# Clinical Tests of OESOPHAGEAL FUNCTION

Richard Earlam

# *Clinical Tests of Oesophageal Function*

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# *Foreword*

Knowledge concerning oesophageal physiology has until recently lagged far behind that of the physiology of other portions of the gastrointestinal tract for reasons that remain unclear. Yet it is a fact that, at least until the last few decades, interest in the oesophagus was primarily anatomically based and surgery for oesophageal disease reflected a preoccupation with pathologic anatomy and the details of surgical techniques for its correction. The development of methods of studying oesophageal function since the Second World War has resulted in a better understanding of normal and abnormal oesophageal function with a corresponding improvement in treatment techniques which are now, for the most part, physiologically rather than anatomically based. This monograph of Mr Richard Earlam has profited from these advances, in many of which he himself has participated, and as a result the field of oesophagology has been provided with a text incorporating all that is new and useful in analysing the patient with oesophageal disease. The scope of the text indeed is far greater than its title implies, for though clinical tests of oesophageal function are an integral part of the text, the reader is offered á much more comprehensive analysis of oesophageal behaviour.

The author himself is uniquely qualified for this ambitious undertaking, for early in his career he spent time in the physiology laboratory of Dr Code at the Mayo Clinic, where some of the early work on oesophageal manometry was then underway at a time when I was privileged to be associated with him in some of the early physiologic studies of this organ. His original interest in the oesophagus continued and was fostered by a productive interval in the surgical clinic of one of Germany's finest surgeons, Rudolf Zenker. This was followed by further investigative and clinical experience in England, ultimately culminating in a consultant's post at the London Hospital where he continues to work productively in the field.

This continuing interest has led to the publication of this fine monograph whose tone was set by wisely avoiding lengthy discussions of treatment well covered by other texts. Rather, Mr Earlam has concentrated on a careful scientific analysis of the nature of various oesophageal diseases and appropriate investigative techniques for the elucidation of their nature. Proper treatment follows logically. This is a long-overdue volume which will be of interest not only to surgeons but to gastroenterologists and students alike and should benefit most those patients who are unfortunately disabled by one or more of the debilitating symptoms due to an inability to swallow properly.

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# *Preface*

In this book an attempt has been made to explain how the oesophagus normally works and what can go wrong. The author's intention is that it will be suitable for physicians and surgeons both during their postgraduate training period and afterwards in practice. This is not intended as a manual of oesophageal function tests, containing all the experimental and technical details required, because the majority of readers will not actually want to perform them. Similarly detailed descriptions of operations have been omitted since their correct place is in textbooks of operative surgery. Older monographs on the oesophagus emphasised anatomy, pathological changes and their correction by surgery but a modern book should utilise recent advances in the knowledge of smooth-muscle physiology and intestinal motility which were not available to previous authors. Physiology, as demonstrated in the human by the results of clinical tests of function, has now replaced a considerable quantity of tedious anatomy which was never really necessary for the practising doctor.

Emphasis has been placed on the aetiology of oesophageal symptoms and it is clear that many are associated with disturbed physiological processes in the upper gastrointestinal tract without any pathology being present. It is also apparent that the actual pathological change, whether it be a hiatus hernia, ulcer or gall-stones, can frequently be asymptomatic. In clinical practice, variations in normal physiology more often lead to symptoms than does the pathological manifestation itself. The inevitable but controversial conclusion is that an understanding of the altered physiology is just as important as the pathological end-results. Our knowledge of the control of oesophageal motility and other aspects of digestion has recently been revolutionised by the discovery that gastrointestinal polypeptide hormones act on smooth muscle. Consequently there is a chapter on this field in which future advances will be made.

# *Acknowledgements*

It is obvious that no single individual can have had personal experience of all the clinical and experimental aspects of this book. I therefore recognise the efforts of others who have been interested in the oesophagus and upper gastrointestinal physiology by quoting their work. In spite of the large number, many have been unavoidably omitted and it is appreciated that a mere reference is inadequate recompense for the labour involved in such original work. There are three source books which have been especially valuable: Postlethwait and Sealy's *Surgery of the Oesophagus*, Ellis and Olsen's *Achalasia of the Oesophagus* and, above all, the monumental *Handbook of Physiology: The Alimentary Canal*, edited by Dr Charles Code.

In particular I should like to thank Dr Charles Code, Dr F. Henry Ellis Jr and Jerry Schlegel for introducing me to the subject of oesophageal manometry at the Mayo Clinic where so much of the early work was done. In the last five years this knowledge has been used in research projects at The London Hospital and I have been excellently helped by my research assistants, Mr P. Thomas and Mrs E. Holly. Of particular value has been the continuous presence and aid of Sister Keenan both with manometry, questionnaires and alleviating the worries of patients. I am grateful for financial aid from The London Hospital and Medical College and a grant from the Department of Health and Social Security. The Alexander von Humboldt-Stiftung kindly gave me the pH capsule telemetering equipment (Fig. 48).

The text has been typed and retyped by Miss D. Tolfree with great patience. The diagrams, figures and manometry have been drawn by Ms Y. P. Banks. The majority of the radiological pictures originate from the collection of Dr R. S. Murray, and the pathological figures from Dr D. Pollock. Certain other illustrations have been generously provided and I would like to acknowledge these individually: Dr J. Briggs and the Cavendish Medical Centre (Fig. 99), Mr G. Flavell (Fig. 23), Dr K.

Mendl (Fig. 27), Mr W. D. Park (Fig. 130), Professor G. R. Seward (Fig. 103), Dr G. F. Swann (Figs. 25 and 97). S.E. Laboratories, Feltham, Middlesex, allowed me to publish Figs. 3 and 4 showing their transducer and galvanometer, and all the manometry figures were originally obtained on one of their S.E. ultraviolet recorders and then subsequently traced by Ms Y. P. Banks. The photography has been most conscientiously completed by Mr R. Ruddick and his staff. Suggestions concerning the text have been made by Dr F. Henry Ellis Jr, Dr D. Gibbs, Dr R. S. Murray, Dr D. Pollock, Dr M. Swash and Dr B. Boucher. It is impossible, even with many words, to thank all these people sufficiently, but I hope they will understand how valuable their help has been. In addition numerous colleagues at The London Hospital have been of great assistance in many ways.

Finally, I would like to express my thanks to my publishers, and especially Mrs Gillian Gosnay, for their encouragement.

R.J.E.
*February 1975*

To Roswitha

# *Contents*

# 1 *Gastro-oesophageal junction*

## Mechanisms preventing reflux

The oesophagus is a hollow muscular tube normally kept empty by peristaltic waves which clean up after a bolus has passed. At both ends are muscular sphincters. The upper or cricopharyngeal sphincter is normally closed to prevent entry of air into the oesophagus during breathing. The lower or gastro-oesophageal sphincter remains shut to prevent the reflux of gastric contents into the oesophagus. Both relax their tonic contraction to allow a bolus to pass through. This mechanism is basically the same whether it occurs in the striated muscle of the upper or the smooth muscle of the lower sphincter, the main difference being that the movement is faster in striated than in smooth muscle.

Swallowing is an involuntary act which commences when a bolus of food or fluid touches any mucosa behind the anterior pillar of the fauces. Mastication and chewing can proceed in the mouth without initiating this reflex; so can gargling. But when swallowing is initiated intentionally by pushing the bolus backwards, an orderly sequence of reflex events which cannot be controlled voluntarily will transmit the bolus through the oesophagus and into the stomach within 10 sec.

The present chapter conveys an account of the mechanisms at the lower end of the oesophagus which prevent gastro-oesophageal reflux, the reflexes involved and a short description of smooth muscle and its control. This is vital to an understanding of the oesophagus. Chapter 2 contains details on the body of the oesophagus, its disorders and pathology. The upper sphincter and its disorders are described in Chapter 3.

Situated at the junction between the oesophagus and the stomach are anatomical structures which serve two purposes: (1) to allow a bolus to pass into the stomach without obstruction and (2) to prevent the reflux of gastric contents once they have entered the stomach. The term 'cardia' was originally applied to this region by Fabricius ab Acquapendente

FABRICIUS AB ACQUAPENDENTE (1533–1619), Italian anatomist

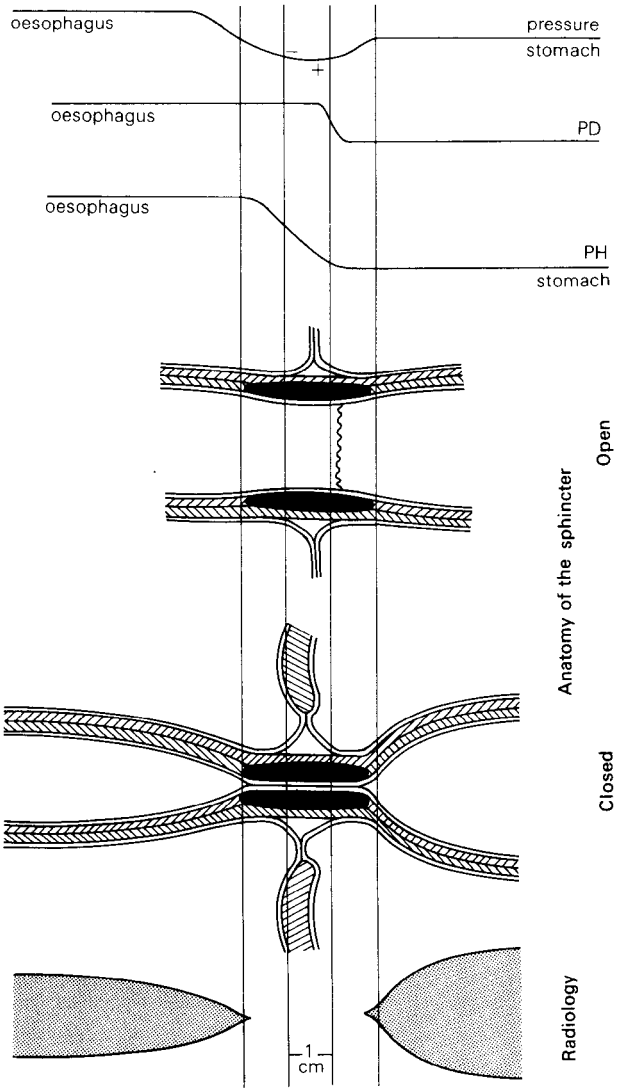


*Fig. 1. Correlation of the radiological appearances with the anatomy of the gastro-oesophageal sphincter, pH, potential-difference (PD) and pressure measurement.*

because he had noted that cardiac symptoms could be similar to those arising in the lower oesophagus, but its continued use – except as a rather vague term – is not justified in view of our present knowledge of the different factors maintaining gastro-oesophageal competence. The six possible structures involved in preventing reflux are the:

gastro-oesophageal sphincter;
intra-abdominal segment of oesophagus;
gastro-oesophageal angle;
mucosal rosette;
diaphragmatic crura;
phreno-oesophageal ligament.

Each of these will now be discussed in more detail, but it must be emphasised that the physiological sphincter is the most important single structure.

**Gastro-oesophageal sphincter** (Fig. 1)

A sphincter is a band of circular muscle surrounding an orifice which is thus able to relax and contract. Since there are many systems with low-pressure sphincters, it is unnecessary to insist upon the presence of an anatomical counterpart. The anal sphincter must be capable of resisting the hydrostatic pressure of the abdominal contents and has a resting pressure of 40 cm $H_2O$. But the gastro-oesophageal sphincter is at the upper end of this cavity, with no pressure exerted by the intrathoracic contents because of the diaphragm and therefore no constant background of hydrostatic pressure, so it has a lower pressure of 10–15 cm $H_2O$. If one stood on one's head all day, the sphincter would undoubtedly hypertrophy, and indeed there are animals – the bat and the sloth – with easily visible sphincters because they spend considerable time upside-down. Since humans are usually erect, there is no definite anatomical evidence of this weak sphincter, and surgeons are unlikely to discover it by poking with an inquisitive finger during an operation.

Anatomically the best method of demonstrating the slight thickening of the circular sphincteric muscle is to open the oesophagus longitudinally and then let it contract as much as it can spontaneously, before fixation in formalin. If the oesophagus is fixed immediately after slitting, or distended with cotton wool without cutting, no sphincter will be demonstrated. Since one is only looking for an increase in circular muscle thickness compatible with the low resting pressures of 10–15 cm $H_2O$, no thick

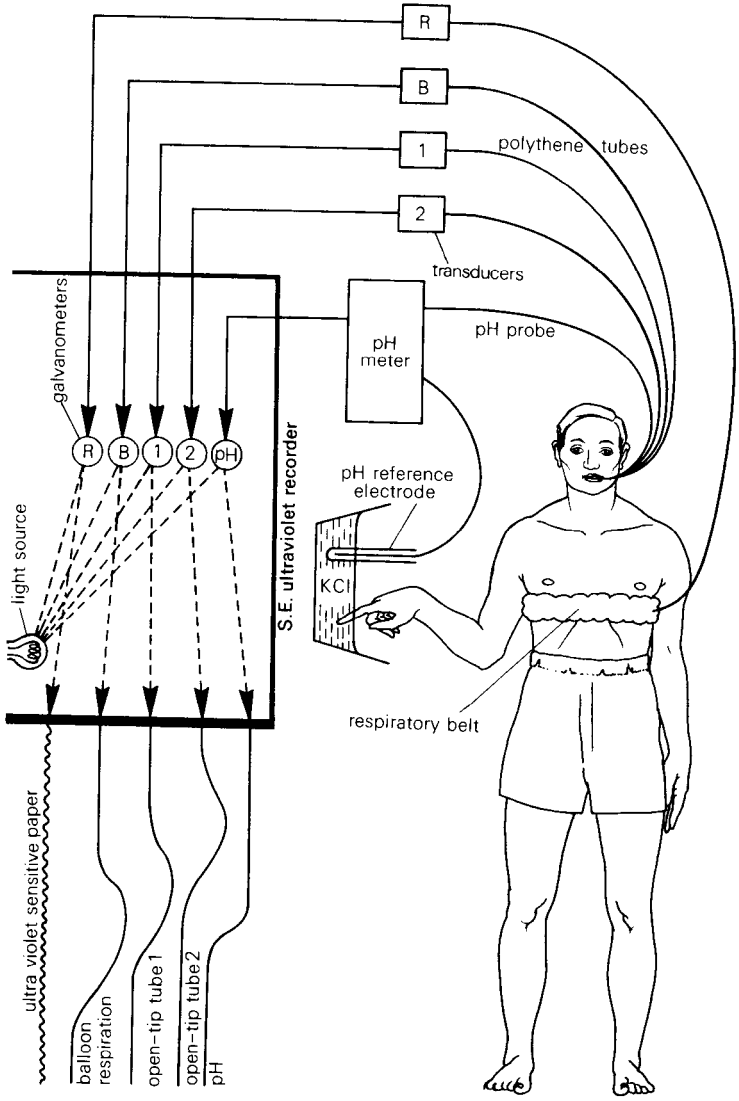


*Fig. 2. Diagram of the circuit used for measuring oesophageal pressure and pH. The polythene tubes and pH probe are shown in detail in Fig. 5, the transducers and galvanometers in Figs. 3 and 4. This type of recorder has the advantage that each channel can swing across the whole width of the paper. A specimen record is depicted in the lower right-hand corner.*