



# Changes in the length and diameter of the normal appendix throughout childhood

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Received 25 May 2012; revised 30 January 2013; accepted 2 February 2013

## Key words:

Appendix;  
Growth;  
Length;  
Diameter;  
Paediatrics;  
Childhood;  
Conduit;  
Mitrofanoff stoma;  
Malone stoma;  
Histology;  
Immune;  
Function

## Abstract

**Background/Aim:** It has been proposed that the narrow diameter of the appendix is important in providing a 'safe zone' for commensal intestinal flora, while the length of the appendix can be variable. This study aimed to investigate the relationship between appendiceal length, diameter and age, in children under the age of eighteen years, to determine if the appendix changes in size with age.

**Methods:** The histological records of all cases of children undergoing appendectomy at the Royal Children's Hospital (Melbourne) between 2009 and 2011 were retrospectively reviewed. Participants were excluded on the basis of histological evidence of acute inflammation, and data on the diameter and length of the appendix were collected from 210 children, aged zero to seventeen years.

**Results:** Data were stratified by age for analysis into  $\leq 3$  years,  $>3$  and  $\leq 9$ ,  $>9$  and  $\leq 13$  and  $>13$  years. Mean diameters per group were 3.7 ( $\pm 1.3$ ), 6.3 ( $\pm 1.2$ ), 6.7 ( $\pm 1.6$ ) and 6.9 ( $\pm 1.6$ ) millimetres respectively. Mean lengths per group were 39.7 ( $\pm 16.1$ ), 66.3 ( $\pm 15.3$ ), 63.7 ( $\pm 21.3$ ) and 68.8 ( $\pm 18.2$ ) millimetres. Both diameter and length were higher in the older age groups, compared with the  $\leq 3$  year olds ( $p < 0.001$ ). A positive correlation was seen between age and appendix diameter ( $R = 0.5$ ,  $p < 0.001$ ) and length ( $R = 0.3$ ,  $p = 0.03$ ) in the  $\leq 3$  group only. Mean diameter and length values did not differ significantly between groups aged  $>3$  years old.

**Conclusion:** This study showed that following an initial growth period during early infancy up to about 3 years, the appendix achieves its adult proportions and does not continue to grow throughout childhood. © 2013 Elsevier Inc. All rights reserved.

Appendectomy is one of the most commonly performed surgical procedures in hospitals [1]. In recent times the

appendix has proven useful as a conduit to access bladder or bowel, such as via Mitrofanoff appendicovesicostomy, or Malone stoma [2,3]. Yet there remains little consensus as to the apparent function of the caecal appendix, and evidence is lacking about how it grows.

Despite the accepted wide range of anatomical variation in appendix location and length [4–8] limited data were available on the dimensions of the appendix in children.

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With a small, but significant number of children undergoing reconstructive surgery with the appendix, we wondered about the growth pattern of the appendix in relation to long-term operative outcomes.

The aim of this study therefore, was to investigate whether the length and diameter of the appendix changes with age in children less than eighteen years.

## 1. Methods

### 1.1. Data collection

A search of the hospital's Medipath database was performed, for histopathology reports featuring the keyword "appendix" between January 1, 2009 and September 19, 2011. Reports were then analysed manually and data recorded on age at time of operation, appendix length, and diameter millimetres. Ages of children under six years were recorded in months; with children whose age at operation was less than one month classified as neonates of 'zero' months. Where appendix diameter was reported as a range, mean values were recorded. Patients were excluded on the basis of acute inflammation, incompleteness or fragmentation of the specimen, or pathology distorting the normal appendiceal architecture. Specimens with descriptions of periappendicitis, or 'healed' appendicitis were included in the study as long as the appendix itself appeared normal. Hospital laboratory numbers were recorded, however no identifying details of patients were kept.

Approval for the study was obtained from the Institute's Human Research Ethics Committee (31148 A) prior to commencement of the study.

### 1.2. Statistical analysis

Data were stratified by age for analysis into the following categories:  $\leq 3$  years,  $>3$  and  $\leq 9$  years,  $>9$  and  $\leq 13$  years and  $>13$  years. Appendix diameter and length was described for each age group, and analysed using Stata 12 for Windows (StataCorp LP, College Station, TX, USA). Pearson co-

**Table 1** Summary of appendix dimensions by age group.

Parameter	Mean $\pm$ SD
<b>Diameter (mm)</b>	
$\leq 3$ yrs	3.7 $\pm$ 1.3
$>3$ to $\leq 9$ yrs	6.3 $\pm$ 1.2
$>9$ to $\leq 13$ yrs	6.7 $\pm$ 1.6
$>13$ yrs	6.9 $\pm$ 1.6
<b>Length (mm)</b>	
$\leq 3$ yrs	39.7 $\pm$ 16.1
$>3$ to $\leq 9$ yrs	66.3 $\pm$ 15.3
$>9$ to $\leq 13$ yrs	63.7 $\pm$ 21.3
$>13$ yrs	68.8 $\pm$ 18.2

**Table 2** One-way ANOVA on appendix dimensions.

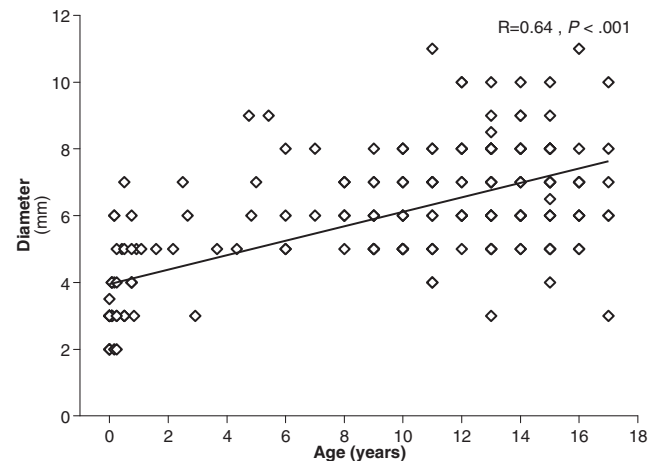
Parameter	F	P-value
<b>Diameter (mm)</b>		
Age group	53.77	<0.001
[0–3] vs (3–9]	57.06	<0.001
[0–3] vs [10–13]	116.94	<0.001
[0–3] vs [14–18]	127.12	<0.001
<b>Length (mm)</b>		
Age group	28.68	<0.001
[0–3] vs (3–9]	40.32	<0.001
[0–3] vs (9–13]	49.56	<0.001
[0–3] vs (13–18]	73.79	<0.001

efficients were calculated to quantify linear correlation between appendix dimensions and age. A one-way ANOVA was used to compare means between age groups.

## 2. Results

A total of 805 histopathology reports were reviewed, of which 552 were excluded on the basis of "acute inflammation", with 39 excluded due to incomplete or fragmented specimens. Three reports were rejected on account of pathology disrupting normal appendiceal anatomy (appendiceal cyst, carcinoid tumour and lymphoma), and 1 further report was excluded due to a description of a "dilated" appendix of unknown cause. Data were recorded from a total of 210 appendix specimens which were not acutely inflamed and the cause of the abdominal pain was presumed to be non-specific viral infection or idiopathic.

Age of patients at the time of operation ranged from 0 years of age to 17 years. Fifty three (25.2%) children were under 3 years old at time of operation, 31 (14.8%) between 3 and 9 years old, 67 (31.9%) between 9 and 13 years old, and 59 (28.1%) over 13 years old.



**Fig. 1** Diameter (mm) of appendix versus age (yrs).

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