

Anatomical variations of the cecum and vermiform appendix: Basis for a new nomenclature for McBurney's points

Kabanga, T. K.^{1,2,3}, Kilara, T. K.⁴, Kapinga, B. M.¹, Kazadi, D. B.², Kabanga, A. T.^{3,6}, Kabanga, H. K.^{2,3}, & Kabongo, J. M.⁵

¹Department of Surgery, Sino-Congolese Friendship Hospital, Kinshasa, Democratic Republic of the Congo

²Anatomy Section, Department of Basic Sciences, Faculty of Medicine, University of Kinshasa, Democratic Republic of the Congo

³Good Pastor Hospital, Kinshasa, Democratic Republic of the Congo

⁴Pharmacology Service, Department of Basic Sciences, Faculty of Medicine, University of Kinshasa, Democratic Republic of the Congo

⁵Anatomopathology Department, Faculty of Medicine, University of Kinshasa, Democratic Republic of the Congo

⁶Department of Medical Imaging, University of Kinshasa Clinic, Kinshasa, Democratic Republic of the Congo

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Correspondence to:

Dr. Thomas Kabuya Kabanga

thomaskabanga@gmail.com

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ABSTRACT

Introduction

Appendicitis is one of the most common surgical emergencies worldwide, resulting from inflammation of the vermiform appendix attached to the cecum. Although pain is classically localised at McBurney's point, the lack of consensus regarding its precise position, as highlighted by the studies of Karim and Naraysing, continues to fuel diagnostic and surgical debate. These uncertainties emphasise the need for a clearer understanding of the anatomical variations of the cecum and appendix to improve clinical accuracy and surgical outcomes.

Purpose

To describe and analyse anatomical variations of the cecum and vermiform appendix in order to assess their topographical and clinical implications. It is hypothesised that these variations influence the location of McBurney's point and may affect diagnostic accuracy and surgical planning. The study also aims to propose a standardised anatomical nomenclature for McBurney's point, which could enhance its clinical and surgical relevance.

Methods

A prospective descriptive study on the vermiform appendix was conducted between January 2017 and December 2022 in three hospitals in Kinshasa. The sample comprised 160 patients, selected by non-probability convenience sampling, who underwent midline infra-umbilical laparotomy. Intraoperative observations were collected, entered into Excel, and analysed using SPSS v20.0. Proportions were compared using the chi-square test, with statistical significance set at $p < 0.05$.

Results

In the study population ($n = 160$), females predominated (115; 71.9%, sex ratio = 2.56), and younger subjects were overrepresented, with the 11–20-year age group being the most frequent (60; 37.5%). The iliac position of the cecum was the most common (95; 59.4%), and a mobile cecum was observed in 124 cases (77.7%). The appendiceal base corresponded to the midpoint of McBurney's line in 52 patients (32.5%). The appendix was mainly cylindrical (129; 80.6%), with a length between 7 and 12 cm in 86 patients (53.8%). The iliac position of the cecum predominated among patients aged 3–22 years (57; 35.6%), with a statistically significant difference ($p = 0.023$).

Conclusion

The study confirms the anatomical variability of the cecum and appendix. The cecum was predominantly mobile in the right iliac fossa, and the appendix, cylindrical and of medium length, often adopted a descending position. The appendicular base projected mainly on the umbilical–spinal line, justifying the use of the terms *mid umbilical–spinal point* and *lateral umbilical–spinal point*. These findings support promoting the laparoscopic approach to improve appendicitis management and reduce complications associated with anatomical variations.

INTRODUCTION

Appendicitis remains one of the most frequent surgical emergencies worldwide, with an estimated 17 million new cases reported in 2021 (*GBD 2021 Appendicitis Collaborators, 2023*). In sub-Saharan Africa, incidence rates are likely underestimated due to underreporting and limited access to care (*Adesunkanmi et al., 2023*). In the Democratic Republic of the Congo (DRC), adjusted mortality remains higher than in many countries, reflecting persistent diagnostic delays and surgical constraints (*World Health Organization [WHO], 2023*).

Anatomically, the base of the vermiform appendix is traditionally associated with McBurney's point, a key clinical landmark for both diagnosis and surgical approach (*McBurney, 2022*). However, there is no consensus on its exact location. Francophone authors often place it at the midpoint of the right spinoumbilical line (*Kamina et al., 2023*), whereas most Anglophone authors describe it at the junction of the middle and lateral thirds of the same line (*Smith et al., 2024*).

Radiological studies further highlight this variability: *Karim et al. (2021)* reported a more cranial projection of the appendiceal base, while *Naraysing et al. (2022)* found it more caudal, questioning the validity of McBurney's point as a stable reference. In response, *Duque (2023)* suggested replacing the eponym "McBurney's point" with "supraspinal point" to integrate it into official anatomical nomenclature. However, this proposal applies only to a single location and does not account for the observed anatomical variations.

This ongoing controversy underscores the need to better understand the topographic and morphometric variations of the cecum and appendix. Such knowledge is essential not only to improve diagnostic and surgical accuracy in appendicitis but also to propose a more coherent and internationally consistent anatomical nomenclature. The aim of this study is to analyse the anatomical variations of the cecum and vermiform appendix to identify their topographical and clinical implications. The ultimate goal is to propose a more precise and standardised anatomical nomenclature for McBurney's points, enhancing their diagnostic value and surgical relevance.

METHODS

Type of Study, Setting, Period, and Sampling

This was a prospective, descriptive, anatomical study focusing on the morphological and topographical analysis of the vermiform appendix. Intraoperative observations were made in three hospitals in Kinshasa—Kintambo General Reference Hospital, Bon Berger Hospital, and Sino-Congolese Friendship Hospital—between 3 January 2017 and 31 December 2022.

Sampling was non-probabilistic (convenience sampling) and included 160 patients who underwent surgery and met the inclusion criteria. The sample size was determined based on the availability of records and the representativeness required to analyse anatomical variations of the vermiform appendix. This approach is justified by the exploratory and descriptive nature of the study, where the main objective is to identify and characterise anatomical variations rather than to infer findings to the entire population.

Inclusion Criteria

- Consenting patients admitted to the surgery or gynaecology departments for an abdominal or pelvic condition requiring a midline sub-umbilical laparotomy.
- Laparotomy allowing adequate exposure of the ileocaecal and appendiceal region due to sufficient muscle relaxation.

Exclusion Criteria

Patients in the following conditions were excluded from the study:

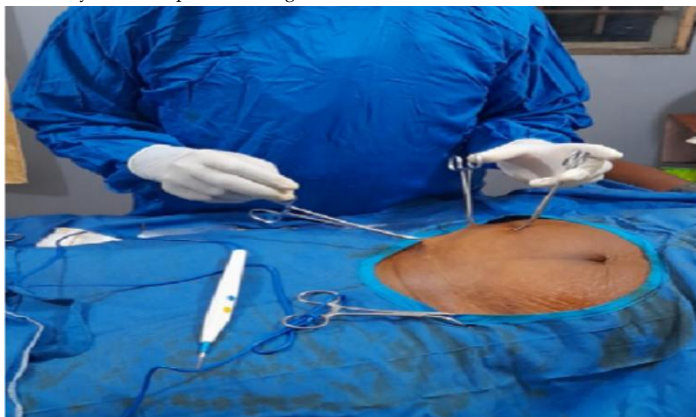
- Hospitalisation for acute appendicular conditions.
- Limited laparotomy that did not allow sufficient exposure of the ileocaecal and appendiceal region, or inadequate muscle relaxation preventing complete anatomical evaluation.

Observation Procedure

After anaesthesia and sterile abdominal preparation, anatomical landmarks were identified: McBurney's point (midway along the umbilical–spinal line, at the junction of its middle and lateral thirds) and Lanz's point (at the junction of the lateral and middle thirds along the interspinous line). A midline laparotomy was then

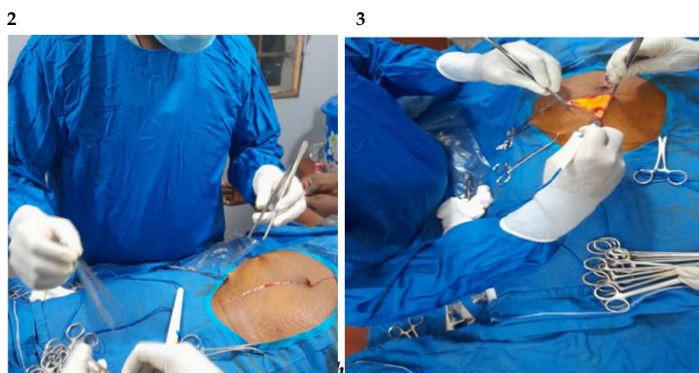
performed using standard surgical techniques, allowing complete access to the peritoneal cavity and the ileocaecal region.

Figure 1:
McBurney and Lanz point markings



An abdominal retractor was used to expose the ileocaecal region and the right lower quadrant, allowing examination of the cecum and the vermiform appendix. In elective (non-emergency) surgeries, anatomical evaluation was carefully performed to document morphological and topographical variations.

Figures 2-3:
Skin incision with mechanical scalpel



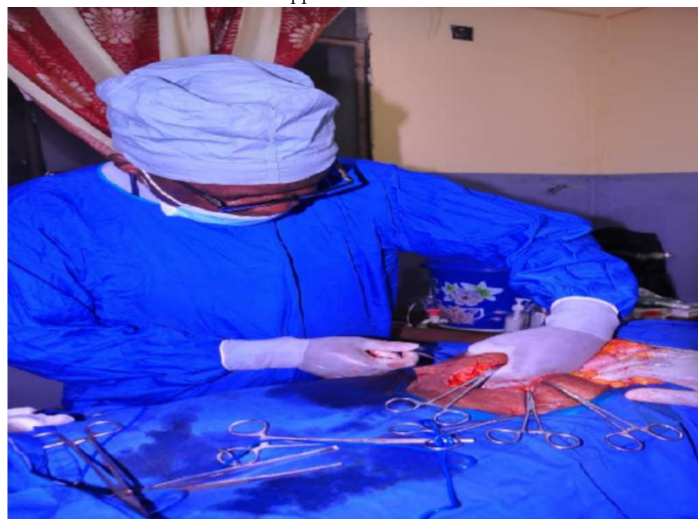
Inspection of the ileocaecal region and the vermiform appendix was performed prior to the main surgical procedure in elective cases. In emergency surgeries, anatomical evaluation was carried out after the necessary therapeutic steps. The contents of the right lower quadrant were carefully examined, and, when required, some intestinal loops were temporarily mobilised to allow complete visualisation of the cecum and appendix.

Figure 4:
Incision of subcutaneous tissue with an electric scalpel and step-by-step haemostasis



The vermiform appendix was located at the convergence of the three longitudinal bands on the medial aspect of the cecum, approximately 3 cm below the ileocaecal junction. Anatomical observation began with determining the cecum's position, which could be iliac, high, or low.

Figure 5:
Externalisation of the vermiform appendix for measurement



The positions of the vermiform appendix were described according to the classification proposed by Gray (2016), supplemented by the clock-face model used by Sudagar et al. (2019). The length of the appendix was measured by placing a sterile thread along the organ and then transferring it onto a graduated ruler, following the method described by Ndoeye et al. (2018) in Senegal.

Parameters of Interest

1. Socio-demographic variables:
 - Age

- Sex
2. Main variables (topography):
- Position of the appendicular base (anatomical reference): anterior/posteromedial, relative to the cecum
 - Cecal anatomical variations: position (iliac, pelvic, subhepatic, retrocecal), mobility (fixed/mobile), visible cecal length
 - Appendix variations: classic positions (retrocecal, pelvic, preileal, subhepatic, medial, etc.), length (mm), diameter (mm), orientation
3. Clinical variables:
- Abdominal pain
 - Point of maximum preoperative sensitivity

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 20.0.

The variables were defined as follows:

- **Dependent variables:** position of the cecum and vermiform appendix (midpoint of the umbilical-spinal line or junction of the middle and lateral thirds), appendix length
- **Independent variables:** age, sex, type of surgery (elective or emergency)

Proportions of appendix positions were compared using the chi-square test, which is appropriate for categorical variables. A 95% confidence interval was applied, and statistical significance was set at $p < .05$. Results are presented in tables summarising frequencies and proportions. Missing data were handled by excluding only incomplete cases for the specific analysis to maintain the validity of statistical comparisons.

RESULTS

We enrolled 160 patients diagnosed with abdominal or pelvic diseases requiring surgical treatment, using a median subumbilical laparotomy approach with adequate wall muscle relaxation.

Socio-demographic parameters

In the study population (n = 160), females predominated, with 115 women (71.9%; 95% CI [64.5%–78.3%]), resulting in a sex ratio of 2.56. The age distribution showed an

overrepresentation of younger subjects, with the 11–20-year age group being the most common (60 patients, 37.5%; 95% CI [30.4%–45.2%]). Note: 95% CI = 95% confidence interval. Comparisons between subgroups showed no statistically significant differences (χ^2 test, $p > 0.05$).

Table 1
Age and sex distribution

Variables	Frequency (n=160)	Percentage (%)
Gender		
Male	45	28.1
Female	115	71.9
Age group (years)		
≤10	6	3.8
11–20	60	37.5
21–30	50	31.3
31–40	26	16.3
41–50	16	10.0
≥51	3	1.9

Anatomical characteristics of the cecum (CM) and vermiform appendix (VA)

Among the 160 patients, the iliac position of the cecum was the most frequent, observed in 95 cases (59.4%). A mobile cecum was found in 124 patients (77.7%). The projection of the appendiceal base corresponded to the midpoint of McBurney's line in 52 patients (32.5%). The morphology of the vermiform appendix was predominantly cylindrical (129 cases, 80.6%). The length of the appendix ranged between 7 and 12 cm in more than half of the patients (86 cases, 53.8%).

Table 2
Anatomical characteristics of CM and VA

Variables	Frequency (n=160)	Percentage (%)
Cecal location		
Iliac	95	59.4
Pelvic	63	39.4
Upper	2	1.3
Cecum mobility		
Mobile	124	77.5
Fixed	36	22.5
Projection of appendiceal base		
Mid McBurney	52	32.5
Lateral McBurney	47	29.4
Lanz	43	26.9

Variables	Frequency (n=160)	Percentage (%)
Others	18	11.3
Morphology of vermiform appendix		
Cylindrical	129	80.6
Fusiform	18	11.3
Infundibular	13	8.1
Appendix length		
Short (<7 cm)	4	2.5
Medium (7–12 cm)	86	53.8
Long (13–18 cm)	63	39.4
Very long (>18 cm)	7	4.4

Analysis of anatomical characteristics by gender

The iliac location of the cecum was the most frequent, observed in 63 women (39.4%; 95% CI [32.1–47.1]). Cecal mobility was present in more than half the cases, involving 89 women (55.6%; 95% CI [47.9–63.1]). The appendiceal base most commonly projected at the mid-McBurney point in 43 patients (26.9%; 95% CI [20.6–34.2]). The appendix was predominantly cylindrical (94 patients, 58.8%; 95% CI [51.0–66.1]). The majority of appendices measured between 7 and 12 cm (63 patients, 39.4%; 95% CI [32.1–47.1]). The descending position was most frequent, recorded in 57 women (35.6%; 95% CI [28.6–43.3]).

Table 3
Analysis of anatomical characteristics of CM and VA by gender

Variable	Category	Male (n = 45)	Female (n = 115)
Cecal location	Iliac	32 (20.0%)	63 (39.4%)
	Pelvic	13 (8.1%)	50 (31.3%)
	High	0 (0.0%)	2 (1.2%)
Cecal mobility	Mobile	35 (21.8%)	89 (55.6%)
	Fixed	10 (6.3%)	26 (16.3%)
Appendiceal base projection	Middle McBurney	9 (5.6%)	43 (26.9%)
	Lateral McBurney	15 (9.4%)	32 (20.0%)
	Lanz	8 (5.0%)	35 (21.9%)
	Other	3 (1.8%)	15 (9.4%)
Appendix shape	Cylindrical	35 (21.9%)	94 (58.8%)
	Fusiform	5 (3.1%)	13 (8.1%)
	Infundibular	5 (3.1%)	8 (5.0%)
Appendix length	Short (< 7 cm)	0 (0.0%)	0 (0.0%)
	Medium (7–12 cm)	23 (14.4%)	63 (39.4%)
	Long (13–18 cm)	20 (12.5%)	43 (26.9%)
	Very long (> 18 cm)	6 (3.7%)	5 (3.1%)
Appendix position	Descending	24 (15.0%)	57 (35.6%)
	Retrocecal	8 (5.0%)	31 (19.4%)

Variable	Category	Male (n = 45)	Female (n = 115)
Cecal location	Prececal	4 (2.5%)	6 (3.8%)
	Subcecal	4 (2.5%)	11 (6.9%)
	Pre-ileal	4 (2.5%)	3 (1.8%)
	Retro-ileal	1 (0.6%)	7 (4.4%)

Analysis of anatomical characteristics by age group

Analysis of anatomical variations across age groups revealed that the iliac location of the cecum predominated in younger patients (3–22 years), accounting for 57 cases (35.6%), with a statistically significant difference (p = 0.023). Cecal mobility was also more frequent in this group (74 patients, 46.3%). The appendiceal base most often projected at the mid-McBurney point in the 3–22-year group (30 cases, 18.7%; p = 0.016). Cylindrical morphology of the appendix was also more frequent in younger patients (65 cases, 40.6%). Appendices of medium length (7–12 cm) were more often seen in older patients (23–60 years; 46 cases, 28.8%). The descending position was predominant in the younger group (45 patients, 28.1%).

Table 4:
Analysis of Anatomical Features by Age Group (N = 160)

Variable	Category	3–22 years (n = 83)	23–60 years (n = 77)
Cecal location	Iliac	57 (35.6%)	38 (23.8%)
	Pelvic	26 (16.3%)	37 (23.1%)
	High	0 (0.0%)	2 (1.2%)
Cecal mobility	Mobile	74 (46.3%)	50 (31.3%)
	Fixed	9 (5.6%)	27 (16.8%)
Projection of the appendiceal base	Middle McBurney	30 (18.7%)	22 (13.7%)
	Lateral McBurney	23 (14.4%)	20 (12.5%)
	Lanz	8 (5.0%)	20 (12.5%)
	Other	22 (13.8%)	15 (9.4%)
Appendix morphology	Cylindrical	65 (40.6%)	64 (40.0%)
	Fusiform	12 (7.5%)	6 (3.8%)
	Infundibular	6 (3.8%)	7 (4.3%)
Appendix length	Short (< 7 cm)	0 (0.0%)	0 (0.0%)
	Medium (7–12 cm)	40 (25.0%)	46 (28.8%)
	Long (13–18 cm)	38 (23.8%)	25 (15.6%)
	Very long (> 18 cm)	6 (3.7%)	5 (3.1%)
Appendix position	Descending	45 (28.1%)	36 (22.5%)
	Retrocecal	22 (13.8%)	17 (10.6%)
	Prececal	4 (2.5%)	6 (3.8%)
	Subcecal	4 (2.5%)	10 (6.2%)
	Pre-ileal	2 (1.2%)	6 (3.8%)

Variable	Category	3–22 years (n = 83)	23–60 years (n = 77)
	Retro-ileal	1 (0.6%)	7 (4.4%)

DISCUSSION

Understanding the anatomical variations of the cecum and vermiform appendix is crucial for surgical practice, especially in the diagnosis and management of acute appendicitis. In this context, examining these variations provides an opportunity to update the anatomical nomenclature of McBurney’s point and propose more reliable landmarks tailored to observed anatomical diversity. The objective of this study was to analyse these variations to identify their topographical and clinical implications and propose a more precise, standardised nomenclature for McBurney’s points.

In this series, 71.9% of patients were female, with a female-to-male ratio of 2.56. This female predominance aligns with regional data (65.8% of appendectomies in eastern DRC involved women; [Ngenzihakazi et al., 2023](#)) and reflects certain international trends, although proportions vary according to demographic and sociocultural contexts ([GBD 2021 Appendicitis Collaborators, 2024](#)).

The most represented age group was 11–20 years (37.5%), consistent with regional and global observations showing a peak incidence during adolescence ([Mukenge et al., 2024](#); [GBD 2021 Appendicitis Collaborators, 2024](#)). This pattern likely reflects both demographic dynamics and the higher frequency of surgical consultations among adolescents. The iliac location of the cecum was the most common (59.4%), slightly lower than rates reported in some radiological or anatomical series (78–82% in Korea and Senegal; [Kim et al., 2023](#); [Mbaye et al., 2022](#)), suggesting interregional variability or sample-specific differences. Cecal mobility was very frequent (77.7%), considerably higher than in classical anatomical series (~20–25%; [Omer et al., 2024](#); [Consorti et al., 2013](#)). This discrepancy may result from surgical selection bias, as increased cecal mobility leads to atypical presentations and more frequent operative exploration.

The appendix was predominantly cylindrical (80.6%), with a length of 7–12 cm in most patients (53.8%), consistent with recent radiological and surgical data ([Kaya et al., 2022](#); [Naar et al., 2025](#)). The base of the appendix projected to the mid-

McBurney point in only one-third of patients (32.5%), confirming that this classical landmark is influenced by variations in cecal and appendiceal position ([Tantia et al., 2023](#); [Khanduri et al., 2024](#)). The downward orientation of the appendix was the most common, consistent with CT-based studies ([Rao et al., 2022](#); [Mbwana et al., 2024](#)).

Iliac localization and cecal mobility were more frequent in younger patients (3–22 years), while average appendix length (7–12 cm) predominated in older patients (23–60 years). These differences may reflect developmental, anatomical, and physiological factors, as well as potential sampling biases.

Our findings indicate that relying on a single McBurney point is insufficient for surgical guidance. A revised nomenclature incorporating two landmarks – the midpoint and the junction of the middle and lateral thirds – modulated according to common appendiceal positions (retrocecal, pelvic) and cecal mobility, may improve diagnostic and surgical accuracy. For instance, in cases with a mobile cecum and retrocecal appendix, the lateral point may better predict pain localization and guide surgical access.

Several limitations must be acknowledged. Although the sample size was adequate for descriptive purposes, it may introduce sampling bias, limiting generalizability. The absence of comparison with other geographic or demographic contexts reduces external validity. Additionally, the reliance on intraoperative assessment without imaging correlation (CT, MRI) may have introduced interpretation bias. Finally, selection bias cannot be excluded since only patients undergoing appendectomy were studied.

CONCLUSION

This study confirms the anatomical variability of the cecum and vermiform appendix, with a frequently mobile cecum in the right iliac fossa and a predominantly cylindrical, medium-length, downward-oriented appendix. The base of the appendix more often projected along the umbilicospinal line than the classical McBurney point, supporting the adoption of the terms “average umbilicospinal point” and “lateral umbilicospinal point.” These findings may enhance surgical planning and support laparoscopic approaches to improve appendicitis management and reduce anatomical

complications. Future research should validate this nomenclature in other populations using imaging modalities (CT, MRI) for greater standardisation.

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Ethical Approval: This study was approved by the Ethics Committee of the Kinshasa School of Public Health, University of Kinshasa, Democratic Republic of the Congo (ESP/CE/128/2017).

Conflicts of Interest: None declared.

ORCID iDs:

Kabanga, T. K.^{1,2,3}: <https://orcid.org/0009-0004-1695-6637>
 Kilara, T. K.⁴: <https://orcid.org/0009-0003-2110-3594>
 Kapinga, B. M.⁵: <https://orcid.org/0009-0002-2629-8821>
 Kazadi, D. B.⁶: <https://orcid.org/0009-0006-0492-4798>
 Kabanga, A. T.^{3,6}: <https://orcid.org/0009-0009-6209-8529>
 Kabanga, H. K.^{2,3}: <https://orcid.org/0009-0008-1369-6808>
 Kabongo, J. M.⁵: <https://orcid.org/0009-0003-0271-4816>

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