Histomorphometric Profile of the Human Vermiform Appendix

A.I. Shugaba, M.B.T. Umar and S.P. Singh

The mucosal, luminal and lymphoid follicle diameters of the vermiform appendix were measured in micrometers from the basal, middle and terminal segments and their relationships analyzed and plotted. There is a strong relationship between these diameters, especially between lymphoid follicle diameter and the thickness on one hand and that between the luminal diameter and the lymphoid follicle diameter on the other. The lumen decreases when either the thickness or the lymphoid follicle diameter increases in size, suggesting that obstruction can occur at such sites with the resulting microscopic and macroscopic changes that come to bear on normal subjects. This segmental profile shows that, histomorphological and histomorphometric changes in the appendix are capable of explaining the basis and indeed the likely sites of obstruction in appendicitis.

Key words: Histomorphology, histomorphometry, luminal, lymphoid follicle, serosa-mucosal diameters, micrometers, segments
INTRODUCTION

The vermiform appendix is described as a narrow blind tube usually about three or four inches (7.6 to 10.2 cm) long that extends from the caecum in the lower right hand part of the abdomen, has much lymphoid wall tissue, normally communicates with the cavity of the caecum and represents an atrophied terminal part of the caecum (Roper, 1987).

Beyond this simple definition is the myriad of clinical presentations associated with this tube so much so that many lives have been lost in the past as a result of either misdiagnosis or mis-management of conditions associated with it. In ordinary situations any structure attached to a larger more important part is referred to as an appendix.

But as far as anatomy, surgery and histopathology are concerned this worm-like appendix and indeed its attaching larger part are very important.

Although, grossly, the vermiform appendix has been described to help both the student and clinician, a lot more has been done and needs to be done at the microanatomy level to actually understand its structure and also give us the likely trends of events that lead to clinical conditions and the basis for further research.

Many factors in the past were thought to cause appendicitis which is the clinical condition as a result of its inflammation, which include diet, bacterial infection and parasitic infestation (Farquharson, 1978; Charles et al., 1975).

But this condition does not occur or arise de novo except as a consequence of the interplay of various factors that involve either its wall, length, diameter positions in the abdomen or pelvis or its blood supply (Charles et al., 1984; Sahibston, 1981; Williams, 1983). That is to say that the luminal, intraluminal or extra luminal structures of this organ far more than anything else are more responsible for the causation of clinical states.

Therefore, the histologic detail of this organ has to be fully understood. And this is exactly what I have set out to do. Especially also that the occurrence of appendicitis now cuts across race, social status, age and sex.

MATERIALS AND METHODS

This study was done in 2002 in Abnira Medical Centre, Jos, Plateau State, Nigeria as part of my thesis for the award of MSc Human Anatomy by the Ahmadu Bello University, Zaria. Two human Vermiform appendices were taken at operation from two patients who had no symptoms and signs at all for appendicitis but came for elective surgery; one for left ovarian cyst and the other for ventrosuspension of the Uterus after obtaining an informed consent for both the surgery and the removal of the appendix.

Under general anaesthesia, each appendix was carefully dissected, noting in the process the position of the appendicular artery and its branches within the mesoappendix. This was then stretched and measured in centimeters before immersing in a medium containing 10% formal saline as fixative. Both borders of the appendix were freed and the two ends were then pinned down inside the Petri dish to allow for fixation in a straight tubal position for 4 h. Each appendix was processed for microscopic demonstration in the straight intact form by dehydration in graded series of alcohol (50, 70, 80, 90, 95%, Absolute), clearing in xylene for 3 h, embedding in paraffin wax and sectioning at 5 m on a rotary microtome. About 300 serial sections from the tip to the base of the appendix were taken and one out of every 10 sections was taken and measured out of which again one was then stained in Haematoxylin and Eosin.

The entire appendicular length was divided into three equal segments (base, middle and tip).

Each section representing a segment was then examined carefully under microscope for the general histomorphology and the following Histomorphometric parameters, the luminal diameter, mucosa-serosa thickness and the diameter of the lymphoid follicle in the submucosa at the points of maximal diameters and/or thickness were taken. Microtome direct measurements of these parameters preceded the microscopic measurements in order to find the shrinking factor all in micrometers which was then added overboard to all the values before statistical analysis.

For each parameter the micrometer calibration was checked and ensured to be within 0.00 before taking the ocular micrometer reading and multiplying both to get the actual morphometric reading.

Using analysis of (ANOVA), these parameters were compared at the various zones of the vermiform appendix. Using this the values of the observed parameters were compared to examine for significance.

The profiles of these variables were studied to see their relations individually and in groups along the three segments of the organ.

RESULTS

Grossly, both appendices measured between 8 and 11 cm in length. Subject one, 24 years old 8.80 cm and subject two 32 years old, 10.60 cm. Their diameters were 0.64 cm for subject one and 0.76 cm for subject tow.
Table 1: The mean luminal, lymphoid follicle, mucosa-serosa diameters of the vermiform appendix in micrometers

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<th>Diameter</th>
<th>Lum men (um)</th>
<th>Lymphoid follicle</th>
<th>Mucosa-serosa</th>
<th>Lum men</th>
<th>Lymphoid follicle</th>
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Fig. 1: Lymphoid follicle along the three segments and zones of the appendix

Fig. 2: Thickness (Mucosa-serosa) of the appendix along its length

All the specimens were found to be truly retrocaecal and not to be adherent either to the posterior abdominal wall as the caecum by fibrous tissues.

These specimens showed complete peritoneal covering of well formed mesentery, the mesoappendix. Within its were the appendicular arteries running along the free margin with that of Salamati giving low branches along its course and Rabiati's giving two branches. The mesenteries ended at the tips of the appendices. Rabiati's showed profuse anastomosis at the base.

The slides stained with Haematoxolin and Eosin (H and E) and the observed parameters; the luminal diameter, lymphoid follicle diameter and serosa-mucosa diameter or thickness measured as shown in Table 1.
Fig. 3: Luminal diameter of the appendix from its base in the tip

Fig. 4: Relationship between the lymphoid follicle diameter (LFD) and the mucosa-serosa thickness (MSD) along the different segments of the vermiform appendix

Fig. 5: Relationship between the lymphoid diameter (LFD), luminal diameter (LD) and the mucosa-serosa diameter (MSD) along the zones of the vermiform appendix from the base to the tip

This stain clearly showed the glands, various layers of the appendicular wall including areas of vascular deficiencies and distribution of the epithelium (Table 1).

The observed parameters were each plotted against the zones of the appendix from the base to the tip (Fig. 1-5).

A total of 60 zones were compared for the lymphoid follicle diameter, thickness (mucosa-serosa diameter) and luminal diameter. Individually and finally all these parameters compared together on a graph.

The lumen diameter has seen in the various segments is interestingly not largest in the middle zones of the organ. Within zones 1 to 30 this diameter is greatest in the middle zone whereas from zones 1 to 60 the lumen diameter is largest in the tip.

The lymphoid follicle diameter in the three segments of each subject does not particularly follow a certain trend.

The most interesting observation is that of the organ thickness (serosa-mucosa) where the natural trend of the thickness of the caecum does not follow by decreasing from the base of the appendix towards its tip.

The thickness from zones 31-60 shows an expected trend of decreasing along the length of the appendix, but
in zones 1 to 30, there is an initial rise at the base, then decreased in the middle segment before increasing in the tip.

**DISCUSSION**

The general Anatomical Morphology of the vermiform appendix as described in standard anatomy textbooks, journals and other studies is not analyzed and discussed here since it is the histomorphological and histomorphometric profile and variations of the observed parameters that are being considered. And there are not also computed between different individuals being foundation research in this area of the organ.

Such detail as the general disposition of the organ within the abdominal cavity and the noted variations and compliance of the normal vascular supply of the organ cannot also not be analysed in this study, because the number needed for such is not considered when doing histomorphometry.

The figures obtained for the lengths and diameters of these specimens fit into the normal range for the human appendix and rightly in those of the age groups of these subjects. Meaning therefore that the studied appendices can be said to be “normal”. In fact, if these organs were pelvic in position they might have shown some evidence of inflammation due to recurrent sub clinical pelvic inflammatory disease (Okojie, 1979; Ojo et al., 1991; Robins and Cotran et al., 1979; Shigang et al., 2000).

Using analysis of variance (ANOVA), these diameters were compared at the various zones of the appendices. Using this statistical analysis, the values of the observed parameters as shown in Table 1 were compared to examine for significance in their relationship. Either individually along the entire course of the organ or when two or three at these diameters are combined along the course of this very important part of the gastro intestinal tract.

The zones of the organ were numbered from the most proximal segment (1 and 31) to the most distal segment at the tip of each specimen (30 and 60). Similarly, Fig. 1-5 of these measured diameters were each plotted against the appendicular zones from the base to the tip and also for the lymphoid follicle diameter and thickness and finally for all the observed parameters.

The human vermiform appendix has been grossly understudied as not really studied in relation to the profile of these parameters along its course thereby making available data for within species comparison scanty. This infact leaves me with the burden of setting some sort of foundation data at least for this environment for further research and discourse.

The Table 1 and Fig. 1-5 for these diameters give us and overview of their profiles along the entire length of the appendix and their relationships that bear on clinical conditions in diseased situations.

The luminal diameter does not show uniformity along this organ. So other factors like the thickness, amount of lymphoid follicle in the submucosa, the age of the subject or indeed the normality of the processed organ must be playing roles in determining the luminal diameter. Unfortunately these factors have not yet been studied and documented in the literature as those of other lower animals like the human oviduct (Ogunnati, 1988a, 1991; Seekinger, 1923).

In the same way, the lymphoid follicle diameter in the three segments of the appendix does not particularly follow a certain trend. Herein lies the area for further research both in the human appendix and those of the lower animals especially now that diseases of the appendix are beginning to be understood in the light of nutrition and immunology. These two together with both the age and other concurrent diseased conditions of the subjects go a long way in determining the amount of the lymphoid follicle and thereby the diameter. Of course, this diameter will together interplay with whether the luminal diameter or the thickness of the organ to determine the probable site or sites of obstruction of this organ as shown in both the figures plotted for lymphoid follicle diameter and thickness against the zones and that of the three observed parameters against the zones.

The most interesting observation is that of the organ thickness (serosa-mucosa) It would have been naturally assumed that this thickness should decrease from the base to the tip (i.e., from zones 1-30 and 31-60) since the base is directly from the thick walled caecum but this is not the case as shown in Table 1 for the subjects and the analysis of both data and the plotted graphs.

The thickness of the second subject has shown the expected trend from the base to the tip (i.e., zones 31-60) where the thickness decreases along the course, whereas that of the first subject shows an initial rise at the base, then decreased in the middle segment before increasing in the tip.

All these observed variations have well been illustrated in the preceding interaction bars. But by far the most interesting finding of this study is the relationship between the observed parameters especially as seen in the middle segment zones of the second subject (zones 40-50) and to some extent also the middle segment zones of the first subject (zones 10-20).

A veritable ground for further exploration of the roles of the lymphoid follicle and thickness (Serosa-Mucosa diameter) of the organ has been shown in the plotted
figures and thickness against the zones where an explicit
finding has been illustrated in the middle segment zones
of both subjects (zones 10-20 and zones 40-50). This will
probably explain the occurrence of appendicular
obstruction in the middle segments of the vermiform
appendix. This finding has not been reported in the
literature apart from the usual knowledge that
appendicular obstruction is either as a result of arterial
blockage or luminal obstruction caused by either faecalith
or foreign bodies or parasites. (Farquharson, 1978; Glover,
1984; Kelly and Hurdon, 1965; Okojie, 1979; Schwartz,
1984; Sleisenger and Fordtran, 1983; Shigang et al., 2000;
Charles et al., 1975; Wilson et al., 1978, Williams, 1983).
This finding seems to me both convincing and scientific
in the sense that these two parameters; the thickness of
the organ and lymphoid follicle diameter ultimately
determine the calibre of the luminal diameter and hence its
affectation.

What needs to be investigated however the factors
both in vivo are (if possible) and in vitro that affect these
parameters. Together with such a research is also the
comparative study of these parameters between human
vermiform appendix and those of lower animals like the rat
and rabbit with similar appendicular gross and
microscopic structures.

CONCLUSIONS

This analysis of the segmental profile of the
vermiform appendix has provided histomorphometric
changes in its structure capable of answering the age long
question of whether diseases associated with it are
causd only by vascular phenomenon and luminal
intrusion of extra appendicular substances or as a result of
the interplay of its structural configurations with other
factors. This is so because of the noted strong expression
of relationship between the observed parameters, more
especially the ones existing between the lymphoid follicle
diameter and the thickness on one hand and that between
the luminal diameter and the lymphoid follicle diameter on
the other. For example, the lumens decreases when either
the thickness or more importantly the lymphoid follicle
diameter increases in size suggesting that obstruction can
occur at such sites with the resulting microscopic and
macroscopic changes that come to bear on normal
subjects. The basis for further studies of the vermiform
appendix has been established from this study especially
in the areas of comparative histomorphometry and finding
the effects of hyper cholesterol diet on the lymphoid
follicle. Because other variables like the vascular pattern
of the appendix, the various positions seen in our local
areas both for the living surgical patients and dead are
being looked at more than these parameters.

This study will also give a basis for caution
especially when teaching students the basis for and
occurrence of appendicitis and its related sequelae in
clinical medicine. For those interested in appendix
transplantation and endoscopic studies of the appendix,
these are the results for guidance and future
manipulations.

RECOMMENDATIONS

One will in the light of the preceding therefore
recommend further histomorphological,
histomorphometric and histochemical studies of the
vermiform appendix in various age groups, sexes and if
possible races.

Apart from this it will be worthwhile studying these
parameters in vivo using modern harmless radio active
substances and comparing same with Cadaveric
Specimens. The effects of hyper cholesterol diet on the
lymphoid follicles of the appendix should be studied and
also the variation of the lymphoid follicle in clinical cases
of perforated appendix will be another area of interesting
research.

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