measurement of the state of the affected limb by circumference or plethysmography. Further tests are being performed on larger sample groups.

Addendum: The instrument was designed by L. Deak.

References

1 *Clodius, L.:* Secondary Arm Lymphoedema. In "Lymphoedema". Ed. L. Clodius. Stuttgart: Thieme 1976
2 *Drinker, C.K., M.E. Field, J. Homans:* The experimental production of edema and elephantiasis as a result of a lymphatic obstruction. American Journal of Physiology, 108 (1934) 509
3 *Olszewski, W.:* On the pathomechanism of experimental lymphoedema. Polski przeg. chirurgie 9 (1973) 926
4 *Piller, N.B., L. Clodius:* The clinical effectiveness of Venalot on primary and secondary lymphoedema. British Medical Journal – submitted for publication 1976
5 *Stillwell, G.K.:* Treatment of postmastectomy lymphoedema. Modern Treatment, 6 (1969) 396

N.B. Piller, Electron Microscope Unit, Department of Zoology, University of Adelaide, Adelaide, 5001, South Australia

Lymphology 9 (1976) 5-10

On Radioactive Labelling of the Lymph Drainage Regions of the Pelvis

H. Janisch, S. Leodolter

Vienna University Hospital, Depatment for Gynecology and Obstetrics (I)
Vienna University (Director: Prof. Dr. E. Gitsch)

Summary

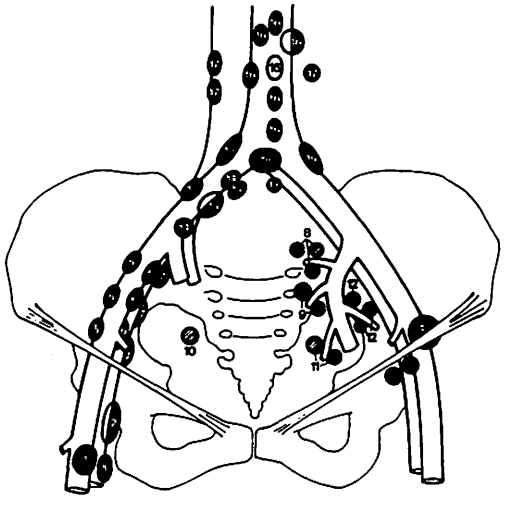
The introduction of radioisotopes in the surgical management of cervical carcinoma at our clinic in 1970 constituted a major advance in this respect. Prior to surgery the lymphatic tissue of the pelvic region is labelled by subcutaneous applications of radioisotopes. Our experience shows that the body's kinetics encourage the deposition of the radionucleide and thus visualization even of the groups of lymph nodes located in the deeper layers of the pelvic region. This method allows virtually complete lymphonodectomy with resultant improvement of cure rates.

The possibility of carcinomatous spread to regional lymph nodes should be taken into consideration in all clinical stages of uterine cervix carcinoma (1, 2). Authors who perform compulsory lymphonodectomies report an incidence of gland- positive cases which is 60–100% higher than the one found by authors performing optional removal of lymphatic tissue with cancer metastases (3). This along with other statistically significant evidence indicating that obligatory lymphonodectomy can improve the 5 year cure rate (4), makes the conventional radical operation with obligatory removal of lymphatic tissue the procedure of choice for treating operable cases of carcinoma of the cervix. In order to achieve as complete as possible a removal of the regional lymphatic tissue, the *Radioisotope Radical Operation* was introduced in 1970 and became part of the therapy program for treatment of uterine cervical carcinoma (5). In this technique the fact that lymphoreticular tissue will store radioactive colloids following interstitial administration

in made use of during surgery. By the conventional radical operation with mandatory, so called primary lymphonodectomy only a certain amount of lymph nodes are removed. In every case a considerable amount of lymphatic tissue remains all regions of the pelvis. This is due to difficulties in locating these nodes. By our technique the gamma activity in the residual lymphatic tissue is measured and this tissue is then removed step by step. This procedure is considered a decisive contribution toward a more radical lymphnode exstirpation.

This treatment applied routinely at the Department of Gynecology and Obstetrics in Vienna's University Hospital to all patients suffering from operable carcinomas of the uterine cervix in stages I and II, may be regarded as useful only if interstitial application on the radioactive colloid succeeds in labelling all the regional lymph drainage areas of the cervix uteri.

References in literature to this problem are contradictory. The majority of authors are of the opinion that interstitial as well as endolymphatic application of radionuclides according to the technique of *Kinmonth* (6) will only result in labelling the Lnn. inguinales, iliaci ext. et comm. and the Lnn. aortici abdominales (7, 8, 9) (In our text these lmyph nodes are summarized as lymph drainage area one) (Fig. 1), while the lymph nodes combined under the term Lnn. iliaci interni (lymph drainage area two), i.e. the Lnn. sacrales laterales, glutaei superiores et in-feriores, parauterini and the Lnn. obturatorii (Fig. 1) are rarely labelled.



Lnn. inguinales
1. Lnn. inguinales superficiales inferiores
2. Lnn. inguinales profundi
3. Lnn. inguinales superficiales superomediales
4. Lnn. inguinales superficiales superolaterales
(=Ln. anuli femoralis medialis Rosenmuelleri)

Lnn. iliaci externi
5. Lnn. iliaci externi laterales
6. Lnn. iliaci externi intermedii
7. Lnn. iliaci externi mediales

Lnn. iliaci interni
8. Lnn. sacrales laterales
9. Lnn. glutaei superiores
10. Lnn. parauterini
11. Lnn. glutaei inferiores
12. Lnn. obturatorii

Lnn. iliaci communes
13. Lnn. iliaci communes mediales
14. Lnn. iliaci communes intermedii
15. Lnn. iliaci communes laterales

Lnn. aortici abdominales = lumbales
16. Lnn. praeaortici et retroaortici
17. Lnn. lateroaortici
18. Lnn. subaortici = promontorii

Fig. 1 Lymphdrainage areas of cervix uteri: black: area one; hatched: area two.

This paper is intended to contribute towards clarifying this problem which is also of major importance for the *Radioisotope Radical Operation* as performed at our clinic. We are of the opinion that decisive information may be obtained through in vitro measurements of radioactive labelled lymph tissue carried out immediately after surgery.

Methods and Materials

The patients are prepared in the same way as for lymph scintigraphy of the pelvis. Between the first and second toes a subcutaneous deposit of 120–150 μCi colloidal Au^{198} with a particle size of 50 Å is injected and 6–12 hours after these injections a lymph scintigram is recorded. 24 hours later the *Radioisotope Radical Operation* is performed. Upon completion of the radical surgery according to Latzko-Okabayashi-Meigs, including primary, obligatory lymphonodectomy,

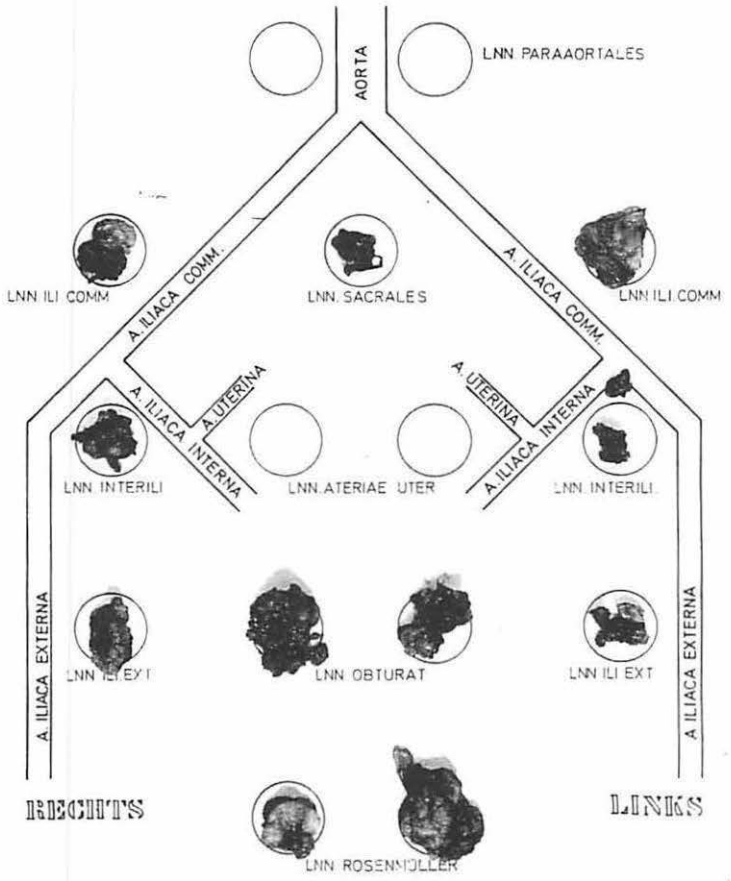


Fig. 2 Lymph node pattern, where the extirpated lymph tissue is placed according to its original location.

the search for radioactive, residual lymph tissue is carried out. In most cases, the lymph node groups are located behind the major vessels of the pelvic wall, i.e. in regions not primarily exposed to the view of the surgeon. The remains are then systematically removed in stages (10). The extirpated lymph tissue is placed on a lymph node pattern according to its original location (Fig. 2). The lymph node groups from the different areas are weighed individually and a count (counts/min/g-tissue) performed with a 3-inch-probe as well as a flat field collimator (the preparation remaining at a constant distance of 5 cm from the crystal surface). In vitro measurements performed by us showed that an activity of 1 μCi corresponds with 30.000 counts/minute.

Histological examination is then carried out. Immediately after surgery another lymph scan is done as additional check on the radical nature of the operation. During the initial period of this *Radioisotope Radical Operation,* the intraoperative location of residual lymphatic tissue was achieved in only 60% of the cases (11) – a figure that did not meet our expectations – the scanner method was replaced and a gamma surgical camera which was designed especially for this purpose, was applied. This technique which marks the second stage in this development of the *Radioisotope Radical Operation* and which has already been described elsewhere (10, 11,

Table 1 Overall review. Acitivity and weight of the lymphatic tissue removed by primary and secondary extirpation. Extent of removal and consideration of the carcinomatous lymphatic tissue removed in primary and secondary extirpation.

Number of cases	Removal of lymphatic tissue		mean counts/minute (cpm) of tissue removed			weight of tissue removed (gms)			removed carcinomatous infiltrated tissue (No. of cases)	
	compl.	incompl	total	primary	secondary	total	primary (% of total)	secondar	primary	secondary
34	29	5	1.386170	1.124955= 81.2%	261.215 = 18.8%	50,95	41.76 = 81.9%	9.19 = 18.1%	7	5

12) may now be regarded as almost ideal. We therefore would like to confine our presentation to the results attained with this camera.

Thus far this procedure has been applied to 34 patients. In 28 women the radioactive gold was applied in the manner already described (*Radioisotope Radical Operation* Type I) (13), in the other 6 cases the gold injection was preceded by endolymphatic application of 1 mCi ^{32}P Lipiodol UF according to Kinmonth. In this operation type II, gold is administered interstitially and the radical operation performed after expiration of one half-life of ^{32}P i.e. 14 days following this endolymphatic treatment (14).

Due to unfavorable results the procedure designated as operation type II has had to be abandoned (15) and currently only type I of the *Radioisotope Radical Operation* is being practiced.

Results

In 29 out of the 34 patients thus far subjected to radical surgery using our gamma surgical camera, for practical purposes, complete extirpation for the radioactively labelled regional lymphatic tissue of the cervix uteri was achieved (Tab. 1). The secondary, so called target extirpation on the average resulted in the removal of 1/5 of the total positive area (in cpm). The weight of the tissue removed in secondary extirpation also amounted to about 1/5 compared to the primary removal (Tab. 1). In 5 out of 7 cases in which histological examination revealed carcinomatous infiltration of the regional lymphatic tissue, our method succeeded in removing additional positive lymphatic tissue (table 1).

The lymph node tissue removed secondarily belonged to all different regions of the pelvis. In most cases additional lymph nodes could be identified and removed in the area of the Lnn. iliaci externi and Lnn. obturatorii.

As expected, the highest count rates per gram of tissue were recorded in the aortic and inguinal lymph node groups. However, this activity did not differ significantly from the values recorded in the nodes which were termed Lnn. iliaci (table 2). By the statistical comparison of the activities recorded in the Lnn. inguinales, iliaci, ext. et comm. and Lnn. aorti aortici (lymph drainage area one) with the average count rates recorded in the Lnn. iliaci interni (lymph drainage area two) no significant difference was detected (table 3).

Table 2 Gamma impulse rates (counts/min) per gram of tissue in the different lymph node regions of the pelvis (type I operation only). Reported as: average values ± mean errors of the median value.

drainage area 1		drainage area 2	
Lnn. inguinales	51125 ± 9538	Lnn. interiliaci	44587 ± 5770
Lnn. aortici	49756 ± 10727	Lnn. obturatorii	35435 ± 5354
Lnn. iliaci comm.	34232 ± 6700	Lnn. iliaci int.	41105 ± 6863
Lnn. iliaci ext.	35471 ± 5401		

Thus, the interstitial administration of radioactive colloidal gold succeeded in labelling the Lnn. iliaci interni in the same manner as all the other regional nodes of the cervix uteri, a fact, which could be proved in our material using the method of autoradiography (16).

The 6 patients who were subjected to endolymphatic ^{32}P therapy, manifested a significant reduction in the storage capacity of the lymph nodes with respect to the colloidal gold (table 3). The energyladen beta radiation of the ^{32}P had destroyed the reticulohistiocytary system of the lymphatic tissue. It was particularly striking that this reaction occured in all lymphatic drainage areas of the pelvis. Since the effective range of the beta radiation following endolyphatic application of ^{32}P on the average amounted to no more than 4 mm (17), it must be assumed that the Lnn. iliaci interni are also accessible by the Kinmonth method of lymphography.

Table 3 Gamma impulse rates (counts/min(per gram of tissue broken down into the two different lymph drainage areas of the pelvis (type I, type II, with consideration of non-carcinomatous and carcinomatous lymph nodes).
Reported as: average values ± mean error of the median values.
Significance (compared to type I-total).

	drainage area	cpm/g
–	total	41 217 ± 1750
Type I	drainage area one	43 228 ± 2026
	drainage area two	39 390 ± 2140
	total	35 002 ± 2264
Type II	drainage area one	34 682 ± 4738
	drainage area two	35 363 ± 3913
Type I	carcinom, infiltr. 1n	28 047 ± 5808 *
Type II	carcinom. infiltr. 1n.	12 427 ± 3543 **

* $p < 0.05$
** $p < 0.001$

As expected, tissue with carcinomatous infiltration has a reduced storage capacity with respect to radioactive colloidal gold (table 3). The activities recorded in positive nodes to which phosphorus had previously been applied were particularly low (table 3).

Discussion

The results obtained permit the conclusion that the Lnn. iliaci interni are reached by interstitial administration of the radiocolloid as well as by the endolymphatic Kinmonth method. This is based on the fact that numerous connections exist between the Lnn. inguinales, aortici, iliaci comm. et ext., Lnn. sacrales, glutaei sup. et inf. and Lnn. obturatorii, which, in many respects, must be regarded as a functional unit.

Reiffenstuhl, who has gone into particular detail with regard to the lymphatic system of the female pelvis, has stated that only his method of direct application of the radioactive substance to an inguinal lymph node (the so called lymphirradiatio pelvis) will succeed in achieving strictly regional irradiation of the Lnn. iliaci interni (18). When using this technique, one may expect change in the pelvic lymphatic vessels pressure (19). However, this cannot explain why even under abnormal conditions the lymphatic connections that always exist between the different pelvic regions would not transport the radioactive substance – even though the rate might be reduced in intensity compared to the "lymphirradiatio pelvis". Our findings, reveal less storage of activity in Lnn. iliaci interni compared to other regions of the pelvis; however, these differences were statistically not significant.

This result is of decisive importance for the *Radioisotope Radical Operation* as practiced by us. Another fact is, since in carcinoma of the cervix we operate only patients with clinical stage I or II, the involvement of the nodes we generally encounter is either partial, or the nodes carry only micrometastases. With our method we reach these lymph nodes too.

Even though the "radical'. nature of the lymphatic tissue resection carried out by us may be termed relative, we believe that through our *Radioisotope Radical Operation* we have advanced in the direction of the complete removal of regional lymphatic tissue. The results achieved thus far suggest the using our technique. It is likely that therapeutic results in the surgical treatment of carcinoma colli uteri will be improved.

References

1 *Navratil, E.:* Die Schauta'sche Operation. Arch. Gynäk. 186 (1955) 394

2 *Ober, K.G., F.O. Huhn:* The Ausbreitung des Cervixkrebses auf die Parametrien und die Lymphknoten der Beckenwand. Arch. Gynäk. 197 (1962) 262

3 *Reiffenstuhl, G.:* Das Lymphknotenproblem beim Carcinoma colli uteri und die Lymph – irradiatio pelvis. Urban & Schwarzenberg, Wien-Berlin-München (1967) 57

4 *Artner, J., J.H. Holzner:* Selektive oder obligatorische Lymphonodektomie bei der Wertheim'schen Radikaloperation. Arch. Gynäk. 209 (1971) 452

5 *Gitsch, E.:* Die Radioisotopenoperation in der Gynäkologie. Wien. klin. Wschr. 82 (1970) 727

6 *Kinmonth, J.B.:* Lymphography in man. Clin. Sci. 11 (1952) 13

7 *Fuchs, W.A.:* Lymphographie und Tumordiagnostik. Springer Verlag, Berlin-Heidelberg 1965

8 *Progress in Lymphology.* Proc. Intern. Symp. on Lymphology. Zürich, Juli 1966, Editor: A. Rüttimann. Georg Thieme, Stuttgart 1967

9 *Reiffenstuhl, G.:* Das Lymphknotenproblem beim Carcinoma colli uteri und die Lymphirradiatio pelvis. Urban & Schwarzenberg, Wien-Berlin-München (1967) 195

10 *Gitsch, E., H. Janisch, S. Leodolter:* Der Einsatz der Gamma-Operationskamera bei der abdominalen Radikaloperation des Neoplasma colli uteri Arch. Gynäk. 215 (1973) 377

11 *Gitsch, E.:* The abdominale Radioisotopen-Radikaloperation mit der Gamma-Operationskamera. Wien. klin. Wschr. 84 (1972) 618

12 *Gitsch, E., H. Janisch, S. Leodolter:* Radical surgery of cervical carcinoma using radioisotopes. IAEA/SM – 164/82 (1972)

13 *Gitsch, E., H. Janisch, H. Tulzer:* Die Radioisotopen-Radikaloperation vom Typ I. Zbl. Geburtsh. Gynäk. 175 (1971) 253

14 *Gitsch, E., H. Janisch, H. Tulzer:* Die Isotopen-Radikaloperation des Kollumkarzinoms vom Typ II. Schweiz. Z. Gynäk. Geburtsh. 3 (1972) 121

15 *Gitsch, E., H. Janisch, S. Leodolter:* Zur Problematik der endolymphatischen ^{32}P-Applikation bei der Radioisotopen-Radikaloperation des Kollumkarzinoms vom Typ II. Gynäk. Rdsch., 14 (1974) 210

16 *Ulm, R., K. Jentzsch, H. Tulzer, M. Holzner, G. Wolf:* Die Korrelation der morphologischen und radiologischen Befunde nach endolymphatischer Applikation radioaktiver Isotope. Gemeins. Kongreß der Deutschen u. Österr. Röntgengesellschaft in Wien, April 1973

17 *Zum Winkel, K.:* Lymphologie mit Radionukliden. Verlag Hildegard Hoffmann, Berlin (1972) 85

18 *Reiffenstuhl, G.:* Das Lymphknotenproblem beim Carcinoma colli uteri und die Lymphirradiatio pelvis. Urban & Schwarzenberg, Wien – Berlin - München (1967) 128

19 *Zum Winkel, K.:* Lymphologie mit Radionukleiden. Verlag Hildegard Hoffmann, Berlin (1972) 78

Dr. H. Janisch, I. Univ.-Frauenklinik, Vorstand Prof. Dr. E. Gitsch, A-1090 Wien IX, Spitalg. 23