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FURTHER DEVELOPMENT OF THE HEYMAN RADIUM PACKING METHOD

by

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The treatment of cancer of the body of the uterus has long been a matter of controversy. Some are in favour of primary surgery with or without postoperative radiotherapy while others prefer radiotherapy with or without postradiation surgery. Today most investigators agree that some of the carcinomas of the corpus uteri, e. g. the highly differentiated adenocarcinomas in an early stage, can be operated upon primarily. These cases need however postoperative radium treatment of the vagina to lower the risk of postoperative vaginal metastases. Advanced cancers of the corpus, although highly differentiated, should be treated with preoperative radiation to achieve a good result. Low-differentiated tumours of the corpus must, however, without exception be treated primarily with radiation and later, in operable cases, with total extirpation of the uterus, tubes and ovaries; in so doing one may expect the best results possible. Primary surgery in low-differentiated carcinomas of the corpus, even though clinically limited to the uterine cavity, is connected with a poor prognosis (KOTTMEIER 1959).

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Table 1

Irradiators used at Radiumhemmet

Irradiator No.	Radium tubes			Additional filters	
	Radium content	Size	Filtration	Size	Filtration
0.0	10 mg	14 × 2.3 mm	0.2 Au + 0.3 Pt = 0.8 mm Pb	18 × 5.1 mm	2 mm Pb
0.5	10 mg	»	»	18 × 6.3 mm	»
1	8 mg	20 × 2.8 mm	0.35 Au + 0.3 Pt = 1 mm Pb	25 × 7.8 mm	2 mm Pb
2	8 mg	»	»	26 × 9.8 mm	»
3	8 mg	»	»	27 × 11.8 mm	»
4	8 mg	»	»	29 × 13.8 mm	»

Some institutions in which gynecologic cancer therapy is centralized prefer to treat cases of carcinoma of the body of the uterus primarily with radiation, supplemented when suitable with surgery. This mode of treatment has certain advantages, e. g. the cases are centralized for uniform evaluation and diagnosis in a hospital where expert treatment can be given. It carries, however, the disadvantage that some of the early and highly differentiated adenocarcinomas of the corpus which could instead have been operated upon primarily, and the patient later sent for postoperative vaginal radium therapy, will not receive this treatment.

The Heyman radium packing method

The primary radium treatment of cases of cancer of the corpus has varied. The radium packing method developed by Heyman, in which a suitable number of irradiators are used to 'balloon out' the uterine cavity, appears, however, to have been the most successful. The method has been thoroughly described by HEYMAN, REUTERWALL & BENNER (1941) and HEYMAN & BENNER (1946). They recommended a dose of about 3 000 R at a distance of 1.5 cm from the nearest irradiator, regardless of the number of irradiators used. This corresponds approximately to the serosal surface of the uterine corpus. The dose in the bladder and the rectum is measured and a dose to the anterior wall of the rectum of 4 000 to 5 000 R, part of which comes from the vaginal radium, should not be exceeded. The radiation dose is given in two or three applications.

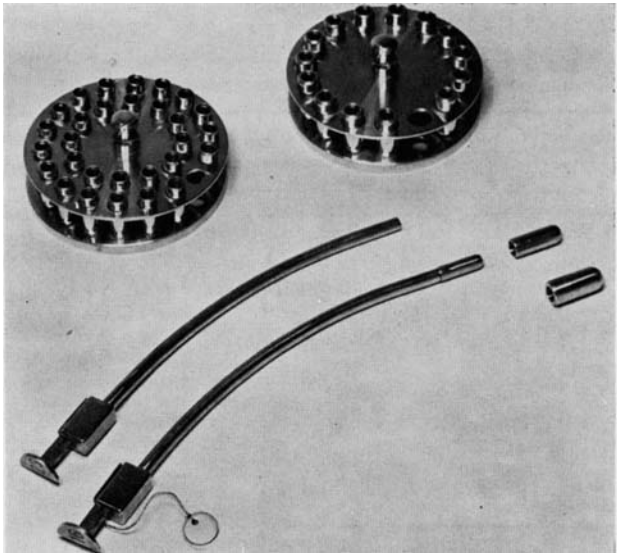

Fig. 1. The permanently closed irradiator, additional filters and applicators.

The original equipment of HEYMAN & BENNER for packing the uterus with a number of irradiators of uniform size and shape was based on the use of radium tubes having an external length of 20 mm and an outside diameter of 2.8 mm. The wall thickness was equivalent to 1 mm of lead (0.35 mm Au + 0.30 mm Pt) and each radium tube contained 8 mg of radium element. The radium tube was placed in a tube holder with a screw plug and to this an additional filter of suitable size was attached. A string with a badge was fixed to the irradiator which was applied to the uterine cavity by specially constructed applicators. The original additional filters had diameters of 7.8, 9.8, 11.8 and 13.8 mm for filter numbers 1, 2, 3 and 4, respectively. Later, in 1946, HEYMAN & BENNER introduced two smaller sizes of additional filters with a diameter of 5.1 and 6.3 mm; these, called No. 0.0 and No. 0.5 respectively, were made of gold and carried 10 mg of radium. The original four sizes of the filters have an inner wall of lead and an outer wall of stainless steel, both of equal thickness, in order to keep the radiation transmission constant. There will therefore be an air space between the inner and outer walls, the size of which will depend on the filter sizes. Details of the filters, the radium tubes and the filtration are collected in Table 1.

This equipment for packing the uterine cavity by multiple irradiators has many advantages. It possesses, however, certain hazards. The personnel hand-

Table 2

Irradiators used by the authors

Permanently closed irradiator (No. 0)

Length	Diameters Inner	Diameters Outer	Wall thickness	Radium tube	Total filtration	Dose rate at 1.5 cm
20 mm	3 mm	6 mm	1.5 mm steel	Radium content 10 mg External length 17 mm Active length 10 mm Diameter 2.9 mm Filtration 2 mm Pb	2.4 mm Pb	32.2 rad/h = 100 %

Additional filters

No.	Length	Diameters Inner	Diameters Outer	Wall thickness	Total filtration	Dose rate at 1.5 cm
1	22.5 mm	6.1 mm	8 mm	1 mm steel	2.6 mm Pb	30.8 rad/h = 96 %
2	23.5 mm	6.1 mm	10 mm	2 mm steel	2.7 mm Pb	29.9 rad/h = 93 %

ling the equipment are exposed to gammaradiation, a danger that is likely to arise when the radium tubes are transferred from the storage to the instrumental equipment and put into the tube holders, and especially when the additional filters are screwed on the screw plugs with the radium tubes. The handling of the equipment with the irradiators ready for application also entails some risk. Special shielding arrangements had therefore to be made (Walstam; Ragnhult et coll. 1962).

Present authors' instrumental equipment

The aim of the further development of the Heyman radium packing method has been to make the handling of the irradiators and additional filters as practical as possible and to reduce the radiation hazards. Permanently closed irradiators of small size, called No. 0, and additional filters so constructed that they could be pushed on this irradiator immediately before the application in the uterus, have therefore been used. A special tool to remove the additional filter from the irradiator has also been constructed.

Table 3

Treatment times in hours to deliver 1000 rad at 1.5 cm depth with different numbers and sizes of irradiators

Numbers of irradiators	Irradiator No.		
	0	I	II
6	15 1/2	19	21 1/2
7	14 3/4	18	20
8	14	17	18 3/4
9	13	16 1/4	17 1/2
10	12 1/4	15 1/4	16 1/2
11	11 1/2	14 1/2	15 1/2
12	10 3/4	13 3/4	14 3/4
13	10 1/4	13 1/4	14
14	9 3/4	12 3/4	13 1/2
15	9 1/4	12 1/4	13

The permanently closed irradiator for intrauterine packing. Most cases of cancer of the corpus can be packed sufficiently by using 10 to 15 irradiators No. 0, loaded with a radium tube of the standard type T5 manufactured by the Radiumchemical Centre, Amersham, Buckinghamshire, England. The tube contains 10 mg of radium and has a length of 17 mm (active length 10 mm), a diameter of 2.9 mm, and a sheath of 10 % IrPt of 1 mm wall thickness. The container is of stainless steel, with an outer diameter of 6 mm and a length of 20 mm, and is permanently closed. A small eyelet at one end is for the attachment of a thin steel wire with a numbered badge (Fig. 1).

The total filtration of this irradiator is 1 mm IrPt + 1.5 mm steel, which is equivalent to about 2.4 mm of lead or 1.15 mm of platinum. When the width of the uterine cavity demands larger irradiators, additional filters, sizes 1 or 2, are attached to the irradiator.

The additional filters. A high primary filtration of the radium tube (2 mm of lead) has some advantages. The radiation quality is very little influenced when filters of steel are added to the radium tube. The decrease in output is even smaller with increasing filtration when the primary filtration is high. The change in radiation quality by the addition of about 2 mm steel to the irradiator may be neglected. The change in output must however be taken into account; the measurements obtained are given in Table 2.

The additional filters are made of stainless steel. A groove at a distance from the bottom somewhat greater than the length of the irradiator is cut in the inner wall of the open end of each filter. A spring of ellipse shape is placed in

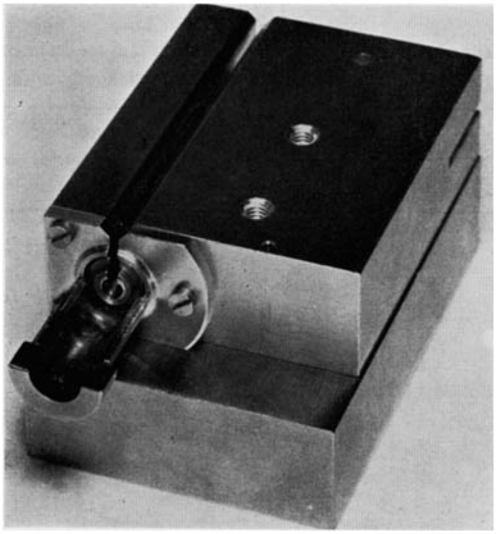

Fig. 2. Removing instrument insert.

Fig. 3. Irradiator-handling tool.

the groove. When the irradiator No. 0 is attached to the additional filter the spring is expanded by the irradiator and then locked behind it. Two additional filters, sizes Nos 1 and 2, are used. The inner diameter of both filters is 6.1 mm, and the outer diameter is 8 and 10 mm, respectively. The additional wall filtration will be 1 mm and 2 mm, respectively, which will give a total filtration of about 2.6 mm and 2.7 mm of lead for irradiators Nos 1 and 2, respec-

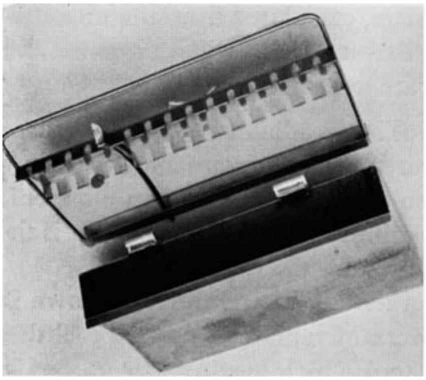

Fig. 4. Frame with applicator and insert.

Fig. 5. The radium cart loaded with irradiators ready for use.

Fig. 6. The radium cart.

tively. The equivalent platinum filtration is 1.2 mm and 1.25 mm. The data are collected in Table 2.

The intrauterine radium packing treatment used in the department is based on three treatments at two-week intervals. A dose of approximately 1 000 rad is administered to a point 1.5 cm from the nearest irradiator in the corpus, i. e. a total dose of 3 000 rad in four weeks. The treatment times with different numbers of irradiators of different sizes, calculated from the measurements performed by BENNER (see HEYMAN & BENNER 1946) with due consideration of the change in output and filtration, are collected in Table 3.

Equipment for removing the additional filters. The irradiators after being used are put into a shielded container in the ward. First they are immersed in a saline solution to avoid incrustations and then they are washed in an ultrasonic cleaning tank before being placed in the radium cart. This procedure is the same for all the types of radium irradiators used by the department.

A semi-automatic instrument for removing the additional filters is shown in Fig. 2. This is shaped as an insert to the universal irradiator handling tool that forms part of the radium storage unit. The tool, which has been developed in the department, is supplied with a radiation shield to reduce radiation hazard to the hands (Fig. 3). The mechanism of the removing instrument consists of two cylindrical plungers placed concentrically; both are spring-loaded and have a common slit for the steel wire. It functions as follows. The irradiator is placed on the semi-cylindrical irradiator holder in front of the plungers. When the irradiator is forced towards the plungers by a manual pull on the steel wire, the inner plunger acts on the small spring in the additional filter which is expanded to release the irradiator. The outer plunger works on the additional filter and pushes it off. The filter is then easily removed with forceps. This forms a rapid and handy procedure which is much quicker than unscrewing the additional filters as was necessary in the Heyman-Benner technique.

The radium cart. A special radium cart has been developed for storing and transporting the permanently closed irradiators; the radiation shielding is sufficient for 15 irradiators. The cart contains a stainless steel insert surrounded by a lead shield; one part of this shield forms a cover. The insert is easy to remove for sterilization. The lead shield is covered by a stainless steel envelope mounted on the base of a surgical operation table, the hydraulic system of which is modified to open or close the heavy cover. (See Figs 5 and 6.)

The irradiators No. 0, fitted to their applicators, are arranged (Fig. 4) in a straight line in numerical order in the frame for convenience of handling at the application. The frame is sterilized and placed in the insert container.

SUMMARY

A further development of the Heyman radium packing method, based on a high primary filtration of the radium tube, is described. The radium tube is permanently closed in a container of stainless steel to avoid the loading procedure. A rapid means of attaching and removing additional filters, special handling tools and a radium cart, are special features of the technique.

ZUSAMMENFASSUNG

Eine weitere Entwicklung der Heyman Radium Packung mit höherer Primärfiltrierung der Radiumröhre wird mitgeteilt. Die Radiumröhre ist dauernd in einer rostfreien Stahlröhre eingeschlossen um das dauernde neue Laden zu vermeiden. Neue Methoden zur leichten Auswechslung des Filters, neue Greifzangen, und ein neuer Radiumtransportwagen, wurden ebenfalls eingeführt.

RÉSUMÉ

Description d'un nouveau perfectionnement de la méthode de packing de Heyman, basé sur une forte filtration primaire du tube de radium. Le tube de radium est enfermé de façon permanente dans un étui d'acier inoxydable pour éviter d'avoir à charger l'étui. Cette technique se caractérise encore par un moyen permettant d'ajouter ou d'enlever rapidement des filtres additionnels, ainsi que par des instruments de manipulation du radium spéciaux et par un chariot à radium.

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