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THE EVOLUTION OF ANORECTAL MANOMETRY

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The history of physiology testing

The history of anorectal research can be dated back to 1200 BC to the Chester Beatty Medical Papyrus [1] which described anal diseases and contained scanty descriptions of the anal canal. This knowledge was further enhanced by the descriptions of Galen and illustrations of Versalius and John Calcar. It was many centuries later that the physiology of the anal sphincter control was elucidated. In 1867, Masius identified the center of the lower spinal cord as being responsible for anal sphincter tone and reflex contractions in the dog and rabbit. During the same period, manometry studies were first carried out to study anorectal function. The first phenomenon to be described was the recto-anal inhibitory reflex reported by Gowers in 1877. This was followed by the observations of Langley and Anderson where they demonstrated that in the cat, the stimulation of lumbar sympathetic nerves causes relaxation of the rectum and the contraction of the internal anal sphincter.

Anorectal manometry

Joltrain et al first described a method for measuring colorectal pressures in 1919. He used a rectal tube after rectal infusion to measure pressures of the lower gastro intestinal tract. This method was refined in 1940 by White et al [2] who developed the colonometrogram which was based on cystometry. This primitive device contained of a vertical glass tube manometer connected in one side to an intravenous drip line and at the other end to a rectal tube (Figure 1). He used this to assess the colonic tone in patients with injuries in the brain, spinal cord, cauda equina or sacral nerves and noted that the compliance of the colon and rectum depended on the level of the lesion.

Based on these initial maneuvers, Anorectal manometry (ARM) was developed. The procedure involves insertion of a catheter into the anorectum and connecting it to a pressure recorder to measure the intraluminal pressure. It had first been used in assessing patients in the 1980s , although more complex procedures had been attempted several decades previously [3]. Transducers have often been developed first for oesophageal manometry and subsequently the same technology used to create devices for anorectal manometry. The initial devices had an intraluminal balloon. Subsequently water perfused and solid-state manometers had been used. Conventional manometry probes contained a few sensors that were spaced at 3-5 cm and incapable of acquiring the pressures the entire anal canal simultaneously. Therefore, they required pull-through manoeuvres or rotation to sample the entire area of interest. This prevented a continuous measurement of pressures throughout the entire anal canal. Moreover, radial sensors required a pull through procedure that introduced motion artefacts.

With the advancement of electronics and miniaturisation of sensors, more and more sensors could be fitted into the probes, and this resulted in the development of high-resolution anorectal manometry (HRARM) in 2007 [4]. In HRARM, the space between 2 adjacent sensors is less than 1 cm. Most systems have circumferential sensors, each with 12 pressure sensitive segments arranged radially. Ten of these sensors are fitted within 6 cm on the probe. The 12 sector pressures are averaged to obtain a single mean pressure value for each level.

Three dimensional (3D) high definition anorectal manometry (3DHDM) was introduced in 2010 [5]. This uses 16 sensors, each with 16 radial pressure sensitive sectors, arranged over a space of 6.4 cm. This sensor arrangement for the first time provided sufficient radial resolution to allow accurate, simultaneous circumferential assessment of the anal ASC. It is also a static test and therefore minimises motion artefacts and other confounders.

Both these modern techniques are heavily dependent computer hardware and software for recording and interpolation of the data. There are several advantages and disadvantages in HRARM / 3DHDM when compared to conventional manometry [6] (see Table 1).

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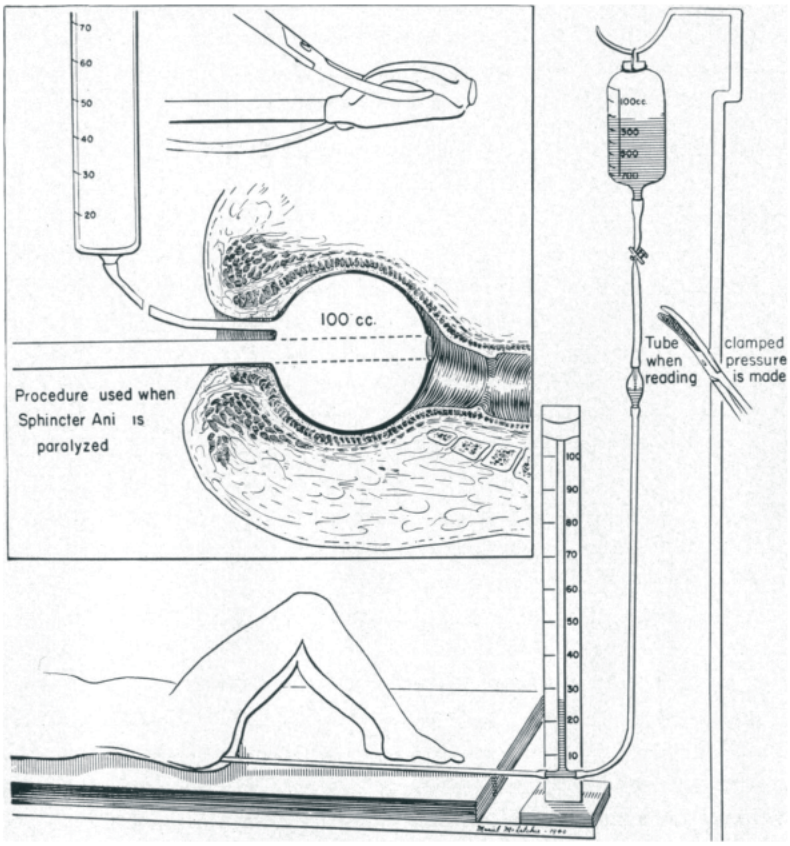

Fig. 1. Colonometrogram, developed by White et al [2].

Table 1. Comparison of conventional manometry and HRARM / 3DHDM, From Lee et al [6]

HRM / 3DHDM	Conventional manometry
More sensors at close intervals (continuum in space and time) E-sleeve for high-pressure zone	Few sensors at wider intervals Dent sleeve for high-pressure zone
Stationary examination, less discomfort	Pull through, can be uncomfortable
Color topographic display, better resolution allowing easier interpretation with less time	Lines display, poor anatomical resolution, less easy to interpret and time-consuming
High resolution allows radial bedside pressure measurement	Only circular pressure measurement
More fragile, shorter life span, greater maintenance required	Less susceptible to wear and tear, little maintenance and seldom malfunctions

ARM provides information about the resting pressure (RP), squeeze pressure (SP) and length of the anal canal (anal high pressure zone length – HPZL) by direct measurement. A balloon attached to the tip of the catheter allows additional measurements such as rectal sensory thresholds and rectoanal inhibitory reflex to be elicited.

The normal pressure values for a given age and gender varies significantly, depending on the technique and the type of catheter used and thus it is recommended that every laboratory establish its own normal values for every technique. Presently, there is a classification system for anal incontinence based on anorectal manometry findings [7].

A group of patients who are incontinent will demonstrate normal anorectal manometry findings under static conditions. They require monitoring of anorectal motor events over a prolonged period and in the fully ambulatory state. The methods used utilise micro pressure transducers with or without simultaneous EMG recordings of the EAS. Ambulatory ARM was first used in patient evaluation in the last decade of the 20th century [8]. The study by Kumar et al [8] identified that spontaneous transient relaxations of the IAS were more frequent and of longer duration in patients with idiopathic anal incontinence. Furthermore, the motility index of the rectum and colon were lower in patients with slow transit constipation. Despite the promising results, the clinical role of ambulatory ARM has not yet been established.

Traditional manometry assesses the pressure in the anal canal at each level as a single value and ignores the possibility of radial asymmetry. Vector manometry assesses the radial and longitudinal pressure profile along the entire length of the anal sphincter. Radial asymmetry, which is expressed as a percentage calculates the degree to which the integrated cross sections deviate from a perfect circle. The Vector Symmetry Index (VSI) on the other hand, is expressed as a value from 0 to 1 [9] with values closer to 0 indicate greater asymmetry. Despite being shown to have an accuracy comparable to endoanal ultrasound and needle EMG in some studies, Yang and Wexner found that the localisation of sphincter injuries with vector manometry is poor.

The diagnostic utility of anorectal manometry

Anorectal manometry is useful in objectively evaluating a multitude of disorders. In patients with chronic constipation, ARM helps identify patients with defaecatory disorders [10]. However, there can be significant overlap between the subtypes. Manometry can help in distinguishing weaknesses in the internal and external anal sphincters in patients with anal incontinence [10]. The response to treatment can also be serially monitored using ARM. ARM is also useful in excluding dyssynergic defaecation in patients with proctalgia.

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