

## Review Article

# Appendix: Between the Older Concepts and New Frontiers

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**Abstract:** Appendix has long been thought of as an organ serving no useful purpose in the body. The newer researches prove to the contrary, as with the advent of the newer histological techniques and surgical avenues, it has been found to have very useful functions. The position of the tip of the appendix determines its clinical presentation in case of any disease pertaining to appendix, specially the very common condition of the inflammation of the appendix, clinically termed Appendicitis. Extensive literature review was done and it was observed that location of its tip is subject to ethnic and geographic variations, and therefore, presentation may mimic a disease other than the appendicitis, to the disadvantage of the attending or diagnosing physician. Now it has also been found to be a very important part of gut associated lymphoid tissue (GALT). Reconstructive surgery has found it as an organ that can be restructured and used for the repair and reconstruction of various organs. It is found that there is a lot of room for further studies in the light of new found evidences.

**Keywords:** Vermiform, Appendix, Positions, Retrocaecal, Pelvic, Vestigial, GALT

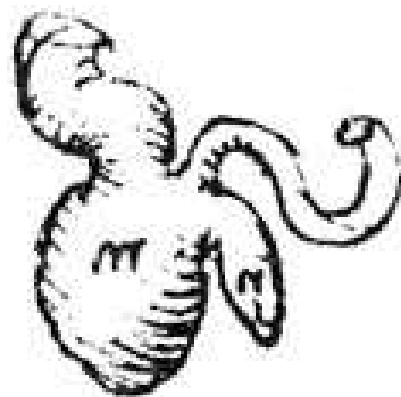
## 1. Introduction

Appendix is a narrow, muscular tube containing a large amount of lymphoid tissue. It varies in length from 3 to 5 inches (8 to 13 cm.). Its base is attached to the posteromedial surface of the cecum about 1 inch (2.5 cm) below the ileocecal junction, while the rest of it hangs free in the abdomen or pelvis, as the case may be. The base of appendix is consistently found in a fixed position and forms the basis for the surface anatomical landmark, the 'McBurney's point', named after Charles McBurney. He was also the one who first described the now famous surgical incision for exploring the appendix that bears his name. The tip of the appendix hangs free in the abdominal cavity and is found in variable positions. It has a complete peritoneal covering, and a short mesentery of its own called the mesoappendix. Vessels and nerves to the organ traverse through this mesentery. Its opening is occasionally guarded by a semicircular fold of mucous membrane known as the Valve of Gerlach. [1-3]

Embryologically, the cecal bud that appears at around the sixth week of development is a small conical dilation of the caudal limb of the primary intestinal loop and also is the last part of the gut to re-enter the abdominal cavity. During this retraction of intestinal loops back into the abdominal cavity, a

narrow diverticulum grows at the distal end of the cecal bud, the appendix. Since the appendix develops during descent of the colon, its final position frequently is posterior to the cecum or colon. These positions of the appendix are named retrocaecal or retrocolic, respectively. [4]

## 2. Historical Review



**Figure 1.** The earliest known drawing of the appendix by Leonardo DaVinci alongwith its caption given below: "The appendix n, of the colon m, is a part of the caecum and is capable of contracting and dilating so that excessive wind does not rupture the caecum." [4] [5]

Appendix was first depicted in anatomic drawings in 1492 by Leonardo da Vinci, one of the earliest known anatomists, who is now termed as a man “*ahead of his time*” [5-6] (Figure 1). Appendix found its first mention in the literature as an anatomic structure in 1521 by Jacopo Berengari da Capri, a professor of human anatomy at Bologna, Italy. [7] Vido Vidius first named this worm-like organ as the *Vermiform Appendix* in 1530. [8]

Inflammation of the appendix, appendicitis, was first recognized as a surgical disease in 1886 by an American Pathologist, Reginald Heber Fitz in 1894. [9]

**Table 1.** Various positions of the Appendix (after Sir Cecil Wakeley London, formerly President Royal College of Surgeons). [2]

Position of the tip at the time of surgery	Prevalence
Retrocaecal	74%
Pelvic	21%
Paracaecal	2%
Subcaecal	1.5%
Preileal	1%
Postileal	0.5%

Varying positions for its tip have been mentioned in the literature, however, during surgery for the removal of the appendix, it may be found in certain varying positions. A general consensus as found in a standard textbook of surgery is given in Table-1. [2]

### 3. Methodology

An exhaustive review of the available literature, both past and present, was done. Electronic sources were used exhaustively to look for the latest knowledge and text books both of anatomy, surgery and comparative sciences were studied for academic research.

### 4. Discussion

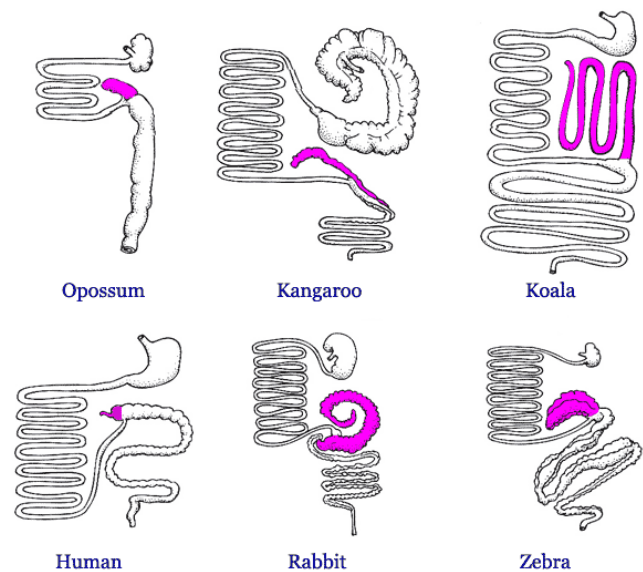
The first comprehensive study made for the position of the appendix was completed by Gladstone and Wakeley in 1924, who studied 3000 anatomic dissections. They concluded that 69.2% were postcecal and retrocolic, 27.5% were pelvic, 1.86% were subcecal and beneath the caput ceci, 0.9% were anterior or preileac, 0.5% were splenic or post-ileac, lying on the psoas major muscle near or hanging over the brim of the pelvis and 0.033 % were ectopic. [10]

This study was later on extended and the length and position of 4,680 appendixes derived from post-mortem material were studied. 78.5% of the appendixes were situated anteriorly and 21.4% were found to be present retrocaecally. [7-10]

Various ethnic and geographic variations have been cited in the literature for the position of the tip of the appendix. In Turkey while doing a scanning study, it was found to be more commonly in the pelvic position. In another study in Sudan, it was found to be present more commonly in the retrocaecal position, while in UK it has been reported to be in retroileal position, more commonly. [11-13]

It is to be noted that the names of the positions kept on changing as the new surgical techniques emerged, for example, sub-hepatic position of the appendix seems to have been clubbed together with the retrocaecal position in the recent literature.

Some authors hold the view that reason that the appendix is not mentioned in very early anatomical studies is probably because the studies were done on animals not possessing an appendix. This cannot be held true for all animals as most of the experimental animals, especially mammals, have been found to have the appendix and in rabbits it is considered to be one of the longest. (Figure 2) [6, 14]



**Figure 2.** Gastrointestinal tracts of various mammals. For each species, the stomach is shown at top, the small intestine at left, the caecum and associated appendix (if present) in magenta, and the large intestine at bottom right. Scale differs between species. [14]

It has long been thought that the appendix serves no useful purpose as a digestive organ in humans, and it was believed to be gradually disappearing in the human species over evolutionary time. Earliest schools of thought had believed that the appendix is a part of caecum that failed to dilate during development. However to the author, it seems to be a case of differential growth, and not a case of failed growth.

Appendicectomy is one of the most frequently performed urgent abdominal operation and often the first major surgical procedure performed by a doctor in training. Importance of the appendix in surgery results from its propensity for inflammation, which results in the clinical syndrome known as *Acute Appendicitis*.

With the advancement in the histological techniques it was observed that the mucosa and sub mucosa of the appendix are dominated by lymphoid nodules, and its primary function is that of an organ of the lymphatic system.

The appendix currently seems to have its predominant functions due to its content of lymphoid follicles, which are highly specialised structures. Although it was thought the appendix itself could be the site for B-lymphocyte induction, the latest opinions favour this programming being more

centralised in the bone marrow. [24] The appendix may still have a role in this highly significant function, but not alone, and its lymphoid tissue is known for certain to be involved in antibody production. These antibodies are of two types:

IgA type immunoglobulins for secretory or mucosal surface immunity.

IgM and IgG immunoglobulins for humoral or bloodstream immunity.

The above type functions have proven the appendix to be part of the gut associated lymphoid tissue (GALT). [15-27]

It has been reported that the first appearance of the endocrine cells in human fetus occurs at the 11<sup>th</sup> week of development. These cells produce various biogenic amines and peptide hormones that specially assist in the various biological control (homeostatic) mechanisms. [28]

The lymphoid tissue accumulates in the appendix shortly after birth and peaks at the second and third decades of life. Thereafter, it decreases rapidly and disappears, practically, after the age of 60. During the early years of development the appendix has been shown to function as a lymphoid organ, assisting with the maturation of B lymphocytes and in the production of the class of antibodies known as immunoglobulin A (IgA) antibodies. Appendix is also involved in the production of molecules that help to direct the movement of lymphocytes to various other locations in the body. [29]

More recently it has been reported that the appendix appears to expose white blood cells to the wide variety of antigens present in the GIT. It helps in suppressing potentially destructive humoral antibody responses while promoting local immunity. This function plays a vital role in the immune response and in the control of food, drug, microbial or viral antigens. [30]

In the past, appendix was routinely removed and discarded during other abdominal surgeries to prevent any possibility of a later attack of appendicitis. Nowadays it may be spared due to emerging use of this organ in reconstructive surgery. It has been successfully fashioned into a makeshift replacement for a diseased ureter. Therefore, now it is regarded as an important 'back-up' that can be used in a variety of reconstructive surgical techniques. [31]

Researchers in the Duke University Medical Centre in North Carolina have found that following a severe bout of cholera or dysentery, that can purge the gut of bacteria essential for digestion, the appendix acts as a reserve for good bacteria to emerge. [32]

The tip of appendix is present more commonly in the pelvic and retrocaecal positions. Attachment of its base to the caecum remains constant, whereas the tip can be found in a retrocaecal, pelvic, subcaecal, preileal or post-ileal positions. [2] The most common position reported and found during surgery is the retrocaecal position, with the pelvic position next in order of frequency; but recent scanning studies suggested that a retroileal site is the most common site in the absence of any disease. [33]

Identification of the normal position of appendix is important because a case of appendicitis due to variable positions may present symptoms and signs related to that

particular position, hence mimicking other diseases like ureteric colic, renal colic, or this may lead to misinterpretation of an ovarian pathology etc. It shall be in the mind of physician working on a case of acute abdomen that, although very rare, the appendix can be present on the left side of the body also; that too in varying positions because of the malrotation of the gut during development. [4]

Incidence of appendicitis is on the decline, thanks to the better health education and sanitary conditions. This shall discourage the incidental and prophylactic appendectomy or appendicectomy, that has its own and known complications. Lumen of the appendix is always patent with a reliable vascularity. It, therefore, forms an ideal conduit structurally for the reconstructive surgeries. It has been reported to be successfully used in the reconstruction of the male urethra, reconstruction of the cervix vagina and esophagus more recently. [34]

## 5. Conclusion

A lot of literature has been published about the diseased appendix but still very few studies are available on the healthy appendix, as most of the time its position is determined per operatively and subsequently recorded in operation notes. Although variable in position, its location does not affect the clinical course of an inflamed appendix. Newer avenues have developed for this organ after its successful use in the replacement and reconstructive surgeries and it may be treated as an *Insurance Organ*, lying safely inside the body.

Current available statistics, regarding the position of appendix are about a century old. At that time dissection was the only tool at the hands of the anatomists. There is a need to reevaluate the position of appendix using modern tools such as ultrasound, CT etc. to localise the appendix, based on the presence of geographic and ethnic variations.

We can safely assume that biochemically it has moved a long way from being considered as a vestigial organ to a source of useful rebooting bacteria, but position wise it is still present "retrocaecal" in majority of the cases.

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