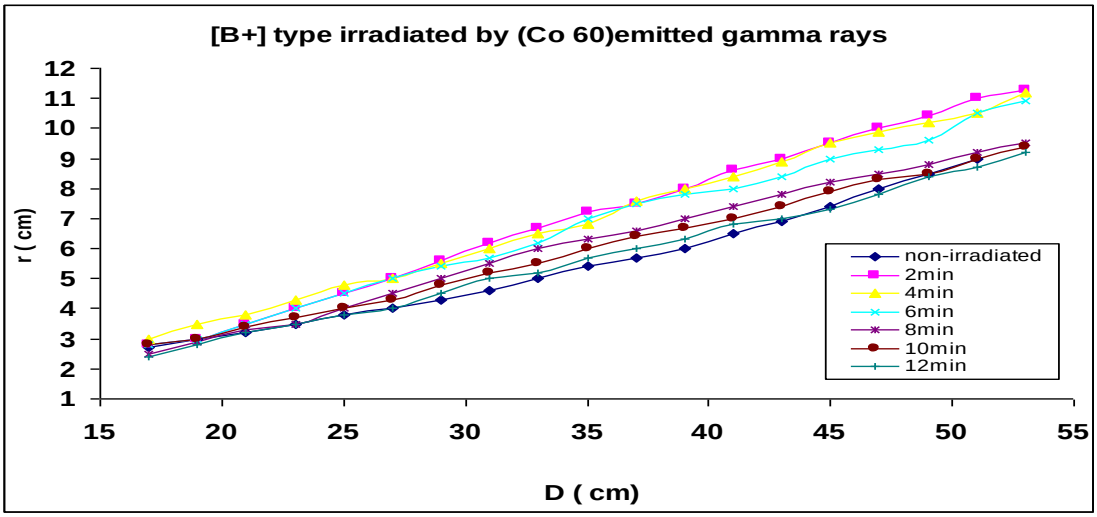


Figure (4-a): shows the relation between the distance (D) and the radius of the fringe (r) for (B) type

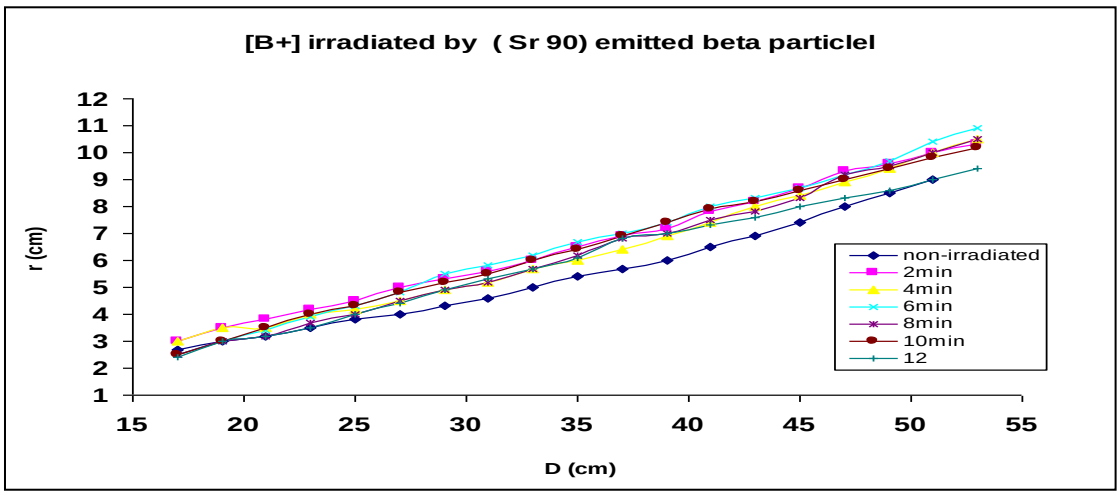


Figure (4-b): shows the relation between the distance (D) and the radius of the fringe (r) for (B) type

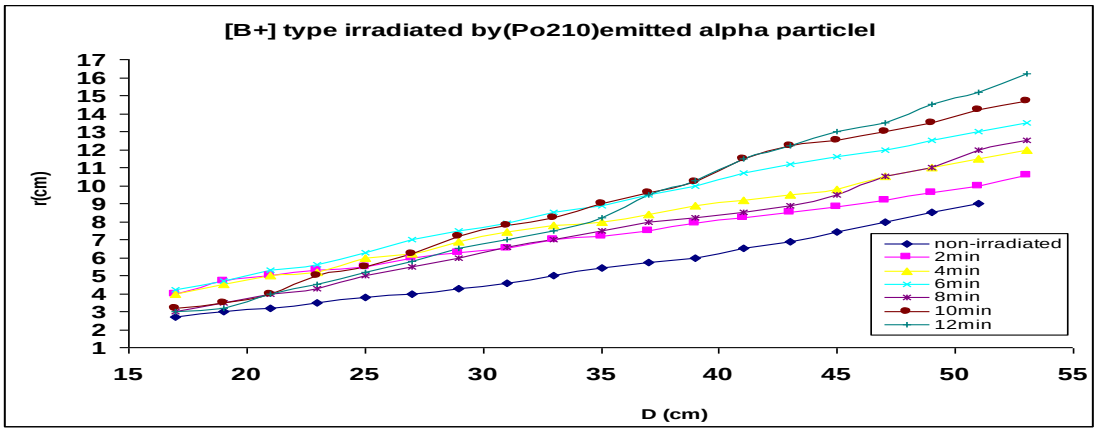


Figure (4-c): shows the relation between the distance (D) and the radius of the fringe (r) for (B) type

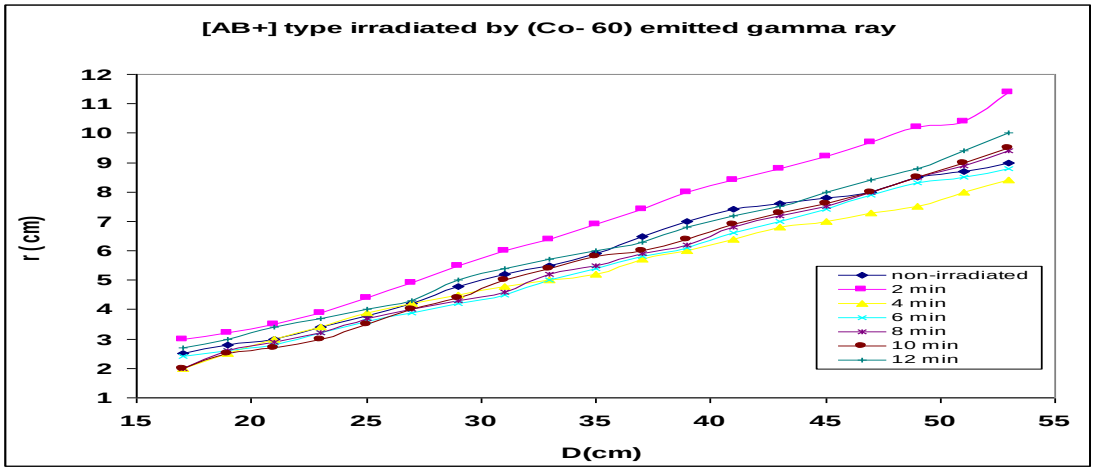


Figure (5-a): shows the relation between the distance (D) and the radius of the fringe (r) for (AB) type

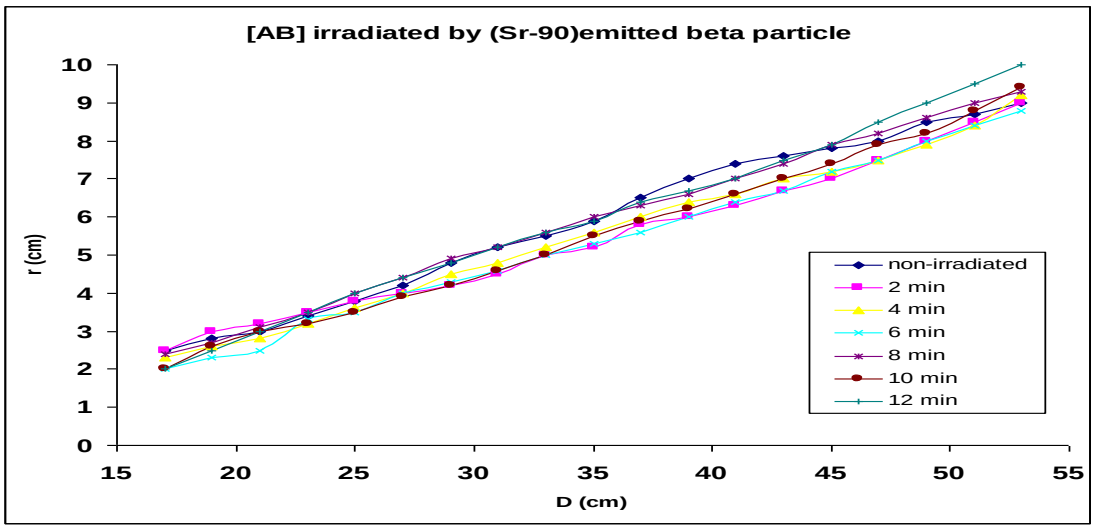


Figure (5-b): shows the relation between the distance (D) and the radius of the fringe for (AB) type

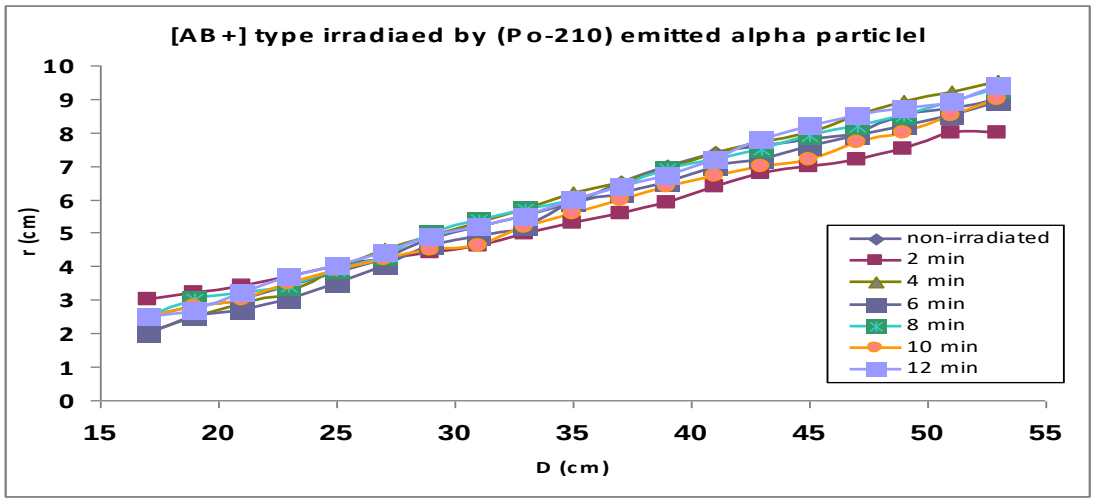


Figure (5-c): shows the relation between the distance (D) and the radius of the fringe (r) for (AB) type

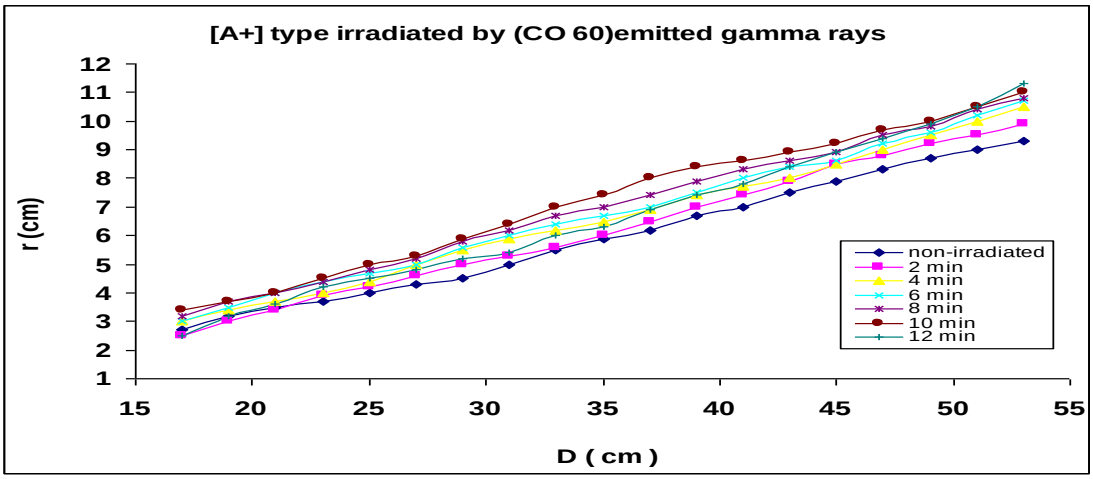


Figure (6-a): shows the relation between the distance (D) and the radius of the fringe (r) for (A) type

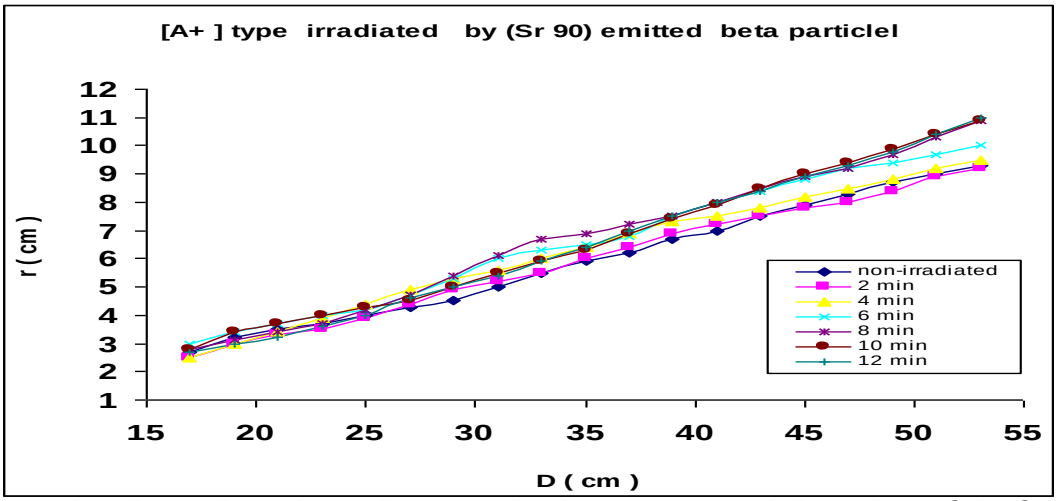


Figure (6-b): shows the relation between the distance (D) and the radius of the fringe (r) for (A) type

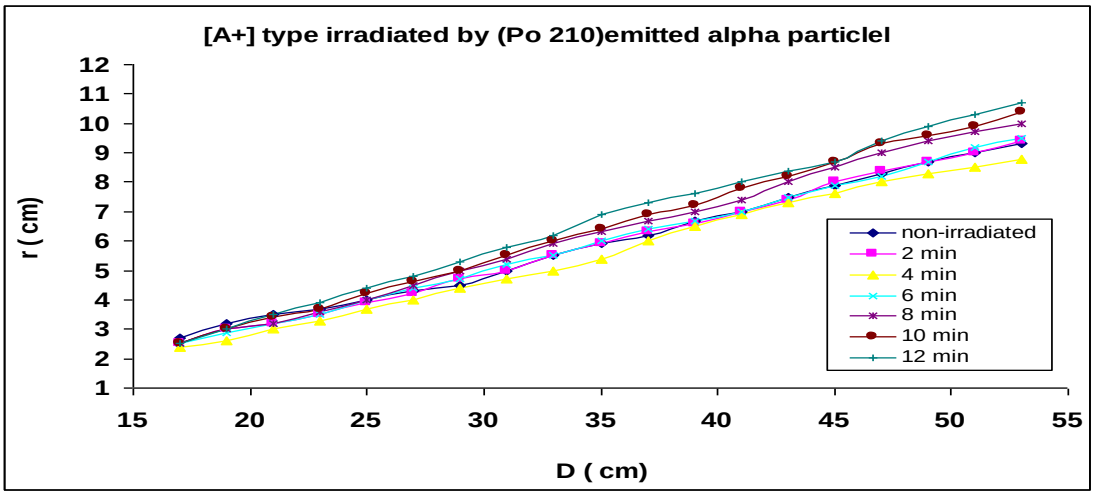


Figure (6-c): shows the relation between the distance (D) and the radius of the fringe (r) for (A) type

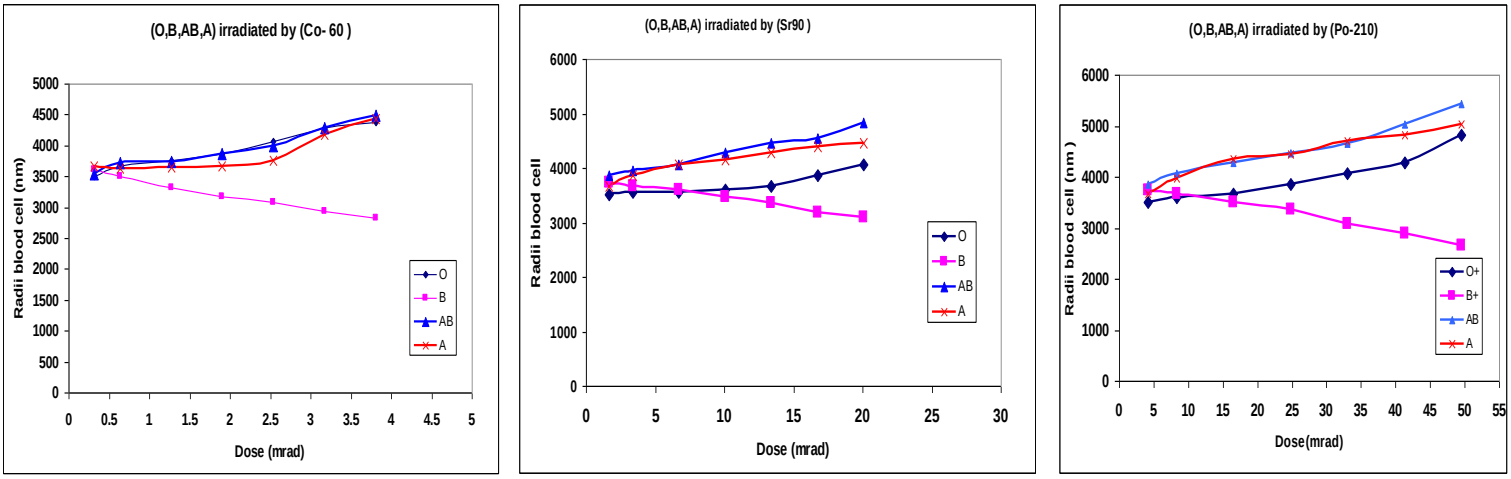


Figure (7): shows the relation between the Dose (D) and the radius of the blood cells (r) for (O ,B,AB,and A) types irradiated by (Alpha particles, Beta particles, Gamma rays).

4- Conclusions :-

1- The results of the radii of the blood cells obtained by using laser are very approximately agreement with results which obtained by biological processes.
2- When using the irradiative sources, the radii of the (AB ,A& O) blood cells had increased about (100-1500nm) because of the biological changes done to the cells, while the radii of (B) blood cells had decreased because the shape of this cell type different to another types then the radiation scattering, as shown in table (1).

Table (1) radius of blood cells with and without irradiative sources ^{60}Co ,^{90}Sr and ^{210}Po respectively for (O^+,B^+,AB^+,A^+) type.

Type of Blood	d_{normal} (nm)	Irradiated Time	d_{Co} (nm)	d_{sr} (nm)	d_{Po} (nm)
O	3509	2min	3570	3558	3608
		4min	3574	3571	3676
		6min	3676	3607	3860
		8min	3860	3677	4063
		10min	4265	3860	4289
		12min	4541	4063	4825
B	3730	2min	3607	3673	3676
		4min	3574	3608	3509
		6min	3386	3478	3357
		8min	3216	3357	3088
		10min	2970	3190	2902
		12min	2828	3089	2662
AB	3860	2min	4042	3959	4063
		4min	4062	4063	4288
		6min	4290	4288	4462
		8min	4437	4463	4651
		10min	4825	4541	5046
		12min	5045	4825	5437
A	3676	2min	3918	3860	3979
		4min	4289	4063	4362
		6min	4389	4151	4437
		8min	4541	4289	4707
		10min	4651	4387	4825
		12min	4825	4463	5046

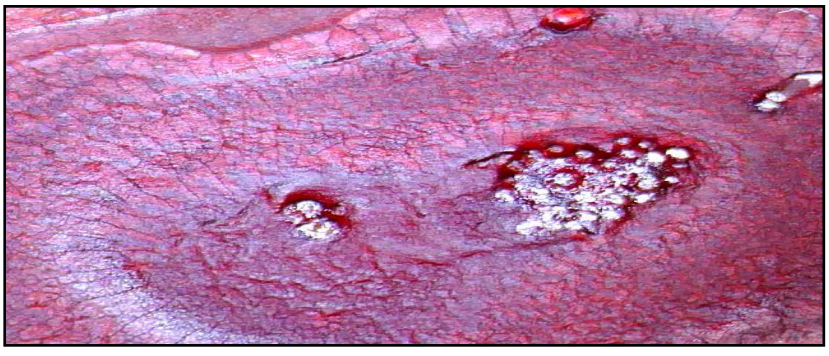


Figure (8): The Shape of Blood Cells irradiated by Alpha particles

3- Using of laser source is very good idea because of the properties of the laser (directionality, coherence and brightness), and the visibility of the laser source help to increase the accuracy of measurement.
4- Using low power laser and this will not effect on the radii of the blood cells.

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