

LYMPH DRAINAGE FROM THE UPPER AND MIDDLE THIRD OF THE RECTUM AS DEMONSTRATED BY ¹⁹⁸Au

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The lymphatic spread of rectal carcinoma follows three different directions: (1) upward spread to lymph nodes along the superior haemorrhoidal and inferior mesenteric vessels including their branches in the mesosigmoid and to lymph nodes anterior and lateral to the abdominal aorta and vena cava, e.g. the lumbar retroperitoneal lymph nodes, (2) lateral spread via lymphatics accompanying the middle haemorrhoidal vessels to the external and interiliac lymph nodes including obturator nodes and to lymph nodes along the common iliac vessels, and (3) inguinal spread via lymphatics from the most distal part of the ampulla recti and anal canal ultimately draining into the inguinal lymph nodes. These lymph nodes are only exceptionally involved in the spread of rectal carcinoma.

These conclusions are based mainly on empirical grounds from observations of the position of lymph node metastases in operative specimens and from autopsy findings (WESTHUES 1934, GILCHRIST & DAVID 1938, 1948, DEDDISH 1950, 1951, BACON & SAUER 1950, SAUER & BACON 1952, STERNS & DEDDISH 1959).

In the past many different techniques have been described for the removal of rectal carcinoma. With the increasing safety of surgery the perineal excision of the

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rectum has been abandoned in favour of the more radical combined methods, e.g. abdomino-perineal or perineo-abdominal excision (MILES 1926, GABRIEL 1934, 1948).

Further attempts to broaden the scope of radical excisions or resections for carcinoma of the rectum included high ligation of the inferior mesenteric artery and lumbar retroperitoneal lymph node dissection from a short distance above the origin of that artery and down to the aortic bifurcation (GILCHRIST & DAVID 1948, ROSI 1949) or even combined with pelvic lymph node dissection (DEDDISH 1950, 1951, SAUER & BACON 1952, STERNS & DEDDISH 1959). Restorative resections, i.e. anterior resections and so-called 'pull through' operations in the operative treatment of rectal carcinoma were at first less radical as regards the lymph node dissection, but after functional-anatomic analysis of the blood supply to the left colon the lymph node dissection could be as radical as in combined excisions (BACON & SMITH 1947, LLOYD-DAVIES 1948, GOLIGHER 1954, MORGAN & LLOYD-DAVIES 1950). However, the evidence as to whether these more extensive operations do in fact confer any benefit as regards the cure rate is somewhat equivocal (STERNS & DEDDISH 1959, GRINNELL & HIATT 1952). Since previous investigations have failed to disclose any significant advantage of extensive lymph node dissections, most surgeons today prefer the orthodox abdomino-perineal, i.e. combined rectal excision or restorative resection in the treatment of carcinoma of the rectum. Even in centres specialized in this type of surgery extensive lymph node dissections have been more or less abandoned.

The aim was therefore to investigate in more detail the lymph drainage from the rectum as reflected by the transport of a colloidal suspension of ^{198}Au after submucous injection in the middle or upper third of the rectum. This could possibly elucidate the regional rectal lymph drainage both qualitatively and quantitatively, which would be of particular interest in evaluating the importance of the extra-mesenteric lumbar and pelvic lymph nodes in metastatic spread.

Material and Methods

The material comprised 7 patients, 3 females and 4 males, age range 44 to 72 years, with carcinoma of the rectum located within reach of the sigmoidoscope (Table 1).

Injection of ^{198}Au . 0.5 to 1.0 ml of a colloidal suspension of metallic ^{198}Au (Code GCS.IP, The Radiochemical Centre, Amersham, England), containing 1 to 5 mCi was injected into the submucosa on the dorsal circumference of the rectum, 1 to 2.5 cm above the upper edge of the tumor. Thus, the injection was made at a level of 7.5 to 19 cm above the anus, in 3 patients within the middle third and in 4 patients in the upper third of the rectum. The submucous application was facilitated by mixing the tracer suspension with patent blue. The injection of the isotope was

Table 1

Size and site of rectal tumor, site of ^{198}Au injection, interval between injection and operation and presence of lymph node metastases

Case	Sex and age (years)	Size of tumor (cm)	Upper border of tumor above anus (cm)	Inj. site, cm above anus	Interval between inj. and op.	Type of operation	Lymph node metastases
1	F 44	4.5 × 5.0	18	19	6 days	Anterior resection	0
2	M 57	5.0 × 5.0	14	15	3 days	Anterior resection	0
3	M 60	1.5 × 1.5	13	15	6 days	Anterior resection	One in meso-colon with perinodal growth
4	F 62	4.0 × 2.5	12	13	4 days	Anterior resection	0
5	M 70	6.0 × 9.0	11	12	2 hours	Abdomino-perineal excision	0
6	F 72	3.0 × 3.0	7	8.5	2 hours	Abdomino-perineal excision	One in meso-colon
7	M 57	4.0 × 3.5	5	7.5	3 days	Abdomino-perineal excision	One in meso-colon

performed 3 to 6 days before operation in 5 patients, in 2 only two hours preoperatively.

Operative procedures. An abdomino-perineal excision of the rectum was made in 3 patients and in 4 patients an anterior resection was performed. The same operative procedure for the lymph node dissection was applied in both groups. The adhesions to the pelvic colon were separated and the peritoneal incision was continued along the left leaf of the descending and sigmoid colon and further to the left side of the pelvis. The colon and rectum were then mobilized on the left side. The next step comprised the incision of the right leaf of the sigmoid colon continuing on the right side of the pelvis. The upper end of the incision in the right leaf was extended upwards to the lower border of the third part of the duodenum, which was retracted cranially to facilitate the exposure above the origin of the inferior mesenteric artery from the aorta. This artery and the corresponding vein were ligated centrally. From this point the mesocolon was divided until the sigmoid colon was reached and divided between clamps.

Table 2
Distribution of ^{198}Au to lymph nodes in different anatomic regions

Case	Total No. of lymph nodes diss. at op.	Mesenteric lymph nodes		Extramesenteric lymph nodes			
		Total No.	No. with ^{198}Au	Lumbar		Pelvic	
				Total No.	No. with ^{198}Au	Total No.	No. with ^{198}Au
1	65	17	17	32	32	16	16
2	46	28	28	10	10	8	8
3	35	6	6	20	18	9	9
4	60	17	17	30	21	13	12
5	63	46	24	14	14	3	3
6	27	9	9	14	14	4	4
7	64	35	35	17	17	12	12

In cases 3 and 4 the figures do not correspond with the number of dots in Fig. 1 c and d since the exact location of 8 lymph nodes was unknown.

The operation was performed in two steps to facilitate proper anatomic localization of the mesenteric lymph nodes and to distinguish them from the lumbar retroperitoneal lymph nodes. The first part of the operation included separation of the mesocolic pedicle anterior to the aorta from the lumbar retroperitoneal tissue with its lymph nodes. The rectum and the sigmoid colon with the adhering mesentery and vascular pedicle, the levator musculature and the perirectal fat, i.e. representing the total intestinal specimen, was removed en bloc. The second part of the operation included the extramesenteric tissues and lymph nodes, i.e. the lumbar retroperitoneal and the pelvic lymph node dissection. The lymphadenectomy started a few centimetres above the ligated inferior mesenteric artery. Adipose tissue and lymph nodes anterior to the aorta and the vena cava, the para-aortic and para-caval lymph node chains, as well as the tissue and lymph nodes below the aortic bifurcation were removed. The pelvic lymphadenectomy included the common, the external and the interiliac lymph nodes, including lymph nodes along the internal iliac vessels and the obturator nodes. The operative specimens were carefully orientated anatomically in key diagrams.

Radiography and microdissection of the specimens. The operative specimens were examined using a special soft tissue technique (HULTBORN et coll. 1970) demonstrating most lymph nodes in relation to blood vessels and the bowel wall. In all specimens each individual lymph node or group of lymph nodes was dissected out using a binocular microscope and transferred to an anatomic diagram in order to guarantee their correct topographical identification. The intervening adipose tissue was collected in a similar manner. A further radiography of the dissected lymph

nodes and remaining tissues was carried out and overlooked lymph nodes were dissected out. The removed lymph nodes were collected in 3 anatomically well-defined groups: first, lymph nodes along the mesenteric inferior artery from its origin from the aorta and including lymph nodes along the branches in the mesosigmoid, secondly, lumbar retroperitoneal lymph nodes anterior and lateral to the aorta and vena cava from a short distance above the origin of the mesenteric inferior artery and down, including lymph nodes on the lateral aspect of common iliac vessels, and thirdly pelvic lymph nodes.

Measurements of activity. All specimens were placed in formalin solution and collected in specially designed test tubes. Their activity was assayed individually in a Picker Autowell II sample changer, having a well crystal 7.6 cm (3 inches) in diameter. The lower level discriminator was set at 350 keV and the channel width was 130 keV. All the samples were first measured for 6 seconds and specimens with low activity were measured again for one minute. High activity in the remaining adipose tissue was assumed to indicate overlooked lymph nodes and the tissue was therefore re-examined. Additional lymph nodes were measured in a similar way.

Five to 8 days after the injection of the tracer into the rectal wall autoradiography of the histologic sections of the lymph nodes was performed using a simple contact method.

Results

The total number of dissected lymph nodes and the number of nodes in the different anatomic subgroups appear in Table 2. In each of the 4 patients operated upon by anterior resection (case 1–4) an average of 52 lymph nodes was dissected out (range 35–65). A similar number of lymph nodes (average 51, range 27–64) was collected in the patients operated upon with rectal excision (case 5–7).

In both series of operated patients the number of pelvic nodes was comparatively small (average 9, range 3–16) comprising about one-fifth of the total number of collected lymph nodes in the 7 patients.

Irrespective of the time interval between the injection and the operation the vast majority of the lymph nodes in the 3 different anatomic groups were radiation active, indicating that they were all to some extent engaged in the rectal lymph drainage.

The main pathways of the lymphatic drainage from the middle and upper third of the rectum, as reflected by the transport of the tracer, are illustrated in Figs 1 and 2. The distribution of the tracer injected in the upper third of the rectum differed insignificantly from that obtained by injection in the middle third. The lymph nodes with the highest activity were with few exceptions observed in the lymph nodes along mesenteric inferior vessels, including those in the mesosigmoid and in lumbar lymph nodes, i.e. those anterior and lateral to the abdominal aorta and vena cava from a short distance above the origin of the inferior mesenteric artery down to the aortic

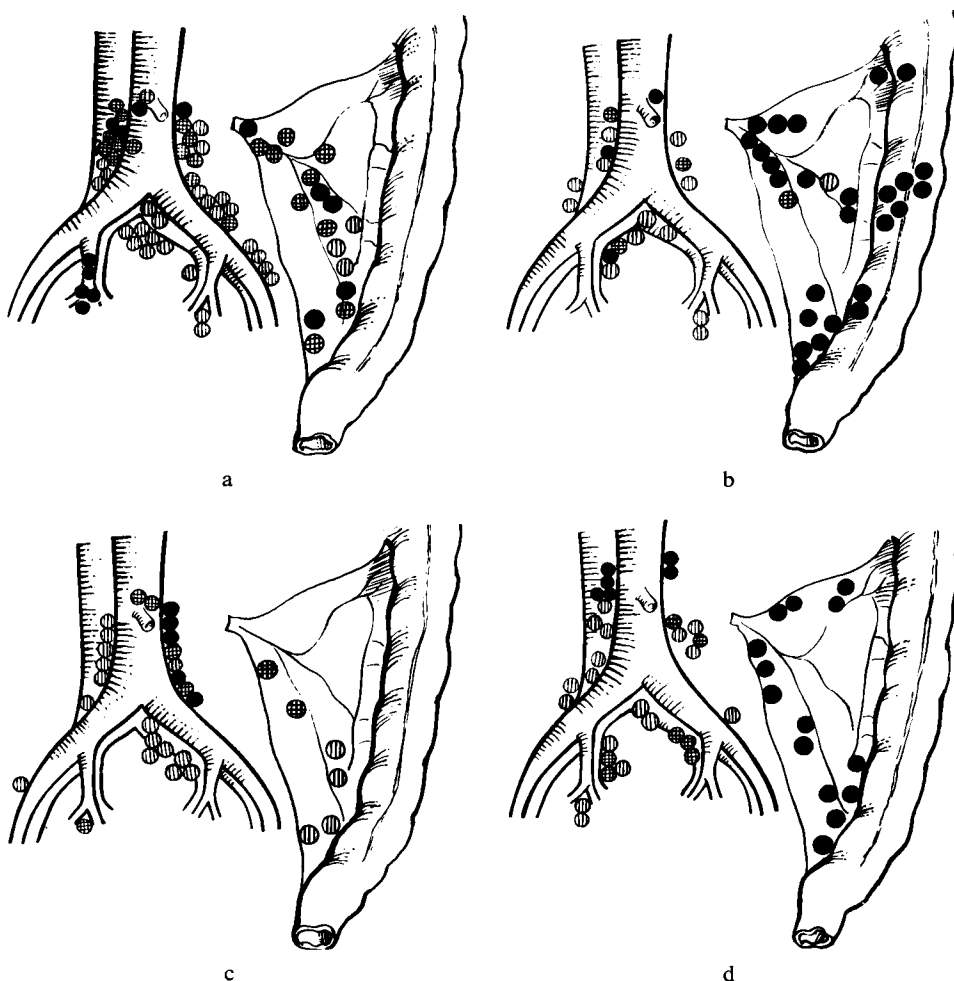


Fig. 1. a) to d) Cases 1 to 4 (anterior resection). Lymph nodes containing ^{198}Au in the retroperitoneal space, pelvis and mesosigmoid. Lymph nodes without tracer are not depicted. Solid dots indicate $>10^4$ counts per min, criss-crossed dots 10^4 to 10^3 counts per min and hatched dots $<10^3$ counts per min.

bifurcation and including the lymph nodes on the lateral aspect of common iliac vessels. Only occasionally a high level of activity was recorded in pelvic lymph nodes.

A rough quantitative calculation indicated that of the total amount of tracer which had been transported to removed lymph nodes, about two-thirds of the activity was found in those along the inferior mesenteric artery and its branches and one-third in lumbar retro-peritoneal lymph nodes. The corresponding figure for pelvic lymph nodes was for 6 of the 7 cases less than one per cent but in one the figure was 45 per cent. This case was the only one in which the tracer was injected as high as 19

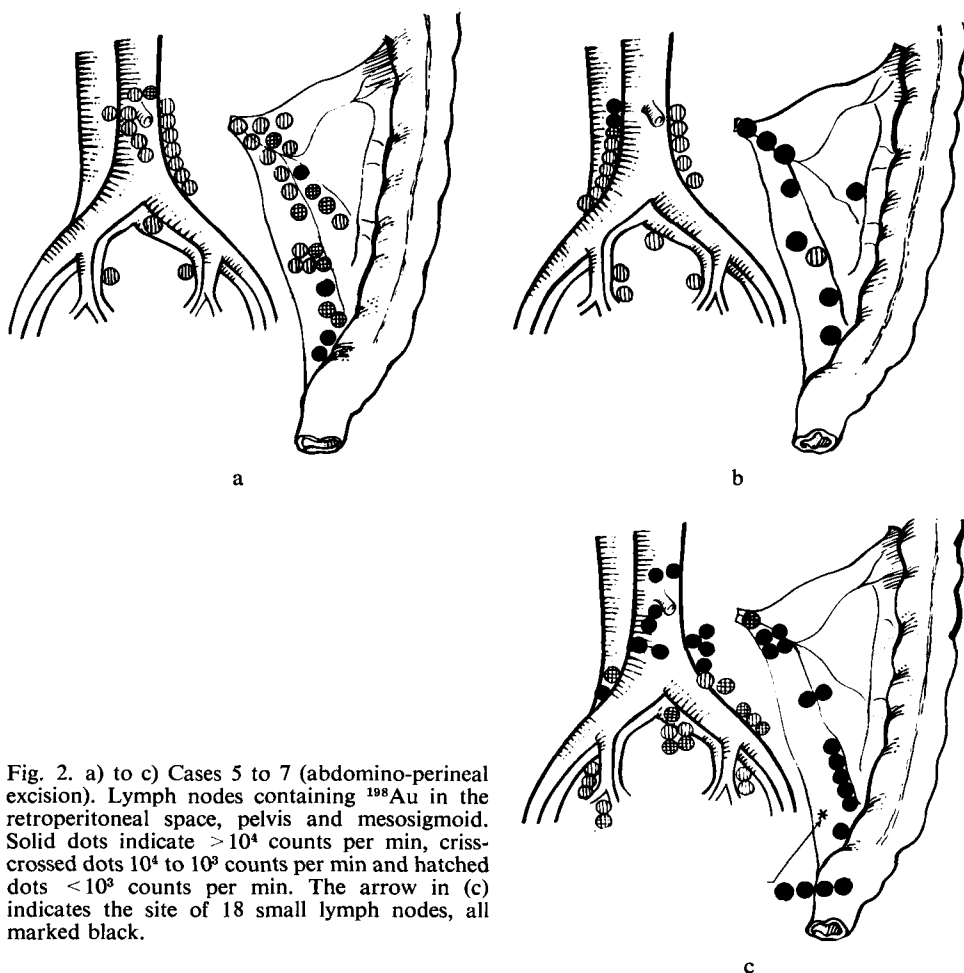


Fig. 2. a) to c) Cases 5 to 7 (abdomino-perineal excision). Lymph nodes containing ^{198}Au in the retroperitoneal space, pelvis and mesosigmoid. Solid dots indicate $>10^4$ counts per min, criss-crossed dots 10^4 to 10^3 counts per min and hatched dots $<10^3$ counts per min. The arrow in (c) indicates the site of 18 small lymph nodes, all marked black.

cm above the anus and the possibility cannot be excluded that the needle had penetrated the bowel wall and the tracer had been injected intraperitoneally or into the extrarectal pelvic tissue, causing the high uptake in the pelvic lymph nodes.

Discussion

Great efforts have been made in the past to demonstrate the rationale in extending the orthodox abdomino-perineal excision and anterior resection for rectal carcinoma by including not only the mesosigmoid but also the lumbar retroperitoneal and pelvic lymph nodes. However, the initial enthusiasm for these extended procedures has gradually subsided. Therefore, an attempt was made to evaluate qualitatively and quantitatively the importance of the mesosigmoid lumbar retroperitoneal and

pelvic lymph nodes in the rectal lymph drainage using ^{198}Au . The results indicate that the most important lymphatics from the rectum are those along the superior haemorrhoidal and inferior mesenteric vessels and their branches in the mesosigmoid, and also the lymphatics anterior and lateral to the aorta and vena cava and on the lateral aspect of common iliac vessels. In fact two-thirds of the activity in all removed lymph nodes was located to lymph nodes along the mesenteric inferior vessels, including those in the mesosigmoid, and about one-third was located to the lumbar retroperitoneal nodes. This observation suggests that these groups of lymph nodes may play an important role in metastatic spread from rectal carcinoma and that dissection of these lymph nodes will probably be worthwhile. The pelvic lymph nodes, i.e. external and inter-iliac lymph nodes and lymph nodes on the medial aspect of common iliac vessels, and subaortic and sacral lymph nodes contained small amounts of activity (less than one per cent of the total activity in all the removed lymph nodes), implying that they are probably of minor importance so far as the lymph drainage from the middle and upper third of the rectum is concerned. Considering the increased morbidity following extended pelvic lymph node clearance (DEDDISH 1950, 1951, STERNS & DEDDISH 1959) it appears reasonable to abandon pelvic lymph node dissection in the radical treatment of carcinoma in the upper and middle third of the rectum.

SUMMARY

Extensive lymph node dissections have been performed in an attempt to increase survival after abdomino-perineal excision or anterior resection of the rectum for carcinoma. The lymph drainage from the upper and middle third of the rectum was demonstrated by means of ^{198}Au which was injected into the submucosa. Less than one per cent was drained to pelvic lymph nodes, giving little support for pelvic lymph node dissection for carcinoma in the upper and middle third of the rectum.

ZUSAMMENFASSUNG

Umfassende Lymphknotendissectionen wurden vorgenommen um die Überlebensrate nach abdominaler-perinealer Exzision oder anteriore Resektion des Rectums wegen eines Karzinoms zu verbessern. Die Lymphdrainage für das obere und mittlere Drittel des Rectums wurden mit Hilfe von in die Submukosa injiziertem ^{198}Au dargestellt. Weniger als ein Prozent wurde in die Lymphknoten des Beckens drainiert, was für die Becken-Lymphknotendissection wegen eines Karzinoms im oberen und mittleren Drittel des Rectums von geringem Nutzen ist.

RÉSUMÉ

Des dissections étendues des ganglions lymphatiques ont été faites pour essayer d'augmenter la survie après résection abdomino-périnéale ou résection antérieure du rectum pour carcinome. Le drainage lymphatique du tiers supérieur et du tiers moyen du rectum a été

mis en évidence par ^{198}Au injecté dans la sous-muqueuse. Moins d'un pour cent est drainé vers les ganglions lymphatiques pelviens, donnant peu d'argument pour la dissection des ganglions lymphatiques pelviens dans le carcinome des tiers supérieur et moyen du rectum.

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