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ADVANCES IN EARLY DETECTION OF ENDOMETRIOSIS: THE CRUCIAL ROLE OF TRANSVAGINAL ULTRASONOGRAPHY WITH COLOR DOPPLER AND BOWEL PREPARATION

GIOVANNA GONÇALVES VILAÇA DA CUNHA[1], CLEBER FRIGI BISSOLI[1]

ABSTRACT

INTRODUCTION: Endometriosis is a common gynecological condition that affects many women of reproductive age, characterized by the presence of tissue similar to the endometrium outside the uterus. Early and accurate detection of endometriosis is essential for proper disease management and to improve the quality of life of patients.

OBJECTIVE: The aim of this study was to evaluate the efficacy of transvaginal ultrasonography with color Doppler and intestinal preparation in the detection of endometriosis in women attending an imaging diagnostic clinic in São José dos Campos.

METHODS: A cross-sectional study was conducted, analyzing 50 transvaginal pelvic ultrasound exams for the detection of endometriosis. Variables such as patients' age, reported symptoms, exam quality, location, and characteristics of endometriotic lesions were considered.

RESULTS: Out of the 50 exams analyzed, 22 diagnosed endometriosis, 26 showed no signs of the disease, and two were inconclusive. The majority of positive cases were observed in women between 30-39 years old. In some cases, magnetic resonance imaging was suggested as a diagnostic complement.

DISCUSSION: Transvaginal ultrasonography has proven to be a useful tool in the detection of endometriosis, allowing the identification of lesions and adhesions characteristic of the disease. The combination of clinical symptoms with ultrasound findings can improve diagnostic accuracy.

Conclusion: Transvaginal ultrasonography with color Doppler and intestinal preparation is a promising technique for the detection of endometriosis, as it can assist in the early identification of the disease and guide appropriate treatment for patients. Further studies are needed to validate its efficacy and compare it with other diagnostic modalities.

KEYWORDS: ULTRASONOGRAPHY; ENDOMETRIOSIS; DIAGNOSIS; SIGNS; SYMPTOMS.

INTRODUCTION

Endometriosis is a chronic gynecological disease defined by the presence of endometrial tissue outside the uterine cavity. The endometrium is the tissue responsible for lining the uterus. When a woman is not pregnant, this tissue sheds and is expelled during menstruation. Endometriosis occurs when endometrial cells travel along a different path than expected and instead of being expelled by the uterus, they move to other locations.[1]

There is no scientific consensus on the causes of endometriosis. In the literature, three theories are commonly cited. The theory of retrograde menstruation suggests that due to the presence of free fluid in the pelvis during the menstrual cycle, fragments of endometrial tissue implant in the organs of the region by refluxing through the uterine tubes, causing the lesions. The theory of celomic metaplasia states that the origin of endometriosis comes from normal tissues that have undergone a process of metaplastic differentiation. The genetic theory relates to genetic predisposition or epigenetic changes due to alterations in the peritoneal environment.[2]

In general, some studies indicate that genetic factors, a woman's lifestyle, early menarche, a prolonged period of time between menarche and first pregnancy, and short menstrual cycles are possible reasons for its onset. Because of these characteristics, it is known as the disease of the modern woman.[1]

The foci of endometrial cells outside the uterine cavity also have vascularization, which allows their growth. Even though they are not in the uterine cavity, these cells remain functional. Thus, during menstruation, bleeding occurs, leading to an inflammatory response that generates most of the characteristic symptoms of endometriosis.[3]

The involvement of other sites by endometrial tissue can

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regress, progress, or stabilize over time, also relating to hormonal variations between adolescence and adulthood, since the growth of endometrial tissue depends on estrogen.[4]

It is a disease frequently diagnosed and affects about 10-15% of women of reproductive age. One in ten patients presents characteristic symptoms such as pelvic pain, intestinal and urinary alterations, dyspareunia, dysmenorrhea, anxiety, lower back pain, fatigue, and hematuria. It can also disrupt menstruation, cause difficulty in conceiving, and in more severe cases, lead to infertility. In rare and specific cases involving the diaphragm or lungs, symptoms such as shoulder pain, cough, and chest pain can be evident. [6]

The classification of endometriosis is defined by stages, with the first referring to the size of the lesion and the degree of involvement of the peritoneum and ovaries. The second relates to the destruction of the posterior cul-de-sac, which can be partial or complete. The third is related to the type of adhesion in the ovaries and fallopian tubes. Endometriosis is characterized as infiltrative when the lesions are identified at a depth of more than 5mm into the peritoneum.[8]

The treatment for endometriosis needs to take into consideration several factors, such as the severity of the disease in relation to symptoms and its extent, the woman's desire to conceive, and the patient's age.[9] Medication treatment is usually hormonal and tends to be effective in controlling pain. In the case of women who wish to conceive, laparoscopy or in vitro fertilization are available alternatives. Surgical treatment is indicated for cases where pain does not respond to hormonal treatment and the disease begins to affect other organs such as the bladder, kidneys, ureter, or intestine.[10]

For diagnostic purposes, the most indicated exam is transvaginal ultrasound (TVUS) with intestinal preparation, as it is non-invasive and more cost-effective than magnetic resonance imaging.11 Studies conducted by an Australian group in 2020 indicated that the accuracy of TVUS before surgery is high, demonstrating an overall sensitivity of 85% and specificity of 97%, especially in the posterior compartment. However, in some studies, sensitivity was found to be low in the anterior compartment, such as the bladder.[12]

Despite being one of the best exams for diagnosing endometriosis, transvaginal ultrasound has its drawbacks. One of them is the discomfort it causes the patient during the exam. [13]

Early diagnosis is important and helps in the treatment of endometriosis, offering a better quality of life for women affected by the disease. As it is the most indicated exam for detection, it is necessary to evaluate the procedure for transvaginal ultrasound with intestinal preparation, as well as its effectiveness in the diagnosis and prognosis of endometriosis.

METHODS

A cross-sectional study was conducted using medical records data from an imaging diagnostic clinic in São José dos Campos, from November 2020 to August 2023. During the study period, data were collected from transvaginal pelvic ultrasound exams with color Doppler and intestinal preparation for the detection of endometriosis, with referrals from public and private health services.

The results of 50 TVUS exams for the detection of endometriosis, recorded in the clinic's reporting system, were analyzed. Subsequently, a comparative study was conducted between the exams that confirmed the diagnosis of endometriosis and those that required further diagnostic methods. In cases where the endometriosis research yielded negative results, the quality of the exam was evaluated to determine if it was good and if differentiation from other gynecological anomalies, when present, was possible.

The database for analysis was organized according to the study's variables of interest. The dependent variable was the detection of endometriosis using ultrasound. The independent variables analyzed were: patients' age; signs and symptoms such as pelvic pain, intestinal and urinary alterations, dyspareunia, dysmenorrhea, anxiety, lower back pain, fatigue, hematuria, irregular menstruation, difficulty conceiving, and infertility; adequate preparation performed by the patients; experience of the physician responsible for the exam; the site of adhesion; and the size and depth of endometriotic lesions.

For descriptive purposes, patients who sought the clinic for transvaginal ultrasound for the detection of endometriosis underwent the following procedures:

Patient preparation:

On the day before the exam, the patient should follow a low-residue diet. They should prefer liquids such as water, tea, strained fruit juices, vegetable soup, gelatin, and purees. In addition to the diet, the patient should take medication to aid in intestinal preparation. Muvinlax is the most indicated because it has fewer side effects than other medications. On the day of the exam, the patient is asked to take their medications as usual and only suspend them if the doctor requests it.

One hour before the scheduled exam time, while still at home, the patient should perform rectal intestinal lavage using a Phosfoenema enema bottle. This is the most important part of the intestinal preparation. The patient should also drink 600-800ml of water.

The intestinal preparation eliminates fecal residues, which facilitates the analysis and identification of the layers of the intestinal wall, as well as the detection of deep endometriosis foci.

Exam

Transvaginal pelvic ultrasound with color Doppler and intestinal preparation, including mapping of the total abdomen and abdominal wall, for the detection of endometriosis is performed using an ultrasound machine with endocavitary and multifrequency convex transducers.

The lubricating gel should be placed on the tip of the transvaginal transducer to facilitate insertion into the patient's vagina. Another technique used to improve detection is to apply an injection of 20-50ml of ultrasound gel into the posterior fornix of the vagina, using a syringe. The patient should have an empty bladder and be positioned properly to ensure adequate mobility with the transducer. For this, the knees should be flexed, legs apart, and the hips elevated by a wedge pillow.[14]

The duration of the exam depends on the complexity of the lesions and the skills and experience of the examiner, taking about an hour. The ultrasound report describes the characteristics of the findings in the upper abdomen - evaluating the diaphragm, kidneys, and gallbladder - abdominal wall, uterus, ovaries, cecum, ascending and descending colons, rectum and sigmoid, retrocervical region, uterosacral ligaments and vaginal fornices, rectovaginal septum, bladder, vesicouterine recess, ureters, and finally, adhesions.

To ensure the accuracy of the information obtained in the reports, an analysis of duplicate records belonging to the same individual was conducted, maintaining an organization according to the individual's name and date of birth. Duplicate cases were excluded from the study.

The study project was approved by the Research Ethics Committee of the Universidade Paulista (UNIP), under substantiated opinion No. 6,103,353, issued on June 6, 2023, based on the Certificate of Presentation for Ethical Appreciation (CAAE) No. 69655923.7.0000.5512.

RESULTS

In this study, the results of 50 transvaginal pelvic ultrasound exams with color Doppler and intestinal preparation for the detection of endometriosis in women aged 18-50 years were analyzed. Among them, 22 were diagnosed with the disease, while 26 exams showed no signs of deep endometriosis. Two exams had inconclusive results, where, although endometriosis was not detected by ultrasound, it was not possible to rule it out due to the presence of specific signs such as adhesion of the ovaries, suggesting pelvic magnetic resonance imaging as a complementary exam.

During the analysis of the reports, the ages of patients diagnosed with endometriosis were also identified, with a higher number of positive cases in the age group of 30-39 years, 59% (13/22). Seven patients (32%) were aged 20-29 years, and two patients (9%) were in the age group of 40-49 years.

In addition to the positive results for endometriosis, the main symptoms reported by patients during the anamnesis conducted by the physician before the exam were evaluated. The symptoms of dysmenorrhea and dyspareunia were frequently reported together. The relationship and frequency of symptoms are described in Table 1.

Symptoms	n	%
Dysmenorrhea	13	59.0
Dyspareunia	10	45.4
Menorrhagia	5	22.7
Irregular menstrual cycle	3	13.6
Difficulty getting pregnant	2	9.0
Pain during urination	1	4.5
Discomfort in the hypogastric region	1	4.5

Table 1 - Frequency of symptoms in 22 patients diagnosed with endometriosis.

Regarding the locations affected by endometriosis lesions, the ovaries (figure 1), rectum, uterosacral ligaments (figure 2), vesicouterine recess, retrocervical region (figure 3), and retrovaginal peritoneal region (figure 4) were the most affected regions. The frequency of lesions found in the evaluated locations is reported in Table 2.

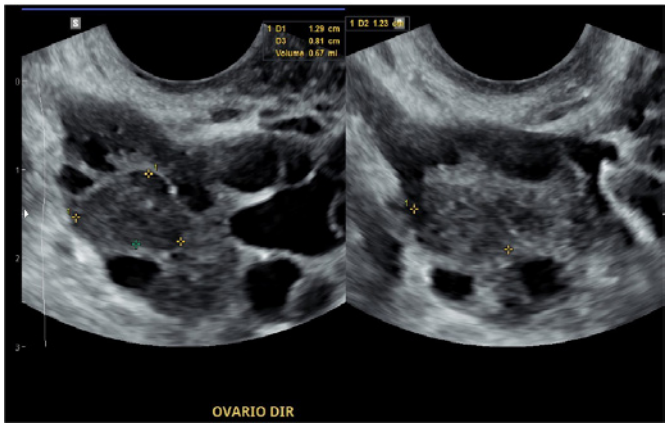

Figure 1 - Endometrioma in the right ovary. Rounded ovarian cyst, with regular margins and echogenicity with a characteristic matte glass appearance of an endometrioma. Source: Dr. Renata Glória

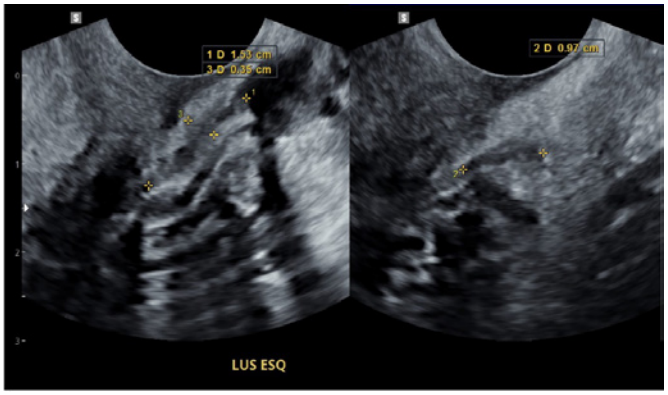

Figure 2 - Signs of deep endometriosis identified in the uterosacral ligaments. Hypoechoic and irregular tissue can be seen in the region of the left uterosacral ligaments, measuring 1.53 x 0.97 x 0.35cm. Source: Dr. Renata Glória.

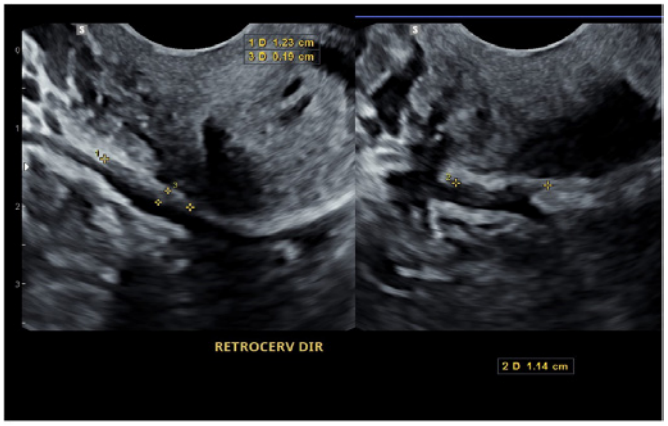

Figure 3 - Signs of deep endometriosis in the retrocervical region. Hypoechoic and irregular tissue can be seen in the retrocervical region to the right, measuring 1.23 x 1.14 x 0.19cm. Source: Dr. Renata Glória.

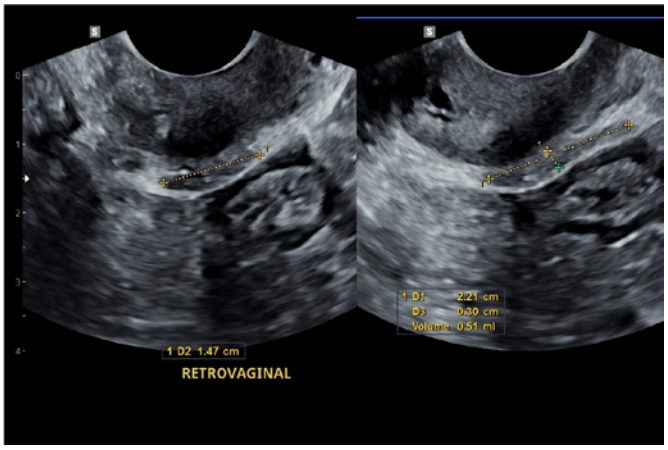

Figure 4 - Signs of deep endometriosis in the retrovaginal peritoneal region. Hypoechoic and irregular tissue can be seen in the retrovaginal region, measuring 2.21 x 1.47 x 0.30cm. Source: Dr. Renata Glória.

Location of the lesion	Frequency of the lesions	%
Ovaries (endometrioma)	7	31.8
Rectum	9	40.9
Uterosacral ligaments	17	77.2
Vesicouterine recess	5	22.7
Retrocervical region	14	63.6
Retrovaginal peritoneum	2	9.1

Table 2 - Frequency of lesions observed in 22 patients diagnosed with endometriosis.

An analysis was performed on the 26 exams that showed negative results for endometriosis. Among these exams, eight (31% - false negative) showed signs of adenomyosis, the presence of endometrial cells infiltrating the myometrium. For the remaining 18 exams (69%), it was possible to differentiate other gynecological alterations, such as pelvic varices, uterine fibroids, and ovarian cysts, when present, as well as normal results and additional findings that are not part of the exam.

Também foi realizada uma análise comparativa entre os resultados dos exames de pacientes que receberam o diagnóstico de endometriose e constatou-se a presença de adenomiose concomitante com endometriose em 40% (9/22) exames avaliados.

A comparative analysis was also conducted between the results of exams from patients who received a diagnosis of endometriosis, revealing the presence of concomitant adenomyosis with endometriosis in 40% (9/22) of the evaluated exams.

Furthermore, the results of two exams (25%) that showed negative results for endometriosis were compromised due to inadequate preparation by the patients, making it difficult to visualize the areas closest to the intestine optimally.

DISCUSSION

Endometriosis is a disease that presents with a variety of clinical manifestations. It affects women of reproductive age and can impair the quality of life of those diagnosed, whether in their work routine or personal life.[6]

This study demonstrated, in the studiedpopulation diagnosed with endometriosis, the predominance of painful symptoms, mainly dysmenorrhea and dyspareunia, which is

consistent with the research conducted by Barreto & Figueiredo[5], where pelvic pain, intestinal and urinary alterations, dyspareunia, dysmenorrhea, anxiety, lower back pain, fatigue, hematuria, irregular menstruation, difficulty getting pregnant, and infertility were described.[5]

The ages of the patients affected by endometriosis in this study ranged from 20 to 50 years, with the majority being between 30 and 39 years old, consistent with the range indicated in the work of Fernandez15, where the peak of the disease occurred between 25 and 44 years old.[15]

Based on the standardized protocols defined by the IDEA Group Consensus (International Deep Endometriosis Analysis)[16], the ultrasound reports used as the basis for this study describe the characteristics of findings in the upper abdomen - evaluating the diaphragm, kidneys, and gallbladder - abdominal wall, uterus, ovaries, cecum, ascending and descending colons, rectum and sigmoid, retrocervical region, uterosacral ligaments and vaginal fornices, rectovaginal septum, bladder, vesicouterine recess and ureters, and finally, adhesions.

The most affected locations by the lesions caused by endometriosis described in the diagnostic impressions of the exams evaluated in this study were: uterosacral ligaments, retrocervical region, rectum, ovaries, vesicouterine recess, and rectovaginal peritoneum. Mendonça et al[17] and Brunelli6 showed in their research that the most affected locations by endometriosis are the ovaries, pelvic organs such as the bladder, peritoneum, rectum, sigmoid, fallopian tubes, uterosacral ligaments, and in more severe and rare cases, it can affect distant organs such as the diaphragm, lungs, and central nervous system.[6,17] No cases of endometriosis lesions in locations outside the pelvis were identified in this study.

Adenomyosis, the presence of endometrial tissue infiltrating the myometrium and studied as a separate disease from endometriosis, was diagnosed in 9 out of 22 (40.9%) patients who tested positive for endometriosis. This result differs from that found by Brunelli6 in her research, where she reported signs of concomitant adenomyosis with endometriosis in about 18-21% of cases.[11]

Regarding the negative results for endometriosis, the ultrasound examination identified the presence of adenomyosis in 8 out of 26 (30.8%) exams analyzed. Additionally, it was possible to differentiate other lesions that were causing discomfort to the patient but did not characterize endometriosis, such as pelvic varices, uterine fibroids, ovarian cysts, kidney stones, as well as additional findings that are not part of the examination, such as the presence of a hepatic nodule.

This data highlights the importance of the ultrasound method for a differentiated and well-characterized diagnosis, as advocated in the work of Scioscia et al.[18] This contributes to the physician accompanying the patient initiating the most appropriate treatment for the case.[18]

Regarding the inconclusive results, typical signs of endometriosis were observed, such as the absence of the penetration sign and the beginning of applications of the ovaries to the uterus, corroborating the symptoms reported by the patient and the protocol of the IDEA Group defined by Oliveira et al. [16]. However, the characteristic lesions of endometriosis could not be discerned on ultrasound, indicating the need for complementary exams, such as magnetic resonance imaging, as suggested by Lima et al. [19], which can identify more subtle lesions.

In the present study, two exams were compromised due to inadequate preparation. It is recommended to follow a liquid diet and use a laxative as instructed by the doctor one day before the exam. On the day of the exam, it is vital to perform a rectal washout and ingest 600-800ml of water. According to Ros et al [20], this intestinal preparation improves the accuracy of transvaginal ultrasound in diagnosing endometriosis.

Most of the patients who sought the clinic for a transvaginal ultrasound (TVUS) exam to investigate endometriosis had been experiencing characteristic symptoms for a long time but considered them normal for the menstrual cycle. Other patients took longer to notice the symptoms due to contraceptive use, which could make the disease asymptomatic for a while. Patients with difficulty getting pregnant also sought the exam after a period of attempts. According to Alves et al. [1] and Barreto & Figueiredo[5], the diagnosis of endometriosis is usually made late due to lack of information, which sometimes leads women to believe that the symptoms are normal and expected during the menstrual cycle. This scenario worsens the quality of life of the patients and leads to more serious problems due to the delay in starting treatment, such as infertility.[1,5]

Moreira et al. [3] argue in their studies that it is necessary to be aware of the signs and symptoms of endometriosis and to seek a gynecologist if there is suspicion of the disease. However, professionals need to be properly qualified and ready for specialized care, both in the follow-up with the gynecologist and in imaging diagnosis, especially in ultrasound.[3]

CONCLUSION

From the exposition of the researches reported above, it can be concluded that:

a) Transvaginal pelvic ultrasound with Doppler and intestinal preparation is the most used technique for detecting deep endometriosis because it is more economical, faster, non-invasive, and has high sensitivity and specificity to identify and classify lesions with more than 5mm of infiltration.

b) Some factors are determinants for the effectiveness of the ultrasound method in the diagnosis of endometriosis, namely: the existence of deep lesions, since ultrasound is not very effective for detecting mild lesions; a good intestinal preparation performed by the patient, to ensure adequate visualization of the intestinal walls and foci of deep endometriosis; and professionals trained about the disease to ensure efficient care and support for the patients, as well as the performance of a good diagnostic exam.

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ORIGINAL ARTICLE

POST MICTIONAL URINARY RESIDUE IN MEN:AN ULTRASOUND ANALYSIS

ANA LUIZA AGUIAR ÁVILA JUIZ[1], CAROLINA DE ARAÚJO MACHADO [1], ARIELAMAULLER VIEIRA PARENTE [2], WALDEMAR NAVES DO AMARAL [3]

ABSTRACT

INTRODUCTION: Prostate ultrasound is commonly requested by doctors for male patients over 40 years old, both for diagnostic and screening purposes. An enlarged prostate can result in voiding dysfunction due to static (mechanical) or dynamic (smooth muscles of the bladder neck and prostatic urethra) obstruction.

OBJECTIVE: Evaluate if there is a correlation between prostate volume and post-void residual (PVR) urine.

METHODS: This is a retrospective cross-sectional observational study. The study was conducted with male patients using data from January to July 2023.

RESULTS: A total of 500 male patients with an average age of 62 years, ranging from 40 to 83 years, were analyzed. Measuring post-void residual (PVR) urine is crucial for assessing potential prostate-related issues. In this study, a PVR of 0 to 40 ml was considered normal, and anything above 40 ml was considered abnormal. The highest PVR recorded was 287 ml, and the heaviest prostate weighed 79.64 g, while the normal weight of a healthy adult prostate ranges between 20-30 grams, or 20-25 cm^3. Out of the 500 patients, 216 were found to have abnormalities: 145 had an increased prostate weight but normal PVR, 71 had both increased prostate weight and PVR, 50 had increased PVR but normal prostate weight, and 234 were normal. According to the Pearson index, the correlation was considered weak. The data distribution was tested using the Kolmogorov-Smirnov test, which showed that these variables did not follow a parametric distribution. Therefore, the Spearman correlation technique was adopted.

CONCLUSION: The retrospective cross-sectional observational study showed that abdominal ultrasound was able to identify changes in prostate size and post-void residual (PVR) urine, providing information for the evaluation and monitoring of these patients. However, there are weak correlations between prostate ultrasound (volume) and post-void residual urine.

KEYWORDS: CHANGES, PROSTATE, ULTRASOUND.

INTRODUCTION

Prostate ultrasound is commonly requested by doctors for male patients over 40 years old, both for diagnostic and screening purposes. The accurate determination of prostate volume is important for determining the degree of hyperplastic enlargement, the resulting tendency for urinary tract obstruction, and the preferred option for surgical treatment. The literature available for transabdominal prostate ultrasound instructs that the scan should be performed with a full bladder and the transducer tilted 15° towards the feet[1].

An enlarged prostate can result in voiding dysfunction due to static (mechanical) or dynamic (smooth muscles of the bladder neck and prostatic urethra) obstruction. Although classical literature is controversial regarding the direct relationship between prostate size and voiding dysfunction in patients with benign prostatic hyperplasia (BPH) and its implications for management and outcomes, some recent studies have highlighted the role of predominant secondary changes in the bladder in small-sized prostates, including a high bladder neck, increased smooth muscle tone in the bladder neck/prostate, and increased prostatic urethral angle, in contrast to the primary obstructive component in large glands[2].

Therefore, the cause of voiding dysfunction in patients with BPH should be established before undergoing surgery to improve the patient's condition, as management strategies differ in bladder outlet obstruction due to small and large prostates. The assessment of post-void residual urine is considered by many urologists to be an important test in patients with benign prostatic hyperplasia. Residual urine is found more frequently in these patients than in the healthy population. However, it does not always correlate with uroflowmetric findings.

Therefore, the objective of this study is to evaluate if there is a correlation between prostate volume and post-void residual urine volume.

METHODS

This is a retrospective cross-sectional observational study conducted with male patients using data from January to July 2023. The sample size was determined by temporal convenience, and the data were analyzed using Excel. The research was submitted to the Ethics Committee through the Brazil platform, respecting the ethical principles regulat-

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ing research in human subjects (resolution 466/12).

The variables related to ultrasound findings were: patient age, prostate weight, and post-void residual urine volume.

For the statistical analysis, the Pearson correlation test was applied, where 1 = perfect correlation; 0.75 = strong correlation; 0.5 = moderate correlation; -0.5 = no correlation. Additionally, the Kolmogorov-Smirnov test and Spearman correlation were used.

For the abdominal prostate ultrasound examination, it is essential to have a full bladder. Patients should drink a large volume of water (5 cups) one hour before the procedure. Once ready, the patient lies down in a supine position, and the transducer is used with gel for visualizing the prostate in the pelvic region. Two measurements are taken with the transducer in the longitudinal plane and one in the transverse plane to calculate the volume (transverse x anteroposterior x longitudinal x 0.52), as shown in figure 1. The initial bladder volume is also calculated in the same way at this time. Afterward, the patient empties their bladder to calculate the post-void residual volume.

The reference values for post-void residual urine (PVR) in the study are: absent (no residue), negligible (0 to 40 ml), moderate (40 to 100 ml), and significant (> 100 ml), as shown in figure 2.

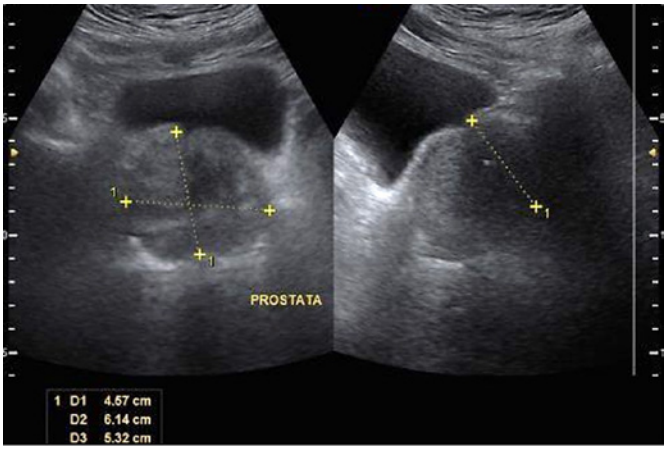

Figure 1. Illustrates an ultrasound image for calculating prostate volume.

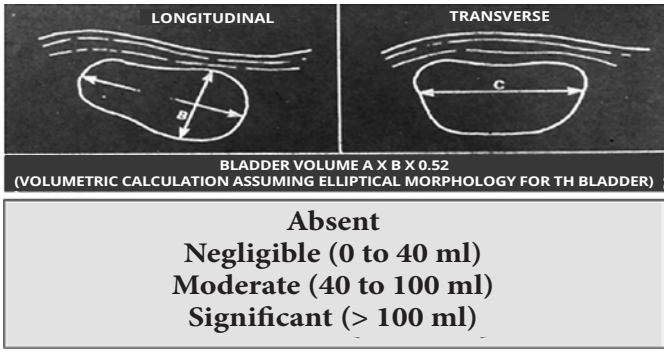

Figure 2. Methodology for calculating post-void residual bladder volume.

RESULTS

A total of 500 male patients were analyzed, with an average age of 62 years, ranging from 40 to 83 years old.

The measurement of post-void residual urine (PVR) is fundamental for evaluating possible prostate-related problems. For this study, a PVR of 0 to 40 ml was considered normal, and above 40 ml was considered abnormal. The highest recorded PVR was 287 ml, and the heaviest prostate weighed 79.64 g. The normal weight of a healthy adult prostate is between 20-30 grams, which is equivalent to 20-25 cm³ (cubic centimeters) - see table 1.

DADOS	RPM (N = 500)	PESO (N = 500)
Média	54,99	29,74
Mediana	28,00	24,45
Erro Desvio	66,13	18,23
Intervalo	287,00	92,53
Mínimo	0,00	2,950
Máximo	287,00	95,48

Table 1 - Illustrates the data regarding post-void residual urine (PVR) and prostate weight.

Out of the 500 patients, 216 were found to have abnormalities: 145 had an increased prostate weight but normal PVR (as exemplified in figure 3A); 71 had both increased prostate weight and PVR; 50 had increased PVR but normal prostate weight (exemplified in figure 3B), and 234 patients were normal.

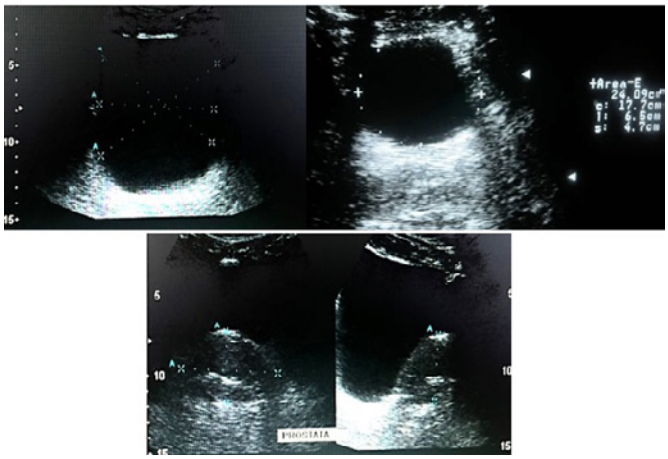

Figure 3A: Illustrates a patient with enlarged prostate and normal PVR.

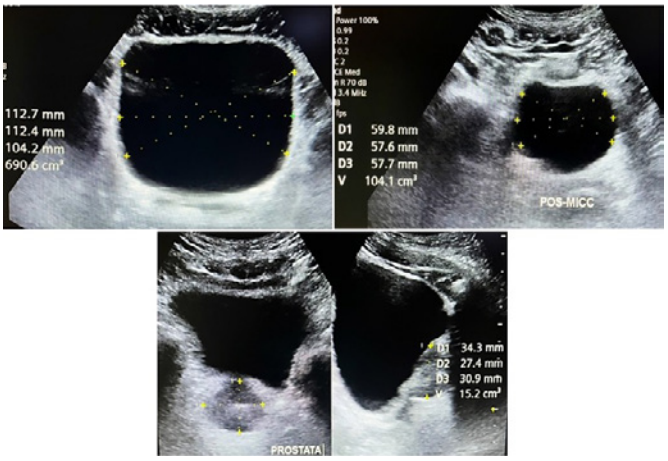

Figure 3B: Illustrates a patient with normal prostate volume and increased PVR.

The Pearson correlation index was considered weak (<0.5). The data distribution was tested using the Kolmogorov-Smirnov test, which determines if the correlation is parametric. It was found that the distribution of these variables does not correspond to a parametric distribution (they are not correlated), as shown in graph 1. Therefore, the correction technique adopted was the Spearman correlation - see table 2.

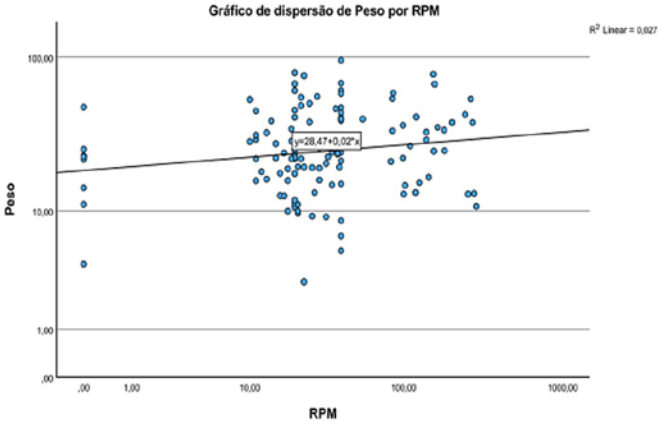

Gráfico 1 – Dispersão de peso por RPM

			RPM	Peso
rô de Spearman	RPM	Coeficiente de Correlação	1,000	,158
		Sig. (2 extremidades)	.	,085
		N	500	500
	Peso	Coeficiente de Correlação	,158	1,000
		Sig. (2 extremidades)	,085	.
		N	500	500

Table 2 - Data related to non-parametric correlations.

DISCUSSION

Prostate volume plays a vital role in all types of prostate diseases. The American Urological Association guidelines (2018) for the surgical management of benign prostatic hyperplasia now include the consideration of measuring prostate volume before surgical intervention. Ultrasound is a fast and radiation-free imaging modality.

Transabdominal ultrasound should be performed in patients complaining of dysuria symptoms. A complement to the exam, especially when the prostate is enlarged, should be the measurement of bladder capacity and evaluation of the amount of residual urine after micturition[3-5].

The importance of prostate ultrasound in the evaluation of urinary problems in men plays a crucial role for several reasons:

• Prostate volume determination: precise measurement of volume;
• Monitoring of urinary function: initial volume and post-micturition residual;
• Diagnosis of prostate diseases: BPH, tumors, and infections;
• Safety and accessibility: safe, non-invasive, and relatively accessible technique.

In addition, post-void residual urine can help indicate dysfunctions in the prostate such as: urinary tract obstruction; voiding dysfunction; and monitoring the effectiveness of BPH treatment. This study revealed significant results regarding the correlation between post-void residual urine and prostate size, as there is not always a strong correlation between the variables. Therefore, not all patients with a history of BPH have increased post-void residual urine or other types of voiding alterations.

A retrospective study with 85 patients undergoing multiparametric magnetic resonance imaging compared to ultrasound concluded that prostate volume measured by multiparametric magnetic resonance imaging and ultrasound showed similar values, and excellent agreement with the actual weight of the prostate from surgical specimens. This demonstrates the importance of ultrasound in these cases. Estimating prostate volume with ultrasound offers many advantages, such as portability, low cost, harmlessness, and suitability for real-time operation [5-9].

There is limited literature analyzing the correlation between prostate volume and post-void residual urine. An analysis that included 452 patients with lower urinary tract symptoms (LUTS) from the Urology Outpatient Clinic of UNICAMP corroborates with our findings and suggests weak correlations between prostate ultrasound and post-void residual urine ($p < 0.001$; $c = 0.31$)[10].

At the end of the analysis, it was observed that there are patients with alterations in post-void residual urine, even without prostatic alterations, due to bladder repletion. The studies analyzed demonstrate that ultrasound is an important tool in the evaluation of the prostate and urinary function, offering advantages such as accessibility, low cost, and safety. These findings reinforce ultrasound as an integral part of clinical practice in urology, contributing to a more precise and effective diagnostic approach in patients with conditions such as benign prostatic hyperplasia and other urinary tract disorders.

CONCLUSION

The retrospective observational cross-sectional study showed that abdominal ultrasound was able to identify changes in prostate size and post-void residual urine, providing information for the evaluation and monitoring of these patients. However, there are weak correlations between prostate ultrasound (volume) and post-void residual urine.

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CASE REPORT

CHALLENGES AND STRATEGIES IN THE DIAGNOSIS AND TREATMENT OF CONGENITAL MULTIPLE ARTHROGRYPOSIS: ULTRASOUND, CLINICAL AND MULTIDISCIPLINARY APPROACHES – CASE REPORT

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ABSTRACT

Arthrogryposis multiplex congenital (AMC) is a rare condition characterized by fixed joint contractures present at birth and may present a variety of clinical manifestations. Early diagnosis and multidisciplinary intervention are crucial to improving patients' quality of life. This Case Report is about a pregnant woman with a fetus with AMC, highlighting the clinical findings, diagnoses and treatments adopted. In the first ultrasound, the patient presented with increased nuchal translucency, complicating with a combination of fetal akinesia, abnormal position of the limbs, intrauterine growth retardation and polyhydramnios, in subsequent examinations. After birth, they presented a series of complications, including oropharyngeal dysfunctions, respiratory and neurological problems, as well as joint deformities. Multidisciplinary treatment was essential to minimize sequelae and promote the patients' motor and cognitive development. This discussion emphasizes the importance of early diagnosis, a multidisciplinary approach and comprehensive monitoring of patients with AMC. The various clinical manifestations of the condition, the complementary exams used in the differential diagnosis and the available therapeutic options are explored, including physiotherapy, use of orthoses and corrective surgeries. Therefore, it is noted that AMC is a complex condition that requires an interdisciplinary approach throughout the patient's life. Early diagnosis and appropriate treatment can significantly improve the quality of life and autonomy of affected individuals.

KEYWORDS: ARTHROGRYPOSIS MULTIPLEX CONGENITA, EARLY DIAGNOSIS, MULTIDISCIPLINARY TREATMENT, QUALITY OF LIFE.

INTRODUCTION

Arthrogryposis multiplex congenita (AMC) is a condition characterized by the presence, at birth, of joint contractures in various parts of the body. The term "arthrogryposis" (from the Greek "arthro" for joint and "gryp" for curve) was coined in the last century to describe conditions with multiple congenital contractures. Arthrogryposis multiplex congenita (AMC) was initially described by Otto in 1841 as congenital muscular dystrophy and later named by Stern in 1923.[1]

The condition is more of a combination of signs than a single diagnosis, with most cases being of neurogenic origin, while others are related to connective tissue or mixed mechanisms. The etiology is multifactorial and may include neuromuscular disorders, central nervous system disorders, genetic syndromes, and chromosomal anomalies.[1]

There are more than 400 specific conditions that can present with congenital joint contractures, with the etiopathogenesis of AMC involving genetic factors, environmental factors, and abnormalities during fetal development. Reduced fetal movement, known as fetal hypokinesia/akinesia, is associated with the severity of the contractures.

Arthrogryposis multiplex congenita (AMC) is associated with decreased fetal movement, known as fetal hypokinesia/akinesia. The earlier the onset of this decrease in movement, the more severe the condition is likely to be at birth. The severity of the contractures is directly related to the absence of fetal movement, as the earlier and more prolonged the absence of movement, the more severe the contractures present at birth.

In most cases of arthrogryposis, joint development during embryogenesis is normal. However, decreased fetal movement is associated with several factors that contribute to the contractures present at birth. These include:

1. Increased connective tissue around the joints (collagenosis), further limiting joint movement and increasing contractures.[2]
2. Disuse and muscular atrophy of muscles associated with the joint.
3. Abnormal joint surfaces, such as square edges instead

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of rounded, increasing the risk of small fractures of the joint surfaces with efforts to mobilize the joints.

This condition highlights the importance of embryonic and fetal movement for the normal development of joints. In addition to joint contractures, AMC can present a series of signs and symptoms, such as thin skin, muscular atrophy, slightly shortened limbs, facial asymmetry, among others.

The etiology of AMC is not fully understood, and several factors are associated with its development, such as the use of medications during pregnancy, infections, trauma, among others. The diagnosis is essentially clinical, and there are different classifications for arthrogryposis, which can range from classification based on the pattern of joint involvement to more detailed classifications that consider specific clinical subtypes.[3]

Some authors propose a classification into four basic groups:

1) Generalized arthrogryposis: all four joints between the limbs and trunk are affected.
2) Distal arthrogryposis: mainly affects the feet, hands, and face.
3) Pterygium syndrome: in addition to contractures, there is a band of skin on the neck.
4) Synostosis syndrome: there is a failure in the differentiation or separation of a limb or part of it, altering its normal shape.

Another more detailed classification was proposed by Judith G. Hall4 and colleagues, which includes:

- Amyoplasia types A, B, and C: clinically more severe forms.
- Distal arthrogryposis types I and II: predominance of involvement in hands and feet.
- Arthrogryposis with associated deficiency in known syndromes, such as trismus-pseudocamptodactyly, Freeman-Sheldon, congenital contractural arachnodactyly, adducted thumbs, among others.
- Arthrogryposis due to environmental teratogen exposure.

Amioplasia forms tend to be clinically more severe. Type A amioplasia presents severe involvement of all four limbs, a rounded facial appearance, anteverted nostrils, a high nasal bridge, and micrognathia. In type B, there is severe global involvement of the upper limbs, while in type C, there is severe involvement of the lower limbs. Distal forms predominantly affect the hands and feet, with more discreet deformities in other joints.[4]

The subtypes of distal arthrogryposis type II present distinct clinical characteristics:

- Type II a: short stature and cleft palate.
- Type II b: eyelid ptosis.
- Type II c: cleft palate and cleft lip.
- Type II d: scoliosis.
- Type II e: trismus.

Currently, arthrogryposis multiplex congenita (AMC) can be detected prenatally through ultrasound, but only 25% of cases are diagnosed at this time because fetal movement is not routinely investigated in obstetric ultrasound. It is important to value the maternal perception of fetal movement absence, correlating it with possible alterations present in the ultrasound.[5]

As new diagnostic techniques have been incorporated both prenatally and postnatally, the prevalence of congenital birth defects has increased. The diagnosis of AMC can be made prenatally through ultrasound and fetoscopy.[6]

The use of magnetic resonance imaging (MRI) has been reported for AMC and other muscular dysfunctions. It is a non-invasive technique that allows for the identification and quantification of changes in isolated muscles.[7,8] Some studies suggest that MRI may be useful in children with arthrogryposis, providing information about the underlying pathological process and/or aiding in the search for genes and proteins responsible for the alterations. Computed tomography (CT) is also useful for evaluating both central nervous system involvement and muscle mass impairment.[9]

Other diagnostic methods include muscle biopsy, skin biopsy for fibroblast culture and chromosomal analysis, electromyography, nerve conduction testing, and chromosomal studies.[10]

The differential diagnosis should be made with bilateral brachial plexus paralysis and bony ankylosis. Most patients are diagnosed after birth, and clinical findings in the neonatal period, as well as responses to possible treatments, can contribute to the investigation of the etiology of AMC.

AMC does not have a definitive treatment. The therapeutic goal is to improve the patient's quality of life and autonomy, even though physical limitations remain. Follow-up is done by a multidisciplinary team, and the indication for physical therapy and/or orthopedic surgeries should be individualized. Early rehabilitation and active participation of parents in conducting exercises are fundamental for a favorable evolution of the case.

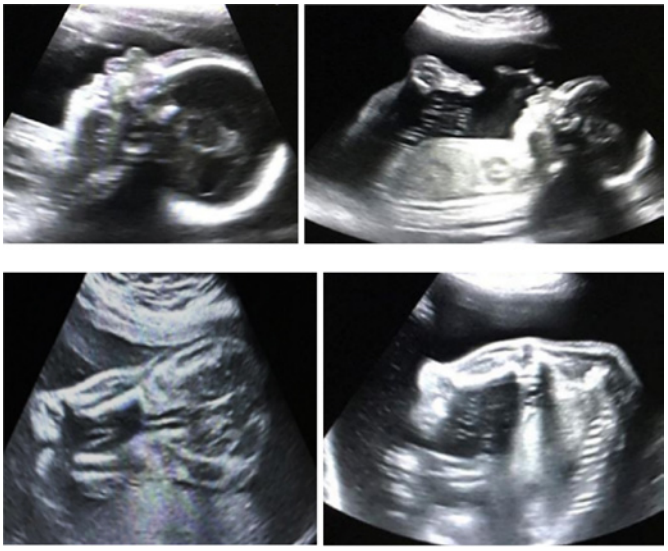
It is worth noting that AMC is a rare condition that requires more studies to elucidate its causal factors and prognostics. Case reports are relevant to assist in understanding the association of AMC with population risk factors. Ultrasonographic examination contributes to the diagnosis of this disease and highlights the importance of visualizing and valuing fetal movement during the examination. Therefore, the radiologist needs to be familiar with the concepts regarding this condition so that a multidisciplinary team is ready to provide adequate follow-up and improve the prognosis of the disease.[9]

The objective of this study is to report the case of a pregnant woman referred to the high-risk service due to a finding of nuchal translucency measurement above the 95th percentile and to discuss the outcome of this case, as well as its clinical evolution.

CASE REPORT

Pregnant woman, 31 years old, currently on her third pregnancy, with two previous cesarean deliveries, and no reported gestational complications. She denies a history of trauma or infectious diseases during pregnancy. She does not consume alcohol, tobacco, or other substances. She has no previous history of diseases, gestational pathologies, uterine alterations, or stillbirth experiences. There is no report of congenital malformations or other diseases in the family. It was observed that the parents have a fourth-degree consanguinity relationship.

Referred to the Fetal Medicine Service at Hospital do Rocio in Campo Largo, Paraná, Brazil, due to a first-trimester ultrasound finding of increased nuchal translucency measurement (5.7 mm). Upon admission at 24 weeks of gestation, fetal hydrops, cystic hygroma, micrognathia, and fetal akinesia were observed. Additionally, moderate micrognathia and the presence of multiple contractures were identified, suggesting a condition compatible with arthrogryposis multiplex congenita (AMC). Ultrasound findings included decreased fetal movement, with a fixed and unusual position of the upper and lower limbs: closed hands, overlapping left fingers, thighs joined, parallel and flexed over the trunk; hyperextension of the knees, as well as polyhydramnios – amniotic fluid index (AFI) = 31cm (Figures 1-4).



Figures 1-4. Illustrates ultrasound images with micrognathia, polyhydramnios, and multiple contractures.

In serial ultrasounds, the changes were confirmed, and worsening of some findings was noted, such as polyhydramnios (AFI 36.7 cm) - figure 5.

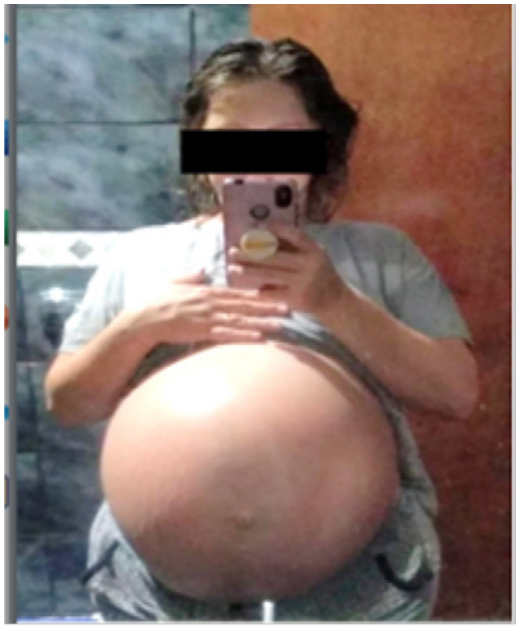


Figure 5. Illustrates maternal abdomen distended by severe polyhydramnios.

A male newborn, delivered by cesarean section in 2018, with a gestational age of 37 weeks, weighing 3,240g at birth. At birth, the Apgar score was 5/7 due to hypoactivity and apnea. He did not demonstrate sucking and swallowing reflexes. The same anomalies observed on the ultrasound examination were confirmed, with fixed joint contractures and micrognathia (see Figure 6). A small presence of cervical cystic hygroma was observed, which did not require immediate investigation or intervention.

The neonatal hearing screening test revealed abnormal results, leading to the request for Brainstem Auditory Evoked Potential testing, which showed normal bilateral results. The expanded neonatal biological screening did not show any abnormalities, and the karyotype was 46,XY.

In the ocular fundus examination, bilateral and diffuse pre-retinal hemorrhages were observed in the posterior pole, with the presence of a single microhemorrhage in the macular region, which was in the process of reabsorption.

Additionally, a patent foramen ovale, hip dislocation of the hips and knees, and the electroencephalogram showed epileptiform activity in the fronto-centro-temporal regions, consistent with the diagnosis of AMC, treated with clonazepam and phenobarbital, were observed. The neonate was subsequently transferred to the neonatal intensive care unit, where he remained for another 45 days and required mechanical ventilation, nasogastric tube, and later, gastrostomy.

In the computed tomography of the skull, signs of brain volume loss were observed, with areas of hypodensity in the periventricular and semi-oval white matter, with nonspecific characteristics.

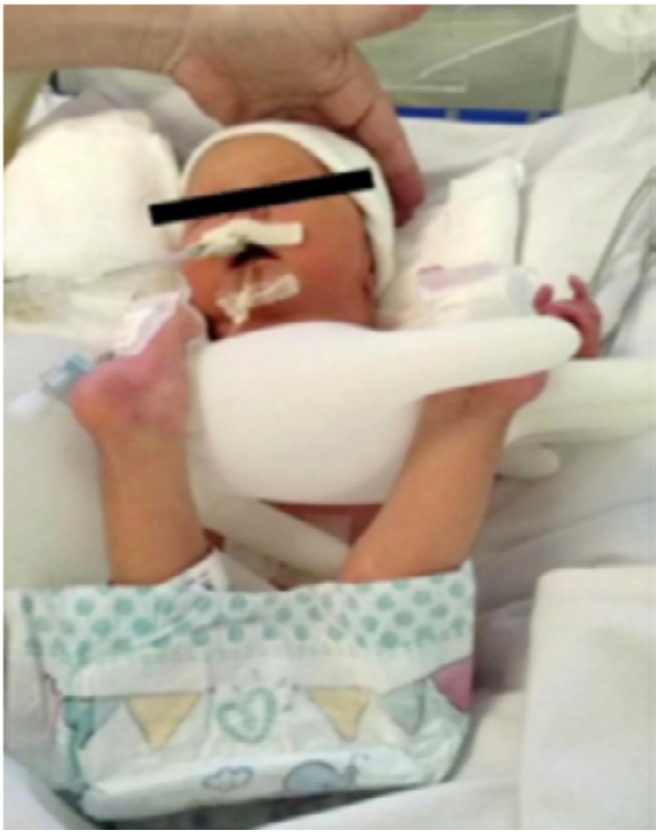


Figure 6. Five-day-old neonate. Joint contracture and hyperextension of the lower limbs are observed.

DISCUSSION

The fetal akinesia or hypomobility, the main etiological characteristic of arthrogryposis, can have various origins, including myogenic factors, fetal environmental conditions, maternal diseases, mechanical, vascular, nutritional, and neurogenic influences. Joint contracture, a symptom common to more than 400 diseases, can arise independently of the underlying pathology that leads to hypomobility.

The diagnosis of arthrogryposis is challenging and is primarily based on clinical evaluation, given the wide variety of syndromes associated with joint contractures. In approximately 75% of cases, the diagnosis is made late, after birth, possibly due to the lack of investigation of fetal movement during prenatal care, which delays the early initiation of treatment and negatively affects the prognosis. For a comprehensive postnatal evaluation, it is crucial to investigate the gestational history, family history, and perform a detailed physical examination, especially to classify the type of contractures, affected limbs, flexion or extension postures, and identify any muscular and neurological abnormalities.

The list of differential diagnoses for arthrogryposis is extensive, and tests such as X-rays, genetic tests, muscle biopsies, and blood analyses are useful to exclude other causes when the clinical diagnosis is uncertain. Conditions that need to be differentiated include Larsen syndrome, Escobar syndrome, osteogenesis imperfecta, fetal alcohol syndrome, myelomeningocele, Turner syndrome, trisomy 21, among others. AMC should be considered a diagnosis of exclusion in cases of doubt, after the exclusion of other possible causes.

Congenital multiple arthrogryposis can lead to dysphagia and swallowing difficulties in patients with sequelae such as micrognathia. Contraction of the temporomandibular joint is also common. When these oropharyngeal dysfunctions are present, they can prevent safe oral feeding due to the risk of aspiration, requiring, in some cases, the implantation of a gastrostomy to ensure a safe long-term enteral nutrition pathway.

It is crucial, in the follow-up of these patients, to investigate additional problems such as respiratory, aesthetic, and speech issues, which are common in individuals with micrognathia, aiming to improve their quality of life and increase their survival.

Early diagnosis, as exemplified in this case, and treatment coordinated by a multidisciplinary team are extremely important to minimize sequelae and preserve the baby's autonomy. The follow-up and treatment of arthrogryposis should be carried out in a careful and multidisciplinary manner, due to the wide range of disease manifestations and the tendency to recur over time, requiring prolonged follow-up with a multidisciplinary team.

In more severe or advanced cases of AMC, in addition to physiotherapy, orthoses, and immobilization, corrective surgeries may be necessary to correct osteoarticular deformities, aiming to promote independence in socialization and ambulation. In the mentioned case, the use of orthoses and immobilization with plaster casts was necessary.

The patient in question showed improvement in motor skills and neck support after treatment with physiotherapy and speech therapy. Continuous monitoring in a specialized hospital, with a team composed of gastroenterologists, neurologists, orthopedists, and geneticists, has been fundamental to his progress. Despite the limitations, early intrauterine diagnosis has resulted in a significant improvement in the patient's quality of life.

At four years of age, the child shows significant progress, such as independent movements through rolling, the ability to sit without support, hold objects, swallow liquids, and communicate verbally with some words and gestures. Additionally, he demonstrates fine motor skills, such as picking up objects and fitting blocks together (figures 7-12).

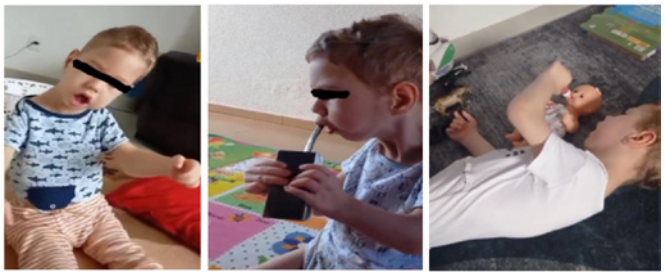


Figure 7. Infant, 45 days old, with legs hyperextended. Also note micrognathia and flexed hands. Figures 8-9. Child at 16 and 20 months, respectively, in physical therapy and orthopedic cast. Photos authorized and provided by the mother.

Figure 10-12. Four-year-old child sitting without support. Able to hold a cup, use a straw, and swallow liquids. Plays and performs some fine motor activities.

CONCLUSION

The diagnosis of arthrogryposis multiplex congenita is predominantly clinical, with an emphasis on investigating fetal movement during prenatal care, facilitated by ultrasound. For a comprehensive approach to the condition, a multidisciplinary team comprising pediatricians, orthopedists, neurologists, geneticists, physiotherapists, psychologists, nutritionists, social workers, and other professionals is essential.

This multidisciplinary approach ensures comprehensive care for AMC patients at all stages of life, providing education and awareness to parents about the nature of the disease. The integrity of care is crucial to ensure comprehensive follow-up, addressing health promotion, treatment, and rehabilitation, and ensuring access to all levels of care through service integration.

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CASE REPORT

HAND TENDINITIS FROM CAT BITE: A CASE REPORT

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ABSTRACT

INTRODUCTION: Cat bites account for a significant portion of injuries treated in emergency services and can result in serious soft tissue infections, including tendon infections. The diversity of the feline oral flora, with multiple microorganisms, increases the risk of infectious complications.
Objective: This case report aims to present a case of hand tendonitis resulting from a cat bite, highlighting the importance of accurate diagnosis and appropriate treatment for these infections.
CASE REPORT: A 27-year-old female veterinarian was bitten by a cat on the third finger of her right hand. After initial treatment with cephalexin without improvement of symptoms, she underwent an ultrasound, which revealed findings consistent with tendonitis. The antibiotic regimen was adjusted to amoxicillin-clavulanate, resulting in complete symptom remission in 10 days.
DISCUSSION: Ultrasound played a crucial role in the accurate diagnosis of post-cat bite tendonitis, allowing for the identification of tendon changes and guiding appropriate treatment. The use of this bedside imaging examination proved to be effective in altering the therapeutic management of joint infections.
CONCLUSION: A multidisciplinary approach, including clinical evaluation, imaging studies such as ultrasound, and appropriate adjustment of antibiotic therapy, is fundamental in the treatment of infections resulting from cat bites. Rapid identification and intervention are essential to prevent serious complications.

KEYWORDS: TENDONITIS, CAT BITE, ULTRASOUND, DIAGNOSIS, TREATMENT.

INTRODUCTION

Animal bites, including those from humans, account for 1% of overall presentations in emergency departments, with cat bites representing approximately 20% of cases. Early medical and surgical intervention becomes crucial to minimize the risk of infection, which can lead to limb complications and life-threatening situations[1]. The most common infectious agents in bite wounds are streptococci, staphylococci, Pasteurella multocida, Capnocytophaga canimorsus, and anaerobic bacteria, with the latter participating in mixed infections in up to 60% of cases[2]. Pasteurella spp. is often present in the oral flora of animals, recovered from the mouths of 70-90% of cats and 20-50% of dogs, and therefore are the organisms most commonly isolated from bite wound cultures[3].

Cat bites commonly occur more in women and usually affect the hand and wrist. They are notorious for potentially causing damage to deeper structures than initially estimated, specifically involving bones, joints, and tendons in a normal puncture wound[4]. Cat bites are twice as likely to become infected compared to dog bites[1]. They commonly present as cellulitis but can lead to severe infections such as tenosynovitis, abscesses, arthritis, and osteomyelitis[5].

Imaging plays a critical role in the diagnosis and treatment of musculoskeletal infections, as when used appropriately, it allows for the proper characterization of bone and soft tissue infections, often guiding clinical management even in cases where the infection is clinically apparent. Imaging typically provides additional information, including the extent of infection in deeper tissues, presence of abscesses, joint involvement, and vascular complications[6].

The objective of this article is to present a case of infectious arthritis following a cat bite and the respective ultrasound imaging findings.

CASE REPORT

Female, 27 years old, veterinarian, was attacked by a cat while working, and was bitten on the third finger of her right hand. She started empirical treatment with cephalexin 500mg three times a day, and one week after the accident, she underwent ultrasound examination due to intense pain, swelling, redness, and warmth in the area of the interphalangeal joint, on its dorsal aspect (Figure 1).

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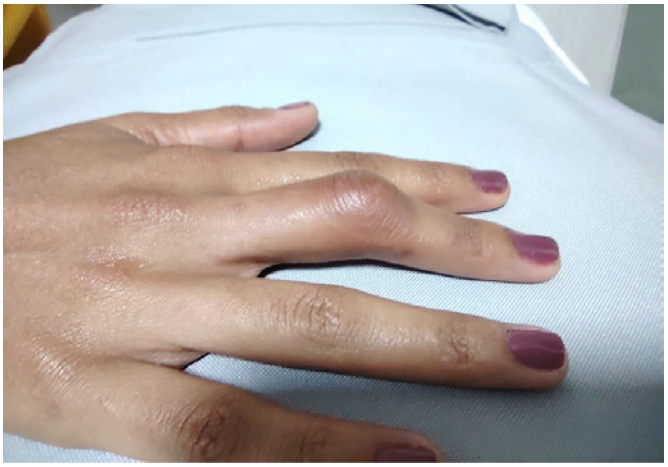

Figure 1. Photo of the patient's hand on the day of the ultrasound examination. Note the swelling and redness on the third finger of the right hand at the dorsal aspect of the proximal interphalangeal joint.

During the examination, there was an increase in thickness and hypoechoic appearance with loss of the normal fibrillar pattern of the extensor apparatus of the third finger of the right hand (Figure 2). Color Doppler and power Doppler mapping revealed hypervascularization of the affected region, both in the periphery and at the center of the tendon (Figures 3 and 4).

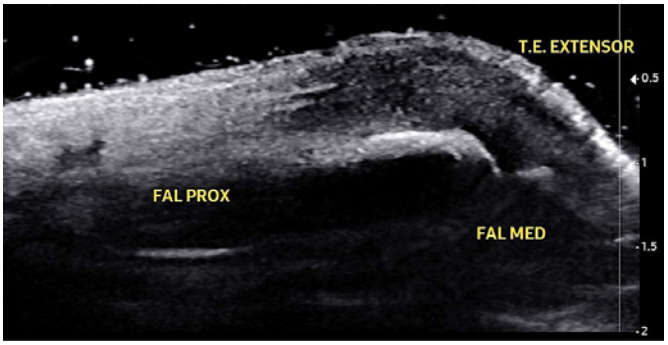

Figure 2: B-mode ultrasound showing the extensor apparatus of the third finger as hypoechoic, thickened, and with loss of the normal fibrillar pattern.

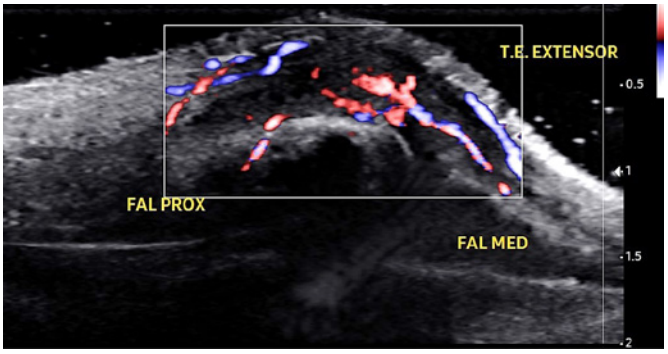

Figure 3: Directional power Doppler showing hypervascularization of the tendon.

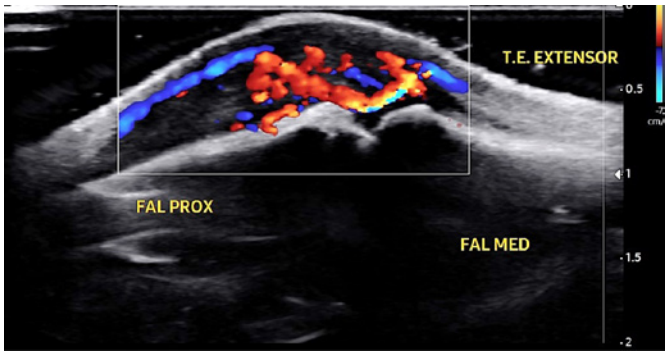

Figure 4: Color Doppler showing intense vascularization of the tendon, both centrally and peripherally.

After the examination, the antibiotic regimen was corrected, and amoxicillin-clavulanate 825/125mg twice a day for 10 days was started. This adjustment aimed to target the most common microorganisms found in feline oral flora. There was complete resolution of the symptoms within 10 days.

DISCUSSION

According to the appropriateness criteria of the American College of Radiology, due to the limited information provided by plain radiography, the use of ultrasound (US) can assist in obtaining an accurate diagnosis because of its easy access, speed, and lack of ionizing radiation place it at the top of the list of the most appropriate exams for the initial evaluation[6].

Compared to the gold standard, magnetic resonance imaging (MRI), for joint evaluation, ultrasound (US) has several advantages, including patient comfort, cost-effectiveness, accessibility, interventional guidance, and can be performed in point-of-care settings such as the emergency department. Therefore, ultrasound can assist in distinguishing between periarticular disease and intra-articular effusion and should be considered the first-line imaging technique to be used in point-of-care settings[7].

In a retrospective review of 54 patients seen in the emergency department with joint pain, erythema, and edema who underwent bedside ultrasound, ultrasound altered management in 35 of the 54 patients (65%; 95% CI, 52-77.5%) and there was a statistically significant difference in treatment plans after the addition of bedside ultrasound findings ($P < 0.01$), showing that edema of any cause, soft tissue collections, and bursitis are common causes easily diagnosed by ultrasound[7-8].

FINAL CONSIDERATIONS

The rational use of ultrasound in cases refractory to treatment continues to be recommended, as it is an easily accessible, inexpensive, and radiation-free examination. In addition to diagnosis, it allows for real-time guided intervention when soft tissue infections require it.

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CASE REPORT

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CONGENITAL KYPHOSIS AND LUMBOSACRAL MENINGOMYELOCELE: PRENATAL FINDINGS OF A RARE ASSOCIATION – CASE REPORT

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ABSTRACT

INTRODUCTION: Congenital kyphosis is a condition rarely described, especially in fetuses in the prenatal period, and its association with meningomyelocele is even more unusual. This case report describes the prenatal findings of a fetus with congenital kyphosis and lumbosacral meningomyelocele, highlighting the importance of evaluation by fetal ultrasound and magnetic resonance imaging for an accurate diagnosis and appropriate treatment planning.

CASE REPORT: A 35-year-old woman, in her second pregnancy, was referred to the fetal medicine service due to findings suggestive of fetal spina bifida. Fetal ultrasound and magnetic resonance imaging exams revealed the presence of significant congenital kyphosis, segmental spinal dysgenesis, lumbosacral meningomyelocele, hydrocephalus, as well as agenesis of the corpus callosum and septum pellucidum. Based on the findings observed, it was planned to perform the delivery and surgery, which occurred immediately after birth.

TREATMENT: the treatment involved planning for delivery and immediate surgery to correct the meningomyelocele identified in the prenatal exams, aiming to improve the quality of life and prevent complications associated with the diagnosed conditions. The patient also underwent a ventriculoperitoneal shunt due to hydrocephalus.

DISCUSSION: the importance of joint evaluation through fetal ultrasound and magnetic resonance imaging for the accurate diagnosis of complex conditions, such as congenital kyphosis associated with meningomyelocele, was emphasized. Additionally, the clinical and surgical implications of these malformations were discussed, highlighting the need for a multidisciplinary approach to provide the best treatment for the patient.

CONCLUSION: the case report highlights the importance of detailed prenatal evaluation in cases of complex malformations such as congenital kyphosis associated with meningomyelocele. The use of fetal ultrasound and magnetic resonance imaging allowed for an accurate diagnosis, as well as appropriate planning for delivery and surgical treatment, demonstrating the relevance of these complementary exams in clinical practice.

KEYWORDS: CONGENITAL KYPHOSIS, MENINGOMYELOCELE, PRENATAL DIAGNOSIS, ULTRASOUND, MAGNETIC RESONANCE IMAGING.

INTRODUCTION

Congenital kyphosis is a condition characterized by a malformation involving the spine, specifically the vertebral bodies, which undergo abnormal growth and posterior convex angulation. This condition can occur in isolation or be associated with other malformations, such as meningomyelocele[1]. It is worth noting that there are few reports in the literature of congenital kyphosis diagnosed prenatally, showing the findings identified through imaging exams, such as fetal ultrasound (US) and, especially, magnetic resonance imaging (MRI)[2].

Therefore, our objective was to describe the prenatal findings of a fetus with congenital kyphosis associated with meningomyelocele, emphasizing the characteristics identified in imaging exams, as well as their potential applicability in clinical and surgical practice.

CASE REPORT

The patient was a 35-year-old woman in her second pregnancy, who was referred to the fetal medicine service due to a fetal ultrasound with findings suggestive of fetal spina bifida. A new examination performed at our hospital drew attention to the presence of the "banana" and "lemon" signs, as well as abnormal closure of the lumbosacral spine associated with significant kyphosis (measuring 61 degrees, according to angular evaluation based on the ossification centers of the vertebral column) (Figure 1A and B).

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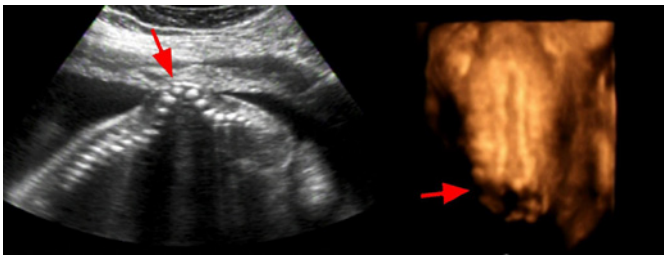

Figure 1. Two-dimensional and three-dimensional fetal ultrasound (A and B, respectively), performed at 24 weeks of gestation, showing congenital kyphosis and meningomyelocele (see the arrows).

Furthermore, there was a significant axial deviation of the lower limbs. Fetal MRI revealed segmental spinal dysgenesis and confirmed the presence of severe kyphosis. Additionally, posterior dysraphism associated with a cystic collection (suggestive of meningomyelocele), supratentorial hydrocephalus, partial parallelism of the lateral ventricles with enlarged occipital horns (suggestive findings of agenesis of the corpus callosum), and agenesis of the septum pellucidum were observed (Figure 2A). Additionally, there was a considerable reduction in the dimensions of the posterior fossa, with narrowing of the fourth ventricle and abnormal morphology of the cerebellum, which was inferiorly displaced and partially herniated into the vertebral canal. These findings were compatible with Arnold-Chiari malformation type II (Figure 2B).

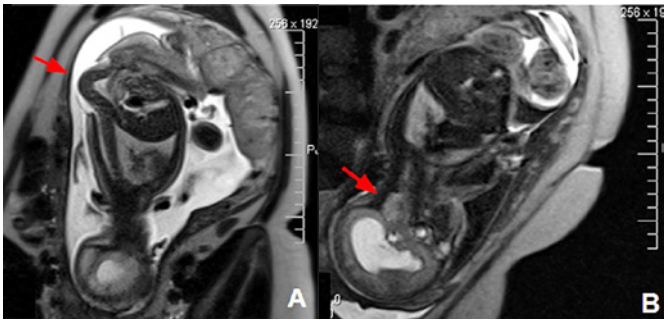

Figure 2. Fetal MRI images showing congenital kyphosis associated with meningomyelocele (A), as well as Arnold-Chiari malformation (B) (see the arrows).

The child was born via cesarean section, weighing 3,250g, measuring 45cm, with a head circumference of 37cm, and Apgar scores of 8 and 9 at the first and fifth minute, respectively. An important bony defect affecting the lumbar spine (kyphosis) was found, along with a meningomyelocele. Additionally, the suspicion of agenesis of the corpus callosum that arose during pregnancy was confirmed through MRI, as well as the presence of bilateral congenital clubfoot.

The patient underwent surgery to correct the meningomyelocele on the second day of life. A cerebral ultrasound, performed on the seventh day, showed supratentorial hydrocephalus, with the right lateral ventricle measuring 2.9cm and the left 3.7cm. There was also agenesis of the septum pellucidum, in addition to the previously described agenesis of the corpus callosum. Therefore, a ventriculoperitoneal shunt was performed at 16 days of life.

At three months, the child weighed 4,950g and was fed through a nasoenteric tube. It was also found that she had laryngomalacia. She was using a tracheostomy tube and receiving oxygen therapy via Ayre's T-piece, and she had an episode of convulsive crisis.

DISCUSSION

Defects in the formation of the vertebral column, such as the congenital kyphosis observed in our patient, can originate in different stages of embryonic development, but mainly occur during gastrulation and neurulation. During the gastrulation period (in the 2nd and 3rd weeks of gestation), the notochord originates and forms the basis for the development of the axial skeleton. In primary neurulation (in the 3rd and 4th weeks), the neural plate forms, which arises from the interaction between the notochord and the ectoderm, and its bending and folding to form the neural tube. This closes like a zipper, going in both directions[3].

Congenital kyphosis originates, therefore, from an anomaly in the formation of the notochord, which leads to a malformation of the vertebral bodies and, consequently, to different angles of the spine. The vertebral anomaly most commonly described in association with congenital kyphosis consists of hemivertebra, which usually affects more than one vertebral body (44%)[4].

Perhaps due to the proximity and timing of embryonic development (still in the first month of gestation), congenital kyphosis has been described in association with neural tube closure defects, as observed in our fetus, in up to 10 to 15% of cases. However, similar prenatal reports seem to be quite uncommon. Congenital kyphosis can also be associated with other conditions, including hemifacial microsomia/oculo-auriculo-vertebral spectrum (Goldenhar syndrome); Alagille, Jarcho-Levin, Joubert, and Gorlin syndromes, as well as Klippel-Feil sequence, VACTERL association, trisomy 18 (Edwards syndrome), and diabetic embryopathy[2].

Fetal ultrasound is an important prenatal tool capable of identifying not only structural abnormalities of the fetal spine but also congenital kyphosis. Furthermore, it is possible to diagnose associated alterations with great precision, such as neural tube closure defects[5], like the meningomyelocele identified in our case.

The evaluation of the fetal spine by ultrasound is commonly performed through the analysis of the ossification centers of the vertebrae, which are usually observed from the second trimester of pregnancy. They are located at two points in the neural arches and one in the vertebral body. Therefore, the main scanning planes used to assess the spine by ultrasound are the parasagittal, transverse, and coronal planes[5]. Most spinal defects are apparent between 20 and 22 weeks of pregnancy. In our case, the alterations were first visualized by ultrasound at 24 weeks, which is in accordance with what is described in the literature[6].

Through ultrasound, it is also possible to measure the degree of curvature of congenital kyphosis using assessment in the parasagittal plane. This method measures the angle formed between the line passing through the center of ossification of the most proximal vertebral body of the kyphosis with the line crossing the most distal center. Another method described in the literature for measuring the curvature of congenital kyphosis is by measuring the angle formed between perpendicular lines from the ends of the most cephalic and caudal vertebral bodies involved in the kyphosis. This method is analogous to the "Cobb angle," which is used to measure the degree of fetal scoliosis (see Figure 3). Ultrasound would also be a very reliable examination to determine the level of congenital kyphosis present in fetuses[7].

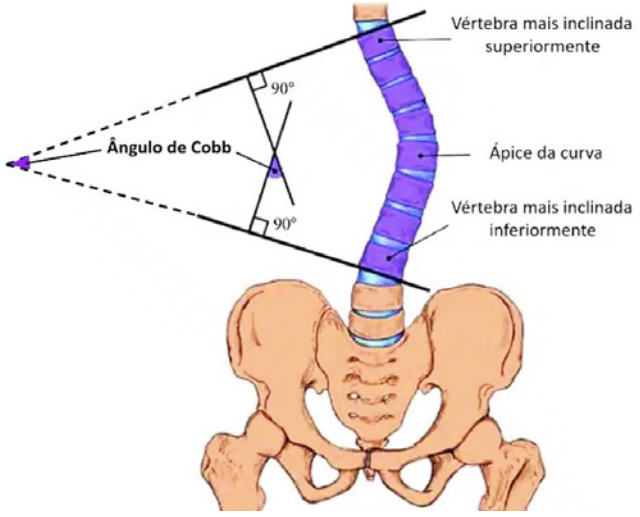

Figure 3. Illustrates the criteria for calculating the Cobb angle in scoliosis evaluation (Teixeira, R).

The findings observed on ultrasound suggesting the presence of meningomyelocele include the so-called "lemon sign" (in which there is overlapping of the fetal frontal bones) and the "banana sign" (resulting from the anterior curvature of the cerebellum towards the cisterna magna, which can lead to its obliteration). The ultrasound evaluation performed at our hospital was able to identify both signs, along with the defect in spinal cord closure at the lumbosacral level (meningomyelocele) associated with the spinal anomaly.

On the other hand, fetal MRI evaluation has been used as a complement to ultrasound in various situations. However, as mentioned earlier, there is almost no scientific literature describing prenatal reports of congenital kyphosis evaluated by fetal MRI2. In our case, this evaluation identified segmental spinal dysgenesis of the vertebral column, mainly affecting the lumbar segment, in addition to severe kyphosis associated with scoliosis.

In cases of neural tube closure defects, such as the meningomyelocele present in our patient, the importance of using MRI is already evident, as it is superior and complementary to ultrasound in evaluating certain abnormalities, such as involvement of nerve roots and the presence of Arnold-Chiari malformation observed in our fetus. The latter is characterized by herniation of the cerebellar vermis through the foramen magnum, caudally. It is best observed through sagittal sections obtained by fetal MRI. From this, it is also possible to determine the type of Arnold-Chiari malformation present, which in our fetus was type II, which is most commonly associated with meningomyelocele[8]. Other alterations in which this applicability exists include rhombencephalic hernia, cervicomedullary torsion, tectal beak, corpus callosum abnormalities, and heterotopias[3]. In our fetus, it was also possible to identify partial parallelism of the lateral ventricles, with greater volume increase of their occipital horns, findings indicative of agenesis of the corpus callosum. Additionally, agenesis of the septum pellucidum was noted.

Fetal MRI is also very important when considering surgery, including fetal surgery, to correct meningomyelocele, as it helps confirm the diagnosis and exclude the presence of associated anomalies. For all these reasons, we believe that the combined evaluation, through both ultrasound and MRI, is ideal.

Although there are conservative therapies, surgical correction remains the main treatment for congenital anomalies that significantly affect the spine, such as congenital kyphosis. Its main goal is to decompress neurological elements and correct the malformation. The surgical approach to be adopted varies according to the severity of the defect[9,10]. In our case, the surgical procedure was performed on the second day of life. Additionally, a ventriculoperitoneal shunt had to be subsequently performed due to hydrocephalus secondary to meningomyelocele.

Regarding prognosis, there is a great diversity in the literature regarding the approach to the topic. Nevertheless, there are descriptions of deterioration of the secondary and tertiary curves of the spine with growth in cases of congenital kyphosis. Over time, this can cause recurrent skin lesions, located at the apex of the kyphosis, as well as difficulty in balance and sitting ability. There may also be collapse of the lower portion of the rib cage onto the thighs, leading to respiratory compromise[8].

CONCLUSION

Congenital kyphosis is a condition rarely described in the literature in fetuses during the prenatal period. Additionally, it is noted that there is almost no description of cases evaluated, not only by fetal ultrasound but also by fetal MRI. As we have seen, the latter examination can serve as a complement to the former, for a better understanding, both of congenital kyphosis and also of related anomalies, such as the meningomyelocele observed in our fetus. In the present report, MRI also assisted in the planning of the delivery and the surgery to be performed immediately afterward. Thus, the importance of a combined approach, using both examinations, is emphasized, with the aim not only of diagnosing and improving the understanding of the alteration presented by the patient but also of identifying possible associated abnormalities and offering the best conditions for management and treatment.

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CASE REPORT

EXPLORING THE COMPLEXITY OF CONGENITALLY CORRECTED TRANSPOSITION OF THE GREAT ARTERIES: ULTRASOUND DIAGNOSIS AND CLINICAL IMPLICATIONS - AN INTEGRATIVE APPROACH AND CASE REPORT

FREDERICO DE BASTOS CAMBRAIA, BRUNA PAIVA DE BASTOS CAMBRAIA, MARCOS FARIA, ARTHUR PETTERSEN, JULIA CABRAL GOMES, HEVERTON PETTERSEN

ABSTRACT

INTRODUCTION: Congenitally corrected transposition of the great arteries (CCTGA) is a rare congenital heart disease that presents challenges in prenatal ultrasound diagnosis. Early and accurate identification of this condition is crucial for treatment planning and proper patient monitoring.
OBJECTIVE: This study aims to analyze the challenges of ultrasound diagnosis of CCTGA, highlighting the importance of confirming the occurrence of double atrioventricular and ventriculoarterial discordance for an accurate diagnosis. Additionally, it presents an illustrative case report to exemplify the prenatal echocardiographic diagnosis of this condition.
METHODS: An integrative literature review was conducted, with an emphasis on the prenatal ultrasound/echocardiographic diagnosis of CCTGA. Seven articles were selected from a search in the PUBMED and Virtual Health Library databases, using the keywords "corrected transposition of the great arteries" and "prenatal fetal diagnosis." The case report presented in this study was analyzed alongside the selected studies to contribute to the understanding of the challenges in diagnosing this condition.
CASE REPORT: The presented case describes a prenatal echocardiographic diagnosis of CCTGA without other associated cardiac abnormalities. It highlights the importance of careful evaluation of routine echocardiographic views to facilitate the accurate diagnosis of this condition.
DISCUSSION: The discussion addresses the importance of identifying specific ultrasound markers, such as double atrioventricular and ventriculoarterial discordance, to confirm the diagnosis of CCTGA. Additionally, it discusses the challenges and strategies for early and accurate diagnosis of this condition, especially when found in isolation without other associated cardiac abnormalities.
CONCLUSION: The integrative review and case report presented in this study reinforce the importance of careful and systematic prenatal echocardiographic evaluation for the diagnosis of CCTGA. Confirming the occurrence of double atrioventricular and ventriculoarterial discordance is essential for an accurate diagnosis of this condition. Early and correct identification of CCTGA allows for appropriate treatment planning and monitoring of patients affected by this rare congenital heart disease.

KEYWORDS: CONGENITALLY CORRECTED TRANSPOSITION OF THE GREAT ARTERIES, PRENATAL ULTRASOUND, DIAGNOSIS, ECHOCARDIOGRAPHY, CONGENITAL HEART DEFECTS.

INTRODUCTION

Congenitally corrected transposition of the great arteries (CCTGA) is an uncommon heart defect characterized by the atria connecting to anatomically discordant ventricles, and the ventricles connecting to discordant and transposed great arteries. Parallel vessels are evident in CCTGA, but since this sign is also present in transposition of the great arteries (TGA), a cardiac anomaly that requires major cardiac surgery in the postnatal period, it is important to differentiate between these entities prenatally. It is a rare congenital heart anomaly, representing less than 1% of live births with congenital heart disease. Most cases of CCTGA have associated anomalies, but isolated forms are rarely detected prenatally, with the isolated variant accounting for 9-16% of all cases[1].

Embryologically speaking, a mirror image looping (to the left) of the primitive heart tube during embryonic development places the anatomical left ventricle on the right side. The great arteries also present a discordant connection, maintaining the laterality. In this way, the pulmonary and systemic venous returns are properly directed to the aorta and pulmonary arteries, respectively, causing these

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two connection anomalies to neutralize each other, minimizing hemodynamic repercussions[2]. This double discordance results in a physiologically corrected circulation, but the left ventricle supports the pulmonary circulation and the right ventricle supports the systemic circulation[2,3].

CCTGA is not inherently associated with intrauterine congestive heart failure. In the absence of congestive heart failure, there is no indication to alter standard obstetric management. However, delivery should be performed in a tertiary referral center where a pediatric cardiologist is present at the time of birth[2].

The importance of this review lies in identifying ultrasound markers that could detect fetuses with CCTGA, whether isolated or associated with other cardiac malformations. This, in turn, aids ultrasonographers performing routine obstetric or fetal echocardiographic examinations in identifying fetuses with this congenital heart disease.

METHODOLOGY

This is an integrative literature review aimed at synthesizing the main findings associated with CCTGA, a rare congenital heart disease, as described in case reports and multicenter studies published in major medical journals worldwide. To illustrate the difficulty of diagnosis, we describe a case report of a fetus diagnosed prenatally with isolated CCTGA without other associated cardiac or extracardiac abnormalities.

For this study, in order to satisfy the strategy of clinical practice based on scientific evidence, we established the following PICO/PIO question: "Is there a single ultrasound marker that can define the diagnosis of congenitally corrected transposition of the great arteries? If not, what would be the best ultrasound criterion for the definitive diagnosis?"

The PUBMED and VHL (Virtual Health Library) databases were searched using the following descriptors: "corrected transposition of the great arteries" AND "prenatal fetal diagnosis".

Using the descriptors for searching scientific studies, without using filters for temporal restriction and other filters, 40 studies were returned by the search in PUBMED and 58 studies were returned in the VHL, between the years 1975 and 2024. The selection criteria for the studies included those whose themes fit the objectives of this integrative review and that could answer the guiding question.

Among the 40 studies returned by PUBMED, seven studies were selected because they met the study's interest in the diagnosis of Corrected Transposition of the Great Arteries (CCTGA) in fetal life. From the 58 studies in BVS, seven studies were chosen for meeting the criteria of interest, all of which were discarded due to duplication found with those selected by PUBMED. Additionally, a review of a specialized textbook on fetal cardiology was conducted. Thus, this integrative review was based on seven (7) studies identified in the literature and one (1) textbook (Figure 1).

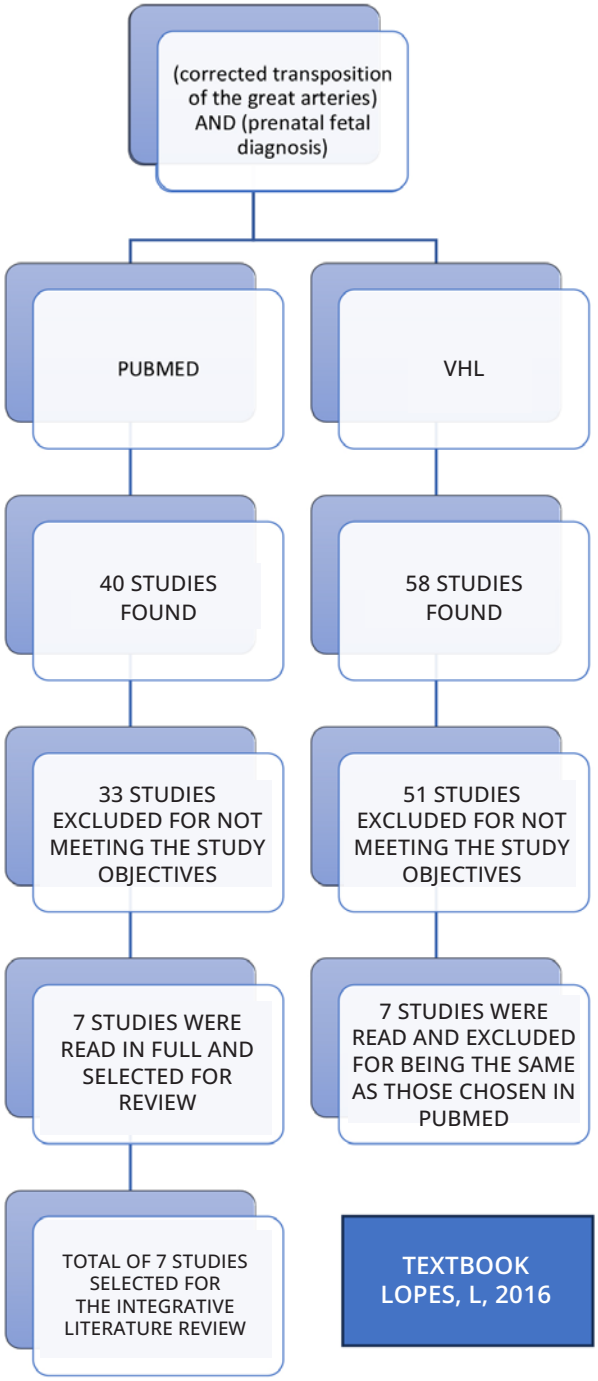


Figure 1: Flowchart of the study selection process.

Table 1 categorizes the selected studies for use in the integrative literature review, along with the designs of each study.

STUDY	DATABASE	JOURNAL	DESIGN
E1- Congenitally corrected transposition of the great arteries: clues for prenatal diagnosis. McEwing, et al., (2004)[1]	PUBMED	Ultrasound Obstet Gynecol. 2004 ;23(1):68-72.	Case Report
E2- Atrioventricular and ventriculoarterial discordance (congenitally corrected transposition of the great arteries): echocardiographic features, associations, and outcome in 34 fetuses. Sharland, et al., (2005)[3]	PUBMED	Heart. 2005 ;91(11):1453-8.	Retrospective cohort study
E3- Diagnosis, characterization and outcome of congenitally corrected transposition of the great arteries in the fetus: a multicenter series of 30 cases. Paladini, et al., (2006)[4]	PUBMED	Ultrasound Obstet Gynecol. 2006 ;27(3):281-5.	Retrospective cohort study
E4- Postnatal outcome following prenatal diagnosis of discordant atrioventricular and ventriculoarterial connections. Day et al., (2019)[5]	PUBMED	Pediatr Cardiol. 2019;40(7):1509-1515.	Retrospective cohort study
E5- Prenatal diagnosis and outcome of congenital corrected transposition of the great arteries - a multicenter report of 69 cases. Vorisek et al., (2021)[6]	PUBMED	Ultraschall Med. 2021;42(3):291-296.	Retrospective cohort study
E6- Prenatal diagnosis, associated findings and postnatal outcome in fetuses with congenitally corrected transposition of the great arteries. Krummholz, et al., (2021)[7]	PUBMED	Arch Gynecol Obstet. 2021 ;303(6):1469-1481.	Retrospective cohort study
E7- Congenitally corrected transposition of the great arteries: fetal diagnosis, associations, and postnatal outcome: a fetal heart society research collaborative study. Cohen, et al., (2023)[8]	PUBMED	J Am Heart Assoc. 2023;12(11):e029706.	Retrospective cohort study

Table 1 - Categorization of Studies

RESULTS

The final sample of this review consisted of seven publications, selected based on the predetermined inclusion criteria. The selected works were published between 2004 and 2024, covering the last 20 years.

The studies in this integrative review are summarized in ascending chronological order in Table 2, listing the results found and the relationship of responses to the questions of interest.

Study	Objective	Response to the questions of interest
E1	To describe the prenatal ultrasound characteristics and neonatal evolution of three cases of essentially isolated corrected transposition	Only the detection of both double discordance of the atrioventricular and ventriculoarterial connections is capable of confirming the diagnosis of CCTGA by ultrasound.
E2	To identify fetal echocardiographic characteristics, associations, and results of atrioventricular and ventriculoarterial discordance in a cohort of 34 fetuses.	Only the detection of the concomitant occurrence of double atrioventricular and ventriculoarterial discordance is capable of confirming the diagnosis of CCTGA by ultrasound.
E3	To describe the anatomy, associated anomalies, and evolution in a cohort of 30 cases of CCTGA detected prenatally.	Only the detection of both atrioventricular and ventriculoarterial double discordance is capable of confirming the diagnosis of CCTGA by ultrasound.

E4	To describe the spectrum of atrioventricular and ventriculoarterial discordant connections diagnosed during fetal life, as well as the medium-term outcome (beyond 5 years of age and up to early adulthood) in a cohort of 98 fetuses with prenatal diagnosis.	Only the detection of the simultaneous occurrence of double discordance of atrioventricular and ventriculoarterial connections is capable of confirming the diagnosis of CCTGA through ultrasound.
E5-	To investigate the natural history, associated anomalies, and outcomes of a cohort of 69 patients with a prenatal diagnosis of CCTGA.	Only the detection of the concomitant occurrence of double discordance atrioventricular and ventriculoarterial is capable of confirming the diagnosis of CCTGA, by ultrasound.
E6	To analyze the anatomical characteristics and associated malformations in a cohort of 37 cases of CCTGA detected prenatally and to evaluate the prenatal course, neonatal outcome, and medium-term follow-up.	Only the detection of double discordance between the atrioventricular and ventriculoarterial connections is capable of confirming the diagnosis of CCTGA through ultrasound.
E7	To investigate the natural history, associated anomalies, and outcomes of a cohort of 205 fetuses diagnosed with CCTGA.	Only the detection of both double discordance in atrioventricular and ventriculoarterial connections is capable of confirming the diagnosis of CCTGA through ultrasonography.

Table 2 - Illustrates the objectives and answers to questions of interest.

All selected studies were conclusive and unanimous in affirming that only the confirmation of double discordance, atrioventricular and ventriculoarterial, is capable of confirming the prenatal ultrasonographic diagnosis of CCTGA.

DISCUSSION

The congenitally corrected transposition of the great arteries (CCTGA) is a rare congenital heart defect characterized by the atria connecting to the ventricles in an anatomically discordant manner, and the ventricles connecting to the great arteries in a discordant and transposed manner. Parallel vessels are evident in CCTGA, but as this sign is also present in complete transposition of the great arteries (TGA), a cardiac anomaly that requires major cardiac surgery in the postnatal period, it is important to differentiate the entities prenatally. It is an uncommon congenital heart anomaly, accounting for less than 1% of live births with congenital heart disease. Most cases of CCTGA have associated anomalies, but isolated forms are rarely detected prenatally, with the isolated variant accounting for 9-16% of all cases[1] .

The venoatrial connections are normal, and the discordance in both atrioventricular and ventriculoarterial connections allows hemodynamic compensation (Figure 2). Careful examination of the ventricles allows distinguishing between the morphological right and left ventricles and detecting the atrioventricular discordance[1].

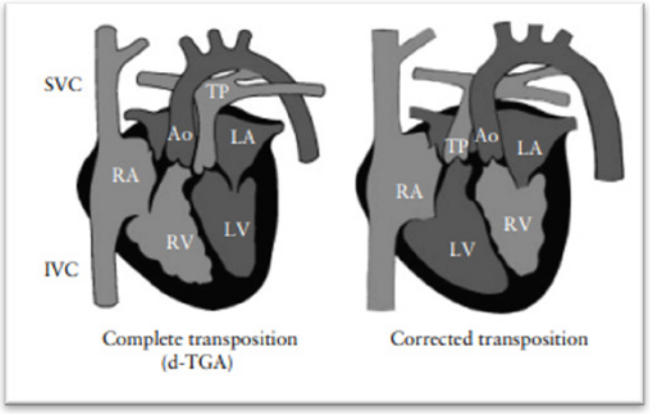


Figure 2: RA, right atrium; LA, left atrium; RV, right ventricle; LV, left ventricle; Ao, aorta; TP, pulmonary trunk; IVC, inferior vena cava; SVC, superior vena cava1.

Reiterating, in CCTGA, the right atrium drains into a morphological left ventricle on the right side through the mitral valve, and the left atrium drains into a morphological right ventricle on the left side through the tricuspid valve (atrioventricular discordance). The morphological left ventricle is connected to the pulmonary artery, while the aorta arises from the morphological right ventricle (ventriculoarterial discordance). The great vessels have a parallel course without crossing, with the aorta usually located anteriorly and to the left of the pulmonary trunk (Figure 3). This results in a physiologically corrected blood flow, with the morphological right ventricle controlling the systemic circulation in postnatal life[7].

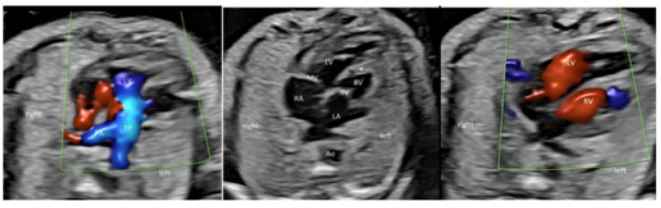


Figure 3: Ao - aorta, LA - left atrium, RA - right atrium, TV - tricuspid valve, MV - mitral valve, RV - right ventricle with left morphology, LV - left ventricle with right morphology[7].

Sharland et al.[3] published the first retrospective cohort of 34 fetuses with prenatal diagnosis of CCTGA, from patients treated at a tertiary cardiology center, aiming to confirm the position of the ventricle with the moderator band, the parallelism or abnormality in the orientation of the great arteries, associated cardiac abnormalities, outcomes, and postnatal confirmation of findings, confirming the high prevalence of associated heart diseases and the rare occurrence of the isolated form.

Paladini et al.[4] conducted a retrospective multicenter study of 30 cases of CCTGA with prenatal diagnosis confirmed by autopsy or postpartum echocardiography. In this study, with a mean gestational age at diagnosis of 25.5 weeks, the authors suggest a low correlation between CCTGA and chromosomal and extracardiac anomalies, confirming the high prevalence of associated cardiac abnormalities. The associated anomalies found are in accordance with values derived from pediatric literature. They are, in decreasing order of frequency: ventricular septal defects, pulmonary stenosis/atresia, anomalies of the left tricuspid valve (including dysplasia, Ebstein-like insertion, "straddling", tricuspid atresia), rhythm disorders, and dextrocardia, and are consistent with those mentioned in subsequent retrospective multicenter studies, as shown in Table 3.

Anomalias Associadas (%)	Sharland (2005)	Paladini (2006)	Day (2019)		Vorisek (2020)	Krummholz (2021)		Cohen (2023)	Literatura pediátrica	TOTAL
			Pré-Natal	Pós-Natal		Pré-Natal	Pós-Natal			
Defeito septal ventricular	62,0	70,0	65.3	67.4	75.9	73	73,5	68.3	70-84	**69,4**
Obstrução pulmonar	35.2	40,0	28.6 (21.4+civ)	32.6 (23.3+civ)	35.2	35.1	55.9	38.4	30-50	**20,6**
Anormalidades da valva tricúspide	26.4	33.3	ND	ND	33.3	18,9	23.5	19.6	14-56	**25,8**
Bloqueio atrioventricular completo	ND	13.3	ND	ND	18.5	5.4	11.8	11.3	12-33	**12,1**
TCCGA isolada	14.7	13.4	15.3	20.9	13,0	13.5		21.5	9-16	**16,1**
Anomalias do arco aortico	11.7 CoAo	10.0	14.3 CoAo	9.3 CoAo	9.3	13.5	29.4	10.7	13,0	**13,5**

Table 3 illustrates the most prevalent associated anomalies with CCTGA found in the selected studies.

Associated anomalies

After reading the studies thoroughly and comparing them, it was possible to evaluate the occurrence of associated anomalies – table 3.

The most frequent cardiac anomaly in all studies was ventricular septal defect (VSD), with occurrence ranging from 69.4% in the selected studies. In the study by Vorisek et al.[6], most VSDs were large, diagnosed in the B-mode, and involved the membranous septum, with no specific percentage found. In the largest representative cohort of CCTGA to date, Cohen et al. [8] estimated the percentage of perimembranous VSD at 52.9%, inlet VSD at 23.2%, muscular VSD at 11.6%, double outlet VSD at 5.8%, and malalignment VSD at 1.5%[8].

Pulmonary obstruction presented with varying degrees, from mild stenosis to severe degrees of atresia, with an incidence of 20.6%.

Tricuspid valve abnormalities were found in 25.8%, with the most frequent being Ebstein's anomaly, tricuspid regurgitation, and straddling of the tricuspid valve.

Aortic arch anomalies and complete atrioventricular block were found in 13.5% and 12.1%, respectively.

Other abnormalities, no less important, were recognized by the studies, such as right ventricular hypoplasia, persistent left superior vena cava, heterotaxy, and pericardial effusion. When evaluating the presence of isolated CCTGA, the total incidence was 13.5%.

The prenatal ultrasound diagnosis of CCTGA is possible with good accuracy, especially in specialized centers. It is recommended to focus on differentiating the left and right ventricles on echocardiography, for example, by identifying the morphological right ventricle in the four-chamber view by its posterior and left position, a prominent moderator band, a more irregular endocardial surface, more apical attachment of the atrioventricular (tricuspid) valve, and distal and central attachment of the papillary muscles. In contrast, the morphological left ventricle is characterized by a smooth surface, a more elongated shape, a less apical insertion of the mitral valve, and papillary muscles that attach to the lateral wall of the ventricle. This identification is important, particularly when a parallel course of the great arteries is found, to distinguish CCTGA from complete transposition of the great arteries (TGA), a cardiac anomaly that requires different management shortly after birth[7].

Unless there are associated malformations, CCTGA may not be easily identified during routine ultrasound investigation and can be confusing for ultrssonographers and those inexperienced in fetal heart examination. The fetal spectrum is therefore biased towards these cases. However, prenatal detection during obstetric screening is clearly possible, as most fetuses (91%) in this series were referred due to a suspected problem during routine obstetric screening[8].

The cardiac assessment aimed at diagnosis through the evaluation of routine ultrasound or echocardiographic sections facilitates the diagnosis. In a publication for the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG), Carvalho et al.[9] recommend a guide for good ultrasound practices for the detection of congenital heart diseases in low-risk groups - ISUOG Practice Guidelines (updated): fetal cardiac screening, 2023[9]. The authors acknowledge that the assessment of the fetal heart goes beyond the four-chamber view and the three vessels and trachea (some lesions, such as transposition of the great arteries, coarctation of the aorta, may not be evident only in the four-chamber plane). Complementing the four-chamber view with views of the outflow tract and great vessels in the cardiac screening exam has played an important role in improving the detection of congenital heart diseases. The guideline proposes a

checklist to be followed by ultrssonographers for good practices to improve the assessment of the fetal heart. It proposes a systematization of the exam, with axial scanning, starting at the fetal abdomen and tilting the transducer cephalically, as demonstrated in figures 4 and 5[9].

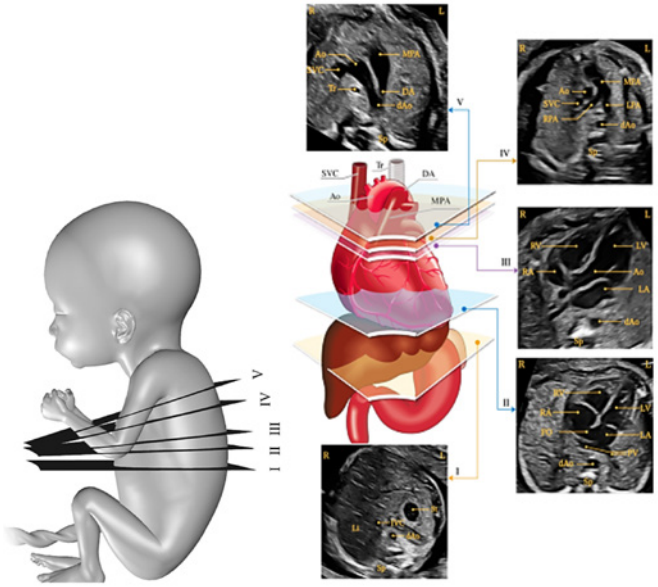


Figure 4 and 5. Illustrates the left five transverse planes in a fetal model and the left ultrasonographic images of these planes. I - transverse plane of the abdomen – situs solitus (St) fetal stomach, (dAo) descending aorta, (IVC) inferior vena cava, (Sp) spine, (Li) liver; II - transverse plane of the heart - four-chamber view - (RV, LV) right and left ventricles, (RA, LA) atria, (FO) foramen ovale, (PV) pulmonary veins; III - long axis of the left ventricle with aortic output - (Ao) ascending aorta; IV - short axis of the pulmonary trunk leaving the right ventricle - (MPA) main pulmonary artery, (RPA) right and (LPA) left pulmonary arteries; V - transverse section of the three vessels and trachea9 - (SVC) superior vena cava, (DA) ductus arteriosus, (Tr) trachea. L, left, R, right.

CASE REPORT

35-year-old primigravida, without known comorbidities, except for gestational hypothyroidism. On 02/03/2023, she underwent a fetal morphological ultrasound examination at a reference service, with an estimated gestational age of 23 weeks and 6 days, where it was observed: 'parallel arteries emerging from the ventricles, with the aorta connected to the right ventricle and the pulmonary artery connected to the left ventricle,' without other detectable abnormalities by the method and concluded as: transposition of the great arteries (Figure 6).

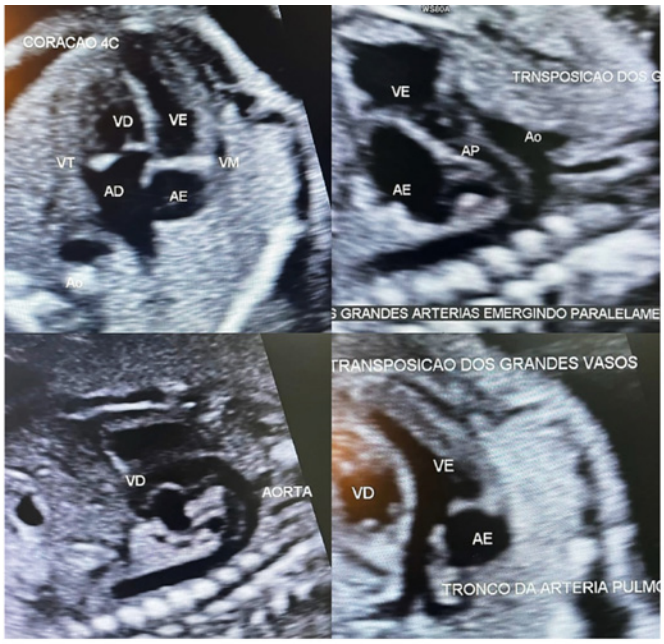


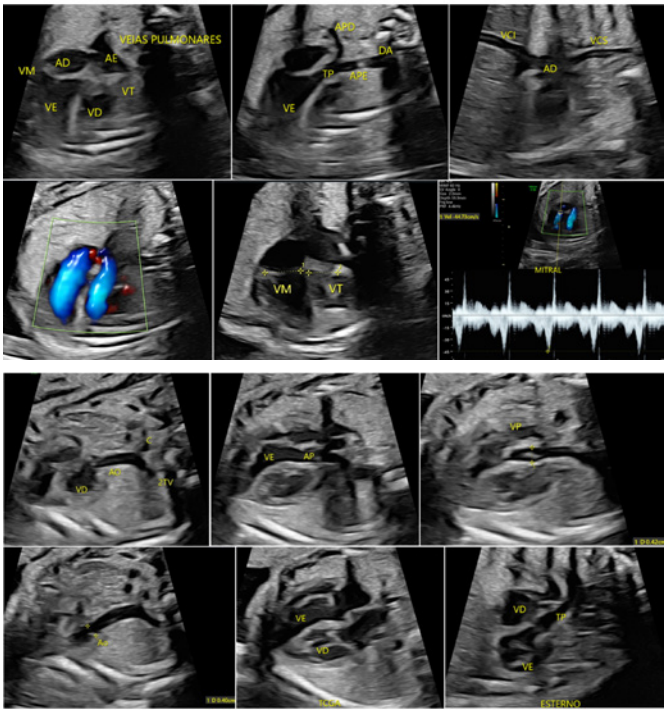
Figure 6: Four-chamber view followed by parallel great vessels. Lower images represent the great vessels, aorta from the right ventricle, and pulmonary trunk from the left ventricle. Courtesy of Dr. Alexandre Henrique Sidney de Andrade.

She was referred to our service for a color Doppler echocardiogram on 02/28/2023, at 27 weeks and 3 days of gestational age, confirming the findings. The following report was issued (figures 7-23):

- Fetus in cephalic presentation, with the back to the left;
- Heart rate 142 bpm, sinus rhythm;
- Abdominal situs solitus; Heart in levoposition and levocardia, presenting four chambers;
- Presents venoatrial concordance;
- Presents atrioventricular and ventriculoarterial discordance - corrected transposition of the great arteries (CTGA), left ventricle of right morphology and right ventricle of left morphology. Aorta emerges from the right morphology ventricle and the pulmonary artery emerges posteriorly from the left morphology ventricle;
- Intact interventricular septum, without any detectable communication by the method;
- Normal septal thickness for gestational age;
- Cardiac chambers with normal dimensions;
- Pulmonary arteries and aorta flow with antegrade flow directions.
- Evaluation of the tricuspid, mitral, and ductus venosus valves without evidence of retrograde flow;
- Foramen ovale with anatomical characteristics, presenting right-to-left flow, with a usual appearance lamina;
- Mitral valve measuring 9.7mm (Z score=1.29), with peak systolic velocity of 44.7cm/s; Aortic valve measuring 4.0mm (Z score=-0.61), with peak systolic velocity of 70.5cm/s;

• Tricuspid valve measuring 7.9mm (Z score=-0.63), with peak systolic velocity of 48.5cm/s; Pulmonary valve measuring 4.2mm (Z score=-1.90), with peak systolic velocity of 64.6cm/s;

DIAGNOSTIC IMPRESSION:
• Corrected Transposition of the Great Arteries (CTGA).
All photographic documentation of this fetal echocardiography at 27 weeks and 03 days is presented below (Figures 7-23), illustrating the findings, the connections, the normality and functionality of the heart valves, as well as documenting the absence of other associated cardiac abnormalities and confirming the case as isolated CCTGA.



Figures 7-23 - Illustrate ultrasound images of the fetal echocardiogram. RV right ventricle; Ao aorta; 2TV two vessels trachea; LV left ventricle; PA pulmonary artery; PV pulmonary valve; PT pulmonary trunk; RA right atrium; LA left atrium; MV mitral valve; TV tricuspid valve; RPA right pulmonary artery; LPA left pulmonary artery; DA ductus arteriosus; IVC inferior vena cava; SVC superior vena cava.

After the study, the pregnant woman was referred by her attending obstetrician to a tertiary referral center for scheduling the birth with a cardiologist present at the time of delivery.

On 05/03/2023, at 36 weeks of gestation, at the request of the tertiary referral center team, a new color Doppler echocardiogram was performed in a specialized service, confirming the findings of the previous study, concluding the diagnostic hypothesis as corrected transposition of the great arteries.

The birth was via cesarean section at 39 weeks and 1 day, on 05/24/2023, with 14 hours of ruptured membranes and clear amniotic fluid. The male newborn was born well with an APGAR score of 9/9, without alterations on the initial physical examination. The newborn was referred to the neonatal intensive care unit for further investigation of the heart condition.

On 05/26/2023, still in the neonatal intensive care unit, a two-dimensional echocardiogram was performed, confirming the findings of the prenatal examinations. Additionally, there was a minimal patent ductus arteriosus shunt, mild tricuspid regurgitation, and mild narrowing at the level of the aortic isthmus, without causing significant gradients.

The newborn progressed without complications, was discharged from the hospital on 05/29/2023 and returned to the pediatric cardiologist on 06/272023. The family was advised to schedule a two-dimensional color Doppler echocardiogram when the child reaches one year of age.

CONCLUSION

The present integrative review showed that congenitally corrected transposition of the great arteries (CCTGA) is a rare congenital heart defect, more commonly associated with other congenital heart diseases and less prevalent when found in isolation without other abnormalities, as in the presented case. Directed cardiac evaluation for diagnosis, through routine echocardiographic cuts, facilitates diagnosis.

Responding to the guiding question (PICO), all selected studies were conclusive and unanimous in affirming that only the confirmation of the occurrence of double discordance, atrioventricular and ventriculoarterial, is capable of confirming the prenatal ultrasonographic diagnosis of CCTGA.

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REVIEW ARTICLE

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

LOREN MENDES SOUZA[1], TATIANA RIBEIRO GOMES DA MATTA[1], LEONARDO DE SOUZA PIBER[1]

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.

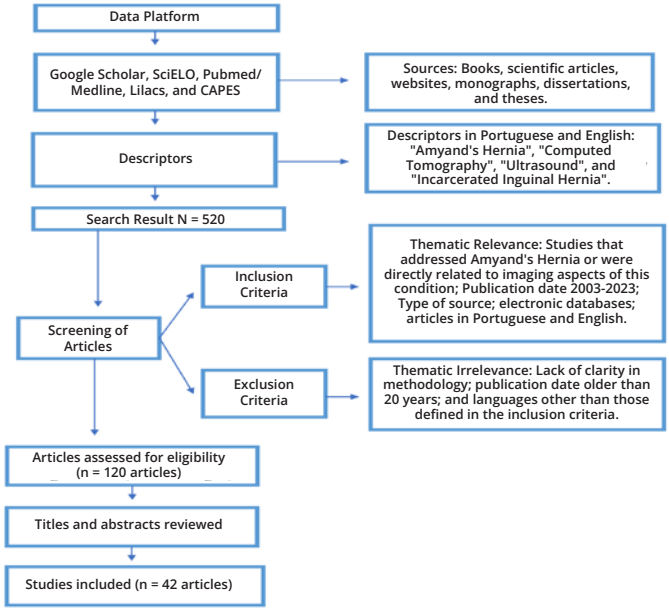

Figure 1. Flowchart - narrative review methodology

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].

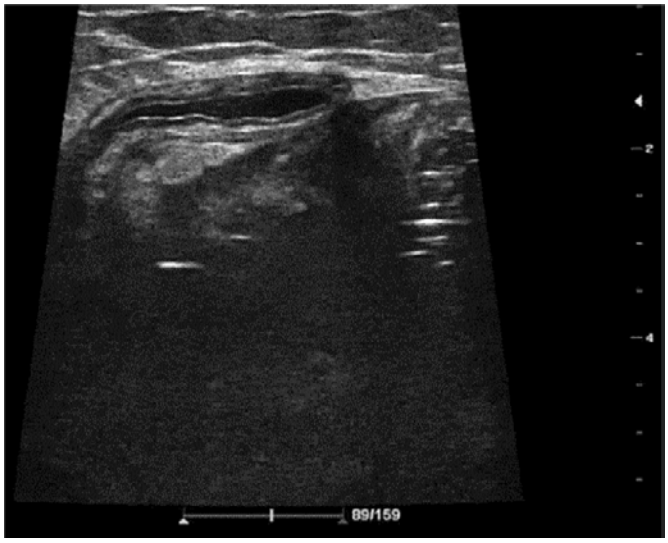

Figure 2. Ultrasound of the inguinal mass, showing a blind tubular structure with a thick wall inside the hernia sac, corresponding to the incarcerated appendix[29].

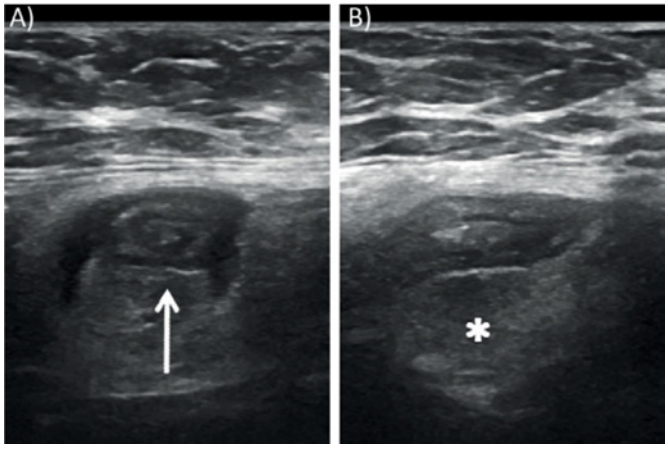

Figure 3. Grayscale ultrasound. Axial (A) and sagittal (B) views of the appendix inside an inguinal hernia sac[9].

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].

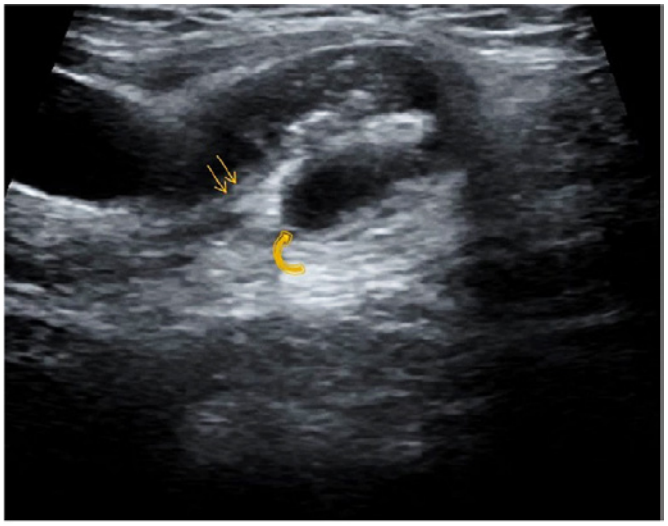

Figure 4. Ultrasound revealed an inflamed appendix in the inguinal hernia sac (thin arrows), ending with a blind end (curved arrow) in the hernia sac[4].

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.

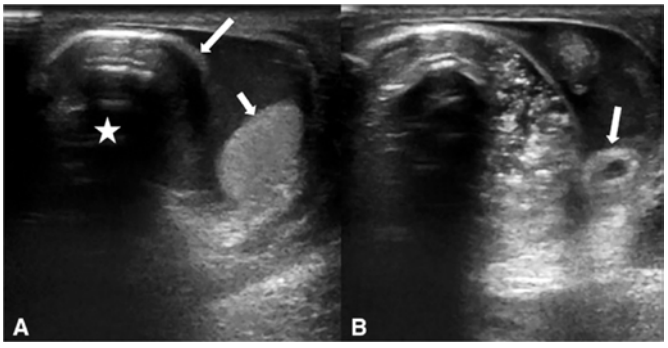

Figure 5. (A) Ultrasonography revealed the herniation of a segment of the colon into the scrotal sac (long arrow) and observed an air artifact generated from the colon (asterisks). Note the normal appearance of the testicle (short arrow). (B) Vermiform appendix was seen in the scrotal sac (arrow). The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

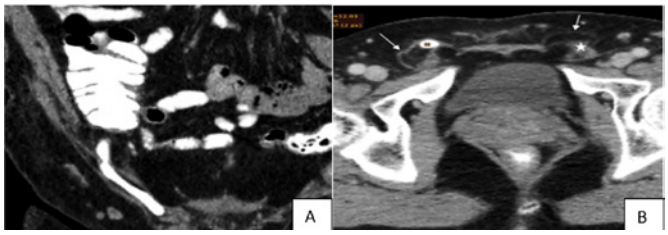

Figure 6. Computed tomography. A - Coronal section, B - Axial section. Amyand hernia type 1[35].

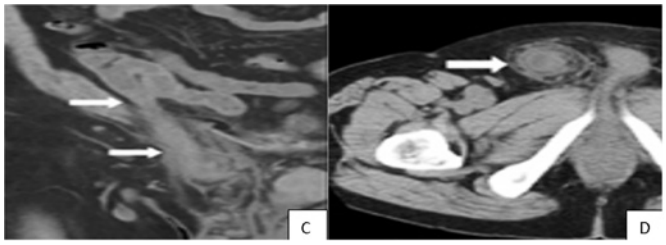

Figure 7. Computed tomography. C - Coronal section, D - Axial section, without intravenous contrast. Amyand hernia type 2. Thickening of the appendiceal wall and fatty filament[35,36,42]

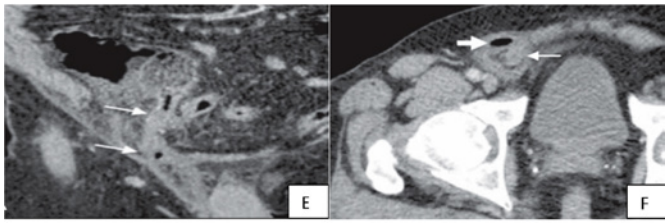

Figure 8. Computed tomography. E - Coronal section, F - Axial section. Amyand hernia type 3. Distended appendix with thickened wall within a right inguinal hernia, with adjacent focus of free gas[25,45]

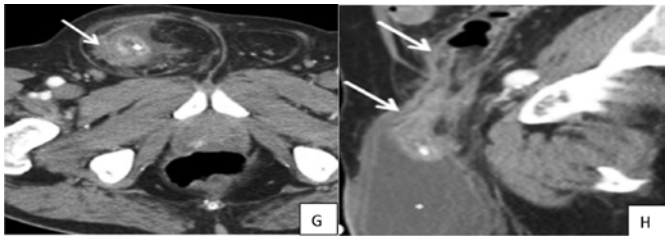

Figure 9. Computed tomography. G - Axial section, H - Sagittal section. Amyand hernia Type 4. Acute appendix associated with scrotal collection (larger arrow)[37].

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].

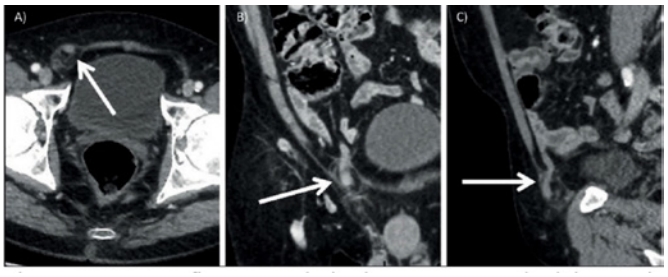

Figure 10. Contrast-enhanced abdominal computed tomography. Axial (A), coronal (B), and sagittal (C) views of the appendix located within the right inguinal hernia sac[9].

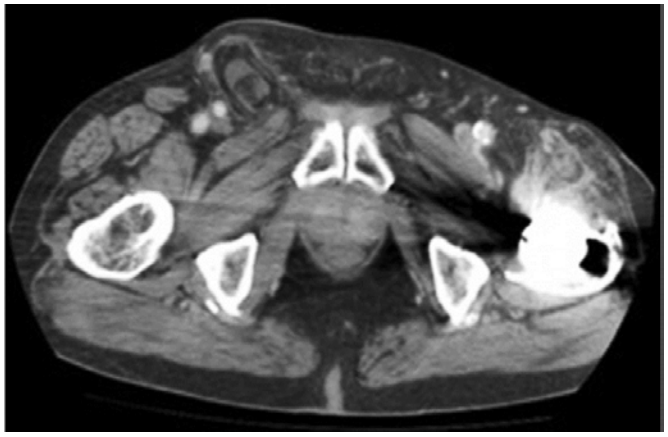

Figure 11. Anteroposterior view of the described Amyand's hernia on computed tomography[38].

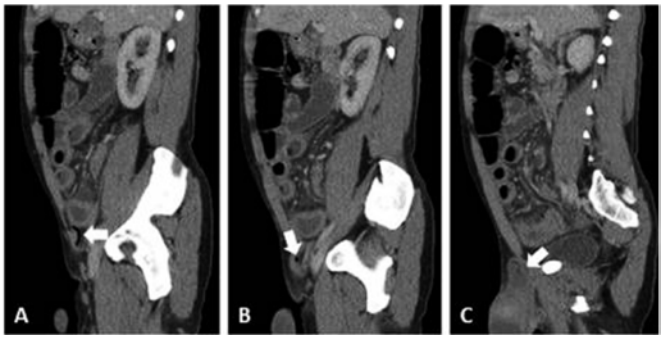

Figure 12. Contrast-enhanced sagittal computed tomography images from lateral (A) to medial (C) showing the progression of the appendix as it extends into the right inguinal hernia. Technique: The sagittal contrast enhanced CT images increased the images of the lower abdomen[41]

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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ULTRASOUND AS A SCREENING TOOL FOR EARLY DIAGNOSIS OF DEEP VENOUS THROMBOSIS IN HOSPITALIZED PATIENTS

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ABSTRACT

INTRODUCTION: Deep vein thrombosis (DVT) of the lower limbs is a serious vascular disease where accurate diagnosis and treatment are crucial to prevent embolization and other complications. Point-of-care ultrasound (POCUS), an ultrasound examination performed at the bedside, has been increasingly used due to its diagnostic accuracy comparable to other radiological exams in the diagnosis of DVT.

OBJECTIVE: To assess the application of POCUS in hospitalized patients for the diagnosis of DVT, observing its sensitivity and specificity.

METHODOLOGY: Narrative review in the PubMed database, considering eligible articles in English, from 2018 to 2024, with information about POCUS with two and three-point compression, with data that allows analyzing if it is a method with good sensitivity and specificity.

RESULTS: Five eligible articles were selected for consideration in this review if they reported the use of POCUS in the diagnosis of DVT. The sensitivity of POCUS in detecting DVT ranged from 82.8% to 100%, and the specificity ranged from 90% to 98.8%. The positive predictive value ranged from 61.5% to 83%, while the negative predictive value ranged from 97% to 100%.

CONCLUSION: It is evident that POCUS presents excellent effectiveness in addition to being low cost and easy to perform. The time from examination to DVT diagnosis is shorter compared to other methods, favoring the anticipation of antithrombotic therapy and improving morbidity and mortality.

KEYWORDS: POCUS, DEEP VEIN THROMBOSIS, HOSPITALIZED PATIENTS.

INTRODUCTION

Acute deep vein thrombosis (DVT) of the lower limbs is a serious vascular disease with an annual incidence of 0.1% in adults. Accurate diagnosis and treatment of acute DVT are crucial to prevent embolization and other complications. Mortality from pulmonary embolism, a potentially fatal complication of DVT, can reach 30% if left untreated[1].

While the gold standard for diagnosing DVT is contrast venography, ultrasound is a good diagnostic alternative, especially when considering other diagnostic methods such as clinical diagnosis, D-dimer, Wells and Geneva scores, due to its wide availability, cost-effectiveness, absence of radiation, absence of intravenous contrast, and patient comfort [1, 2].

Point-of-care ultrasound (POCUS), an ultrasound examination performed and interpreted by the physician at the bedside, has been increasingly used in the emergency department, intensive care unit (ICU), wards, and outpatient settings for evaluating the venous system of the lower limbs. Studies have found that POCUS can have diagnostic accuracy comparable to other radiological exams, making it a very useful tool in routine clinical practice1.

The American College of Emergency Physicians has supported the use of POCUS to assess DVT since the 1990s, but it was only in 2017 that DVT was added to the list of twelve main ultrasound applications for emergency medicine[1].

DVT still poses a challenge regarding diagnosis, treatment, and follow-up. Vascular ultrasound has been shown to be necessary for establishing the diagnosis, the type of thrombosis, and the appropriate treatment course. When the criteria are accurately met, they lead to the diagnosis of DVT, early initiation of treatment, and establishment of the ideal strategy after the initial treatment period[3].

METHODOLOGY OF THE POCUS EXAM

Patient Position

Initially, it is necessary to clarify the techniques applied in performing POCUS in the lower limbs for research and possible detection of DVT in patients. There are two types of POCUS techniques used, the two-point compression and three-point compression. The two-point POCUS evaluates

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the compressibility of the common femoral vein (CFV) and popliteal vein, and the three-point POCUS includes the superficial femoral vein (SFV)[3].

To perform the ultrasound examination of the veins of the lower extremity, the patient should lie on their back, with the head elevated at an angle of preferably 30°. This inclination helps to prevent the accumulation of blood in the leg veins and facilitates the visualization of the blood vessels[3].

Next, the examiner should externally rotate the patient's hip and slightly bend the knee. This position is most commonly used as it enlarges the femoral veins and brings them closer to the ultrasound transducer's field of view. Additionally, the position allows for examination of the inguinal region and popliteal fossa without the need to reposition the patient. When possible, the prone position can be useful for examining the popliteal veins[3].

The examiner usually stands beside the patient, on the same side as the extremity being evaluated. If using a ultrasound machine mounted on a cart, it should be positioned within reach of the examiner at the head of the bed. The bed height should be adjusted for the comfort of the examiner[3].

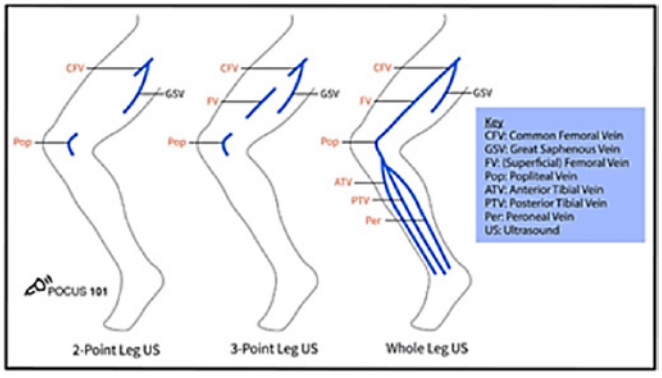

Figure 1: Vessels analyzed in lower limb ultrasound types. POCUS, 2022[5].

Description of the techniques:

Correct vein compression: apply pressure until the pulsatile artery is slightly compressed, if the adjacent vein compresses completely, there is no DVT.

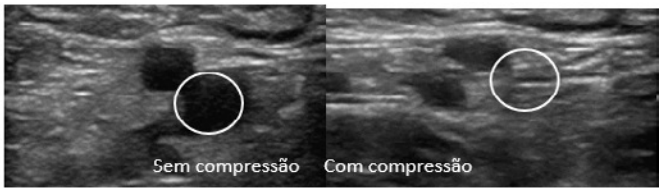

Figure 2: Example of artery and vein visualized without and with compression. POCUS, 2022[5].

Step 1: Femoral Vein

• With gel on the transducer, place it along the inguinal ligament, between the pubic symphysis and the anterior superior iliac spine (ASIS).

• Position the transducer perpendicular to the skin, in the transverse direction.

• Locate the common femoral vein (CFV) and common femoral artery (CFA).

• Note that the CFV is medial to the CFA.

• Apply firm pressure with the transducer until the artery is slightly compressed. In a normal scan, the vein should be fully compressed [4, 5].

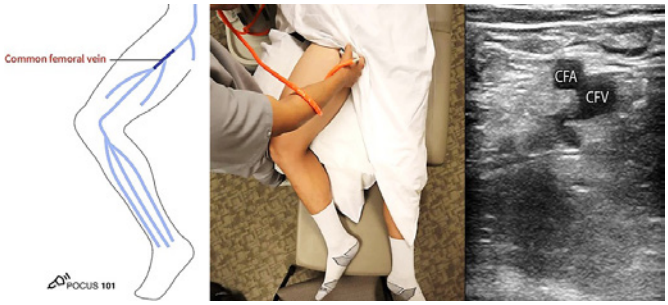

Figure 3: Visualization of the common femoral artery and common femoral vein without compression. POCUS, 2022[5].

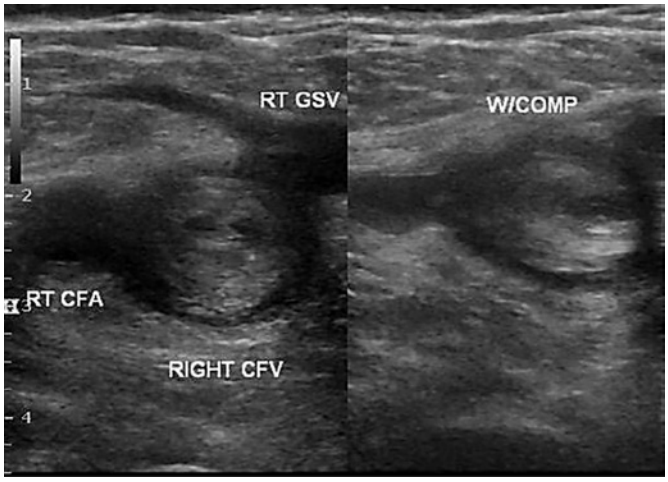

Figure 4: Example of common femoral vein with thrombus (without and with compression). POCUS, 2022 [5].

Step 2: Great Saphenous Vein

• Slide the transducer 1-2cm down the patient's leg to find where the great saphenous vein branches off from the CFV.

• As the transducer moves distally, the artery typically bifurcates first, followed by the vein.

• Compress the CFV at the junction with the great saphenous vein.

• Depending on the size and proximity of a clot in the great saphenous vein with the CFV, there is evidence that these should also be treated as DVT [4, 6].

Figure 5: Visualization of the branching of the great saphenous vein and common femoral vein. POCUS, 2022 [5].

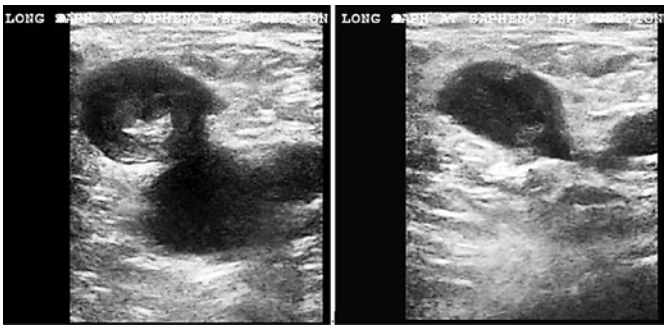

Figure 6: Example of thrombus in the great saphenous vein at the junction with the common femoral vein (without compression and with compression) [6].

Step 3: Femoral Vein (Superficial)
• Slide the transducer 1-2cm down the patient's leg to find where the CFV branches into the deep and superficial femoral veins.
• The deep femoral vein will dive deeply into the thigh. The superficial femoral vein will run alongside the femoral artery.
• Compress the superficial femoral vein immediately distal to the bifurcation.
• Optional: although the three-point ultrasound protocol requires compression just distal to the bifurcation, you may also check for clots in the remainder of the superficial femoral vein by gradually moving the transducer downward and medially toward the popliteal fossa where the superficial femoral vein dives into the adductor canal[4, 5].

Figure 7: Visualization of the femoral artery and superficial femoral vein. POCUS, 20225.

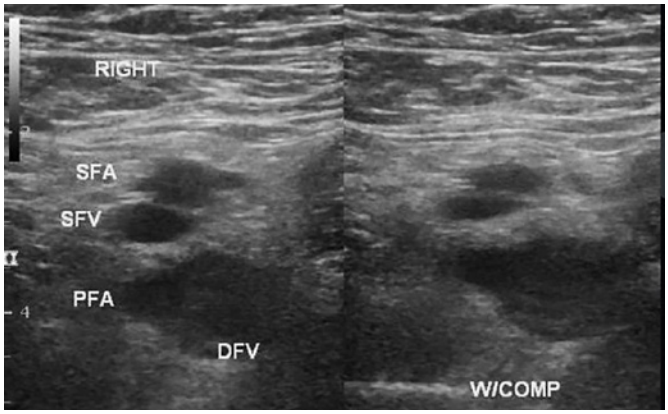

Figure 8: Example of superficial and deep femoral veins with thrombus (without and with compression). POCUS, 2022[5].

Step 4: Popliteal Vein
Step 3: Femoral Vein (Superficial)
• Move the transducer to the posterior fold of the knee and slide 2cm above and below to find the popliteal vein.
Step 3: Femoral Vein (Superficial)
• Locate the popliteal vein by placing the transducer directly between the two hamstring tendons, behind the knee. Use the transducer to compress the popliteal vein and check for clots.
Step 3: Femoral Vein (Superficial)
• Note in the visualization that the popliteal vein is now at the top and the popliteal artery is at the bottom[4, 5].

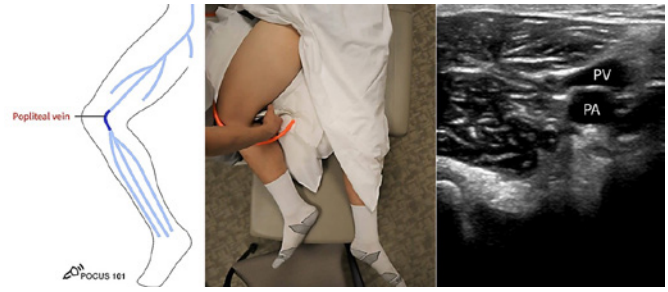

Figure 9: Visualization of the popliteal artery and popliteal vein. POCUS, 2022[5].

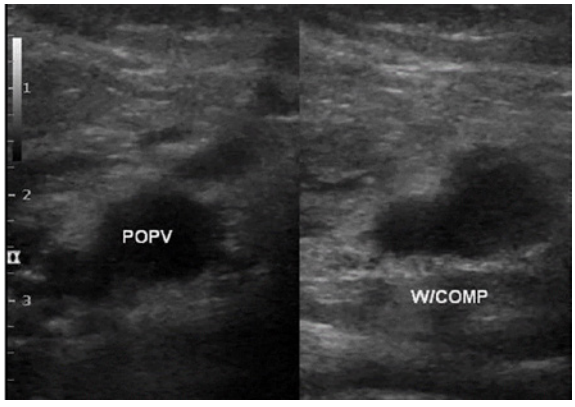

Figure 10: Example of popliteal vein with thrombus (without and with compression). POCUS, 2022[5].

Step 5: Trifurcation of the Popliteal Vein
• Continue scanning slightly more distal to the popliteal vein to find its trifurcation.
• Compress the popliteal vein until you find where it trifurcates into the anterior tibial, fibular, and posterior tibial veins.
• This junction signals the end of the exam[4].

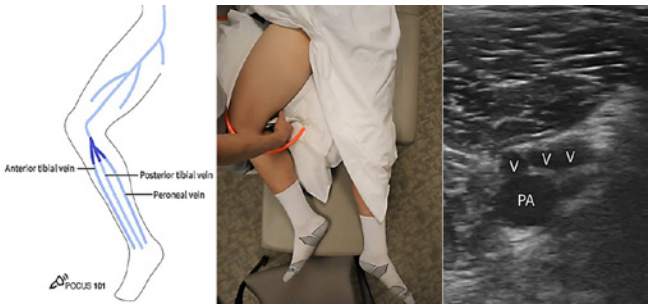

Figure 11: Visualization of the trifurcation of the popliteal vein (where the exam ends). POCUS, 2022[5].

In all POCUS techniques, the diagnosis of DVT is made by visualizing an echogenic clot or an area of the vein that cannot be fully compressed. Acute venous thrombosis usually results in the non-compressibility of a vein before an echogenic clot can be visualized. When testing the compression of a vein, the examiner should apply enough pressure so that the nearby pulsatile artery is slightly compressed. The pressure should be applied quickly and perpendicular to the vein with the transducer in a transverse orientation. Weak compression can result in a false-positive result. Rarely, too much compression can result in a false-negative result.[1].

OBJECTIVE

Evaluate the application of POCUS in hospitalized patients for the diagnosis of DVT, observing the sensitivity and specificity of the method found in each of the studies.

MATERIALS AND METHODS

A narrative review was conducted, considering eligible studies for this review those that reported the use of POCUS in the diagnosis and treatment of DVT. Studies published in English, conducted between 2018 and 2023, with information on POCUS with two and three-point compression, were included. The data allowed for an analysis of whether it is a method with good sensitivity and specificity in the evaluation of DVT in hospitalized patients.

The Pubmed databases were searched between August 20th and September 20th, 2023. A combination of free text words and MeSH terms was used, including the terms: POCUS, diagnosis, deep vein thrombosis, hospitalized, and patients.

Filters used: Free full text, last five years, and Case Reports, Clinical Study, Clinical Trial, Comparative Study, Multicenter Study, Observational Study, Case Reports, Clinical Study, Clinical Trial, Comparative Study, Multicenter Study, Observational Study and review.

138 articles were found, applying the publication year filters, 38 articles remained, of which only 28 met the selection criteria, describing the sensitivity and specificity of the method, for abstract reading. Afterwards, nine articles were read in full and five selected for data analysis (see flowchart - figure 12).

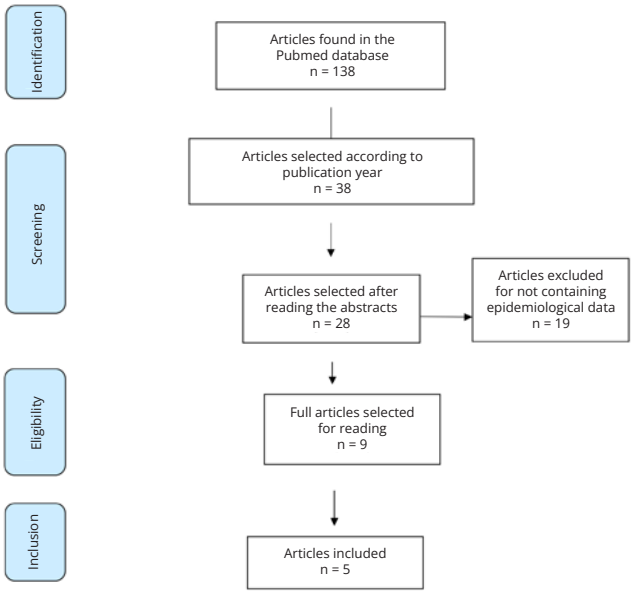

Figure 12: Flowchart of study selection

RESULTS

Analyzing all these studies, the sensitivity of POCUS in detecting DVT ranged from 82.8% to 100%, and the specificity ranged from 90% to 98.8%. The positive predictive value ranged from 62% to 83%, and the negative predictive value ranged from 97% to 100%. Both two-point and three-point POCUS techniques demonstrated comparable performance in the diagnosis of DVT, being highly effective (see Table 1).

Autor	Nº	Sens (%)	Espec (%)	VPP(%)	VPN(%)	Falso negativo(%)
Lee et al., 2019	195	Pocus 2: 91	Pocus 2: 98			Pocus 2: 4.0
		Pocus 3: 90	Pocus 3: 95			Pocus 3: 4.1
Zuker-Herman et al., 2018	266	Pocus 2: 82,8	Pocus 2: 98,5			
		Pocus 3: 90,6	Pocus 3: 98,5			
Canakcib et al., 2020	73	100	95,8	61,5	100	
Fischer et al., 2019	1337	93	93	83	97	

Table 1: Distribution of studies according to the number of patients evaluated by the study, sensitivity (sens), specificity (spec), positive predictive value (PPV), negative predictive value (NPV), author and year of publication, false negative.

DISCUSSION

POCUS is a method that is gaining increasing prominence in the diagnosis of DVT. Interest in the use of this method has grown substantially, not only in emergency medicine and intensive care, but also in internal medicine and hospital medicine[3].

Considering other diagnostic methods, such as clinical diagnosis, there is low sensitivity and specificity, with confirmation in 20-40% of patients with suggestive symptoms. D-dimer, despite high sensitivity (around 95%), has low specificity (40%), as several other clinical conditions can cause its elevation, such as inflammation, myocardial infarction, active cancer, stroke, pregnancy, and old age. However, a high negative predictive value is observed in suspected DVT cases. Scores that can be used to assess the probability of DVT, such as the Wells Score, have shown sensitivity between 64-79%, and specificity between 49-90%. In the Geneva score, sensitivity ranged from 55-74%, and specificity from 49-90%. The high probability of PTE in the aforementioned diagnostic methods can be confirmed by applying POCUS[2].

A meta-analysis conducted by researchers from the emergency and radiology departments at university hospitals in Korea compared results obtained from the evaluation of patients with suspected DVT using two-point and three-point compression POCUS. The researchers reviewed 17 studies in 16 original articles that included patients undergoing two-point POCUS (1337 patients in nine studies) and three-point POCUS (1035 patients in eight studies). Two-point POCUS showed a sensitivity of 91% (95% CI, 0.68-0.98) and specificity of 98% (95% CI, 0.96-0.99). Three-point compression POCUS achieved a sensitivity of 90% (95% CI, 0.83-0.95) and specificity of 95% (95% CI, 0.83-0.99). Overall, the performance of both POCUS methods was similar, with similar sensitivity and specificity rates, and the rates of false negatives in two-point and three-point compression POCUS were very close, 4.0% and 4.1% respectively [7].

A study conducted with 195 patients at the Rabin Medical Center-Beillinson Hospital in Israel was able to correctly diagnose DVT through two-point POCUS in 79% of patients with positive findings on traditional radiological methods and had a false-positive rate of 1.5% in patients without DVT. It showed a sensitivity of 82.8% and specificity of 98.8%. On the other hand, using three-point POCUS, the rate of correct diagnoses of DVT in hospitalized patients was 90%, with the same false-positive rate (1.5%). It had a sensitivity of 90.6% and specificity of 99%. In this study, the sensitivity of three-point compression POCUS was significantly higher than that of two-point POCUS ($p < 0.001$), and the specificity was similar in both methods[8].

Members of the emergency department and biostatistics departments at Eskisehir Osmangazi University and Yildirim Beyazit University Yenimahalle Training And Research Hospital, both in Turkey, conducted a study using two-point compression POCUS. They examined 266 patients, of whom 68 were diagnosed with DVT. 93% of these were detected through POCUS, showing a sensitivity of 93% (95% CI, 84-98) and specificity of 93% (95% CI, 89-96). The positive predictive value (PPV) was 83% and a negative predictive value (NPV) of 97% in this study[9]. These results support the usefulness of POCUS as a valuable tool in the emergency department for the initial evaluation of patients with suspected DVT, allowing for a rapid diagnosis and timely management. The use of gold standard reference tests increases the validity of the study results[9].

Another study conducted by the University of Minnesota, MedStar Georgetown, Health Partners/Regions, and Cincinnati Medical Center also compared the results of POCUS use by trained professionals with diagnosis by radiologist-interpreted exams, evaluating the lower limbs of 73 hospitalized patients in wards with a high pre-test probability of DVT. The results showed that hospitalist professionals achieved a sensitivity of 100% and a specificity of 96% in detecting DVT using POCUS, with positive and negative predictive values of 62-100%, respectively. Additionally, the average time from request to completion of POCUS was significantly shorter than the average time from request to finalization of the radiology report, with a difference of 5.7 hours between the completion of both exams. It was concluded that hospitalists from various specialties, when trained, are capable of performing POCUS for DVT with accuracy similar to radiologists, and the results are available more quickly than with the radiology team. POCUS has proven to be a good method for ruling out DVT. However, additional studies are needed to determine how to incorporate POCUS in the case of positive DVT exams in clinical practice.

A study at a general hospital in Spain, using three-point POCUS in 109 patients with suspected DVT, compared the results with Doppler ultrasound performed by radiologists afterward. Of these patients, 60 were found to have DVT by POCUS, and of these, 55 were confirmed by Doppler ultrasound, resulting in a sensitivity of 93% (95% CI, 83.8-97.3%) and specificity of 90% (95% CI, 78.6-95.7%), with an accuracy of 92% (95% CI, 85-95.6%). This indicates that emergency physicians can achieve a level of competence similar to that of radiologists in performing these exams, but substantial training and practice are necessary to achieve and maintain this performance. It is important for professionals to be aware of their limitations and to stay updated on ultrasound applications.[11].

CONCLUSSION

Based on the studies evaluated on the application of POCUS in the diagnosis of deep vein thrombosis (DVT), it is evident that this technique has excellent effectiveness, low cost, and easy implementation. The time taken to perform the exam and reach a diagnosis of DVT is significantly shorter compared to other methods, favoring the early initiation of antithrombotic therapy and improving morbidity and mortality.

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REVIEW ARTICLE

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EVALUATION OF ELASTOGRAPHY IN BREAST NODULES: COMPARISON BETWEEN QUANTITATIVE AND SEMI-QUANTITATIVE TECHNIQUES

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ABSTRACT

INTRODUCTION: Since its introduction into clinical practice in the 1970s, ultrasound has been a crucial tool for medical diagnostics. Continuous developments, such as Doppler and elastography, have provided new ways of non-invasive assessment of tissue properties. Elastography, in particular, uses changes in tissue elasticity to offer qualitative and quantitative information for diagnosis. It is of special interest due to its wide availability and relatively low cost.

OBJECTIVE: This study reviews the ultrasound elastography technique, exploring its potential applications in differentiating benign and malignant breast lesions, as well as its limitations.

METHODS: The study is a narrative review of the available literature on breast elastography, analyzing studies that investigated the effectiveness of this technique in characterizing breast lesions. Different scoring systems, criteria, and evaluation methods of elastography are considered, as well as studies that use both strain elastography (SE) and shear wave elastography (SWE) to assess breast lesions.

RESULTS: Breast elastography has proven effective in differentiating between benign and malignant lesions, particularly in cases of indeterminate lesions on conventional ultrasound. The combination of conventional ultrasound with elastography, along with semi-quantitative analyses, has shown significant improvements in diagnostic accuracy.

DISCUSSION: Despite its effectiveness, elastography faces some technical limitations, such as the lack of uniformity in commercial systems and the subjectivity in measurements. However, its promising clinical potential makes it an active area of research in various medical fields.

CONCLUSION: Breast elastography is a useful tool in differentiating between benign and malignant breast lesions, especially in cases of indeterminate lesions on conventional ultrasound. The combination with conventional ultrasound and semi-quantitative analysis can significantly improve diagnostic accuracy. However, elastography may have limitations in lesions classified as BI-RADS 4, and the decision to perform a biopsy should still be based on a comprehensive clinical evaluation.

KEYWORDS: ELASTOGRAPHY, BREAST LESIONS, DIAGNOSTIC ACCURACY.

INTRODUCTION

Ultrasound has been widely used for diagnosis since its introduction into clinical practice in the 1970s. Since then, new ultrasound modalities have been developed, such as Doppler, which provides new information for diagnosis. Elastography was developed in the 1990s[1].

Elastography-based imaging techniques have received substantial attention in recent years for non-invasive assessment of the mechanical properties of tissues. These techniques exploit the alteration of soft tissue elasticity in various pathologies to produce qualitative and quantitative information that can be used for diagnostic purposes. Measurements are acquired in specialized imaging modes that can detect tissue stiffness in response to applied mechanical force (compression or shear wave). Ultrasound-based methods are of particular interest due to their many inherent advantages, such as wide availability, including bedside, and relatively low cost. Several ultrasound elastography techniques using different excitation methods have been developed. In general, these can be classified into strain imaging methods that use internal or external compression stimuli, and shear wave imaging that uses traveling shear waves stimuli generated by ultrasound[2].

Tissue stiffness has long been known as a biomarker of tissue pathology. Ultrasound elastography measures the mechanical properties of tissue by monitoring the tissue's response to acoustic energy. Different elastographic techniques have been applied to various tissues and diseases. Depending on the pathology, patient-based factors, and ultrasound operator-based factors, these techniques vary in accuracy and reliability.[3].

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Breast elastography is an ultrasound technique that provides additional characterization information of breast lesions compared to conventional ultrasound and mammography. This technique provides information about the tension or hardness of a lesion, similar to a clinical palpation exam. Two techniques are now available for clinical use: strain (compression-based elastography) and shear wave elastography. Initial assessment of these techniques in clinical trials suggests that they can substantially improve the characterization of breast lesions as benign or malignant[4].

Furthermore, elastography can help reduce the number of unnecessary biopsies in benign breast lesions, especially in Category IV lesions of the Breast Imaging Reporting and Data System (BI-RADS). Ultrasound elastography is a cheap, readily available, useful, quick, and non-invasive method, but it requires specific training and recognition of technical and pathological factors that can influence it[5].

Breast elastography has been available for over 15 years but is not widely incorporated into clinical practice. Many publications report extremely high accuracy for various breast elastography techniques. However, results in the literature are extremely variable[6].

In this context, this review explores through a review the technique of ultrasound elastography and its limitations.

Ultrasound elastography techniques

The currently available techniques can be classified according to the physical quantity measured: 1) strain imaging and 2) shear wave imaging. Stimulation methods include nearly static displacement induced mechanically by active external compression or passively induced physiological motion (orange), mechanically induced dynamic compression using a probe that "taps" on the tissue surface to generate shear waves (green), and ultrasound-induced dynamic tissue, waves with acoustic radiation force impulse excitation (blue) - figure 1.

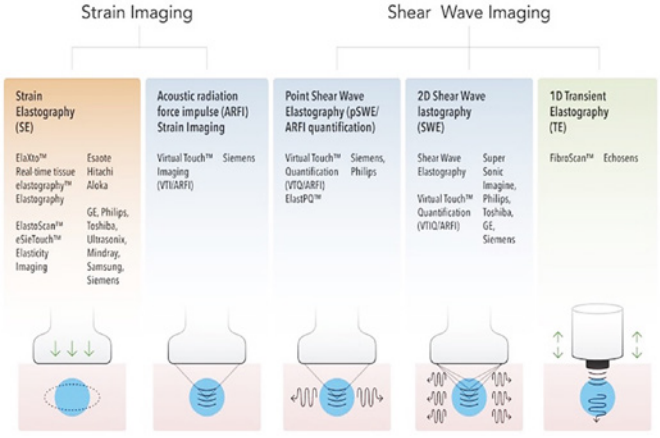

Figure 1 - Differences between techniques.

The successful performance of breast elastography, both strain (SE) and shear wave (SWE), involves several essential technical factors. Below, I summarize the main aspects of the two techniques:

Difference between techniques

1. Strain Elastography (SE)[7]:

Minimum Pre-compression: The application of pre-compression is essential in elastography because when a material is compressed, its stiffness increases. However, in SE, applying significant pre-compression results in noise, while light to moderate pre-compression can produce alternating good and noisy images. Quality images are obtained during the upward compression movement. Applying minimal and consistent pre-compression is crucial.

Maintaining the same image plane: The image plane of the lesion must remain within the field of view (FOV) during data acquisition. The patient should be positioned so that the transducer is perpendicular to the floor, and the patient should be instructed to breathe in a way that moves the lesion within the image plane.

Including different tissues in the FOV: For breast SE, it is important to include various tissues in the FOV, such as fat (softer tissue), fibro-glandular tissue, pectoral muscle, and the lesion. Benign lesions generally have stiffness similar to that of fibro-glandular tissues, while malignant lesions are stiffer than all other tissues.

Choice of color scale: Various color scales can be used in SE, with the grayscale being the most recommended for detecting subtle changes between tissues and identifying noise. It is important to recognize the color scale used, as some display red as rigid, while others use blue to indicate stiffness. Figure 2 illustrates a case of invasive ductal carcinoma using the B-mode and SE technique.

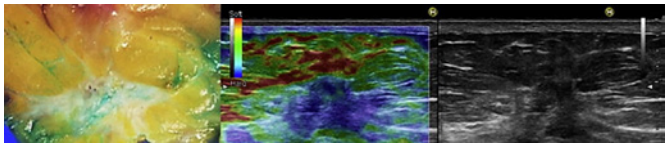

Figure 2 - A 55-year-old woman presented with a spiculated mass on screening mammography. A spiculated mass (maximum length of 10mm) was detected on B-mode ultrasound imaging. The diagnosis was invasive ductal carcinoma (pT2, pN0, luminal A type) confirmed by core needle biopsy. The Hitachi-Aloka SE image is in the center, the B-mode image is on the right, and the pathological image is on the left. The rigid area on the SE (blue area) closely resembles the cancer on macroscopic pathology (white area) and is larger than the mass represented in the B-mode[8].

2. Shear Wave Elastography (SWE)[7]:

Minimal Pre-compression Application: In SWE, the transducer is placed on the breast with minimal pre-compression and held stationary over the area of interest to obtain the measurement. The SWE technique can be either point-based or two-dimensional (2D). Since breast masses, especially malignant ones, tend to be very heterogeneous in terms of stiffness, the 2D-SWE technique is preferred, as the larger FOV can represent stiffness differences and identify the area of greatest stiffness. Figure 3 illustrates two cases using the SWE technique, showing the difference between an invasive ductal carcinoma and a fibroadenoma.

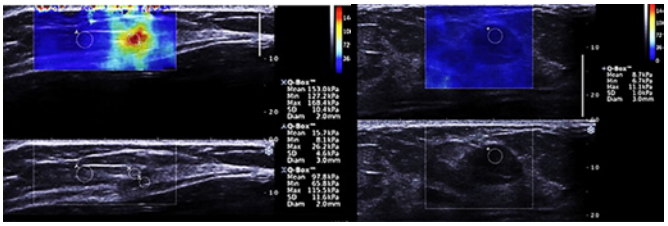

Figure 3 - A 50-year-old woman with an abnormality in the left breast on screening mammography. The left image is the color-coded SWE image, and the B-mode image is below the SWE image. The mass had a high shear wave velocity (153 kPa) coded in red. On biopsy, the lesion was an invasive ductal carcinoma (pT1a, pN0). Right: A 48-year-old woman who presented with an abnormality in the left breast on screening ultrasound. The mass is coded in blue, having a low shear wave velocity (8.7 kPa). On biopsy, the lesion was a fibroadenoma.[8].

The table below lists the main technical factors important in obtaining breast elastography images:

Important Technical Factors

• Minimal pre-compression application for SE and SWE;

• Maintaining the same image plane during acquisition;

• Including various tissues in the FOV, such as fat, fibro-glandular tissue, pectoral muscle, and the lesion;

• Using the appropriate color scale for SE;

• Preferring the 2D-SWE technique to assess the heterogeneity of stiffness in breast masses;

• These technical factors are crucial for obtaining reliable and high-quality elastography images, which are essential for differentiating between benign and malignant breast lesions.

A systematic review with meta-analysis on the use of Shear Wave Elastography (SWE) revealed that SWE has a sensitivity of 0.84 and specificity of 0.87 in the Asian population, while in the Caucasian population, the sensitivity was 0.92 and specificity was 0.89. These results demonstrate that SWE is a valuable tool in identifying malignant breast lesions, regardless of the patients' ethnicity. The diagnostic accuracy of SWE was considerably high in both population groups, with a slight advantage for the Caucasian population (0.95 vs. 0.92). This suggests that SWE is effective in distinguishing between malignant and benign lesions in diverse populations, which is an encouraging finding. The study also compared SWE with another technique, Virtual Touch Tissue Quantification, which showed slightly higher specificity and a superior summary ROC curve compared to SWE. This may indicate that different elastography techniques have their own strengths and that the choice between them may depend on specific clinical needs. The analysis highlighted that maximum stiffness exhibited higher detection sensitivity than mean stiffness (0.91 vs. 0.85). This implies that evaluating maximum stiffness may be particularly useful in identifying malignant lesions, which can guide clinical technique. In conclusion, SWE serves as a precise diagnostic technology in differentiating between benign and malignant breast lesions. This finding is crucial as it suggests that SWE can be widely adopted in clinical practice to increase accuracy in breast cancer diagnosis[9].

Scoring System, Criteria, and Evaluation Methods

Breast elastography uses different scoring systems, criteria, and evaluation methods to differentiate breast lesions and characterize them as likely benign or malignant. These methods are classified into three categories of assessment: qualitative, quantitative, and semi-quantitative[10].

In qualitative evaluation, which is generally less precise, a color map is typically used. The Tsukuba[8] scoring system, which is most commonly used for strain elastography, compares the size of the lesion between B-mode ultrasound and elastographic images. Malignant lesions appear larger on the elastographic image. The stiffness or deformation in the tissue of the lesion is displayed in a black and white or colored image. This system has demonstrated a sensitivity of 87% and specificity of 90% (Figure 4). The system assigns a score of 1-5:

Score 1: Complete deformability of the lesion.

Score 2: Deformability of a large part of the lesion with areas of low stiffness.

Score 3: Presence of a rigid area in the center with peripheral deformability of the lesion.

Score 4: Completely rigid lesion.

Score 5: The entire lesion and surrounding area are rigid. According to this system, elasticity results are considered negative (score 1), equivocal (scores 2-3), and positive (scores 4-5).

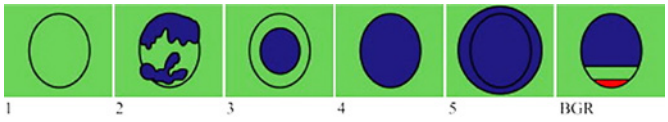

Figure 4. Graphical representation of the Tsukuba score (elasticity score). This scale combines changes in the size ratio and the degree of stiffness of the lesion. If the lesion is soft, it is classified with a score of 1; if the lesion has a mixed pattern, it receives a score of 2. A lesion that is hard but smaller on the elastogram receives a score of 3. When the lesion is hard and the same size on elastography as in B-mode, the lesion receives a score of 4. If the lesion is hard and larger on elastography, the lesion is classified as 5. It is recommended that lesions with a score of 4 or 5 be biopsied. Scores 1 to 3 are classified as likely benign. With some equipment (Hitachi, Toshiba), a trilaminar appearance of blue, green, and red (BGR) is identified in cysts (tricolor artifact)[8].

The Italian multicenter study scoring system uses five levels and takes into account both solid and cystic lesions.

Score 1: BGR pattern characteristic of cysts.

Score 2: Mostly elastic.

Score 3: Mostly elastic with some stiff areas.

Score 4: The main lesion is non-deformable.

Score 5: Stiff tissue surrounding a non-deformable lesion.

These scoring methods should always be incorporated into the ultrasound or mammography examination, as they are not sensitive for determining the depth, diameter, or volume of the lesion.

Quantitative assessment:

This method expresses the elasticity of the lesion in units (kPa in shear waves or mm/s in ARFI)[10].

Shear Wave Elasticity Criteria: The color-coded assessment of maximum elasticity is the most useful method in shear wave elastography, which correlates with the maximum elasticity value (kPa). The prognostic value for malignancy is directly proportional to the increase in stiffness, ranging from 0.4% for dark blue to 81.8% for red colors. These are classified into three main categories: Lesions with soft elasticity are represented by dark blue and light blue and considered negative. Lesions with intermediate elasticity are represented by green and orange and considered equivocal. Lesions with high elasticity are represented by red and considered positive. Different cutoff values have been proposed in clinical trials to distinguish benign from malignant lesions.

ARFI Elasticity Criteria: These criteria are used in ARFI quantification. The proposed marginal value for malignant lesions is 4.49-8.22 mm/s, while for benign lesions it is 2.25-3.25 mm/s. An appropriate sensitivity cutoff value of 3.065 mm/s has been recommended.

Semi-quantitative Assessment:[10]:

This assessment uses the strain ratio (SR) to compare the elasticity of the lesion with the surrounding normal breast tissue.

Strain Ratio (SR): The ratio between the average strain in the lesion and the adjacent breast tissue. Malignant lesions have a higher SR than benign lesions. Lesions are considered suspicious for malignancy with an SR greater than [3].

Application of Elastography

In a literature review, a study analyzed the capability of breast elastography to improve the characterization of breast lesions, particularly in cases of indeterminate lesions on conventional ultrasound. The results highlight that ultrasound alone showed high sensitivity (98.1%) in detecting lesions, but with a lower specificity (40.6%). By incorporating elastography, the qualitative analysis demonstrated an increase in specificity (80.2%) and accuracy (81.8%). Notably, the combination of conventional ultrasound with qualitative elastography achieved 100% sensitivity but with 63.2% specificity[11].

Another study evaluated the utility of elastography in characterizing indeterminate breast lesions. Radiologists analyzed both conventional ultrasound and elastography. The results indicate that the combination of elastography and conventional ultrasound led to a significant improvement in sensitivity and specificity compared to conventional ultrasound alone. Semi-quantitative analysis, with measurements such as the strain ratio and width ratio, proved particularly effective in distinguishing between benign and malignant lesions12. Indeterminate breast lesions classified on conventional ultrasound were analyzed. Elastography achieved a sensitivity of 70% and a specificity of 79.6%. The results showed that elastography obtained higher specificity in lesions classified as BI-RADS 3 compared to those classified as BI-RADS 4.

These studies highlight the utility of breast elastography in differentiating benign and malignant lesions, particularly in cases where conventional ultrasound is inconclusive. Qualitative and semi-quantitative elastography analysis has proven effective in improving specificity and diagnostic accuracy. The combination of conventional ultrasound with elastography, along with semi-quantitative assessment, resulted in a high negative predictive value, which may be useful in avoiding unnecessary biopsies in lesions classified as BI-RADS 3. However, elastography alone may not be sufficient to eliminate the need for biopsies in lesions classified as BI-RADS 4, due to its lower specificity. Therefore, the decision to perform a biopsy should still be based on a comprehensive assessment that takes into account all available clinical data[11,12].

Regarding the technique, one study used both SE and SWE to evaluate breast lesions. The analysis of the mean strain elastography ratio (SE) revealed an average value of 4.1, with a cutoff point of 2.86 to differentiate benign from malignant lesions. The area under the ROC curve (AUC) was 0.911 for SE, with a sensitivity of 95.8% and specificity of 89.3%. Regarding SWE, the AUC was 0.929, with a sensitivity of 95.8% and specificity of 85.7%. The results indicate that both SE and SWE are highly effective in distinguishing between benign and malignant lesions. By combining these techniques with B-mode ultrasound, sensitivity can reach 100%, and specificity 96.3%[13].

Another study also employed both SE and SWE in the evaluation of breast lesions. Researchers used multiple variables, including maximum elasticity (Emax), mean elasticity (Emean), standard deviation of elasticity (Esd), lesion-to-fat elasticity ratio, and elastographic classification for analysis. The combination of SWE with SE, incorporating Esd, elasticity ratio, and SWE classification, significantly increased diagnostic efficacy, with an area under the ROC curve (AUC) of 0.89. The study reinforces the effectiveness of combining SWE and SE in differentiating between benign and malignant breast lesions. Specifically, the Esd parameter proved to be a valuable diagnostic factor when used alone or in conjunction with SE and SWE[14].

Both studies emphasize the value of elastography, whether strain elastography (SE) or shear wave elastography (SWE), in differentiating between benign and malignant breast lesions. These techniques provide a detailed analysis of the stiffness of lesions, which can be a crucial indicator of the nature of the lesion.

Limitations of Elastography:

Elastography is affected by technical limitations that hinder the reproducibility of measurements. General ultrasound limitations, such as shadowing, reverberation, and artifacts, can impact elastography. Tissue attenuation with depth limits the accurate assessment of deep tissues. The presence of subcutaneous fat or fluid in the region of interest can affect measurements, especially in cases of obesity or abdominal ascites. System settings and parameters, such as ultrasound frequency and gain, need to be standardized to avoid biased results[15,16].

The lack of uniformity in the design and settings of commercial systems makes comparing measurements between different manufacturers challenging. Measurements in methods that use external stimuli, such as strain elastography, are highly subjective due to the difficulty in controlling applied stress and

the variability of physiological motion[15,16].

The selection of the region of interest can be operator-dependent, introducing variability. Assumptions about tissue made by elastography, such as linearity, elasticity, isotropy, and incompressibility, may not be applicable in all clinical situations. Elastography may require more complex models to adequately describe the mechanical properties of tissues, especially in cases of highly heterogeneous tumors[15,16].

Despite its limitations, elastography has promising clinical potential and is widely researched in various medical fields.

FINAL CONSIDERATIONS

The studies indicate that breast elastography is a useful tool in differentiating between benign and malignant lesions, especially in cases of indeterminate lesions on conventional ultrasound. The combination of conventional ultrasound with elastography, along with semi-quantitative analysis, appears to be the most effective approach to improving diagnostic accuracy. However, elastography may have limitations in lesions classified as BI-RADS 4, and the decision for biopsy should still be based on a comprehensive clinical evaluation.

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