BRAZILIAN JOURNAL OF ULTRASONOGRAPHY 2024; 36: 37-46 - DOI - 10.29327/275505.32.36-7

REVIEW ARTICLE

DIAGNOSTIC APPROACH TO AMYAND'S HERNIA: A COMPARATIVE ANALYSIS OF IMAGING FINDINGS BY ULTRASONOGRAPHY AND COMPUTED TOMOGRAPHY

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ABSTRACT

INTRODUCTION: Amyand's hernia is a rare condition in which the cecal appendix protrudes through an inguinal hernia. This anomaly presents a range of clinically challenging manifestations for diagnosis and treatment, and its approach has been a topic of discussion for centuries since its first description by Claude Amyand in 1735.

OBJECTIVE: The purpose of this study is to investigate the imaging findings related to Amyand's hernia, examining its various and multifaceted presentations. A narrative review of scientific articles was conducted to provide a comprehensive overview of these findings, aiming to deepen the understanding of this complex clinical condition.

MATERIAL AND METHODS: A narrative review was conducted using a theoretical approach based on a retrospective analysis of the literature. Relevant articles from the last 20 years were selected from electronic databases using specific search terms. Inclusion and exclusion criteria were applied to ensure the relevance and validity of the included studies.

RESULTS: The review revealed a wide range of imaging findings associated with Amyand's hernia, ranging from the presence of the appendix in the inguinal hernia to complications such as inflammation and necrosis. The importance of using ultrasound and computed tomography for accurate assessment and treatment guidance is highlighted.

DISCUSSION: In the analysis of the results, the challenging diagnostic nature of Amyand's hernia is highlighted, emphasizing the pressing need for an interdisciplinary approach to its management. The discussion emphasizes the crucial importance of a thorough clinical assessment and effective integration between clinical practice and radiology, essential for ensuring accurate and individualized diagnosis and treatment.

CONCLUSION: This study provides an analysis of the imaging findings of Amyand's hernia, highlighting the complexity of this condition. The importance of integration between clinical and radiological aspects for accurate diagnosis and effective treatment is emphasized. This information is crucial for guiding future research and clinical practice in this specific field, significantly contributing to the advancement of knowledge and improvement of care for patients with Amyand's hernia.

KEYWORDS: AMYAND'S HERNIA; COMPUTED TOMOGRAPHY; ULTRASOUND; INCARCERATED INGUINAL HERNIA.

INTRODUCTION

Amyand's hernia (AH) is a rare condition characterized by the protrusion of the cecal appendix into an inguinal hernia. Initially described by Claudius Amyand in 1735 during an appendectomy in an 11-year-old boy, this clinical entity presents diagnostic challenges due to its low incidence and variety of presentations[1,2]. Although inguinal hernias are common in clinical practice, the presence of the appendix in its hernia sac is uncommon, occurring in approximately 1% of cases, with the presence of an inflamed appendix being even rarer, occurring in about 0.13% of cases[3].

This condition most commonly affects males and can occur at any age, although it is found more frequently in children compared to adults, due to the persistence of the vaginal process in the pediatric population. On the other hand, most female patients with herniated appendicitis are in the postmenopausal period[1].

The location of the appendix within the inguinal canal makes it more vulnerable to trauma and adhesions, as suggested by Abu-Dalu and Urca. Compression of the appendix due to the contraction of abdominal muscles and increased intra-abdominal pressure can lead to additional inflammation and microtrauma. Consequently, fibrosis may develop, resulting in the adherence of the cecal appendix to the hernia sac[4-6]. These changes compromise blood supply and/or luminal obstruction at the hernia ring site, leading to inflammation and excessive bacterial growth. However, it is important to note that not all cases of appendix migration into the inguinal canal progress to acute appendicitis[7,8].

Amyand's hernia can be classified into three types,

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according to the degree of inflammation, and its diagnosis is not always clinically evident and can be challenging, especially in complicated cases, where symptoms may be similar to those of a strangulated inguinal hernia. Additionally, the location of the appendix in the inguinal canal makes it vulnerable to trauma and adhesions, contributing to additional complications[1,3,4,9].

The diagnosis of AH is usually incidental on imaging studies. Among the available diagnostic options, two methods stand out in emergency units. Ultrasound (US) is useful for detecting all types of inguinal hernias, being a low-cost method and free of ionizing radiation, although its effectiveness depends on the operator's skill. Computed tomography (CT), despite involving ionizing radiation and being more expensive, allows for the characterization of AH, identification of complications (perforation and abscess), exclusion of other causes, and assists in surgical planning[9].

The treatment of AH varies and depends on the subjective evaluation of the surgeon, which may involve concomitant appendectomy with inguinal hernia repair or preservation of the appendix with correction of the hernia defect. However, there is no established consensus on the preferred approach, and the decision is often made after joint medical discussion[1,10].

Given the rarity of AH and the complexity of its clinical presentation, a thorough understanding of this condition is essential to ensure early diagnosis and appropriate treatment. This study aims to investigate the imaging findings associated with AH, contributing to a better understanding of this complex and multifaceted clinical condition. In this context, case reports accompanied by literature reviews play a relevant role in disseminating knowledge about this disease, as well as in aiding in early diagnosis and establishing more appropriate management for future cases.

OBJECTIVE

To display the imaging findings associated with Amyand's hernia and contextualize them within the broader landscape of medical literature, providing a more comprehensive and informed view of this complex clinical condition.

METHODOLOGY

This study adopts a narrative review approach, based on a retrospective literature review. The main objective is to provide a descriptive analysis of a qualitative and applied nature.

For the selection of studies included in this review, inclusion and exclusion criteria were established. The inclusion criteria comprise thematic relevance, meaning that studies should address Amyand's hernia or be directly related to the imaging aspects of this condition. In addition, studies published in the last 20 years were considered to ensure the relevance and timeliness of the information. Various sources were accepted, such as books, scientific articles, websites, monographs, dissertations, and theses, as long as they met the other inclusion criteria. Exclusion criteria were applied to studies that did not meet the inclusion criteria, such as thematic irrelevance, lack of clarity in the methodology, publication date earlier than 20 years, and languages different from those defined in the inclusion criteria.

The research was conducted on specific electronic databases, including Google Scholar, ScienceDirect, Scientific Electronic Library Online (SciELO), Medical Literature Analysis and Retrieval System Online (PUBMED/MEDLINE), Latin American Literature (LILACS), and the Periodicals Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES). The search was conducted using predefined keywords: "Amyand's hernia," "computed tomography," "ultrasound," and "incarcerated inguinal hernia."

The selection process involved reviewing the initial results for relevance based on the inclusion criteria. Next, a screening based on titles and abstracts was performed, excluding studies that clearly did not meet the inclusion criteria. The remaining studies after the title and abstract screening had their full texts evaluated for eligibility. During this process, all included and excluded studies were recorded, with a justification for each exclusion decision. Studies that met all inclusion criteria were included in the narrative review. Subsequently, they were analyzed and synthesized to provide a comprehensive overview of the imaging findings associated with Amyand's hernia.

The selection process aimed to ensure the inclusion of relevant studies and the exclusion of studies that did not meet the established criteria, thus ensuring the quality and validity of this narrative review. The flowchart is presented in Figure 1.

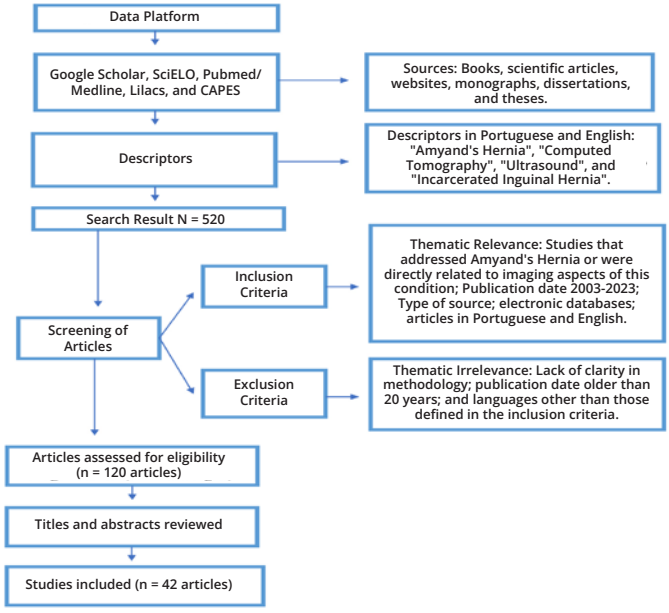

Figure 1. Flowchart - narrative review methodology

DEVELOPMENT

Anatomy and physiopathology of the vermiform appendix and its association with Amyand's hernia

The appendix is an organ characterized by its tubular shape, with a length ranging from 6-10 centimeters, a diameter of 6mm, and a thickness of 4mm. It usually emerges at the confluence area of the colon's taeniae, but its position can vary, with the retrocecal position being the most common (20.1-65.3%). The mesoappendix, in some cases, can allow the appendix to move and position itself in atypical locations. Although its base is located at the junction of the muscular bands of the colon on the cecum, the distal end of the appendix can occasionally present anatomical variations, such as its presence in the lower left or upper right quadrant of the abdomen[11,12].

Appendicitis is a medical condition characterized by inflammation of the vermiform appendix. This inflammation can occur due to various causes, including obstruction of the appendix by hardened feces, a foreign body, viral or bacterial infections, or anatomical problems, among other factors. It can be classified as acute, chronic, or recurrent, with acute appendicitis further subdivided into simple, gangrenous, or perforated. Chronic appendicitis is characterized by recurrent pain in the right lower quadrant, due to partial luminal obstruction of the appendix[11].

Amyand's hernia is a rare condition in which the appendix, whether pathological or not, is present in the hernial sac in the inguinal region. Its incidence is low, usually less than 1% of all inguinal hernias. Right-sided Amyand's hernia is more common, but left-sided cases also occur, especially due to atypical anatomical factors[13,14].

The physiopathology suggests that appendicitis in Amyand's hernia is caused by extraluminal compression leading to edema of the appendix with narrowing of the ring along with the contraction of abdominal wall muscles causing incarceration and strangulation. The classical intraluminal obstruction of the appendix does not seem to play a significant role. However, diffuse peritonitis is considered less likely in cases of complicated appendicitis due to the location of the contents within the sac[15].

The clinical presentation correlates with the severity of the case, usually characterized by episodic abdominal pain and nonspecific symptoms that provide little insight into the pathology. Tenderness at McBurney's point is usually absent. More severe patients with signs of appendicitis report pain in the right iliac fossa region associated with vomiting, fever, and presence of leukocytosis in laboratory tests.[16,17].

Due to the low frequency of occurrence of HA, clinical and semiological findings are varied and will depend on the presentation of the hernia (without alterations, incarcerated, or strangulated) and the appendix (without alterations, inflamed, perforated, or gangrenous). Therefore, preoperative clinical diagnosis is almost impossible, requiring ultrasound (US) or computed tomography (CT) to suspect this condition.[8,18].

Diagnostic Techniques of ultrasound and computed tomography in the clinical evaluation of Amyand's Hernia

The ultrasound (US) is an imaging diagnostic modality that uses non-ionizing radiation and is characterized by its quick execution, practicality (it does not require prior patient preparation or contrast medium administration, unlike tomography), non-invasive nature, and affordable cost[19].

In the ultrasound, inflamed content can be found in the hernial sac, showing a tubular image connected to the cecum with thickening. However, it is important to emphasize that the quality of images produced by ultrasound significantly depends on the skill of the operator, who must have solid technical training to ensure the acquisition of sharp, detailed images that provide adequate visibility of the anatomical structures of interest. The ultrasound stands out as a widely accepted technique by both physicians and patients due to its safety, speed, lack of pain, and relatively low cost compared to other imaging techniques such as computed tomography and magnetic resonance imaging.[19,20].

Computed tomography is another imaging technique used in medicine that involves the use of ionizing radiation. It plays a key role in the early characterization of Amyand's hernia, in the identification of possible complications such as perforation and abscesses, and in assisting in surgical planning21.

This method is based on obtaining images by performing a series of X-ray projections from different angles, which are then processed to generate cross-sectional slices of the body. CT is capable of producing three-dimensional images, making it extremely valuable in complex diagnoses[22].

When it comes to evaluating patients with suspected acute appendicitis, abdominal and pelvic CT has been frequently used since the 1980s. With technological advancements, especially with the introduction of multi-detector scanners, this exam can be performed in a matter of seconds, provided the patient is adequately positioned. The most common approach involves visualizing the entire abdominal and pelvic cavities through thin slices (usually ≤ 5mm). However, it is important to mention that CT can be performed both with and without the administration of contrast agents.[21,22].

These contrasts can be administered intravenously (IV), orally, or both, and each approach has its advantages and disadvantages. Oral contrast, for example, can make the exam more time-consuming and uncomfortable for the patient, and may even induce nausea and vomiting, which in turn can delay the diagnosis. Intravenous contrast administration is usually reserved for patients with adequate renal function and may increase the total procedure time. Additionally, both oral and IV contrast are associated with possible allergic reactions, varying in severity and potentially putting the patient at risk[21,22].

The choice between ultrasound and computed tomography depends on various factors, including the specific clinical needs of the patient, the clinical conditions in question, and the inherent advantages and disadvantages of each method[8,21,22].

AH has been classified into three types based on the

degree of inflammation, as described by Fernando and Leelaratna: 1) Appendix without signs of inflammation, responsible for the majority of cases; 2) Appendix with signs of inflammation; 3) Perforated appendix. Appendectomy becomes necessary in cases of types 2 and 33,4,23. AH can also be classified according to Losanoff and Basson24. The classifications are presented in Table 1.

AUTHOR	CLASSIFICATION	DESCRIPTION
Losanoff and Basson	Type 1	Normal appendix in an inguinal hernia
	Type 2	Acute appendicitis in an inguinal hernia, without abdominal sepsis
	Type 3	Acute appendicitis in an inguinal hernia, with abdominal or peritoneal sepsis
	Type 4	Acute appendicitis in an inguinal hernia, with related or unrelated abdominal pathology
Fernando and Leelartre	Type a	Normal appendix
	Type b	Acute appendicitis
	Type c	Acute appendicitis with perforation

Table 1. Classification of Amyand's Hernias

We also have the classification by Constantine et al[43], which reclassified the four subtypes of AH by CT, based on the classification by Losanoff and Basson[24]. The four subtypes and their characteristic images are presented in Table 2.

CLASSIFICATION	DESCRIPTION
Type 1	Incarcerated ormal appendix (Figures A and B, white arrows)
Type 2	Appendix appears enlarged and thickened, with inflammation of surrounding fat (Figures C and D, white arrows)
Type 3	Excessive inflammatory changes, which may obscure the appendix within the inguinal canal (Figures E and F, white arrows)
Type 4	Acute appendicitis accompanied by another abdominal pathology, related or unrelated to AH (Figures G and H, white arrows)

Table 2. Classification of Amyand's hernias by computed tomography

TREATMENT

The treatment of Amyand's hernia is surgical and consists of either appendectomy alone or appendectomy followed by hernia repair with or without the use of mesh[26-28].

Despite the initial surgical approach being independent of the contents of the hernia sac, there is controversy regarding the decision to excise or not excise a normal appendix in the context of an AH.

The classifications of AH, such as those by Losanoff and Basson and Fernando and Leelaratre (Table 3), help support the decision regarding appendectomy and the type of hernia repair, taking into account not only the presence or absence of acute appendicitis but also whether there is associated peritonitis.

Classification	Description	Surgery
Losanoff and Basson		
Type 1	Normal appendix in an inguinal hernia	Hernia reduction, repair with mesh, appendectomy in young patients
Type 2	Acute appendicitis in an inguinal hernia, without abdominal sepsis	Appendectomy, hernia repair without mesh
Type 3	Acute appendicitis in an inguinal hernia, with abdominal or peritoneal wall sepsis	Laparotomy, appendectomy, hernia repair without mesh
Type 4	Acute appendicitis in an inguinal hernia, with related or unrelated abdominal pathology	Same as types 1 to 3, treat secondary pathology accordingly
Fernando and Leelartre		
Type a	Normal appendix	Mesh repair without addressing the appendix
Type b	Acute appendicitis	Appendectomy, hernia repair without mesh
Type c	Acute appendicitis with perforation	Appendectomy, hernia repair without mesh (by different incisions if abscess or peritonitis)

Table 3. Classification of Amyand's hernias and type of repair

There is a consensus regarding surgical treatments for types 3 and 4, which involves an appendectomy with primary hernia repair[29].

The classic treatment of AH includes appendectomy and herniorrhaphy through the same incision. Some believe that prophylactic appendectomy is not necessary when there are no signs of inflammation; however, when there are signs of inflammation, appendectomy should be performed[27].

There is also a classification regarding the physical state and anesthetic risk. It is an evaluation of the patient performed by an anesthesiologist preoperatively. This evaluation is primarily based on the patient's comorbidities and clinical condition. It is given in numbers as follows: 1. Healthy patient. 2. Patient with mild systemic disease. 3. Patient with severe, but not incapacitating systemic disease. 4. Patient with incapacitating systemic disease that poses a constant risk of death. 5. Seriously ill patient, with no life expectancy exceeding 24 hours, whether or not undergoing surgical procedures[30].

Hernias can also be classified according to intraoperative findings following the classification proposed by Nyhus[13], as follows: Nyhus type 1 - widened deep inguinal ring (open); Nyhus type 2 - indirect hernias, including inguinoscrotal her-

nias; Nyhus type 3A - direct hernias; Nyhus type 3B - mixed hernias (direct and indirect); Nyhus type 3C - femoral hernias; Nyhus type 4 - recurrent hernias[31].

The surgical approach used for hernia repair and/or appendectomy varies. Several authors advocate for anterior hernia repair without opening the hernia sac with laparoscopic appendectomy if indicated, or performing laparoscopic appendectomy and hernia repair through the same approach. In cases where the initial laparoscopic approach is used for an inguinal hernia without inflammatory signs, and if the extraperitoneal technique is chosen, the diagnosis of Amyand hernia is not made since the hernia sac is not opened. If the transabdominal preperitoneal technique is employed, it is possible to diagnose Amyand hernia with eventual appendectomy and inguinal hernia repair[32].

RESULTS

The results of the studies analyzed provide a comprehensive overview of the different presentations and therapeutic approaches of Amyand's hernia. In the first study, a patient complained of a bulge in the right inguinal region, accompanied by colicky pain requiring analgesics for pain control. During surgery, a macroscopically normal cecal appendix was identified inside the hernia sac, leading to its invagination into the abdominal cavity and repair with a polypropylene mesh, according to the Falci-Linchestein technique[28].

In another case, the patient presented with a hardened mass in the right inguinal region, associated with a cessation of bowel movements. During the surgical procedure, a more severe situation was found, with a ruptured, necrotic cecal appendix adhered to the region with omental blockage. In this case, in addition to the appendectomy, a more invasive approach was required, including exploratory midline laparotomy and adhesiolysis. Another study by Santos et al. involved a patient with a strangulated inguinal hernia. During surgery, a suppurated and perforated ileocecal appendix was discovered inside the hernia sac, requiring appendectomy and hernia repair without the need for a mesh[33].

Studies conducted by Guler et al.[4] also highlighted the importance of ultrasound and computed tomography in identifying specific characteristics of Amyand's hernia, such as the presence of a tubular structure in the hernia sac and thickening of the appendicular wall. Additionally, a proposed classification allowed categorization of Amyand's hernia subtypes based on distinct tomographic features, facilitating the definition of appropriate therapeutic strategies.

A recent study by Fonseca et al.[34] described a case of right inguinal hernia with the appendix in the hernia sac. The treatment involved reducing the hernial content and performing hernioplasty with a polypropylene mesh, without the need for appendectomy. This incidental finding highlights the importance of carefully evaluating the structure of the appendix to guide appropriate surgical management. These cases reinforce the complexity of Amyand's hernia and the need for an individualized approach for each patient.

Based on the findings of the authors who used images to describe cases of Amyand's hernia, it was possible to observe different aspects related to the condition. Through ultrasound, Vehbi[29] showed an inguinal mass with a blind tubular structure, evidencing an incarcerated appendix within the hernia sac. Additionally, Mebis9 presented grayscale images, showing axial and sagittal views of the appendix within the inguinal hernia sac.

Regarding the tomographic findings, Fezaulidi[35] demonstrated coronal and axial cuts of a type 1 Amyand's hernia, while Maekawa[36] presented a case of type 2 Amyand's hernia, showing thickening of the appendicular wall and a fat filament. Terceiro[25] described a type 3 Amyand's hernia, where the appendix was distended and with thickened wall within a right inguinal hernia, with an adjacent focus of free gas. Finally, Deshmukh[37] illustrated a case of type 4 Amyand's hernia, characterized by an acute appendix associated with a scrotal collection.

The characteristic tomographic findings for Amyand's hernia include a blind-ended tubular structure within the hernia sac, originating from the base of the cecum, as well as thickening of the wall, hyperemia, and peri-appendiceal fat[9,38,39].

An analysis of the studies reveals a variety of clinical findings and the use of imaging modalities for the diagnosis of Amyand's hernia. Table 4 presents a summary of the authors, the clinical findings described, and the type of imaging used in some studies.

Authors	Key clinical findings	Type of Exam
Santos et al[33]	Large hernia of the right inferolateral abdominal wall extending to the ipsilateral inguinal region with intestinal content showing thickened walls and hypo-peristalsis, suspected incarcerated hernia.	Ultrasound
Santos et al[33]	bulky expansive formation with irregular contours, multiseptated, and with areas of degeneration, hypogastric region, to the right of the midline.	Tomography
Batista et al[40]	Flat and painless abdomen to palpation; presence of a bulge in the right inguinal region, reducible and painful, after Valsalva maneuver; lower limbs without edema and calves free.	Physical Examination
Graça et al[45]	Presence of a flat abdomen, minimally depressible, painful, with guarding and signs of peritoneal irritation, upon palpation of the lower quadrants, associated with a right inguinal hernia that is irreducible and with marked inflammatory skin signs.	Physical Examination
Sousa et al[39]	Reducible bilateral inguinal hernia, without inflammatory signs.	Physical Examination

Guler et al[4]	Hydrocele in the right scrotum, inguinoscrotal hernia of the colon and vermiform appendix.	Ultrasound
Deshmukh[37]	Acute appendix, associated with scrotal collection.	Tomography
Fonseca et al[34]	Giant right inguinal hernia. Vermiform appendix inside the hernia sac.	Physical Examination
Vehbi[29]	Inguinal mass with a blind tubular structure, corresponding to an incarcerated appendix in the hernia sac.	Ultrasound
Guler et al[4]	Inflamed appendix in the inguinal hernia sac, with a blind end. Herniation of a segment of the colon into the scrotal sac, along with the vermiform appendix, without signs of inflammation.	Ultrasound
Fezaulidi[35]	Coronal and axial cuts showing type 1 Amyand hernia, with a normal incarcerated appendix.	Computed Tomography
Maekawa[36]	Amyand hernia type 2, with thickening of the appendicular wall and presence of a fat filament.	Computed Tomography
Terceiro[25]	Type 3 Amyand hernia, with a distended appendix and thickened wall within the right inguinal hernia, with an adjacent focus of free gas.	Computed Tomography
Deshmukh[37]	Type 4 Amyand hernia, with an acute appendix associated with a scrotal collection.	Computed Tomography
Mebis[9]	Blind-ended tubular structure within the hernia sac, originating from the base of the cecum, along with thickening of the wall, hyperemia, and periappendicular fat.	Computed Tomography
Holmes[38]	Anteroposterior computed tomography showing the location of the appendix within the right inguinal hernia sac.	Computed Tomography
Shekhani[41]	Computed tomography showing the progression of the appendix as it extends into the right inguinal hernia, with sagittal contrast-enhanced images of the lower abdomen.	Computed Tomography

Table 4. Clinical findings and types of imaging used in studies on Amyand's hernia

DISCUSSION

The diagnosis before surgery is a challenge, often being established during surgery. Imaging exams, such as computed tomography and ultrasound, are frequently requested, especially in acute presentations. This is done to rule out other conditions, assess possible complications, and guide clinical management[26,28].

The primary characteristic associated with inguinal hernias is the presence of a protrusion in the inguinal region, which complicates the clinical evaluation for an accurate preoperative diagnosis. Often, the symptoms are interpreted as an incarcerated or strangulated hernia due to the difficulty in distinguishing Amyand's hernia[8]. Additionally, manually reducing this protuberance poses the risk of not identifying Amyand's hernia, making detection even more challenging[42,44]. Therefore, it is common for the definitive diagnosis to be made only during hernia repair surgery, being a common finding at the time of surgical intervention[38].

The search for radiological confirmation of this condition is usually related to the need to exclude more serious diseases or complications, such as intestinal obstruction or ischemia, abdominal abscesses, and colon cancer[42,44]. It is worth noting that in most situations, identifying Amyand's hernia through preoperative imaging is challenging, and the diagnosis often occurs incidentally during hernia repair surgery[8].

In the study conducted by Batista et al[40], a 58-year-old male patient presented to the outpatient clinic with a complaint of a bulge in the right inguinal region for approximately 14 months, following an episode of intense physical exertion. He reported frequent colicky pain radiating to the lower right quadrant of the abdomen, requiring the use of analgesics for pain control. The bulge was easily noticed with exertion and reducible. On physical examination, the patient was lucid, oriented, afebrile, with a bulge in the right inguinal region that became evident after a Valsalva maneuver and was painful. Preoperative evaluation classified the patient as ASA 1. He underwent a right oblique inguinotomy under spinal anesthesia, during which local inventory revealed an indirect hernia sac containing a macroscopically normal cecal appendix, which was also part of the hernia sac wall (Nyhus Classification 3B). The procedure included invagination of the indirect hernia sac into the abdominal cavity without appendectomy and repair with polypropylene mesh using the Falci-Linchestein technique[44].

In the study conducted by Santos et al[33], a 72-year-old male patient presented with a complaint of a hardened mass in the right inguinal region for about 30 days and cessation of bowel movements for 4 days. An ultrasound of the total abdomen was requested, reported as: a voluminous infero-lateral right abdominal wall hernia extending to the ipsilateral inguinal region with intestinal content with thickened walls and hypoactive peristalsis, suspecting an incarcerated hernia. A contrast-enhanced CT scan of the upper abdomen and pelvis was performed, which concluded: a voluminous expansive formation with irregular contours, multiseptated, and with areas of degeneration in the hypogastric region, to the right of the midline. The lesion had an intraperitoneal component in contact with intestinal loops. Surgery was performed: Incision in the right inguinal region; Destruction of muscular planes by necrosis and purulent collection identified; Median xiphopubic laparotomy performed to expand the abdominal cavity; Purulent fluid, peritoneal destruction, muscular plane destruction, as well as a ruptured, necrotic

cecal appendix with an intact base entering the inguinal canal, adhered to the region with omental blockage identified; Adhesiolysis, appendectomy, and omentectomy performed; Intussusception of the appendix stump with suture in two planes; Option not to place polypropylene mesh, primary synthesis in two planes of the inguinotomy and median incision performed; Dermosynthesis performed. As the case was revealed to be an Amyand hernia with evident peritoneal infection, the option for exploratory median laparotomy with appendectomy followed by primary herniorrhaphy without mesh was the most appropriate and consistent with the current literature[33].

In another study, the authors reported the case of a 38-year-old man, with no known medical history, who sought medical attention due to pain and swelling in the right inguinal region, lasting for two days, without other associated symptoms. During the physical examination, the patient had a flat, poorly compressible, and painful abdomen, with muscle guarding and signs of peritoneal irritation in the lower quadrants. Additionally, a right inguinal hernia was identified that could not be reduced and showed signs of inflammation in the surrounding skin. Given the diagnosis of strangulated inguinal hernia, surgical treatment was proposed, which was promptly accepted by the patient. During surgery, it was observed that the hernia sac contained a suppurative and perforated ileocecal appendix, resembling a fishbone. Appendectomy was performed through the inguinal approach, followed by removal of the hernia sac and correction of the abdominal wall without the need for a prosthesis, using the Shouldice technique[45].

In the study conducted by Sousa et al[39], a 68-year-old male patient was admitted for elective surgery for bilateral inguinal hernia repair. Physical examination revealed reducible bilateral inguinal hernia without inflammatory signs. During the surgical intervention, a non-inflamed vermiform appendix was found inside the right indirect hernia sac, consistent with the diagnosis of Amyand's hernia. Appendectomy and hernioplasty were performed according to Rutkow and Robbins.

In the ultrasound, the changes that can be evidenced in this exam are: abscess in the right iliac fossa, inflamed appendix cecal, presence of a blockage or mass in the right iliac fossa, echoes inside an appendicular cyst, thickening of the appendicular wall, presence of a cystic structure with a thin wall in the cecal appendix, and polypoid lesions in the appendix[46].

The most significant ultrasonographic finding is the presence of a non-compressible tubular structure in the hernia sac. In the case of appendicitis, there is also thickening of the wall and hyperemia[42-44].

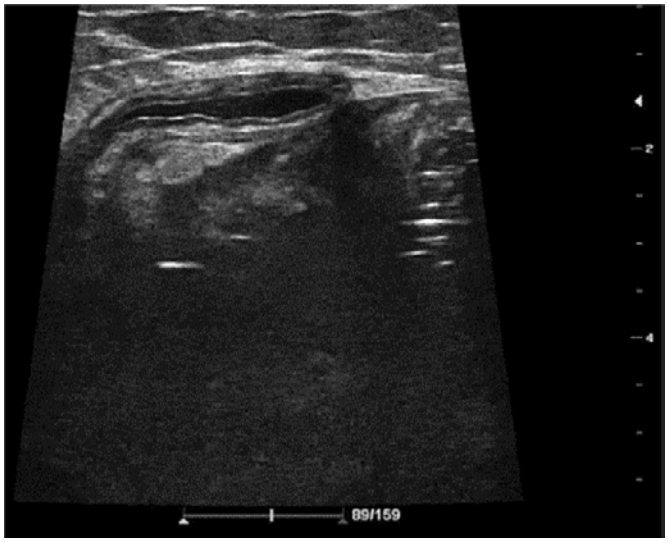

Figure 2. Ultrasound of the inguinal mass, showing a blind tubular structure with a thick wall inside the hernia sac, corresponding to the incarcerated appendix[29].

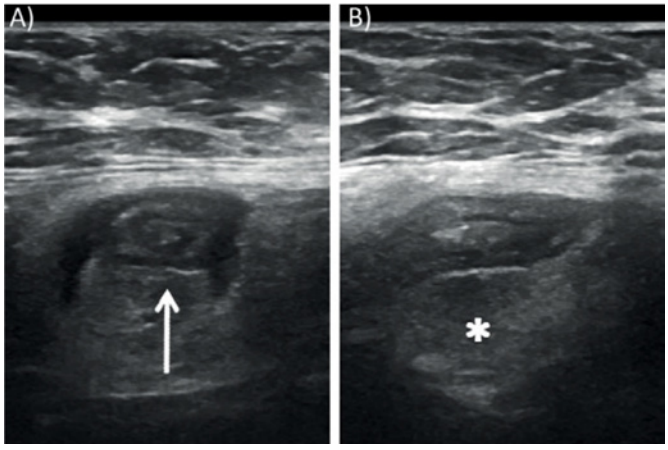

Figure 3. Grayscale ultrasound. Axial (A) and sagittal (B) views of the appendix inside an inguinal hernia sac[9].

Guler et al.[4] reported a clinical case in which the initial diagnosis was a hydrocele in the right scrotum. However, during the ultrasound examination, an inguinoscrotal hernia involving the colon and the vermiform appendix was also identified. These findings led to the diagnosis of an acute herniation (AH). The patient was referred for surgery, where the hernia correction was performed[4].

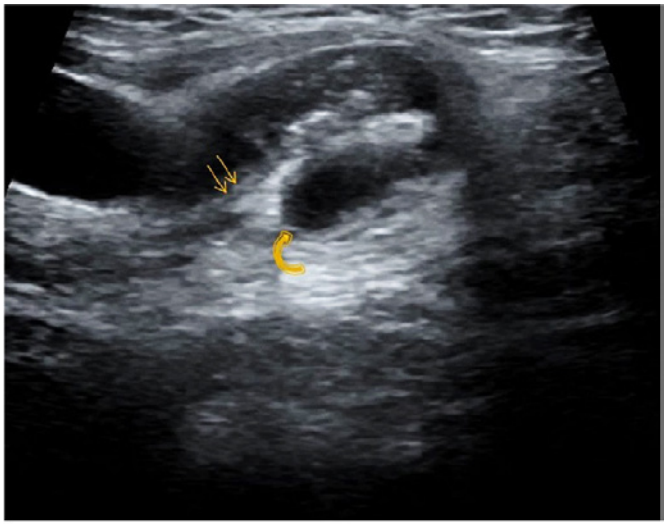

Figure 4. Ultrasound revealed an inflamed appendix in the inguinal hernia sac (thin arrows), ending with a blind end (curved arrow) in the hernia sac[4].

In the classification proposed by Constantine et al[43], which refined the categorization of Amyand's hernia subtypes through computed tomography, based on the previous classification by Losanoff and Basson[24], we can identify four distinct subtypes. Subtype 1 corresponds to the presence of a normal appendix incarcerated (figures A and B, white arrows). Subtype 2 is characterized by an enlarged and thickened appendix, accompanied by inflammation of the surrounding fat (figures C and D, white arrows). Subtype 3 is marked by excessive inflammatory changes, which may make it difficult to visualize the appendix within the inguinal canal (figures E and F, white arrows). Finally, subtype 4 involves the presence of acute appendicitis associated with another abdominal pathology, which may or may not be related to Amyand's hernia (figures G and H, white arrows). The characteristic images of each subtype are presented below.

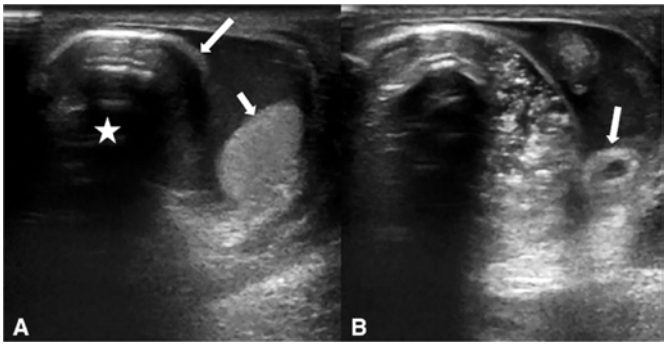

Figure 5. (A) Ultrasonography revealed the herniation of a segment of the colon into the scrotal sac (long arrow) and observed an air artifact generated from the colon (asterisks). Note the normal appearance of the testicle (short arrow). (B) Vermiform appendix was seen in the scrotal sac (arrow). The appendix was normal (non-inflamed) [4].

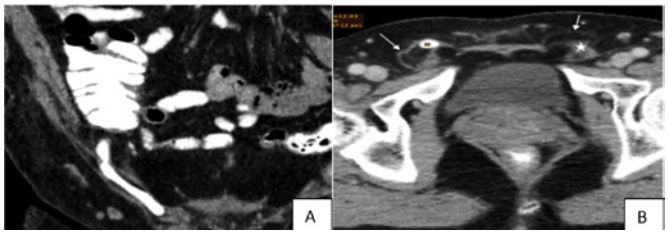

Figure 6. Computed tomography. A - Coronal section, B - Axial section. Amyand hernia type 1[35].

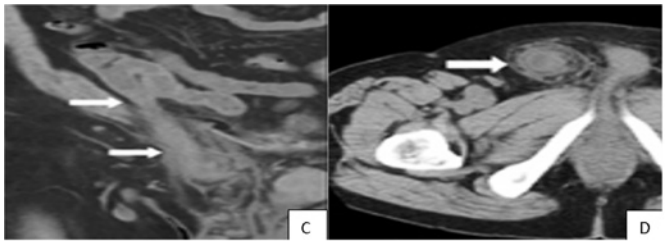

Figure 7. Computed tomography. C - Coronal section, D - Axial section, without intravenous contrast. Amyand hernia type 2. Thickening of the appendiceal wall and fatty filament[35,36,42]

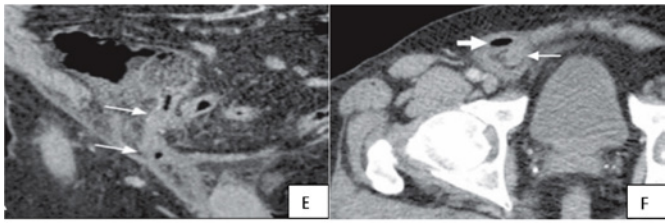

Figure 8. Computed tomography. E - Coronal section, F - Axial section. Amyand hernia type 3. Distended appendix with thickened wall within a right inguinal hernia, with adjacent focus of free gas[25,45]

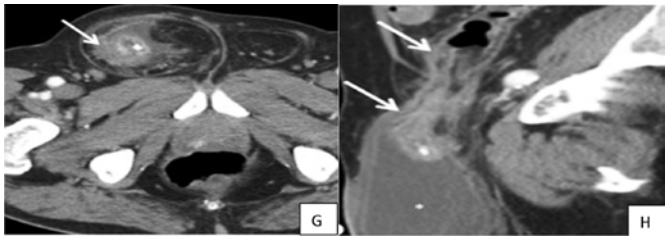

Figure 9. Computed tomography. G - Axial section, H - Sagittal section. Amyand hernia Type 4. Acute appendix associated with scrotal collection (larger arrow)[37].

The main tomographic signs considered pathognomonic for AH are a blind-ended tubular structure within the hernia sac, originating from the base of the cecum, thickening of the wall, hyperemia, and periappendicular fat, as can be seen in figures [10-12,42,44].

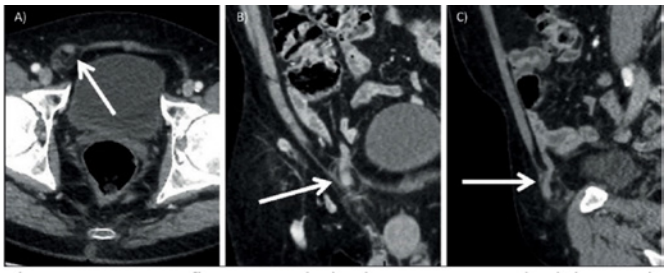

Figure 10. Contrast-enhanced abdominal computed tomography. Axial (A), coronal (B), and sagittal (C) views of the appendix located within the right inguinal hernia sac[9].

Figure 11. Anteroposterior view of the described Amyand's hernia on computed tomography[38].

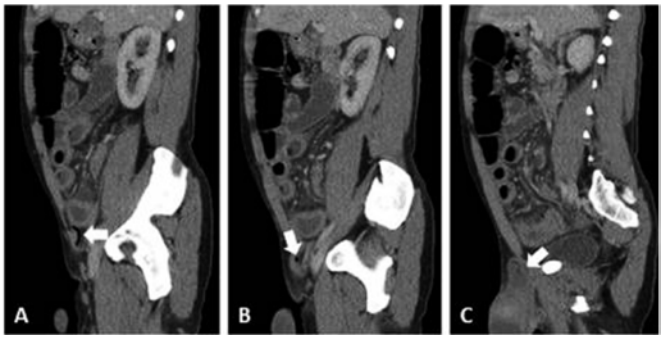

Figure 12. Contrast-enhanced sagittal computed tomography images from lateral (A) to medial (C) showing the progression of the appendix as it extends into the right inguinal hernia. Technique: The sagittal contrast enhanced CT images increased the images of the lower abdomen[41]

The 2022 study describes the case of a 44-year-old patient with a giant right inguinal hernia that had been present for approximately three years. During the management of the case, the vermiform appendix was identified within the hernia sac. The hernia was classified as type 1, according to the Losanoff and Basson classification. The treatment consisted of reducing the hernial content and performing a hernioplasty using a polypropylene mesh, without the need for an appendectomy[42-44].

Based on the information provided, it is evident that the clinical presentation of Amyand's hernia can vary widely depending on the state of the involved appendix. In cases where the appendix is not inflamed, the condition may resemble a reducible inguinal hernia. However, when the appendix becomes inflamed, the clinical presentation can be similar to that of an incarcerated or strangulated inguinal hernia.

CONCLUSION

In summary, Amyand's hernia is a rare and challenging condition involving the protrusion of the vermiform appendix through the abdominal wall in the inguinal region. Its preoperative diagnosis is often an enigma and is frequently only confirmed during surgery. Imaging exams, such as ultrasound and computed tomography, play a crucial role in providing crucial information about the appendix's condition and assisting in surgical planning. The complexity of Amyand's hernia clinical presentation underscores the importance of considering it as a possibility in patients with inguinal bulges, especially when there are signs of inflammation or acute symptoms. The variety of clinical scenarios highlights the need for a personalized approach to treatment, which usually involves performing a hernioplasty followed by an appendectomy. Ultimately, awareness of this condition and the judicious use of imaging exams are essential for the successful diagnosis and treatment of Amyand's hernia. Healthcare professionals' knowledge and clinical suspicion play a crucial role in the early identification and proper management of this complex and multifaceted clinical condition.

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Scientific Editor - Heverton Pettersen
Spelling Check: Dario Alvares
Received: 03/18/24. Accepted: 04/02/24. Published: 04/12/2024.