LYMPHATIC METASTASES OF CARCINOMA OF THE COLON AND RECTUM*

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CARCINOMA OF THE COLON AND RECTUM spreads by local extension, by the blood stream, and by the lymphatics. The last channel of dissemination is the subject of this report. The lymphatic routes of spread determine to a large extent its surgical treatment. These routes have been established by the injection studies of Jamieson and Dobson,[1] Rouviere[2] and others and have been shown to follow the superior and inferior mesenteric vessels and their branches. Jamieson and Dobson found that the accompanying nodes fell into four main groups, epicolic, paracolic, intermediate and principal. These groups were not completely distinct and separate entities but tended to merge into each other. The lymph flow was usually first to the epicolic and paracolic nodes which acted as the first line of defense, but occasionally went by direct channels to the intermediate nodes and less often directly to the principal nodes. According to Rouviere, direct channels to the intermediate and principal nodes occur chiefly in the hepatic flexure and the sigmoid, especially the latter. Jamieson and Dobson reported that in the splenic flexure and in the distal two-thirds of the transverse colon the paracolic nodes were never bypassed. On the basis of their studies they indicated the amount of mesentery and bowel that should be removed at operation for lesions in the various segments of the colon. The epicolic, paracolic and intermediate nodes were included in these resections, but the principal nodes were usually not within reach. McKittrick[3] has recently reviewed their findings and advocates somewhat more extensive resections especially in the left colon. As Gilchrist[4, 5] has emphasized, the lymphatic spread of carcinoma of the colon and rectum is primarily embolic and, as elsewhere in the body when lymph glands become blocked by tumor cells, alternate routes are called into play. These routes are usually more circuitous and may even involve a reversed or retrograde flow. It is these alternate channels and their effect on the extent of tissue removed at operation in which we have been particularly interested. On the basis of our lymph node studies we have attempted to re-evaluate this subject in this report (Fig. 1).

In the last ten years the lymphatic spread of carcinoma of the colon and rectum has been studied in many of the specimens removed at operation. They have been cleared of fat by a modification of the Spalteholtz technic. Each lymph node has been then dissected out under transillumination, sectioned, and its position charted on a drawing to show its position in relation to the tumor and the main blood vessels. By this procedure, more nodes and conse-

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quently more metastases could be found and a more accurate picture of the lymphatic spread of the tumor obtained. Up to the present time 322 carcinomas have been studied, 171 from the colon, 33 from the rectosigmoid, and 118 from the rectum. Of the 33 from the rectosigmoid, 30 were removed by anterior resection with ligation of the superior hemorrhoidal vessels and three by anterior excision and colostomy (Hartmann). This group was arbitrarily limited to tumors removed by these two procedures. Of the 118 rectal lesions, 108 were removed by abdomino-perineal resection and 10 by perineal proctectomy. The specimens were not examined consecutively, but when opportunity permitted. Over 12,000 nodes were sectioned during this study.

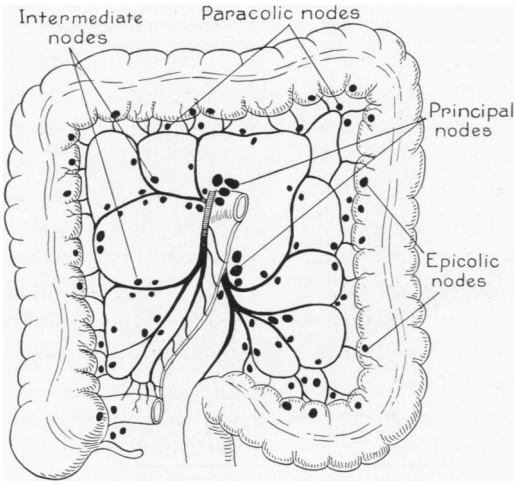


FIG. 1.—Diagrammatic drawing showing the epicolic, paracolic, intermediate, and principal lymph node groups accompanying the vessels of the colon.

It is evident that by the time the patient is operated upon somewhat less than one half (43 per cent) of the colon tumors and slightly over one half (53 per cent) of the rectal tumors have metastasized to the regional nodes. Recent studies on this same group of tumors to be published elsewhere show that one third (colon 33 per cent, rectum 36 per cent) have already invaded the veins locally near the tumor before operation. The higher incidence of lymph node metastasis in the rectum than in the colon was also found by Gilchrist and David[6, 7] and by Coller, Kay and MacIntyre[8] in specimens studied by similar technics. When node metastases were present the average number per specimen was five for both the colon and rectum. The highest number in any specimen was 25 for the colon and 34 for the rectum.

Cecum, Ascending Colon, and Hepatic Flexure. In the right colon, grouping the cecum, ascending colon and hepatic flexure together, there were 16 specimens with lymph node metastases. In seven of these the involved nodes

were so placed that the direction of the lymphatic flow could be determined, for; and in every specimen it was found to follow the ileocolic vessel route. It was only in tumors distal to the hepatic flexure that the middle colic route began to be used. Coller, Kay and MacIntyre reported two lesions in the hepatic flexure that spread along both the ileocolic and middle colic lymph chains. In none of the specimens were we able to demonstrate with certainty metastases along the right colic artery. This may have been due in part to variability or inconstancy of the vessel itself or to our failure to identify it.

TABLE I.—*Incidence of Node Metastases.*

	Number of Specimens	Average Number Nodes per Specimen	Specimens with Node Metastases	Per Cent with Metastases
Colon	171	35	73	43%
Rectosigmoid*	33	28	14	42%
Rectum	118	45	63	53%
Total	322	38	150	47%

* Anterior resection 30
Hartmann 3

There were no specimens with retrograde spread upwards towards the hepatic flexure or along the ileum. No specimens showed lymph spread direct to an intermediate node without first involving an epi- or paracolic node. Four specimens showed involvement of the most proximal node along the ileocolic vessels.

TABLE II.—*Incidence of Node Metastases.*

	Specimens	Specimens with Node Metastases	Per Cent with Metastases
Cecum, ascending and hepatic flexure	35	16	46%
Transverse	33	18	55%
Splenic flexure and descending	32	14	44%
Sigmoid	71	25	35%
Rectosigmoid*	33	14	42%
Rectum	118	63	53%
Total	322	150	47%

* Anterior resection 30
Hartmann 3

Transverse Colon. In the transverse colon there were 18 specimens with lymph node metastases. In ten of these the direction of lymph drainage was evident. In nine the main drainage was along the middle colic vessels irrespective of what portion of the transverse colon was involved and in one it was along the left colic vessels only. In lesions of the distal transverse colon the drainage was to the right along the middle colic vessels in two instances and to the left along the left colic vessels in the case just cited. In two lesions with extensive metastases chiefly along the middle colic vessels involving 23 and 25 nodes respectively, there was considerable lateral spread along the paracolic

lymphatics on one or both sides of the tumor, suggesting blockage of the main route and retrograde flow laterally. The need for wide excision of both bowel and mesentery in such cases is obvious. Four tumors had spread to glands in the gastrocolic omentum close to the greater curvature of the stomach. In each specimen node metastases were excessive, 23, 25, 9 and 7 nodes respectively, suggesting that such spread is a secondary and alternate one when the main route is blocked.

One tumor of the distal transverse colon showed a single node metastasis near the point of ligation of the middle colic vessels. This represents a direct metastasis to an intermediate node and an exception to Jamieson and Dobson's contention that the epi- or paracolic nodes are never by-passed in the distal transverse colon.

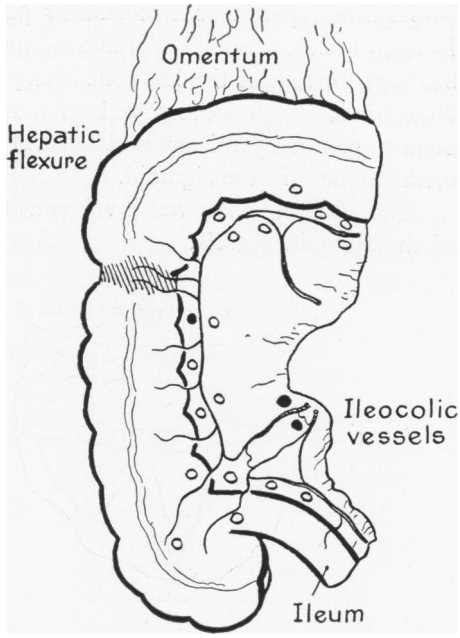


FIG. 2.—S. P. 74287. A carcinoma of the ascending colon with lymphatic spread along the ileocolic vessels.

Eight specimens showed involvement of the most proximal node along the middle colic vessels.

Splenic Flexure and Descending Colon. There were 14 carcinomas with node metastases in the splenic flexure and descending colon. One lesion of the splenic flexure had spread to the right toward the middle colic lymphatics as well as downward along the left colic. One tumor of the descending colon with 18 node metastases showed lateral extension both upward along the left colic and downward along the sigmoid vessels. This is another case where wide resection was especially indicated. There were no cases in this group with direct dissemination to the intermediate glands without first involving the epi- or paracolic nodes. Five specimens showed involvement of the most proximal node along the left colic artery.

Sigmoid. In the sigmoid colon there were 25 tumors with node metastases. Four of these showed considerable lateral spread of the involved nodes. All had an unusual number of metastases, 21, 13, 9 and 8 respectively, suggesting again that the lateral extension was due to a blockage of the more direct routes. Here again it is doubtful whether the resections were extensive enough. There may be several sigmoid branches of the inferior mesenteric artery supplying the region of the tumor. As the nodes along any one or all branches may be involved by tumor, all branches should be included in the area resected.

In three specimens a metastasis passed directly to an intermediate node. In one of these a node was removed at operation for frozen section from just below the origin of the left colic artery and was found to contain tumor cells. No other involved nodes were later found in the excised specimen. This would seem to confirm Jamieson and Dobson's opinion that such direct channels are most frequent in the sigmoid.

Ten specimens showed involvement of the most proximal node along one of the sigmoid vessels.

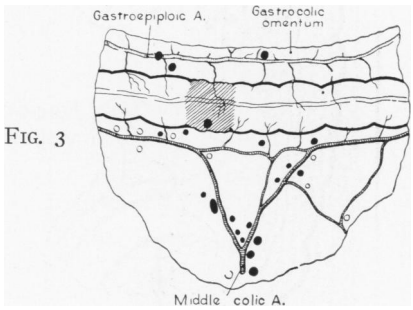
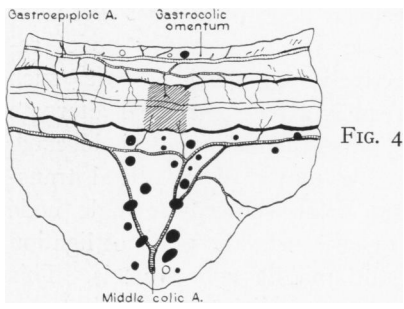


FIG. 3



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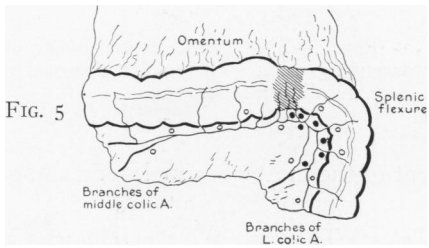


FIG. 5

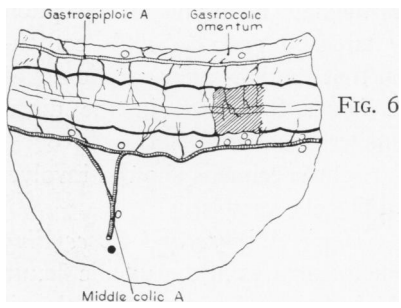


FIG. 6

FIG. 3.—S. P. A5082. A carcinoma of the transverse colon with involvement of the middle colic nodes and of nodes in the gastrocolic omentum near the greater curvature of the stomach. There is some lateral spread distally along the paracolic lymphatics. There were 23 node metastases in all.

FIG. 4.—S. P. A9272. A carcinoma of the transverse colon with 24 middle colic metastases and one metastasis near the greater curvature of the stomach. There is lateral spread distally along the paracolic lymphatics. The excision here may have been inadequate.

FIG. 5.—S. P. 74489. A carcinoma of the distal transverse colon with lymphatic spread distally along the left colic vessels.

FIG. 6.—S. P. A5025. A carcinoma of the distal transverse colon with a single metastasis in an intermediate node near the origin of the middle colic vessels.

Recto-Sigmoid. In the recto-sigmoid there were 14 specimens with node metastases that had been removed by anterior resection and anastomosis with ligation of the superior hemorrhoidal vessels. In all the lymphatic spread was upward along these vessels with no evidence of retrograde downward spread.

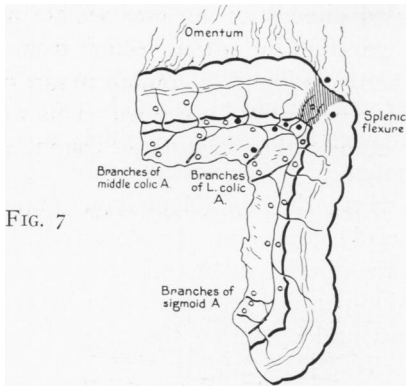
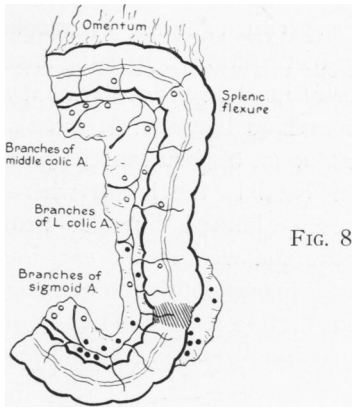


FIG. 7



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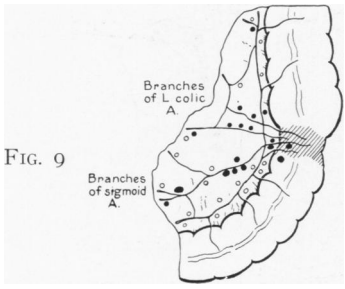
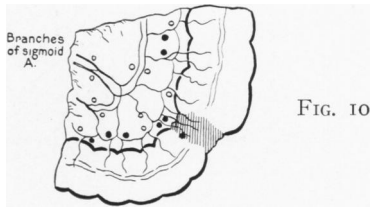


FIG. 9



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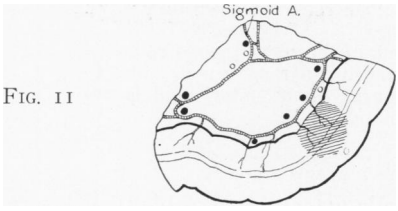

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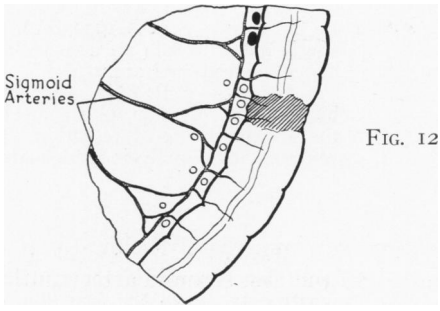


FIG. 12

FIG. 7.—S. P. 70814. A carcinoma of the splenic flexure with lymphatic spread along both the middle colic and left colic vessels.

FIG. 8.—S. P. 73652. A carcinoma of the descending colon with lymphatic spread proximally along the left colic vessels and distally along the sigmoid vessels. There were 18 node metastases.

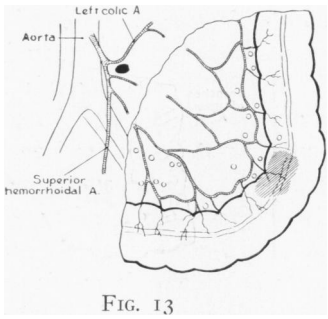
FIG. 9.—S. P. 70947. A carcinoma of the upper sigmoid with extensive lymphatic spread along both the left colic and sigmoid vessels. The excision is probably inadequate.

FIG. 10.—S. P. 97675. A carcinoma of the sigmoid with wide lateral spread to the paracolic nodes proximally and distally.

FIG. 11.—S. P. A4236. A carcinoma of the sigmoid with spread to the paracolic nodes proximally and distally. The excision may be inadequate.

FIG. 12.—S. P. A10218. A carcinoma of the sigmoid with spread proximally along the paracolic lymphatics. Lymphatic block was apparently not a factor in the lateral spread. The excision may well be inadequate. This is a recent specimen not included in the report.

One specimen showed a paracolic lymph node metastasis close to the proximal line of resection suggesting inadequate excision of bowel proximally. Three specimens showed involvement of the most proximal node along the superior hemorrhoidal vessels. In most of the specimens removed by anterior resection the amount of tissue and bowel resected tended to be small. Not only was this true distal to the lesion where the amount of tissue for resection was by necessity limited, but also proximally where the main lymphatic drainage occurs and where wide excision is especially important. To do an adequate cancer operation, the point of ligation of the inferior mesenteric vessels should be as high in these cases as in an abdomino-perineal resection. Lloyd-Davies[9] has pointed out that in the abdomino-perineal operation the upper limit of



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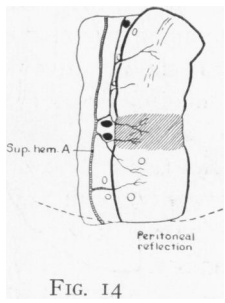

FIG. 14

FIG. 13.—S. P. A9303. A carcinoma of the sigmoid with a single metastasis in an intermediate node removed separately from above the resected area.

FIG. 14.—S. P. 7847. A carcinoma of the rectosigmoid removed by anterior resection with a metastasis in a paracolic node close to the proximal line of resection. The area of mesentery and bowel removed proximally is inadequate.

ligation was immediately below the left colic artery in two-thirds of his cases and below the first sigmoid artery in the remaining third. In anterior resection and in other types of sphincter preserving operations a greater length of colon has to be retained and such a high ligation may be more difficult. He tests the adequacy of the descending branch of the left colic artery by compressing the main inferior mesenteric trunk and noting the point at which arterial pulsation on the bowel ceases. Greater length may be obtained by dividing the sigmoid branches just proximal to their arcades. If the middle colic vessels are sufficiently long it may even be possible to anastomose the distal transverse colon to the rectum. In 30 anterior resections Lloyd-Davies was able to ligate the inferior mesenteric trunk just below the left colic artery in one-half of the cases and below the first or second sigmoid artery in the remaining one-half. Dixon[10] and McKittrick[3] have also emphasized the need of mobilizing the whole descending colon and splenic flexure in many of these cases.

Rectum. In the rectum there were 63 lesions with lymph node metastases. Five of these showed evidence of retrograde downward spread with metastases

distal to the lower edge of the tumor and only one lateral spread along the middle hemorrhoidal vessels. The involved nodes occurred from 1 to 2.0 cm. distal to the tumor in the fixed specimen and in no instance were over 2 cm. distal to it. This would represent a maximum spread of about 3.0 cm. in the fresh specimen, allowing for loss by tissue elasticity and shrinkage during fixation. Although Glover and Waugh[12] claim that any downward extension to as much as 2 cm. is within the limits of normal intramural drainage, we believe these specimens do represent true retrograde spread, as they were the only ones found of all those examined, and in all of them the number of metastases was excessive, which is typical of such cases. In the five specimens the average number of involved nodes was 19 as compared to an average of five for all rectal specimens with involved nodes.

Only one specimen, previously reported,[11] showed definite evidence of lateral spread along the middle hemorrhoidal vessels. There were three other specimens that showed involved nodes close to the anastomosis between the middle and superior hemorrhoidal vessels which were questionable examples of lateral spread. Two of the three specimens had many metastases with probable lymphatic block. All were within 4 cm. of the pectinate line. We agree with Waugh and Kirklin[13] and Dixon[10, 14] that studies of lateral spread are inconclusive because of the small amount of tissue available for study. It may well be that this route is more important in low rectal tumors than previously believed. They report a poorer survival rate after abdomino-perineal resection of low rectal lesions than that following resections of lesions higher in the rectum. As they suggest, the explanation may be that the removal of both the direct extension and the lateral lymphatic spread of these low tumors tends to be limited and inadequate.

Thirteen specimens removed by abdomino-perineal resection showed a metastasis in one of the most proximal nodes near the point of ligation of the inferior mesenteric vessels. These specimens emphasize the need for ligating the vessels and removing the nodes at the highest possible level.

DISCUSSION

As shown previously in this paper, lymph node metastases occurred in 43 per cent of the colon and rectosigmoid tumors. These metastases were limited to the epi- and paracolic nodes in 25 per cent of the specimens but had reached the intermediate nodes in 18 per cent. A direct metastasis to an intermediate node without involvement of an epi- or paracolic node was found in four tumors, one in the transverse and three in the sigmoid colon. How often a direct lymph channel is present to one of the principal nodes usually out of reach of surgical excision is not known, but it must be infrequent.

Intramural extension in the long axis of the bowel in carcinomas of the colon is limited in extent and relatively unimportant. Black and Waugh[16] found it never to exceed 12 mm. in 103 tumors of the left colon. The greatest spread was in the submucosa. Extramural spread, however, in the lymphatics

and especially in the paracolic lymphatics parallel to the bowel can be considerable. There were 12 lesions that showed significant spread laterally along the paracolic lymph node chain on one or both sides of the tumor. This represents seven per cent of all the colon tumors and 16 per cent of those with metastases. One was in the ascending colon, five were in the transverse colon, three in the splenic flexure and descending colon, and three in the sigmoid. There were undoubtedly others whose metastases lay beyond the limits of the excised tissue and which were not recognized. The average number of metastases in this group was 13 as compared to five for all colon cases with metastases, and illustrates how blockage of the usual drainage routes by involvement of the nodes shunts the lymph flow into more circuitous routes. There were two specimens, however, in which the lateral spread apparently could not be explained by lymphatic block unless perhaps the blocking nodes lay outside the excised specimen. The maximum lateral spread was about 13 cm. All these patients died of recurrence except for two who were operated on recently and have only been followed for a few months. It is this group in which wide removal of bowel and mesentery is especially needed. As it is impossible to recognize these cases at operation, resection should be extensive wherever possible. It may be argued perhaps that by the time lateral extension has occurred from blockage of the direct lymph channels, the principal nodes located beyond the reach of surgical attack are probably involved and the prognosis hopeless. We have no right to assume this, however.

The preceding discussion has dealt mainly with the lateral lymphatic spread. It is, however, the spread along the main lymphatic trunks that is the most important. The highest possible ligation of the vessels accompanying these trunks is needed. The most proximal intermediate node along the main lymphatic route was involved by tumor in 27 specimens from the colon, three from the rectosigmoid, and 14 abdomino-perineal specimens from the rectum, representing an incidence of 16, 9 and 12 per cent respectively or of 37, 21 and 24 per cent of those specimens with node metastases. These are the tumors that Dukes[15] classifies as C2. Although the prognosis in these cases is obviously poor, yet it is by no means hopeless, as we have shown in another report to be published. These C2 cases are surprisingly numerous and present a challenge to radical surgery. Certainly every effort should be made at operation to divide the vessels and their associated lymphatic trunks as high as possible, whether they be the ileocolic, the middle colic, the left colic, or the inferior mesenteric. The level of ligation of the ileocolic and middle colic arteries is definitely limited by the danger of compromising the superior mesenteric artery and vein. In the left colon, however, higher ligation than usually practised seems feasible. In tumors of the descending colon, sigmoid and rectosigmoid it may be possible to divide the inferior mesenteric artery above the left colic and anastomose the transverse or descending colon to the upper rectum or lower sigmoid. Not only should the ligation of the vessels in anterior resection be done at a higher level but also the range of the operation should be extended upward to include most sigmoid lesions and possibly some in the descending

colon. In certain advanced cases a Hartmann type of operation, with end colostomy in the transverse or descending colon, inversion of the lower bowel and ligation of the inferior mesenteric at its origin, might have a limited usefulness.

In abdomino-perineal resection for tumors of the rectum a similar extension in lymph node removal with little cost to the patient can be gained by ligating the inferior mesenteric artery at its origin, making the colostomy in the transverse or descending colon and removing all bowel distal to it. This procedure has been suggested by Dr. John S. Lockwood. Examination of

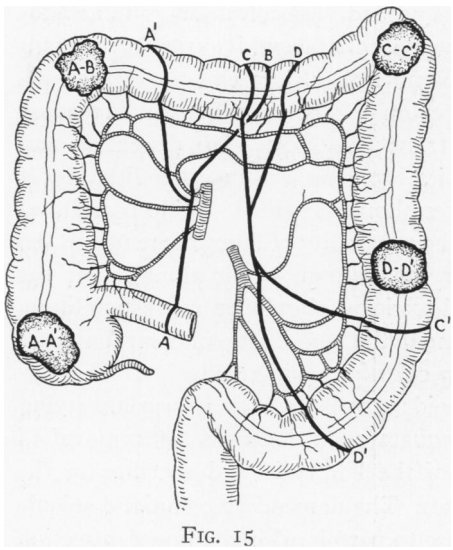

FIG. 15

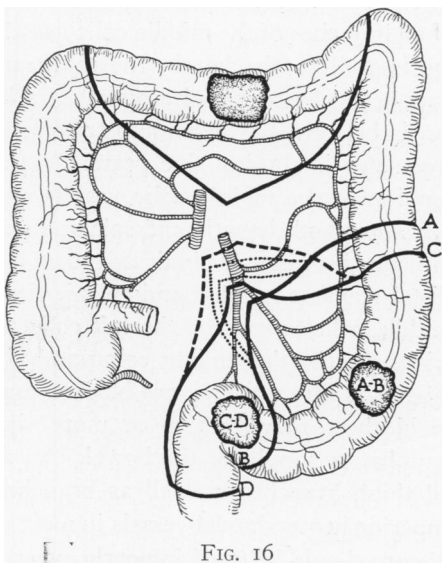

FIG. 16

FIG. 15.—Segments of bowel and mesentery to be removed for carcinoma of cecum, A-A'; hepatic flexure, AB; splenic flexure, C-C'; and descending colon, D-D'. (Modified from McKittrick)

FIG. 16.—Segments of bowel and mesentery to be removed for carcinoma of transverse colon; sigmoid colon, A-B; and lower sigmoid or rectosigmoid, C-D. Broken and dotted lines indicate alternate segments of mesentery permitting high ligation of the inferior mesenteric vessels. (Modified from McKittrick)

these specimens and their lymph nodes by the clearing technic should help to determine the advantage gained by these more radical procedures.

In the two accompanying schematic drawings adapted from McKittrick we have attempted to show what we believe to be the ideal amount of tissue and bowel that should be removed at operation for carcinomas of the various segments of the colon on the basis of our studies on lateral lymphatic spread. The areas suggested for resection are similar to those advocated by him except for some minor differences. The suggested procedures involving high ligation of the inferior mesenteric artery in certain tumors of the left colon, rectosigmoid and rectum are also indicated. A true cancer operation calls for an attempt at complete eradication of the disease with its local extensions, its

lymphatic spread, and its vein involvement before embolism to the liver has occurred. Fortunately, the two latter routes run together and can be removed together. Of course, operative findings and variations in blood supply may make the ideal operation impossible or inadvisable, but usually it can be approximated (Figs. 15, 16).

In lesions of the right colon proximal to the hepatic flexure, the lymph drainage follows the ileocolic vessels and their branches. Ileocolectomy with high dissection and ligation of the ileocolic and right colic vessels should be done, care being taken to avoid injury to the blood supply of the small intestine. For lesions in the hepatic flexure and proximal transverse colon high ligation of all branches of the middle colic vessels is needed. Ileocolectomy with anastomosis well to the left in the mid-transverse colon would ensure maximum lymph and blood vessel removal. End-to-end rather than end-to-side anastomosis between the ileum and transverse colon has been used with increasing frequency in the last five years. In the transverse colon high dissection and ligation of the middle colic vessels and its branches are again indicated. If necessary both hepatic and splenic flexures should be freed. Wide bowel and mesenteric removal is indicated to offset the possibility of lateral spread. In the distal transverse colon and splenic flexure spread may occur along either the middle colic vessels or the left colic and excision should be correspondingly wide. In the descending colon and sigmoid the possibility of lateral spread when the direct routes are blocked again calls for wide removal. In the sigmoid there may be two or more sigmoid vessels and their accompanying lymphatics supplying the bowel. An adequate operation calls for removal of all these branches as well as branches of the left colic and sacrifice of the superior hemorrhoidal vessels in most cases. The descending colon and splenic flexure should be freed in nearly every case to permit adequate bowel resection and to avoid tension on the anastomosis. Moreover, as McKittrick has pointed out, the anastomosis can then often be done outside the abdomen more easily and more safely. In the rectosigmoid, when removal of the tumor is done by anterior resection, there should be no compromise as to the level at which the inferior mesenteric vessels are divided. It should be done as high as local conditions will permit. High ligation will ensure maximum lymph node and vein removal and adequate bowel excision proximal to the tumor. The descending colon and splenic flexure should be freed if necessary. Distal to the tumor as much bowel and retroperitoneal tissue as possible should be removed, preferably to 5 cm. and more if possible. There is usually a tendency to resect somewhat less retroperitoneal tissue than bowel because of the difficulties of exposure deep in the pelvis. It is, of course, the latter with its lymphatics and blood vessels which is the most important, provided excision is wide of the tumor itself. Using a minimal margin of 3 cm., Dixon[10] has recently reported a large series followed five years with most encouraging results. The question as to what constitutes a safe margin distal to the tumor has still to be finally decided.

Other procedures suggested for carcinomas of the left colon, rectosigmoid, and rectum with high ligation of the inferior mesenteric artery at its source have already been discussed.

SUMMARY AND CONCLUSIONS

1. A study of lymph node metastases by a modification of the Spalteholtz technic was made in 322 specimens of carcinoma of the colon and rectum. Metastases were found in 43 per cent of the colon tumors, 42 per cent of the rectosigmoid tumors (only anterior and Hartmann resections included), and 53 per cent of the rectal lesions.

2. The lymphatic routes of spread in the colon have been discussed. When the main routes are blocked by node metastases, lateral and often retrograde extension may occur chiefly along the paracolic lymphatics leading to more circuitous channels. Evidence of such spread was seen in seven per cent of the colon specimens or 12 per cent of those with node metastasis. There were undoubtedly other instances that were not discovered. To deal with this possibility wider routine resection of both bowel and mesentery is necessary, especially in the transverse and left colon.

3. The frequency of metastasis in the highest node along the main tributory vessels in the specimens (colon 16 per cent, rectosigmoid 9 per cent, rectum 12 per cent) emphasizes the need for ligating the vessels and removing the nodes at the highest possible level. It is suggested:

(a) that the operation of anterior resection and anastomosis with ligation of the inferior mesenteric vessels be extended upward to include tumors of the sigmoid and that the vessels be ligated as high as possible, even above the left colic branch in certain cases.

(b) that in abdomino-perineal resection for carcinoma of the rectum the inferior mesenteric vessels be ligated at their origin above the left colic branch and the colostomy be made in the transverse or descending colon.

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