

C. A. LOEHRY AND B. CREAMER: POST-MORTEM STUDY OF SMALL-INTESTINAL MUCOSA

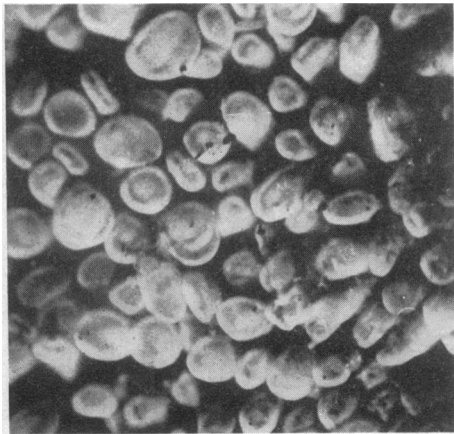


FIG. 1A

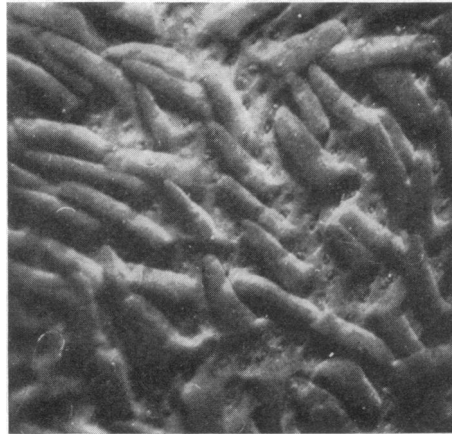


FIG. 1B

FIG. 1.—Surgical biopsy of ileum. A: Fixed immediately in formalin. B: Allowed to autolyse for 24 hours. Many of the villi are lying flat. ( $\times 30$ )

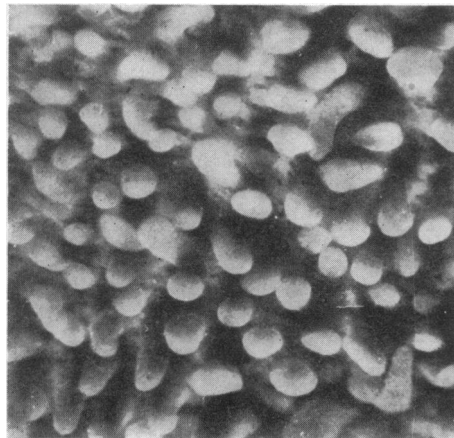


FIG. 2

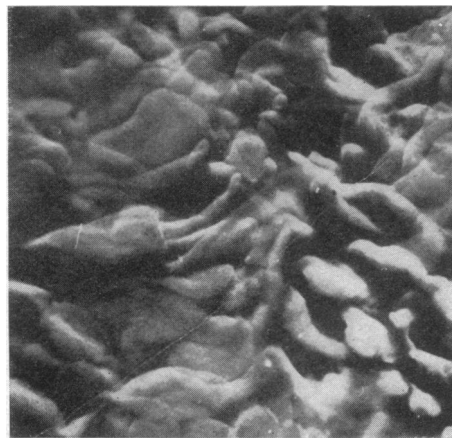


FIG. 3

FIG. 2.—Normal jejunal mucosa at post-mortem examination. ( $\times 30$ )

FIG. 3.—Leaf-shaped villi at post-mortem examination. ( $\times 30$ )

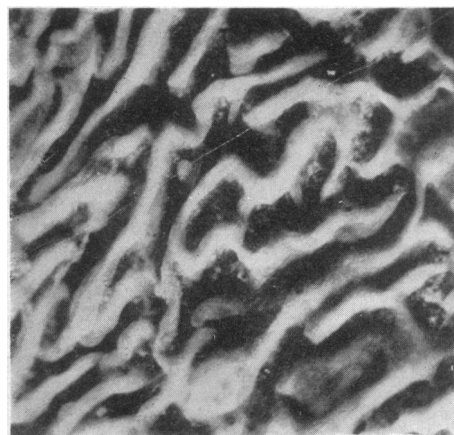


FIG. 4

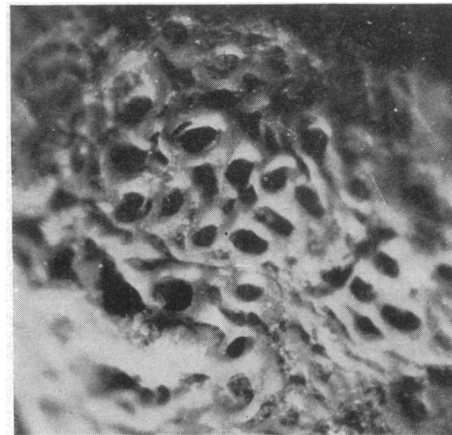


FIG. 5

FIG. 4.—Convoluted villous shapes at post-mortem examination. ( $\times 30$ )

FIG. 5.—A flat mucosa at post-mortem examination. ( $\times 30$ )



FIG. 6

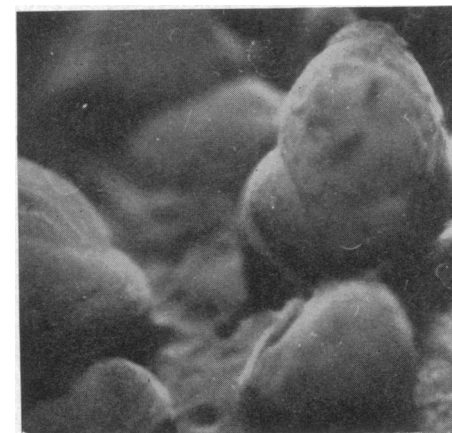


FIG. 7

FIG. 6.—Peyer's patches in the ileum at post-mortem examination. ( $\times 30$ )

FIG. 7.—Huge rounded villi at post-mortem examination due to infiltration with malignant cells. ( $\times 30$ )

survival of tissues which are damaged. This applies to bone as much as to any other viable tissue, and, for the same reason, the dosage of diagnostic irradiation ought to be drastically limited.

A sequestrum separates naturally by the formation of granulation tissue at a line of demarcation. Removal of the fully separated sequestrum leaves this bed of granulation tissue, which will soon accept a skin graft. If a sequestrum be chiselled away, compact bone will be exposed and skin is not likely to grow upon it: sequestration will probably proceed. At this stage the internal fixation may usually be removed.

If bone union is occurring and the skin cover is sufficient no further action is necessary: let it proceed to consolidation. Should the skin-grafted area prove unsatisfactory from instability or adherence, it may be excised at convenience and permanent cover substituted by a definitive pedicled flap.

If bone union is not occurring a period should elapse to ensure quiescence and that there is no residual infective process in soft tissues or bone. Then the skin graft should be excised and stable definitive skin cover provided. Premature use of the definitive pedicled flap may be disastrous.

At open operation the plastic surgeon should co-operate with his orthopaedic colleague; the plastic surgeon ought to raise the skin flap and protect it from damage. He should suture it carefully himself, and, despite protest, he should insist upon the wound being drained by suction for 48 hours rather than risk a haematoma.

Established gross or long-standing infection is due to an unwise persistence with a closed or insufficiently exposed wound. It occurs where the surgeons have not had the courage to abandon the conventional technique and adopt this heretical open method wholeheartedly. It is worth while laying such wounds open very widely and proceeding as in cases of non-union; but the problem is not the same—osteitis is easier to avoid than to cure, and more of these cases come to amputation.

This technique, suitable for robust and young patients, does not necessarily apply to the elderly, where it may be wiser to amputate. A prosthesis is a good substitute for an indifferent lower limb, but it can be a burden and nuisance in the tropics.

Economically we may be at an advantage over the civilian, because the Services will retain a patient on full pay and allowances if there is a reasonable prospect of fitness within 18 months. This period appears reasonable also in considering whether to persist in saving a limb or amputating, but a great deal depends upon the character of the patient and whether he is "with you" or not.

## Other Fields

Much should be written in appreciation of rehabilitation, welfare, and resettlement, but these subjects are too important to dismiss shortly; they could worthily absorb the whole period of the lecture. Nor will space permit a survey of elective reconstructive work. One example of close co-operation is outstanding: the field of hand surgery. Training in plastic surgical technique is a great advantage in hand surgery, and this is a field of happy relations between our specialties. In the British Club for Surgery of the Hand we are all interested in hand surgery but not in the label of any individual surgeon. It is unfortunate but inevitable that the degree of specialization necessary to the highest achievement leads to some partition, some individualism, almost isolationism, of surgical practice. But the characteristic lesion of the modern accident patient is multiple injuries, frequently requiring the simultaneous attention of specialists in several different fields.

## Summary

The restoration of normal function and appearance following injury is best achieved by adopting plastic-surgical procedures at the time of the initial treatment, and not by referring the patient for camouflage at a later stage.

Skeletal injuries of the face require early correction of deformity, as fixation of bones occurs early and normal function can be preserved only by adequate reduction.

Skin loss should be treated by skin cover at the earliest possible moment. The indications for split-skin and pedicle grafts are described.

Fractures complicated by skin loss are treated by promoting soft-tissue healing, which will accelerate bony union.

It is essential to the application of this knowledge that the skills and the necessary equipment should be made available at the time and place that they are required.

I wish to record my thanks to Air Marshal Sir Richard Nelson, Director General of Royal Air Force Medical Services, for permission to deliver this lecture and to publish this account of it, but I emphasize my sole responsibility for the opinions expressed therein.

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## Post-mortem Study of Small-intestinal Mucosa

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[WITH SPECIAL PLATE]

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Histological examination of the small-intestinal mucosa at post-mortem examination has always proved unrewarding because of the high incidence of autolysis. Peroral biopsy has clearly defined the major abnormalities and answers the need for diagnostic information. However, there are at least two aspects that could be usefully studied if post-mortem material was readily interpretable. The prevalence of abnormal

mucosal patterns in disease states and communities could be assessed, and the extent and distribution of these lesions in the whole small intestine could be accurately mapped out.

It has already been shown in a case of the coeliac syndrome that the small-intestinal mucosa can be easily examined post mortem by the dissecting microscope, though histological examination showed extensive autolysis (Creamer and Leppard, 1965). In this case the appearance of the post-

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mortem tissue was somewhat different from the biopsy specimens obtained in life, and this was shown to be due to the loss of surface epithelium, so that the basement membrane was now the external surface. This made the villous structures, whether normal or abnormal, thinner than in life and the openings of the crypts became easily visible. In the present study this finding is confirmed and the variations of villous structure are described. A survey of the prevalence of abnormalities in 100 unselected post-mortem examinations is presented.

**Materials and Methods**

Specimens were obtained from cases coming to necropsy at St. Thomas's Hospital. Squares of tissue approximately 1/2 by 1/2 in. (1.3 by 1.3 cm.) were taken from mid-duodenum, mid-jejunum, and mid-ileum. They were gently rinsed in water to rid them of excess blood, mucus, and food particles and then pinned, without stretching, on to small cardboard squares. All the specimens were then fixed in formalin for at least 24 hours and then put into one change of 70% alcohol, and two of 95% alcohol at two hours each. They were then stained with 5% alcoholic eosin for four minutes, treated with two changes of absolute alcohol, again at two hours each, and finally placed in xylol. All the specimens were then photographed under the dissecting microscope at X8 magnification.

**Results**

**Number of Successful Examinations**

Of 354 pieces of mucosa examined only 25 were rejected, usually because of food residues and mucus adhering to the mucosa. The time between death of the patient and post-mortem examination seemed to make little difference to the quality of the material.

**Post-mortem Appearances**

In most cases the mucosal architecture was easily recognizable under the dissecting microscope. The villous structures were thinner than those seen in life and the crypt openings were clearly visible. Further evidence that these villi were bereft of epithelium was obtained by operative specimens of ileum where half was fixed in formalin and half allowed to autolyse in saline for 24 hours before fixing (Special Plate, Fig. 1). The autolysed specimen showed the same changes as those taken at necropsy. The only case not showing the loss of epithelium at post-mortem examination was that of a patient who died from prolonged hypothermia, where lack of autolysis might be expected.

In almost all the patients who had died suddenly without preceding illness the appearances in the duodenum and jejunum were of long finger-like villi analogous to the known finding at biopsy (Special Plate, Fig. 2). Ileal specimens always showed finger-like villi, but these were usually shorter than those in the jejunum, and the crypt orifices between them appeared more numerous. The range of abnormal villous shapes also paralleled biopsy findings: leaves, convolutions, and a flat mucosa could be easily recognized (Special Plate, Figs. 3, 4, and 5). Peyer's patches appeared as domed structures surrounded by villi: these have been confirmed histologically (Special Plate, Fig. 6). One curious anomaly was the finding of huge rounded villi in a woman aged 31 who died from an anaplastic carcinoma of the stomach with multiple metastases (Special Plate, Fig. 7). Histological examination showed that the villi were distended with masses of malignant cells that had presumably travelled retrogradely through the lymphatics and lacteals.

**Survey of 100 Post-mortem Examinations**

Specimens from mid-duodenum, mid-jejunum, and mid-ileum were obtained from 118 necropsies. In 18 of these one or more of the specimens were in such a condition that adequate photographs could not be obtained—a rejection rate of 15%. The findings in the 100 necropsies are summarized in Table I. An abnormal mucosa was often found in the

TABLE I

	Duodenum			Jejunum		
	Normal	Leafy	Con-voluted	Normal	Leafy	Con-voluted
Malignant disease ..	18	15	7	30	10	
Blood dyscrasia ..	1	2	1	2	2	
Chronic heart failure ..	10	7	*	17	1	
Uraemia ..	2	2	1	3	2	
Myocardial infarct ..	9			9		
Road-traffic accident ..	3			3		
Cerebrovascular acci- dent .. .. .	6		1	7		
Empyema ..	1			1		
Rheumatoid arthritis ..	1			1		
Pulmonary embolus ..	2			2		
Burns ..	1			1		
Dystrophia myotonica ..	1			1		
Pulmonary tuberculosis ..	1			1		
Cirrhosis ..	2	1		3		
Pneumonia ..	1			1		
Septicaemia ..		1		1		
Intestinal obstruction ..		1		1		
Myxoedema ..	1			1		
Total .. .. .	60	29	10	85	15	

\* Flat.

FIG. 1

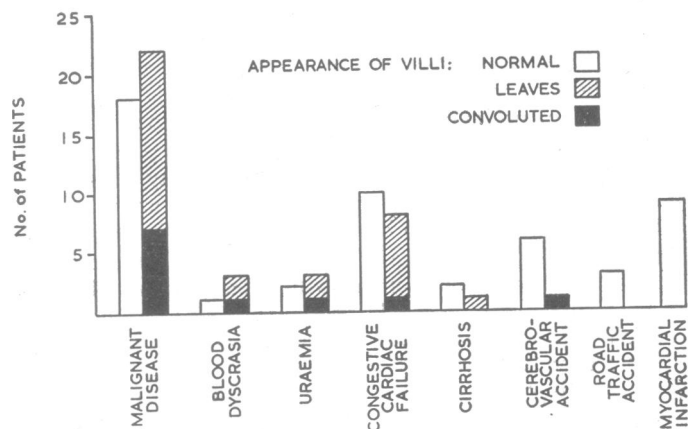


FIG. 2

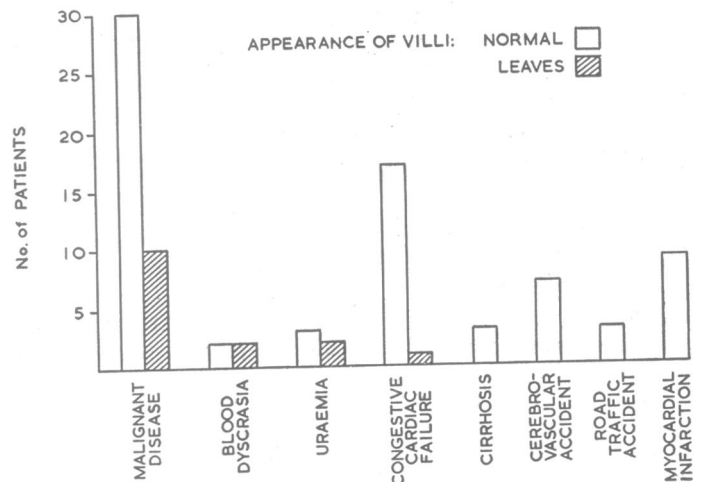


Fig. I.—Mucosal abnormalities in mid-duodenum.

Fig. II.—Mucosal abnormalities in mid-jejunum.

duodenum (40%), sometimes in the jejunum (15%), and never in the ileum. In the duodenum one mucosa was flat, 10 showed a convoluted pattern, and 29 were leafy. The jejunal abnormality was always a leaf-like villous structure.

When the mucosal structure was correlated with the disease from which the patient had died certain striking associations became apparent (Figs. I and II). In those 19 patients who had presumably been in good health before sudden death in a road-traffic accident, a cerebrovascular accident, or a myocardial infarct all the specimens were normal with finger-shaped villi, except for one with a convoluted pattern in the duodenum. By contrast those patients dying of malignant disease had a high proportion of abnormalities (Table II). Out of 40 cases with malignancy 22 (55%) had an abnormal mucosa in the duodenum and 10 (25%) in the jejunum. The mucosal pattern in the duodenum was convoluted in seven and leaf-like in 15. In the jejunum the abnormalities were always a leaf-like change, and this was more common in those cases where the duodenum had shown a convoluted pattern. Patients with uraemia, cirrhosis of the liver, blood dyscrasias, and congestive cardiac failure also showed a high proportion of abnormalities, the only completely flat specimen being seen in a patient with uraemia (Special Plate, Fig. 5).

TABLE II

	Duodenum			Jejunum		
	Normal	Leafy	Con- volut- ed	Normal	Leafy	Con- volut- ed
Carcinoma of stomach	3	2	2	4	3	
Carcinoma of prostate	1			1		
Carcinoma of bronchus	7	4	2	10	3	
Carcinoma of pharynx	1			1		
Carcinoma of rectum	2	1		3		
Carcinoma of bladder	2	1		2	1	
Carcinoma of larynx		3	1	3	1	
Carcinoma of pancreas		1			1	
Hypernephroma ..			1	1		
Glioblastoma .. ..			1	1		
Melanoma .. ..	1	2		2	1	
Reticulosis .. ..	1	1		2		
Total .. ..	18	15	7	30	10	

In patients dying of malignancy the abnormalities were not associated with any particular neoplasm, the degree of spread, radiotherapy, or antimitotic drugs. Those showing an abnormal duodenal mucosa were rather younger than those with a normal mucosa; the average age of the patients with malignancy and a normal mucosa was 65, with a leaf-like mucosa 57, and with a convoluted mucosa 50 years.

### Discussion

This study has shown that it is perfectly possible to examine the small-intestinal mucosa in the majority of cases coming to post-mortem examination. There is no doubt, however, that proper staining is essential for obtaining clear pictures. In 85% of necropsies where specimens had been taken from duodenum, jejunum, and ileum all three were clearly visible and recognizable under the dissecting microscope. What is revealed is the mucosal structure, not the mucosal epithelium, which is autolysed away. The resulting appearance is in some way more informative than a biopsy specimen, for not only is more tissue available but the crypt orifices can be clearly seen. All the varieties of villous structure that are visible on

a biopsy have their counterpart at necropsy. The change in appearance seems to be due solely to the lack of epithelial cells.

The results of the survey of 100 necropsies are of interest because of the association of mucosal abnormalities with certain diseases. An abnormal duodenum, and, to a less extent, jejunum, were common in malignant disease, blood dyscrasias, uraemia, cirrhosis, and heart failure. It is difficult to be sure of the exact extent of these lesions as the specimens are taken from mid-duodenum and mid-jejunum, while biopsy specimens are usually taken from the upper jejunum. However, a convoluted appearance such as is found in the coeliac syndrome was present in the duodenum in 18% of patients with malignant disease. A flat mucosa in malignancy has been reported previously (Creamer, 1964; Hindle and Creamer, 1965; Wangel and Deller, 1965), and the present findings lend support to the notion that a neoplasm may bring about a flattening of the upper small-intestinal mucosa. In a previous communication Hindle and Creamer (1965) advanced the hypothesis that the coeliac syndrome—a clinical picture of malabsorption and a flat jejunal mucosa—could be primary or secondary. Many diseases may be associated with a secondary coeliac syndrome, and malignancy is probably the commonest, as the present study suggests. Blood dyscrasias, uraemia, and cirrhosis would also seem to be potent causes of a secondary coeliac syndrome. The finding of an abnormal mucosa in cardiac failure is interesting, as Vaughan Jones (1961) reported three cases of steatorrhoea out of 17 patients with cardiac failure, and the present observations would seem to give a reasonable explanation for this.

The abnormalities described in this study were confined to the upper part of the small intestine, and by the mid-jejunum the villous shape was either leaf-like or finger-like. It may be argued that these lesions are too localized to be associated with malabsorption. Clearly more observations and details about the exact extent of the abnormalities are required.

The significance of leaf-like villi in jejunal biopsies of patients without obvious intestinal disease has been difficult to assess. The present study suggests that a marked leaf-like pattern may be uncommon in people who suffer sudden death, but the whole pattern of mucosal structure on an epidemiological scale needs further investigation.

### Summary

A method of examining the small-intestinal mucosa at post-mortem examination is described. The villous structure can usually be clearly seen under the dissecting microscope after staining with eosin. The range of abnormal findings in disease is the same as that found in biopsy specimens. A survey of 100 post-mortem examinations is detailed. Abnormal mucosae were commonly found in the upper small intestine in patients dying of malignancy and other chronic diseases.

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