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Mohammad Ahmad Abdalla

MORPHOLOGICAL, ANATOMICAL AND SURGICAL FEATURES OF THE VERMIFORM APPENDIX: A HISTORICAL REVIEW

Department of Human Anatomy, Tikrit University College of Medicine, Tikrit, Iraq

The aim of this review is to focus light on the history of the human vermiform appendix from the morphological, anatomical, surgical, classification of the origin, types, blood supply aspects in order to understand the real function and summarized this information that positively impacts the clinical decision in case of appendicitis, the most popular surgical condition. Although the characteristic features of the normal and diseased appendix had been reported for many previous centuries, it was still the most common challenge facing every single day in the operation room. The appendectomy, the commonest surgical emergency procedure, may cause little confusion for the surgeons due to highly variable situations of inside the abdominal cavity. However, the recent imaging techniques have increased the surgeon's ability for crucial diagnosis of the diseased appendix. Besides the above-mentioned criteria, with its clinical features diagnosis and management, the author was deeply searched in many scientific databases including EMBASE, Cochrane Library, PubMed, Pubmed Central (PMC), Medline, Web of Science, and Scopus.

K e y w o r d s : Appendectomy, Appendicitis, Mesoappendix, Review, Vermiform Appendix (VA).

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For correspondence: Mohammad Ahmad Abdalla, Department of Human Anatomy, Tikrit University College of Medicine, Yarmook Street, Box 45 / Tikrit 28001 / Iraq. e-mail: dr.mohammad68@tu.edu.iq

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Introduction

Appendicitis is still one of the commonest surgical challenges that facing surgeons in the whole world. Most of the previously published articles regarding the vermiform appendix usually focused on its suspected etiology, pathogenesis, diagnosis, and management with old or the newly discovered procedures including endoscopic methods. In ancient civilization of Egypt 3000 BC when the process of mummification was performed the viscera of the abdomen were collected in Coptic jars and from some inscriptions written on these jars, the human appendix was possibly the first recorded as "the worm of intestine" [1].

In 1521, Berengario De Capri declared few sketches pointed to the vermiform appendix (VA); while in 1543, Andrew Vesalius published some illustration for it in his famous book "De Human Corporis Fabrica» [2].

In 1544, Jean Fernel was the first individual who described in a published paper the appendicular diseases [3].

Materials and Methods

This review is an attempt to do a comprehensive historical updating on the presently available information of the human vermiform appendix. Including the morphological, anatomical, surgical, classification of the origin, types, blood supply aspects in order to understand the real function and summarized this information that positively impacts the clinical decision in case of appendicitis. Besides the above-mentioned criteria, with its clinical features diagnosis and management, the author was deeply searched in many scientific databases including EMBASE, Cochrane Library, PubMed, Pubmed Central (PMC), Medline, Web of Science, and Scopus. Finally, all the collected data was filtered, assessed, and arranged in an interesting manner that mingles the historical information with the scientific one.

Results and Discussion

Published Researches in the 18th and 19th centuries

In 1711, a surgeon at Helmstedt, Lorenz Heister realized that appendix could be the suspected structure in acute inflammation [4].

In 1736, Amyand a surgery professor at Saint George's hospital was the first physician who performed appendectomy to eleven-years old boy associated with hernia in his scrotum. Amyand discovered that the appendix was perforated within the sac of scrotal hernia [1].

In 1742, Leonardo Da Vinci regarded as the first individual who described the human vermiform appendix that found in his illustrations or drawings. He referred it as «Erecchio» which means "ear» to signify it as an auricular-shaped appendage emerged from the caecum [5].

In 1883, Fergus the first Canadian surgeon did an elective appendectomy [6].

In 1886, Reginald Fitz a pathological anatomist at Harvard University was the first who used the term «Appendicitis» because he recognized that the appendix is the primary suspected cause for acute inflammation at the right lower abdominal quadrant [2].

In 1889, the great surgical procedure discovered by Charles McBurney who described the characteristic McBurney's point as the most tender area when palpated the abdomen by the adult fingertips as one-half to two inches above a line imaginary drawn from right anterior spines process of the ilium to the umbilicus [7].

In 1890, Treves FA defended the conservative approach for acute appendicitis by appendectomy following subsiding of the infection [6].

In 1895, Berry RJA examined the appendicular length for one hundred human cadavers and his results were ranged from 3.1 to 13.3 cm, the length average was 8.3 cm, and the diameter average was recorded 0.6 cm at its base [8].

Published Researches in the 20th century

In 1901, Oschner AJ an American surgeon suggested the conservative management for each patient diagnosed with perforated appendix causing generalized peritonitis in order to permit surgical operation after period of time [3].

In 1904, Hedinger mentioned the appendicular diverticulum [6].

In1905, Hurdon and Kelly explained the arterial supply of the appendix in details. In 66% of cases the distal three-quadrants of the appendix was supplied with the main appendicular artery and the proximal one-quadrant was supplied by the accessory appendicular artery [2].

In 1913, Deaver reported that longest human vermiform appendix was 23 cm and the shortest was 1 cm in length and the diameter was approximately 0.6 cm in a morphological study for the vermiform appendix of 200 human cadavers [9].

In 1915, Gladstone recorded the agenesis of the vermiform appendix, while Schrup discovered the left-sided appendix [8].

In 1917, Macphil examined 220 cadavers to study the appendicular morphology and he recorded 9.9 cm as its average length, 6 mm as its average diameter, also mentioned that it is shorter in females than males [2].

In 1923, Wakeley and Gladstone recorded the different appendicular positions of 3000 cadavers with 65% as retrocolic and retrocaecal, 31% pelvic, 2.26% subcaecal, 1% preileal, 0.5% postileal, and 0.05% ectopic. The retrocolic and retrocaecal was the commonest position. In retrocolic appendix, its mesoappendix was very short. A short mesentery keeps the appendix attached to the posterior border of the ascending colon and caecum [5].

In 1931, Donald Collins studied 4680 specimens of appendix and reported 8.21 cm was its average length, and according to the appendicular position, 50% was pelvic, 21.5% retrocaecal, 1.24% subcaecal, 1% preileal, 0.71% post-ileal and 1% ectopic [9].

In 1933, Wakeley who analyzed 10,000 cases of human appendix mentioned that the most common site was the retrocaecal position with 65% followed by 31% pelvic, 2.26% subcaecal, 1% preileal and 0.4% postileal. A short mesentery keeps the appendix attached to the posterior border of the ascending colon and caecum [2].

In 1941, Waugh observed the first case of duplicated appendix and the cavity of each one was in communication with the other [10].

In 1945, Shah and Shah mentioned the arterial supply pattern in seven types [6].

In 1951, King and Singleton recorded a rare case of constant vitellointestinal canal continuous with the appendix, while in 1954, Douglas reported a case of the whole right side of colon was congenitally absent as well as the caecum and its appendix [8].

In 1960, Maisol observed the numerous sites in various individual aged groups and discovered some abnormalities that were common among children [11].

In 1970, Solanke studied the morphological characteristics of VA in Nigerians population. The pelvic site was the most common and the cause of relatively rare appendicitis among Africans may be results from the double arterial supply and blood anastomosis at the mesoappendix [12].

In 1971, Grosfeld et al described the use of an appendicular grafting in dogs [13].

In 1976, Weinberg was the first who use VA tubing instead of the ureter as long-time patent and functional tubal structure [6].

In 1979, Katezarski analyzed the morphological appearance and the arterial supply of VA in 103 Zambian cadavers. He recorded 43.6% was pelvic, 20.3% retrocaecal, 20% retro colic, and 16% for other sites. Its average length was 12 cm in males and 11.9 cm in females. Double arterial supply was in 39.8%. He concluded that the pelvic site was commonest and the double arterial supply could be the cause of rare appendicitis among Africans population [14].

In 1980, Pense and Bax reported a rare case of perforated VA in neonate child [15].

In 1980, Mitrofanoff mentioned the using of VA as a persistent vesicostomy by creation of a cannel for the catheter to pass between urinary bladder and the abdominal wall [6].

In 1983, Abramson and Daniel recorded a rare case for aberrant VA situation that lied within the posterior caecal wall and below the serosa [8].

In 1983, Ajmani and Ajmani analyzed the site, length and arterial supply of VA among 100 Indians. The site was 68% retrocaecal, 20% pelvic, 10% postileal, 1% preileal and 1% other sites. Its average length was 9.5 cm in males and 8.7 cm in females. Dual appendicular arterial supply was in 39%. He mentioned that the postileal site in Indians could be in association with some complications like the intestinal obstruction [16].

In 1989, Gupta et al was the first who use the VA in biliary atresia. The principal complication of such patient might be the postoperative cholangitis because of the main role of the lymphatic follicles in the appendicular wall [5].

In 1991, Karim et al studied 50 cases for the VA positions; he found 59% pelvic, 15% umbilical, 11% inguinal, and 20% in right iliac area. Accurate site determination of the base of VA could affect the incision level for appendectomy [1].

In 1993, Ramsten et al studied the association between the base of VA and McBurney's point and he observed that in 75% cases the VA base was medial and about 5 cm from this point, while in 20% cases, the VA base located also medial but at about 10 cm from McBurney's point, whereas in the rest 5% cases, the VA base sited lateral to McBurney's point [6].

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In 1994, Lobert et al mentioned the use of VA mucosa in urethroplasty [10].

In 1996, Michael et al implemented cholecystoappendicostomy in Alagille syndrome child. He made a partial biliary deviation by the use of VA as a tube connecting the gallbladder to the skin of anterior abdominal wall. The lumen of VA is closer in diameter to the biliary free but cannot accumulate considerable bile amounts and has very small stoma [3].

In 1996, Val Bernal et al published a rare case of VA torsion in six-year old child that situated in the pelvis with abnormal VA length 13.5 cm. The authors suggested that abnormal length VA occupied the pelvic situation could be the principal factor causing torsion [10].

In 1997, Yasaka Okado did a renal reconstruction by the use of VA as a tubal conduit in twelve individuals suffered from pelvic tumors. The VA used as a channel from the ureter to the skin by the continent vesicostomy or modified Mainz pouch. By VA conduit an easy catheterization and complete continence may be obtained. On the other side, in 1998, Simforoosh et al utilized an unchanged insitu appendicular tube for continent renal diversion in nineteen patients. This technique is effective, safe, and time saving compared to other related methods [6].

In 1999, Warille and Bakheit analyzed the abnormalities of VA in Saudi Arabia population; he found that 58.3% was retrocaecal in position, 1.7% pelvic, 10% postileal, 2% preileal and 8% other situations [2].

In 1999, Rebhandl et al used VA conduit to treat the biliary diversion (Choleocystoappendicostomy) of a child with progressively intrahepatic cholestasis. The modified Mitrafanoff's technique can be used to drain the gallbladder in patient with Byler disease. The VA gives an isoperistaltic vascularized, epithelialized conduit with very small diameter compared to jejunum and maybe separated more simply than jejunum [17].

Published Researches in the 21th century

In 2001, Dubois et al reported the use of the caecoappendicular tubal conduit for continent renal diversion cases; Also Retten et al analyzed the external diameter of VA at its base to exclude acute appendicitis among 278 individuals, and he mentioned that if the external diameter greater than 6 mm, it indicates that the susceptibility of appendicitis occurrence will be higher [18].

In 2001, Kajbafzadeh et al performed a synchronized Malone Antegrade Continent Enema (MACE) with Mitrafanoff principle for continent renal diversion in forty cases. All included individuals had anti-refluxed Mitrafanoff conduit established using the terminal portion of the VA with its split mesothelium if the VA length about 9 cm or even more. It confirmed precious to treat children who have urinary incontinence with low prevalence of stomal complication conditions [19].

In 2002, Singh et al recorded clinical significant variations between the situation of VA base and the McBurney's point. The VA base was the cephalic in 67%, caudal in 32% and 1% only on it [2].

In 2002, Shah AA and Shah AV performed operative procedures for three children suffered from extrahepatic biliary duct atresia by utilizing VA as biliary conduit. They described these operations as simple, minimum time consumption, and carried out an anatomic structural reconstruction that is closely similar to normal [8].

In 2002, Delic et al reported numerous variations in the site and origin of VA in about 500 Croatian cadavers. The pelvic position was the commonest [18].

In 2002, Ferri et al recorded the average diameter of VA in 200 cadavers was 6.5 mm, while the wall thickness was 2.5 mm, 5% of cases revealed diameter variability throughout the same VA length [5].

In 2003, Golalipour et al carried out a study on 117 Iranian cadavers, and he reported 6.61 cm as an average length of VA in males and 6.06 cm in females. The VA sites were in 33% pelvic, 32.4% retrocaecal, 32.4% retrocolic, 18% preileal, 12.8% subcaecal and 2.6% postileal. The mesoappendix extends up to VA tail in 34.2% but failed to do so in 65.8% [6].

In 2004, Wall bridge and Cave classified the duplicated VA into 3 groups Type I: partially duplicated VA sited on a caecum, Type II: one caecum with 2 completely split VA, and Type III: characterized by 2 caecum each with its separated VA [8].

In 2005, Shah and Shah treated 6 children with choledochal cyst by using the VA as a biliary tubal conduit. After mobilizing the VA on the vascular side, a tunneled anastomosing was created with the second duodenal portion and VA. No cholangitis postoperatively recorded after two years following up [19].

In 2006, Chen et al carried out a modern procedure for voice reconstruction by VA usage, when 3 patients undergo free transport of VA to create tracheaoesophageal fistula. This procedure had a potential functional role but needed more refinement and experience [6].

In 2006, Cleg-Lamptey et al tested a hypothesis on the retrocaecal VA to minimum inflammatory susceptibility performed by a retrospective survey. The retrocaecal VA site was commonest among both female and male autopsy cases as well as among inflamed VA, compared to non-retrocaecal site previously was susceptible to inflammation [20].

In 2006, Griffith et al recorded a case of bifid VA in young male; one was totally gangrenous with no mesoappendix, while the second VA seemed normal with a mesoappendix [13].

In 2006, Pathak and Sarin reported a case of VA torsion in nine years old boy. The VA was 8 cm in length, retrocaecal in position, and with 270 degrees clockwise torsion [15].

In 2006, Uriev et al recorded the first case report of triple VA. It was barrel type with 5.5 cm long, 1.6 cm diameter and the cut-section revealed 3 small lumina connects the base to tail [2].

In 2008, Thakre et al represented a robot assisting Mitrafanoff with Malone Antegrade urinary continence by enema reconstruction using divided VA in child case. The VA stumps by the caecum as an ideal cannel synchronized with VA of nine cm or even more with branched mesoappendix [21].

In 2009, Mejia et al recorded a VA absence in middle aged male performed a colonoscopy; he reported it as

type IV Collins appendicular agenesis throughout the mesenteric adenitis. Also, in same year, Paul et al studied the VA positions of 60 cadavers, which showed the commonest situation was retrocaecal with 65% and followed by pelvic then postileal, but the preileal and subcaecal were not recorded. However, in order to determine the VA sites, sonographic facilities were recommended [6].

In 2009, Rehman et al mentioned the mesoappendix extension and the VA anatomical situation variations in Bangladeshi individuals. The most common site in both genders was the pelvic position. In males, the whole extended or the two-thirds mesoappendix were the commonest in male cases with the pelvic site commonly reported among them. The mesoappendix extension to about two-thirds of the whole VA length was 45% and seen more commonly in the pelvic site. More than 50% showed two-thirds extended mesoappendix, while 15 cases revealed whole extension; this extension is in charge of VA vascularization and the degree of severity in the course of inflammation [22].

In 2010, Ninos et al discovered a horse-shoe VA in a case with non-specific abdominal cavity pain previously diagnosed with Non-Hodgkin lymphoma. Besides, in this year, Calota et al also recorded a horse-shoe VA approximately 13 cm in length in case of bowel obstruction. This abnormality maybe a result of the insistence of temporary embryologic second VA [23].

In 2010, Hosseini et al performed an appendicular conduit in treatment of biliary atresia case accompanied with partial bowel atresia in very young boy. Therefore, to overcome the biliary atresia, an appendicoduodenostomy procedure was achieved as a second surgical procedure that preventing refluxes cholangitis as well as saving the whole small intestine [17].

In 2010, Rink et al approved catheterized sacs in renal diversion for urinary bladder cancer individuals particularly those with carcinoma in situ; also the female patients may use VA stoma. More than 95% were recorded as satisfactory continence for almost all techniques, whereas the life quality was similar to orthotropic continent diversion [16].

In 2011, Chua et al mentioned the Malone Antegrade continence enema might be used in chronic constipated pediatric cases of unknown or idiopathic causes. MACE procedure or open laparoscopy simply performed if accompanied with VA conduit [3].

In 2011, Ahmadpour et al represented a rare case of sub-hepatic VA in a macrosomic baby of diabetic mother. This condition of sub-hepatic VA found in association with other abnormities like the maldescendant of the caecum, the intraperitoneal position of the ascending colon, and the retroperitoneal situation of the ileum [20].

In 2011, Prabhasubhash and Geetanjali done a study on 52 cadavers and found the highest prevalence of VA was in the pelvic position with 36.54%, then 33% was a retrocaecal. He recorded 6.47 cm as an average length of VA for male cases and 5.34 cm for females with a statistical significant difference among both genders. The mesoappendix revealed obvious extension and reaches the VA tip in 69.23% whereas in the rest 30.77% failed to do so [6].

In 2011, Kulkarni et al reported that the accessory appendicular artery supplies the VA tip which may reduce the gangrenous possibility in appendicitis and provides good amount of immunological factors during appendicitis infection [13].

In 2012, Ashindoitiang et al presented the highest prevalence of acute appendicitis recorded in young age Nigerians who originated from two major population, and commonest among Yosubas was retrocaecal position with 51%, while in Ibos both pelvic and retrocaecal positions were the commonest with 28%. The VA average length was 11.5 cm with more than about 0.4 cm in male cases and the mesoappendix extension had no obvious influence [2].

In 2012, Sarcar recorded a rare case of VA agenesis in cadaver of sixty years old male, which suggests that VA might absent or become rudimentary at its final fate [11].

In 2012, Veeresh et al performed a study on 52 human autopsies for the VA arterial supply and found 23% of the cases were with abnormal appendicular arterial supply. In 46.15%, the origin of appendicular artery was from the inferior branch of ileocolic artery, while in 30.76% originated from the ileal branch, and in 19.23% was directly originated from the ileoclolic artery. Many anastomoses revealed between the appendicular artery with the ileal, posterior caecal, and common caecal arteries [8].

In 2012, Sharma et al recorded a bifid VA case, one was 2.3 cm and the second 1.8 cm arose from VA stump base and about 6.5 cm in length with a normal appendicular artery within its mesoappendix [6].

In 2012, McKiernan and James stated that the continent renal diversion was strongly accepted by the patient and surgeon in the urinary reconstruction procedure proceeded by cystectomy. Orthotropic urethral anastomosis procedure and the continent catheterized stomal reservoir could be investigated for all suspected patients. Four specific technical procedures had been used to produce a dependable catheterized continence area or zone including the appendicular technique, the right colon pouch, the ileocaecal vulvar plication, and psedoappendicular tube, but the appendicular tunneling procedure stills the simplest among all known techniques and stay with a reliable and attractive continence method [24].

In 2012, Sabiston et al mentioned the commonest site of VA was the retrocaecal followed by pelvic position. The VA length ranged 2-20 cm with 9 cm as an average length in adult cases. The VA tip can be found at various positions; this variation might clarify the numerous symptoms that associated with the inflamed VA [19].

In 2013, Bailey and Love's recorded the VA site was postileal in 0.5%, preileal in 1%, subcaecal in 1.5%, paracaecal in 2%, pelvic in 21%, and the commonest was the retrocaecal in 74%. The VA average length ranged 7.5-10 cm [8].

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In 2013, Settee et al carried out a morphometric study about the human caecum and VA in Indian cadavers. This study demonstrated that the commonest site was the retrocaecal in both adult and fetal cases; the VA length was longer in male adult and fetal cases than those of female cases; and the average width of VA also greater in male adult and fetal cases than those of female cases [11].

In 2013, Reshma et al examined the morphometric parameters and the morphological characteristics in human fetal VA at various gestational age groups by dissecting the aborted fetal cadavers with age ranged 18-41 weeks. In this study; an equal prevalence for the right iliac fossa and subhepatic recorded both was 40%, while 20% for right lumbar site. The subhepatic site was the commonest in male cases, while the right iliac fossa was the commonest in female cases, and the right lumbar site was equal between the two genders. According to VA base site related to the caecal wall, the posterior wall reported the higher score. The percentage of VA site that medially located to McBurney's was approximately twice time more than that of laterally located to it. The VA orifice situated at the McBurney's point was more prevalence in female cases than male cases. The VA tip direction that pointed downward was the commonest type in about 47%. The commonest site of VA was the postileal in 37%. The VA length increased proportionally according to the fetal age, but in general it was longer in males compared to females; on contrary, the VA diameter was broader in the female fetal cases than males [25].

In 2013, Manisha et al carried out a study on the morphological features of VA in 200 human cases. The commonest site found was the retrocaecal in 55% of male cases and 56% of females; while the least common site was the subhepatic (0.007%) in males, and the paracaecal (0.04%) in females. The VA average length was 5.6 cm and the average width was 7 mm in males, while in females was 5.4 cm and 6 mm respectively. Determination of the different VA sites was important to realize the possible results of appendicitis due to particular situation of the pain [8].

In 2013, Boddeti et al recorded a rare case of VA with 28 cm long situated retrocaecal. This might be highly susceptible for medical conditions including torsion, appendicitis, enteritis, peritonitis, salpingitis and so on [24].

In 2014, Rao and Mohammad studied the possible variety in the arterial supply for the VA. This study revealed a branch from inferior part of the ileocolic artery passed in front of the terminal end of ileum to enter the mesoappendix then directed towards the VA tip and located on the appendicular wall. Also, another accessory artery originated as an obvious recurrent artery at the free margin of the mesoappendix to anastomose with the posterior caecal branch [13].

In 2014, Panda et al recorded a case of double VA in Meckel's diverticulum in young man. Associated abnormalities or duplicated large intestine or genitourinary system can be existing particularly in type C and B1 regarding to the Wall Bridge Modified Classification [6].

In 2014, Makandar and Patil carried out a study on South-Indians about the length, site, and arterial supply of VA. The commonest site was the retrocaecal with 20%, 7.5 cm was the VA average length in male cases and 6.0 cm was in females; in 99% cases, the arterial blood supply was similar in both genders from the inferior branch of the ileocolic artery, while the rest 1% from the arterial loop [2].

In 2014, Mwachaka et al reported the differences in the length and site of VA in 48 Black-Kenyan cadavers. The most common type was the retrocaecal in both genders, the subileal and pelvic with 36.4%. The longest VA was a paracaecal type with 110 mm, while the shortest was subhepatic with 63 mm. The VA length was 76.5±23.6 mm, and the average length of spinoumbilical line that drowns across the anterior superior iliac spine and umbilicus was 158.3±17.9 mm. In 52% of cases, the VA base was situated straight over this line [11].

In 2014, Ghorbani et al performed a study on 200 Indian cadavers concerning the anatomical site of VA. The pelvic site was the commonest site with 55.8% and the preileal was the least with only 1.5%. In male cases, its mean length was 91.2 mm and 80.3 mm in females. In 79.5% of total cases, the mesoappendix was complete but it revealed incomplete in only one age-group that under ten years. No significant statistical association was recorded between the gender and the anatomical site of VA [8].

In 2014, Das et al accomplished a study on 16,128 Indian individuals about the VA site, and recorded the retrocaecal was the most common site with 51% and the ectopic was the least common with 0.03%. In male individuals, the retrocaecal site represented 56% as the commonest site, on contrary; the pelvic site represented 48% as the commonest site in female cases. This study also mentioned that the pelvic site in the vegetarian persons and the retrocaecal in non-vegetarian persons were the commonest found sites [26].

In 2014, Salwe et al carried out a research on 60 cadavers at western Maharashtra area in India to study the morphological appearance of VA and caecum. The most common site was the retrocaecal position in both genders, 23% in males and 33% in females. The VA average length was 5.93 cm but the average external girth was 2.8 cm, and the average distance for VA from ileocaecal junction was 2.47 cm [19].

In 2015, Srinivas and Suyakumari carried out a study of 62 fetal cases. The most common site was the retrocaecal in 29.5% followed by paracaecal in 19.67%. In 91.8%, the mesoappendix was complete and only one case with VA agenesis was recorded. The origin of VA from the posteromedial border was higher than that from the medial wall in approximately 85.24% of fetuses. The average length of VA was 24.1 mm and the width was 2.67 mm. The appendicular artery originated mainly from the lower branch of the ileocolic artery [8].

In 2015, Malarski presented a rare case of the size and site of VA in seventy years old man. This VA was retrocaecal, retroperitoneal and nearby to the liver. Its length was about 16.3 cm and the width was 0.8 cm. This case was very interesting for the surgical proce-

dures because the direction of the descending colon was to the right and sloping toward caecum. The abnormal site for the mesoappendix and colon maybe clarified due to the common developmental origin of both [20].

In 2015, Umamaheswara et al performed the differences in situations length, width of VA, extension of mesoappendix and the blood supply in fifty cadaveric cases. The commonest site was the retrocaecal in 66% but no paracaecal site recorded. The average length of VA was 77.2 mm in male cadavers, and the width was 12.4 mm. While in females, the average length of VA was 69.3 mm and the width was 10.8 mm. In 34.1% of all cases, the mesoappendix extension was complete but in 66% failed to extend to its tip. A single appendicular artery was in 70% of studied cadavers and two appendicular arteries were found in 30% [6].

In 2015, Swargam et al studied the prevalence of numerous VA and caecum sites that play an important role in surgical procedures performed in complicated caecoappendicular sites. The commonest site was the retrocaecal in 44% followed by the subcaecal site 18% [19].

In 2015, Sugunkara and Naik recorded a case of situs inversus totailis in adolescent male with left-sided VA who undergo laparoscopic appendectomy [26].

In 2016, Ashalatha et al reported the VA average length of male cases was 6.56 cm and ranged 2.2-11.5 cm, while of female cases was 4.58 cm and ranged 3.3-6.2 cm. In males, the VA length was longer than females. In adults, the VA average diameter that located at its base was 0.5 cm and ranged 0.3-0.8 cm. Also in adults, the average distance from the ileocaecal valve to VA was 1.65 cm, ranged 0.42-3 cm but in fetal cases was 0.39 cm, ranged 0.2-0.8 cm. The commonest position for adults was the pelvic site with 57.6% and for fetal cases was the paracaecal site with 39%. In 19 cases of this study, the mesoappendix extension was complete but in 14 cases was incomplete. In all adults, only one appendicular artery observed to arise from the lower branch of the ileocolic artery [27].

In 2016, Naik and Patel analyzed the information of 50 cadavers about the VA length. In 92%, the normal VA ranged 2-20 cm and its mean length was 6.9 cm. The shortest VA was 1.5 cm and found in 4%, while the longest was 21 cm and also found in 4%. The identification of VA relative length affects the diagnosis time of acute appendicitis case [28].

In 2016, Bharti et al A carried out a histological and morphological study on the VA in human beings, goats and rabbits. This study determined ratio of VA length of humans to rabbits was 0.87, and the most common site was the retrocaecal in humans. This study concluded that the histological and morphological differences were recognized in the VA and caecum of human, rabbit and goat might be due to the various food habits [13].

In 2017, Kaneko et al reported a case of appendicular giant gastrointestinal stromal tumor with sized more than 22 cm with a peritoneal metastasis which was managed by imatinib and laparoscopic surgical procedure [6].

In 2018, Vass et al reported that diverticulitis of VA maybe with clinical symptoms same as acute appendicitis [8].

In 2019, Knol et al reported a rare case of middle aged female patient with VA torsion due to a mucocele that undergo diagnostic laparoscopy to manage this case [2].

In 2020, Papaconstantinou et al found that Amyand's hernia which is a very rare kind of inguinal hernia complicated to a case of appendicitis. He stated that this type of hernia reconstructed by tailoring each case individually according to extension of the inflamed inguinal canal [29].

In 2020, Drumond et al reported a 32 years old patient confirmed the diagnosis of him with appendicular endometriosis. The primary role for management of this case was laparoscopy with appendectomy [30].

Conclusion

Appendicitis is a common clinical condition caused by multiple factors and etiopathogenetic mechanisms. The historical steps of the human vermiform appendix discovery including its morphology, anatomy, blood supply, and other aspects were essential to understanding the real function and summarized this information that positively impacts the clinical decision in case of appendicitis. The discovery of recent procedures was important in the selection for the more effective surgical procedure.

From a historical point of view, this review approaches recognizing the pathogenesis that can provide better ideas to solve the vermiform appendix problems. Therefore, this article is entirely established on previously performed studies so that no new studies on animal or human subjects were conducted by the author.

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