Bangladesh Journal of Anatomy January 2015, Vol. 13, No. 1, pp. 1-7

Original Articles

Shape and Height of Human Duodenal Villi

Sharmina Sayeed[1], Shamim Ara[3], Rumana Reza[3], Sadia Rahman[1], Kanetarin Kashem,[4] Uttam Kumar Paul[5]

Abstract

Context: *Villus atrophy of the small intestine is one of the causes of chronic diarrhoea. The etiology of villus atrophy of the small intestine includes celiac disease, tropical sprue, Giardiasis etc. The knowledge of villus shape and height of duodenum in Bangladeshi people can help the gastroenterologist to diagnosis and provide better treatment.*

Materials & Methods: *A Cross sectional, analytical type of study was performed in the Department of Anatomy of Dhaka Medical College, Dhaka from July 2010 to June 2011 on histological slides of 19 human duodenums of Bangladeshi people. The sample was divided into 5 different age groups, group A (20-29 years), group B (30-39 years), group C (40-49 years), group D (50-59 years) and group E (60-69 years). From group A, B and C five duodenums and from group D and E two duodenums were stained with Harris' Haematoxylin and Eosin stains. From each four parts of duodenum four paraffin blocks were prepared and best 76 slides were taken.*

The shape of villi in each four parts of the duodenum was observed and noted. The height of villi was measured by using a stage micrometer and ocular micrometer.

Results: *The shape of the villi were broader & shorter in age group E (60-69 years). Villi were found finger sharped in all age groups. The mean difference in height of villi in different parts of duodenum between group A and B, group B and C, group B and D, group C and D, group C and E, group D and E were statistically not significant. But the difference between height of villi of the first part of the duodenum in group A and C, group A and D, group A and E, group B and E found statistically significant ($p< 0.05$) and the difference between height of villi of fourth part of the duodenum in group A and C, group A and D, group A and E found statistically significant ($p < 0.05$).*

Key words: *duodenum, villi, shape, height.*

Introduction:

The mucosa of the normal small intestine is designed so that a maximum absorptive surface is presented to the intraluminal intestinal contents. The mucosal surface itself is studded with increase numerous epithelial-lined villi which are approximately 0.5-1.0 mm in height and which have been estimated to increase the absorptive surface eightfold[1]. The duodenal villi are shorter and broader with branching extensions. When four normal villi are identified in a specimen, it usually indicates that the entire specimen has a normal villous architecture[2]. In pathological conditions, a whole range of appearance is seen, from normal finger villi to leaves, to convolutions, and in some cases to a completely flat mucosa[3]. Villous atrophy of the small intestine is one of the causes of chronic diarrhea[4]. The aim of this study is to observe the shape of the duodenal villi and examine the height of villi of different parts of duodenum in Bangladeshi people. With this study, we can differentiate between pathological abnormalities and normal appearance.

1. Assistant Professor, Department of Anatomy, Ibrahim Medical College, Dhaka
2. Head & Professor, Department of Anatomy, Dhaka Medical College, Dhaka
3. Assistant Professor, Department of Anatomy, Green Life Medical College, Dhaka
4. Assistant Professor, Dhaka Central International Medical College, Dhaka.
5. Associate Professor, Department of Anatomy, Sir Salimullah Medical College, Dhaka

Correspondence: Dr. Sharmina Sayeed

Materials and methods:

Materials of the study:

The present study was performed on histological slides of four different parts of 19 human duodenums in different age groups of Bangladeshi people (Table-I). The study was done from July 2010 to June 2011.

Grouping of the samples:

The samples were divided into five age groups according to Simadibrata et al[1].

Table-I

Grouping of samples

Groups	Age in years	Total number (n)
A	20-29	5
B	30-39	5
C	40-49	5
D	50-59	2
E	60-69	2

Procedure of preparing histological study:

a) Preparation of the slide:

The duodenums were fixed in 10% formol saline. The sections were stained with Harris' Haematoxylin and Eosin (H & E) stains. From group A, B and C five duodenums and from group D and E two duodenums were taken. From each four parts of duodenum four paraffin blocks were prepared. Total 19 paraffin blocks were prepared and best 76 slides were taken.

b) Observation :

The shape of the villi of the duodenum was observed. Out of them, the histological section of duodenum contain at least four normal villi in a specimen indicates normal villous architecture and selected for the observation for the shape of villi. [2] The shape of the four parts of the duodenum was observed according to Kierszenbaum[5] and recorded (Figure-1).

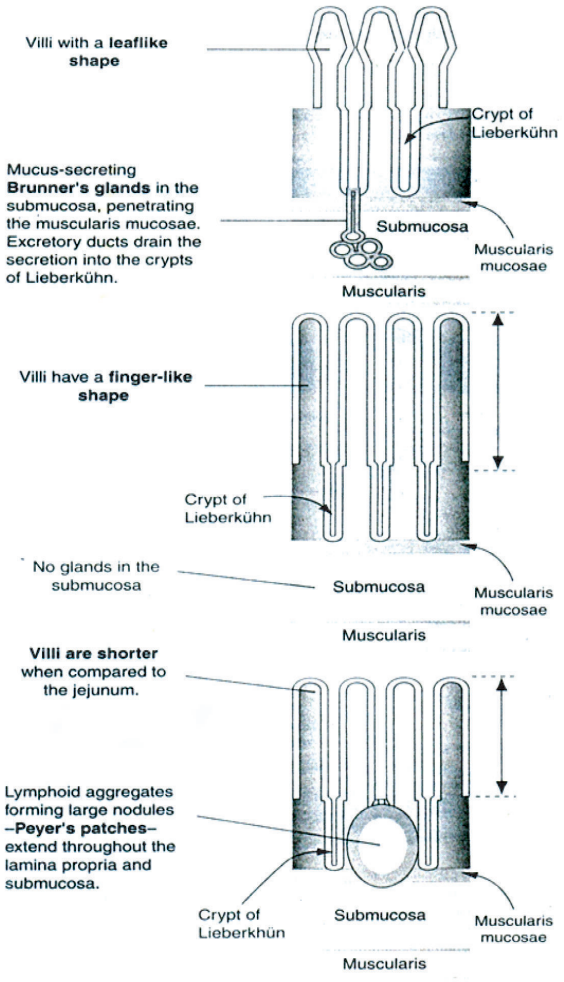

Fig.-1: *Different shape of villi (according to Kierszenbaum[5])*

c) Microscopic measurement:

For this study, the stained tissue section on the slide was divided into three different fields and then chosen for height of the villi in different parts of duodenum. The tissue sections were divided into three equal parts by drawing two transverse lines with fine marker pen on a transparent plastic sheath[6] (Figure-2). Then the sheet was fixed on the top of the cover slip by adhesive tape. Thus from each slide, three different fields were taken. For measuring the height of villi, best four villi were chosen[2] and then the average was recorded. The height of villi was measured by using a stage micrometer and ocular micrometer.

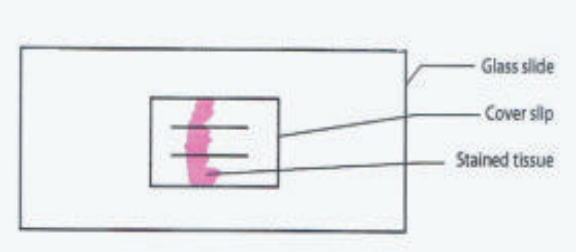

Fig.-2: *Showing the equal divisions of the tissue section.*

The stage micrometer calibration was focused under the objective to be used and the ocular micrometer calibration was superimposed on them in such a way that starting mark on the ocular micrometer matched exactly with a starting mark on the stage micrometer. Then the marker on the stage and ocular micrometer that corresponds to each other most closely was noted. In this way determination of how many of the smallest division of the ocular micrometer corresponds to how many smallest division of the stage micrometer was done. The number of ocular micrometer divisions was then converted into absolute values in micrometer.

The height of villi was measured from base of villi to top of the villi (Figure 3).

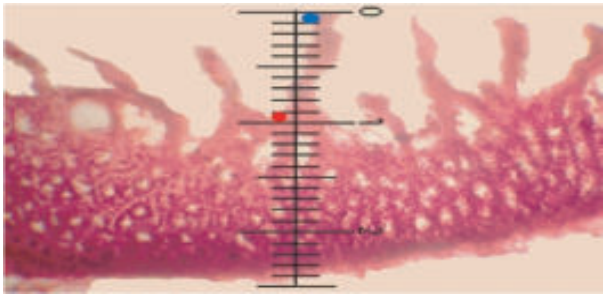

Fig-3: *Photograph showing measurement of the height of the villi with the help of ocular micrometer under low power objectives (× 10) [H & E]. Red dot indicates base of the villi and blue dot indicates top of the villi*

Statistical processing of data:

The data collected from the histological studies were processed and statistical analyses were done by Chi-square test unpaired Student's 't' test and one-way ANOVA test.

Ethical clearance: The study was approved by Ethical Review Committee of Dhaka Medical College, Dhaka

Results:

The result of the shape of villi in the different parts of the duodenum is shown on table -IIa, b, c, d, Fig. 4, Fig. 5.

Table-IIa

Shape of the villi in first part of the duodenum in different age groups

Age groups	Shape of villi							
	Leaf		Finger		Tall		Broad	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
A(n=5)	1	(20.0)	2	(40.0)	2	(40.0)	0	
B(n=5)	0		5	(100.0)	0		0	
C(n=4)	1	(25.0)	3	(75.0)	0		0	
D(n=2)	0		2	(100.0)	0		0	
E(n=2)	2	(100.0)	0		0		0	

Table-IIb

Shape of the villi in second part of the duodenum in different age groups

Age groups	Shape of villi							
	Leaf		Finger		Tall		Broad	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
A(n=5)	1	(20.0)	2	(40.0)	2	(40.0)	0	
B(n=5)	0		4	(80.0)	1	(20.0)	0	
C(n=4)	1	(25.0)	3	(75.0)	0		0	
D(n=2)	1	(50.0)	1	(50.0)	0		0	
E(n=2)	2	(100.0)	0		0		0	

Table-IIc

Shape of the villi in third part of the duodenum in different age groups

Age groups	Shape of villi							
	Leaf		Finger		Tall		Broad	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
A(n=5)	1	(20.0)	3	(60.0)	1	(20.0)	0	
B(n=5)	2	(40.0)	2	(40.0)	1	(20.0)	0	
C(n=4)	2	(50.0)	2	(50.0)	0		0	
D(n=2)	2	(100.0)	0		0		0	
E(n=2)	0		0		0		2	(100.0)

Table-IId

Shape of the villi in fourth part of the duodenum in different age groups

Age groups	Shape of villi							
	Leaf		Finger		Tall		Broad	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
A(n=5)	0		3	(60.0)	2	(40.0)	0	
B(n=5)	2	(40.0)	3	(60.0)	0		0	
C(n=4)	2	(50.0)	2	(50.0)	0		0	
D(n=2)	2	(100.0)	0		0		0	
E(n=2)	0		0		0		2	(100.0)

Statistical analysis done by Chi square test, ns = not significant

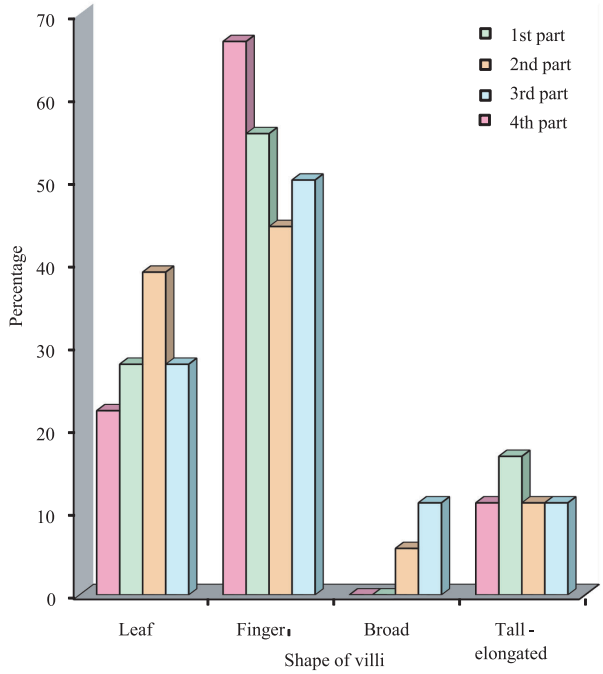

Fig.-4: *Shape of the villi in different parts of the duodenum*

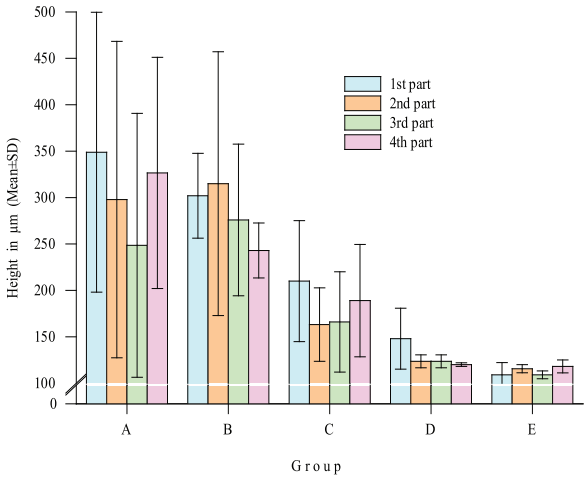

Fig.-5 *Height of the villi in the different parts of the duodenum in different age group*

Group A : Age 20 29 years
Group B : Age 30 39 years
Group C : Age 40 49 years
Group D : Age 50 59 years
Group E : Age 60 69 years

The result of the height of villi in the different parts of the duodenum is shown on table -III.

Table III

Height of the villi in the different parts of the duodenum in different age groups

Age groups	Height (¼m) 1st part Mean±SD	2nd part Mean±SD	3rd part Mean±SD	4th part Mean±SD
A	348.84±150.76	297.82±170.47	248.58±142.15	326.52±124.56
(n=5)	(171.40 516.60)	(166.60 485.70)	(85.70 466.60)	(192.80 485.70)
B	302.18±45.70	314.98±142.07	275.84±81.69	243.00±29.61
(n=5)	(233.30 341.60)	(175.00 533.30)	(208.00 416.60)	(216.00 283.00)
C	210.23±65.15	163.15±39.57	166.03±54.03	189.70±60.52
(n=4)	(128.50 281.20)	(121.40 212.50)	(114.20 218.70)	(121.40 243.70)
D	148.20±32.81	123.60±6.93	123.60±6.93	120.05±1.91
(n=2)	(125.00 171.40)	(118.70 128.50)	(118.70 128.50)	(118.70 121.40)
E	109.35±13.22	115.60±4.38	109.00±4.24	118.10±6.93
(n=2)	(100.00 118.70)	(7.10 8.00)	(106.00 112.00)	(113.20 123.00)
P value	*P value*	*P value*	*P value*	
A vs B	$>0.10^{ns}$	$>0.50^{ns}$	$>0.50^{ns}$	$>0.10^{ns}$
A vs C	$<0.05^{*}$	$>0.10^{ns}$	$>0.10^{ns}$	$<0.05^{*}$
A vs D	$<0.05^{*}$	$>0.10^{ns}$	$>0.10^{ns}$	$<0.01^{**}$
A vs E	$<0.01^{**}$	$>0.10^{ns}$	$>0.10^{ns}$	$<0.01^{**}$
B vs C	$>0.10^{ns}$	$>0.05^{ns}$	$>0.10^{ns}$	$>0.10^{ns}$
B vs D	$>0.05^{ns}$	$>0.05^{ns}$	$>0.05^{ns}$	$>0.05^{ns}$
B vs E	$<0.05^{*}$	$>0.05^{ns}$	$>0.05^{ns}$	$>0.05^{ns}$
C vs D	$>0.10^{ns}$	$>0.50^{ns}$	$>0.50^{ns}$	$>0.10^{ns}$
C vs E	$>0.10^{ns}$	$>0.50^{ns}$	$>0.10^{ns}$	$>0.10^{ns}$
D vs E	$>0.50^{ns}$	$>0.50^{ns}$	$>0.50^{ns}$	$>0.50^{ns}$

Figures in parentheses indicate range. Comparison between sex done by unpaired Student's 't' test, and between different age group by One way ANOVA (PostHoc), ns = not significant, */** = significant

Group A : Age 20 29 years

Group B : Age 30 39 years

Group C : Age 40 49 years

Group D : Age 50 59 years

Group E : Age 60 69 years

Discussion:

Creamer[3] stated that the normal appearance of the small intestinal villi is finger shaped, but many healthy people show some leaf-shaped villi. The present study is similar with the above findings. Simadibrata et al[1] found that in Indonesian people, villi are not all perfectly tall, finger-like structures standing in a row perpendicular to the lumen. Rather, many villi tend to bend in different directions and to vary in their structure from slender, index finger-like structures to plumper, thumb like structures with corrugated edges. The present study is similar with the above findings. Wood, Gearty and Cooper[7] examined the distal duodenal biopsy from 35 Indian, 30 White and 20 Afro-Caribbean residents of West Birmingham and found that finger-shaped villi were significantly less frequent in the Indian and Afro-Caribbean subjects than in the White subjects. They observed that Indian and Afro-Caribbean subjects living in England had shorter villi than White subjects. This implies that these changes are environmental rather than genetic. Environmental factor that could be responsible are nutrition, diet, parasites, viral and bacterial infections. There is very few literature especially on the normal appearance of small bowel mucosa amongst Bangladeshi people. So, the present study could not be compared with any previous similar study on the Bangladeshi population. The comparison had been made mostly with the findings in the Asian population. Simadibrata et al[1] stated that the mean height of the villi in the first part of the duodenum was 265.00 ± 81.89 µm and mean height of the villi of the second part of the duodenum was 317.27 ± 74.14 µm. In the present study the height of the villi of the first part of the duodenum were shorter than in the descending duodenum in group B and E that correspond with the above findings. The highest height of the villi present in group A was 348.84 ± 150.76 µm and the height of villi decreased in old age in group E 109.35 ± 13.22 µm. According to Lipski, Bennett, Kelley and James[8] the mean villous height was 471 µm which was higher than the present study. Webster and Leeming[9] found in their study that in elderly the villi tend to be shorter and that corresponds to present the study findings. Wood, Gearty and Cooper[7] found that mean height of villi in distal duodenum in White subjects was 386 µm, ranging from 287-529 µm, in Indians mean height of villi was 349 µm ranging from 149-442 µm, and in Afro-Caribbean the mean height of villi was 302 µm ranging from 138 -581 µm. The height of villi of the present study correspond with the height of villi of Indian population. Brown, Khan, Moore and Wigley[10] found that villi are about 0.5 – 1.0 mm in height. Thibodeau and Patton[11] described that each villi is about 1 mm in height. Bloom and Fawcett [2] stated that the length of villi is 0.5 – 1.5 mm depending on the degree of distension of the intestinal wall and the degree of contraction of smooth muscle fibers in their interior. According to Seeley, Stephens and Tate[13] the villi are 0.5 – 1 mm in length. Young, Heath and Lowe[14] observed in 2006 that the villi tend to be longest in the duodenum and shorter towards the ilium. Arey[15] described that the villi are 0.2 -1.0 mm tall. Einhorn[16] found in 2009 that the villi are about 0.5 – 0.7 mm in height. Ross and Pawlina[17] stated that villi are 0.5 – 1.5 mm long.

Conclusion:

The shape of the villi was found finger shaped in all age groups and broader and shorter in age (60-69) years. The height of villi was found significantly more in the first and the fourth part of the duodenum in young age group (20-29 years).

References:

1. Simadibrata M, Yuwono V, Kate FJWT et al. Normal histological appearances of the duodenum, jejunum and terminal ileum in Indonesian people. Medica.1999; 6:1-8
2. Segal GH, Petras RE. Small intestine in Sternberg SS editor. Histology for pathologists. 2nd ed. Lippincott-Raven, Philadelphia; 1997. 495-515.
3. Creamer B. Variations in small- intestinal villous shape and mucosal dynamics. Brit. Med. J.1964; 2:1371-1373.
4 Simadibrata M, Yuwono V, Kate FJWT et al. Villous atrophy of the small intestine in chronic

diarrhea in Indonesian people. Medica. 2001; 9: 86-94.

5 Kierszenbaum AL. Lower digestive system. In: Histology and cell Biology. United States of America: Mosby; 2002: 421-427.

6 Begum T. Histomorphological study of trachea and left bronchial tree in Bangladeshi adult male (Thesis). Dhaka: SSMC, 2007: 65-71

7 Wood GM, Gearty JC and Cooper BT. Small bowel morphology in British Indian and Afro-Caribbean subjects: evidence of tropical enteropathy. Gut.1991;32:256-259.

8 Lipski PS, Bennett MK, Kelly PJ and James OFW. Ageing and duodenal morphometry. The Journal of Clinical Pathology.1991; 45:452-454.

9 Webster SGP and Leeming JT . The appearance of the small bowel mucosa in old age. Age and ageing. 2005;4(3):168-174.

10 Brown JL, Khan, Moore LA and Wigley C. Small intestine. In: Borley NR Gray's Anatomy. 40th ed. UK: Churchill Livingstone Elsevier; 2008. 1125-1135.

11 Thibodeau GA and Patton KT. Anatomy of the digestive system. In: Anatomy and Physiology.5th ed. Philadelphia : Mosby; 2003. 751-783.

12 Bloom and Fawcett. Intestines. A text book of histology. 12th ed. Great Britain: Chapman & Hall; 2004. 617-619.

13 Seeley RR, Stephens TD and Tate P. Regulations and maintenance. In: Anatomy and Physiology. 6th ed . New York: McGraw-Hill Higher Education;2003. 860-884

14 Young B, Heath JW, Lowe JS and Stevens A. Gastrointestinal tract. In: Wheater's Functional Histology.4th ed. Singapore: Elsevier Limited; 2006. 274-277.

15 Arey LB. The digestive tube. Human histology.3rd ed. Philadelphia: W.B. Saunders Company;1968: 220-224

16 Einhorn M. Structure of the small intestine. Diseases of the intestines. 4th ed. Pennsylvania:Saunders;2009. 44-48.

17 Ross MH and Pawlina W. Digestive system II: Esophagus and gastrointestinal tract. In: Primrose JN. Histology a text and atlas with correlate cell and molecular biology. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2006: 535-543.