FROM THE DEPARTMENT OF GYNECOLOGY (DIRECTOR: PROF. H. L. KOTTMEIER), RADIUMHEMMET, THE INSTITUTE OF RADIATION PHYSICS (DIRECTOR: PROF. R. WALSTAM), AND THE DEPARTMENT OF DIAGNOSTIC RADIOLOGY (DIRECTOR: PROF. B. NORDENSTRÖM), KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN.

DOSE DISTRIBUTION FROM INTRACAVITARY RADIUM AND SUPPLEMENTARY EXTERNAL IRRADIATION WITH REGARD TO TOPOGRAPHY OF LYMPH NODES IN CARCINOMA OF THE UTERINE CERVIX

by

INGEMAR JOELSSON, ANDERS BÄCKSTRÖM, JAN DIEHL and CURT LAGERGREN

Analysis of the results of radiation treatment of carcinoma of the cervix uteri at Radiumhemmet reveals that during the ten year period 1948—1957 the five year apparent recovery rate was considerably better than during the preceding decade. This applied particularly to clinical stages I and II a, but less so to the stage II b and III. It appears that the improvement may be due at least in part to changes in intracavitary treatment policy with increased regard to the requirements of the individual patient. The principles of supplementary external irradiation to the parametrium remained the same.

Intracavitary treatment has not been altered since 1957 but the external therapy has been modified significantly. For purpose of comparison certain years have been taken as representative. For example during the period 1958—1959 conventional roentgen rays were given to the parametrium through four portals.

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Table 1

Corrected survival rate figures for those stage II b and III cases from the consecutive series of carcinoma of the uterine cervix, which were treated with conventional roentgen rays, and ^{60}Co, two opposed beams, and ^{60}Co, three beam technique, respectively. Frequency of complications from bladder and rectum are given as 3- and 5-year corrected rates for the combined stage II b and III cases using the grading system defined by KOTTMEIER *(1964). Figures obtained from an analysis of case reports at Radiumhemmet* (JOELSSON *1970*).

	Conventional roentgen rays, four portals 1958—1959		Cobalt 60, two opposed beams 1960—1962		Cobalt 60, three beam technique 1964—June 1966	
	Stage II b	Stage III	Stage II b	Stage III	Stage II b	Stage III
Number of patients	138	57	42	65	37	71
Percentage of total	72 %	42 %	16 %	42 %	22 %	58 %
3-year corrected survival rate	61 %	34 %	53 %	25 %	52 %	43 %
5-year corrected survival rate	48 %	31 %	42 %	24 %	—	—
Bladder complications grade II to III						
3-year corrected rate	6 %		15 %		2 %	
5-year corrected rate	8 %		15 %		—	
Rectal complications grade II to IV						
3-year corrected rate	8 %		20 %		9 %	
5-year corrected rate	10 %		20 %		—	

During 1960—1962 some patients were treated with two opposed cobalt 60 beams; in 1964 a cobalt 60 three beam technique with individual dose planning was introduced.

The patients in the second and third groups were selected in that those with conditions more advanced than the average were treated with high energy radiation while those in the first group formed an unselected series. Within the respective clinical stages, the 5- and 3-year survival rates are not strikingly different in the three periods (Table 1). The only tendency towards the superiority of high energy therapy with doses of about 4 500 rad to the parametrium over 5 to 7 weeks, is found in the series of stage III patients receiving individually planned cobalt 60 by the three beam technique. However, the series are small and only 3-year follow-up figures are available.

Several points must be considered as to the factors that may be used by the clinician as a guide in attempts to increase the cure rate. Interest at Radiumhemmet has for example been focused upon the correlation between the histology and prognosis (WETTERDAL 1934) as well as upon the possible prognostic guid-

ance from serial biopsies during treatment time (KOTTMEIER 1959). The sensitization and radiation responses in carcinoma of the cervix have been thoroughly investigated by KJELLGREN (1958) and RUBIO et coll. (1965). All these studies have contributed greatly towards our present understanding of the subject, even though the situation is still not clear.

The present authors have consequently resorted to the physical aspects and have investigated the dose distribution in the pelvis from routine intracavitary radium treatment. Special attention has been paid to the lymph nodes along the iliac vessels, which are recognized as highly likely to be involved by carcinoma even in the early clinical stages. The topography of these nodes has also been correlated to the tissue volume irradiated homogeneously by supplementary external treatment.

Methods. Ten patients, 5 with stage I b carcinoma and 5 with stage II a were chosen; four of the patients had an exophytic tumor growth, three had disc-shaped tumors and in three patients the carcinoma was endocervical.

Lymphography was performed after insertion of a cannula into a lymphatic vessel on the dorsal surface of the foot (RÜTTIMANN 1962, TJERNBERG 1962). Lipiodol Ultra Fluide (0.48 mg iodine/ml) was injected at a rate of 0.12 to 0.15 ml/min in a total amount of 8 ml to each side. The lymph vessels running along the external and common iliac vessels may be observed during the injection procedures on films taken at this time. The location and the characteristics of the lymph nodes may be studied twenty-four hours later. The external iliac lymph nodes and the common iliac lymph nodes may be subdivided into lateral, intermediate and medial groups, as already proposed. The internal iliac lymph nodes are seldom demonstrated by this technique. The subdivisions of the parietal nodes of the internal iliac lymph node system are the superior and inferior gluteal, the obturator and the lateral sacral lymph nodes. The visceral nodes of the same system are those of the bladder, the para-uterine tissues and the rectum (KUBIK et coll. 1967). In the literature the lymph nodes between the external and the internal iliac arteries are sometimes called the interiliac nodes and are subdivided into the hypogastric nodes in the angle between the external and the internal iliac arteries, and the obturator nodes in the obturator fossa cranial to the obturator artery (REIFENSTUHL 1967).

Phlebography was carried out after inserting polythene catheters percutaneously into both common iliac veins. One hundred milliliters Urografin 45 % were injected into both tubes at a rate of 5 to 8 ml/sec when the tips of the catheters lay close to the internal iliac veins. The inferior vena cava was blocked with a rubber balloon pressed against the abdomen with a plastic plate

held by a belt (HELANDER & LINDBOM 1955). The a.p. and lateral roentgen films were sometimes supplemented with oblique views.

Thermoluminescence dosimetry. Commercially available detectors, lithium fluoride (LiF) in teflon, 6 mm long and 1 mm in diameter, were introduced between spacers of lead, 7 mm long and 1 mm in diameter, in a teflon catheter, with an outer diameter of 1.8 mm. Each catheter was loaded with 18 detectors.

The teflon catheters were inserted percutaneously into the femoral veins immediately before the radium application under roentgen TV control until the tips lay in the inferior vena cava. They were fixed in position and their location recorded with a.p. and lateral roentgen films. The catheters remained in the veins during the primary radiation treatment of the patient which consisted of combined intra-uterine and intravaginal radium application with the current Stockholm technique (KOTTMEIER 1964).

After removal of the radium from the patient the catheters were withdrawn and the separate detectors were recovered in order and numbered. A partly rebuilt commercial instrument (Con-Rad read-out instrument, model 5100 A) was used for the determination of the dose on each detector, employing its individual calibration factor. Various sources of error can be discriminated and reduced in using thermoluminescence LiF (CARLSSON 1969). The standard deviation varied between 6.6 and 8.7 % of the mean in a study of 10 detectors, treated in the same way as those in the study, and run through eight exposure events.

Dose rate measurement in the bladder and rectum was performed with a Siemens Gammameter by a technique described in detail in a previous paper (JOELSSON & BÄCKSTRÖM 1969). The important features will be repeated:

The centimeter graduated probe of the Siemens Gammameter was introduced into the urinary bladder and starting 12 to 13 cm cranial to the orifice of the urethra, the values of dose rates were noted during its withdrawal. Attention was paid to the mean of the three highest, consecutive measurement values at centimeter intervals. Similar measurements in relation to the anal sphincter were performed in the rectum.

All the measurements were made with the patient supine, immediately after the application of the irradiators. They were repeated at the end of the treatment immediately before removal of the radium.

The mean of the values determined at the beginning and at the end of the treatment were used as the definitive. The fact that the Siemens Gammameter was calibrated at room temperature but used at body temperature was considered only when dose rates in bladder and rectum were related to doses measured by LiF dosimetry. The observation that the reading of the instrument was lowered by 0.7 % per degree centigrade in temperature was made recently (JOELSSON & BÄCKSTRÖM 1969). Uncorrected figures have been used earlier and have also been correlated to frequency of complications (KOTTMEIER 1964).

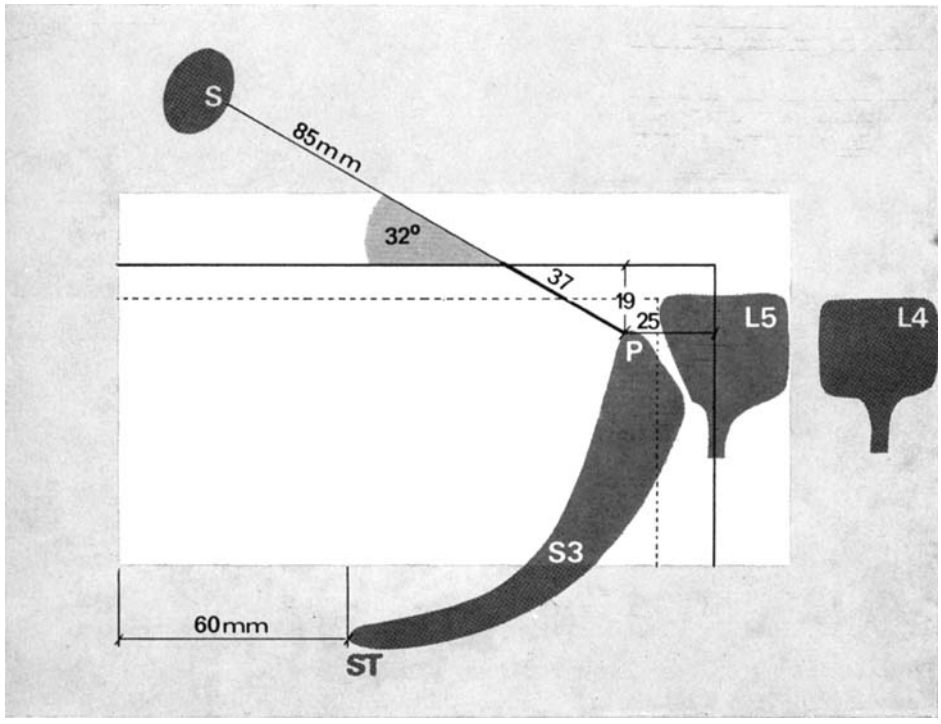

Fig. 1. The relationship between the target volume and the pelvic structures. The ventral and cranial surfaces of the volume together with the limits of variation. Figures of distances are mean values in mm for the 10 patients under investigation. Due to individual differences in the inclination of the pelvis in supine position the angle formed by the ventral surface of the target volume and the line between the symphysis pubis (S) and the promontory of the sacrum (P) varied between 23° and 53°, mean 32°. The mean distance between the caudal surface of the target volume and the tip of the sacrum (ST) was 60 mm. S3 = middle part of the third vertebra.

Supplementary external irradiation. Dose planning was performed for external cobalt 60 therapy by the three beam technique developed at Radiumhemmet (RANUDD 1965). The target volume which was to be surrounded by the 95 % isodose curve was carefully determined in each individual instance after thorough clinical examination of the anesthetized patient. The extension of the target volume in the ventrodorsal direction was defined by the size of the tumor as estimated bimanually with the addition of 2 cm ventrally and 2 cm dorsally. Laterally the target volume was extended to the pelvic wall, and in the 10 patients was found to be 16 cm wide. The cranial-caudal range of the target volume was taken as 16 cm, symmetrically distributed around the center of the tumor. This was represented in the a.p. and lateral roentgen films by means

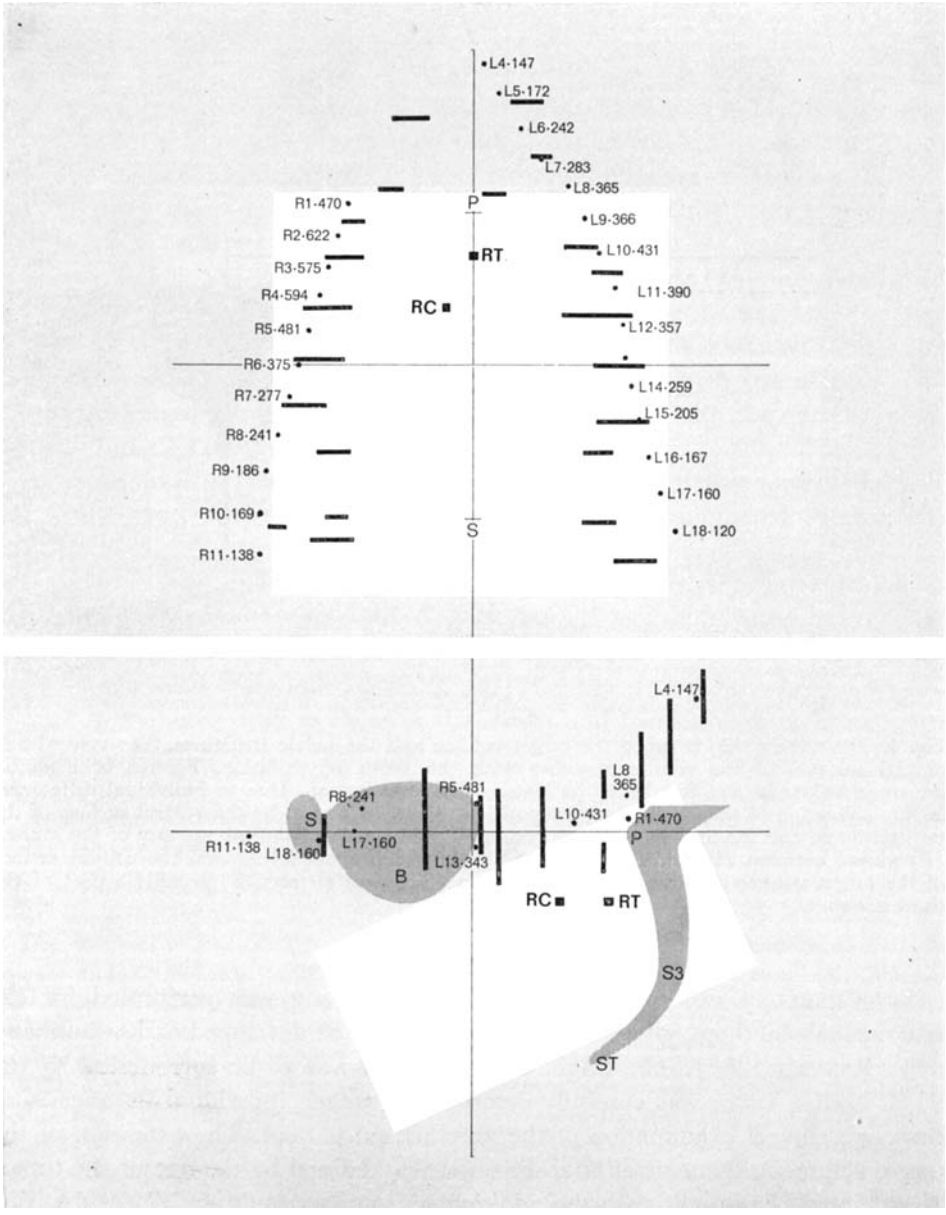

Fig. 2. Stage I b. Exophytic carcinoma. The intra-uterine irradiator contains 61 mg Ra (active length 40 mm) and the vaginal flat box 71 mg Ra. Treatment time 24 hours. Dose at the posterior wall of the bladder 2 030 rad, at the anterior wall of the rectum 2 260 rad.

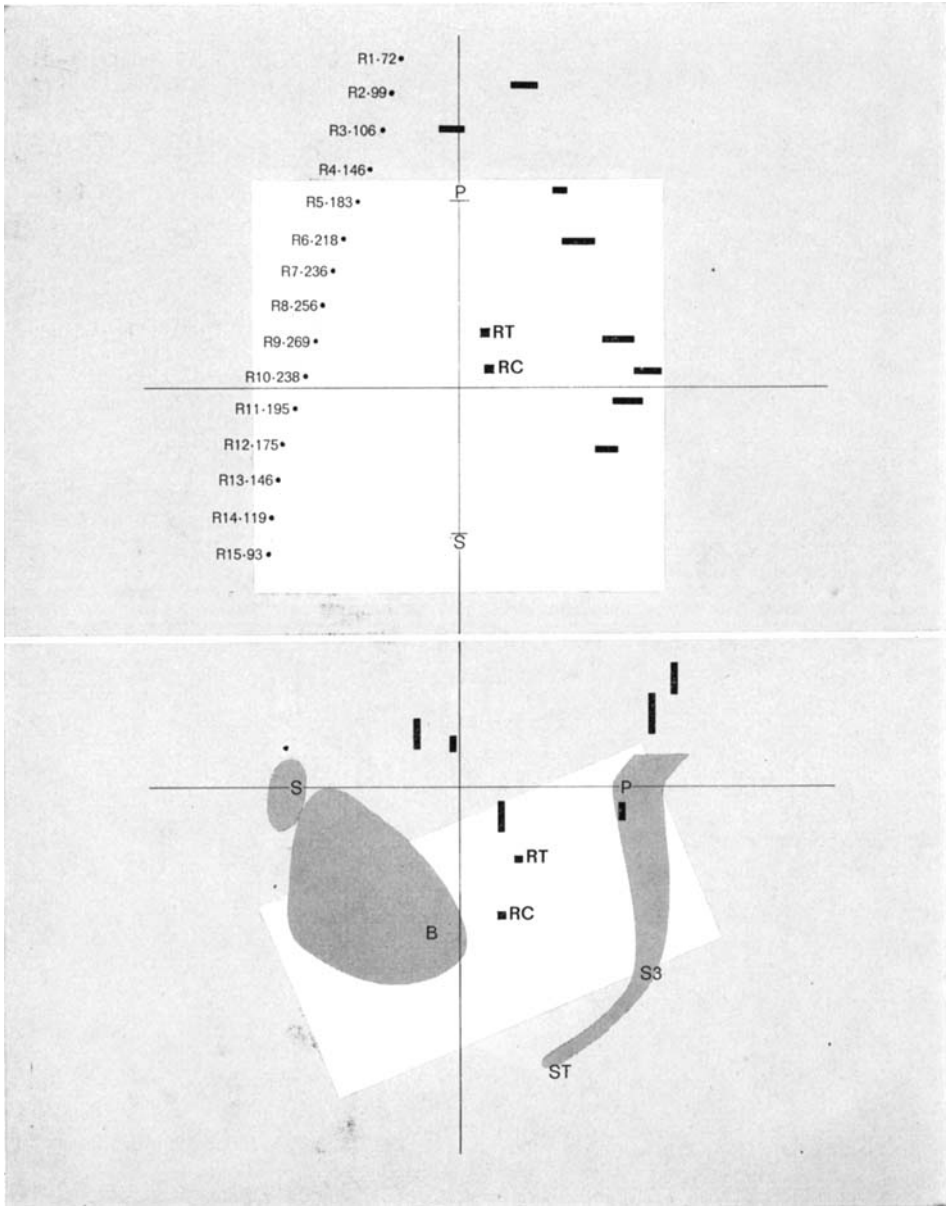

Fig. 3. Stage I b. Endocervical carcinoma. 61 mg Ra, 40 mm active length in uterus. Flat box, 71 mg Ra, in vagina. Treatment time 25 hours. Bladder dose 2 110 rad, rectal dose 1 730 rad.

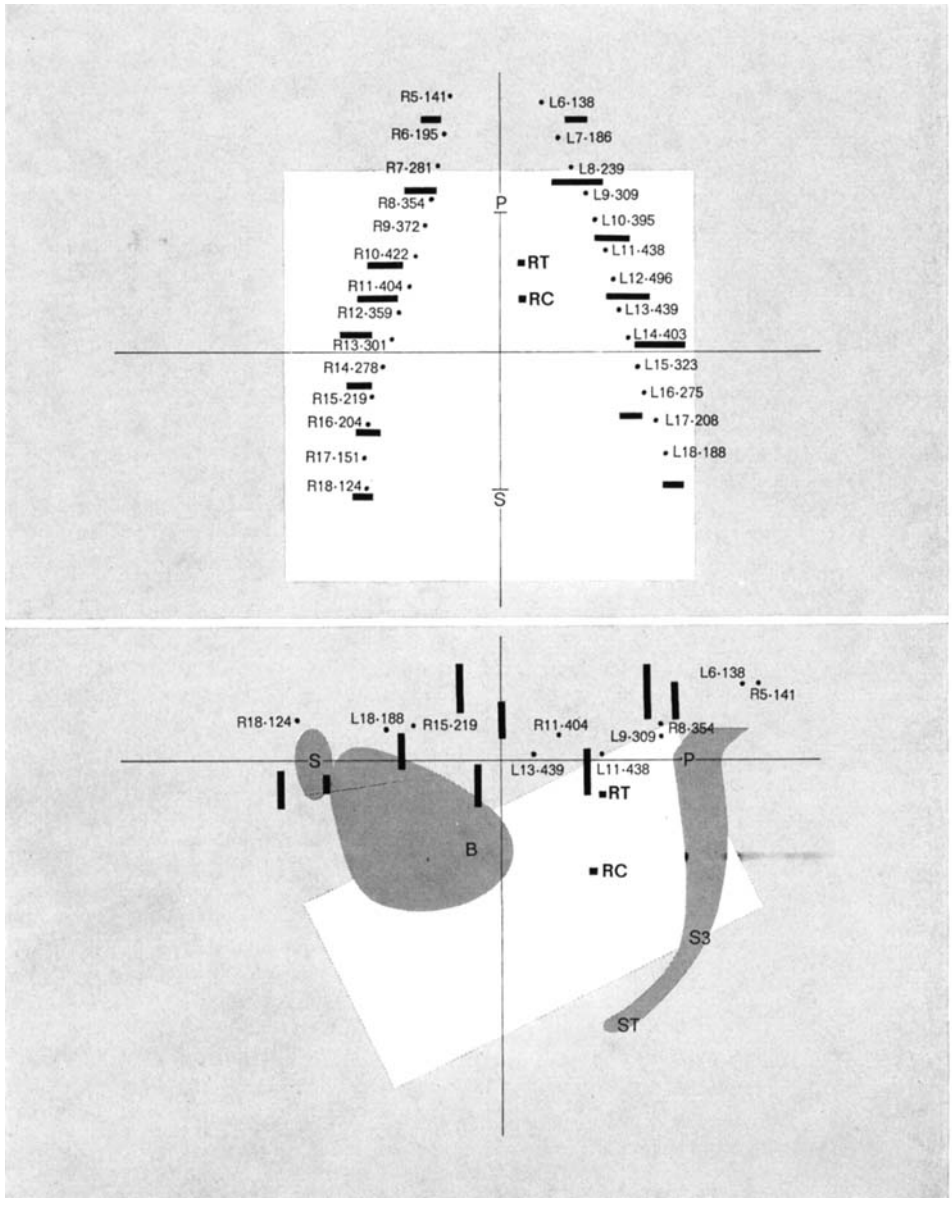

Fig. 4. Stage I b. Exophytic carcinoma. 43 + 54 mg Ra intra-uterine tandem, 16 + 27 mm active length. 71 mg Ra in flat box in vagina. Treatment time 25 hours; 2 090 rad to the bladder, 1 790 rad to the rectum.

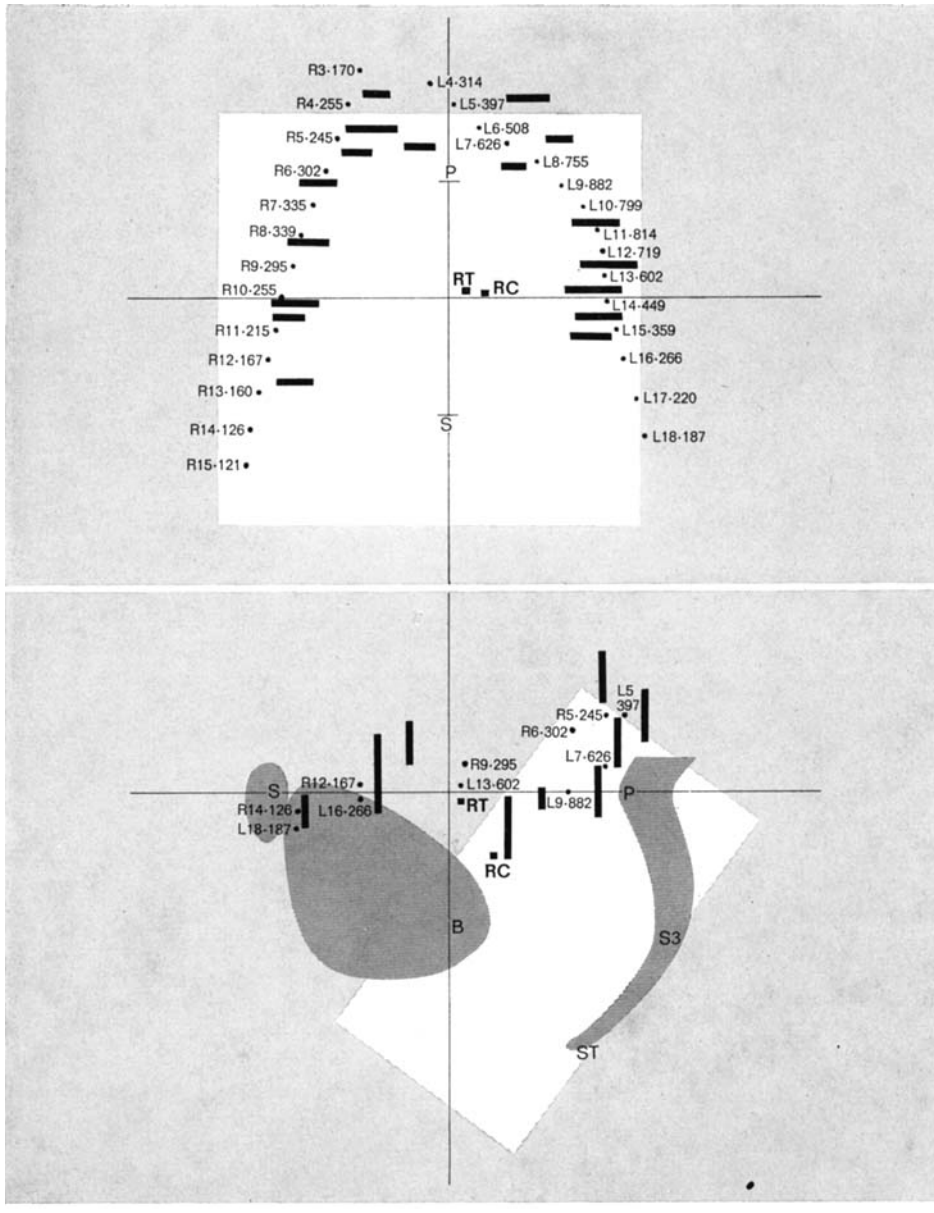

Fig. 5. Stage I b. Endocervical carcinoma. 68 mg Ra, 45 mm active length in uterus. Flat box, 71 mg Ra, in vagina. Treatment time 28 hours; 2 200 rad to the bladder and 1 640 rad to the rectum.

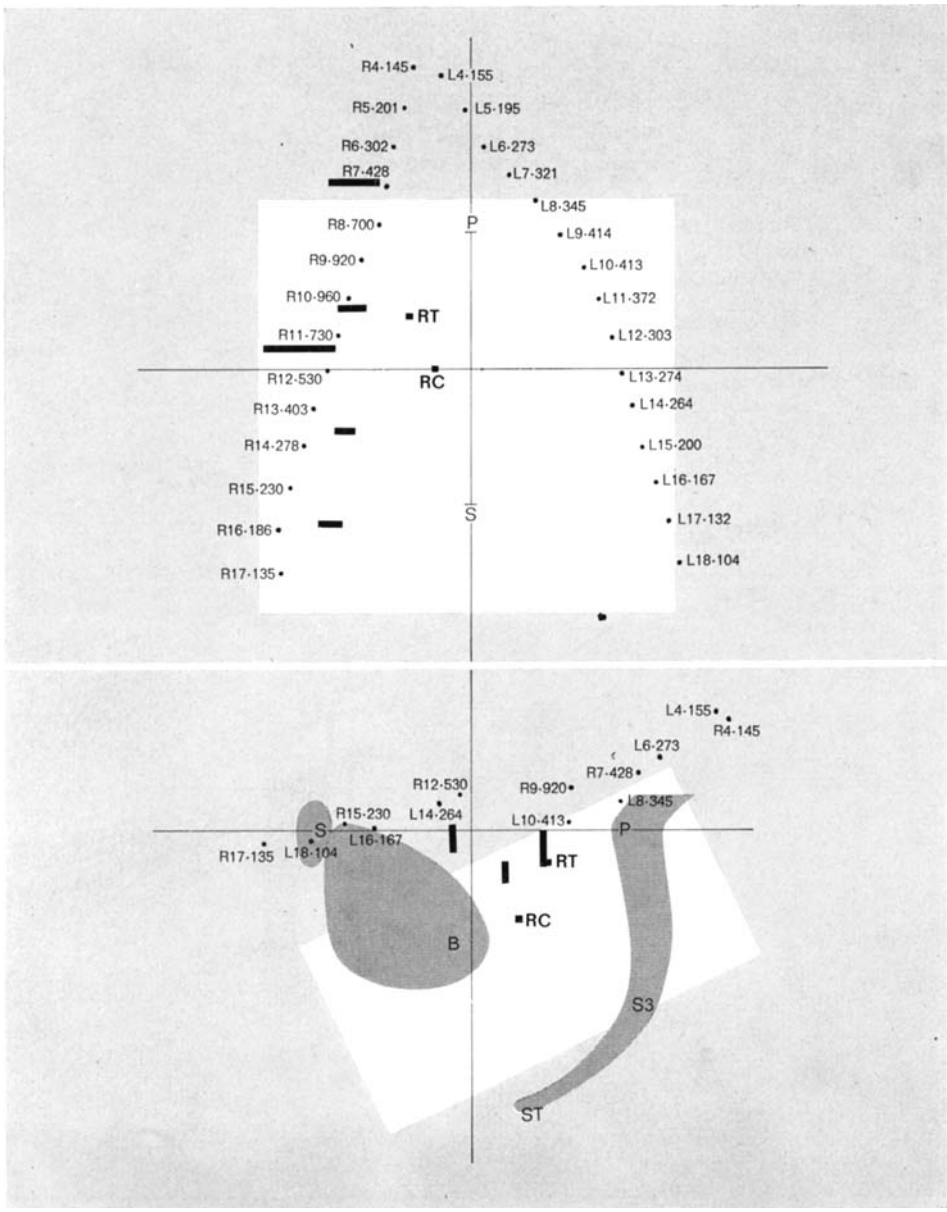

Fig. 6. Stage I b. Endocervical carcinoma. 68 mg Ra, active length 45 mm in uterus. 71 mg Ra in flat box in vagina. Treatment time 22 hours; 2 410 rad to the bladder and 2 180 rad to the rectum.

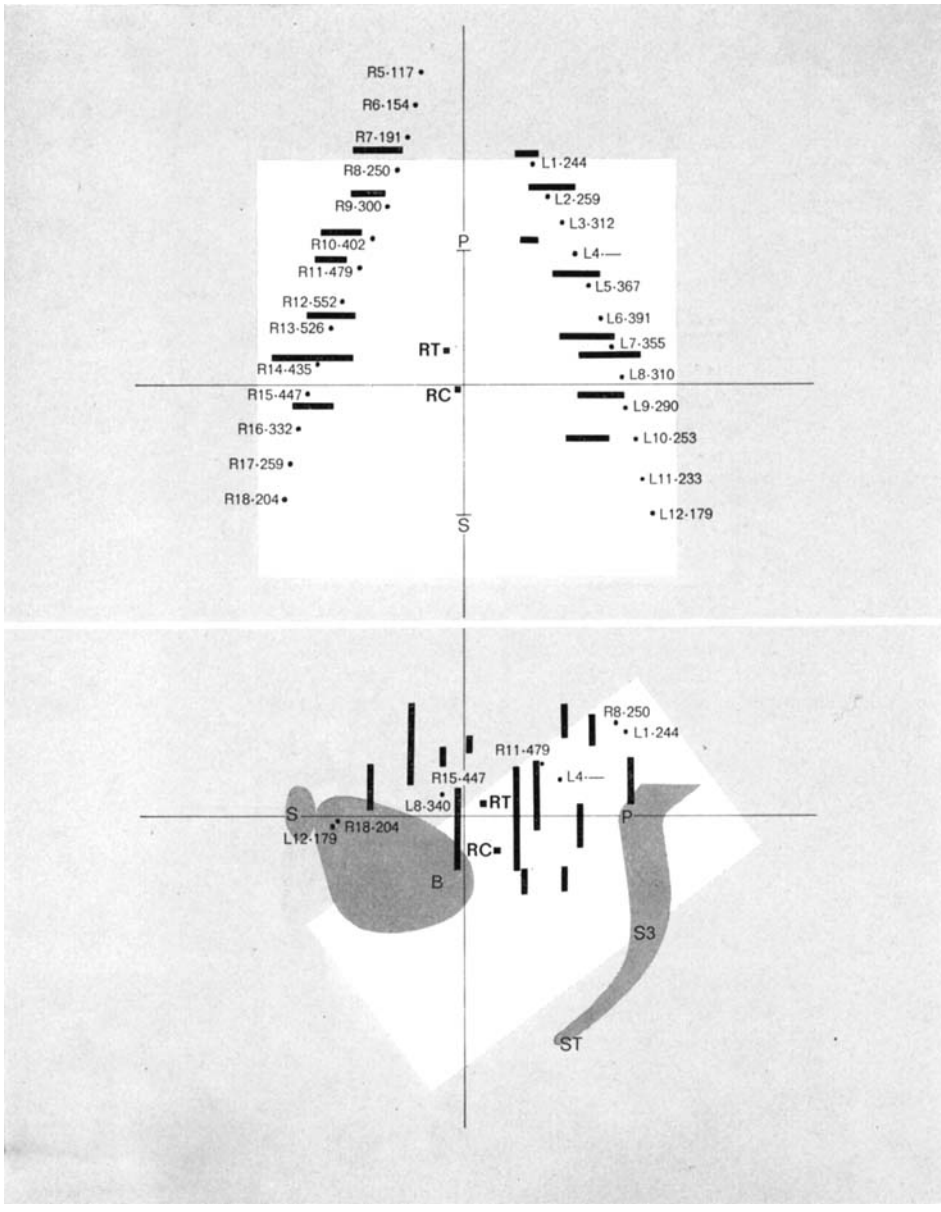

Fig. 7. Stage II a. Exophytic carcinoma, cauliflower type. 62 mg Ra, active length 39 mm in uterus. 80 mg Ra, flat box in vagina. Treatment time 22 hours; 2 380 rad to the bladder and 2 640 rad to the rectum.

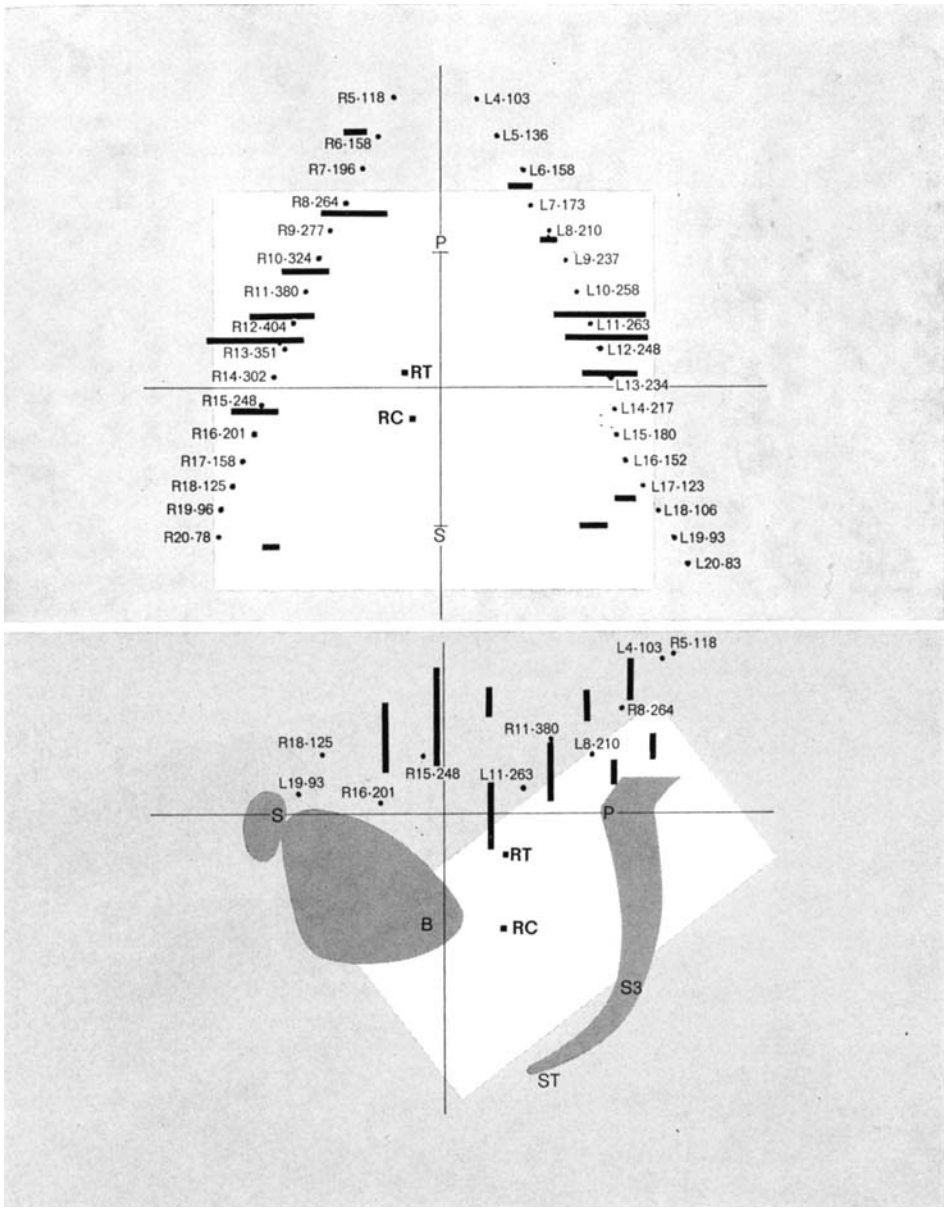

Fig. 8. Stage II a. Disc-shaped carcinoma. 70 mg Ra, active length 54 mm in uterus. 71 mg Ra in flat box in vagina. Treatment time 26 hours; 1 330 rad to the bladder and 1 940 rad to the rectum.

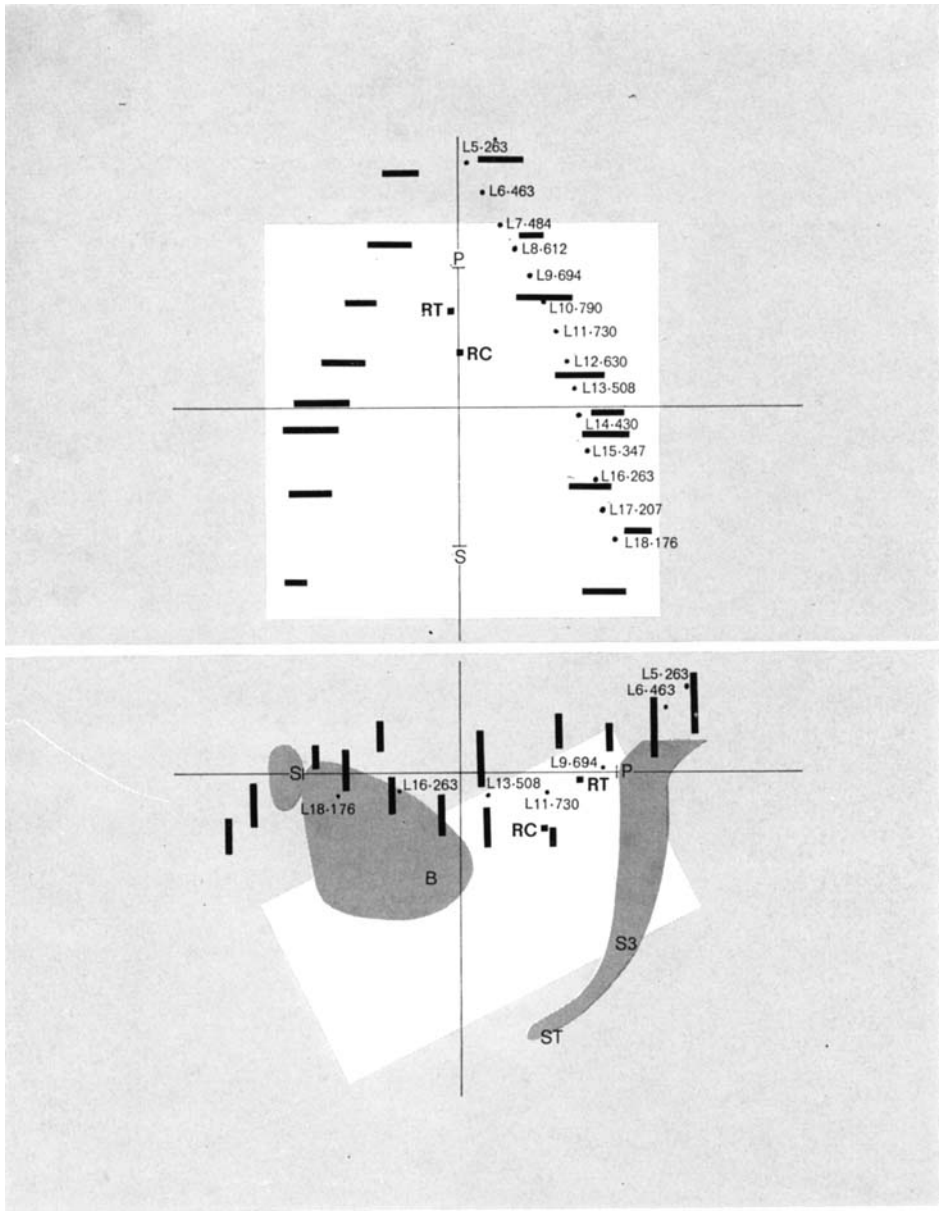

Fig. 9. Stage II a. Exophytic carcinoma. 68 mg Ra, active length 45 mm in uterus. Flat box, 72 mg Ra, in vagina. Treatment time 22 hours; 2 280 rad to the bladder and 2 590 rad to the rectum.

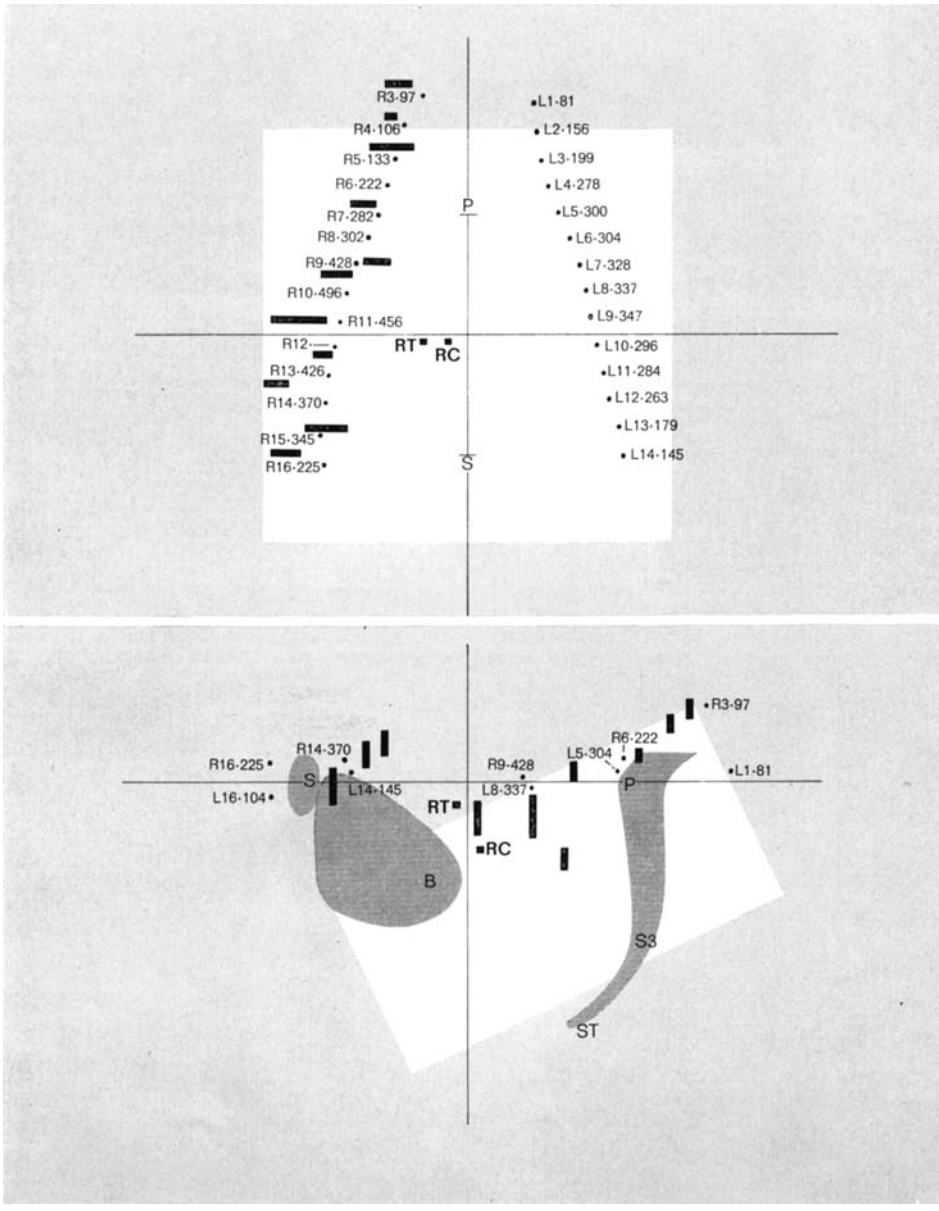

Fig. 10. Stage II a. Exophytic carcinoma. 68 mg Ra, active length 45 mm in uterus. Curved box, 77 mg Ra, in vagina. Treatment time 22 hours; 1 800 rad to the bladder and 3 090 rad to the rectum.

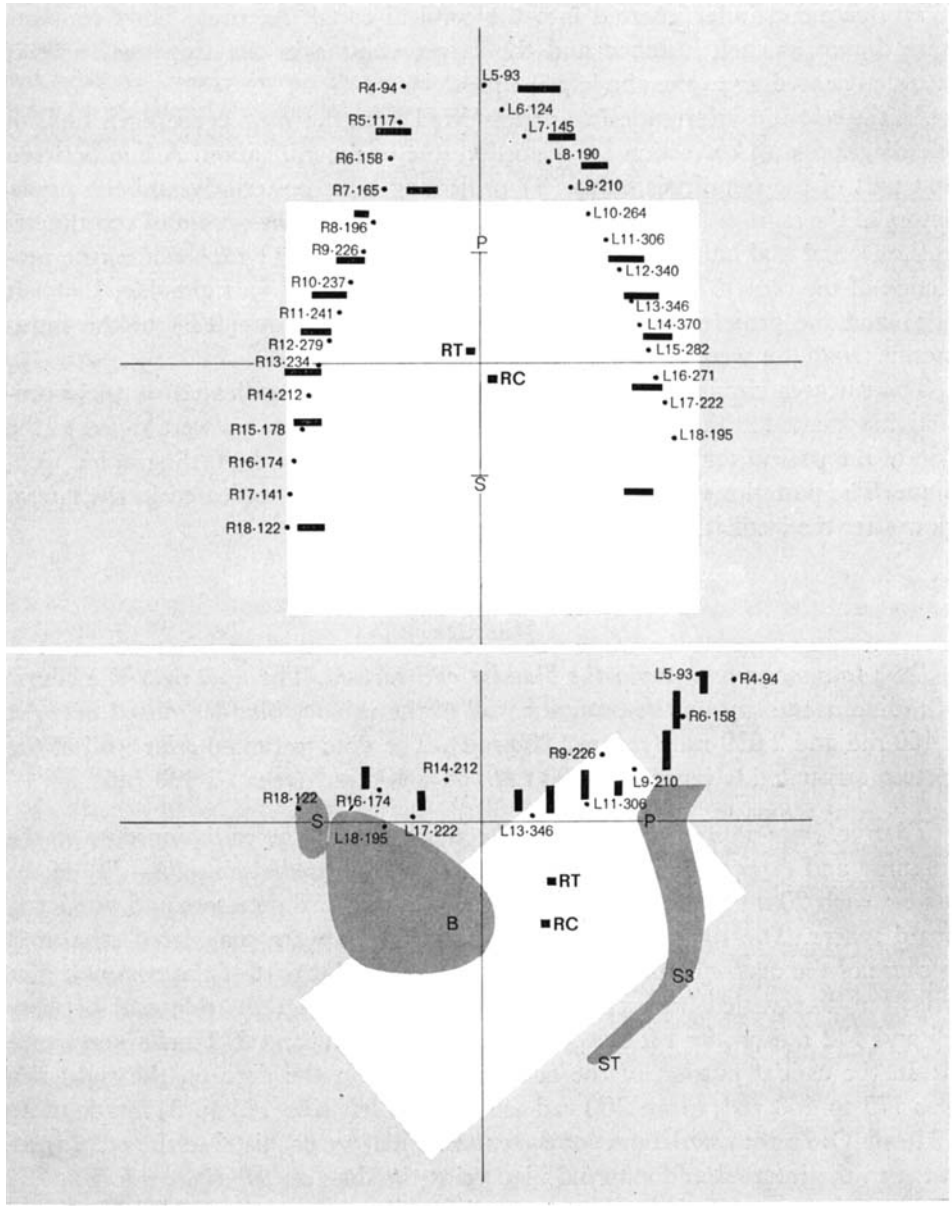

Fig. 11. Stage II a. Disc-shaped carcinoma. 62 mg Ra, active length 39 mm in uterus. 84 mg Ra in flat box in vagina. Treatment time 26 hours; 1 430 rad to the bladder and 2 020 rad to the rectum.

of an opaque cylinder inserted into the cervical canal. Accurate body contours were drawn in each instance and the target volume in the transverse section recorded according to the above principles.

All the relevant information was transferred from the various roentgen films to one diagram with correction for distortion due to magnification. A line between that part of the symphysis pubis (S) projecting most posteriorly and the promontory of the sacrum (P) was chosen as the main axis of the system of coordinates in the frontal and lateral views. The representation of the lymph nodes, the projection of the centers of the lithium fluoride detectors, (R = right side, L = left side) and the projection of the center (RC) and the top (RT) of the intrauterine irradiator were all referred to this axis (Figs 2 to 11).

The surfaces circumscribing the target volume were indicated as their projection appeared in the frontal and lateral views. Metal frames were taped to the skin of the patient and demonstrated on roentgen film by the orthographic technique. The posterior wall of the urinary bladder (B) was indicated in the lateral view after the instillation of 50 ml Urografin 30 %.

Results

Dose rate measurements in the bladder and rectum. The dose over one course of radium treatment on the posterior wall of the urinary bladder varied between 1 460 rad and 2 650 rad (mean 2 200 rad). The dose to the anterior wall of the rectum amounted to between 1 800 rad and 3 400 rad (mean 2 400 rad).

Thermoluminescence dosimetry in the pelvic veins. The radiation dose to the common and external iliac veins, were referred to four divisions (A—D) of the vessels, each 20 mm in length, corresponding to two LiF detectors and one interposed spacer. The right and left sides of the pelvis were considered separately because of the anatomic inequalities. A: In the cranial part of the common iliac vein, the dose varied between 87 and 300 rad on the right side and between 95 and 472 rad on the left side, mean values 173 rad and 232 rad respectively. B: In the caudal portion of the common iliac vein the dose on the right side was 175 to 468 rad, mean 300 rad and on the left side 145 to 817 rad, mean 381 rad. C: In the cranial part of the external iliac veins, distal to the confluence between the internal and external iliac veins the dose on the right side was 230 to 808 rad, mean 410 rad, while on the left side corresponding values were 190 to 805 rad with a mean of 443 rad. D: In the caudal part of the external iliac vein, cranial to the inguinal ligament the dose on the right side ranged between 252 and 628 rad, mean 382 rad, and on the left side between 254 and 659 rad, mean 360 rad.

Table 2

Radiation doses during one course of intracavitary radium treatment to separate parts of the veins in rad as mean values and limits of determinations in ten patients. The values for the cranial and caudal parts of the common and external iliac veins and for the femoral vein are based on measurements of two LiF detectors for each patient. Correction has been made for the contribution from diagnostic roentgen procedures. Data on irradiators used are given in Figs 2 to 11.

	Inferior vena cava	Common iliac vein			External iliac vein			Under inguinal ligament
		Cranial A	Middle	Caudal B	Cranial C	Middle	Caudal D	
Right side								
Mean	110	173	195	300	410	473	382	310
Limits	53—171	87—300	116—273	175—468	230—808	239—958	252—628	210—445
Left side								
Mean	146	232	297	381	443	384	360	285
Limits	57—261	95—472	188—508	145—817	190—805	246—567	254—659	203—497

The location of the catheters in some of the patients allowed determinations to be made on detectors in the inferior vena cava and in the middle parts of the common and external iliac veins. The detector exactly posterior to the inguinal ligament was always considered separately. The complete list of determinations is given in Table 2.

Diagnostic roentgen films were taken with the LiF detectors in place. A special study disclosed that the contribution to the thermoluminescent signal from these procedures, was 2 to 3 rad. The values in the text and in Table 1 are accordingly corrected while in Figs 2 to 11 the uncorrected dose determinations are given for each specific detector.

The effect on the thermoluminescent detectors from the lead spacers between them in the teflon catheters was investigated in a separate study although no measurable contribution to the signal was anticipated. The results of the measurements indicate no detectable influence on the signal of the detectors from the spacing with lead.

Topography of target volume for supplementary external irradiation. It was a consistant finding that in the a.p. projection the cranial surface of the target volume was located 1 to 4 cm cranial to the promontory (Figs 2 to 11, upper halves). Related to the finding at phlebography the cranial surface of the volume crossed the middle parts of the common iliac veins. The frontal projection of the caudal surface of the target volume in all cases extended caudally to the symphysis pubis by 3 to 5 cm; thus in this view the caudal surface crossed the femoral veins

Table 3

Frequency of lymph node inolvement (%) in stage I and II carcinoma of the uterine cervix. The patients underwent operation as primary treatment and lymphadenectomy was performed compulsory. (From REIFENSTUHL *1967 and the references therein.)*

	Number of patients	Stage	
		I	II
ANTOINE (1959), (FROEWIS & ULM)	544	8.5	27.9
DE BIASI (1954), (PAPADIA)	135	20.7	31.9
BRUNSCHWIG & ROESLER (1957)	74	14.0	34.0
CARTER et coll. (1953)	79	16.7	25.9
CATTANEO (1954), (MARZIALE)	66	20.0	—
CHRISTENSEN et coll. (1955)	100	21.3	41.0
CURRIE (1962)	339	16.0	38.0
GRAY (1958)	61	11.0	35.0
GUSBERG et coll. (1953)	64	10.0	31.0
KIMBROUGH (1959)	84	34.0	51.0
LANGE (1960)	178	28.8	43.8
LIU & MEIGS (1955)	258	17.0	40.0
MARTINEZ et coll. (1953)	442	23.0	41.0
MEDINA et coll. (1959)	60	20.0	40.0
MEIGS & MORTON (1958)	130	18.0	37.0
MITANI et coll. (1957)	182	39.9	33.6
MITANI et coll. (1962)	78	30.2	—
MITRA (1959)	192	18.0	29.0
MORTON et coll. (1952)	89	15.0	24.0
NAVRATIL (1955)	180	20.0	29.0
PARSON (1962)	80	13.0	22.0
SHERMAN et coll. (1952)	176	12.0	29.0
TACHIBANA (1956)	416	12.0	23.7
WELCH et coll. (1961)	383	12.0	24.0

below the inguinal ligaments. The lateral surfaces of the target volume in every instance enclosed the frontal projection of the lymph nodes although the margin was small.

In the lateral view the intersection between the projection of the ventral surface of the target volume and the line connecting the promontory of the sacrum with the symphysis pubis was located a sixth to a half (mean a third) of its length from the promontory (Fig. 1 and Figs 2 to 11, lower halves). The angle between the projection of the ventral surface of the target volume and the conjugate diameter varied between 23° and 53° (mean 32°). The lateral projection of the ventral surface of the target volume was 0.8 to 3.7 cm (mean 1.9 cm) ventral

to the promontory. The cranial surface of the target volume was evident at a distance of 0.7 to 4.5 cm (mean 2.5 cm) cranial to the promontory. The projection of the dorsal surface of the target volume, which was always parallel to the firm support of the patient, usually crossed the sacrum at about the middle of its third vertebra. The caudal surface of the tumor volume was located 2.5 to 8.0 cm (mean 6 cm) caudal to the tip of the sacrum.

It is apparent from the results that the projection of the ventral surface of the target volume crossed the distal part of the common iliac vein or the proximal part of the external iliac vein. The lymph nodes along the external iliac vessels were located outside the target volume in the ventral direction. The target volume enclosed the posterior part of the urinary bladder in all but one patient. Although the rectum was not demonstrated on the roentgen films it was concluded that a part was within the target volume.

Discussion

The fact that survival rates in carcinoma of the cervix uteri are about the same irrespective of differences in techniques should not produce a nihilistic feeling with no attempt being made to improve the results with the facilities now available. The survival rates in early stages of carcinoma of the cervix have already been raised to such a level that a reduction of adverse side effects of treatment may be considered a worth while objective on its own.

High energy therapy makes it possible to deliver a cancericidal dose to the whole pelvis with one or two ventral and dorsal beams, and at Radiumhemmet this technique has been applied in several patients with stage II b and III carcinoma of the uterine cervix. No individual dose planning was performed during the period 1960—1963. Between 2 000 and 5 000 rad (mean 3 700 rad) were delivered over 4 to 5 weeks. An analysis of the patients in stage II b who received cobalt 60 irradiation with two opposed beams in addition to one or two intracavitary applications of radium reveals that the 3- and 5-year survival rates were not statistically different from the figures for those who received conventional roentgen ray irradiation. The same applies to the patients with stage III carcinoma. The differences may be partly explained by the fact that only a small proportion of the total number of patients in stage II b during the time under review were treated with two opposed cobalt beams. In contrast to that in the roentgen ray series, almost three fourths of the patients received the specified treatment, which invalidates too close a comparison between survival rate figures (Table 1). It is of interest however, to find that the frequency of complications from the urinary bladder grade II to III was raised from 6 % (conventional roentgen rays) to 15 % (^{60}Co, two opposed beams) and the

frequency of rectal complications grade II to IV from 8 % to 20 %. (For the grading system the reader is referred to KOTTMEIER 1964.)

It was hoped that a more accurate administration of the dose to the tumor area and especially to the internal iliac and common iliac lymph nodes with the three beam technique established in recent years might improve the results without causing damage to normal tissue. This technique in combination with individual dose planning and absorbers of special size and shape in the frontal beam during a number of the fractions also reduces the dose to the anterior part of the bladder and posterior part of the rectum. Only three-year figures are available at the present time and even if these do not consistantly indicate any superiority of the technique as regards survival, a clear tendency towards a decreased incidence of complications exists in spite of an average dose of 4 500 rad (2 500 to 6 700 rad) over 5 to 7 weeks.

The routes of spread of carcinoma of the cervix are into the vaginal mucosa, into the myometrium of the lower uterine segment and into the network of lymphatics of the paravaginal as well as the paracervical tissues. Combined statistics in the literature present figures of involvement of the nodes at the pelvic wall of between 15 and 20 % in stage I carcinoma, and 30 to 35 % in stage II carcinoma (Table 3). The variation in the figures are to some extent dependent upon whether single or serial sections of the lymph nodes have been studied. A considerable increase in lymph node involvement has been observed by some authors when serial sections have been examined (LANGE 1960, AHRENS & TSCHOKE 1961, HUHN 1962 and MITANI et coll. 1962). It is known that a considerable proportion of involved nodes are to be found along the external iliac vessels (cf. REIFENSTUHL 1967). The doses to the common and the external iliac vein are comparatively low with intracavitary radiation methods and compared to the doses to the posterior wall of the bladder and the anterior wall of the rectum the doses at the pelvic wall are five to eight times smaller. Doses of similar magnitude measured both by intravascular thermoluminescence detectors (TJERNBERG et coll. 1968) and with an ionization chamber during the procedure of extraperitoneal lymphadenectomy (KOTTMEIER 1951) have been reported earlier. The correlation between isodose rates around the combined intra-uterine and vaginal irradiators and pelvic anatomy reported by WALSTAM (1954) are also in agreement with the observations in the present study.

The magnitude of the supplementary dose to be given to the parametrium by external irradiation is determined in each instance by the stage of the disease and condition of the patient. The three beam technique produces steep dose rate gradients towards the surrounding tissue, and necessitates the inclusion of relevant tissues in the target volume. The observation is described in this paper that the routine three beam technique may well exclude some potentially malignant

tissue. It is reasonable to postulate that a modification of the technique of external irradiation to include the lymph nodes along the external iliac vessels in the target volume would be to the advantage of the patient and lead to an improvement in the survival rates. Changes have therefore been considered along different lines. The simplest modification implies an increase in the load on the ventral beam by a factor of two or more. If high energy electrons are available another choice will be two frontal electron beams as a supplement to the original three beam technique. The electron portals can be designed so that they obliquely transverse the frontal cobalt 60 field and cover the lymph node chain only. The energy of the electrons must be adapted to the individual patient within the limits of 15 to 25 MeV.

SUMMARY

A series of patients examined with lymphography, phlebography, LiF dosimetry and localization of the target volume disclosed that the pelvic wall dose from intracavitary treatment was small and that the three beam technique for external cobalt irradiation failed to include the lymph nodes along the external iliac vessels. This finding necessitates a modification of the technique. A redistribution of the loads of the three beams or the addition of high energy electron beams are suggested.

ZUSAMMENFASSUNG

Es zeigte sich bei der Untersuchung von einer Serie von Patienten mittels Lymphographie, Phlebographie, LiF-Dosimetrie und nach Messung der Tiefendose, dass die Dosis zur Wand der Pelvis bei intrakavitärer Behandlung niedrig war und dass die Dreifelderbestrahlung mit der Kobaltbombe die Lymphknotengruppe entlang der A. iliaca externa nicht genügend erfasst. Hieraus ergiebt sich, dass eine Abänderung der Technik nötig ist. Eine Neuverteilung der Felder ist notwendig oder die Zugabe von zusätzlichen Feldern von hochgeschwindigen Elektronenstrahlen.

RÉSUMÉ

Les examens au moyen de lymphographie, phlébographie, dosimétrie par LiF et la localisation du volume cible, chez une série de malades atteintes de cancer du col de l'utérus, ont montré que la dose à la paroi du bassin est petite et que la technique d'irradiation externe au cobalt par trois champs n'inclue pas les ganglions lymphatiques situés le long des vaisseaux iliaques externes. Cette constatation impose une modification de la technique. Les auteurs proposent une répartition différente des doses faites par les trois champs ou l'addition d'une irradiation par des électrons de haute énergie.

REFERENCES

AHRENS C. A. und TSCHOKE S.: Lymphknotenbefunde nach Wertheim-Meigscher Operation. Geburtsh. u. Frauenheilk. 21 (1961), 219.

CARLSSON C. A.: Thermoluminescence of LiF: dependence of thermal history. Phys. in Med. Biol. 14 (1969), 107.

HELANDER C. G. and LINDBOM Å.: Sacrolumbar venography. Acta radiol. 44 (1955), 410.

HUHN F. O.: Drüseneinschlüsse in Beckenlymphknoten und Endometriose. Geburtsh. u. Frauenheilk. 22 (1962), 335.

JOELSSON I.: A study of three different techniques of supplementary external irradiation in carcinoma of the uterine cervix with special reference to frequency of complications and to survival rate. To be published in Acta radiol.

— and BÄCKSTRÖM A.: Dose rate measurements in bladder and rectum. Intracavitary radiation of carcinoma of the uterine cervix. Acta radiol. Ther. Phys. Biol. 8 (1969), 343.

KJELLGREN O.: The radiation reaction in the vaginal smear and its prognostic significance. Studies on radiologically treated cases of cancer of the uterine cervix. Acta radiol. (1958) Suppl. No. 168.

KOTTMEIER H. L.: Studies of the dosage distribution in the pelvis in radium treatment of carcinoma of the uterine cervix according to the Stockholm method. J. Fac. Radiol (Lond.) 2 (1951), 312.

— Do serial biopsies disturb the healing process of the irradiated cervical canal. Acta cytol. (Philad.) 3 (1959), 397.

— Surgical and radiation treatment of carcinoma of the uterine cervix. Acta obstet. gynec. scand. (1964) Suppl. No. 2.

— Complications following radiation therapy in carcinoma of the cervix and their treatment. Amer. J. Obstet. Gynec. 88 (1964), 854.

KUBIK S., TÖNDURY G., RÜTTIMANN A. and WIRTH W.: Nomenclature of the lymph nodes of the retroperitoneum, the pelvis and the lower extremity. *In:* Progress in lymphology, p. 52. Georg Thieme Verlag, Stuttgart 1967.

LANGE P.: Clinical and histological studies on cervical carcinoma. Precancerosis, early metastases and tubular structures in the lymph nodes. Acta path. microbiol. scand. (1960) Suppl. No. 143, p. 9.

MITANI Y., FUJII J. I., MIYAMURA M. et coll.: Lymph node metastases of carcinoma of uterine cervix. Amer. J. Obstet. Gynec. 83 (1962), 515.

RANUDD N. E.: Dose distribution studies in external irradiation of carcinoma colli uteri. Acta radiol. Ther. Phys. Biol. 4 (1966), 353.

REIFENSTUHL G.: Das Lymphknotenproblem beim Carcinoma colli uteri und die Lymphirradiatio pelvis. Urban & Schwarzenberg, München 1967.

RUBIO C. A., HERTZBERG O., KOTTMEIER H. L. et coll.: Sensitization and radiation response in cases with carcinoma of the uterine cervix. Acta radiol. Ther. Phys. Biol. 3 (1965), 241.

RÜTTIMANN B.: Die Lymphographie mit öligen Kontrastmittel. Fortschr. Röntgenstr. 97 (1962), 551.

SELDINGER S. I.: Catheter replacement of the needle in percutaneous arteriography. A new technique. Acta radiol. 39 (1953), 368.

TJERNBERG B.: Lymphography. An animal study on the diagnosis of Vx2 carcinoma and inflammation. Acta radiol. (1962) Suppl. No. 214.

— JOHANSSON J. M. och LINDSKOUG B.: Thermoluminescensdosimetri vid radiologisk behandling av gynekologisk kancer, klinisk tillämpning. (In Swedish.) Nord. Med. 80 (1968), 1537.

WALSTAM R.: The dosage distribution in the pelvis in radium treatment of carcinoma of the cervix. Acta radiol. 42 (1954), 237.

WETTERDAL P.: Does the microscopical diagnosis afford prognostic guidance in cervical cancer? Acta obstet. gynec. scand. 14 (1934), 302.