



Original Research Article

Length of Small Intestine in Formalin Fixed Adult Human Cadavers

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ABSTRACT

Small intestinal length has shown lot of diversification according to various types of studies. Its length varies from 2 to 7 meters. Aim of the present study is to obtain the length of the small intestine among formalin fixed adult human cadavers. In present study we studied 100 adult formalin fixed cadavers (80 males and 20 females). Small intestinal length ranges between 300 to 456cms; in females from 325 to 456cms and in males from 300 to 446cms. Small intestinal length is variable and is moderately affected by various factors like environmental factors, method of study, alive or cadavers, formalin fixed or unfixed.

Key words: small intestine, jejunum, ileum, duodenum, length of intestine

INTRODUCTION

Length of small intestine remains the controversial matter as seen in the literature. The small intestine consists of the duodenum, jejunum and ileum. It extends from the pylorus to the ileocaecal valve. In the living adult it has total length of about 5 meters, but this can range widely from less than 3 meters to more than 7 meters in length. ^[1] Duodenum is the widest and most fixed part of the small intestine. It is approximately 25 cm long. ^[2] As stated in the past literature the length of the small intestine ranges from 4.7 to 9.7meters postmortem and 2.4 to 3.7 meters in vivo. ^[3] Previous studies have correlated various measures with sex, age, weight, height and

ethnic background. ^[4] Age-related alterations in the structural and functional properties of different regions of the gastro intestinal tract is also studied. ^[5] Mechanical properties of the intestine is also studied to check the changes in the tensile properties of different layers of the intestine. ^[6] From the previous literature it was seen that variation was seen in the length of the small intestine depending upon the type of method used to take measurements like in alive patients undergoing laprotomy, radiological barium study or studies done in cadavers. So present study is undertaken to know the average length of the small intestine among the adult formalin fixed cadavers.

MATERIALS AND METHODS

Formalin fixed adult cadavers were used for the study from department of Anatomy of various medical colleges of Western Maharashtra. In total 100 cadavers were studied, 80 were male and 20 were females. Measurements were taken along the antimesenteric border by the unstretchable nylon thread from the pylorus to the ileocaecal junction. Duodenum was measured in situ and rest of the small bowel i.e. jejunum and ileum was taken out of abdomen to take the measurement. All measurements were taken in centimeters and were taken twice by the same individual to reduce the observer bias. Subjects with congenital gastrointestinal anomalies or gross pathologies of gastrointestinal tract or other gross pathologies which can affect the length measurement were excluded from the study.

RESULTS



Figure 1. Measurement of the length of small intestine against antimesenteric border by unstretchable nylon thread.

Length of the small intestine from pylorus to ileo-caecal junction in 100 adult cadavers ranges between 300 to 456cms. In females, small intestinal length ranges from 325 to 456cms and in males from 300 to 446cms. The mean length of the small

intestine was 385.83 with standard deviation of 49.91. In male cadavers mean length were 379.47 with standard deviation of 50.64. In female cadavers mean length were 411.25 with standard deviation of 38.31.

DISCUSSION

The small bowel length is the topic of controversies since past. Many studies are available regarding the overall length of the small intestine. Studies on the alive patients are more than the cadaveric studies. And in that studies on the formalin fixed specimens are few.

In 1965, Reiquam CW, Allen RP and Akers DR ^[7] conducted the study on 389 autopsy cases in infants and children to analysis normal and abnormal small bowel length. Their interest in the study was aroused by an error in radiographic diagnosis. A film of the abdomen of a 1-day-old infant was interpreted as atresia of the jejunum because only two gas filled intestinal loops were seen. At operation, the atresia was almost at the ileocecal valve, but the total bowel length was only 50 cm, thereby accounting for the misinterpretation.

In 1984, Fanucci A, Cerro P, Fraracci L and Letto F ^[8] conducted the radiographic study. The jejunoileal length was measured on double-contrast small bowel barium radiographs, obtained from 10 patients who were investigated for abdominal pain. The length of the small bowel ranged from 230 to 370 cm, with an average length of 280 cm. In 1988, Fanucci A, Cerro P, Fanucci E ^[9] again presented another study in which they determined small-bowel length, number and thickness of folds in the jejunum and ileum, diameter of the loops, and thickness of the bowel wall on double-contrast small-bowel barium radiographs, obtained from 182 patients with no jejunal or ileal morphologic abnormalities. The length of the small bowel ranged from 160 to 430 cm, with an average

length of 291 cm. No correlation was observed between the number of folds and the total length.

In 1991 Palma A, Mineo F and Salerno G [10] examined some anatomical parameters concerning the jejunum and ileum as the relationship between the loops, their extension, length, diameter and the wall thickness. 2019 patients were studied by double contrast small bowel barium radiographs. The results were in general according with the literature. Only the measure of the length changed which were shorter than that indicated in the literature.

In 2002 Hounnou G, Destrieux C, Desme J, Bertrand P and Velut S [3] done the anatomical study to assess the length of intestine in 200 non-fixed adult cadavers. They found the average length of the whole intestine was 795.5 ± 129 cm and was significantly higher in men and younger subjects.

In 2008, Hosseinpour M and Behdad [11] A presented a study conducted between May 2007 and December 2007 on 100 patients (54 males and 46 females) aged 20-43 years. Data such as age, sex, height, weight and bowel length were measured and analyzed. For comparison they used 30 cadavers as control group after case control matching. The small bowel length was 459.6 ± 78.47 cm in patients and 632.5 ± 88.9 cm in cadavers ($P < 0.01$). Small bowel length was 452.2 ± 79.36 cm in males and 468.2 ± 80.44 cm in females ($P =$ Not significant). Jejunum length was 140.2 ± 45.4 cm in males and 138.6 ± 40.2 cm in females ($P =$ Not significant). Ileum length was 286.3 ± 34.7 cm in males and 289.9 ± 37.8 cm in females ($P =$ Not significant). No correlation was found between bowel length and age, gender, height and weight.

In 2012 Gondolesi G. et al [12] presented the cohort study done in intestinal donors. In this study small bowel length was measured and compared with various

parameters. Finding shows that small intestinal length does not increase with growth like other anthropometric variables. The small intestinal length and height ratio significantly decreases with growth; however, bowel diameter increases.

In 2014 Lohsiriwat V, Wiangphoem N and Lohsiriwat S [13] enrolled 64 Thai patients during the study period. According to the exclusion criteria, only 48 patients were eligible for study. There were 27 men and 21 women, with an average age of 60 years. The average length of only jejunum and ileum was 428 ± 105 cm (range 169-745cm). Male adults had about 90 cm longer jejunoileal length than female adults (468 ± 105 cm vs. 376 ± 81 cm; $p < 0.01$), particularly of the jejunum (179 ± 78 cm vs. 106 ± 38 cm; $p < 0.01$). The ileum accounted for about two-third of the total jejunoileal length. There was no association between jejunoileal length and age, body weight, height, or body mass index.

The veterinary study was conducted in 2014 by Clarke BS, Banks TA and Findji L [14] with the aim to quantify the longitudinal shrinkage of canine small intestinal specimens after resection and fixation in 10% formalin. The length of each sample was measured before excision, immediately after excision, and after 24 h in 10% formalin. The samples indicated a significant decrease in length after resection and fixation. The mean shrinkage from the pre-excision state was 28.3% immediately after excision ($P < 0.0001$) and 26.3% after 24 h of fixation ($P < 0.0001$).

The growth rates of small intestinal changes during embryological, prenatal, and postnatal life. Factors like altered food availability, diseases and other pathophysiological conditions alter the alimentary tract functions. Even loss of muscle tone after death leads to apparent lengthening of the small intestine. [15] Significant age-related alterations in the

structural and functional properties of different regions of the gastrointestinal tract are also studied previously. [5] A tensile property of the different parts of the intestine is studied and shows significant differences. Such factors can also alter the gastrointestinal distension under different storage conditions. [6] Factors responsible for the different small intestinal length are very vague and include environmental factors, method of study, alive or cadavers, formalin fixed or unfixed.

CONCLUSION

Small intestinal length is variable. It is moderately affected by various factors like environmental factors, method of study, alive or cadavers, formalin fixed or unfixed. However its length is ranging between 2 to 5 meters approximately as against the larger length of small intestine mentioned in standard anatomy books. More and more studies will certainly confirm this conclusion.

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