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VALUE OF KIEL COMPENSATING SYSTEM IN THE MANTLE FIELD TREATMENT OF MALIGNANT LYMPHOMAS

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INTRODUCTION

Numerous suggestions have been advanced to recent years aiming at improving the irradiation technique for patients with Hodgkin's disease. However, the only method which was widely used was broad beam irradiation, empolying specially prepared irregulary shaped shield. Although desirable additional measures have been worked out theoretically, they have rarely been adopted as daily routine measures, because in most cases they could not be translated into practical reality.

The irradiation time or the "jump orders" to be given by the monitor are determined in irradiation planning in the central beam on a reference plane situated at one-half of the body diameter when using a dorsoventral opposing technique.

The expected transverse and depth distribution of the dosage if no data on the irregularly shaped body surface are incorporated and if tissue inhomogeneities are likewise disregarded, differs from the permissible or desired dosage by up to ± 20 percent.

However, planed dosage variation can be affected only after the dosage has been homogenised in the reference plane. In the present study we are introducing a relevent compensations method which takes into account a maximum of data relating to the patient and his disease, in accordance with the present state of irradiation technique.

MATERIAL AND METHODS

The primary requirements before the design and calculations of the compensator, is the measurements and calculation of the scattering from the compensator and its role in the companisator calculation.

The corner stone in the design and calculation of the compansator is separation of the scattering coeffecient from the measured or the total absorption coeffecient.

The absorption as well as the scattering coeffecient were measured for different elements which may be suitable for compansation such as lead, Tungestan, Copper, Tin granulesand wax, Aluminum and plexiglass.

Fig. I represents these measurements for Tin granules and Wax For field size 10 x 10 cm for energies Co^{60}, 8 MV and 16 MV. Photone, at different depths in the phantom and different heights for the absorber. The calculation were done through what is called the solid angle from a formula that correlates the solid angle to the scattering coeffecient.

These data are programed in a computer program considering the scattering coeffecient. The design and calculation of the compensator as it is a high complicated process for irrigular fields as mantle fields so it is done with the aid of the computer using C.T. scan slices for the region to be compansated. The C.T. data represents the individual anatomy of the irradiated volum. These data entered to the computer that contain the program of the compansator or calculation. All the CT values are transelated pixel by pixel into the corresponding therapy beam coeffecient using not yet an arethmatic but still an emperical correlation between the C.T. number and physical density. The water equivalent length is calculated for every point in the plan of compensation. The calculations are done in three dimensions. The compensator is calculated from the stored water equivalent length. After that the data of the compensator is transfered to the cutting machine, which is computer controlled also, and by using the cutting program the compensator could be cut easly using subdirectory compensator data.

Quality assurance is the final but the important step before clinical application of the compensator.

Fig. 2 showing the arrangements of the equipments used for quality assurance measurements of the compensator. We could calculate the dose at the planning the compensator using only 2 measurements one with the patient and compensator and other measurement with the compensator without the patient, the measurements are behind the patient.

RESULTS

The results of the prelimenary experiments before the design and calculation of the compensator showed that the scattering from any absorbing material in the way of the beam which represented by the compensator is + 12%- 40%, it has proved that the geometrical factor plays its effect on the scattering junction through what's called solid angle, which is an imaginary angle has also relation to the open angle. Fig. 3 represents the relation between the mass absorption coeffecient Cu2 in relation to the hight of the absorber from the surface of the phantom for energies Co^{60}, 8 Mv, 16 MV and 42 MV X-ray, for different depth in the phanton. 1-15 cm for cO6°, 3-15 cm for 8 MV, 16 MV and 5-20 cm for 42 MV X-ray . These measurements done for different materials used for compensator e.g. Tin granule and wax. Plotting the scattering coeffecient against the solid angle represented in Fig. (4,5,6,7). For tin granules and wax for energies Co^{60}, 8, 16, 42 MV, it shows that there is a direct power functional relation between the scattering coeffecient and solid angle for quality control .

DISCUSSION

It is highly desirable to treat multiple lymph node chains in continuity with as few fields as possible (Kaplan, 1962, 1966). This is due to the fact that the dosimetry in the vicinity of junctions between adjacent fields is more complex and difficult. The error may result in the delivery of inadequate dose in the plan of the junction, or hot spots which may produce serious damage in underlying normal tissues in the plan of the junction. For this purpose, contoured lead or lead-bismuth, low melting point alloy (cerrobend) blocks or equivalent volumes of lead shots are used to protect normal tissues such as the lungs and most of the heart. However, major radiotherapy centers treating a large number of patients have generally found it preferable to prepare templetes shaped to the contours of mediastinal and hilar lymphademopathy of individual patients.

The importance of repeated verification films to assure accuracy of mantle fields localization has been stressed by Mondai et al., (1980) who detected 330 localization errors among 902 treatment verification films in 99 patients undergoing mantle field treatment.

Certain other refinements in the mantle technique have been introduced in recent years, as protection of cervical spinal cord by shield which extend to cover the dorsal spinal cord in addition . The larynx is shielded during the anterior mantle. The skin of the axillae and the humeral heads are shielded during both anterior and posterior treatments (Kaplan, 1968).

Regarding to the complication arising due to irradiation treatment by mantle field. First and before all is the respiratory system complications (Dexon et al., 1979). Such distorted scarred lung are vulnerable to repeated bouts of pneumonitis often associated with progressive bronchiectasis. Moreover radiation injury to the heart was manifested in a variety of ways.

Actually most of the compensators constructed in the past tried to solve the problem of irregular contour so they compansated only for body contour as those of Ellis, hall and Oliver, 1959, Van de Geifen, 1965, Mok and Boyer, 1984 . On the other hand some tried to compansate for both the irregular contour and the inhomogenecity of different tissues specially for the lungs (Ellis, 1960, halt and Oliver 1962; Renner et al., 1983 and Dexon et al., 1979).

For the same prupose we have developed our compensating system (Kiel compensating system "KCS").

In practice the KCS is considered a complementary system which compensate for both the irregular contour and tissue inhomogenecity, moreover, we can control the dose at any point in the field which is called field integrated dose modification (FIDM), as well as we can choose the plan at which it will be compensated.

KCS uses the C.T. slices in the design of the compensator. Each slics of CT in the field is evaluated separately then all the slices evaluated collectively.

From the physical point of view KCS is not so simple as all the geometrical factors and the scattering function are considered. Regarding the problem of scattering function of the compensator in order to reach an accurate value for the attenuation coefficient of the compensating material, However it is not considered before but it is neglected by the authors while our experimental preliminary work has proved that this fraction represents about 12-40% of the measured dose according to the distance of the compensator from the patient surface. We agree with Wiks and Cazbow (1969) who used the measured attenuation coefficient of the compensating material for broad beam and not used the published one which is usually for narrow beam and are quite differ. KCS considered more or less a simple technique for design and construction of the compensator, just we need the computer program, the proper attenuation coefficient and Ct scan in the region to be compensated then the design takes only 15 minutes on the computer which is PC computer, so the design is not time consuming as in most of compensators.

From the literatures the authers made quality assurance on the phantom, that is to say compensation for irregular contour only (Renner et al., 1982).

Actually we consider that the quality assurance during the patient setup is the most accurate one as measurments on the patients avoid any mistake in design or construction or even in the setup of the patients.

SUMMARY AND CONCLUSION

We have presented a method which enables the radiotherapist to achieve homogenization of dosage in relation to an arbitrary reference plane in the body of the patient, within a mantle field.

The irrigularly shaped body surface of the patient and tissue inhomogenecities are taken into account by this method.

In addition, the required compensator can be conceived by the broad beam will receive a dosage different from that applied to the rest of the field.

Beside irradiation of a patient with Hodgkin's disease, the technique described her is suitable for treatment of tumors in the region of the head and neck, and for the breast cancer preserving treatnent.

Another advantages of the kiel compensating system is compansation of distortion of dose distribution, caused by surface irregularities and inhomogenecitis, by means of C.T. monitored compensation, and limetation of the whole treatment volume by using individually shaped divergent field shields. further more, its safe and practicable adjustment with defind positioning and few tatlooable adjustment points without making field limits render it very practical.

Moreover we have developed a new and unique method for quality asserance with measurements only behined the patients, no measurements on the patients surface as well as within the patients.

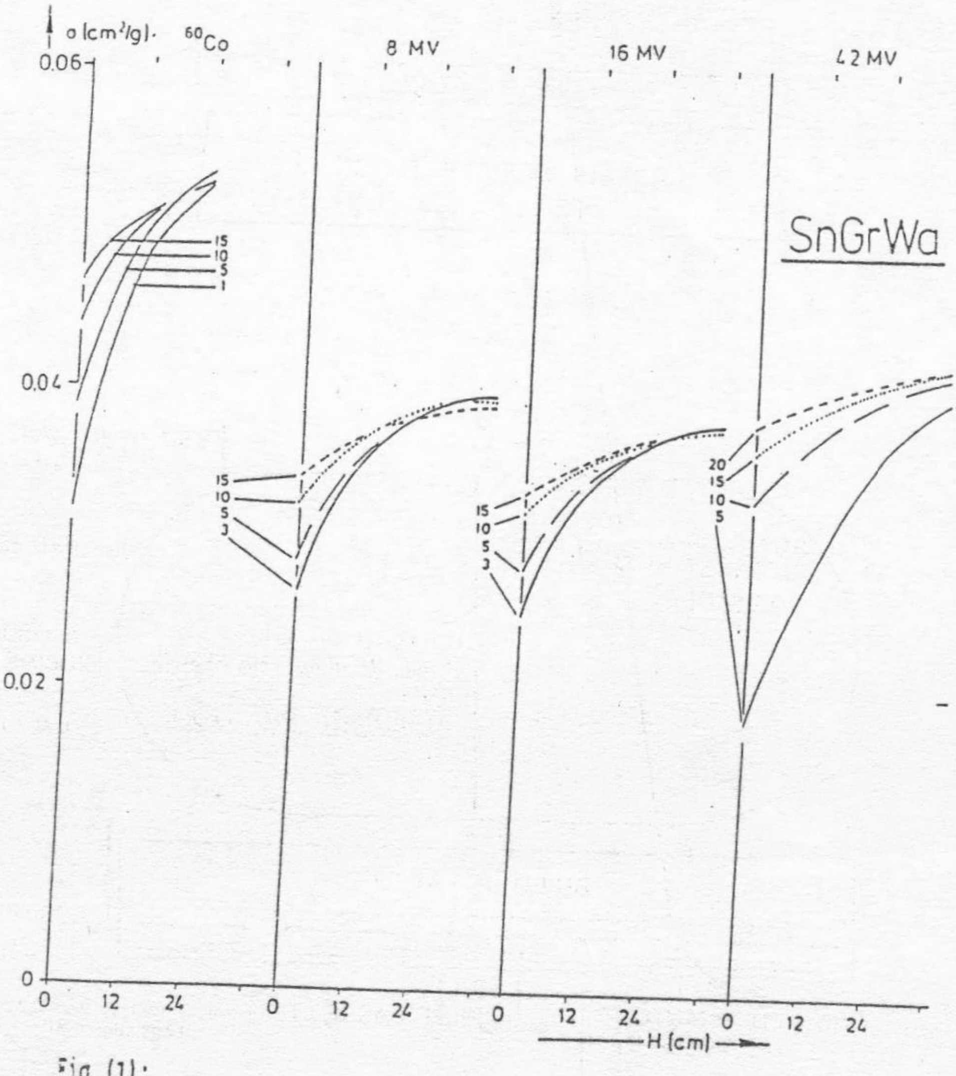

Fig. (1):

The mass absorption coefficient σ (cm²/g) in relation to the height of the absorber (H), and different depths in the phantom. For tin granules & wax (SnGrWa), energies Co60 and 8Mv, 16 Mv & 42 Mv x ray.

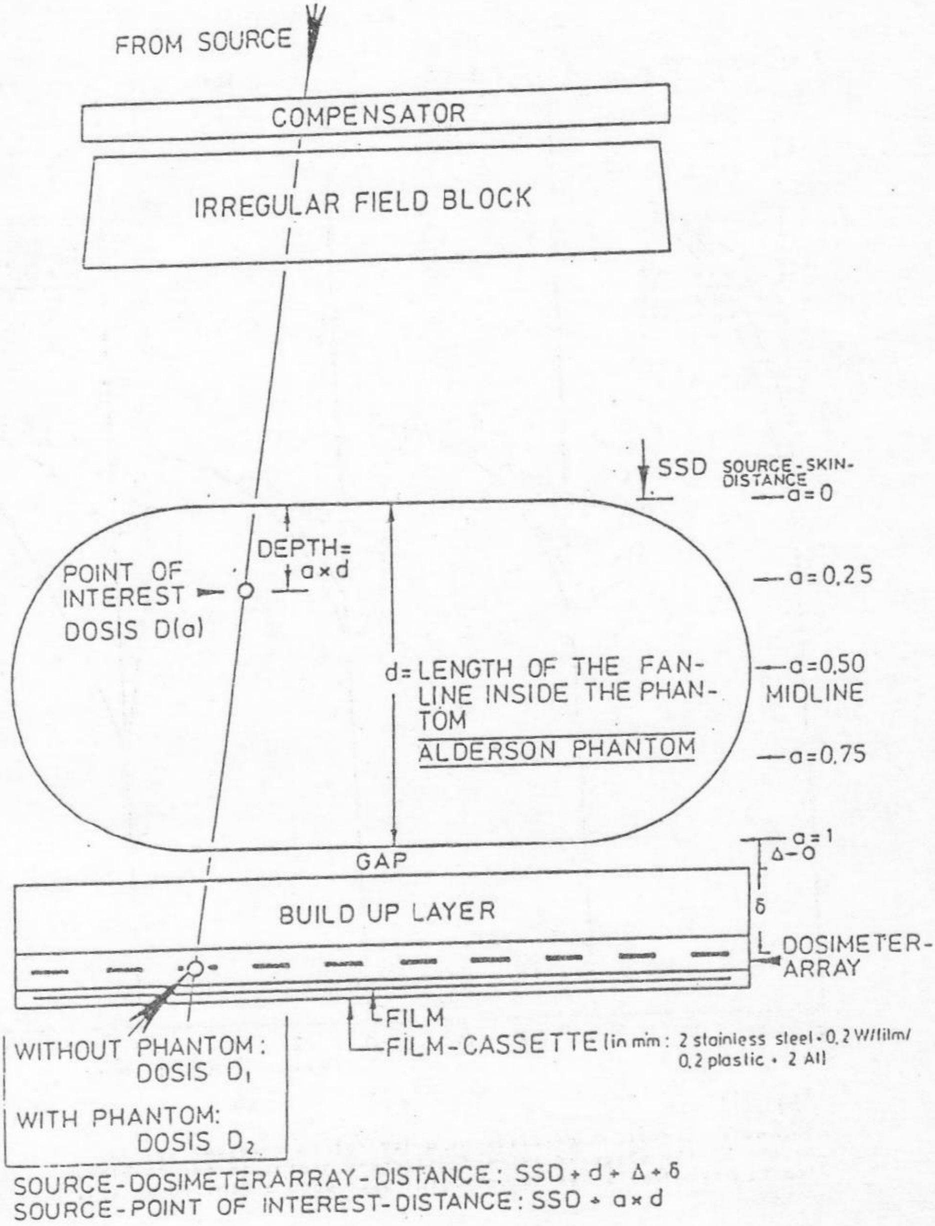

Fig. (2):

Measurements on the phantom and sources of scattering.

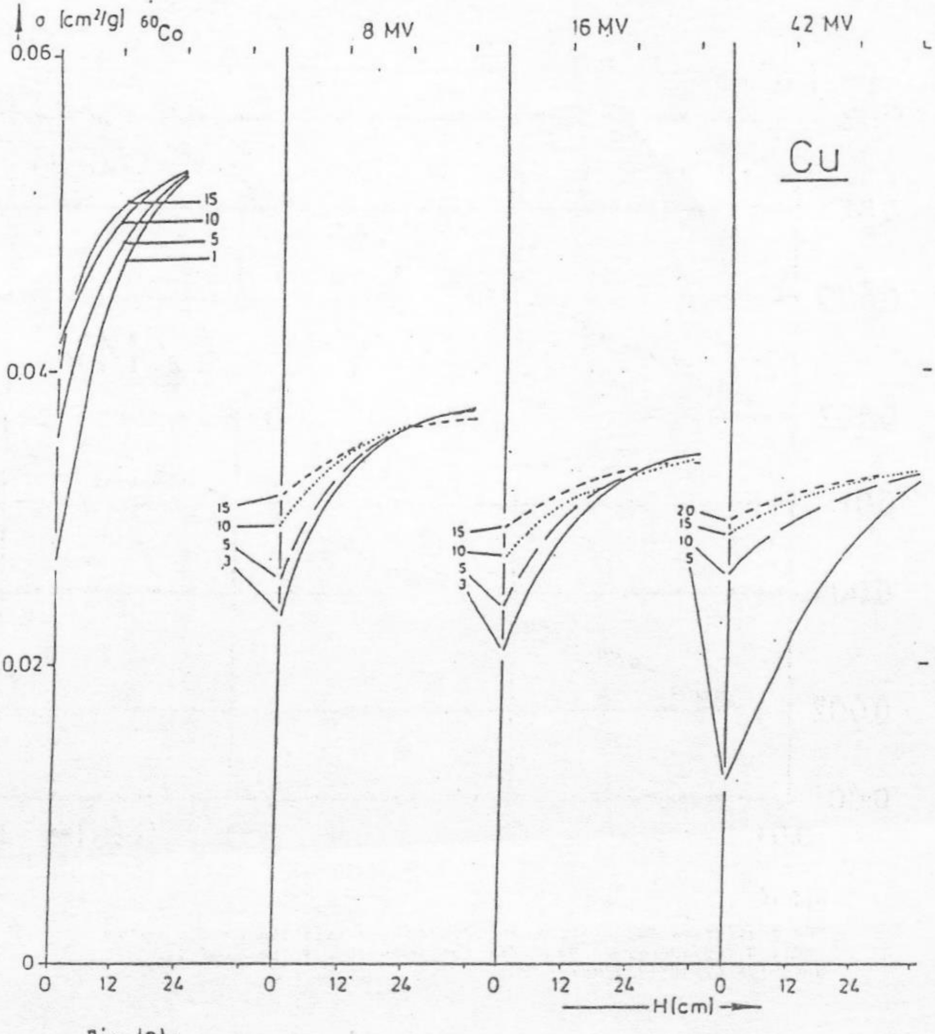

Fig. (3):

The mass absorption coefficient σ (cm^2/g) in relation to the height of the absorber (H) and different depths in the phantom. For cupper (Cu), energies Co60 and 8 Mv, 16 MV & 42 Mv x ray.

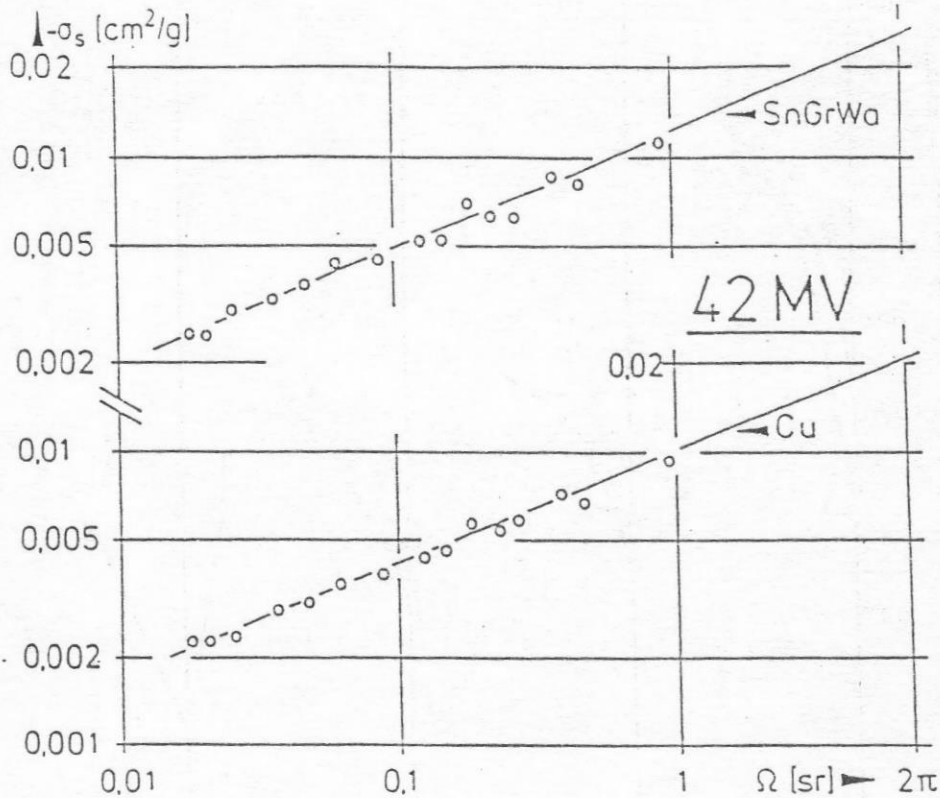

Fig. 4 :

The scattering coefficient σs [-cm²/g] in relation to the solid angle Ω for energy 42 Mv x ray, for both cupper (Cu) and tin granules & wax (SnGrWa).

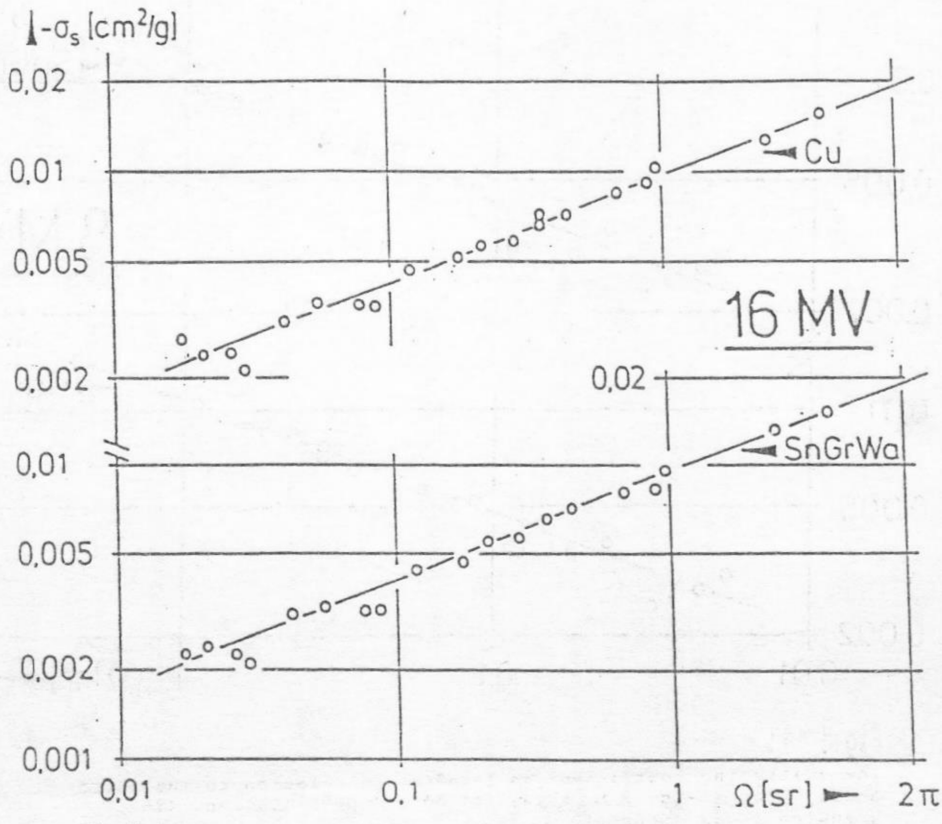

Fig. (5):

The scattering coefficient σs [-cm²/g] in relation to the solid angle Ω for energy 16 Mv x ray. for both cuppar (Cu) and tin granules & wax (SnGrWa).

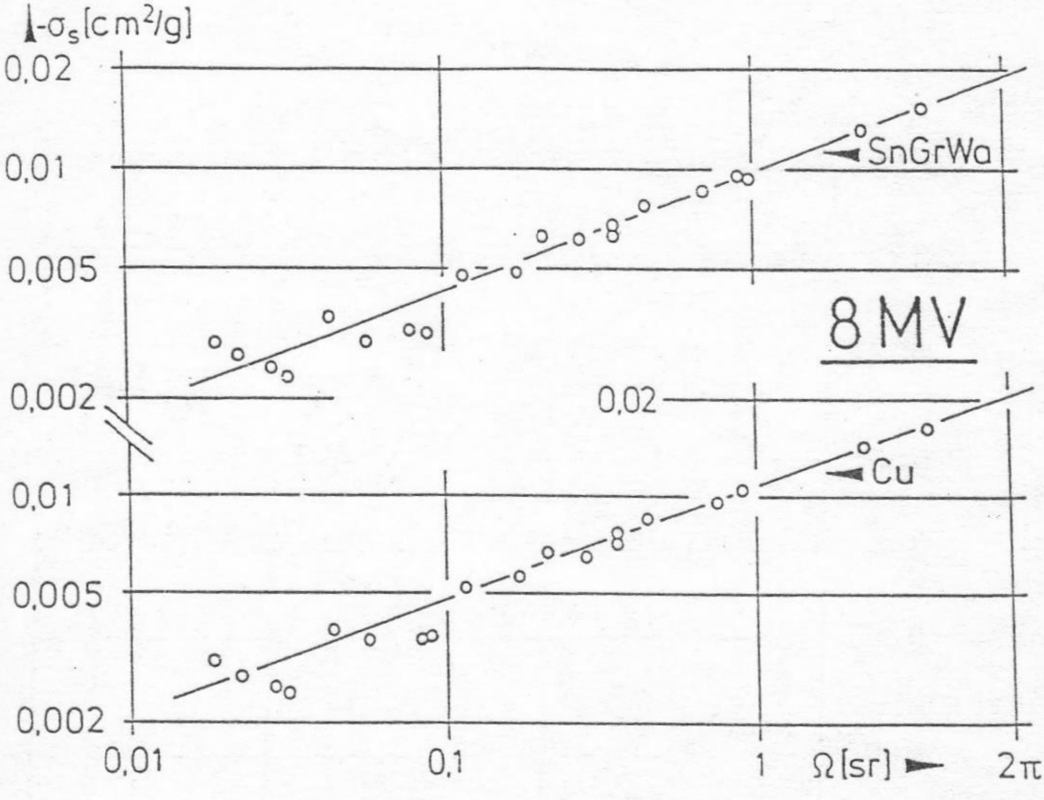

Fig. (6):

The scattering coefficient σs [-cm²/g] in relation to the solid angle Ω for energy 8 Mv x ray.for both cupper (Cu) and tin granules & wax (SnGrWa).

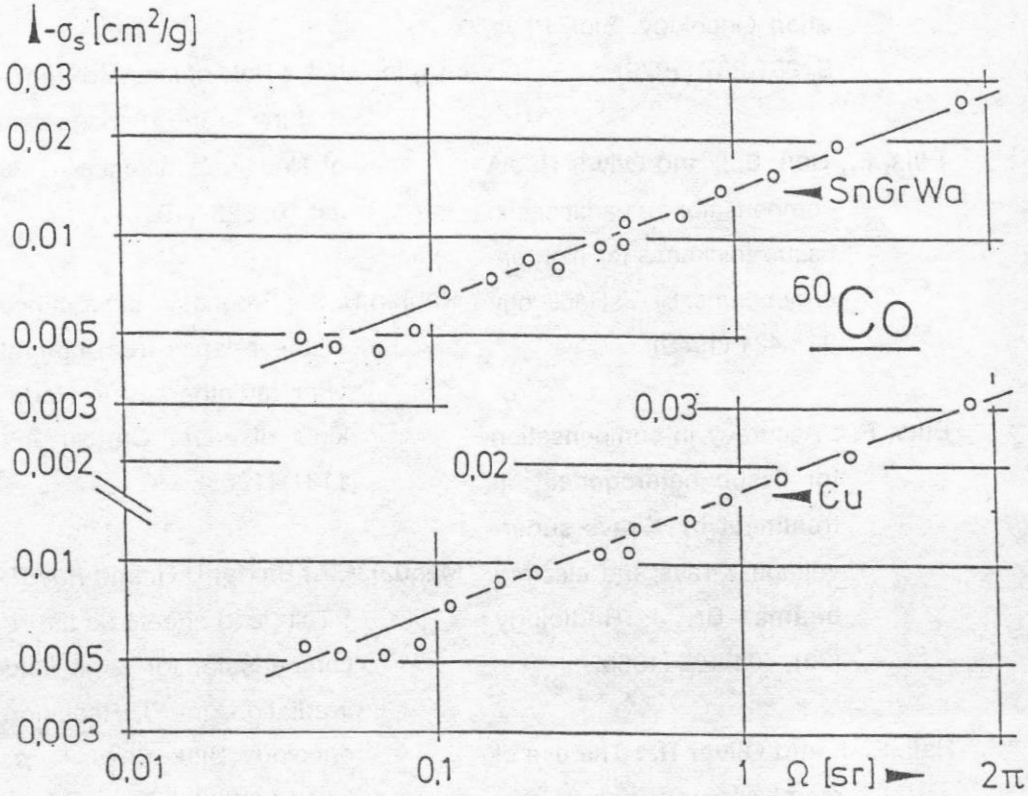

Fig. (7):

The scattering coefficient σs [-cm²/g] in relation to the solid angle Ω for energy Co60, for both cupper (Cu) and tin granules & wax (SnGrWa).

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"الملخص العربى"

تم فى هذا البحث إجراء عدد من التجارب القياسية لحقل المانتل حيث تم التوصل إلى طريقة تجعل من الممكن توصيل جرعة متجانسة بنسبة تشتت مقبولة إلى المستوى المطلوب العلاج عنده. ويتم فى هذه الطريقة استخدام نظام كيل التعويضى الذى يتم فيه استخدام الأشعة المقطعية بالكمبيوتر للحقل المعالج به مع الأخذ فى الاعتبار عدم استواء السطح الخارجى لجسم المريض كذلك عدم تجانس الأنواع المختلفة لجميع أنسجة الجسم.

كذلك أمكن فى هذا النظام التحكم فى الجرعة المطلوب توصيلها إلى عدة مناطق مختلفة فى نفس الحقل. ولقد تم التوصل إلى طريقة للتأكد واختبار صلاحية الفلتر المعوض بعد بقائه من حيث توصيل الجرعة المطلوبة إلى المستوى المطلوب وذلك من خلال قياسات فعليه على المريض من خلال الجلسة ويتم ذلك عن طريق قياستين خارجيتين خلف المريض أثناء الجلسة فى وجود الفلتر المعوض.

وأخرى فى وجود الفلتر المعوض بدون المريض.

وعن طريق معادلة تم استنباطها أمكن حساب الجرعة عند المستوى النصفى للمريض والتأكد من صلاحية الفلتر المعوض.

والجدير بالذكر أنه يمكن استخدام هذا النظام التعويضى فى علاج أورام الرأس والرقبة، كذلك أورام الثدى بالإضافة إلى استخدامه فى حقل مانتل فى علاج أورام الغدد الليمفاوية.

لذلك يمكن تلخيص مميزات نظام كيل التعويض كالآتى :-

١- تعويض اختلاف التجانس فى الجرعة لوجود اختلاف فى استواء السطح الخارجى للجسم، كذلك عدم تجانس أنسجة الجسم المختلفة مثل الرئة والعظام.

٢- التمكن من تخفيض الجرعة عند الأنسجة السليمة ذات الحساسية الحرجة بالنسبة للاشعاع وذلك فى نفس الوقت الذى يتم فيه علاج الورم السرطانى.

٣- تحديد الحقل الخارجى المراد العلاج به باستخدام محددات خاصة بكل مريض.

٤- سهولة ضبط المريض على الجهاز يومياً باستخدام نقط وشيمة على جلد المريض بدون تحديد الحقل على المريض.