modified one. On the other hand, the incidence of bad effects was only slightly higher with the standard operation.

It is emphasized that the assessment of the value of a leucotomy operation to the patient is a subjective one whoever makes it; and it is pointed out that in the past the patients' opinion has tended to take second place to that of the medical investigator.

We would like to thank our colleagues at the National Hospital for letting us see and investigate all their patients who came to leucotomy over the time covered by this study, and for their permission to publish the results of this investigation. One of us (A.E.) has been supported by the Medical Research Council and would like in particular to thank Dr. E. A. Carmichael, Director of the Neurological Research Unit, for his advice and encouragement. To Mr. Eric Glitheroe and his colleagues in the Social Welfare Department we are indebted for the main labour of the conduct of the follow-up clinic and for invaluable help in collecting the material.

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RESULTS OF TREATMENT IN CARCINOMA OF COLON AND RECTUM*

BY

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Reviews of this subject are often derived from special hospitals or private clinics. They show the good results of specialized service or of work amongst a section of the population perhaps better able to recognize the early symptoms of disease and more interested in it. They do not usually include in their numbers the same proportion of advanced or inoperable cases, or those admitted in acute obstruction, as are found in general hospital beds. Becker (1953) pointed out that while 25% of all cases of colon carcinoma admitted to the Charity Hospital, New Orleans, were in complete obstruction, the corresponding figures at the Lahey Clinic and the Mayo Clinic were only 2% and 5.6% respectively, indicating a somewhat different type of surgical practice. These factors should weigh with both operability and the results of treatment.

This article reviews the results obtained in a series of 714 cases of carcinoma of the colon and rectum admitted to a group of some 650 general hospital beds, located in three separate hospitals, over the ten-year period 1945-55. All cases are included whether admitted for radical surgery, for palliative surgery in the inoperable case, or for investigation of ascites, enlarged liver, or other distant metastases. There were in this series 109 patients with carcinoma of the right colon, 74 with carcinoma of the left colon, 114 with carcinoma of the sigmoid, and 417 with carcinoma of the rectum and recto-sigmoid.

Acute Obstruction

Of the 714 cases, 75 were admitted in acute obstruction. The site and the frequency of acute obstruction with growths in that site are shown in Table I.

* Part of the third Lettsomian Lecture delivered to the Medical Society of London on March 5, 1956

TABLE I

Site of Growth	Total in Series	No. Admitted in Obstruction
Right colon	109	11 (10%)
Left	74	16 (21.6%)
Sigmoid colon	114	33 (28.9%)
Rectum and recto-sigmoid ..	417	15 (3.5%)
Total	714	75 (10.5%)

Of the 297 cases of colonic carcinoma, 60 (20.2%) were admitted in acute obstruction. This figure is lower than that reported by Newell (1951), when out of 490 cases 59% were undiagnosed until obstruction had occurred, and is similar to that of Becker (1953) already quoted. It is still surprisingly high, and, as in most series, the highest frequency was found in the sigmoid colon.

Treatment in Acute Obstruction

A straight x-ray film of the abdomen, gastric suction, and intravenous fluids appear to have been routine preliminaries in almost all cases. Of the 75 patients, one was admitted moribund and 1 refused all operative treatment; the treatment of the remaining 73 is shown in Table II.

Caecostomy.—This was done in 18 cases, with 2 deaths, a mortality of 11.1%. Both deaths occurred in gravely ill patients a few hours after operation, and do not appear to have been due to peritonitis or leakage; one other patient, however, developed a right subphrenic abscess and empyema after caecostomy but survived. Seven caecostomies were "blind"; in the remainder a laparotomy was performed. In recent years caecostomy has received considerable criticism. Becker (1953) cites an operative mortality of 42% and quotes Wangenstein as stating that the mortality at the University of

TABLE II.—Acute Obstruction: Operative Treatment

Operation	Right Colon	Left Colon	Sigmoid	Rectum and Recto-sigmoid	Mortality
Caecostomy ..	2	6	10		2 (11.1%)
Colostomy ..		3	16	15	4 (12.5%)
Enterostomy ..	7		1		4 (36.3%)
Resection ..	2	2	3		1 (14.2%)
Laparotomy only			2		2
Died under G.A.		1			1
Total ..	11	15	32	15	14 (19.2%)
Cases subs. resected	6	8	15	12	

Minnesota Hospital is almost 50%. It is difficult to understand these figures unless one assumes that in these centres the operation is used only in almost moribund patients. Its disadvantages are: a distended caecum is difficult to handle; tube drainage may permit leakage and peritonitis; though the operation relieves tension it does not divert the faecal stream; and drainage is occasionally difficult. A distended caecum can be decompressed before it is handled, for much of the distension is due to gas, and, while it is true that it does not divert the faeces and that at the second operation the bowel above the growth may still be loaded, most of this can be prevented by careful lavage through the caecostomy and per rectum. "Blind" caecostomy can sometimes be performed on a very ill patient when a laparotomy cannot. The presence of a caecostomy does not really interfere with the subsequent resection of the right colon, for it is simply removed with the bowel; if it has been used for a growth of the left colon its presence is a safety vent for subsequent resection. The choice of a caecostomy is governed by the taste of the surgeon, but it seems to have been a useful operation in this series.

Colostomy.—This is the decompressive operation favoured by most surgeons at the present time. It was used on 34 cases with 4 deaths (12.5%). One death was due to pneumonia, one to cerebral thrombosis, one to pulmonary

embolus and one to a most unusual accident, the colostomy being placed below the obstructing growth. The patient, admitted in complete obstruction, had a palpable high rectal growth and an undiagnosed obstructing carcinoma of the splenic flexure. None of the deaths could be attributed to the type of operation. A colostomy has the advantage that it not only relieves the obstruction but diverts the faecal stream from the future operation site. It is suitable for any growth other than those in the right colon, and the ideal site is just distal to the hepatic flexure, as far away as possible from future operations. A colostomy in the left half of the transverse colon has the disadvantage that it interferes with mobilization of the splenic flexure, and prolapse of the proximal limb can occur in this site, while a left iliac colostomy is usually reserved for an inoperable growth of the sigmoid or rectum. When the patient's condition was satisfactory, a laparotomy had obviously been preferred before making the bowel decompression, and "blind" decompressions seem to have been reserved for the very ill patient. There are obvious advantages and disadvantages to both procedures.

Entero-anastomosis.—An attempt to relieve obstruction by short-circuiting the growth was made in 11 cases and there were 4 deaths (36.3%). This is a high mortality. One death resulted from peritonitis, the others from multiple peritoneal secondaries and ascites, auricular fibrillation, and coronary thrombosis at intervals of two, three, and five weeks after operation. In seven of the cases the growth was inoperable and the operation was made to avoid a colostomy, and seven of the cases were in the right colon. A short-circuit in the presence of obstruction is the operation of choice when laparotomy has shown an inoperable growth of the right colon, an alternative to caecostomy for an operable growth of the right colon, and in obstruction it is probably not wise to employ it anywhere else.

Resection.—Primary resection of the growth was performed on seven patients with one death, a mortality of 14.2%. With one exception the operation performed was a Paul-Mikulicz resection and the one death occurred after a sigmoid resection on the third post-operative day and without definite cause. These numbers are too few for deductions. If this review had been based on pre-war cases it is probable that the Paul-Mikulicz operation would have been featured far more often in the treatment of acute obstruction due to carcinoma. The control of infection is now so considerable that the disadvantages of the Paul-Mikulicz resection are now more apparent and it is less commonly employed. It still has a valuable place in colonic surgery, but it is not the ideal planned operation, and it should be reserved for cases where there is a real indication for its use. With the occasional exception of the right colon, decompression alone is the first step in obstruction due to growth. The only exception among these resected cases to the use of the Paul-Mikulicz operation was a right hemicolectomy with ileostomy drainage, a useful procedure when laparotomy shows an operable right colon growth and the patient's condition is satisfactory (Muir, 1947).

Results in Acute Obstruction

The evidence suggests that in acute obstruction of this type the simplest decompressive measures have the lowest mortality and, except in special circumstances, are to be preferred to more extensive procedures.

Of the 73 patients operated upon for acute obstruction 14 died (19.2%). Eleven of the deaths have been described. One of the remaining three patients died at the beginning of the anaesthetic and in the other two the growth was so extensive that only laparotomy was performed. Forty-one patients went on to a subsequent resection, and of the 14 who died with obstruction at least eight were quite inoperable. The average age was 66 years, with a range between 36 and 92. Obstruction in this age group is a serious complication to an already serious disease and will probably continue to have a high mortality, though comparison with some previously published figures (Table III) suggests that it may be improving.

TABLE III.—*Mortality in Acute Obstruction Due to Malignant Disease*

Souttar (1925)	..	..	..	..	43.5%
Newell (1951)	..	..	..	..	38%
Morley (1951)	..	..	..	..	29.7%
Lockhart-Mummery (1951)	..	..	..	..	22%
Becker (U.S.A.) (1953)	..	..	..	..	42%
Shallow <i>et al.</i> (U.S.A.) (1955)	..	..	..	..	15.2%
Present series	..	..	..	..	19.2%

Elective Surgery: Operability

Whenever possible a primary growth in the colon or rectum should be excised even if the presence of hepatic secondaries makes the expectation of life short, and under such circumstances without a colostomy if that is possible. The operability rate of these 714 cases has been considered with regard to the site of the growth, the operative mortality, and also to the five-year period in which they occurred (Table IV). Growths of the sigmoid have the lowest operability

TABLE IV.—*Operability, Site, and Resection Mortality*

	1945-9	1950-5
Right colon (109)	42	67
Operable	21 (50%)	50 (74.6%)
Operative deaths	2 (9.5%)	4 (8%)
Left colon (74)	25	49
Operable	18 (72%)	32 (65.3%)
Operative deaths	1 (5.5%)	5 (15.6%)
Sigmoid colon (114)	44	70
Operable	17 (38.6%)	40 (57.1%)
Operative deaths	2 (11.7%)	4 (10%)
Rectum (417)	178	239
Operable	128 (71.9%)	186 (77.8%)
Operative deaths	10 (7.8%)	14 (7.5%)

rate, and in all sites there was a definite rise in the numbers for the second five-year period. Since the Registrar-General's figures for the ten-year period 1945-55 show no overall increase in malignant growths of the large bowel, this increase can only be attributed to local conditions. Apart from the left colon there was a slight increase in operability rate in the second five years, but over the whole period it was not high. It is not uncommon to read of operability rates of 90% for growths of the colon and rectum, this figure naturally including cases in which the resection has been palliative. This figure gives a false impression, for it suggests that nine out of ten patients with carcinoma of the bowel should have a resectable growth. I do not believe that the real figure is as high. A great deal depends on local conditions, and one would not expect to find the same operability rate in the Charity Hospital, New Orleans, and the Lahey Clinic. In the one hospital 25% of all colonic growths are admitted in complete obstruction and in the other the corresponding figure is only 2%. In the present series it was 20.2%.

Further, there is more than one way of assessing an operability rate. Among the 714 patients in this series there are a large number of my own cases, and my own operability rate is higher than that for the series as a whole; but in assessing my figures I consider only the patients upon whom I operate. The inoperable case upon which an assistant performs a colostomy is not included, nor the patient for whom no operation is advised. In the present series all such cases are included, a number of different surgeons and surgical registrars are concerned, and it can be claimed that it is representative of what is happening in this country at the present time. Standards of operability necessarily vary, but it is illustrative to consider the reasons for inoperability given for the cases in just one group—growths of the right colon.

In the right colon there were 109 growths, and 38 of them were regarded as inoperable (Table V). The operability rate was only 65.1%.

TABLE V.—*Right Colon. Indications for Inoperability (38 cases)*

No laparotomy performed (7)	Post-mortem examination only	..	3
	Biopsy glands in neck	..	2
	Biopsy glands in groin	..	1
	Secondaries in lungs	..	1
Laparotomy performed (31)	Ascites and peritoneal spread	..	9
	Liver, omentum, and peritoneum	..	6
	Biopsy glands, and local fixity	..	4
	Local fixity alone	..	3
	Local fixity and glands	..	3
	Local fixity alone	..	5
Age 92		..	1

In seven cases the disease was so advanced that even laparotomy could not be advised; if these are excluded the operability rate rises to over 70%. Eight cases might be open to question: those where inoperability was judged on the fixity of the growth and the presence of enlarged glands, both of which conditions may be inflammatory and not due to growth. When these are the only contraindications to resection it is well worth removing the growth if at all possible.

Elective Surgery: Resection

Colon.—In this series 178 resections were performed for carcinoma of the colon; the operative measures used are shown in Table VI. The use of a Paul-Mikulicz operation

TABLE VI.—*Resection for Carcinoma of Colon*

		1945-50	1950-5
Right colon (71)	End-to-end	20	50
	Paul-Mikulicz	1	0
Left colon (50)	End-to-end	6	23
	Associated bowel drainage	(3)	(11)
Sigmoid colon (57)	Paul-Mikulicz	12	9
	End-to-end	8	35
	Associated bowel drainage	(4)	(15)
	Paul-Mikulicz	8	3
	Hartman's operation	1	2

on the right colon has never been popular in this country because of the small-intestinal fistula. The figures suggest that it is now less frequently used in the remainder of the colon. Excluding the right colon, end-to-end resection *without* bowel drainage was used in only 39 cases (36.4%). This figure seems low, but it was associated with a group in which 20.2% of all patients with colonic growths were admitted in acute obstruction.

Rectum and Recto-Sigmoid (Table VII).—The standard radical operation for these cases was some form of combined excision. Anterior resection was used for certain growths in the upper rectum and recto-sigmoid, while perineal resection and Hartman's operation were occasionally used for frail patients.

TABLE VII.—*Resection for Rectal and Recto-sigmoid Carcinoma (417)*

No.	1945-50	1950-5
Operable (palliative operations included)	178	239
Perineal resection	128 (71.9%)	186 (77.8%)
Hartman's operation	5 (2 deaths)	5 (1 death)
Anterior resection	33	52
Abdomino-perineal	64 (4 deaths)	88 (8 deaths)
Synchronous combined	14 (4 ..)	33 (3 ..)
Perineo-abdominal	7	2
Pelvic exenteration	—	4 (1 death)
Operative mortality	7.8%	7.5%

The frequency with which *anterior resection* has been used—85 out of 314 resections (27%)—is rather higher than it would normally be for purely rectal growths and is due to the inclusion of recto-sigmoid growths in this group. Those selected for anterior resection should be early growths, not of high malignancy, at least 10 cm. from the anal verge, 5 cm. above the reflection of the peritoneum in the pouch of Douglas, and ensuring that a clear margin of bowel 5 cm. in length can be removed below the growth. There were no deaths among these 85 operations, and this has reduced the overall mortality rate: if these cases are excluded the mortality rises by 3%. The figures in this series suggest that while the abdomino-perineal operation is still in common use the *synchronous combined operation* is gaining in favour. The overall mortality of the abdomino-perineal operation was 7.9% and that of the synchronous combined operation 14.9%, but in the last five-year period both operations had the same operative mortality—9%. *Pelvic exenteration* was used on four patients with one death.

Operative Mortality

Colon.—Resection was performed on 178 patients with 18 deaths (Table VIII), a mortality of 10.1%.

Rectum and Recto-Sigmoid.—Resection was performed on 314 patients with 24 deaths (7.6%).

TABLE VIII.—*Causes of Post-operative Deaths*

Colon	Rectum
Peritonitis	4
Pulmonary embolus	4
Shock	2
Cardiac failure	2
Uraemia	2
Sepsis	1
Cerebral thrombosis	1
Coronary	1
Small-bowel obstruction	1
	Peritonitis 3
	Pulmonary embolus 3
	Shock 4
	Cardiac failure 4
	Uraemia 3
	Sepsis and uraemia 2
	Cerebral thrombosis 2
	Pneumonia 2
	Haemorrhage 1

In the three hospitals concerned in this series, pre- and post-operative exercises were routine throughout the greater part of this ten-year period, yet it is interesting to note that fatal pulmonary embolus equalled peritonitis as the most common cause of death.

Recurrence

Among patients dying from recurrence after resection there were 145 in whom necropsy or other evidence was sufficient to indicate the main metastases at death. Only a limited number were submitted to necropsy, and while the recurrence rate for the liver may be overestimated it will certainly be underestimated for the lungs, adrenals, skeleton, and lymph nodes. Brown and Warren (1938), in a series of necropsies on cases of rectal cancer, found hepatic metastases in 34%, pulmonary in 22%, adrenal in 11%, and occasional metastases in sacrum, spine, thyroid, and brain. In the present series the percentage of those dying from recurrence with liver metastases was 50.5% for the rectum and 48% for the colon, with pulmonary metastases 13.2% for the rectum and 6% for the colon, and with skeletal metastases 17.6% for the rectum and 2% for the colon; metastases also occurred in the brain and spinal cord, adrenals, lymph nodes, and kidneys. There were two cases of "A" rectal growths (Dukes's (1944) classification) treated by combined excision where metastases occurred in the brain and spinal cord at intervals of five and eight years after operation. Skeletal metastases and those in the brain and spinal cord were more frequent with rectal than colonic growths, and it is reasonable to explain this on the more likely involvement of the paravertebral venous plexus by rectal growths. Many writers have stressed the frequency with which excised growths show venous invasion and the influence which this has on prognosis. The frequency with which blood-borne metastases contribute to the patient's death is undoubted.

Evidence, at death, of peritoneal recurrence was present in 33% of rectal cases and in 39.6% of colonic cases, and these figures were not materially altered by the exclusion of "C" cases (Dukes's classification).

Recurrence at the anastomotic site occurred in 6 out of 85 cases of rectal cancer treated by anterior resection (7%) and is believed to have occurred in 15 out of 178 cases of colonic resection (8.4%). It is believed that the figures for the rectal cases are accurate and that all such recurrences are included, but for the colonic cases the evidence is less certain and the local recurrence rate may be higher. The importance of post-operative supervision after anterior resection is shown by the fact that five recurrences were treated by combined excision and that two of these patients were alive and free from recurrence six and six and a half years after the second operation. The remaining anastomotic recurrence had followed a palliative operation.

Survival After Colonic Resection

Although there are 297 colonic growths in the series, only 77 remain to be considered when from the total are deducted those inoperable cases, operative deaths, and (the largest deduction) those cases operated upon less than five years ago. The figures, which include palliative resection, show an overall five-year survival rate of 57.1%, with a high level of 68.6% for B cases and 34.6% for C cases (Table IX). If the figures are broken down into groups it is found that growths in the sigmoid colon have the lowest survival rate. This is in keeping with other findings, for of the 114 cases of sigmoid carcinoma in this series 28.9% were admitted with acute obstruction, 10.4% with general or local peritonitis, and 6.1% with a vesico-colic fistula, and the operability

TABLE IX.—*Colonic Resection. Five-year Survival Rate (five years elapsed since operation). Palliative Resections Included; Three Untraced Cases not Included*

Group	Operation Survivors	Died in Less Than 5 Years	Survived 5 Years
A	—	—	—
B	51	16	35 (68.6%)
C	26	17	9 (34.6%)
Total ..	77	33	44 (57.1%)

Two patients died of recurrence after five years.

rate was only 50%, the lowest of any group. One could sum up the outlook for carcinoma of the colon in this series, which I believe to be fairly representative, as follows: of every 100 patients admitted to hospital, including all cases, 60 will have a resection, 6 will die from operation, and of the remaining 54, 31 will survive five years. A few of those (two cases in this series) surviving five years will subsequently die of recurrence. In a series reported by Colcock (1947) 13.6% of the five-year survivors died of recurrence in the next five years.

It is interesting to compare these results with those of Grinnell (1953) in a larger series from the Presbyterian Hospital, New York, consisting of 890 colon and 777 rectal growths over the years 1916 to 1945 inclusive. In the colon the five-year survival rate of all cases admitted rose from 5.9% for the period 1916–20 to 32% for 1936–40, but in 1941–5 it dropped to 30.8%. Unlike my own series, Grinnell found the worst prognosis to be in growths of the hepatic flexure, which he attributed to early invasion of the liver and duodenum. As regards lymphatic involvement, he found a 67.9% five-year survival rate for curative colon resection when no glands were involved and 36.7% of those with metastases. In the present series the figures are 68.6% and 34.6%, but all operations, including palliative resections, are included. Broder's grading on growth histology has not been applied to these figures, but it has always been shown that the degree of differentiation influences prognosis.

Survival After Rectal and Recto-Sigmoid Resection

Out of 314 cases, 162 survivors of this operation had been operated upon more than five years ago. The proportion of C cases is less than is usual in a series of rectal growths, and it is likely that fuller dissection might have placed some of the B cases in the C group. The figures, which include all palliative resections, show an overall five-year survival rate of 47.5%, with a high level of 78.2% for A cases and 28.8% for C cases (Table X). Taken with the operability rate

TABLE X.—*Rectal and Recto-sigmoid Resections. Five-year Survival Rate (five years elapsed since operation). All Operations, Palliative Resections Included. Four Untraced Cases not Included*

Group	Operation Survivors	Died in Less Than 5 Years	Survived 5 Years
A	23	5	18 (78.2%)
B	87	43	44 (50.5%)
C	52	37	15 (28.8%)
Total ..	162	85	77 (47.5%)

Three patients died of recurrence after five years.

and mortality rate they suggest that of every 100 patients admitted to hospital with carcinoma of the rectum, 75 will have a resection, 6 will die from operation, and of the remaining 69, 33 will survive five years. This figure is slightly better than that for carcinoma of the colon. Dukes (1944) quotes a figure of approximately 40% of the total entry at St. Mark's Hospital surviving five years after operation, but it is probable that general hospital beds are more likely to receive the frankly inoperable case. In Grinnell's series the five-year survival rate for all cases of carcinoma of the rectum admitted to hospital rose from 17.5% for the period 1916–20 to 32.7% for 1936–40, but in 1941–5 it dropped to 28.6%. These comparisons suggest that though the numbers in this series are small the picture they present of the disease is

probably a fair one. Private patients comprised over 40% of all cases in Grinnell's series and under 10% in the present series.

Survival After Combined Excision and After Anterior Resection

The after-results of cases treated by combined excision and by anterior resection are compared in Table XI, which shows that in this series the results of anterior resection were better than those of combined excision in all groups. Because of the small numbers, C cases show better results than B. Waugh, Block, and Gage (1955), from the Mayo Clinic, have

TABLE XI.—*Five-year Survival Rate after Combined Excision and After Anterior Resection (five years elapsed since operation)*

Group	Operation Survivors	Died in Less Than 5 Years	Survived 5 Years
<i>Combined Excision</i>			
A	12	4	8 (66.6%)
B	56	28	28 (50.0%)
C	36	28	8 (22.2%)
Total ..	104	60	44 (42.3%)
<i>Anterior Resection</i>			
A	10	1	9 (90%)
B	27	12	15 (55.5%)
C	9	3	6 (66.6%)
Total ..	46	16	30 (65.2%)

reviewed a series of 625 cases of rectal cancer treated by three procedures: combined resection, combined resection with sphincter preservation (an operation in which continuity is restored by perineal anastomosis), and anterior resection. They quote a five-year survival rate of 65.6% for anterior resection, 53% for the combined resection with sphincter preservation, and 51.6% for combined resection. While the five-year survival rate for anterior resection is the same, that for combined operations compares favourably with the figures in the present series.

The figures for anterior resection should not occasion any surprise: they are only to be expected. If radical restorative operations such as anterior resection are practised only on properly selected cases their results should be better than those of combined excision. Anterior resection should be chosen for a high rectal growth, and we know that, however treated, this type of growth has a better prognosis; it should be chosen for an early growth—and this has a better prognosis; and it should be chosen for a growth of low malignancy, again a factor for better prognosis. While I remain an advocate of the operation of anterior resection I do not think we should be unduly influenced by figures. However well selected, a patient treated by anterior resection will retain a slight risk of recurrence which would not be present had the whole rectum been removed. As against this must be set the advantage of retaining an anal orifice, and an operative mortality rate which is lower than that of combined excision.

Conclusions

In this series 20.2% of cases of carcinoma of the colon were not admitted to hospital until suffering from acute obstruction.

The mortality of the patient admitted in obstruction was approximately twice that of an elective resection when unobstructed.

Simple decompressive measures appeared to carry the lowest mortality in obstruction.

If all cases of the disease are included it is difficult to achieve a high operability rate in carcinoma of the colon or of the rectum.

End-to-end resection with associated bowel drainage was favoured for the colon; some form of combined resection for the rectum.

The operative mortality for the colon (10.1%) was slightly higher than that for the rectum (7.6%). Amongst the causes of post-operative death, pulmonary embolus and peritonitis were equally the most frequent.

The pathology of local and general recurrence is considered.

The overall five-year survival rate is slightly higher for the rectum (33%) than for the colon (31%). A comparison is made between the results of anterior resection and combined excision and their significance discussed.

Further improvements in surgical technique will still further reduce mortality, but when age, the severity of the necessary operations, and the causes of death are considered it is certain that the best reduction would be achieved by earlier diagnosis.

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RECONSTRUCTIVE SURGERY OF THE HAND, WITH SPECIAL REFERENCE TO SKIN COVER*

BY

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This paper sets out to establish the principles of reconstructive surgery of the hand, on an understanding of the normal functional anatomy and the modified anatomy following the effects of injury. The first principle is the preservation of function, the second is the preservation of tissue. The methods used for repair following injury, here presented, incorporate these two principles.

Functional Anatomy

The power of grip is greatest on the radial side of the hand, the ulnar side being mainly concerned with the interpretation of stresses and strain by virtue of its highly sensitive hypothenar surface. The thumb and little finger have a greater range of movement than the other digits and, acting together, produce the cupping of the palm in flexion and the flat palm in extension. They can compensate for damage to joints and tendons and adapt themselves to their disability, in striking contrast to the index, middle, and ring fingers. This is due, in the thumb, to the fact that the thenar muscles can partly flex and extend the terminal phalanx when the long flexor or extensor is divided and the short abductor can to some extent compensate for the loss of the long abductor.

In the little finger, ankylosis of the metacarpo-phalangeal joint can be compensated for, by shortening in this area, thus allowing the pulp of the terminal phalanx to reach the palm. Ankylosis of the proximal inter-

phalangeal joint in 50 degrees of flexion will allow the pulp of the terminal phalanx to reach the palm and, in extension, bring it within the plane of extension of the fingers by an increase in the range of extension and flexion of the metacarpo-phalangeal joint assisted by the mobility of the fifth metacarpal. This degree of

FIG. 1

compensation cannot be achieved in ankylosis of the proximal interphalangeal joint of the index, middle, or ring fingers.

When the terminal phalanx of the little finger has been amputated the stump can be flexed into the palm by an increase in the range of flexion of the metacarpo-phalangeal and the carpo-metacarpal joints, producing little or no dysfunction in the stability or power of grip. In the case of the thumb, ankylosis of the metacarpo-phalangeal joint can be compensated for by an increased range of movement in the carpo-metacarpal joint.

The preservation of the thumb and the little finger is of primary importance to the damaged hand, and the so-called cosmetic amputation of the little finger should be avoided if the breadth and mobility of the palm are to be preserved.

Planes of Flexion and Extension

In full extension the flat surface provided by the palm and fingers is an essential functional requirement, and a finger-tip which transgresses this plane by a fixed flexion deformity should be shortened (see Fig. 1).

In flexion the heads of the metacarpals and phalanges produce a series of parallel transverse planes, and any phalanx which lies out of alignment presents a disability (see Fig. 2). This may be corrected by mobilization of the joint involved, re-education to correct a defence mechanism, or shortening. Patients often hyperextend a finger as a defence to bring the stump out of the range of function.

When a short middle phalanx does not flex it is subject to trauma, as it does not lie in the transverse plane of the proximal phalangeal heads when the fingers are in full flexion. It should therefore be shortened to lie in this plane.

FIG. 2

Physiological Position of Rest and After-care

After operation the hand should be immobilized in the position of rest. The wrist is held in 30 degrees of extension and slight ulnar deviation, and the fingers should be immobilized in the position they adopt with this degree of extension. This varies with the age of the patient. In young children, with the wrist extended, the little finger is flexed

*Lecture given to the Royal College of Surgeons of Edinburgh.