

Appendix Positions and their Clinical Implications: Literature Review

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Abstract: *Anatomical variations of the appendix cause most unforeseen events in appendectomies, in addition to other surgeries, and are related to atypical clinical. To present the anatomical variations of the appendix and their clinical, diagnostic and therapeutic repercussions, based on a systematic literature review, carried out in the PubMed database in March 2021, using the descriptors: "appendix", "appendiceal", "variation", "anatomical", "abnormal position" and "appendicitis". Studies published between 2012 and 2021 that presented appendicular anatomical variations were included, and after excluding those that did not report clinical, diagnostic and/or therapeutic aspects, 5 studies were selected. In cases of mobile cecum, there may be atypical clinical and diagnostic difficulties, with computed tomography (CT) being useful; of intracecal appendix, the usefulness of CT has not been established; of the lateral pouch type, in addition to the variable clinical, difficulties in laparoscopy; and appendix duplication should be considered as a differential diagnosis even if reported previous appendectomy. Cecum and appendix's anatomical variations may be related to the atypical clinical of acute appendicitis or concomitant visceral anomalies, being knowledge of the variations, CT and surgical inspection useful in the location's identification of cecum and appendix, avoiding diagnostic, conduct and manual inability, severe complications and judicial demands.*

Keywords: Appendix, Appendix cecal, Vermiform appendix, Anatomical variation, Appendicitis

1. Introduction

Acute appendicitis is described as the most common surgical abdominal emergency in developed countries. The various anatomical variations of the appendix, mainly observed in adults, although rare, are the cause of most of the unforeseen events found in appendectomies, in addition to being observed in other surgical procedures (CHAUHAN and ANAND, 2017; DUBHASHI et al, 2013)

The position of the appendix can vary widely in relation to the cecum or its mobility. Among the anatomical variations related to the appendix, there is the mobile cecum, a congenital anomaly, whose recognition of this atypical location of the cecum can influence the diagnosis of appendicitis. Another variation is the intracecal appendix, reported for the third time in 2017, after case reports in 1972 and 1983. The lateral pouch appendix is also reported, located between the cecum and the abdominal wall, with the base of the appendix in the posterolateral wall of the cecum. One can also observe vermiform appendix duplication or appendicular duplication, which should be considered as a differential diagnosis of lower abdominal pain, even if there is a report of previous appendectomy (CHAUHAN and ANAND, 2017; DUBHASHI et al, 2013; NAYAK et al, 2014; TOPRAK et al, 2012; YAZAWA et al, 2018).

Although the diagnosis of acute appendicitis, in general, is based on the clinical condition and laboratory exams, in

patients with anatomical variations of the appendix there are atypical clinical conditions, such as suprapubic pain or others located far from the McBurney point, which may determine the relevance of imaging tests in diagnosis and treatment (NAYAK et al, 2014; TOPRAK et al, 2012; YAZAWA et al, 2018).

Thus, knowledge of the anatomical variations of the appendix and its respective development is important in understanding the pathophysiology, diagnosis and decision-making in the treatment of acute appendicitis (NAYAK et al, 2014).

2. Literature Survey

The aim of this study is to address the anatomical alterations of the appendix, due to their importance in determining atypical clinical aspects in cases of acute appendicitis, guiding the diagnosis and treatment.

3. Methodology

This is a narrative review of the literature, for which a search was performed in the PubMed database, during the month of March 2021. PubMed was chosen due to the breadth and relevance of the database in terms of dissemination knowledge in the area of health. There was a delimited period, considering the studies published between 2012 and 2021, in order to provide the reader with updated data. To

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select the search descriptors, words from the Medical Subject Heading Terms (MeSH) dictionary were used. The descriptors used, in English, were "appendix", "appendiceal", "variation", "anatomical", "abnormal position" and "appendicitis".

The inclusion criteria were studies published between 2012 and 2021 that presented appendicular anatomical variations, and studies that did not address anatomical and clinical, diagnostic or therapeutic aspects were excluded. Initially, 22 articles were identified and, when the exclusion criteria were applied, 5 studies were found.

Following the inclusion criteria, articles were selected (n = 5) to analyze the results, as shown in the flowchart in Figure 1.

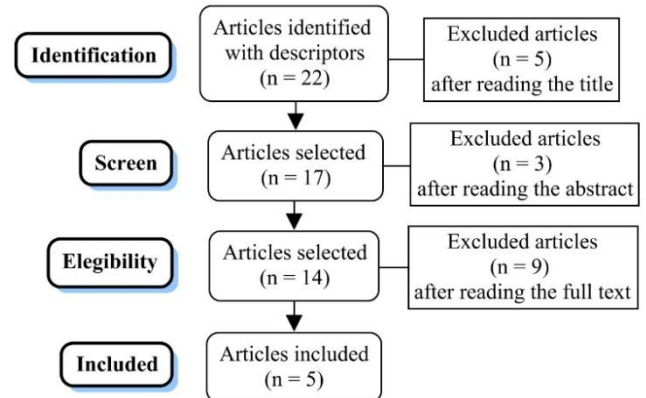


Figure 1: Explanatory flowchart of the article eligibility process

4. Results & Discussion

The articles included were organized in an Excel spreadsheet, in descending chronological order of publication. After the distribution in Excel, there was data analysis and description.

Table 1: Name of the article, authors and conclusion

Article	Authors	Conclusion
<i>Abdominal CT - aided diagnosis of acute appendicitis in the presence of mobile cecum: A case report.</i>	YAZAWA, Kentaro et al	Acute appendicitis with mobile cecum may present atypical clinical manifestation (in location or tenderness) and an imperceptible diagnosis. Mobile cecum is not uncommon and should be considered in the differential diagnosis of acute abdomen. CT is indicated for inconclusive acute abdomen evaluation.
<i>Intracecal appendix: an extremely rare anatomical variation. A case report and review of literature.</i>	CHAUHAN, Sushila; ANAND, Sunil	The anatomical variations of the appendix are rare and little reported in the literature, surgeons should know the possible ones to be found in surgeries, being more skillful in the evaluation and management, for example, of the intracecal appendix, with no established CT value for this.
<i>Lateral pouch appendix associated with retroperitoneal terminal part of the ileum: a potential diagnostic and surgical challenge.</i>	NAYAK, B. Satheesha et al	The lateral pouch type is a rarer appendicular positional variation compared to other variations reported in the literature, with a possible atypical clinical manifestation and presenting greater difficulty for surgeons in laparoscopy.
<i>Double appendix.</i>	DUBHASHI, Siddharth P. et al	Surgeons should be aware of potential anatomical variations of the appendix and carefully inspect the cecum at laparotomy. The appendix duplication should be considered in the differential diagnosis of lower abdominal pain, even if there is previous appendectomy. Incorrect diagnosis can cause serious complications, life-threatening to the patient and medico - legal demands.
<i>Diagnosis of appendicitis in patients with abnormal position of the appendix due to mobile caecum.</i>	TOPRAK, Huseyin et al	In patients with abdominal pain and atypical clinical manifestation, imaging tests, especially CT, are useful in identifying the location of the cecum and appendix, avoiding incorrect diagnosis.

The influence of knowledge of potential anatomical variations of the appendix on diagnostic and therapeutic assertiveness demonstrates the relevance of the present research, which is important for presenting current knowledge and signaling the relevance of scientific deepening in anatomical aspects of the appendix.

YAZAWA et al (2018) presented a case of acute appendicitis in a 48 - year - old man, diagnosed after performing CT for peritonitis. The patient had mobile cecum, a prevalent condition that should be considered in the differential diagnosis of acute abdomen.

According to YAZAWA et al (2018), in the presence of a mobile cecum, there may be an atypical presentation of acute appendicitis – in terms of location and sensitivity – due to the abnormal position of the appendix, with the

possibility of misdiagnosis of the cause of the acute abdomen.

Thus, it is important to recognize the mobile cecum, based on a high index of suspicion of this condition, and CT as the imaging test of choice in inconclusive acute abdominal conditions.

Regarding appendicular variations due to mobile cecum, TOPRAK et al (2012) report a 32 - year - old patient hospitalized due to constant generalized abdominal pain complaint, without irradiation for a day and, on physical examination, tenderness in the upper left and lower quadrant with voluntary custody. Ultrasonography (US) showed thickening of the colon wall and did not show gynecological changes or signs of appendicitis in the right lower quadrant. Intravenous contrast - enhanced CT, requested to rule out

other diagnostic hypotheses, showed a tubular structure of 15 mm in diameter consistent with appendicitis located posteroinferiorly to the cecum, extending inferomedially to the umbilical scar. At surgery, a median incision was made from the epigastric to the suprapubic region, and the CT findings were confirmed.

In another case, of a 21 - year - old patient, hospitalized after complaining of suprapubic pain for 12 hours, with sensitivity in the right lower quadrant and in the suprapubic region with mild voluntary guarding, CT revealed pelvic location of the cecum and posterior tubular structure of 16 mm in diameter consistent with appendicitis, the base of the appendix being located in a retrovesical pouch with the tip directed towards the iliac vessels. During surgery, a McBurney incision was made, and the mobile and pelvic cecum were identified and the characteristics of the appendix were confirmed.

Therefore, the importance of tomographic findings of the cecum and appendix with an atypical location associated with acute appendicitis is described. TOPRAK et al (2012) also pointed out that, to identify the abnormal location of the cecum, barium studies can be used, which, however, in patients with clinical acute abdomen, can delay the diagnosis and result in peritonitis in perforation case.

Furthermore, TOPRAK et al (2012) infer that US has high diagnostic sensitivity and specificity in acute appendicitis. In cases of normal appendix not identified with US, CT should be used for diagnosis. However, in the presence of mobile cecum, there may be diagnostic errors – sigmoid diverticulitis, tube - ovarian abscess, infected urachus, mesenteric or duplication cyst, and Meckel's diverticulum.

According to CHAUHAN and ANAND (2017), most variations identified in appendectomies are due to the position of the tip of the appendix, which, although normally retrocecal, is dependent on the length of the appendix, the degree of cecal descent and peritoneal fixation, cecum configuration, associated adhesions, and the patient's habitus. In cases of intracecal appendix, although CT is establishing itself as the gold standard in the diagnosis of acute appendicitis, which can provide information on variations of the appendix, it is very difficult to identify positional variations, with most of the appendicular variations found on CT due to abnormal positions of the cecum. Therefore, the value of CT in detecting intracecal appendix is unknown and unreported.

Appendix duplication is also described by CHAUHAN and ANAND (2017), who consider the incidence of appendix duplication to be rare, on the other hand, they mention that this incidence is a little less rare when compared to the incidence of absence of the appendix and of ectopic appendix. The study considers the Wallbridge classification in use, based on the one elaborated by Cave, containing types A, B (subdivided into B1 and B2) and C, as cited by Wallbridge (1963).

The authors infer that, after insertion of CT and laparoscopic surgery, publications related to anatomy showed a marked reduction. However, the lack of tactile feedback

characteristic of laparoscopy supports the importance of knowledge about appendicular anatomical variations. Therefore, it is suggested that the surgeon pay attention to the anatomical variations of the appendix in order to provide greater skill in handling them during surgery.

NAYAK et al (2014) describe positional variations of the ileum, cecum and appendix in a male cadaver, with the appendix located posterolaterally to the cecum, configuring the lateral pouch type. The fixation of the mesoappendix to the anterolateral wall of the cecum was also identified. It is therefore an extremely rare case of variation in the position of the appendix.

Regarding the implications of this anatomical configuration in cases of acute appendicitis, there could be pain located laterally to the McBurney point and a greater degree of difficulty during laparoscopic surgery, considering the limited visual field.

NAYAK et al (2014) emphasize the high positional variation of the tip of the appendix: retrocecal (65.3%), pelvic (31%), subcaecal (2.3%), pre - ileal, lateral pouch, mesocolic, left, intra - herniary, lumbar (1%) and post - ileal (0.4%). The knowledge of the development and possible variations of the appendix influences the understanding of its pathophysiology, the identification of appendix malformations associated with other visceral anomalies and the treatment of acute appendicitis.

DUBHASHI et al (2013) report a case of appendix duplication in a 24 - year - old woman complaining of pain in the right iliac fossa for 2 days, associated with nausea, emesis and intermittent fever, with no change in bowel habits. On physical examination, the patient reported sensitivity in the McBurney point and a positive Blumberg sign. The blood count showed leukocytosis and US was performed, showing a dilated, non - compressible and thickened appendix. During surgery, a McBurney stitch incision was performed, identifying two appendages joined by fragile adhesions, followed by the removal of both and confirmation of double appendix in the histopathological examination. Regarding the classification of appendix duplications, the study refers to the one elaborated by Cave, in 1936, with subsequent modifications, containing, as mentioned by Mushtaque et al (2012), types A, B (subdivided into B1 to B4), C and D.

DUBHASHI et al (2013) state that appendix duplication should be considered in the differential diagnosis of lower abdominal pain, even if the patient reports previous appendectomy, in order to avoid misdiagnosis and consequent serious complications with life - threatening problems for the patient and medico - legal demands.

Surgeons must know the potential anatomical variations of the appendix, as well as carefully inspect the cecum during laparotomy. In cases with only one inflamed appendix, both must be removed to avoid further misdiagnosis. However, there is no need for appendectomy in the case of a duplicated, non - inflamed appendix found in another procedure.

5. Conclusion

The anatomical changes inherent to the appendix or due to the position of the cecum determine atypical clinical manifestations, in addition to a possible association with other visceral anomalies, in cases of acute appendicitis, denoting the importance of: suspecting these changes that cause clinical symptoms and variable findings, respectively, in the anamnesis and physical examination; and use CT in preoperative diagnosis and in choosing the appropriate treatment, regarding the incision, for example.

Therefore, anatomical variations must be recognized in order to avoid incorrect diagnoses and conduct and consequent serious complications with risk to the patient's life and medico - legal lawsuits.

Surgeons should know the potential anatomical variations of the appendix for greater diagnostic accuracy during the clinical evaluation and prior knowledge of possible approaches to surgical procedures – it is noteworthy that variations can be identified in appendectomies and any other abdominal surgeries –, it should also be performed thorough inspection of the cecum during laparotomies.

6. Future Scope

It is suggested that studies be carried out to standardize the recognition and management of appendicular variations, as well as the development of more anatomical studies for the surgeons' knowledge of the positional variations of the appendix found in laparoscopic surgeries.

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