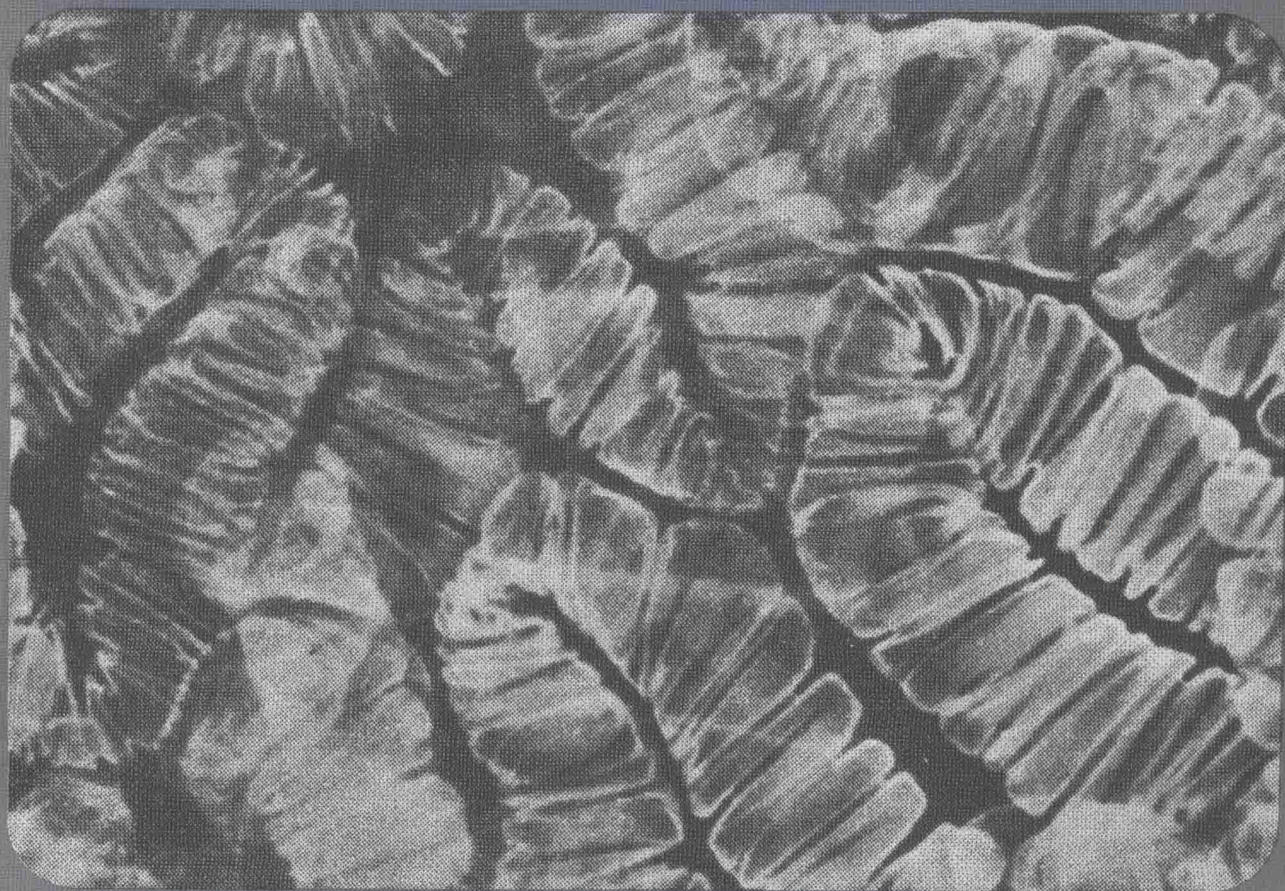


J.L. Sellink M.D.

RADIOLOGICAL ATLAS OF COMMON DISEASES OF THE SMALL BOWEL



Stenfert Kroese

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RADIOLOGICAL ATLAS
OF COMMON DISEASES OF
THE SMALL BOWEL

PREFACE

This atlas is a selection of the roentgenograms of patients who visited the Radiology Department at the University Hospital in Leiden between 1970 and 1974. The heads of this department are Prof. J. R. von Ronnen and Prof. A. E. van Voorthuisen.

In this atlas, the most frequently occurring radiological abnormalities of the small intestine are illustrated as clearly as possible – without the shadows caused by flocculation or segmentation of the contrast fluid. The author hopes it will be a positive contribution towards the attainment of the highest possible diagnostic score. It should be remembered that the key to good diagnostics is not only a perfect examination technique, but also the knowledge and character of the physician. If these factors are optimal, then the best possible series of roentgenograms will be obtained, at least as far as technique is concerned. All patients were examined by the enteroclysis technique. With this method of examination of the small intestine, the contrast fluid is administered via an infusion directly into the duodenum instead of orally. The infusion method has added a new dimension to the radiological examination of the small intestine. This method has turned out to be especially suitable for the comparative evaluation of motility, and also for the study of disturbed motility. In addition the course of the examination can be adapted to the situation at any given moment and can be redirected as required. Each new enteroclysis examination can therefore be a source of considerable satisfaction for the physician since it – more than any other gastro-enterological examination – demands his constant attention and all of his skills.

Many radiologists in our department have mastered the enteroclysis technique during the past five years and it is not surprising that, as a result of their great enthusiasm, many have become deeply interested in a particular aspect of the pathology of the small intestine. The author and compiler of this atlas was able to benefit from the experience of these associates and was given permission to use their data which in most cases have been published elsewhere.

I wish to thank the following for their cooperation: J. R. Achterberg (staff) – drug-induced atony; C. A. van Hees – Meckel's diverticulum; W. F. Müller – celiac disease (awarded with the Boris Rajewski medal at the A.E.R. congress in Edinburgh in June 1975); J. Th. Schlangen – radiation enteritis; W. H. B. Tuynman – melanoma metastases; P. J. van Wiechen – yersinia enterocolitica infections and C. J. L. R. Vellenga – a-specific ulcerations.

The following former members and consultant radiologists of the Department of Radiology at the Leiden University Hospital sent me interesting photographic material and we hereby thank them for their efforts:

Dr. A. S. J. Botenga; mesenterial cyst, fig. 10.3

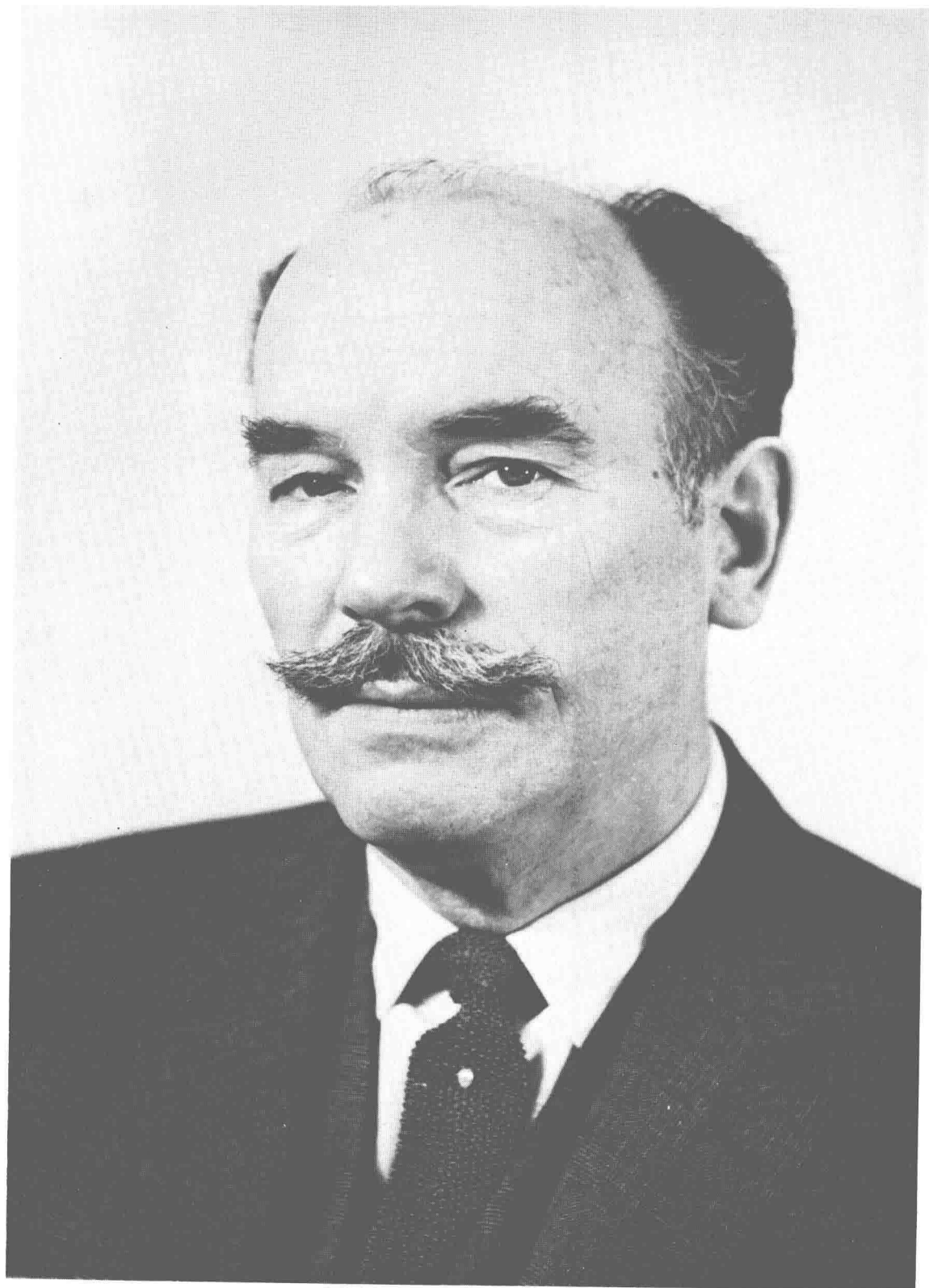
G. Coerhamp; amebic abscess, fig. 9.68

J. G. van Dorssen; adenocarcinoma of the jejunum, figs. 8.40N and 10.24

C. A. van Hees; sclerosing peritonitis, fig. 14.12

J. O. op den Orth; mesenterial thrombosis, fig. 11.13

Dr. G. R. Prager; carcinoid lesion, figs. 8.40L and 10.17



J. R. VON RONNEN

F. Rodenboog; jejunal intussusception, fig. 14.18, lipoma, fig. 10.12.

J. Th. Schlangen; lymphoid hyperplasia, fig. 9.76

Dr. H. E. Schütte; appendicular abscess, figs. 9.65 and 9.67 PQ, cong. lymphedema, fig. 8.8ABC

H. Verhoef; lymphosarcoma of the jejunum, fig. 10.26

We are also grateful to the following colleagues for the use of their exceptionally fine roentgenograms:

D. M. A. Agenant and Dr. G. N. Tijtgat (gastroenterologist of the Wilhelmina Gasthuis, Amsterdam University) Whipple's disease, figs. 8.23 and 9.54FG, eosinophilic gastroenteritis, fig. 9.46; Naish syndrome, figs. 12.4 and 12.5 amyloid disease, figs. 12.35–1,3 and 12.36; ascaris, figs. 8.29–1,2.

Dr. G. Rosenbusch and Dr. J. M. H. van Tongeren (gastroenterologist of the St. Radboud Hospital, Nijmegen University) reticulum cell sarcoma, figs. 8.8E and 10.27K; ascaris, figs. 8.29–5; Whipple's disease, figs. 9.55, 9.56–2; Zollinger-Ellisons disease, fig. 9.71.

Dr. R. W. Radder; a-specific jejunal ulcer, fig. 8.36

W. P. L. van Ouwerkerk; primary amyloidosis, figs. 12.33 and 12.35–4

Dr. G. P. Gooris-Namur; Peutz-Jegher syndrome, fig. 10.11B.

It can be regarded as a special coincidence that the publication of this atlas coincides more or less with the retirement of Professor von Ronnen and the transfer of his position as head of the Department of Radiology at the Leiden University Hospital to his successor Prof. Dr. A. E. van Voorthuisen.

During Prof. von Ronnen's 20 years as head of the above-mentioned department, he succeeded in raising its status to a level in accordance with the glorious history of the 400-year-old Leiden University. In addition he improved, at least on a national level, the position of radiology as an independent specialty as well as that of the radiologist to such an extent that colleagues of most other European countries are justifiably envious.

Many years ago Prof. von Ronnen realized that radiology is much too broad a field for one professor and several residents to be able to work within the university on further developments and that for this purpose the formation of a permanent staff of enthusiastic associates was indispensable. The magnetism of the considerably higher fees in peripheral hospitals however made this task impossible. Prof. von Ronnen then made the decision – unique at that time – to form an association with his close co-workers and to divide the revenues of the collective practise with them equally. That he not only regarded this move as inevitable but also was on friendly terms with his younger associates and wholeheartedly approved of their increased income is characterized by the fact that in later years he even went so far as to limit his own share. It was many years before this vision and his approach were understood and even longer before they were adopted on a broader scale. Only recently in the last few years have the means been found in most other university clinics to form a scientific staff in a more or less similar manner. The early introduction of these concepts by Professor von Ronnen was however certainly one of the reasons that his department assumed a leading position in the Netherlands. Under his guidance, post-graduate courses were organized and annual reunions were held for radiologists who had studied in Leiden. Although the social function of the latter was certainly not unimportant and was greatly appreciated, they were in fact mainly scientific in character. Only recently in the past few years has the Dutch Association of Radiologists organized periodic post-graduate courses and courses for the training of residents on a national level.

It is not surprising that a leader with the stature of Prof. von Ronnen, a man who during his career could be considered the undisputed Master of Radiology in the Netherlands, fulfilled numerous prominent administrative functions, not only within the Netherlands but also internationally. Quite recently, at the Third A.E.R. Congress in Edinburgh, he turned the presidency of the Association Européenne de Radiologie over to a man of similar capabilities, the Swede Olle Ollson.

One basic requirement for good leadership, and certainly not the least important, is the ability to delegate responsibility adequately. It is even questionable whether one can fulfill an executive position satisfactorily without this characteristic, which is highly developed in Prof. von Ronnen. Prof. von Ronnen was a master of the art of delegation and was able to let others do the work even when he knew that he could do it better himself. In his criticism, which was always very constructive and stimulating, he avoided at all costs offending the individual involved, although this must have required considerable effort now and then. His 22 Ph.D. students in particular acquired the deepest respect for this attitude and will remember with gratitude and esteem the dignity of this personality – a dignity which is seldom encountered today.

In addition to his daily practice which he always pursued with the greatest satisfaction and dedication and in spite of the time-consuming chores arising from his many functions and the management of the department, Prof. von Ronnen was able to prepare countless lectures and more than 60 publications, some in collaboration with one or more of his colleagues or colleagues of other disciplines; this certainly can be attributed, at least partly, to his ability to delegate.

During the first 15 years of his career as a radiologist, 10 in diverse functions in the former Dutch East Indies and 5 in Bronovo Hospital in the Hague, his interests were diversified as required by the demands made of a radiologist with a general practice. Although his publications covered numerous subjects in diagnostics, his major concerns in this period were the urogenital tract, the digestive tract, aortography and arteriography and later also mammography; the latter was the subject of his Ph.D. thesis in 1956.

During the next 20 years as professor in Leiden, he was still interested in the diagnostics of the gastrointestinal tract. However in the course of time he turned his attention to an ever increasing degree to the diagnostics of the skeleton, in particular of bone tumors. Fifteen years as secretary of the Dutch Commission for Bone Tumors gave him considerable experience in this field. His impressive contribution to the book compiled by this group 'Radiological Atlas of Bone Tumours', which can be considered an unparalleled standard text on this subject, must be regarded as his most extensive scientific work.

The assignment to determine whether it would be possible to improve the disappointing results of the transit examination of the small bowel was given in the fall of 1969; as far as the outcome was concerned, expectations were probably not very high. The conclusion of this study, which was carried out partly under the stimulating influence of the head of the Department of Gastroenterology, Prof. Dr. A. J. Ch. Haex, was not just that the quality of the contrast fluid required improvement but in the first place that the examination technique had to be adapted to the conditions existing in the gastrointestinal tract. Once convinced that enteroclysis of the small bowel signified a not unimportant improvement over all other procedures used at that time, Prof. von Ronnen became in this respect the author's most loyal supporter. Furthermore it was a source of considerable satisfaction that during these past years he, more than any other, could become enthusiastic about the continual new surprises which we still encounter regularly. It was moreover a great privilege during this initial period, when an adequate opponent is in fact of the greatest importance, to be able to talk with a man of such stature. Last but not least the author is grateful to his chief, supervisor and associate for his frequent, friendly and often paternal advice as well as his wise, usually mitigating influence in situations which threatened to boil over. Thus an esteem for his personality and gratitude for his role in the developments which led to this atlas, to which so many of his associates and former students have contributed, have led the author to dedicate this work to Professor von Ronnen.

In addition to the members of the photography section of our department who handled a gigantic amount of work, I am finally and especially also very grateful to and have the deepest admiration for my wife, Mia. In spite of the many chores resulting from our large family, she has in the past 5 years still managed to do all of my typing – not only for this Atlas but also for the book which preceded it (Examination of the small intestine by means of duodenal intubation, 1971) and a book published in 1973 (Dutch antique domestic clocks).

Leiden, August 1975.

J. L. Sellink



J. L. SELLINK

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INTRODUCTION

Although there has been some improvement over the past few years, the radiological examination of the small intestine must still be regarded as a stepchild of radiology and even of the examination of the digestive tract. The net gain of a transit examination of the small intestine was so disappointing for so many years that the negative attitude on the part of many radiodiagnosticians is certainly understandable. Gradually, however, steady improvement has changed this somber situation and nowadays an adequately executed roentgenological examination of the small intestine is definitely worthwhile and its contribution to diagnostics can be considerable.

Early in the fifties, Golden showed that even if the examination techniques are not at an optimum and the contrast fluids are not the best, good results can be achieved if the radiologist himself at least approaches the examination enthusiastically.

Somewhat later in the same decade, Marshak pointed out that better results are obtained if larger amounts of contrast fluid are used. Then not only is there better filling of the intestinal loops so that abnormalities are not as easily overlooked, but in addition an examination carried out in this manner is more efficient since more intestinal loops are visualized per exposure and the examination as a whole is shorter. Moreover, an even shorter examination as well as an improvement in the mucosal patterns was achieved by using drugs to accelerate passage.

Quite often in the past ten years, Bodart has demonstrated very effectively that smaller abnormalities of the mucosa need not escape the attention of the physician if he studies the intestinal loops carefully by using fluoroscopy and the compression technique in combination with detail spot films.

More recently as a result of the introduction of the enteroclysis technique the many meters of small intestine have become much more accessible for radiodiagnosis. With this method, optimum filling of the intestinal loops is obtained and the fear of malabsorption, the major testimonium paupertatis for the conventional transit examination of the digestive tract, has disappeared from the scene forever.

To a certain extent the enteroclysis technique demands more of the radiologist since this examination must be executed properly in every respect. Neglecting one or more of the factors, which will be discussed in detail, leads without fail to disappointment and perhaps even to reinstatement of less adequate procedures. Because of the rather high degree of filling achieved with enteroclysis, careful compression of the superimposed intestinal loops has become essential since otherwise, as before, numerous abnormalities will be overlooked.

Unfortunately it has also been established that the diagnostic output of the radiological examination of the small intestine, even more than that of other examinations, can vary greatly depending upon the technique used and the care and skill with which the examination is carried out.

Although the radiological examination of the small intestine has always been referred to the radiologist with a general practice – and this should continue to be true because of the high frequency of abdominal complaints – it may be to the advantage of these patients if the examination is carried out by those radiologists especially interested or specialized in this aspect of radiodiagnostics.

The scale of radiologically demonstrable abnormalities has by now become quite extensive; further-

more diseases of the small intestine appear to occur much more frequently than previously assumed.

In addition to complaints such as abdominal pain, unexplained high fever, blood loss in the digestive tract, diarrhea and diseases accompanied by malabsorption, all of which clearly require radiological evaluation of the small intestine, this type of examination must also be carried out in the

event of unexplained hypoalbuminemia, whether accompanied by edema in the lower extremities or not. Since without a doubt a well-executed enteroclysis examination must be considered the best possible method of examination, every conceivable aspect and pitfall of this procedure has received special attention in this atlas.

II ANATOMY

1. Normal mucosa in the small intestine

More important for a correct interpretation of the pictures obtained than for the technical execution of the examination is a thorough knowledge of the anatomical structure of the wall of the small intestine. It is, however, difficult to differentiate between examination and interpretation, at least when the radiologist is actively involved in both as is the case for gastric and colon examinations.

The wall of the small intestine, shown schematically in fig. 2.1, consists of the following layers, starting from the outside:

1. the serosa;
2. the tunica muscularis, which consists of an outer longitudinal layer and an inner circular layer;

3. the submucosa, which contains many blood and lymphatic vessels in a loose connective tissue so that the tunica muscularis can move freely with respect to;
4. the mucosa; this layer is made up of three parts:
 - a. the muscularis mucosae which, like the tunica muscularis, consists of an outer longitudinal layer and an inner circular layer. The muscular strands of this inner circular layer extend into the folds of Kerkring and some even extend through the tunica propria into the villi which cover the surface of the mucosa. The villi vary in number from 10 to 40 per mm²; they are 0.2–1 mm high and contain a centrally located, blindended lymphatic vessel. Between the villi are the crypts of Lieberkühn.
 - b. the tunica propria, like the submucosa, consists of a loose connective tissue containing blood and lymphatic vessels as well as nerve

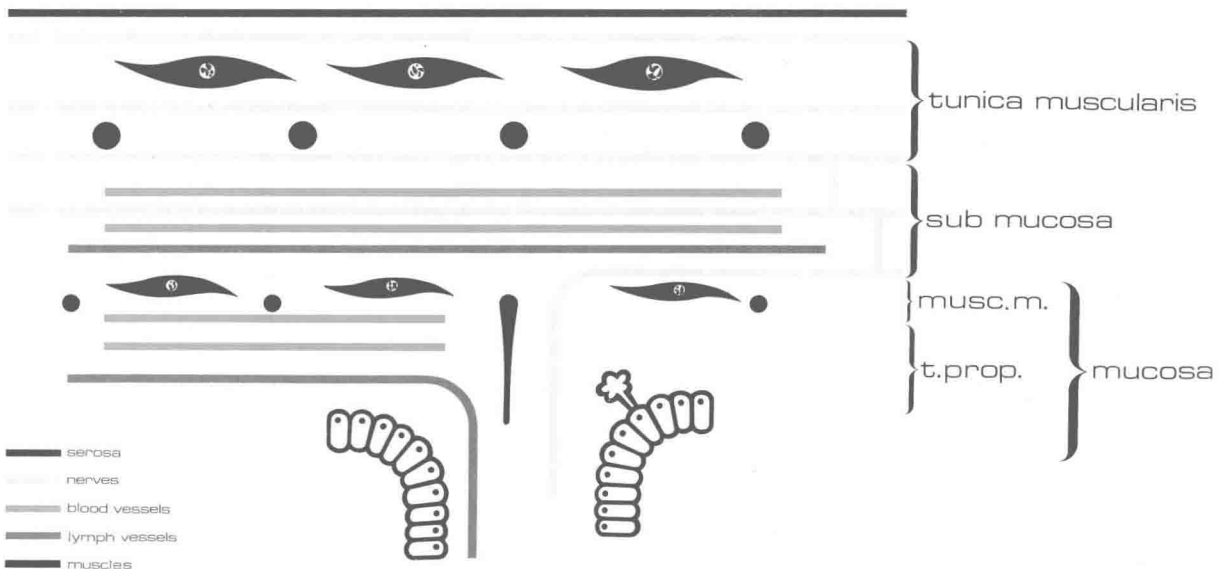


Fig. 2.1
Schematic drawing of a cross-section of the intestinal wall.

fibres. Occasionally conglomerates of lymphocytes are found in this layer.

c. a layer of simple columnar epithelial cells which can move freely with respect to the tunica propria. The surface of each epithelial cell is covered with hundreds of microvilli, which are 0.2–1 mm high and together form the so-called 'brush border'.

Although several studies have been published concerning the length of the small intestine, the definitive answer has yet to be found. Most handbooks list values varying between 5 and 7 metres and the small intestine is assumed to be $\frac{3}{5}$ of the total length of the digestive tract. The distance from nose or mouth to the duodenojejunal flexure varies only slightly; a length of 90 cm is assumed here. It is known that the length as well as the diameter of the small intestine is highly dependent upon the tone, so that the results of measurements taken post-mortem or under anesthesia will be too high. A length of 12 m need not be unusual for American negroes and in India. X-ray films of the small intestine occasionally show that individual variations can be enormous. However, when several measurements are taken of the same patient, the results appear to differ by only 10 per cent at the most (87). Underhill (225) obtained post-mortem values of 4.7–9.7 m with an average length of 6.9 m. Unfortunately she took some measurements several hours after death and others after the body had been stored for several days.

Hirsch et al. (90) report that shortly after death contraction of the smooth musculature causes the intestine to shorten; autolysis later causes a renewed increase in length. They took measurements in vivo by having patients swallow a rubber tube 3.5 mm in diameter; their values then varied between 220 and 270 cm from mouth to anus. When they used a tube 2 mm in diameter, the results were 400–540 cm, thus considerably longer. Post-mortem, however, these values turned out to be 800–900 cm! The shortening of the intestine around an ingested tube is called the 'telescope effect'.

Some authors state that an asthenic will have a slightly longer small intestine than a pyknic. In fact we have almost never encountered problems of superposition of a convolution of ileal loops in the small pelvis in our pyknic patients.

For the jejunum, the diameter is normally assumed to be 2.5–3 cm and for the ileum 2–2.5 cm. Values have also been reported of 1 and 0.5 inch respectively, which are probably a closer approximation of the diameter in vivo and during a conventional transit examination. During an enteroclysis examination, the diameter of the loops of the small intestine is generally greater and more variable, as a result of the more active peristalsis, than during a conventional examination. With a dosage of 600–900 ml and a rate of flow of 80–100 cc per minute, as used in our department, the maximum diameter of the proximal jejunal loops will be 4 cm in normal cases. Generally the diameter of the distal ileal loops depends to a large extent on the counterpressure caused by a contaminated cecum. A diameter of 3 cm for those segments which are in the rest phase can be considered normal in this region. During a conventional transit examination the diameter of the contrast column in the distal ileum depends partly on the degree of thickening of the contrast fluid which in turn is determined by the length of the examination. At the transition between the jejunum and the ileum the diameter of the intestinal lumen differs only slightly from the standard values for a conventional transit examination. Of course in the event of a greater rate of flow, an increased dosage of contrast medium or transit retarding factors, the diameter of the intestinal lumen will increase.

The folds of Kerkring begin 3–5 cm beyond the pylorus; in the proximal part of the jejunum, they are 3–6 mm high and 1–6 mm apart. Occasionally folds 7–10 mm high and local separations of 7–12 mm have been seen under normal conditions in an enteroclysis examination. A separation of 1 mm is only encountered when the tone of the intestine is high (fig. 2.2AB) or in children (fig. 2.2C); there is then also active motility. In the distal jejunum the folds are smaller and also farther apart.

In the ileum the number of folds can vary greatly. In the case of hypermotility (fig. 2.2B) or compensatory hypertrophy as a result of atrophy of the jejunal mucosa (fig. 2.3), there can be as many folds as there are in the jejunum. In patients with atony of the bowel, on the other hand, fold relief may be completely lacking in the ileum; even in normal cases, it can be barely visible (fig. 2.4). In comparison

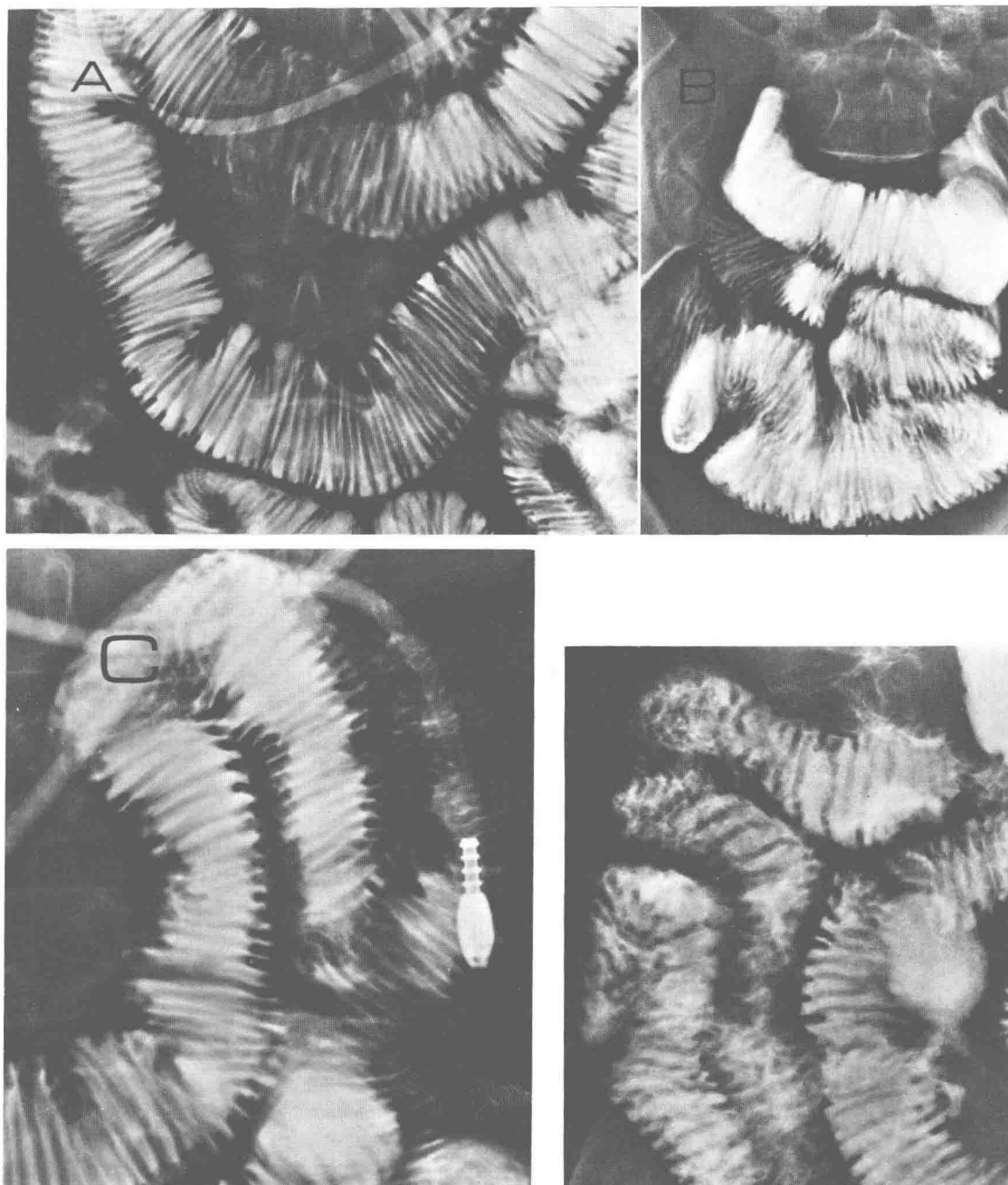


Fig. 2.2

The folds in the jejunum and the ileum are more numerous as a result of the high muscular tone of the intestinal wall (A-jejunum, B-ileum, C-child, 12 years old).



Fig. 2.3

Increased number of folds in the ileum ('jejunization') in a patient with atrophy of the jejunal mucosa as a result of celiac disease.