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Evaluation of the mesenteric continuity on surgical dissection in cadavers using newly developed modified surgical technique

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***Abstract*---**Background: The conventional surgical model is recently questioned via the statement that there is continuity in the mesentery. The concept stating the mesentery regress seems to be accurate with the latest literature stating continuity of mesentery to rectum from the duodenojejunal junction in radiological as well as surgical findings. Aims: The present trial on cadavers was done to evaluate and access the efficacy of this newly developed technique in preserving the continuity of the mesentery and ex-vivo mesentery characterization. Materials and Methods: In 16 cadavers, a newly developed dissection technique by Kumar A et al was adopted for judging and assessing the continuity of the mesentery. The whole mesentery is separated from the abdominal cavity. These observations were recorded photographically and clinically, and the results are formulated. Results: The continuity of the mesentery was continuous and this finding was uniform in all the 16 cadavers examined in the study. As this continuity continued from mesoduodenom to mesorectum, this showed and pointed towards the intestine location at the intestinal margin of the mesentery. With this continuity, the study also depicted that anatomical boundaries that divide the various regions were not prominent on examination. Conclusion: The mesoduodenum presence can be considered universal in the entire human adult population and

not abide by the area, gender, or race. Also, the recent dissection protocol adopted in the present study allows the complete dissection of the entire continuous mesentery along with its adjoining part.

***Keywords*---**mesentery, mesenteric continuity, mesoduodenum, mesocolon, posterior abdomen wall.

Keynote: Cadaveric sections are based on the conventional model in anatomy which does not describe the mesenteric continuity. Hence, the upgrading of the conventional model is required in the latest cadaveric sectioning. Owing to the mentioned fact, a new novel technique of cadaveric section was developed recently, that preserves the mesenteric continuity and was reproducible.

Introduction

The mesentery is the region attached to the ilium and jejunum and is defined as the double fold seen in the peritoneum in the abdominal anatomy. This double fold is separated by the fatty connective tissue having nerves and vessels that help in the suspension of the gut tube from the posterior wall of the abdomen.[1] The nomenclature of a part is obtained from its attachment to the gut tube part like transverse colon provides attachment to the transverse mesocolon. In the conventional mesentery model, there are multiple mesenteries seen. Associated mesenteries in the intestine (intraperitoneal) are also described in the conventional models where multiple mesenteries are mentioned.[2] The regions of the intestine which do not have associated mesenteries are termed retroperitoneal. In the recent past, this conventional model is questioned via the statement that there is continuity in the mesentery. The concept stating the mesentery regress seems to be accurate with the latest literature stating continuity of mesentery to rectum from the duodenojejunal junction in radiological as well as surgical findings.[3]

This continuity of the mesentery is also confirmed in the recent cadaveric studies. However, this concept goes back to ancient history, where it is mentioned that the mesentrum is united and is attached to the aorta in the middle. This mesentery is described as fragmented and discontinuous in the first edition of Gray's anatomy.[4] In another study on the cadaver, it was seen that attachment of the mesentery to descending and ascending colon is seen in a few cases. In various embryological studies in humans, mesenteric continuity is seen and also relates to various congenital anomalies. In embryological studies, it is considered that mesentery first emerges as a continuous sheet which later regresses during the fixation stage. The actual fate of mesentery in embryonic life is decided in the 6th-10th week of intrauterine life.[5]

Midgut rotation in embryonic life leads to flattening of a few of the mesentery regions and its attachment to the posterior wall of the abdomen. These regions involve the duodenum and buds of the pancreas that relates to the rectum, descending colon, and ascending colon. Later, the fusion of mesentery is seen with the mesothelial surface, and this fusion shows the loss of mesentery termed as retroperitoneal with loss of some intestinal part.[6] The remaining fascia remains

patent in adult humans below the mesocolon opposite the posterior wall of the abdomen. This fascia is termed fusion fascia, Toldt's fascia, or fascia of Treitz. Continuity of the mesentery is also described in the various congenital and fetal anomalies including malrotation, non-rotation, and other adverse consequences in the fetus. In animal species such as vertebrates, marsupials, and reptiles continuity in mesentery is also observed.[7]

Cadaveric sections are based on the conventional model in anatomy which does not describe the mesenteric continuity. Hence, the upgrading of the conventional model is required in the latest cadaveric sectioning. Owing to the mentioned fact, a new novel technique of cadaveric section was developed recently, that preserves the mesenteric continuity and was reproducible. This technique aimed at enabling the precise evaluation of the adult mesenteric anatomy and also allowed ex-vivo mesenteric examination.[8] The present trial on cadavers was done to evaluate and access the efficacy of this newly developed technique in preserving the continuity of the mesentery and ex-vivo mesentery characterization.

Materials and Methods

The present trial on cadavers was done to evaluate and access the efficacy of this newly developed technique in preserving the continuity of the mesentery and ex-vivo mesentery characterization. The study was carried out on 16 cadavers donated for medical education purposes. The cadavers were 9 males and 7 females with the age range of 23 years to 57 years with a mean age of 37.8 years. The cadavers were all fixed and stored in 10% formalin with embalmment. The informed consent for the study was taken from the relatives or guardians of the deceased individual. The ethical clearance for the study was obtained from the Ethical committee of the institution. Before the commencement of the study, all the cadavers were confirmed for mesenteric continuity as the inclusion criteria for the study.

The criteria for the dissection followed as developed by the recent study of Kumar et al[9] which enabled the completed mesentery dissection. The procedure followed the following steps: The first step follows the conventional cadaveric section where the anterior wall of the abdomen is opened from up downwards. Along with its attachment to stomach curvature, the omentum is reflected next revealing a lesser sac. Cephalad stomach is reflected by dividing junction of first duodenal part and pyrolus. The second and third part of the duodenum is exposed by separating the underlying structures from the transverse mesocolon. This also revealed the pancreatic head at the duodenal medial border which is then removed with the only body left. Ligation of the pancreatic and bile ducts is performed next, followed by their division at their entrance at the second part of the duodenum. Finally, the exposure is mesentery is performed via reflecting the intestinal loops of the ileum and jejunum towards the left side. On the lateral side, peritoneal reflection is divided to reveal the plane of fascia and colon. The colofascial separation leads to detachment of the posterior wall of the abdomen from the colon.

This is followed by the mesofascial separation on both left and right side and ileocaecal junction exposing mesocolon and allowing its detachment. This

separation is then taken to the midline detaching the mesentery completely to the duodenal fourth part proximally. Mesosigmoid was detached from the posterior wall of the abdomen and underlying fascia. This continued to the distal side beneath the mesorectum separating the mesosigmoid from the musculoskeletal region. This continued distally until the level of the pelvic floor followed by division and ligation of the junction of the anus and rectum. This leads to complete separation of the mesentery except for its attachment to the area of peritoneal ligament connection and major vascular trunk area, dissection of these areas is then performed. Then, the whole mesentery is separated from the abdominal cavity. These observations were recorded photographically and clinically, and the results are formulated.

Results

The present trial on cadavers was done to evaluate and access the efficacy of this newly developed technique in preserving the continuity of the mesentery and ex-vivo mesentery characterization. The study followed the newly developed protocol described in the recent study of 2019. The dissection protocol was kept uniform in all the cadavers of the study disregarding sex or age. The mobilization of the mesentery was achieved in all the cadavers. It was seen that the mesentery was continuous in course to mesorectum from the mesoduodenom. Mesentery dissection in the cadavers allowed various observations possible. The continuity of the mesentery was continuous and this finding was uniform in all the 16 cadavers examined in the study. As this continuity continued from mesoduodenom to mesorectum, this showed and pointed towards the intestine location at the intestinal margin of the mesentery. On evaluating the posterior and anterior mesentery aspect, it was seen that all mesenteric structures were evident from the front view except the mesoduodenom. The mesoduodenom could only be seen and observed from the posterior aspect of the mesentery. From the posterior view of all the cadavers, mesoduodenom was evident in continuity with the small bowel region of the mesentery.

The study showed and confirmed the mesenteric continuity. With this continuity, the study also depicted that anatomical boundaries that divide the various regions were not prominent on examination. Hence, the division of the anatomic regions was based on their continuity with the particular intestinal region. The region of the small intestine that was continuous with mesentery was ileum and jejunum. Transverse mesocolon was continued by the mesenteric ileac region and the ascending mesocolon was continued by the mesenteric region of the small intestine. Transverse mesocolon continued to the descending mesocolon mesentery on the left side at the splenic flexure. This descending/left mesocolon further continued to mesorectum via mesosigmoid distally. The mesentery at the junction lying between mesorectum and mesosigmoid narrowed, then mesorectum was seen to be tapering as it proceeded to the anorectal junction, where it almost disappeared.

Posteriorly to the transverse colon, ascending colon, and the composite mesentery of the small intestine, mesoduodenom, and duodenum were encountered. Transverse colon, ascending colon and small mesentery of the intestine get narrows towards the center and advances to the mesenteric root region. In all the

cadavers examined in the study, the notch of the mesentery was evident at the conversion towards the mesenteric notch. Through this notch, the jejunum was seen which continuation of the duodenal fourth part in the notch. This notch was not visible due to its obstruction via coils of the ileum and jejunum part of the small intestine, which had to be retracted towards the right side to allow the visualization of the mesenteric notch. While the retraction was relieved, these coils again covered the notch hindering its visualization. At the duodenal passage through the notch and with the change in orientation of the mesoduodenum to the jejunal mesentery, a mesenteric twist was seen in the cadavers.

Concerning the vessels of the mesentery, as already mentioned all the mesenteries after they were mobilized, continued to the posterior wall of the abdomen at inferior and superior mesenteric arteries enclosing all the associated branches. The superior mesenteric artery and vein, that comprises the superior mesenteric vessels which were seen at the medial margin of the mesoduodenum. Within the mesoduodenal substance, various structures and components of the neurovascular entities pass from the duodenum. The results of the present study showed that the anatomy of the mesentery observed was overlapping and comparable irrespective of age and gender.

Discussion

The present trial on cadavers was done to evaluate and access the efficacy of this newly developed technique in preserving the continuity of the mesentery and ex-vivo mesentery characterization. The study followed the newly developed protocol described in the recent study of 2019. The dissection protocol was kept uniform in all the cadavers of the study disregarding sex or age. The mobilization of the mesentery was achieved in all the cadavers. The results of the present study showed that the mesentery was mobilized in all the cadavers and mesentery was continuous in course to mesorectum from the mesoduodenom. The results of the present study were per the recent study by Kumar A et al[9] in 2019 where authors concluded that it was possible to mobilize the mesentery and ex-vivo confirmation of the mesentery continuity. The continuity of the mesentery was also described in the previous literature by Coffey JC et al[10] in 2016 and Meyers AM et al[11] in 2011 where the continuity was confirmed in the surgical procedures from the duodenojejunal region to the anorectal region.

In a cadaveric study of Kumar A et al[9] in 2019, this was the first of its kind, which confirmed the mobilization and continuity of the mesentery. The present study utilized the same protocol and procedure as described by the study of Kumar A et al[9] in 2019 which are easier and practical to be used in general surgical settings. The cadaveric study also enabled the operators to see various other findings including continuity of mesentery to mesorectum to mesoduodenum, and the location of the intestine as a whole at the intestinal margin of the mesentery from the duodenum to the rectum. Various other regions of the mesentery including descending colon, ascending colon, and the mesoduodenal areas were also evident during the cadaveric dissection of the present study. Also, in the present study, the associated mesenteric regions of both ascending colon and descending colon were seen which were seen resting at the wall of the abdomen. These findings were in contrast to the studies by Gray et

al[12] in 1858 where these regions were considered as the part of the posterior wall of the abdomen.

Following the conventional anatomic model of the mesentery, the area at which the mesentery of the small intestine goes to the posterior wall of the abdomen was considered as a mesentery roof. However, in the present study, it was seen that it continues to the right side and becomes the ascending colon mesentery. Also, it was seen that no roof of the mesentery exists, as the small intestine mesentery continues with descending colon mesentery. These findings were against the findings of the study by Coffey JC et al[10] in 2016 where the findings of the present study were not confirmed. The continuity of the mesoderm is also confirmed by the various studies done in embryologic life as said by Sadler TW et al[13] in 2012 and Schoenwolf GC et al[14] in 2015 who also confirmed these findings which indicated the presence of additional proximal mesenteric areas in the adult humans which is also evident by the study of Culligan K et al[15] in 2014 who mentioned the similar findings. In the present study, the mesoduodenum was also seen in all the examined cadavers located posteriorly to the mesentery. This finding was also supported by the study of Kumar A et al[16] in 2017 where the posterior location of the mesoduodenum to the mesentery. Owing to the location of the mesoduodenum to the main mesentery, it might have been missed in anatomical examination in the previous literature.

Conclusion

As suggested by the present study, the mesoduodenum presence can be considered universal in the entire human adult population and not abide by the area, gender, or race. Also, the recent dissection protocol adopted in the present study allows the complete dissection of the entire continuous mesentery along with its adjoining part. The present dissection protocol might be beneficial to the various scholars, researchers, and students in dissecting the complete and continuous mesentery. To confirm the results of the present study correlation of the radiographic, clinical, surgical, and anatomic factors is necessary. To reach a definitive conclusion, multi-institution studies in different geographical areas may prove beneficial.

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