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30 YEARS CELEBRATION

This is the first 2023 edition of our Revista Azul, the year we celebrate the 30th anniversary of existence of the SBUS. And the Brazilian Journal of ultrasonography – RBUS is definitely part of this history of actions, overcoming challenges and achievements to scientifically train Brazilian sonographers and offer an even more humane quality service to our patients.

To commemorate this very important date in our history, SBUS will hold a special edition of the Brazilian Congress of Ultrasonography and the International Congress of Ultrasound FISUSAL. We can assure you: the 27th edition of CBUSG, from October 18th to 21st, at the Frei Caneca Convention Center in São Paulo – SP, will be an event worthy of these 30 years of struggles, advances and history of SBUS.

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CASE REPORT

ABNORMAL DRAINAGE OF THE UMBILICAL VEIN. A CASE REPORT AND LITERATURE REVIEW

BEATRIZ LOMBARDI, TAMARA FRANK DAS NEVES GUERRA, GABRIELA TELES CORTEZ, LUIZA CARDONA FELIPE, CAMILA VITÓRIA ANJOS LORENZONI, GREGÓRIO LORENZO ACÁCIO

ABSTRACT

This case report presents the evolution of a fetus diagnosed with agenesis of ductus venosus (ADV). The umbilic vein drained directly to the right iliac vein, bypassing the liver. This is a rare condition, for which little has been elucidated about its prognosis and prevalence. The ADV can be related to chromosomal disorders, fetal hydrops, cardiac and extracardiac anomalies. Its prognosis varies according to the adjacent malformations and hemodynamic instabilities. When the umbilical vein drainage is extra-hepatic, the prognosis is determined especially by the level of hemodynamic instability.

KEYWORDS: UMBILICAL VEINS; DUCTUS VENOSUS; VASCULAR MALFORMATIONS; ULTRASONOGRAPHY

INTRODUCTION

The ductus venosus is a shunt of fetal life that joins the umbilical vein to the inferior vena cava and that is obliterated after birth, becoming the ligamentum venosum[1]. It is through this shunt that the oxygenated blood, coming from the umbilical vein, reaches the right atrium and, through the foramen ovale, passes to the left atrium, flowing to the systemic circulation and favoring the flow with high PO2 to vital fetal organs, such as the brain and heart[1].

The Doppler assessment of the duct is useful during the first trimester morphological examination, both in the suspicion of heart diseases and chromosomal disorders and, in the second trimester, it is also used in cases of alteration on arterial Doppler in extreme prematurity, as one of the criteria for defining the time of delivery [1].

Its absence generates an anomalous drainage of blood from the umbilical vein, which can be an intrahepatic or extrahepatic shunt. In the intrahepatic type, the umbilical vein connects directly to the portal sinus[2] (Figure 1B).

In the extrahepatic type, in turn, what occurs is a deviation that presents variable subtypes, avoiding the liver, and the umbilical vein can drain directly into the inferior vena cava, the most frequent form (figure 1A), into the right atrium (figure 1C), left atrium, coronary sinus, left or right iliac veins (figure 1D) and more rarely with the renal vein and right ventricle.

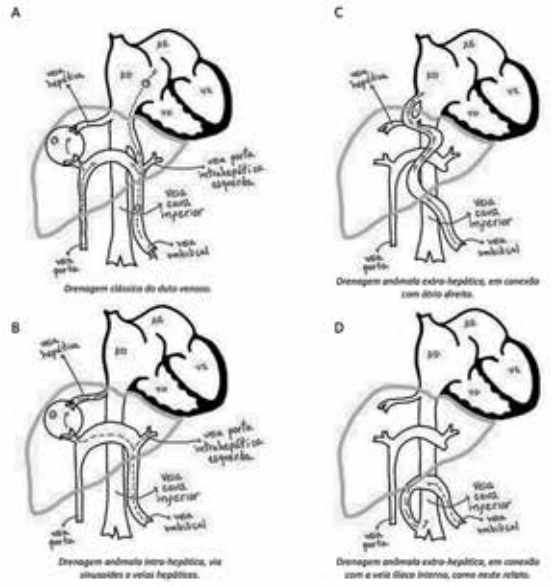

Figure 1. The image shows the different possible drainages of the ductus venosus (DV). In (A) the classic DV drainage is represented, to the upper portion of the inferior vena cava (IVC). In (B), the umbilical vein connects to the systemic circulation through the portal circulation, hepatic sinusoids and hepatic veins, characterizing one of the possible anomalous intrahepatic drainages. In (C), the umbilical vein deviates from the portal vein and the hepatic sinusoids, with extrahepatic drainage directly into the right atrium. In (D), the umbilical vein connects to the systemic circulation, also bypassing the liver and connecting to the right iliac vein, as in this case report [2].

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Agenesis of the ductus venosus is a rare condition with a variable prognosis, which depends on its type, characteristics and associated malformations. The diagnosis of agenesis of the ductus venosus with anomalous drainage may be incidental, at the time of the first trimester morphological examination, when the Doppler sonogram is not obtained in the longitudinal or transverse sections or even when identifying, in the second trimester, deviations in the course of the umbilical vein, abnormality of its caliber or as a result of associated malformations. Extrahepatic forms can be suspected in B-mode, by the anomalous trajectory of the umbilical vein or atypical dilation of the vessels. Intrahepatic connections, in turn, require a colored flow mapping of the fetal portal circulation in several evaluation planes and may, therefore, go unnoticed in many cases where they do not have clinical repercussions.

If the agenesis is associated with other abnormalities or if the venous drainage is extrahepatic, the probability of a worse prognosis is greater when compared to isolated or intrahepatic cases. This paper reports a case of ductus venosus agenesis with anomalous extrahepatic drainage.

CASE REPORT

Patient C.J.P, 25 years old, primigravidae, LMP 06/15/2019, was referred to high-risk prenatal care (PNAR) at the Hospital Municipal Universitário de Taubaté (HMUT) due to a change in morphological ultrasound (USG) of the 2nd trimester (23 weeks and 4 days), with suspicion of probable anomalous drainage of the ductus venosus. An increase in the caliber of the umbilical vein was identified throughout the course of the cord, tortuous intra-abdominal umbilical vein with increased caliber, anomalous drainage to the right iliac vein and inferior vena cava with increased caliber throughout the course (figures 2 and 3). Classical drainage of the ductus venosus was not found.

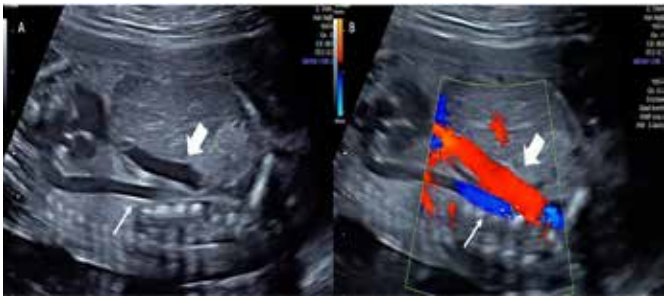

Figure 2. In the image, the thick arrows show the dilated inferior vena cava (IVC) throughout its course and the thin arrows show the abdominal aorta artery. In (A), axial B-mode ultrasonography and, in (B), color Doppler ultrasonography.

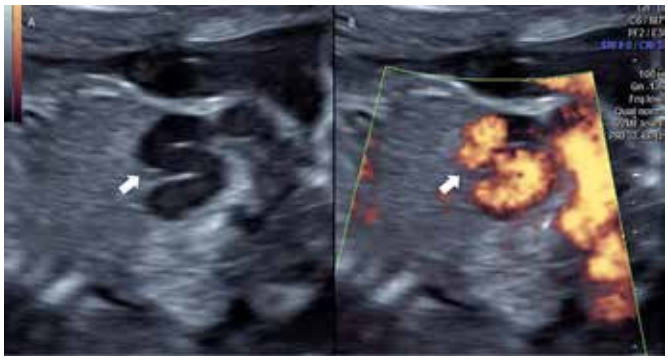

Figure 3. In the image, the thick arrow represents the intra-abdominal, tortuous, dilated umbilical vein, draining into the right iliac vein. B-mode detail on the left (A) and Power Doppler (B) on the right.

The karyotype research did not show quantitative chromosomal alterations. The fetal echocardiogram, performed at 26 weeks, corroborated the hypothesis of anomalous drainage of the ductus venosus, noting mild global cardiomegaly with predominance of the right atrium and mild pericardial effusion.

At 31 weeks and 5 days, fetal growth restriction (FGR), weight of 1,075g (3rd percentile) and Doppler velocimetry without alterations were evidenced, with the need for weekly evaluation of Doppler and amniotic fluid index (AFI), in addition to fetal vitality investigation twice a week. Follow-up with fetal echocardiography was indicated by cardiopediatrics, and three tests were performed, which maintained the pattern described above. Obstetric USG at 34 weeks and 3 days showed breech presentation, oligohydramnios (largest pocket 2.7cm and AFI of 4.8cm), fetal weight of 1,319g (below the 3rd percentile). After cardiotocography with decelerations, a cesarean delivery was performed. Newborn, small for gestational age (SGA), with Apgar 9/9, 1,390g, and GA by the Capurro method at 38 weeks and 4 days. It had a strong cry at birth, adequate muscle tone, 88% saturation and mild tachydyspnea, maintained on nasal CPAP. It was transferred to the neonatal ICU, presenting early neonatal sepsis as a complication, requiring platelet transfusion. On the 26th day of life, it was transferred to the nursery, where it remained for two more days and was discharged in good general condition, weighing 1,940g.

Postnatal echocardiography initially showed patent ductus arteriosus (2 mm), mild right ventricular hypertrophy and patent foramen ovale (PFO). There was closure of the ductus arteriosus in the second postnatal examination, and resolution of the hypertrophy in the examination at discharge. At three months of life, it weighed 4,400g, was at home, with no intercurrences or comorbidities related to anomalous drainage of the ductus venosus and other cardiac alterations during fetal life. So it remains today, at 30 months.

DISCUSSION

The first report of agenesis of the ductus venosus (ADV)

was made in the 19th century by Paltauf R., 1888 [3]. However, currently, the prevalence and prognosis of ADV remain poorly elucidated in the literature. In a high-risk population, referred for echocardiographic analysis at a specialized center, an incidence of 6:100 was demonstrated [4]. Even less has been documented on isolated ADV, for which management remains based on series of cases [5], which make reports of occurrences of this malformation essential.

ADV is associated with chromosomal disorders, such as trisomies 9, 13, 18, 21 and 22, Turner Syndrome, PHACE Syndrome, Wolf–Hirschhor Syndrome, RASA [1] mutations, chromosome [5] microdeletion and mosaicism. In addition, there is a relationship with hydrops fetalis, cardiac and extracardiac anomalies, including portal venous system agenesis and persistence of portosystemic shunt[2,6-8]. The presence of genetic alterations and other malformations is significantly related to a worse prognosis for fetuses with ADV, even after excluding cases in which pregnancy was terminated. On the other hand, the type of anomalous drainage, intrahepatic or extrahepatic, was not significantly associated with greater adverse outcomes, when pregnancy interruptions were excluded [6,7].

However, in fetuses with no or minor anomalies, the presence of extrahepatic drainage was significantly linked to a better prognosis, cases in which the prognosis seems to depend mainly on the presence and extent of congestive heart failure [5,7,9]. This corroborates the clinical evolution of our case, in which the fetus had anomalous extrahepatic drainage to the right iliac vein, without numerical chromosomal alterations or other malformations. An increase in the caliber of the inferior vena cava and mild global cardiomegaly were expected, with no evidence of heart failure. The reduction of amniotic fluid present in this patient is an uncommon clinical situation in cases of ADV. The series of reports demonstrate a higher frequency of polyhydramnios and hydrops fetalis [2,5,7,9-11]. Hydrops is associated with a higher risk of intrauterine and postnatal death[7]. Polyhydramnios may be related to increased circulating blood volume, with consequent greater renal perfusion and atrial secretion of natriuretic peptide, a potent diuretic and vasodilator [12]. Fetal growth restriction (FGR) present in this case, from 31 weeks and 5 days, can be explained by the reduction in hepatic blood supply, an essential organ for regulating fetal growth [13]. In addition, the increase in volume in the venous system can result in placental edema and reduced gas exchange, with consequent fetal hypoxemia and FGR [14]. This restriction may be the etiology of the oligohydramnios present in our case [15]. The FGR and its resulting oligohydramnios were the determinants for fetal distress since we did not observe a significant cardiac overload.

In the literature, there are more descriptions of ADV cases with extrahepatic drainage [2,10]. However, Berg et al. observed 82% of cases with intrahepatic drainage and 17% with extrahepatic drainage, despite the aforementioned difficulty in diagnosing intrahepatic ADV [7]. This data was confirmed in another study, which evaluated 119 cases of anomalous drainage and identified that 70.6% had intrahepatic drainage and 29.4% had extrahepatic drainage [6]. In both studies, the selection of cases was performed in databases of institutions where the morphological screening already included the search for duct anomalies vein as a possible marker of other fetal malformations. This difference between previous studies and the last two mentioned above suggests that cases of anomalous intrahepatic drainage may go unnoticed more easily than those of extrahepatic drainage, when not associated with other malformations [6,7].

The prognosis of ADV conditions is variable and depends on the association with other malformations and fetal alterations. Overall, an adverse outcome was demonstrated in only 4.2% of fetuses with isolated ADV, regardless of the type of drainage. Strizek et al. demonstrates that in cases where there is intrahepatic drainage, without other alterations, the prognosis is good. When isolated ADV has extrahepatic drainage, the prognosis depends on the degree of fetal hemodynamic alteration. A series of seven cases with one neonatal death was reported, after delivery at 26 weeks and complications of early rupture of membranes (16 weeks), with no information about the intrauterine hemodynamic conditions of this patient[6]. In our case, the patient, with extrahepatic drainage to the right iliac vein, had late preterm delivery after cardiotocography with decelerations and oligohydramnios. Upon neonatal examination, it presented right ventricular hypertrophy and patent ductus arteriosus, which closed after subsequent evaluations.

Thus, it is important to perform a careful diagnosis of the type of drainage of the ADV, considering the need for Doppler of the portal circulation, which should be part of the morphological evaluation routine, especially when there are signs of cardiomegaly and altered levels of amniotic fluid. Other signs that there may be ADV are increased umbilical vein caliber and a biphasic Doppler pattern, accelerated in the intra-abdominal course of the umbilical vein [9]. In addition, it is necessary to pay attention to other possible malformations that may accompany ADV and perform a fetal karyotype. Evolutionary control with ultrasonography and Doppler and frequent fetal echocardiography is essential, thus enabling the most opportune moment for delivery to be defined in the face of changes in vitality and/or heart failure.

CONCLUSION

Agenesis of the ductus venosus is still diagnosed as an incidental finding in obstetric exams or in the newborn. However, it is extremely important that the diagnosis be made early, so that the patient can benefit from the management of possible complications, improving its prognosis and quality of postnatal life. This rare case of agenesis of the ductus venosus (DVA), with anomalous extrahepatic drainage into the right iliac vein, demonstrates the importance of an early diagnosis via Doppler and the need for a morphological, ultrasound and cardiotocographic routine, since the follow-up allows the observation of possible signs of chronic or acute

distress. In our case, growth restriction and its resulting oligohydramnios were the determinants for fetal distress, once cardiac overload was absent. The diagnosis therefore aims to drastically reduce the potential risks of fetal morbidity and mortality. Our patient was diagnosed and followed up, ensuring accurate and timely interventions for complications, with a late preterm birth, with good evolution during the puerperium and neonatal period, reaching 30 months today without cardiac alterations or related to the malformation.

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CASE REPORT

FETAL CRANIOPHARYNGIOMA: CASE REPORT

MARCELLO VIGGIANO[1], GUSTAVO TEIXEIRA[1], CAIO MATIAS[1], ROGÉRIO FAGUNDES[2]

ABSTRACT

INTRODUCTION: Craniopharyngiomas are the most common parasellar tumors in children and adults, but rare in the perinatal period (representing only 5.6% of all fetal and neonatal tumors). They are of benign origin from the histopathological point of view, and may present an evolution that is difficult to control due to their location and ability to infiltrate surrounding tissues.

CASE REPORT: This paper reports a case of fetal craniopharyngioma diagnosed by histopathology and suspected based on an obstetric ultrasound examination.

DISCUSSION: Despite the diagnostic difficulty, fetal craniopharyngioma can be suspected in the prenatal period

CONCLUSION: Rare condition during pregnancy. It is concluded that craniopharyngiomas can be suspected during pregnancy through ultrasound and nuclear magnetic resonance, however the definitive diagnosis can only be established with anatomopathological study.

KEYWORDS: BRAIN NEOPLASMS, PREGNANCY, PRENATAL DIAGNOSIS, PREMATURITY

INTRODUCTION

Congenital brain tumors are a rare condition that have an incidence rate of 1.7 to 13.5 per 100,000 live births, representing 10% of all prenatal tumors [1,2]. Congenital tumors of the central nervous system (CNS) can be divided into teratomas and non-teramatous tumors. Teratomas are the most frequent, but there are also neuroepithelial and mesenchymal tumors (such as craniopharyngioma) and others of different origins [3,4].

The association between ultrasound (US) and magnetic resonance imaging (MRI) has allowed more accurate diagnoses of congenital CNS tumors during pregnancy, although a normal ultrasound examination in the first trimester of pregnancy does not rule out the late appearance of a brain tumor in the fetus [3] .However, the final diagnosis can only be confirmed after birth, through histological examinations, molecular analyzes or genetic tests [2].

Craniopharyngiomas are the most common parasellar tumors in children and adults, representing 5-10% of all pediatric tumors, despite being rarely found in the perinatal period, representing only 5.6% of all fetal and neonatal tumors [1]. These tumors develop from embryonic remains of squamous cells originating from Rathke's pouch (ectodermal diverticulum originating from the upper limit of the oropharynx), a structure that extends from the sella to the pharynx, located at the origin of the adenohypophysis. They are of benign origin from the histopathological point of view, and may have an evolution that is difficult to control due to their location and ability to infiltrate surrounding tissues [1,5].

Thus, the aim of this study is to report a case of fetal craniopharyngioma.

CASE REPORT

An 18 years old primigravida patient with no comorbidities was admitted to a public maternity hospital that is a reference for high-risk pregnancies in the state of Goiás, with extreme preterm labor at 23 weeks and 3 days of gestation. Ultrasound was requested to assess presentation, biometrics and fetal morphology.

The ultrasound examination, carried out in the unit, revealed a complex, solid-cystic image, with regular contours (15.7 x 10.5 x 9.4 cm) contiguous to the skull and face, and the diagnosis of fetal teratoma was questioned (Figure 1). Thus, the patient underwent cesarean delivery due to preterm labor, breech fetus, and cephalopelvic disproportion marked by an extensive fetal cranial mass.

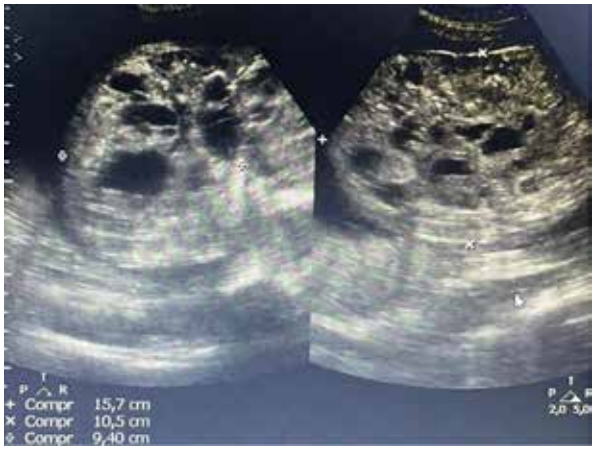

Figure 1 – Ultrasound image of complex image, contiguous to the skull and fetal face

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After extracting the newborn, the female gender was comfirmed, weighing 1465g, with a height of 28cm and a head circumference of 42cm. In addition, she had malformations on the face and skull on the left, with an extensive mass that made it impossible to perform neonatal resuscitation, and he was then declared dead due to the absence of a breathing pattern or heart rate (Figure 2).

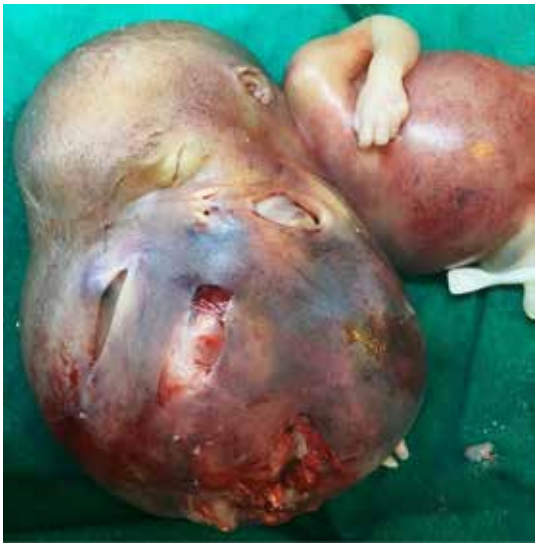

Figure 2 – Craniopharyngioma

The conceptus was sent for anatomopathological study, where it was confirmed a craniopharyngioma and chorioamnionitis, with no other findings.

DISCUSSION

The main finding in the prenatal diagnosis of a congenital tumor is an intracranial mass with a solid, cystic or mixed pattern, with or without visualization of hypervascularization on fetal ultrasound and magnetic resonance imaging. Unlike older children, congenital fetal brain tumors occur mainly in the supratentorial region, in about 70% of cases, and only in 30% are infratentorial[3,4,6].

Most newborns with congenital CNS tumors have a poor prognosis and die shortly after birth, with a survival rate of around 28% [4]. Totally cystic craniopharyngiomas evolve better than those with solid or mixed lesions [5].

Most of these tumors are diagnosed by routine prenatal ultrasound, during the second or third trimester of pregnancy [2,6]. The ultrasound is the main method used to establish the correct diagnosis during pregnancy, as it can detect solid, cystic or calcified lesions [4]. Magnetic resonance imaging can help in determining the remaining brain structures and in the exact location of the tumor, as well as in differentiating between calcifications, hemorrhages and fat deposits, allowing a detailed assessment of the relationship between the tumor and the adjacent brain parenchyma [4,6].

The most common clinical manifestations of these tumors are macrocephaly (28%), due to the presence of a tumor mass and/or fluid and hydrocephalus (17.3%) due to compression of the ventricular system [3]. The presence of macrocephaly can even cause damage such as uterine rupture or severe dystocia with cephalopelvic disproportion, justifying the concern about performing a cesarean section as in the case described [6]. Some factors suggest a poor prognosis, such as tumor location, histological type, surgical resection and general conditions at the time of diagnosis [3].

CONCLUSION

Fetal brain tumors, such as craniopharyngioma, are an extremely uncommon condition and their diagnosis during the prenatal period is challenging. Prenatal care involves a multidisciplinary team, in addition to the use of advanced imaging techniques, such as high-quality ultrasound and fetal magnetic resonance, together with clinical information to guide the decision-making process.

Therefore, despite the imaging exams helping in the process, it is concluded that the anatomopathological analysis remains the gold standard for the definitive diagnosis of this tumor.

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CASE REPORT

ANEURYSM OF THE DUCTUS ARTERIOSUS WITH HEMODYNAMIC CHANGES IN THE FETAL HEART: A CASE REPORT.

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ABSTRACT

INTRODUCTION: Ductus arteriosus aneurysm is a rare finding in fetal life, probably because it is not routinely investigated in the third trimester of pregnancy.

CASE REPORT: Patient 41 years old, second pregnancy, with no cardiac abnormality on fetal echocardiography during first and second trimester screening. In the third trimester, at 36 weeks, a saccular image was observed with turbulent flow in a section of three vessels and trachea in the ductus arteriosus, enlargement of the right heart chambers, ductus venosus with overload in the right atrium and mild polyhydramnios.

In the following week, the patient reported a marked decrease in fetal movement and the fetal echocardiogram showed greater enlargement of the right chambers and marked polyhydramnios. Altered fetal biophysical profile with absence of fetal movements, respiratory movement and decreased tone. Venous Doppler with signs of right cardiac overload.

Patient underwent cesarean delivery without intercurrences. The newborn underwent an echocardiogram on the third day of life, which showed closure of the ductus arteriosus and resolution of the aneurysm. In outpatient follow-up.

CONCLUSION: Ductus arteriosus aneurysms, although rare or poorly diagnosed, most evolve benignly after closure of the ductus arteriosus, however, there are complications such as spontaneous rupture, thromboembolism and neonatal death. Therefore, performing an ultrasound in the third trimester of pregnancy in order to rule out late fetal pathologies is of fundamental importance for the proper monitoring of the newborn.

KEYWORDS: ANEURYSM, ARTERIAL CHANNEL, DUCTUS ARTERIOSUS, ULTRASOUND, PRENATAL CARE, DIAGNOSIS, DUCTUS VENOSUS, HEMODYNAMIC ALTERATION.

INTRODUCTION

The arterial channel or ductus arteriosus represents a communication path between the pulmonary artery trunk and the descending aorta, located 5-10mm distally from the left subclavian artery. This straight conduit is responsible for diverting 50 to 60% of fetal cardiac output from the right ventricle to the descending aorta [1].

Huhta et al demonstrated that, in the second half of pregnancy, blood flow in the ductus arteriosus has the highest flow velocity in the normal fetal cardiovascular system. Maximum systolic flow velocity was 50-140cm/second (mean 80) and normal diastolic flow velocity was 6-30cm/second. Decreased post-ductal flow may be due to the larger diameter of the descending aorta. The pulsatility index (PI) of the normal ductus arteriosus remains constant throughout pregnancy, varying between 1.9-3.0 (mean 2.46 +- 0.521) – figure 1. Pulsatility indexes below 1.9 occur in conjunction with ductus arteriosus constriction and tricuspid regurgitation [2].

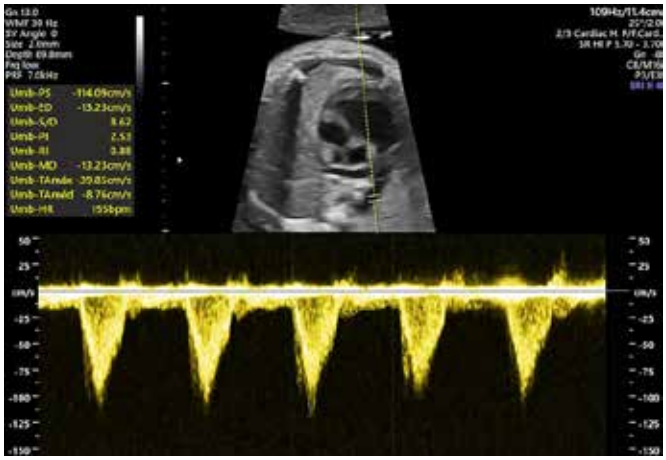

Figure 1. Illustrates the systolic (114cm/s) and diastolic (13cm/s) flow velocity as well as the PI (2.53) of the normal fetal ductus arteriosus at 33 weeks of gestation.

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Its histology is quite different from that of the aorta and pulmonary arteries, as the middle layer is made up of smooth muscle fibers and not elastic fibers. At the end of pregnancy, cushions form in the intima which contribute to its closure after birth [3] (figure 2).

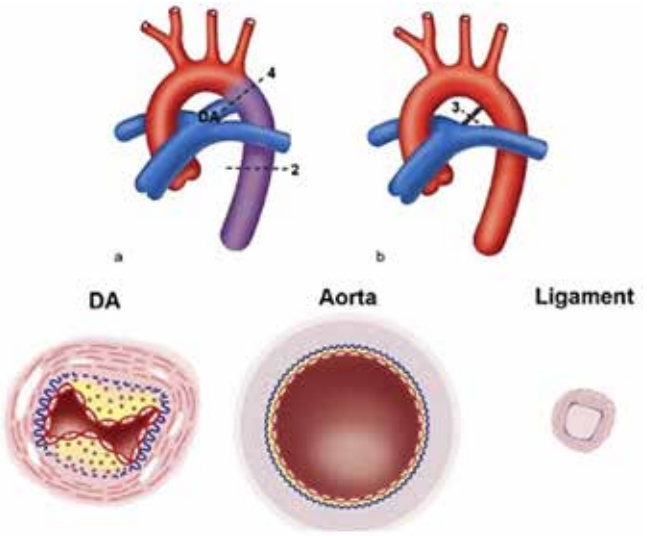

Figure 2. Schematic drawing of the fetal heart showing the upper part of the open ductus arteriosus (DA) and its closure in the neonatal period. The lower part shows a cross-section of the DA and the aorta showing that the middle layer is made up of smooth and elastic muscle fibers, respectively [3].

The ductus arteriosus remains patent during pregnancy, basically for two reasons:

A – Action of prostaglandins, produced by the placenta;

B – Low concentration of O^2 in fetal blood. The fetus is a hypoxemic individual, the saturation in the umbilical artery is around 60%, lower than the amount of oxygen in the vein. The fetus manages to maintain itself in this environment, due to the high avidity of its hemoglobin for oxygen [1].

In normal newborns (NBs), functional closure of the ductus arteriosus usually occurs after 12 hours, and total obliteration occurs in 60% of NBs around the third month of birth. If the ductus arteriosus remains patent after three months of life, it is considered a congenital heart disease, which represents 5-10% of congenital heart diseases in NB [1].

The first case of intrauterine ductus arteriosus aneurysm was described in 1995, by Puder et al, in a pregnant woman at 35 weeks [4].

Jan et al reported an incidence of ductus arteriosus aneurysm (DAA) in 8.8% of full-term newborns, with a mean diameter of 8.2mm (6.5-11.2mm). All babies had spontaneous closure in the postnatal follow-up until the end of the first month of life. However, 30% of these cases had ductus arteriosus thrombosis as a closing mechanism between the 7th and 10th postnatal day. The authors speculated that this finding may even be an anatomical variant at the end of the third trimester and a natural part of the process of spontaneous closure of the ductus arteriosus [5].

The prenatal incidence of ductus arteriosus aneurysm is underestimated. It is increasingly recognized in the prenatal period and is estimated to be between 1.5-2.2% [6,7]. Tseng & Jan followed 509 low-risk patients from 32 weeks and 11/509 (2.2%) of the fetuses had DAA, all with gestational age above 35 weeks [7].

Lund et al reported a complication rate of 31% in 65 neonates aged less than two months, with rupture (9%), erosion of neighboring organs – bronchi or esophagus (2%), infection (8%) and thromboembolism (12%).) [8].

PATHOGENESIS

Its pathogenesis is uncertain and most appear in isolation. However, it is known that in the third trimester there is an increase in circulating blood volume in the fetus and, therefore, an increase in afterload associated with thinning of the vessel wall and inadequate formation of the intima [4,9]. These factors are a consequence of abnormal elastin deposition in the extracellular matrix and inadequate amounts of fibronectin, whose function is intimal proliferation. This process results in necrosis and mucoid degeneration of the medial layer of the vessel [8].

There is a more frequent association of diabetic mothers, pregnant women with blood group A, newborn weight greater than average at birth, lupus erythematosus and MYH11 gene mutation, with the presence of ductus arteriosus aneurysm [5].

Hyperglycemia in diabetic mothers is responsible for the production of metalloproteinases by vascular endothelial cells, enzymes that are responsible for the degradation of extracellular matrix components [5].

Another theory described corresponds to an intrauterine ductal constriction at the end of the pulmonary artery, with post-stenotic dilation of the ductus arteriosus during fetal life.

Ductus arteriosus aneurysm may be present in connective tissue diseases (Marfan, Ehlers-Danlon and Larsen syndrome), chromosomal anomalies (trisomies 13 and 21) and Smith-Lemli-Opitz syndrome [4,6,8].

It may also be associated with other congenital heart diseases such as hypoplastic left heart syndrome and interruption of the aortic arch.

DIAGNOSIS

The ductus arteriosus aneurysm can be identified at obstetric ultrasound as a saccular or fusiform dilation at its distal end, just before joining the descending aorta, projecting to the left of the aortic arch. It may be visible in the three-vessel section (3VT) or longitudinal sections of the aortic arch and ductal arch. Also, a section of the short axis of the ductus arteriosus shows the fetal DAA located in the same plane as the ascending aorta and pulmonary artery trunk. The diagnosis usually occurs after the 34th week. Doppler shows turbulent flow, establishing a differential diagnosis with tumors or cystic masses [6,7,10].

The ductus arteriosus at term is smaller than 7.0 mm. Therefore, the DAA can be classified according to its diameter in: small (< 7.0mm); large (> 8.0mm) [9]. Jan et al used the transverse diameter of the dilated portion of the ductus arteriosus greater than the 95th percentile, when compared with the normal transverse diameter of the ductus arteriosus for gestational age [5].

Smaller ones usually have a favorable resolution, in 70% of cases, while larger ones can be associated with complications, such as: thrombosis, embolism, infection, spontaneous rupture, cerebral infarction, neonatal death and compression of adjacent structures [6,9].

In addition to the color echocardiogram study, other imaging methods can be used, such as angiotomography and magnetic resonance imaging. Xu et al reported a case of DAA that was studied in the neonatal period using angiotomography with 3D reconstruction (figure 3) [11].

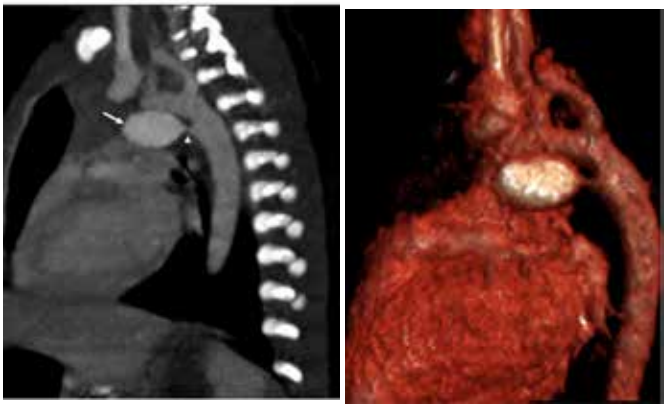

Figure 3. Study of the DAA through angiotomography with 3D reconstruction.

This article reports a rare case of ductus arteriosus aneurysm with progressive fetal hemodynamic repercussions.

CASE REPORT

Patient P.B., 41 years old, G2P1, twin cesarean delivery at 35 weeks five years ago. In the first trimester screening she presented a hypoplastic nasal bone and underwent chorionic villus sampling with normal cytogenetic result (46, XY).

First and second trimester fetal echocardiography without alterations

Mild polyhydramnios appeared at 28 weeks of gestation and negative gestational diabetes screening.

At the 36-week ultrasound, a saccular, vascular image was visualized in the ductus arteriosus in a 3VT section and in the sagittal sections of the aortic and ductal arches, with a mean diameter of 8.0mm. Fetal echocardiography revealed enlarged right heart chambers, moderate polyhydramnios, and a ductus venosus PI above the 95th percentile. No tricuspid valve regurgitation. (see figure 4-8)

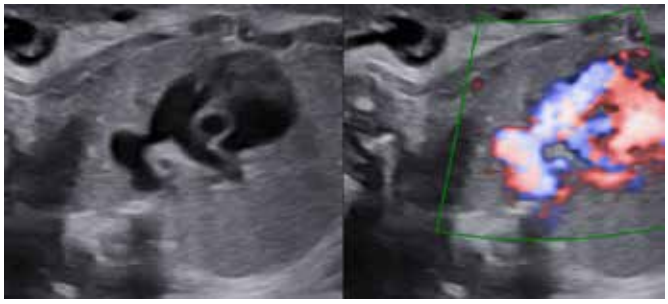

Figure 4 – Section: pulmonary trunk and amplitude Doppler.

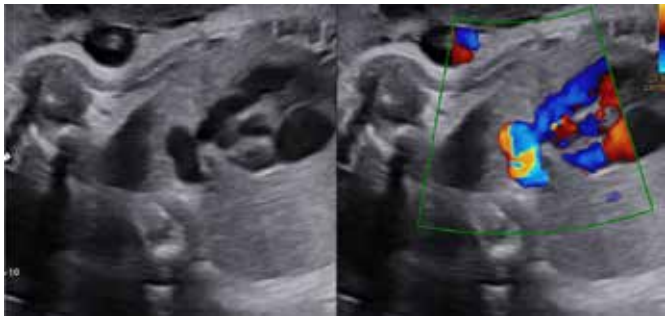

Figure 5 – A. Section of the short axis of the ductus arteriosus, the fetal DAA located in the same plane as the ascending aorta and pulmonary artery trunk can be seen. B. Dilated ductus arteriosus with turbulent flow on color.

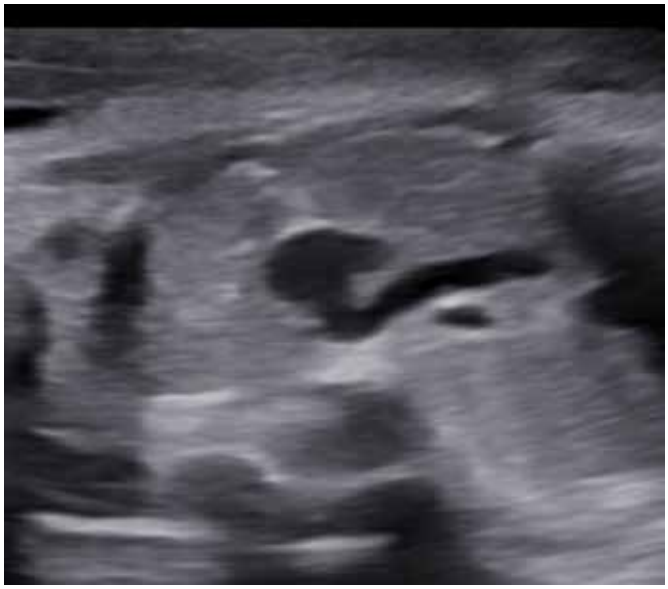

Figure 6 - 3VT section.

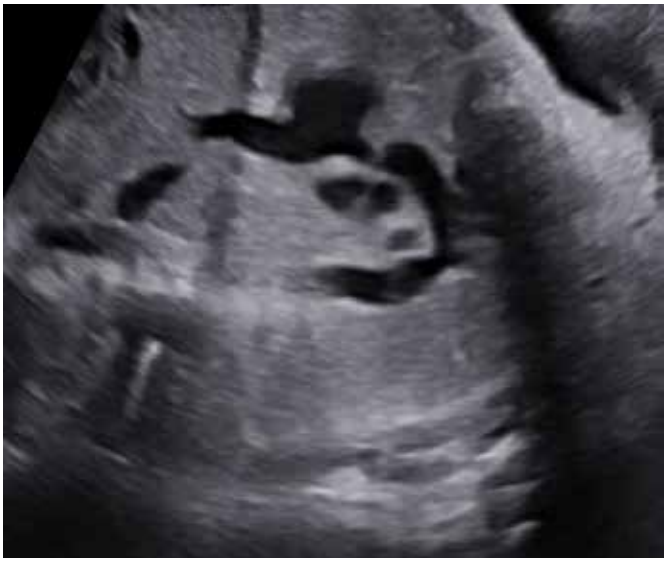

Figure 7- Section of the aortic arch.

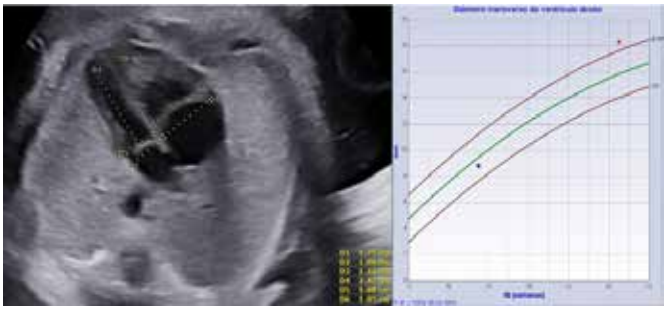

Figure 8 – Section four chambers showing enlargement of right chambers. The RV / LV ratio = 1.36 (normal < 1.18).

Ultrasound at 37 weeks showed a progressive increase in polyhydramnios (AFI: 30.0cm – figure 9) and of the right chambers. The saccular vascular image remained with the same characteristics, dimensions and aspects described above.

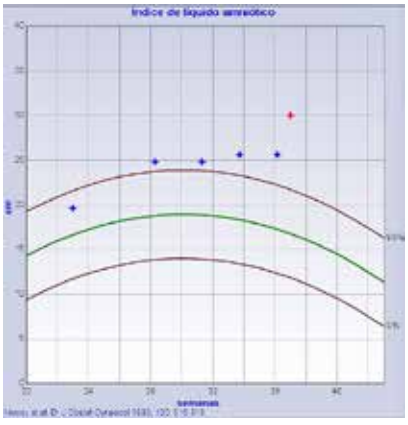

Figure 9. Illustrates polyhydramnios with sudden worsening in recent exams.

As the right chambers were enlarged in relation to the left and significant polyhydramnios, the possible differential diagnoses were: physiological enlargement at the end of pregnancy, coarctation of the aorta or restrictive foramen ovale. All of the above hypotheses were discarded, as PI, velocities and Doppler of the valves and foramen ovale were within normal limits.

At 38 weeks, the patient reported a marked decrease in movement in the last 24 hours and the ultrasound examination revealed an altered fetal biophysical profile (2/8 – only a larger pocket of normal amniotic fluid) and venous Doppler with PI >99th – figure 10.

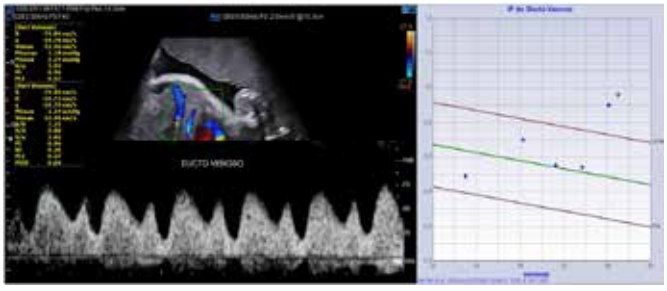

Figure 10. The graph illustrates the progressive increase in pressure in the fetal right atrium by PI=0.96 of the ductus venosus (> 99th).

Scheduled cesarean delivery with asymptomatic newborn, 37 weeks, weighing 3090g, Apgar 9/9, in a hospital with tertiary facilities on 02/15/2023. On the third day, a color echocardiogram was performed, which showed closure of the ductus arteriosus and resolution of the aneurysm. On the seventh day, it presented cyanosis and a new color echocardiogram was performed without alterations. Due to the respiratory condition, he was admitted to the intensive care unit (ICU) for five days, with the diagnosis of bronchiolitis. Within 30 days of birth, he had a new episode of bronchiolitis and was admitted to the ICU for another 12 days. Until the closure of this article, he was under outpatient follow-up to investigate the cause of the bronchiolitis (viral?).

What makes this case rare is that in the case reports found in the literature, only one case showed an increase in the right heart chambers. A direct relationship between ductus arteriosus aneurysm and changes in amniotic fluid (polyhydramnios or oligohydramnios) has not been described.

DISCUSSION

We believe that because ductus arteriosus aneurysm is a third-trimester finding, usually with normal second-trimester echocardiography, its investigation is infrequent and non-routine.

However, the importance of prenatal diagnosis of ductus arteriosus aneurysm is due to the fact that, even though most of them are asymptomatic and have a benign course, a portion of these newborns will develop severe complications that can lead to death. Still, it should be noted that there is a po-

tential for the development of other cardiac lesions associated with tissue diseases, therefore, the continued monitoring of affected babies must be guaranteed.

Even in small aneurysms, the birth must take place in specialized centers. An echocardiogram should be performed on the first day of life and serial follow-ups are required.

The literature has shown that surgery in the treatment of ductus arteriosus aneurysm should be considered in the following situations[6]:

1. Patent ductus arteriosus or ductus arteriosus aneurysm beyond the neonatal period.
2. Enlargement of the aneurysm.
3. Aneurysm associated with connective tissue disease (increased risk of spontaneous rupture);
4. Thrombus within the aneurysm with extension to adjacent vessels.
5. Evidence of thromboembolism.
6. Significant compression of adjacent structures such as airways and nerves.

Surgery should be performed by resection of the aneurysm with cardiopulmonary bypass. Only ligation of the patent ductus arteriosus with aneurysm is contraindicated due to the possibility of sudden rupture during surgery or in the long-term follow-up[6].

CONCLUSION

We describe this rare case with fetal hemodynamic changes, to emphasize the importance of a cardiac study at the end of pregnancy, to identify possible late-onset heart diseases. Emphasizing the need to investigate polyhydramnios of sudden onset, probably due to the production of natriuretic hormone by the enlargement of the fetal right atrium.

Once a ductus arteriosus aneurysm is diagnosed, the newborn should be followed up in the immediate neonatal period until the ductus arteriosus closes and the aneurysm disappears. If connective tissue disorders are suspected, extended monitoring should be advised to parents.

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CASE REPORT

GRYNFELTT'S HERNIA: ABOUT A CASE

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ABSTRACT

INTRODUCTION: proposed by Barbette and confirmed in 1731 by DeGarangeot, lumbar hernias are a rare case among diagnoses, corresponding to 1.5-2% of abdominal wall hernias cases. They are defined as an impairment in the transverse fascia or aponeurosis of the transversus abdominis muscle that results in the extrusion of intra- or extra-peritoneal organs through the discontinuity of the posterolateral abdominal wall and is classified as an inferior or superior lumbar hernia.

CASE REPORT: this paper is to report a case of Grynfeltt hernia, showing the importance of ultrasound in diagnosis. Ultrasonography is an important tool to define the local anatomy and contents of the hernia sac.

CONCLUSION: despite their rarity, lumbar hernias should be considered in the differential diagnosis of masses in this region, and ultrasonography is an instrument with high sensitivity and specificity for its diagnosis.

KEYWORDS: HERNIA; ABDOMINAL HERNIA; ULTRASONOGRAPHY

INTRODUCTION

Hernia, a general term derived from the Greek word "hernios" ("budding"), presents itself as a protrusion through an orifice, natural or accidental, of the cavity that contains it, having a tissue or organ as its content[1]. Lumbar hernia is characterized as a failure in the transversalis fascia or in the aponeurosis of the transversus abdominis muscle that results in the extrusion of intra or extraperitoneal structures through the discontinuity of the posterolateral abdominal wall [2]. Proposed for the first time in 1672 by Barbette et al. confirmed by DeGarangeot in 1731, after an autopsy, lumbar hernias are a rare case among the diagnoses of abdominal wall hernias, accounting for 1.5 to 2% of reported cases [2,3]. Although the disease was described in the 18th century, the first anatomical description of the upper lumbar triangle was made in 1866 by Grynfeltt [4].

The lumbar region is bounded superiorly by the space between the twelfth rib, inferiorly by the iliac crest, medially by the erector spinae muscle, and laterally by the external oblique muscle. Thus, lumbar hernias are anatomically subdivided into upper lumbar hernia (Grynfelt-Lesshaft triangle) and lower lumbar hernia (Petit triangle). In addition, they have two main types, congenital or acquired, the second being classified according to its etiology in primary or secondary [1,2].

Grynfeltt's hernia is a defect in the upper lumbar triangle and has a variable and nonspecific clinical presentation [4]. One in every ten patients with lumbar hernia has acute complications, such as intestinal or urinary obstruction, requiring emergency intervention [5]. Due to low occurrence, this alteration has a low identification rate, even though it is easy to diagnose, being mistakenly diagnosed as other causes that cause bulging in the lumbar region, for this reason its consequences can be serious, increasing morbidity and mortality rates [6].

The aim of this article is to present a case of Grynfelt's hernia and the corresponding ultrasound imaging findings.

CASE REPORT

Female, 63 years old, healthy, presented to the outpatient clinic complaining of bulging in the right lumbar region for more than six months (Figure 1), with no other complaints. No previous surgeries, history of trauma or associated comorbidities. On palpation, the texture is of a soft tissue mass attached to the deep planes.

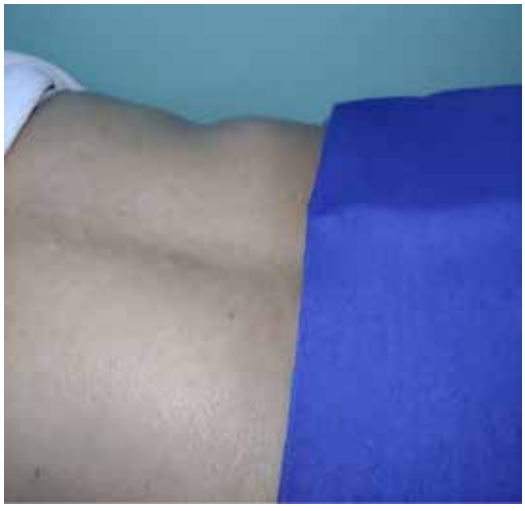

Figure 1 – Upon inspection, a bulge is observed in the right lumbar region.

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She was referred for ultrasound, which was performed with high-frequency linear equipment and the presence of a hernia neck measuring 1.2 x 0.8 cm was detected in the right lumbar region, lateral to the right quadratus lumborum muscle, and to the erector spinae muscle, immediately caudal to the 12th rib. The content of the hernial sac was pararenal fat. A slight increase in hernial volume can be observed with the Valsalva maneuver. Based on the radiological and clinical findings, a diagnosis of right upper lumbar hernia (Grynfeltt's hernia) was made (figures 2 to 4).

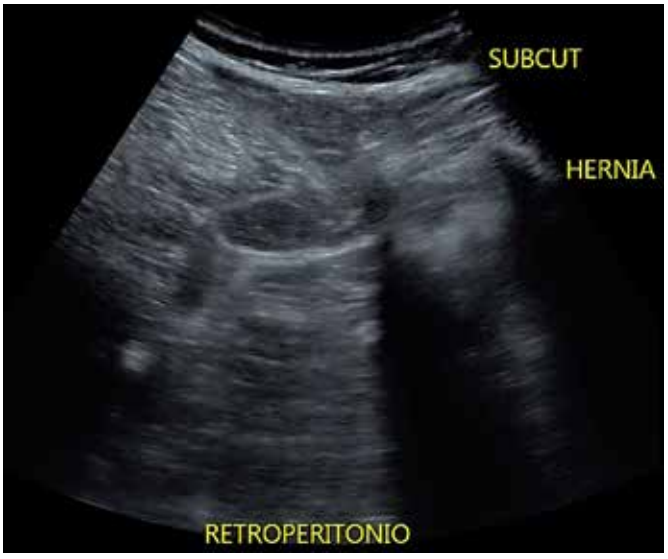

Figure 2: Cross-section of the right upper lumbar triangle showing hernia sac with pararenal fat content.

Figure 3: Dynamic ultrasound image in the sagittal plane of the right upper lumbar triangle region.

Figura 4: Figure 4: Dynamic ultrasound image in the axial plane of the region of the right upper lumbar triangle (note the lower pole of the right kidney and the immediately caudal hernia colon).

DISCUSSION

In 1783, Jean Louis Petit determined the anatomical limits of the inferior lumbar triangle, giving his name to this anatomical structure [3]. After this feat, it was believed that lumbar hernias originated only in the inferior triangle of Petit, but in 1866, Grynfeltt described the anatomical limits of the superior lumbar triangle. In 1870, the German researcher Lesshaft described the same area as Grynfeltt, which is why this space has its proper name of Grynfeltt-Lesshaft triangle [7].

The classification of hernias in the lumbar region is made according to anatomy, and can be divided into superior, inferior or diffuse, the latter being of considerable size and not delimited by any anatomical structure similar to the superior or inferior triangle. The superior lumbar triangle, or Grynfeltt-Lesshaft triangle, is an inverted triangle whose anatomical limits are the 12th rib and superiorly the posterior inferior serratus muscle, laterally the posterior border of the internal oblique muscle and medially the anterior border of the erector spinae muscle [5] .

With only 300 cases reported since its discovery in 1731, lumbar hernias are rare entities, predominantly in males between the 6th and 7th decade of life 7 and represent less than 2% of all hernias of the abdominal wall [4,9]. Clinically, it may appear as a hemispherical protuberance on the back, induced by the Valsalva maneuver, which reduces in the dorsal position [2]. Most affected patients complain of flank pain, of different intensities, and back discomfort [1]. There are no pathognomonic signs or symptoms of Grynfeltt's hernia, and nausea, vomiting and abdominal colic may be present in cases of strangulation with intestinal obstruction [3]. Intercostal neuralgia, abdominal pain, intestinal obstruction, hydronephrosis and hydroureter are rarely described, and there are asymptomatic cases[1]. Occasionally, bowel sounds and the presence of tympanism on percussion are heard when there is colon in the hernial sac [6].

According to the etiology, they are divided into congenital or acquired. The congenital ones represent about 20%

of the cases[7]. Their main causes are musculoskeletal defects during the embryonic period, where the intermuscular septum becomes occupied by the fascia and aponeurosis of the oblique muscles and the weakening of this region can lead to the appearance of herniations [3].

Acquired hernias account for 80% of lumbar hernia cases and are subdivided into two categories: primary, when they occur spontaneously, with the possibility of being precipitated by conditions associated with increased intra-abdominal pressure (pregnancy, ascites, obesity, chronic bronchitis) , extreme thinness, posterior abdominal wall weakness caused by aging and muscle atrophy, accounting for 25%; and secondary, after trauma, surgery (aortic, renal or adrenal), abscesses, retroperitoneal hematoma, direct force or penetrating wounds, accounting for 55% of cases [2,6]. Considering the clinical conditions, history and age, we consider that this case is classified as a primary acquired upper lumbar hernia.

There is a morphometric classification, by Moreno-Egea, which is performed by the surgeon in the transoperative period and helps in choosing the type of hernia repair [7]. One of the parameters is the area of the hernia neck, so it will be of value if the ultrasonographer is able to measure two perpendicular radii of the neck for calculating the ellipse area (area = radius1 x radius2 x ϖ).

The content of the hernial sac is variable, and may be of retroperitoneal origin, kidneys, urinary bladder, ascending or descending colon and extra-peritoneal fat, or intraperitoneal, such as the upper part of the duodenum, jejunum, ileum, omentum, preperitoneal fat, stomach and spleen 8. It can even be paraperitoneal when the peritoneum slips, adhering to the viscera [7].

The recognition of this entity is usually difficult and is not always assumed at the beginning of the condition, given the small number of reports [2]. It should always be included in the differential diagnosis of lumbar masses such as fibromas, lipomas, hematomas, retroperitoneal tumors, locoregional abscesses, kidney tumors , rhabdomyomas, sarcomas, and muscle hernias [3,6,10].

Although the diagnosis is clinically suspected, imaging tests should always be considered, as in addition to the defect in the posterior abdominal wall, it can reveal the hernia content (viscera or extraperitoneal tissue), contributing to surgical planning [5,9].

Ultrasonography, in addition to being free of ionizing radiation, allows obtaining dynamic images both at rest and during the Valsalva maneuver, increasing the sensitivity and specificity of the method [7]. As it is a rare entity, the disease may be underdiagnosed by less experienced sonographers.

CONCLUSION

Although it is a rare entity, the diagnosis of lumbar hernia should be considered in the differential diagnoses of lumbar masses when performing imaging tests. Defining the boundaries of the mass can help the sonographer to identify the hernia cervix.

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REVIEW ARTICLE

E-FAST AS A DIAGNOSTIC METHOD TO ACCURATELY ASSESS LESIONS IN A PATIENT WITH TRAUMA

CARLOS CASTRO RIOJA, ARIELA MAULLER VIEIRA PARENTE, WALDEMAR NAVES DO AMARAL

ABSTRACT

INTRODUCTION: E-FAST is an emergency ultrasound coding protocol for patients with trauma, mainly abdominal, in a synthetic, targeted and simple way. e-FAST visualizes lung bases and lung-related injuries, in addition to intra-abdominal and pericardial bleeding.

OBJECTIVE: To analyze whether e-FAST is a method with good sensitivity to accurately assess injuries in a stable trauma patient.

METHODS: The study was carried out through an online search of scientific productions in international databases, from 2014 to 2022.

RESULTS: Through the descriptors, 34 articles were identified, of which only 18 passed the inclusion criteria and exclusion. Of these, 10 articles were selected that responded to the objective, according to the content analysis.

The overall sensitivity of the e-FAST examination technique (pneumothorax, pleural effusion, spleen injury, liver injury, gastrointestinal injury, pericardial effusion, intra-abdominal free fluid and bladder rupture ranged from 69% to 99% in its sensitivity. the specificity averaged 98%, the positive predictive value averaged 92%, and the negative predictive value averaged 98%, the accuracy rate averaged 98% across the evaluated studies.

CONCLUSION: The main advantage of the method is that the diagnosis is fast, accurate, safe, without radiation effects, with good sensitivity and specificity. Its main disadvantage is that it is operator dependent. However, e-Fast has a high overall sensitivity and should be incorporated into routine assessment as a useful bedside tool to determine pneumothorax, pericardial effusion, and intra-abdominal free fluid in the setting of trauma.

KEYWORDS: E-FAST, SENSITIVITY, ULTRASOUND, INTENSIVE CARE MEDICINE

INTRODUCTION

As a point-of-care tool, emergency ultrasound has the potential to rule out or confirm a diagnosis in most critically ill people[1].

Since the 1990s, ultrasound has quickly established itself as a rapid bedside examination. Several studies, carried out in North America, showed that ultrasound performed by emergency surgeons was not only feasible but, above all, allowed to quickly confirm a lesion with good sensitivity and good specificity. In the same period, many emergency services purchased ultrasound machines. Thus, several attempts at standardization led to the development of a protocol: FAST (Focused Abdominal Sonography for Trauma Patients). This is an emergency ultrasound coding protocol for patients with trauma, mainly abdominal, in a synthetic, targeted and simple way. In the 2000s, in the United States, it is believed to have replaced peritoneal lavage in the diagnosis of hemoperitoneum. It has since continued to be used and is now taught as part of Advanced Trauma Life Support in the North American continent (North American Trauma Management Protocol). In the mid-2000s, assessment of the chest for pneumothorax and hemothorax was added to the traditional FAST exam, resulting in the acronym EFAST (Extended FAST), "extended FAST" for the pleura[2].

The FAST protocol is an important adjunct and extension of clinical examination in an emergency setting that has been used for the past three decades. It may be performed on trauma patients with symptoms of hemorrhagic shock or evidence of intra-abdominal injury. The characteristics of FAST have led this practice to be adopted as an international standard of care in most developed countries. It is a non-invasive, portable, low-cost test that can be performed in less than five minutes, repeatable and without the need for radiation, and can be performed by an emergency physician or surgeon.[3]

The e-FAST visualizes lung bases and lung-related injuries, as well as intra-abdominal and pericardial bleeding. In trauma patients, time is precious. Non-contrast computed tomography (NCCT) of the chest is the gold standard for the evaluation of blunt chest trauma. However, it is cumbersome and time-consuming and leads to increased morbidity and mortality. Therefore, evaluating trauma patients in the trauma room with e-FAST, which is available around the clock, will not only save time, but also the lives of trauma patients[4].

The aim of this study is to analyze through a review whether e-FAST is a method with good sensitivity to accurately assess injuries in a stable trauma patient.

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METHODS

The study was carried out through an online search of international scientific productions, from 2014 to 2022, to respond to the objective of analyzing whether e-FAST is a method with good sensitivity to accurately assess injuries in a stable patient with trauma.

The Latin American and Caribbean Literature in Health Sciences (LILACS) and the Medical Literature Analysis and Retrieval System Online (MEDLINE) databases were used, which uses the Virtual Health Library and Pubmed as a search engine. The descriptors used were: E-fast, trauma, sensitivity in English.

The following inclusion criteria were considered: articles published between 2014 and 2022; in Portuguese, English and Spanish; released in full for reading. Articles that did not respond to the guiding and bibliographic review question were excluded.

Access to the database and collection took place in November 2022. All articles were analyzed by the author. Through the descriptors, 34 articles were identified, of these, only the inclusion and exclusion criteria were applied, remaining 18 articles, being selected 10 articles that answered the guiding question, according to the content analysis.

RESULTS

Through the descriptors, 34 articles were identified, of which only 18 passed the inclusion and exclusion criteria. Of these, 10 articles were selected that responded to the objective, according to the content analysis. Flowchart in figure 1.

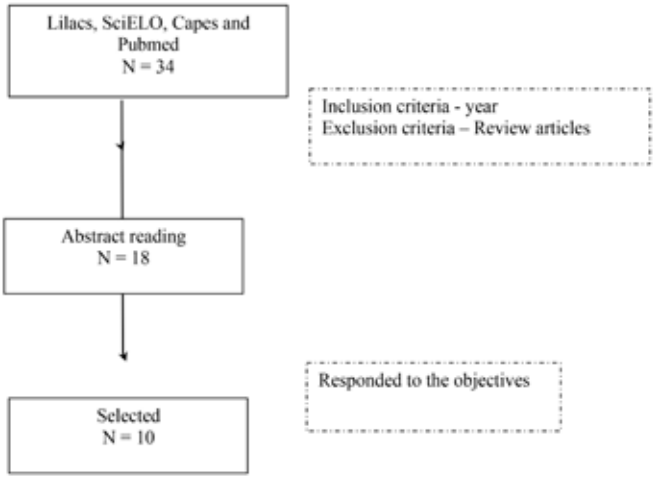

Chart 1 - illustrates the selected studies in terms of purpose, interventions and results.

Chart 1: Distribution of studies according to authors, year of publication, objective, interventions and results.

STUDIES	OBJECTIVE	INTERVENTIONS
Devadoss et al., 2021	To analyze the diagnostic accuracy of e-FAST in stable chest trauma	Observational, prospective study 110 patients
Netherton et al., 2019	Systematically review the published literature on the diagnostic accuracy of all components of the eFAST exam	Systematic review with meta-analysis 75 studies representing 24,350 patients
Akoglu et al., 2018	To compare the diagnostic accuracy of the E-FAST exam performed by EM residents with the results of computed tomography as the gold standard.	Observational, prospective study 140 patients
Ianniello et al., 2014	To evaluate the diagnostic accuracy of extended focused assessment with trauma ultrasonography (e-FAST) in the diagnosis of pneumothorax, compared with the results of multidetector computed tomography (MDCT) and invasive interventions (thoracostomy tube placement).	Retrospective observational studies involving 368 patients
Ianniello et al., 2014	Show the sensitivity of Enhanced Focused Assessment with Sonography for Trauma (e-FAST) for detecting pneumothorax, hemothorax, and intra-abdominal injury.	Observational, prospective study 33 patients
Xu et al., 2018	To investigate the diagnostic value of extended focused assessment with trauma ultrasound (E-FAST) in multiple trauma patients in the intensive care unit (ICU).	Observational, prospective study 76 patients
Basnet et al., 2020	To evaluate the accuracy of extended focused assessment with trauma ultrasound (EFAST) for chest and abdominal injuries performed by rescuers in a tertiary hospital in Nepal.	Observational, prospective study 267 patients
Gul et al., 2022	To determine the diagnostic accuracy of extended focused assessment with trauma ultrasound (E-FAST) to detect thoracoabdominal trauma while maintaining contrast-enhanced CT of the chest and abdomen as the gold standard.	Observational, prospective study 196 patients
Adelin et al., 2020	To evaluate the contribution of EFAST ultrasonography in the management of blunt thoracic and abdominal trauma.	Observational, prospective study 63 patients
Bagheri-Hariri et al., 2019	To examine the effect of using E-FAST on the clinical judgment of physicians treating patients with blunt abdominal and chest wall trauma.	Observational, prospective study 115 patients

Chart 1: Distribution of studies according to authors, year of publication, objective, interventions and results.

DISCUSSION

Performing e-FAST is a common practice in the initial evaluation of trauma patients. The studies selected here highlighted that it is a fast, safe diagnostic method, without radiation effects, with good sensitivity and specificity.

Cross-sectional studies, mostly prospective, were analyzed. A study carried out in a trauma center from November 2017 to 2019, including 110 patientshe showed that e-FAST is a better complement for the diagnosis and treatment of patients with blunt chest trauma[5].

In a systematic review to analyze the diagnostic accuracy of all components of the eFAST exam, with seventy-five selected studies representing 24,350 patients, pooled sensitivities and specificities were calculated for the detection of pneumothorax (69% and 99%, respectively), pericardial effusion (91% and 94%, respectively) and intra-abdominal free fluid (74% and 98%, respectively). Subgroup analysis was completed for detection of intra-abdominal free fluid in hypotensive patients (74% sensitivity and 95% specificity), normotensive adults (76% sensitivity and 98% specificity), and pediatrics (71% sensitivity and 95% specificity). The study suggests that e-FAST is a useful bedside tool to determine pneumothorax, pericardial effusion and intra-abdominal free fluid in the trauma setting[6].

Another study to evaluate the diagnostic accuracy of e-FAST in the diagnosis of pneumothorax, compared with the results of multidetector computed tomography (MDCT) and invasive interventions (thoracostomy tube placement), with 368 unstable adult patients (273 men and 95 women; mean age, 25 years; range, 16-68 years), admitted to the emergency department for major trauma (injury severity score ≥ 15). Of the 736 lung fields included in the study, 87 pneumothoraxes were detected on chest CT (23.6%). The e-FAST detected 67/87 and 20 pneumothoraxes were not identified (17 mild, 3 moderate). The diagnostic performance of ultrasound was: sensitivity 77% (74% in 2011 and 80% in 2012), specificity 99.8%, positive predictive value 98.5%, negative predictive value 97%, accuracy 97.2% (67 true positives; 668 true negatives; one false positive; 20 false negatives); 17 missed mild pneumothoraxes were not immediately fatal (thickness less than 5mm). The results show that chest ultrasound (e-FAST) is a rapid and accurate first-line bedside diagnostic modality for diagnosing pneumothorax in unstable patients with major chest trauma during the primary assessment in the emergency room[7].

The sensitivity of e-FAST was also evaluated in another study for the detection of pneumothorax, hemothorax and intra-abdominal injury. The relationship between e-FAST and the need for invasive treatment was also analyzed. The study included patients who suffered polytrauma. The results of computed tomography (CT) of the abdomen and thorax were reviewed and the size of the pneumothorax was scored. Compared to CT, e-FAST sensitivities for intra-abdominal injury and hemothorax were 54.5% and 71%, respectively. The diagnosis of pneumothorax was established in 27 patients with e-FAST (sensitivity 81.8%) out of 33 (30.8%) patients with pneumothorax. According to the CT grading, no pneumothorax less than 1 cm wide and not exceeding the mid-coronal line in length were identified. The e-FAST was positive for all patients undergoing tubular thoracostomy. The authors conclude that e-FAST can be used with high sensitivity for the determination of pneumothorax that requires an invasive procedure. It has low sensitivity in the diagnosis of intra-abdominal injury and hemothorax; however, e-FAST can predict the need for invasive procedures[8].

Multiple trauma patients in the intensive care unit (ICU) were also analyzed to verify the diagnostic value of e-FAST in a prospective clinical study[10]. Eighty polytrauma patients admitted to the ICU of Anhui Provincial Hospital were included. The e-FAST for trauma check was performed at baseline, and for those who had positive findings, the diagnosis was immediately confirmed by CT scan or surgical exploration. If negative, patients underwent e-FAST every morning for seven days (defined as D-EFAST) and, for those with positive findings, immediate CT or surgery was performed to clarify the diagnosis. 76 patients participated in the study. The overall sensitivity of the e-FAST scanning technique for pneumothorax, pleural effusion, splenic injury, liver injury, gastrointestinal injury, pericardial effusion, and bladder rupture was 75.9% (66/87) and the specificity was 98.3% (587/597), the positive predictive value was 86.8% (66/76) and the negative predictive value was 96.5% (587/608), the hit rate was 95.5% (653/684) and the missed diagnosis rate was 24.1% (21/87). Most late injuries in polytrauma patients occurred 2-7 days after the injury with an incidence of 4.8% (33/684). The diagnostic sensitivity of D-EFAST for late injury was 98.3% (118/120), specificity was 99.8% (563/564), positive predictive value was 99.2% (118/119), the negative predictive value was 99.6% (563/565), the diagnostic accuracy rate was 99.6% (681/684), and the missed diagnosis rate was 1.7% (2/120). When the final clinical diagnosis was defined as the gold standard, the D-EFAST technology for detection rate was 98.3% (118/120) for patients with multiple trauma in organ damage, while the detection rate of e-FAST was 75.9% (66/87), with a statistically significant difference ($P < 0.01$), indicating that D-EFAST was better than e-FAST in checking polytrauma patients with organ damage. While e-FAST technology can quickly diagnose polytrauma patients and gain rescue time for critically ill patients, polytrauma patients injured after 2-7 days are prone to late damage and difficult to detect, while D-EFAST can be used to find damage earlier and reduce the rate of misdiagnosis of patients with multiple trauma [9].

In Nepal, a study was conducted to evaluate the accuracy of e-FAST for thoracic and abdominal injuries. All trauma patients who had an injury severity score ≥15 or direct trauma to the trunk at Dhulikhel-Kathmandu University Hospital were included. The e-FAST results were then compared with contrast-enhanced CT (CECT), radiological ultrasonography (USG)/chest X-ray, or intraoperative findings when e-FAST was positive. Of the 267 cases, 261 patients

underwent the e-FAST exam. Sensitivity and specificity were 94.8% and 99.5%, respectively. The negative predictive value was 98.53%, while the positive predictive value was 98.21%. Overall accuracy was 99.4%. The e-FAST showed high specificity (99.5%) and positive predictive value (98.21%), which indicates that it is an effective technique for detecting intra-abdominal or thoracic injuries. However, the effectiveness of e-FAST is limited by operator dependence and therefore by human error. For negative e-FAST cases, we recommend a monitoring period of at least four hours, serial rapid scan or further investigation by other methods such as CECT [10].

In another study of the diagnostic accuracy of the e-FAST assessment to detect thoracoabdominal trauma, keeping CT of the chest and abdomen with contrast as the gold standard, performed at the Combined Military Hospital, Quetta. A total of 196 patients, aged 18 to 60 years, of both genders, referred for contrast-enhanced chest and abdomen computed tomography were included in the study. The patients were first submitted to a chest and abdomen ultrasound and then to a contrast-enhanced chest and abdomen computed tomography scan. Findings from both modalities were recorded and submitted to statistical analysis to confirm the accuracy of ultrasound, considering computed tomography as the gold standard procedure. Blunt trauma was observed in 131 (66.8%) and penetrating trauma in 65 (32.2%) patients. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of E-FAST for chest trauma was 79.4%, 94.7%, 87.6%, 90.7% and 89.8%, respectively, for abdominal trauma was 68.6%, 95.2%, 88.8%, 84.5% and 85.7%, respectively, and for combined chest and abdominal trauma it was 77.1%, 95.9%, 85.9%, 92.8% and 91.3%, respectively. The results indicate that e-FAST has good diagnostic accuracy for thoracic, abdominal and thoracoabdominal trauma and can be incorporated into the routine assessment of trauma patients[11].

Another study evaluated the contribution of e-FAST in the management of blunt thoracic and abdominal trauma in the emergency and intensive care units of the Centro Hospitalar Universitário de Parakou. 63 patients were analyzed and the e-FAST was positive in 50.79% of the patients. Five patients (7.93%) received emergency treatment due to hemodynamic instability and positive e-FAST in a mean of 3.46 ± 2 hours. Eighteen patients (27.58%) underwent surgery in nine hours and 12 minutes (hemoperitoneum) and 27 hours and 58 minutes (hemothorax), after monitoring by e-FAST. The authors concluded that the introduction of an e-FAST ultrasound as a screening tool in a resource-limited setting is desirable and feasible[12].

In Iran, a cross-sectional study was performed evaluating trauma patients with abdominal or blunt chest trauma and for whom e-FAST was performed. 115 patients were examined. The correlation coefficient between the possibility of hemorrhagic shock, pneumothorax, hemoperitoneum, solid organ injury and hemothorax before and after E-FAST based on the Kappa criteria was 0.803, 0.642, 0.430, 0.331 and 0.318, respectively, showing that the performing e-FAST increases the sensitivity of the history and physical examination in the diagnosis of pneumothorax, hemoperitoneum, damage to solid organs and hemothorax[13].

In Europe, few studies were found on the use of e-FAST by emergency physicians. One study compared the diagnostic accuracy of the E-FAST scan at 132 for abdominal scans and 130 for chest scans. Sensitivity was 42.9% and specificity 98.4% [7]. The results indicate that the e-FAST test has excellent specificity. However, the sensitivity of the test is not high enough to rule out thoracoabdominal injuries in trauma patients when performed by emergency physicians [14].

Table 1 illustrates the sensitivity and specificity of the main traumas such as pneumothorax, pericardial effusion, intra-abdominal fluid and hemothorax described in previous studies, as well as the calculated average.

	Pneumotórax		Derrame Pericárdio		Liq. Intra-abdominal		Hemotórax	
Autor	Sens	Esp	Sens	Esp	Sens	Esp	Sens	Esp
Netherton et al. 2019	69,0	99,0	91,0	94,0	74,0	98,0	-	-
Ianniello et al, 2014	77,0	99.8	-	-	-	-	-	-
Ianniello et al, 2019	81,8	-	-	-	54,5	-	71,0	-
Basnet et al, 2020	75,9	98,3	75,9	98,3	-	-	-	-
Média	**75,8**	**99,0**	**83,5**	**96,2**	**64,3**	**98,0**	**71,0**	

Table 1. Shows the sensitivity and specificity of the main traumas such as pneumothorax, pericardial effusion, intra-abdominal fluid and hemothorax. Sens – sensitivity; – specificity

Figures 2 and 3 illustrate ultrasound images using the E-fast method in a case of hemoperitoneum and pneumothorax, respectively [9].

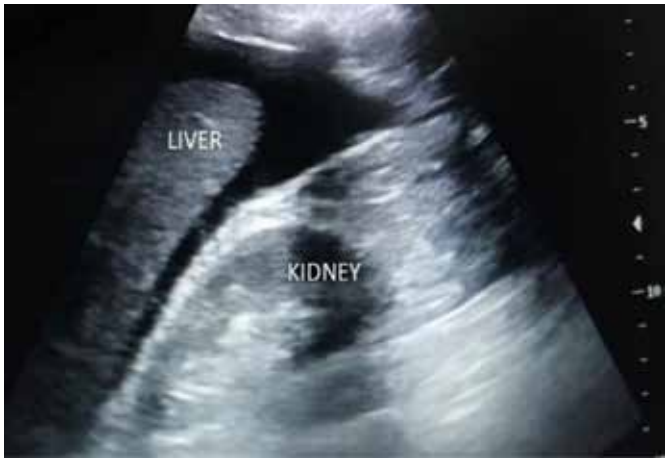

Figure 2. Ultrasonographic image of the upper right quadrant of the abdomen, showing an anechoic image suggestive of hemoperitoneum between the liver and kidney, in an abdominal trauma. (courtesy Basnet et al [9])

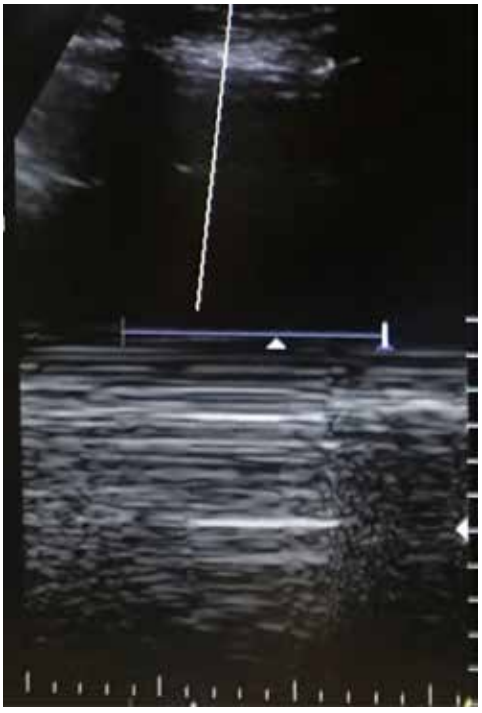

Figure 3 . Ultrasound image of the anterior thorax using the M-mode with identification of the "bar code" sign suggestive of pneumothorax. (courtesy Basnet et al [9])

CONCLUSION

The main advantages of the method is that the diagnosis is fast, accurate, safe, without radiation effects with good sensitivity and specificity. Its main disadvantage is that it is operator dependent.

The overall sensitivity of the e-FAST examination technique (pneumothorax, pleural effusion, spleen injury, liver injury, gastrointestinal injury, pericardial effusion, intra-abdominal free fluid, and bladder rupture ranged from 69% to 99% in its sensitivity

The specificity was on average 98%, the positive predictive value was on average 92% and the negative predictive value was 98%, the accuracy rate was on average 98% among the evaluated studies. Therefore, e-Fast can be incorporated into the routine assessment of trauma patients.

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REVIEW ARTICLE

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ULTRASONOGRAPHIC FINDINGS RELATED TO BLADDER NEOPLASIA: NARRATIVE REVIEW

RAPHAEL BALDARENA MORAES, CARINA ABDALLA OGNIBENE, GABRIEL BASTON REALISTA, LEONARDO DE SOUZA PIBER

ABSTRACT

INTRODUCTION: Bladder cancer is usually diagnosed by chance or due to the investigation of its typical symptoms. Hematuria is the most frequent symptom, occurring in approximately 85% of patients, as well as pollakiuria and dysuria, findings that are also present in benign situations such as urinary tract infection, nephrolithiasis, benign prostatic hyperplasia and other inflammatory conditions. It is estimated that each year in Brazil more than ten thousand new cases of bladder cancer are diagnosed, about 70% in men and 30% in women, being the seventh most frequent cancer in the male population.

OBJECTIVE: This research aims to study the sonographic findings related to bladder cancer.

MATERIAL AND METHODS: This is a narrative review with emphasis on the collection of images. The databases were MEDLINE via PubMed, LILACS and Scielo via BVS (Virtual Health Library). The health descriptors (MeSH terms) in English used: were urinary bladder neoplasms, ultrasonography, ultrasound, in the following search strategy: (ultrasonography or ultrasound) and (urinary bladder neoplasms). Studies published in the last five years were included.

RESULTS AND DISCUSSION: The applicability of imaging tests has been increasingly important for the diagnosis, staging and follow-up of neoplasms, especially for cancers with clinical characteristics similar to several other pathologies, such as bladder cancer. Despite its relatively high incidence, bladder cancer is often under-diagnosed and the appearance of bladder cancer can be confused with other pathologies. Thus, the importance and advantage of ultrasonography as a dynamic imaging modality, capable of optimizing the distinction of bladder cancer from entities of similar appearance, is highlighted. Thus, the work discusses the additive role of ultrasound images for patients with bladder cancer, presenting the most frequent subtypes and their respective ultrasound images and distinguishing their differential diagnoses: urothelial carcinoma, urothelial papilloma and fibroepithelial polyps, rhabdomyosarcoma, leiomyoma, adenocarcinoma of urachus, paraganglioma and lymphoma of the bladder.

CONCLUSION: From the exposure and description of the ultrasound images, the importance of the applicability of ultrasound for the detection and distinction of bladder cancer is reiterated, and its use should be encouraged when the patient presents a compatible clinical condition, since this diagnosis can be confused with other frequent pathologies of the genitourinary tract, consequently causing late discovery of the disease and a worse prognosis.

KEYWORDS: ULTRASONOGRAPHY; BLADDER; NEOPLASM; UROLOGY; DIAGNOSTIC IMAGING

INTRODUCTION

The applicability of imaging tests has been increasingly important for the diagnosis, staging and follow-up of neoplasms, especially for cancers with clinical characteristics that may be similar to other pathologies, such as bladder cancer.

Bladder cancer is usually diagnosed incidentally or as a result of investigating its typical symptoms. Hematuria is the most frequent symptom, occurring in approximately 85% of patients, as well as pollakiuria and dysuria, findings that are also present in benign situations such as urinary tract infection, nephrolithiasis, benign prostatic hyperplasia and other inflammatory conditions. As these conditions are quite common, misinterpretations of hematuria and irritative symptoms can result in a late diagnosis of bladder cancer, when they are already at a more advanced stage of the disease.[1]

The National Cancer Institute (INCA) estimates that each year in Brazil more than ten thousand new cases of bladder cancer are diagnosed, about 70% in men and 30% in women, being the seventh most frequent cancer in the male population. The estimates, according to the American Cancer Society, for bladder cancer in the United States, for the year 2019, was 80,470 new cases, 61,700 in men and 18,770 in women.[2]

Despite its relatively high incidence, bladder cancer is often underdiagnosed and, as seen, even when bladder abnormalities are identified, the appearance of bladder cancer can be confused with other pathologies. Thus, we emphasize the importance and advantage of ultrasonography as a dynamic imaging modality, with the capacity to optimize the distinction of bladder cancer from entities of similar appearance.[3]

In this review, we will discuss the additive role of ultrasound images for patients with bladder cancer, presenting

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the most frequent subtypes and their respective ultrasound images to better identify their characteristics.

OBJECTIVE

This work aims to study ultrasonographic findings related to bladder cancer.

METHODS

This is a narrative review with emphasis on the collection of images. The databases were MEDLINE via PubMed, LILACS and Scielo via BVS (Virtual Health Library). The health descriptors (MeSH terms) in English used were urinary bladder neoplasms, ultrasonography, ultrasound, in the following search strategy: (ultrasonography or ultrasound) and (urinary bladder neoplasms).

Studies were included (clinical trials, pictorial essays, literature reviews, case reports, among others), which had images of diagnostic methods, which were in accordance with the research objective and available online in full text, published in the last five years, in English, Spanish and Portuguese.

RESULTS AND DISCUSSION

The main subtypes of bladder cancer and their respective ultrasound images as well as their differential diagnoses are presented below.

UROTHELIAL NEOPLASMS

Urothelial carcinoma

Urothelial carcinoma is the most common urinary tract malignancy in adults. Potentially lethal, it can present as main symptoms hematuria, polyuria and later, urinary obstruction, evolving with pain and infectious symptoms. On imaging, there are no specific features that differentiate urothelial carcinomas from other bladder lesions, however, they tend to occur in the bladder trigone and ureteral orifices [4] – see figures 1-3.

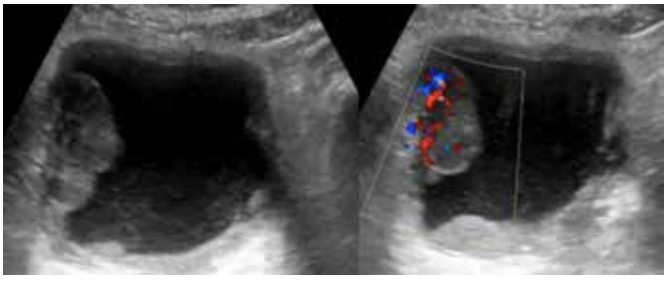

Figure 1. (a) Large well-defined echogenic mass (4.0×2.0×3.7cm) on the right lateral wall of the bladder. (b) Color Doppler ultrasonography detected the presence of vascularization in this mass. Urothelial carcinoma was confirmed. [3]

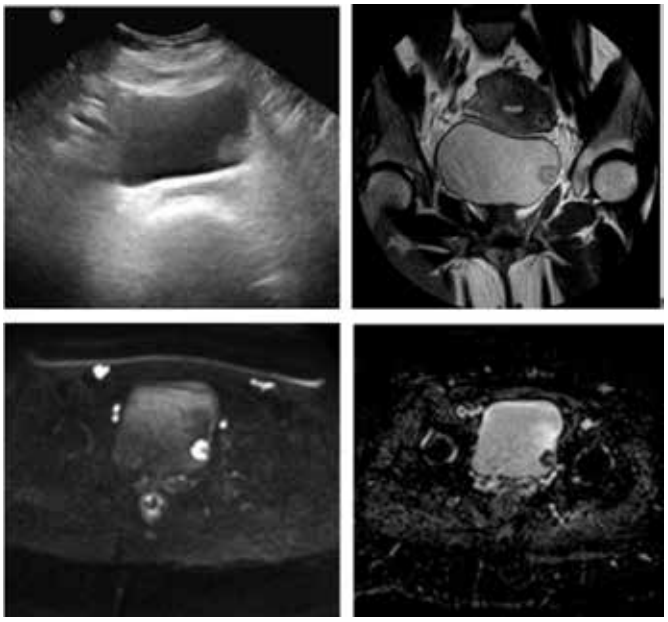

Figure 2. Stage T1 urothelial carcinoma: (a) Echogenic soft tissue mass on the left lateral wall. (b) Superficial soft tissue mass on the left lateral wall with arc-shaped tumor. (c) restricted signs of the tumor and not of the submucosal peduncle. (d) Note remaining intact muscular wall of the urinary bladder. [3]

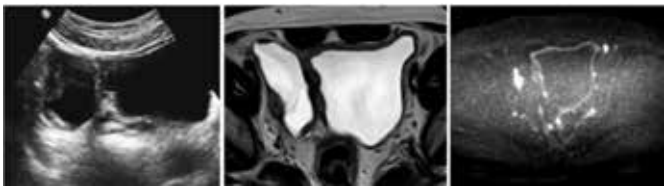

Figure 3. Male patient, 60 years old, with stage T2 urothelial carcinoma (a) ultrasound image of the right bladder diverticulum with intradiverticular soft tissue lesion. (b) intradiverticular mass on the right. (c) intradiverticular mass on the right. [3]

Patients with a history of augmentation cystoplasty have a higher risk of developing urothelial carcinoma, which in this setting occurs more frequently at bladder-bowel anastomosis sites and is more likely to be of high grade and to have an aggressive clinical course. For this reason, some clinicians recommend endoscopic surveillance of patients with this history. This surveillance should begin 10 years after the initial surgery because of the considerable time required for the lesion to develop.

Urothelial papilloma and fibroepithelial polyps

Urothelial papillomas are benign polypoid neoplasms, typically seen in males younger than 50 years of age. Microscopically, these lesions demonstrate a fibrovascular nucleus covered by normal urothelium and without cytological atypia. Occasionally, large papillary structures may arise, giving rise to anastomoses of papillae, which help to distinguish these tumors from fibroepithelial polyps on pathological analysis.

Urothelial papillomas have been described with a frondlike appearance on imaging (although this feature is not pathognomonic) and occurring near the ureteral orifices or along the posterior bladder wall.

On ultrasound, they usually appear as a hypo- or hyperechogenic soft-tissue mass on the lateral walls of the bladder (Figures 4-5).

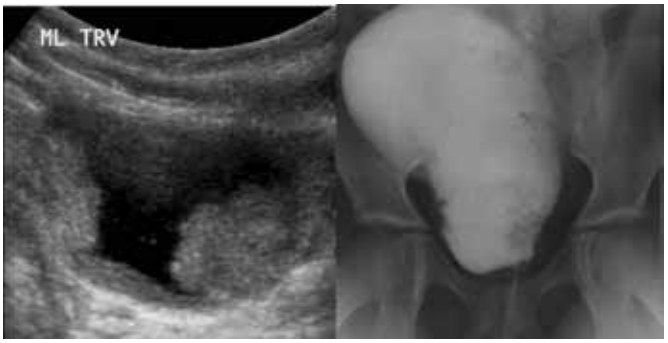

Figure 4. Bilateral bladder papillomas in a six-year-old girl. (a) Cross-sectional midline US image showing bilateral lobulated soft tissue masses at the vesicoureteric junctions. (b) Voiding cystourethrogram shows multiple filling defects in the urinary bladder along the lateral walls. [4]

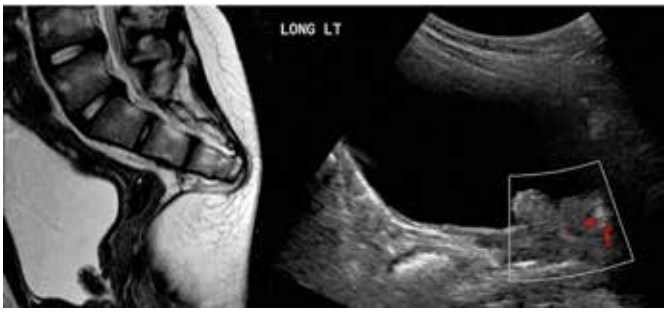

Figure 5. Fibroinflammatory polyp of the urinary bladder in an eight-year-old boy. The polyp was initially identified incidentally on MRI of the lumbar spine. (a) Sagittal T2-weighted MR image of the lumbar spine shows an incidentally discovered bladder lesion in the urethral orifice. (b) Sagittal color Doppler US image of the urinary bladder shows the lobulated lesion with slight internal vascularization.

Fibroepithelial polyps are benign urothelial lesions, most commonly seen in the upper urinary tract. It has a strong male predilection and can manifest during childhood. Manifestations of fibroepithelial polyps include gross hematuria and flank pain that may be due to torsion of the polyp if it reaches a substantial size. However, most of these lesions are solitary and smaller than 5 cm. Some of them may have focal areas of ulceration. [4]

MESENCHYMAL NEOPLASMS

Rhabdomyosarcoma

Rhabdomyosarcomas are the most common malignant tumors of the urinary bladder in children younger than 10 years and represent 5% of all solid childhood cancers. Although rhabdomyosarcomas can arise anywhere in the body where primitive muscle cells exist, they manifest in the bladder and prostate in approximately 20% of cases. Bladder and prostate rhabdomyosarcomas have a bimodal age distribution, with a peak incidence in the first two years of life and another peak in adolescence.

Approximately 10% to 20% of patients with rhabdomyosarcoma (regardless of site of origin) have metastatic disease at the time of diagnosis. Dissemination is typically to the lungs, cortical bone and/or regional lymph nodes, with the incidence and pattern of disease differing according to the site and histological features of the tumour.

On ultrasound images, bladder rhabdomyosarcomas are typically large and nodular and often associated with urinary tract obstruction. The mass is usually well defined and slightly hypoechoic and homogeneous. The botryoid subtype of rhabdomyosarcoma can look like a bunch of grapes. These lesions are commonly located in the bladder trigone and bladder neck (figure 6).

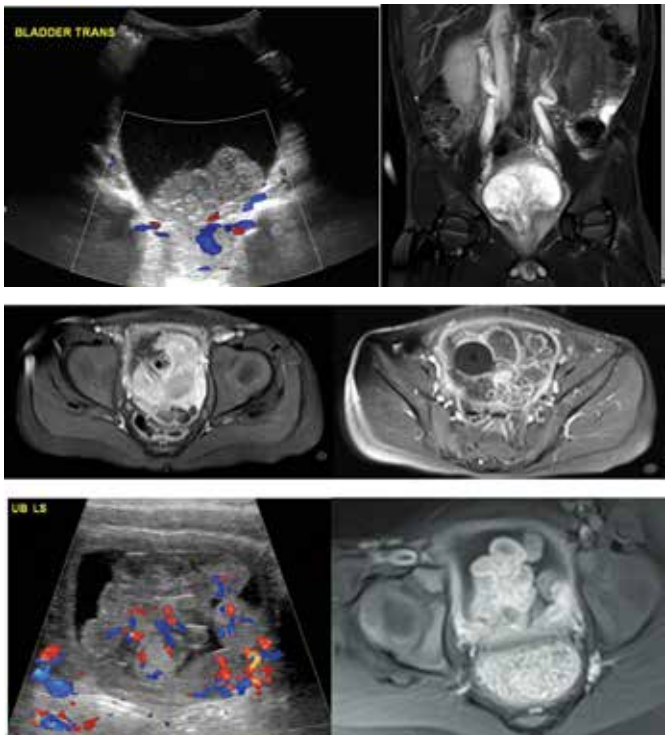

Figure 6. Embryonal rhabdomyosarcoma of the urinary bladder in children. (a) Color Doppler longitudinal section of the bladder shows a multilobulated mass with internal vascularity. (b-d) Mass is the base of the bladder. (e) similar lesion in another patient. (f) the lobulated lesion has high signal intensity. [4]

LEIOMYOMA

Bladder leiomyomas are rare, representing 0.43% of all bladder mesenchymal tumor subtypes. These tumors are commonly found in women between the ages of 30

and 60. General manifestations of bladder leiomyomas include frequent urination, urinary obstruction, dysuria, and hematuria.

Regarding location, bladder leiomyomas can be endovesical (in 86% of cases), intramural (in 11% of cases) or extravesical (in 11% of cases), with the endovesical subtype being the most likely to cause obstructive urinary symptoms. The imaging features of these tumors are very similar to those of uterine fibroids: a typically solitary solid mass, homogeneously attenuated, with variable enhancement characteristics on cross-sectional images, with intermediate to low signal intensity on T1- and T2-weighted MR images (figures 7-8). However, histopathologic analysis is required to confirm the diagnosis and exclude an underlying leiomyosarcoma. Excision is curative, with no risk of recurrence or spread. [6]

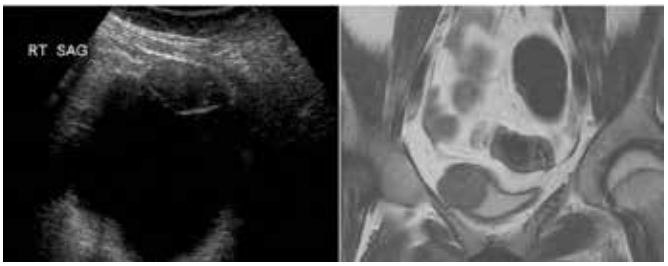

Figure 7. Bladder leiomyoma in an 18-year-old woman. (a) Right sagittal US image showing a hypoechoic lesion of the anterior bladder wall. (b) Coronal T2-weighted MR image shows a round bladder mass that is isointense to the muscle. [4]

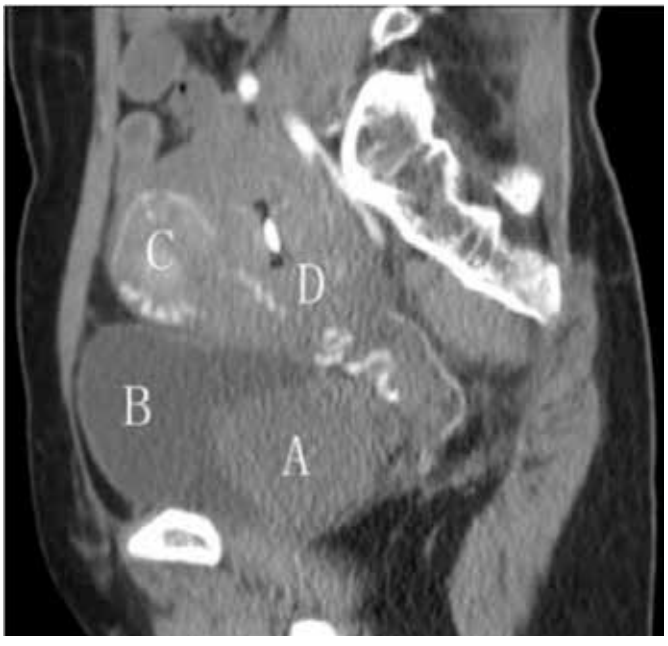

Figure 8. Leiomyoma in a 44-year-old Asian woman. CT scan reveals solitary homogeneous round tumor projecting into the urinary bladder and lobulated enlargement of the uterus consistent with uterine leiomyoma: (A) bladder leiomyoma, (B) bladder, (C) uterine leiomyoma, (D) uterus. [6]

OTHER FINDINGS

Urachal adenocarcinoma

The urachus is a structure that communicates the allantois to the embryonic bladder, measuring between 5-10 cm. It is located on the anterosuperior surface of the bladder extending to the umbilicus region. The urachus regresses throughout life to become the median umbilical ligament. Only 3% of the population has a remnant of this structure.

Urachal carcinoma represents < 1% of bladder neoplasms, with adenocarcinoma being the most frequent. In 90% of cases, urachal carcinoma begins in the urachus adjacent to the dome of the bladder, as the cancer grows it extends cranially towards the umbilicus.

Urachal carcinoma is most often seen in middle-aged and elderly men. Urachal carcinoma can cause abdominal pain, hematuria, purulent or bloody discharge from the umbilicus. Furthermore, as the mass is typically extravesical in location, the patient is often asymptomatic initially, resulting in a late presentation. Urachal carcinoma is highly malignant, which often requires an en bloc resection of the mass as well as the umbilical ligament for long-term disease-free survival. Urachal carcinoma will appear ultrasonographically complex and heterogeneous in echotexture. Calcifications are present in 70% of cases, often along the periphery of the mass. Early urachal carcinomas, limited to the dome of the bladder, can look identical to invasive bladder cancer. The cystic components of the mass, when present, are hypo- or anechoic on ultrasound (Figures 9-10). [4]

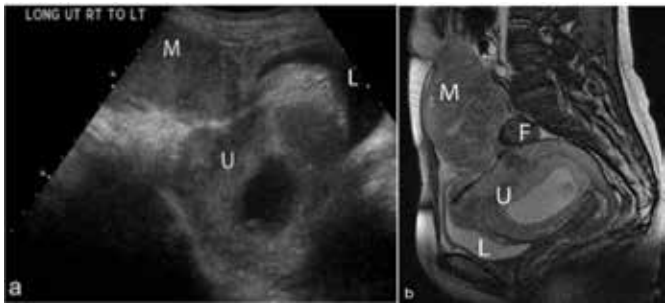

Figure 9. (a) 36-year-old pregnant woman with urachal carcinoma. Longitudinal ultrasound of the pelvis shows a large mass superior to the bladder and anterior to the gravid uterus. (b) Sagittal MRI of the pelvis shows the heterogeneous mass superior to the bladder and extending to the umbilicus. [7]

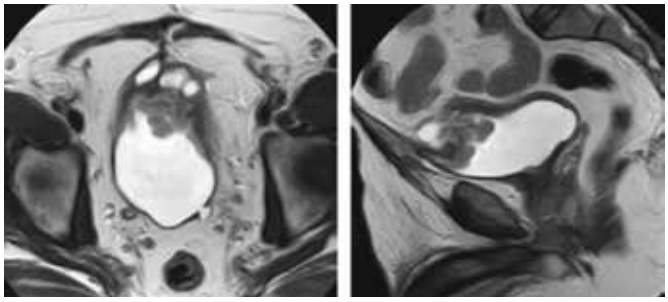

Figure 10. A case of urachal adenocarcinoma (enteric type) in a 60-year-old male patient, complaining of hematuria. (a and b) Heterogeneous midline mass of mixed cystic and soft tissue components, infiltrating the bladder dome and connected superiorly to the umbilicus with a pathway, representing the fibrous remnants of the urachus.3

PARAGANGLIOMA

A paraganglioma is a pheochromocytoma outside the adrenal gland. Of pheochromocytomas, 18% are paragangliomas, 10% of which are located in the bladder. Paragangliomas represent 0.06% of all bladder tumors. An interesting and classic presentation of patients with bladder paragangliomas is acute hypertension during urination due to catecholamine release. This transient release of catecholamines may manifest as headache, blurred vision, or flushing with urination, however, 27% of patients may not have any symptoms associated with bladder paraganglioma.

Bladder paragangliomas appear as a soft tissue mass arising from the bladder wall and protruding into the lumen. These tumors are often indistinguishable from urothelial cells or other bladder cancers. Potential distinguishing features of other bladder tumors include intense enhancement on contrast-enhanced CT or MRI, or the presence of necrosis or hemorrhage within the lesion (Figures 11-12). If bladder paraganglioma is suspected due to history and imaging appearance, further evaluation with an iodine-123-MIBG nuclear medicine study may be performed. On pathology, a paraganglioma has an epithelioid appearance. The architecture is characteristically nested. Immunohistochemistry can be used to confirm the neuroendocrine origin of the mass. [7]

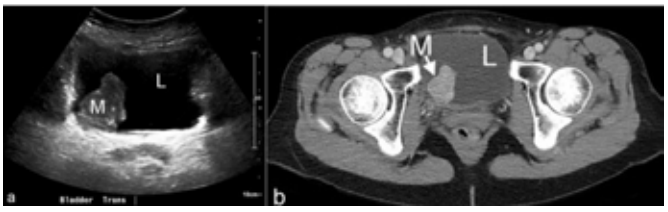

Figure 11. 60-year-old woman with bladder wall paraganglioma. (a) Transverse ultrasound of the bladder shows a mass arising from the right posterior wall of the bladder. (b) Axial contrast-enhanced CT images show that the right posterior bladder wall mass is avidly enlarging.[7]

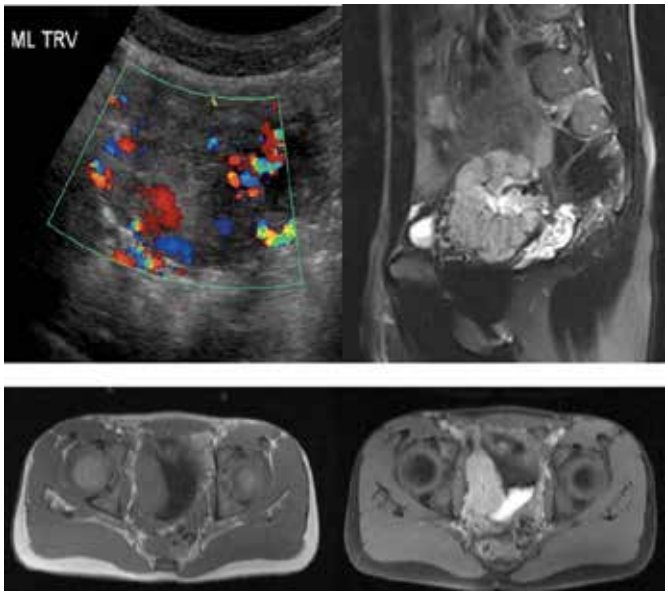

Figure 12. Imaging findings in a 15-year-old boy with hypertension secondary to bladder paraganglioma. (a) Midline color Doppler US image of a moderately full urinary bladder shows a round soft tissue mass on the right lateral wall of the bladder, with marked vascularity. (b) Sagittal fat-saturation T2-weighted MR image shows a tortuous vessel leading to the lesion. (c, d) Axial without contrast (c) and saturated fat with contrast (d) T1-weighted MRI images obtained at the level of the urinary bladder show hypersignal of bladder wall injury. [4]

LYMPHOMA

Bladder lymphoma is rare and more common in middle-aged women, who may have hematuria as their main symptom. By definition, primary bladder lymphoma occurs in the absence of known lymphoma elsewhere.

Most commonly, the bladder is secondarily involved with a known primary extravesical lymphoma. Marginal zone lymphoma of mucosa-associated lymphoid tissue (MALT lymphoma) and diffuse large B-cell lymphoma are the most frequently identified types. Bladder lymphoma presents as a solitary mass in the submucosa of the bladder (70%), with 20% occurring multifocally and 10% presenting as diffuse thickening of the bladder wall.

There are no distinct imaging features known to distinguish bladder lymphoma from other types of bladder cancer. Thus, bladder lymphoma usually appears as a lobular mass along the bladder wall with vascularity on color Doppler (Figure 13). [7]

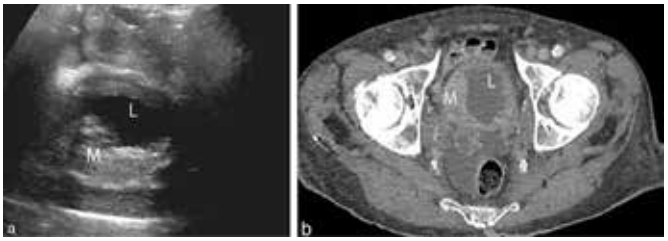

Figure 13. (a) 85-year-old man with diffuse large B-cell lymphoma of the bladder. Transverse ultrasound of the bladder shows a large heterogeneous mass along the right posterolateral wall of the bladder. (b) Axial CT scan in the same patient shows similar asymmetric thickening of the right bladder wall. No additional lymphoma sites were identified in subsequent staging studies. It is important to note that the patient had a history of prostate cancer and pelvic radiotherapy. [7]

CONCLUSION

Ultrasound findings of benign and malignant bladder tumors include isoechogenic or hypoechogenic nodules and/or masses, with heterogeneous echotexture, solid, with flow on Doppler. The contours of the lesions infer benignity when regular, and when irregular, infer malignancy.

From the exposure and description of the ultrasound images, we reiterate the importance of the applicability of ultrasound for the detection and distinction of bladder cancer, and its use should be encouraged when the patient has a compatible clinical condition, since this diagnosis can be confused with other frequent pathologies of the genitourinary tract, causing consequent late discovery of the disease, in an advanced stage and with a worse prognosis.

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REVIEW ARTICLE

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SONOGRAPHIC DIAGNOSTIC CRITERIA IN THE EVALUATION OF SUSPECTED RENAL ARTERY STENOSIS

DANIEL COSTA, FERNANDO MAUAD

ABSTRACT

INTRODUCTION: With the increase in life expectancy and the incidence of atheromatous disease, diabetes and hypertension in the population, the diagnosis for the adequate management of renal stenosis tends to become increasingly important. This trend is evidenced by the increase in the number of patients on dialysis.

METHODS: In this review, comparative studies were collected on diagnostic criteria for Doppler ultrasound of renal artery stenosis published in the following databases: MEDLINE, LILACS and SciELO, according to criteria of impact, citation and visualization between the years 1973 and 2021.

RESULTS: We selected 30 articles. We separated by diagnostic criteria for renal stenosis according to indirect and direct criteria, additional criteria and combination of criteria for their respective analyses.

DISCUSSION: The criteria with better accuracy and greater support in works are the peak systolic velocity of the stenosis; the renal-aortic relationship and the combination of these two criteria.

CONCLUSION: Although there is no consensus regarding the best way to diagnose renal artery stenosis on Doppler, it is evident that there is still room for its use as a population screening as well as for improving its accuracy.

KEYWORDS: STENOSIS, RENAL ARTERY, DOPPLER, ULTRASOUND, DIAGNOSIS

INTRODUCTION

Renal artery stenosis (RAS) refers to the narrowing or partial obstruction of flow in the renal arterial bed. Its etiology can be fibromuscular dysplasia, arteritis of large and medium vessels (such as Takayasu's arteritis), trauma, dissection. However, the most common cause is atherosclerosis, responsible for 90% of cases.

As a cause of secondary arterial hypertension, RAS is considered the most common, reaching 5% of the total cases of hypertension, as in the English study by Connolly. [1]

The work of Dean and Foster suggested that the natural evolution of renovascular disease was a decrease in renal mass and glomerular filtration. Its natural history, therefore, evolves to renal failure.[2]

The term ischemic nephropathy was introduced by Jacobson and Breyer in 1993. It can be defined as a decrease in glomerular filtration rate (GFR) due to hemodynamically significant renovascular disease.

Other names for this entity include ischemic chronic kidney disease, azotemic renovascular disease, or renal failure from renovascular hypertension.

Proper diagnosis in suspected cases provides proper treatment and reduces hospitalizations and treatments for associated morbidities. Therefore, its identification and adequate treatment allow a reduction in costs and hospitalizations. Another challenge is found in the group of patients where the stenosis is asymptomatic until the appearance of its complications. The fact that it is a correctable form of renal ischemic disease makes it the object of some therapeutic studies.

The Brazilian Society of Nephrology has collected annually for more than 20 years the important Brazilian Census of dialysis. These data show that in 1994, 24,000 patients were maintained on a dialysis programme. In 2006 this number surpassed 70,000 patients, 89% of them treated by the Unified Health System. In 2019 this number reached 139,691. [3-5]

As for the profile of patients in the last census, 58% were male in the age group of 45 to 64 years, with 36% of patients over 65 years. In the underlying disease, hypertensive nephrosclerosis is the main cause with 34% of patients, followed by diabetic nephropathy with 32%.

Works such as those by Conlon proposed a prevalence of 11 to 23% of RAS in patients with documented coronary artery disease (CAD). Plouin et al in 2001 found a prevalence of 16% in suspected patients for patients evaluated for CAD through coronary angiography in a study conducted in France. Imori et al, in 2014, in a study carried out in Japan, showed the statistical relationship between CAD, RAS, carotid stenosis and peripheral artery disease, recording a 7% prevalence of RAS in patients suspected of having CAD. This prevalence rose to 9%

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in patients with confirmed CAD. [6-8]

In 2005, Kalra et al conducted a population sample of 1 million people in the United States. The prevalence of renovascular disease was 0.5%. In the chronic kidney disease subgroup, the prevalence of ischemic nephropathy reached 5.5%. In this study, the relationship between renal artery stenosis and atherosclerotic disease was also evidenced. In patients with renovascular disease, 67% had concomitant CAD, 37% had cerebrovascular disease and 56% had peripheral arterial disease. [9]

It is important to note that life expectancy in the US at the time of this work was 77 years. And in 2008 it reached 78 years. This is the importance of the subject that we will deal with.

METHODS

A search was carried out in the main available databases, MEDLINE, LILACS and SciELO using the keywords "renovascular hypertension", "stenosis", "doppler ultrasound" and "renal artery", in the search title field.

From 588 articles returned by the search, we excluded duplicate references. In addition to selecting articles in English and Portuguese, we prioritize open access articles with good or excellent degrees of impact, citation and visualization. Of these, comparative clinical studies were selected whose control group underwent angiography of the renal arteries.

The result was 30 articles that were divided into the direct, indirect, additional and a combination of criteria for their proper analysis.

RESULTS

The following tables show the articles found according to the diagnostic criteria.

Indirect diagnostic criteria (16)	References:
Interlobar artery systolic peak velocity index iaPSV	12, 13
Resistance index difference RId	14-16
Acceleration time AT	17-21
Acceleration Index AI	17-19; 21-24

Table 1. Distribution of references by indirect diagnostic criteria

Direct diagnostic criteria (18)	References
End-diastolic velocity EDV	14, 16, 25, 26
Peak systolic velocity PSV	13, 16, 20, 24, 25, 28-32
Renal-aortic ratio RAR	13, 16, 20, 24, 25, 28, 33-36
Reno-renal ratio RRR	13, 37

Table 2. Distribution of references by right diagnostic criteria

Additional diagnostic criteria (3)	References
Renal-segmental ratio RSR	24
Renal-interlobar ratio RIR	12,13
Critérios diagnósticos combinados (6)	
PSVe + RAR	20, 26, 27, 35, 38, 39

Table 3. Distribution of references by additional and combined diagnostic criteria

DISCUSSION

Diagnostic criteria on Doppler

Several methods have been tested and developed over the last 40 years to assess renal stenosis. The works referenced here carried out their studies on RAS, in the vast majority of them, with lesions due to atherosclerosis. Therefore, the use of the indices and values mentioned here in other causes of RAS such as FMD, dissection or others, must be done with caution, due to their virtual lack of validation for these situations.

The techniques and criteria used in Doppler are separated by most authors as indirect and direct.

The indirect method parameters are measurements and calculations taken from the entire renal vascular tree, except the point of stenosis and the renal artery. Therefore, in most studies, they are flowmetric measurements of samples at the height of the hilum or more distally in segmental arteries.

Direct diagnostic methods use measurements from the sample of the stenosis point, either just the sample from this point, as in the isolated measurement of peak systolic velocity, or in comparison with the sample from other segments of the arterial tree, as in the renal-aortic ratio or in the renal-renal ratio.

Indirect criteria

The indirect diagnostic methods evaluated in this review are:

- The resistance index (RI);
- The pulsatility index (PI);
- The interlobar artery systolic peak velocity index (iaPSV);
- The Resistance index difference (RId);
- The acceleration time (AT);
- The Acceleration Index (AI) and its variations.

Indirect diagnostic criteria were created as the first form of evaluation. Mainly in a time without filters and with low processing machines, it became an immense challenge to evaluate arteries in greater depth. Therefore, in patients where it was not possible to assess the stenosis site directly, the indirect criteria were more reproducible. The speed in obtaining these criteria is also something mentioned with advantage in some works. Currently, some studies suggest their use as important adjuvants in confirming direct assessments of stenoses.

The pulsatility index and the resistance index showed low positive (PPV) and negative (NPV) predictive values during the studies evaluated, being consistently classified as inadequate for population screening, which is why they will only be briefly

discussed here.

Despite the low correlation of RI with the diagnosis of RAS, there are studies that support a reference value of RI=0.8 or more as a predictor of response to interventional correction of RAS, be it angioplasty, angioplasty with stent or surgery. In some publications, the index is referred to as the resistivity index, the only difference in its formula in relation to the conventional one being its multiplication by 100 in these works. Therefore, their reference value is 80. Both Radermacher et al in 2001 and Santos et al in 2010 found a better response to the intervention, with regard to renal function and hypertensive disease in patients with RI less than 0.80. [10,11]

Interlobar artery systolic peak velocity index

This index was evaluated during the work of Li et al in 2006, obtaining it as part of the calculation of the renal-interlobar ratio that will be discussed later. During the work they evaluated interlobar arteries in the superior, middle and inferior pole. As they were analyzing findings from previous works, they used the pyramids as an anatomical marker for their work, mainly because they thought that even a stenosis in the distal portion of the renal artery would have already lost the effect of turbulence and increased peak systolic velocity (PSV) in this segment. The renal-interlobar ratio showed good sensitivity and specificity in severe stenosis, helping in cases of post-stent stenosis and stenosis in the middle third. However, the PSV of the interlobar artery, as an isolated diagnostic criterion, proved to be insufficient, with low sensitivity and specificity. No other work evaluating this criterion was found. [12,13]

The resistance index difference

The resistance index (RI) alone may have shown low accuracy, but the RId has shown evidence to support the diagnosis of RAS. This index is calculated through the RI difference in hilar samples. In the cited works, an evaluation of this value can be seen ranging from 0.01 to 0.007. There is a body of evidence in favor of 0.05 as the cutoff point for hemodynamically significant stenosis (HSS), usually 70% or greater. A reduction of 0.05 or more in one of the hila suggests ipsilateral HSS. As with all criteria, it is suggested that it be measured more than once to increase the reliability of this finding. Figure 1 shows an example of a patient with HSS in the left renal artery confirmed by angiographic control.

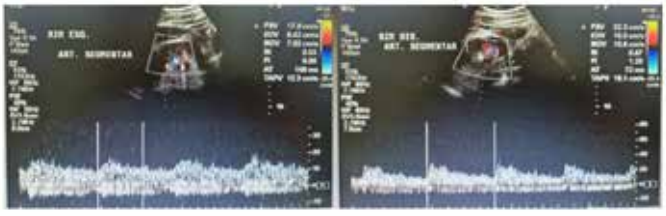

Figure 1: Intrarenal vascular assessment. Note RId which is calculated at 0.67-0.53=0.14, indicating a hemodynamically significant stenosis to the left. It is also important to note the difference in wave morphology and AT.

Zeller et al in 2001 presented a sensitivity of 77% and specificity of up to 99% for a stenosis of 70%. [14]

Ripollés et al in 2001 obtained a sensitivity of 50% and specificity of 90%. However, what was most interesting in this study was the difference in sensitivity and specificity reported for patients over and under 50 years of age. Patients younger than 50 years had better sensitivity and specificity in this criterion, suggesting a probable age interference in the compliance of these arteries and therefore interference in the use of this criterion.[15]

In 2007, Staub et al carried out an extensive retrospective study on the diagnostic criteria in 49 patients diagnosed with renal artery stenosis by Doppler and referred for confirmation by angiography and measurement of intra-arterial pressure. For a 70% stenosis, a RId of 0.05 had a sensitivity of 42%, specificity of 91%, PPV of 69%, NPV of 77%, and overall accuracy of 76%. For a 50% stenosis, the same RId value showed a sensitivity of 31%, specificity of 97%, PPV of 93%, NPV of 50% and accuracy of 58%. [16]

Table 4 summarizes the studies on the RId criterion with regard to their findings.

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Zeller et al	2001	70%	0.05	77%	99%	69%	92%
Ripollés et al	2001	75%	0.05	50%	96%	69%	92%
Staub et al	2007	50%	0.05	31%	97%	93%	50%
Staub et al	2007	70%	0.05	42%	91%	69%	77%
Staub et al	2007	70%	0.07	35%	95%	75%	76%

Table 4: Year of publication (YP), degree of stenosis (St.), cutoff point (CP), sensitivity (Sens.), specificity (Spec.), positive predictive value (PPV), negative predictive value (NPV) .

The acceleration time

This index showed good reproducibility of its methodology in the evaluated works. Of the indirect indices, it presented the highest number of works with its evaluation. It is the time from the beginning of the acceleration ramp to the maximum systolic peak. As a cutoff point, values from 70 to 100ms were used.

In 1988, studies by Handa et al were published showing the use of acceleration time and AI with good sensitivity and specificity for stenosis of 60% or more. Perhaps the first work to evaluate AT. As a cutoff point they suggest 0.07s. [17,18]

Stavros et al published in 1992 their findings in a prospective study with 56 patients having angiography as a control. Using 0.07s or more as a cutoff point for a stenosis of 60% or more, they found a sensitivity of 78%, a specificity of 94%, a PPV of 85%, a NPV of 91% and an overall accuracy of 89 %.[19]

In 1999, House et al published their prospective study with 63 patients, finding a sensitivity of 41% and specificity of 85% for an AT greater than 70ms as a criterion for an RAS of 60% or more. [20]

Bardelli et al in 2006 suggested 80ms as the best cutoff point, with a sensitivity of 93%, specificity of 65, PPV of 51% and NPV of 96% for a stenosis of 60% or more. [21]

Table 5 summarizes the findings on the AT criterion.

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Handa et al	1988	60%	0.07s	100%	83%	66%	100%
Stavros et al	1992	60%	0.07s	78%	94%	85%	91%
House et al	1999	60%	70ms	41%	85%	36%	88%
Motew et al	2000	60%	58ms	58%	96%	97%	52%
Motew et al	2000	60%	100ms	32%	100%	100%	41%
Ripollés et al	2001	75%	80ms	89%	99%	94%	98%
Bardelli et al	2006	60%	80ms	93%	65%	51%	96%

Note the change in units (0.07s=70ms).

Table 5 summarizes the findings on the AT criterion. Note the change in units (0.07s=70ms).

The acceleration index

This is perhaps the most confusing indirect criteria in reproducibility. There are different methodologies for calculating this index. Including works where the loss of the early systolic peak is the result of the morphological analysis of the wave, reflecting a drop in acceleration. The result of this are the different cut-off values and measurement units cited by the sources in this review, such as 3.78KHz/s/MHz, 4m/s2, 300cm/s2 and 9s-1. Figure 2 is an example of evaluating the acceleration index in a renal artery without stenosis.

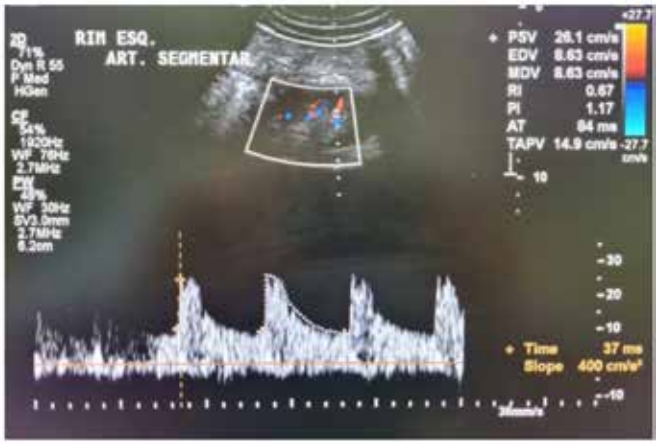

Figure 2: Note that during image post-processing, the slope or acceleration was calculated, which is within normal limits with a value of 400cm/s2.

The first article found by this review dealing with this index is that of Handa et al in 1986. In it, two parameters of flowmetry in the bilateral renal arteries of eight control patients, 19 patients with essential hypertension and 8 with renovascular hypertension are evaluated using echodoppler. The two parameters are the acceleration index and the ratio S (peak systolic)/D (end-diastolic velocity). The study does not define a unit for the acceleration index, but the calculation is shown as the ratio of the tangential slope calculated in KHz by the acceleration ramp in 1 second and divided by the emitted frequency in MHz. It is inferred as KHz/s/MHz unit. This measurement is made in the hilar region. Therefore, it is a technical way of characterizing a tardus parvus flow wave. A cutoff point of 2.5 or less is suggested during the presentation of results. And the average value of the controls revolve around 8.1 and 8.5. In 1988, Handa et al again evaluated AI. In these works, the measurement unit is defined and the best cutoff point is 3.78KHz/s/MHz, with an accuracy of 95%, sensitivity of 100% and specificity of 93%.[17,18,22]

One difficulty with this type of index is finding Doppler machines that perform this calculation, leaving the operator to perform it. It's easier to find machines that do slope calculations, or in Portuguese declive. This function calculates acceleration in cm/s2 or m/s2. So this is another formula for calculating the acceleration ramp.

The presence of one or two kidneys, age, systemic hypertension, atherosclerosis or diabetes affecting the compliance of the renal arterial tree, in addition to heart valve disease, left heart failure and cardiovascular medications are some of the factors that can affect the AI assessment[17,21, 22].

As the AI is an attempt to characterize the wave, it is common for studies to evaluate it in conjunction with other indices, such as acceleration time and loss of early systolic peak.

During the review of articles, the most cited value as a limit for acceleration was 300cm/s2 (also cited as 3m/s2). Therefore, values lower than 300cm/s2 suggest hemodynamically significant RAS. Some studies, such as that by Miralles et al, did not even discuss the AI results, suggesting a low accuracy obtained during the study compared to other indices.

In 1992, Stavros et al attest to an acceleration of less than 3m/s2 (or 300cm/s2), as a cutoff point for stenosis of 60% or more, a sensitivity of 89%, a specificity of 83%, a PPV of 69 , a NPV of 95% and an overall accuracy of 85%. In his methodology, the curve for this index was collected from the segmental arteries of the upper and lower poles. House et al in 1999 also published in their study for the same acceleration value in a stenosis of 60% or more a sensitivity of 56% and specificity of 62%, with an accuracy of 47%. Note that in the methodology of House et al, this index was collected outside the renal parenchyma in the main branch or in the renal artery itself.[19, 20]

In the study by Souza de Oliveira in 2000, the acceleration index was collected in segmental arteries of the three anatomical groups: upper, middle and lower. Angiographic control was used as a control for stenoses equal to or greater than 50%. They were analyzed as a cutoff point of 1-6m/s2. However, none of them presented satisfactory overall accuracy. [24]

The AI presented, throughout some works, varied sensitivities and specificities. Bardelli et al in 2006 evaluated the use of some indirect criteria such as acceleration time and acceleration. Realizing the loss of the early systolic peak, they propose two new indirect indices based on acceleration: the

maximum systolic acceleration (ACCmax) and the maximum acceleration index (AImax). The calculation of the first is made by using the acceleration curve towards the largest PSV, divided by the smallest AT until there is a significant change in the velocity curve. At work it is called maximum acceleration time (ATmax). The AImax calculation is considered a correction for the absolute flow regime. It is calculated by dividing the ACCmax by the maximum systolic peak (PSVmax).[23]

In this study with 200 kidneys and 56 of them with stenosis of 60% or more, indices such as PI (pulsatility index), RI (resistance index), TA, ACCsys (medical systolic acceleration or simply acceleration), ACCmax (maximal systolic acceleration) and AImax. As a result, they report failure of PI and RI independently to reach a suitable NPV for screening. Among the indices that have adequate NPV and PPV values, they point out that AImax reached the highest NPV and the highest PPV among the individually evaluated indirect indices. In their work, the values of 80ms for AT, 4m/s2 (or 400cm/s2) for ACCsys, 4m/s2 for ACCmax and 9s-1 for AImax are evidenced as the best cutoff for RAS graded at 60% or more. . In this cutoff, AImax achieved a sensitivity and specificity of 93% and 84% for a 60% stenosis. Therefore, it was an interesting finding, but no new studies were identified in our research using this form of acceleration calculation. The ACCsys of 400cm/s2 had a sensitivity of 93%, specificity of 56%, PPV of 56% and NPV of 95%.[23]

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Handa et al	1988	50%	AI 3,78	100%	93%	83%	100%
Stavros et al	1992	60%	Ac 3m/s^2	89%	83%	69%	95%
House et al	1999	60%	Ac 3m/s^2	56%	62%	23%	87%
Souza de Oliveira et al	2000	50%	ESA 4,0	40%	22%	20%	43%
Ripollés et al	2001	75%	Ac 1m/s^2	89%	98%	89%	98%
Ripollés et al	2001	75%	Ac 3m/s^2	100%	51%	26%	100%
Bardelli et al	2006	60%	ACCsys 4,0	93%	56%	45%	95%
Bardelli et al	2006	60%	ACCmax 4,0	94%	75%	60%	97%
Bardelli et al	2006	60%	AImax 9,0	93%	84%	70%	97%

Table 6 gathers the findings of the works on the AI criterion.

Direct criteria

In general, the direct criteria, when feasible, obtained better overall accuracy in relation to the indirect ones. However, technically, it may be difficult to obtain these indices due to the interposition of gases or in some degrees of obesity.

Direct criteria are considered:

- Morphological assessment of stenosis
- End-diastolic velocity (EDV)
- Peak Systolic Velocity sor stenosis (PSVe)
- Renal-aortic ratio (RAR)
- Renal Renal Ratio (RRR)

Morphological evaluation

Of the direct criteria, the morphological assessment of the stenosis is not performed transabdominally. The frequency required for the evaluation lacks linear resolution, so there are no works on this form of diagnosis. In order to maintain good accuracy with this method, it is necessary to resort to an invasive method: the IVUS. However, intravascular ultrasound loses some of the advantages of the transabdominal technique, with complications similar to those of invasive procedures.

Therefore, IVUS is not considered a method for screening and diagnosing RAS in the population. However, it is a method for confirming RAS and helping to make therapeutic decisions prior to the procedure, during the procedure and post-procedure.

End-diastolic velocity

Of the direct criteria already evaluated by the transabdominal route, this one has been abandoned by articles of prospective and review studies. It is a measure provided automatically when the velocity curve is enveloped in flowmetry.

The first study found by this review was that of Miralles et al in 1996. However, it is discussed that PSV was found as the best parameter for suspecting stenosis of 60% or more, followed by RAR and EDV. The mean value of EDV in these stenoses was 72.9cm/s against a mean value of 39.9cm/s for minor stenoses or absence. However, the work does not propose a cutoff point for the EDV, much less an assessment of its accuracy. [25]

In 2005, in the work by Engelhorn et al, a speed of 48 cm/s was proposed as a cutoff point for the EDV for stenosis of 60% or more. The sensitivity found was 70% and the specificity 72%, with an accuracy of 70%.[26]

In the 2007 work by Staub et al, they achieved an accuracy of 83% for a stenosis of 70% or more in the angiographic control, using an EDV of 90cm/s or more as the cutoff point. Sensitivity was 77%, specificity 87%, PPV 74%, and NPV 88%. It was the best performance of this criterion in prospective studies.[16]

Zeller et al, in 2008, commented on the increase in RI in the progression of kidney disease, which would reduce the EDV, and ultimately render the use of this criterion useless. Therefore, we must remember that low EDV values cannot exclude the possibility of stenosis. Its dependence on heart rate and peripheral resistance also compromise its use.[27]

In some studies, the EDV was part of the calculation of the end-diastolic ratio through the division of the EDV by PSVe. It was an attempt to find the patients who could respond better to a surgical intervention on the stenosis, but it was abandoned due to the low statistical correlation.

Stenosis systolic velocity peak

With the introduction of low-frequency transducers, the improvement of the ultrasound technique and, consequently, of flowmetric samples, the techniques for direct assessment of the lesion began to show greater overall accuracy in

the published studies. Many works until the 90's deal exclusively with indirect methods. At the end of the 1980s, publications appeared on direct methods, and this trend only increased in the following decades. Some authors emphasize the importance of indirect techniques as more feasible, even in obese patients or those with inadequate preparation. However, over the years, authors cited in this review have been observed suggesting the use of direct techniques whenever possible.

The evaluation of the peak systolic velocity at the greatest point of stenosis is aided by color Doppler both to determine the greatest point of stenosis and to correct the sample angle. Even the decrease in the variability of the values used as a cutoff point from 100 to 220cm/s to 180 to 200cm/s throughout the published works is justified by the review articles as a consequence of this assistance. We see an example in Figure 3 of an PSVe compatible with HSS in the right renal artery and confirmed by angiography.

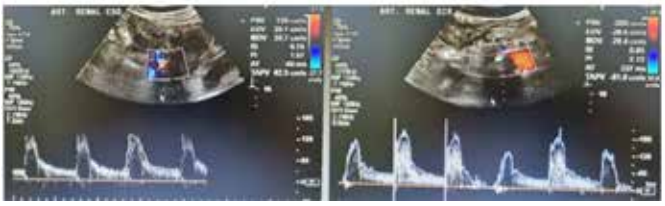

Figure 3: Evaluation of peak systolic velocity demonstrating stenosis of the right renal artery. Observe PSV of 129cm/s on the left and 200cm/s on the right. Observe laminar flow on the left and swirl on the right.

The oldest work using PSVe found by this review was that of Hoffmann et al in 1991. We analyzed 74 renal arteries in 41 patients using angiography as a control. In this work, the sensitivity of this criterion was 95% and the specificity 90%, for a cutoff point of 180cm/s in stenoses of 60% or more in the control. The estimated PPV was 98% and the NPV 75%.[28]

Miralles et al, in 1996, did a study comparing direct and indirect indices prospectively. Of 78 patients, 142 renal arteries were analyzed. In the PSV evaluation, a velocity of 198cm/s was identified as the best cutoff point for a stenosis of 60% or more. A sensitivity of 87% and a specificity of 92% were identified with this value.[25]

House et al in 1999 published a prospective study with 63 patients where a control angiography was available. For a stenosis of 60% or more on angiography, the velocity 180cm/s provided a sensitivity of 80%, a specificity of 77%, a PPV of 43% and a NPV of 95%. The most interesting part of this work was the combination of criteria, an item that will be discussed later. [20]

In 2000, Motew et al published a prospective study on 41 patients with angiography as a control for a stenosis of 60% or more. It compares direct and indirect criteria. As a cutoff point for PSVe, 2m/s or 200cm/s was used, obtaining a sensitivity of 91%, a specificity of 96%, a PPV of 98%, a NPV of 83%, with an overall accuracy of 92%. The superiority of this criterion in relation to AT is evidenced in the work. However, with a high specificity and PPV, the auxiliary importance of this indirect criterion is also suggested.[29]

The first Brazilian study on diagnostic criteria identified by this review was from 2000. Souza de Oliveira et al published a prospective series of 96 renal arteries, excluding nine due to technical difficulties. In this work, angiographic stenosis of 50% or more is a control for the Doppler exam. A PSVe of 150cm/s has a sensitivity of 83% and a sensitivity of 89.47cm/s. A PSVe of 170cm/s had 70% and 98% respectively for the same degree of stenosis. [24]

In 2005, Engelhorn et al published a paper on the importance of validating diagnostic criteria. They even report on the variability of the direct criteria, with the PSV cutoff of 100 to 200cm/s and the RAR between 3.2 and 3.5 in different references. In this work, he individually analyzes the direct criteria used, suggesting a speed of 252cm/s as the best cutoff point for PSV, with sensitivity of 83%, specificity of 92% and accuracy of 87%. [26]

Cardoso et al, in 2006, obtained better accuracies with PSVe, when compared with RAR or even with the combination of criteria. Even when the cutoff point was corrected by the ROC curve. PSVe corrected to 189cm/s obtained the highest accuracy of the work, which was calculated at 97%. [39]

Staub et al, in 2007, carried out a prospective study with 49 patients resulting in an analysis of 98 renal arteries, where the doppler criteria had angiography and the intra-arterial pressure gradient as controls for stenoses of 50% or more and for stenoses of 70 % or more. These cutoff choices had an implication on therapeutic decisions. At the time, several studies indicated the need for intervention for stenoses of 70% or more, but there was disagreement about intervening in stenoses of 60% or more. Therefore, a 50% stenosis would indicate a need for more frequent monitoring of the patient, while a 70% or more stenosis would already indicate the need for intervention. They demonstrated that stenoses above 50% already caused a difference in intra-arterial pressure gradient pre- and post-injury of 20mmHg or more. [16]

In this work, they recorded a sensitivity of 96%, a specificity of 69%, a PPV of 81%, a NPV of 93% and an accuracy of 85% for a PSVe of 180cm/s for stenoses of 50% or more. A PSVe of 200cm/s resulted in a sensitivity of 92%, a specificity of 81%, a PPV of 87% and a NPV of 88%, with an accuracy of 87% for the same degree of stenosis. For a PSVe of 250cm/s, a sensitivity of 78%, specificity of 92%, a PPV of 93%, a NPV of 75% were found, with an accuracy of 84%. Therefore, the best accuracy was with a PSVe at 200cm/s for a stenosis of 50% or more.[16]

In the same study, for a stenosis of 70% or more, the overall accuracy improvement, calculated at 84%, was found with a cutoff point of 300cm/s.

In 2008, Li et al published a prospective study with 77 patients and 153 renal arteries with control angiography for stenoses of 50% or more. PSVe, RId and renal-segmental ratio were the best criteria in this work. The value of 170cm/s had a sensitivity of 90%, specificity of 90%, PPV of 88% and NPV of 91%. An interesting point of this work was the discussion of how the aortic stenosis in [8] patients influenced the direct indices and how

PSVe still achieved good accuracy in this scenario.[13]

Abu Rahma et al in 2012 recorded a sensitivity of 89%, a specificity of 54%, a PPV of 56%, a NPV of 88% and an accuracy of 68% for a PSVe of 200cm/s for a stenosis of 60% or more.[31]

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Hoffmann et al	1991	60%	180cm/s	95%	90%	98%	75%
Miralles et al	1996	60%	198cm/s	87%	92%	86%	92%
House et al	1999	60%	180cm/s	80%	77%	43%	95%
Motew	2000	60%	180cm/s	94%	88%	94%	88%
Motew	2000	60%	200cm/s	91%	96%	98%	83%
Souza de Oliveira et al	2000	50%	150cm/s	83%	90%	80%	92%
Souza de Oliveira et al	2000	50%	170cm/s	70%	98%	95%	87%
Engolhorn et al	2005	60%	252cm/s	83%	92%		
Cardoso et al	2005	60%	189cm/s	100%	87%	96%	100%
Cardoso et al	2005	60%	180cm/s	100%	81%	94%	100%
Staub et al	2007	50%	200cm/s	92%	81%	87%	88%
Staub et al	2007	50%	180cm/s	96%	69%	81%	93%
Staub et al	2007	70%	300cm/s	89%	81%	69%	94%
Staub et al	2007	70%	250cm/s	89%	70%	58%	93%
Li et al	2008	50%	170cm/s	90%	90%	88%	91%
Abu Rahma et al	2012	60%	200cm/s	89%	54%	56%	88%

Renal-aortic ratio

Table 7 shows the findings in the works related to the PSVe criterion.

Obtaining the index by dividing the PSV of the renal artery stenosis by the PSV of the aorta between the superior mesenteric and renal ostium is a correction for the patient's hemodynamic regime. This correction may have problems, as suggested by some studies, such as a drop in the aortic PSV as its caliber increases, which may occur with advancing patient age and with the presence of aneurysms; or even with the presence of hemodynamically significant stenoses in the aorta. Figure 4 exemplifies an RAR compatible with HSS of the right renal artery, confirmed by angiography.

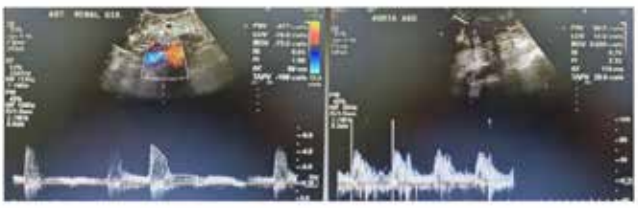

Figure 4: Observe PSV of 471cm/s and a PSV in the aorta of 88.9cm/s. A RAR of 5.29 is calculated. Therefore, in this case, there are 2 indices indicative of hemodynamically significant stenosis: PSVe and RAR. A swirling flow is also observed.

The first study identified by this review was that of Kohler et al in 1986. In it, they retrospectively evaluated 158 patients, and the angiogram of only 43 renal arteries was available as a control. With a sensitivity of 91% and a specificity of 95% for a stenosis of 60% or more, the authors talk about the need for prospective studies to better assess the RAR.[33]

Therefore, in 1988, Taylor et al published a prospective study on this index. Fifty-eight arteries in 29 patients are analyzed with angiography as control. They obtained a sensitivity of 84%, sensitivity of 97%, a PPV of 94% and a NPV of 90% for a stenosis of 60% or more. It is important to note in the methodology that in addition to the change in the RAR, it was necessary to have a focal increase in velocity with downstream turbulence in the color Doppler. A curious fact about this work was the presence of authors such as Strandness Jr., Moneta, and Kohler himself.[34]

The 1990 work by Strandness Jr is a revisitation of the 1988 work with greater details on the technique employed and the methodology, with a new analysis on sensitivity and specificity.[35]

Hansen et al, in 1990, published a prospective study, where 74 patients had control angiography with patent arteries. Of these patients, six Doppler scans were inadequate due to obesity or the presence of gas in the loop, resulting in 142 arteries being comparatively evaluated. A RAR greater than or equal to 3.5 and the presence of turbulent flow in the lesion or downstream for stenoses of 60% or greater on angiography were used as criteria on the Doppler. They then publish a sensitivity of 93%, a specificity of 98%, a PPV of 98% and a NPV of 94%. They report that these indices were obtained from kidneys with only one main artery and in the discussion they refer that a PSVe of 2m/s (200cm/s) was able to predict the presence of stenosis as well as the RAR of [3,5,36]

In the 1991 work by Hoffmann et al, the index of 3.5 demonstrated a sensitivity of 92%, a specificity of 62%, a PPV of 81% and a NPV of 80%.[28]

In 1996, Miralles et al, for a RAR of 3.3, which was identified as the best cutoff point for a stenosis of 60% or more, obtained a sensitivity of 76%, a specificity of 92%, a PPV of 86% and a NPV of 87%.[25]

In the 1999 work by House et al, a sensitivity of 50%, a specificity of 88%, a PPV of 50% and a NPV of 88% were obtained with an index of 3.5 for a 60% stenosis in the angiography. A ratio of 3.0, on the other hand, obtained a sensitivity of 70%, a specificity of 80%, a PPV of 46% and a NPV of 92%.[20]

The work by Souza de Oliveira et al in 2000 obtained for a stenosis of 50% or more in the angiographic control, using an optimized RAR of 1.8 in the Doppler evaluation, a sensitivity of 83% and specificity of 79%.[24]

Engelhorn et al published in 2005 a RAR of 3.27 as an ideal cut-off point for their sample of 137 arteries, with a sensitivity of 85%, a specificity of 86%, with an accuracy of 86%.[26]

Staub et al, in 2007, for a stenosis of 50% or more on angiography, obtained the best overall accuracy for a RAR of 2.5 and 3.0, with a sensitivity of 92%, specificity of 79%, PPV of 86% and NPV of 87% for the first value and 83%, 91%, 93% and 80% respectively for the second value. Both having accuracy calculated at 87%. An accuracy similar to the PSVe criterion of 200cm/s for the same degree of stenosis in the same study. [16]

In the same study, for a 70% stenosis, the RAR of 3.5 had a sensitivity of 84%, specificity of 72%, PPV of 57% and NPV of 91%, with an accuracy of 76%. For the same degree of stenosis, the RAR of 4.0 showed values of 60%, 84%, 63% and 83% respectively. With a cutoff point of 4.5 for the RAR, they obtained a calculated accuracy of 77%, similar to the cutoff point of 4.0, but penalizing the sensitivity.

In 2008, Li et al identified in their prospective work, for a stenosis of 50% or more on angiography with an optimized RAR cutoff value of 2.3, a sensitivity of 76%, a specificity of 89%, a 85% PPV, an 82% NPV, and an overall accuracy of 83%.[13]

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Kohler et al	1986	60%	3.5	91%	95%	93%	94%
Taylor et al	1988	60%	3.5	84%	97%	94%	90%
Hansen et al	1990	60%	3.5	93%	98%	98%	94%
Strandness et al	1990	60%	3.5	84%	97%	94%	90%
Hoffmann et al	1991	60%	3.5	92%	62%	81%	80%
Miralles et al	1996	60%	3.3	76%	92%	86%	87%
House et al	1999	60%	3.5	50%	88%	50%	88%
House et al	1999	60%	3.0	50%	88%	50%	88%
Souza de Oliveira et al	2000	50%	1.8	83%	79%	66%	91%
Engolhorn et al	2005	60%	3.27	85%	86%		
Cardoso et al	2006	60%	3.5	79%	93%	97%	60%
Cardoso et al	2006	60%	2.6	96%	87%	96%	87%
Staub et al	2007	50%	2.5	92%	79%	86%	87%
Staub et al	2007	50%	3.0	83%	91%	93%	80%
Staub et al	2007	70%	3.5	84%	72%	57%	91%
Staub et al	2007	70%	4.0	60%	84%	63%	83%
Li et al	2008	50%	2.3	76,5%	89%	85,3%	82%

Table 8 summarizes the diagnostic tests on the RAR criterion.

Reno-renal ratio

The first work to be published on the reno-renal ratio (RRR) was Chain et al in 2006. The index is a division of the PSV of the lesion by the PSV distal to the lesion in the same main artery.[37]

The first work to be published on the reno-renal ratio (RRR) was Chain et al in 2006. The index is a division of the PSV of the lesion by the PSV distal to the lesion in the same main artery.[37]

In the aforementioned work, criteria such as RAR and PSVe were evaluated, in addition to RRR. To this end, a prospective evaluation was conducted in 34 patients suspected of having RAS, using angiography as a control for a stenosis of 50% or more. The best cutoff point found for the RRR was 2.7, with a sensitivity of 97%, specificity of 96%, PPV of 97% and NPV of 96%. At work, this criterion obtained better overall accuracy in relation to the other two.

In the 2008 study by Li et al, the best cutoff point for the RRR was 2.0 for stenoses of 50% or more in angiographic control, with a sensitivity of 76%, specificity of 93%, PPV of 90% and NPV of 83, with an overall accuracy lower than the PSVe.

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Chain et al	2006	50%	2.7	97%	96%	97%	96%
Li et al	2008	50%	2.0	77%	93%	90%	83%

Table 9 shows the statistics on the RRR criterion.

Additional criteria

There are two criteria cited by three papers that were not identified in the other prospective or revisionist papers. They are classified as indirect criteria in some works, but they also have characteristics of direct criteria. Therefore, in view of the classification dilemma, these criteria were set aside. They are:

- Renal-segmental ratio (RSR)
- Renal-interlobar ratio (RIR)

Renal-segmental ratio

The renal-segmental ratio was explored in the work by Souza de Oliveira et al in 2000. It is an extensive work in which criteria such as early systolic acceleration, PSVe and RAR are also evaluated. Early systolic acceleration was measured in segmental arteries, which makes sense as it would have been influenced by a proximal stenosis, but had low overall accuracy (below 50%). The RSR value is obtained by dividing the PSV of the origin or proximal portion of the renal artery by the PSV of the segmental artery evaluated in the upper, middle and lower anatomical groups. In the prospective study they used control angiography for stenosis greater than or equal to 50%. The best cutoff point found was RSR=5 with sensitivity ranging from 80 to 93% in anatomical segments, and specificity from 84% to 94%. It is also the one that presents the best accuracy in the ROC curve in the evaluation of the inferior segmental artery in relation to the middle and superior segmental arteries. The second best accuracy is for PSVe at 150cm/s with sensitivity of 83% and sensitivity of 90%. [24]

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Souza de Oliveira et al	2000	50%	5.0 segm. sup.	80%	84%		
Souza de Oliveira et al	2000	50%	5.0 segm. med.	90%	95%		
Souza de Oliveira et al	2000	50%	5.0 segm. inf.	93%	90%		
Li et al	2008	50%	4.0	84%	92%	98%	87%

Table 10 shows the findings regarding the RRR criterion.

Renal-interlobar ratio

Li et al in 2006, propose an evolution of the previous criterion. To prevent a stenosis in the middle or distal portion of the renal artery from increasing the hilar or segmental velocity, they collect the PSV from the interlobar artery, using the pyramid as an anatomical reference. They chose the PSV of the interlobar artery with the best flowmetry appearance. Therefore, the PSV of the lesion was divided by the PSV of the chosen interlobar artery. The best cutoff point identified was PSV=5 for a stenosis greater than or equal to 50% in the angiographic control. Sensitivity was 88%, specificity 88%, PPV 91% and NPV 84%.[12]

In 2008, Li et al published a study comparing direct indices, RIR and RSR. In a prospective series where 150 renal arteries were evaluated, having their angiographic control available for classification of stenosis at 50% or more. An important detail in their methodology is that they evaluated the upper, middle and lower segments and used that segment that showed signs of change in the waveform to collect the indices. If none of the segments showed suspicious alteration, indices were collected from the middle segment. The best cutoff point for the RIR was 5.5 with a sensitivity of 85%, specificity of 90%, PPV of 88% and NPV of 88%. The RSR, on the other hand, had its best cutoff point at 4.0, with a sensitivity of 84%, specificity of 91%, PPV of 98% and NPV of 87%.[13]

In the same work, they refer to a case where the stenosis was well advanced in the control angiography, but PSVe and RAR were within normal limits, with the RIR indicating HSS. Similar findings have already been reported for stenoses above 90% in other sites, such as the carotid, where there is a reduction in PSV in more advanced stenoses. This may suggest an advantage in using the RIR.

The criteria cited here were not found in other studies, but the publications found so far are promising. And they should be included in future work.

Author	YP	St.	PC	Sens.	Spec.	PPV	PNV
Li et al	2006	50%	5	88%	88%	91%	84%
Li et al	2008	50%	5.5	85%	90%	88%	88%

Table 11 summarizes the statistics related to the RIR criterion.

Combination of criteria

In some works, the study design allowed both the individual assessment of the criterion and their combined use. Other works only published their combination.

In two works, evaluation details were added that can be described as extra criteria, but with a more subjective aspect in their evaluation. Such as the identification of turbulence in the flow of the lesion, the loss of the early systolic peak, or even the identification of curves with the aspect of tardus parvus without using flowmetric criteria. Despite being somewhat subjective aspects, experience in the field would allow us to reproduce such aspects during the evaluation.

The first work to suggest the combination of criteria as a way to achieve better accuracy was that of Strandness in 1990, with PSVe and RAR.[35]

In 1996, Krumme et al used as criteria a PSVe greater than 200cm/s and a RId equal to or greater than 0.05 for stenoses equal to or greater than 70% in the angiographic control. It obtained a sensitivity of 89%, a specificity of 92%, a PPV of 92% and a NPV of 88%. It was the first work found by this review to combine criteria.[38]

The first study found by this review to evaluate the combination of direct criteria was that of House et al in 1999. In it, PSVe greater than 180cm/s together with an RAR greater than 3.5 for a stenosis of 60% or more in angiography it obtained a sensitivity of 80%, a specificity of 78%, a PPV of 45% and a NPV of 95%. A PSVe of 180cm/s with an RAR greater than 3.0 yielded a sensitivity of 85%, a specificity of 76%, a PPV of 44% and a NPV of 96%. They report better overall accuracy with the combination of criteria than with the criteria alone.[20]

In 2004 we have a Brazilian work on diagnostic criteria. Engelhorn et al published a prospective study with 137 renal arteries of 69 adult patients, with a positive angiography for stenosis of 60% or more as a control. In this study, stenoses of 60% or more were considered positive when velocities of 180cm/s or more were observed in conjunction with an RAR greater than 3.5. Therefore, the sensitivity of 95%, the specificity of 88%, the PPV of 90%, the NPV of 95% and the overall accuracy of 92% come from the combination of the two right criteria. [30]

Engelhorn et al in 2005, based on a cut of 180cm/s of PSV and 3.5 of RAR for a stenosis of 60% or more in the angiographic control, found a sensitivity of 93%, a specificity of 84%, a PPV of 88% and a 90% NPV. In this work, the combination of criteria obtained the highest overall accuracy, closely followed by PSVe, then by RAR and then by EDV.[26]

Cardoso et al in 2006, in a prospective study, used PSVe greater than 189cm/s and a RAR greater than 3.5 as criteria in a study with 127 renal arteries in 62 patients. Angiography was used as a control for a stenosis greater than 60%. They achieved a sensitivity of 79%, a specificity of 97%, a PPV of 99% and a NPV of 61%. When they optimized the cutoff values to 189cm/s and RAR of 2.6, after ROC curve analysis they obtained 96%, 94%, 98%, and 89% respectively as results. Something important to highlight in this work was that greater overall ac-

curacy was not achieved with the combination of criteria, but with the use of PSVe alone. With a cut-off point of 189cm/s, they achieved results of 100%, 87%, 96% and 100% respectively.[39]

In the 2006 study, Li et al proposed two new combinations of criteria for detecting a stenosis of 50% or more. One of them using PSVe with RIR; and another using the RIR with the systolic peak of the interlobar artery (IL PSV), the latter being positive for stenosis when less than 15cm/s. Both with good accuracy.[12]

In 2008, Zeller et al used cutoff points of 3.5 for the RAR and 0.05 for the RId in detecting stenoses equal to or greater than 70% on angiography. They found a sensitivity of 76%, a specificity of 97%, a PPV of 97% and a NPV of 76%. They justified the low sensitivity to the presence of bilateral stenosis in 22% of the patients, which influenced the RId. It is interesting to note the low sensitivity as a probable limitation of this criterion, as it is necessary for there to be laterality of an HSS in only one renal artery. It may not influence criteria such as RIR and RSR, but further studies would be needed. [27]

In 2013 another Brazilian work was published. Borelli et al published a prospective study with 61 patients with suspected RAS. They were submitted to doppler, renal scintigraphy with Tc-99m DTPA and renal angiotomography, with renal angiography as control. For stenoses above 60% or more in controls, PSVe equal to or greater than 180cm/s associated with a RAR equal to or greater than 3.5 were used as a criterion. That is, if the patient had a PSVe equal to or greater than 180cm/s, but with a RAR of less than 3.5, it would be considered a stenosis of less than 60%. As a result, they obtained a sensitivity of 83%, a specificity of 70%, a PPV of 85% and a NPV of 67%. [32]

Author	YP	St.	PC	Sens.	Spec.	PPV	NPV
Krummer	1996	70%	PSVe 200cm/s; RId 0.05	89%	92%	92%	88%
House et al	1999	60%	PSVe 180cm/s; RAR 3.5	80%	78%	45%	95%
House et al	1999	60%	PSVe 180cm/s; RAR 3.0	85%	76%	44%	96%
Engelhorn et al	2004	60%	PSVe 180cm/s; RAR 3.5	95%	88%	90%	95%
Engelhorn et al	2005	60%	PSVe 180cm/s; RAR 3.5	93%	83,6%	88%	90%
Cardoso et al	2006	60%	PSVe 189cm/s; RAR 3.5	79%	97%	99%	61%
Cardoso et al	2006	60%	PSVe 189cm/s; RAR 2.6	96%	94%	98%	89%
Li et al	2006	50%	PSVe 150cm/s; RAR 2	82%	91%	93%	79%
Li et al	2006	50%	PSVe 150cm/s; RIR 5	89%	88%	91%	85%
Li et al	2006	50%	RIR 5; aiPSV 15cm/s	91%	87%	90%	88%
Li et al	2008	50%	PSVe 190cm/s; RSR 5,0	90%	92%	89%	92%
Zeller et al	2008	70%	RAR 3,5; RId 0.05	76%	97%	97%	76%
Borelli et al	2013	60%	PSVe 180cm/s; RAR 3.5	83%	70%	85%	67%

Table 12 summarizes the diagnostic tests on combinations of criteria.

Types of lesion

The work by Hansen et al in 1990 presented 6 arteries with characteristics compatible with fibromuscular dysplasia of 147 evaluated renal arteries.

Hoffmann et al, in their work published in 1991, excluded arteries suspected of having FMD, which leads us to conclude that the lesions found must be of atherosclerotic origin.

House et al in 1999 found in 125 arteries analyzed, two with lesions typical of FMD. Both in the same patient, therefore, a case of bilateral stenosis.

In 2000, Motew et al, in their work on 81 renal arteries, observed 5 lesions compatible with FMD, 2 of them in the same patient.

In the work by Bardelli in 2006, indirect criteria were evaluated and one of the most interesting points of the work were the classifications of the stenosis site and the etiology of the stenoses. Of the 72 stenoses evaluated, 16 were cited as etiology by fibromuscular dysplasia and 56 were by atherosclerosis.

Cardoso et al in 2006, had in their sample 55 patients with atherosclerotic etiology and seven patients with fibromuscular dysplasia (FMD).

The 2006 work by Li et al had an interesting etiologic population. Of the 93 stenoses, 42 were due to atherosclerosis, 30 due to Takayasu's arteritis and 21 due to FMD. This distribution may have influenced his work mainly in relation to PSVe and RAR, as some patients with Takayasu had both aortic and multisegmental involvement.

In his 2009 work, of the 68 renal artery stenoses, 40 were due to atherosclerosis, [17] due to Takayasu, nine due to FMD and two due to pheochromocytoma and polyarteritis nodosa. Here we make the same caveat regarding patients with Takayasu who may have multisegmental involvement, altering the use of some indices. In this work, the authors reaffirm how aortic stenoses can affect the diagnostic indexes, which is not a demerit of the work, but a warning for any examiner who is not aware of the possibility of stenosis in the aorta or even in another segment of the arterial tree kidney during the performance of your Doppler.

The other studies did not specify the etiology, but the description in most of them suggests that it is probably an atherosclerotic etiology.

CONCLUSION

In the following tables we show the arithmetic mean of each statistic of the diagnostic tests of the works according to each diagnostic criterion. Caution is needed when analyzing the average achieved, because the cutoff points differ between studies and the degree of stenosis as well. In some studies where the PPV and NPV were not published, it was calculated based on the prevalence of the sample, sensitivity and specificity.

Mean between papers for the RId criterion.	Sens.	Spec.	PPV	NPV
	47%	96%	75%	77%

Table 13

Mean between works for the AT criterion.	Sens.	Spec.	PPV	NPV
	70%	89%	76%	81%

Table 14

Mean between works for the AI criterion.	Sens.	Spec.	PPV	NVP
	84%	69%	54%	90%

Table 15

Mean between works for the PSVe criterion.	Sens.	Spec.	PPV	NVP
	89%	83%	82%	91%

Table 16

Mean between papers for the RAR criterion.	Sens.	Spec.	PPV	NVP
	80%	87%	81%	86%

Table 17

Author	YP	St.	PC	Sens	Spec.	PPv	NPV
House et al	1999	60%	PSVe 180cm/s; RAR 3.5	80%	78%	45%	95%
House et al	1999	60%	PSVe 180cm/s; RAR 3.0	85%	76%	44%	96%
Engelhorn et al	2004	60%	PSVe 180cm/s; RAR 3.5	95%	88%	90%	95%
Engelhorn et al	2005	60%	PSVe 180cm/s; RAR 3.5	93%	84%	88%	90%
Cardoso et al	2006	60%	PSVe 189cm/s; RAR 3.5	79%	97%	99%	61%
Cardoso et al	2006	60%	PSVe 189cm/s; RAR 2.6	96%	94%	98%	89%
Li et al	2006	50%	PSVe 150cm/s; RAR 2	82%	91%	93%	79%
Borelli et al	2013	60%	PSVe 180cm/s; RAR 3.5	83%	70%	85%	67%
Média				87%	85%	80%	84%

Table 18: in this table, studies with a combination of different criteria were excluded; however, it is important to note the different cutoff points despite the same combination of criteria.

Some more recent works that dealt with indirect criteria mentioned some limitations of the technique. Li et al[12] describes the difficulty of using RId in bilateral stenosis. And Staub el al[16] specifies the difficulty of using indirect criteria in situations such as bilateral stenoses, single kidneys, unilateral renal parenchymal disease, arrhythmia, aortic regurgitation and presence of arteriovenous fistulas.

The direct criteria also have some limitations related to the use of the technique, but when feasible, they proved to be more reproducible and with better overall accuracy compared to the indirect criteria. The works where there were indirect criteria being evaluated together with the direct criteria referred to a better performance of the direct criteria in relation to sensitivity, specificity, PPV and NPV.

Therefore, it is not surprising that review studies, especially the most recent ones, not only confirm the greater reproducibility of direct criteria, but also strongly suggest their use for the diagnosis of renal artery stenosis. Among the direct criteria, PSVe has been the most recommended. And, if necessary, the use of RAR for confirmation. The use of indirect criteria as an adjuvant for diagnosis is also suggested. However, the limitations of indirect criteria must be borne in mind.

It would be interesting in the future to see works on criteria such as RRR, RSR and RIR. The last two in particular have shown promise as diagnostic criteria. Furthermore, these indices would theoretically not be influenced by bilateral stenosis, single kidney, arrhythmia, aortic regurgitation or arteriovenous fistulas. On the other hand, renal parenchymal disease could theoretically influence the latter two. However, further studies are needed to investigate these possibilities.

A detail in the evaluation of these criteria is that the best accuracy does not always define the best cut-off point. As the renal artery Doppler is a screening test, it might be interesting to have a higher sensitivity to actually determine those who should continue the investigation.

With regard to stenosis of non-atherosclerotic origin, it seems necessary to create a collaborative effort between the centers so that a reliable criterion can be established for renal artery stenosis due to other etiologies, mainly due to the low number of patients in the studies presented.

In conclusion, at the current stage of work and knowledge built, it is comfortable to suggest the use of PSVe as a diagnostic criterion for renal artery stenosis, with RAR being an important adjuvant. The use of indirect criteria should be done with caution, always keeping in mind the examiner's familiarity with a tardus parvus wave, with his ultrasound device and the acquisition of several measurements for greater reliability.

Future work should continue to evaluate the contrast-enhanced ultrasound (CEUS) technique in the case of RAS. This technique has been under development since 1996, showing significant improvements with second-generation contrast agents. However, it contains a risk inherent to minimally invasive procedures, since the intravenous injection of a contrasting agent is required. Another drawback has been the cost of contrast in developing countries. However, promising results have emerged in the evaluation of RAS and in the evaluation of other renal and intra-abdominal pathologies.

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REVIEW ARTICLE

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OVARIAN-ADNEXAL REPORTING AND DATA SYSTEM FOR US (O-RADS US) IN OVARIAN CANCER

AMILTON MOURA, ARIELA MAULLER VIEIRA PARENTE, WALDEMAR NAVES DO AMARAL

ABSTRACT

OBJECTIVE: to describe the new System called Ovarian-Adnexal Reporting and Data System for US (O-RADS US) supported by the American College of Radiology to standardize the lexicon in the description of characteristics of ovarian and adnexal masses and assign risk categories for the probability of malignancy Based on the assessment of these characteristics, management recommendations are also standardized.

METHODS: Bibliographic review. For risk stratification, the O-RADS US system recommended six categories (O-RADS 0–5), incorporating the range of normal to high risk of malignancy.

RESULTS: In the studies found, the results for sensitivity, specificity, PPV, NPV and kappa of the method were significant with the use of the Ovarian-Adnexal Reporting and Data System (O-RADS) risk stratification and management system.

CONCLUSION: This system was designed to provide consistent interpretations, to decrease or eliminate ambiguity in US reports, resulting in a greater likelihood of accuracy in assigning malignancy risk to ovaries and other adnexal masses, and to provide a management recommendation for each category. of risk. O-RADS US is the only lexicon and classification system that covers all risk categories with their associated management schemes.

KEYWORDS: O-RADS, CANCER, OVARY, ULTRASOUND

INTRODUCTION

Ovarian cancer is the deadliest gynecological cancer. Less than half of patients survive for more than five years after diagnosis. Ovarian cancer affects women of all ages, but it is most commonly diagnosed after menopause. More than 75% of affected women are diagnosed at an advanced stage because early-stage disease is usually asymptomatic and symptoms of advanced-stage disease are nonspecific. Risk factors for ovarian cancer are old age and a family history of ovarian and breast cancer. Women with symptoms related to ovarian cancer should be evaluated with a physical examination, transvaginal ultrasound, and measurement of biomarkers such as cancer antigen 125 (CA-125). If the results are suspicious for ovarian cancer, the patient should be referred to a gynecological oncologist[1].

Despite the low rate of early diagnosis, guidelines do not recommend routine screening for ovarian cancer in average-risk women because screening, including routine pelvic exams, is ineffective and associated with harm. However, a recent study found a potential benefit of annual screening using an algorithm based on serial measurements of cancer antigen 125, followed by transvaginal ultrasound, for women at increased risk, as determined by the algorithm. Women with a family history of increased risk should be referred for genetic counseling and, if genetic mutations are identified (eg, BRCA mutations), bilateral salpingo-oophorectomy may be considered for risk reduction. In medium- and high-risk women, long-term use of hormonal contraceptives reduces the risk by about 50%. Treatment of ovarian cancer usually involves surgery, with or without intraperitoneal and intravenous chemotherapy[1].

When detected at stage I, ovarian cancer can be cured in up to 90% of patients. Stage II ovarian cancer is associated with a 5-year survival of 70%. However, disease that has spread beyond the pelvis (stage III-IV) has a long-term survival rate of 20% or less. Currently, only 20% of ovarian cancers are diagnosed at stage I-II. Computer simulations suggest that detecting preclinical disease at an earlier stage could improve survival by 10-30%[2].

Currently, the combination of an ultrasound examination with a cancer antigen (CA)-125 assay is the most effective diagnostic technique, but it is not yet accepted as a screening method[3]. Therefore, it is extremely important to be able to differentiate suspicious ovarian and adnexal masses from those that can safely be ignored or followed, remembering that surgery may be appropriate for some benign lesions (to remove symptomatic ones or to prevent future malignancy). To this end, the American College of Radiology (ACR) supported the development and dissemination of the Ovarian-Adnexal Reporting and Data System for US (O-RADS US) and for MRI (O-RADS MRI). By standardizing the lexicon to describe characteristics of ovarian and adnexal masses and assigning risk categories for the likelihood of malignancy based on the assessment of these characteristics, manage-

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ment recommendations are also standardized[4].

The aim of this study is to describe the new system called Ovarian-Adnexal Reporting and Data System for US (O-RADS US) supported by the American College of Radiology.

STANDARDIZATION OF O-RADS FOR OVARIES

Concept

The Ovarian-Adnexal Reporting and Data System (O-RADS) lexicon for US was published in 2018, providing a standardized lexicon that includes all pertinent descriptors and definitions of the characteristic US appearance of normal ovaries and ovaries or other adnexal lesions. The lexicon is based on committee consensus. Taking into account the supporting evidence for the performance of different terminologies used in the literature for classifying a mass as benign or malignant, the committee members agreed on terms similar to those used in the IOTA models.

The descriptors used in the O-RADS lexicon were tested on the large dataset from phases 1-3 of the IOTA study to assign a risk of malignancy to each of them. Terms that proved useful for designating malignancy risk were placed in a condensed lexicon table to facilitate risk stratification. Finally, with the use of other supporting evidence-based studies in the literature that offer additional guidance in differentiating treatment regimens in a variety of almost certainly benign lesions that include simple cysts, hemorrhagic cysts, dermoid cysts, endometriomas, paraovarian cysts, inclusion cysts peritoneal, hydrosalpinx, and O-RADS US working group consensus, guidelines are provided for management in different risk categories. The proposed guidelines are a collaborative, multidisciplinary and international approach that incorporates common European and North American approaches. The guidelines include all risk categories with their respective management strategies, which were not included in any of the previous systems[5].

CLASSIFICATION

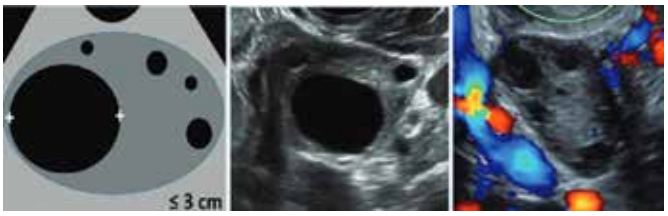
O-RADS 0 - INCOMPLETE EVALUATION

Usually due to technical difficulties, such as intestinal gas, large size of the lesion, location of the adnexa, or the patient's inability to perform an endovaginal exam.

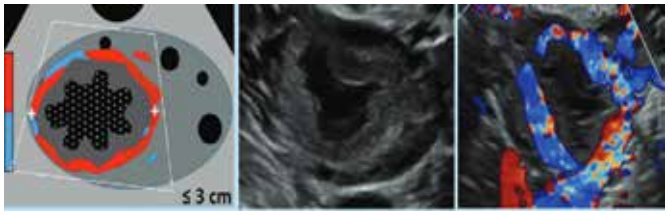
O-RADS 1 - NORMAL OVARIES

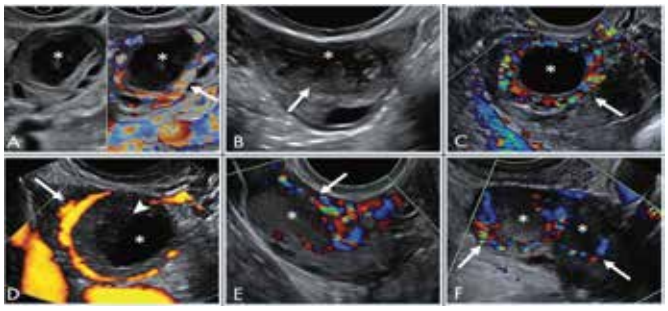
Physiological category. Relevant only in premenopausal patients as it includes the follicle and corpus luteum. One should avoid using the word cyst to describe these structures.

Follicle - anechoic unilocular cyst ≤ 3 cm



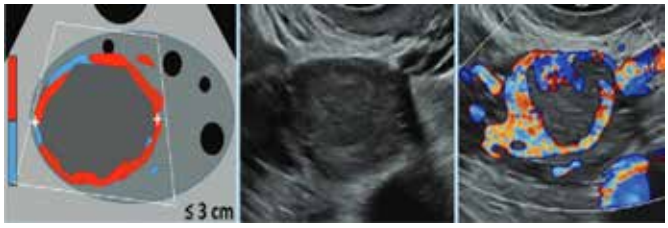
Corpus Luteum - Cyst with thick walls 3cm +-, crenulated internal margin, internal echoes, peripheral flow.





The images show typical corpora lutea. A, Corpus luteum with color Doppler and without color Doppler demonstrates a central cystic component (asterisks) with smooth thickened wall, avascular internal echoes, and peripheral vascularity (arrow). B, Corpus luteum with central component, thickened wall and crenulated inner margin (arrow). C, Thick-walled anechoic cyst (asterisk) with intense peripheral vascularization (arrow). D, Color Doppler energy demonstrates peripheral vasculature (arrow) in this cystic corpus luteum (asterisk) with retracted clot (arrowhead). E, Corpus luteum as a hypoechoic region (asterisk) without a central cystic component, but with peripheral flow (arrow) on color Doppler. F, Two corpora lutea in double ovulation configuration manifested by two hypoechoic regions (asterisks) with peripheral flow (arrows).

Hypoechoic region with peripheral flow, but without a characteristic cystic component.



O-RADS 2 - ALMOST CERTAINLY BENIGN.

Risk of malignancy < 1%

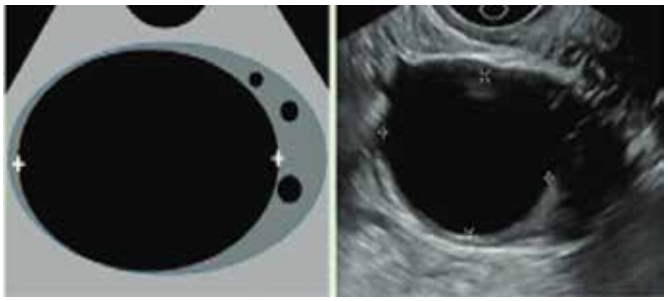
The category includes most unilocular cysts smaller than 10 cm.

Simple cysts, non-simple unilocular cysts with smooth walls and cysts that can be described using classic benign lesions and their descriptors if smaller than 10cm in maximum diameter.

Simple cyst

>3 - < 10cm in premenopausal women

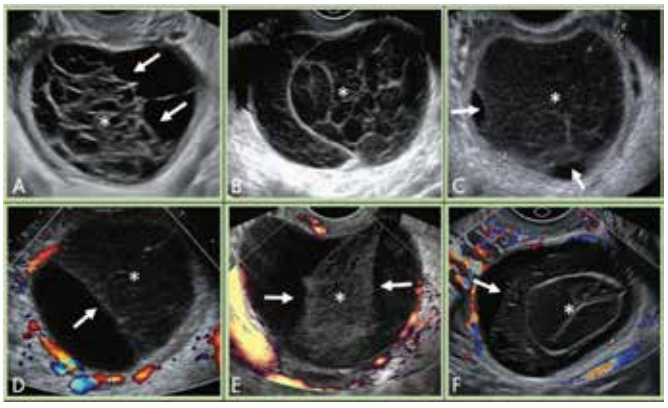
< 10 cm in postmenopausal women



Classic benign lesions – Typical hemorrhagic cyst, dermoid cyst, endometrioma, paraovarian cyst, peritoneal inclusion cyst and hydrosalpinx.

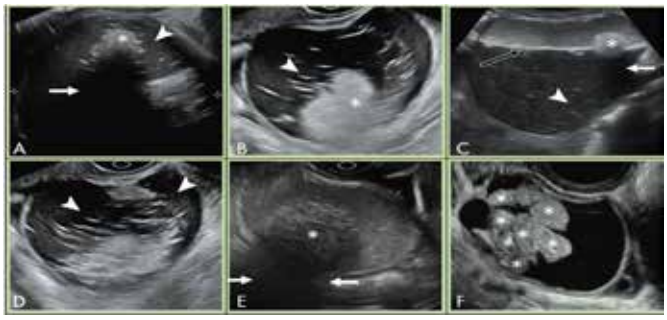
Typical hemorrhagic cyst

The images show typical hemorrhagic cysts. A, Hemorrhagic ovarian cyst with retracted clot demonstrates concave margins (arrows) and internal reticular pattern (asterisk). B, Hemorrhagic cyst with full-length reticular pattern (asterisk). C, Reticular pattern (asterisk) with fine discontinuous linear echoes and early clot retraction in the periphery (arrows). D, Retracted clot with reticular pattern (asterisk) and concave margin (arrow). Color Doppler flow is observed in the surrounding ovarian tissue; however, it is absent in blood products. E, Reticular pattern (asterisk), straight and concave margins (arrows) and no flow in color Doppler energy differentiates retractable clot from solid tissue. F, Avascular hemorrhagic cyst with reticular pattern (asterisk) and concave margin of retractable clot (arrow).



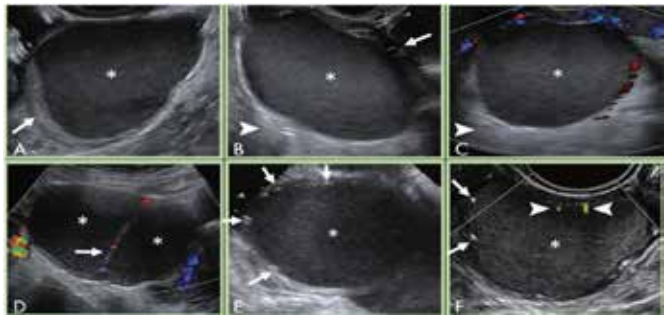
Typical dermoid cyst

The images show typical dermoid cysts. A, Dermoid cyst with hyperechoic component (asterisk) with acoustic shadow (arrow) and hyperechoic lines and dots (arrowhead). B, Hyperechoic lines and dots and hyperechoic component in another dermoid cyst. C, Transabdominal image of dermoid cyst demonstrates fluid-fluid level (black arrow) with non-dependent hyperechogenicity consistent with fluctuating fluid fat. Hyperechoic component (asterisk) with acoustic shadowing (arrow) and subtle hyperechoic lines and dots (arrowhead) are also seen. D, Cystic lesion with prominent hyperechoic lines and dots (arrowheads), which reflect the coiled hair in the dermoid cyst. E, Hyperechoic component (asterisk) with acoustic shadow (arrows) in dermoid cyst containing internal echoes. F, Floating echogenic spherical structures (asterisks) are uncommon but are pathognomonic of a dermoid cyst.



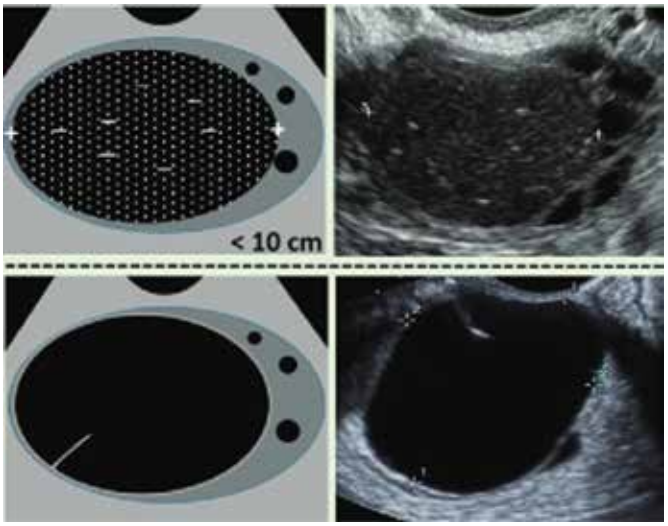
Typical endometriomas

The images show typical endometriomas. A, The common appearance of endometrioma demonstrates homogeneous low-level or ground-glass internal echoes (asterisk); The surrounding ovarian parenchyma (arrow) is observed. B, Similar features of homogeneous low-level or ground-glass echoes (asterisk) with surrounding ovarian tissue (arrow) and posterior acoustic enhancement (arrowhead). C, No inflow on Doppler imaging should be seen in endometriomas; homogeneous low-level echoes (asterisk) and posterior acoustic reinforcement (arrowhead). D, Multiloculated endometrioma with homogeneous low-level echoes (asterisks) in each component; flow can be observed in the intervening septum (arrow). E, Occasionally, peripheral punctuated echogenic foci (arrows) are seen with endometriomas; however, homogeneous low-level echoes (asterisk) are more specific features. F, Although shadowing is not normally associated with peripheral punctuated echogenic foci (arrows) around the endometrioma (asterisk), shimmering artifacts can be seen with Doppler imaging (arrows).

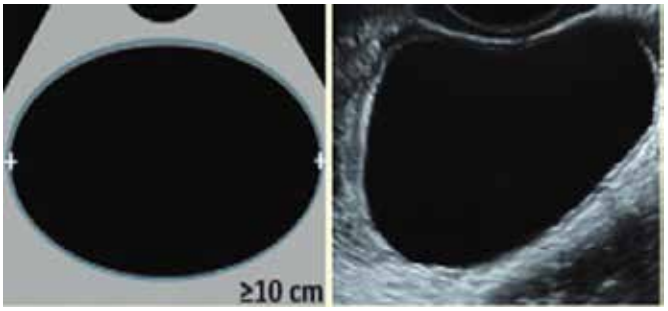


Non-simple unilocular cysts – cysts with internal echoes or incomplete septum.

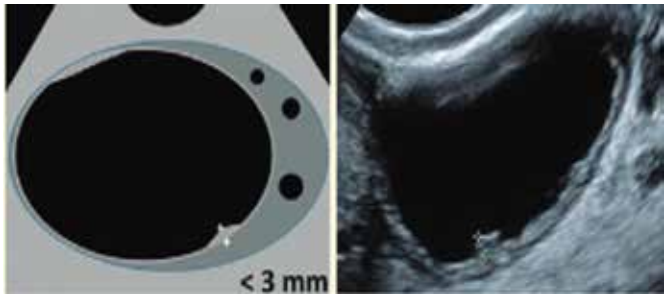
Non-Simple, unilocular cyst with smooth internal margin < 10cm - "Non-Simple" cyst applies when internal echoes or incomplete septa are present. Note that an incomplete septum is not considered a wall irregularity if the inner margin is smooth.



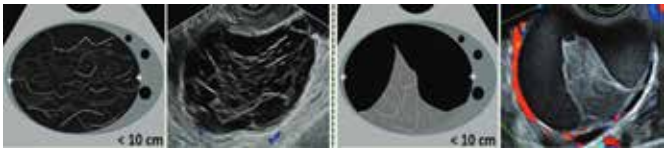
O-RADS 3 - LOW RISK OF MALIGNITY (1% TO 10%)
Simple unilocular cyst > 10 cm.



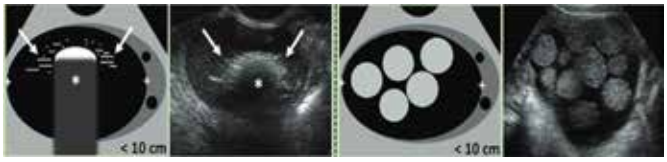
Unilocular cyst of any size, with wall irregularity < 03 mm in height.



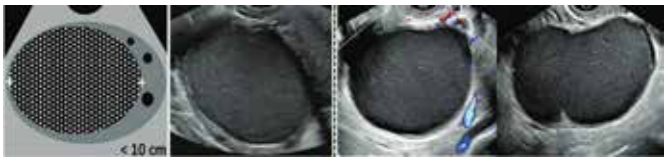
Classical benign lesions > 10 cm – Dermoid, endometriomas or hemorrhagic cysts.



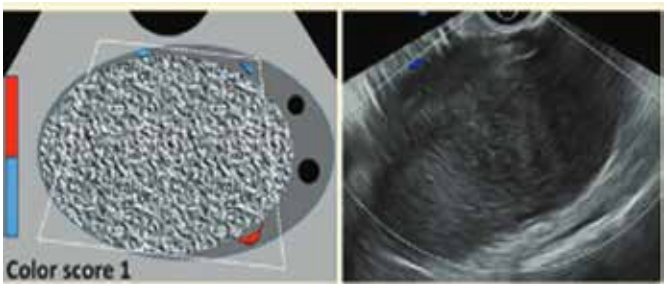
Hemorrhagic cyst



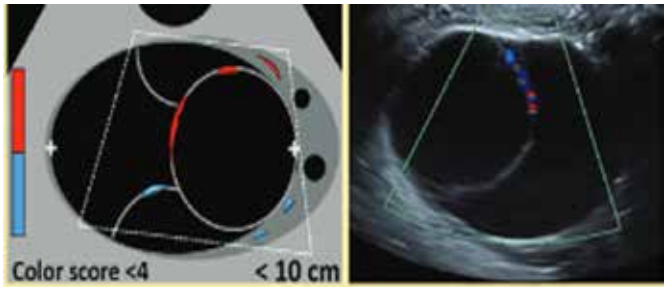
Dermoid cyst



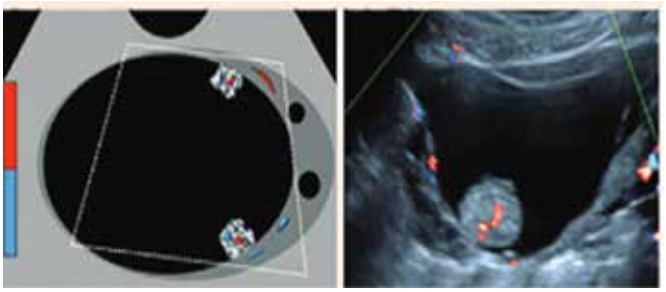
Endometriomas
Solid, smooth-edged lesion of any size, color score 1, no flow.



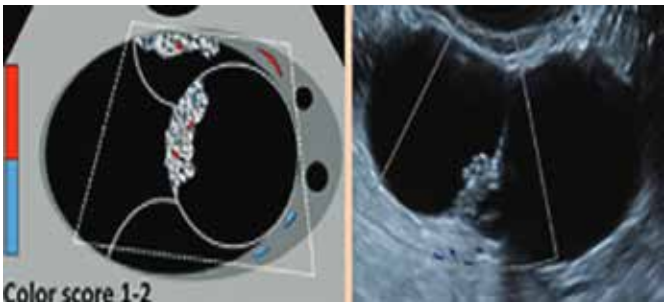
Multilocular cyst < 10 cm, with smooth inner wall, color score 1-3.



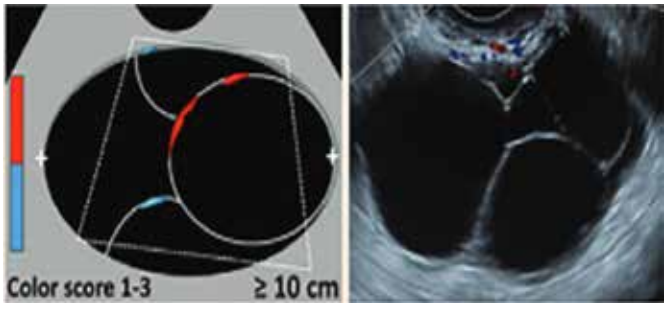
O-RADS 4 - INTERMEDIATE RISK OF MALIGNITY (10% TO 50%)
Unilocular cyst with solid component – 1-3 papillary projections (PP), or solid component that is not PP. Any size and any color score.



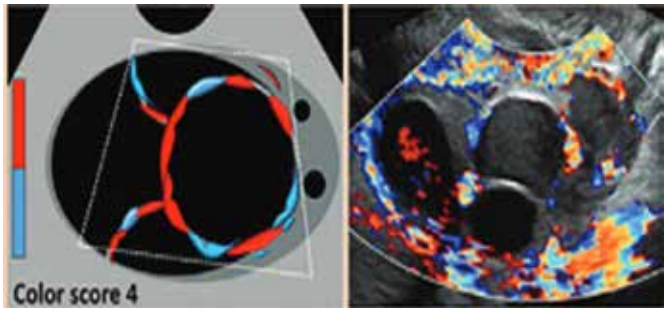
Multilocular cyst with solid component. Any size. Color Score 1-2.



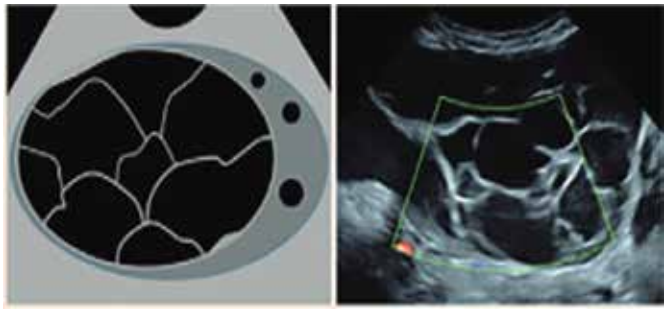
Multilocular cyst without solid component 10cm. Smooth inner wall. Color Score 1-3.



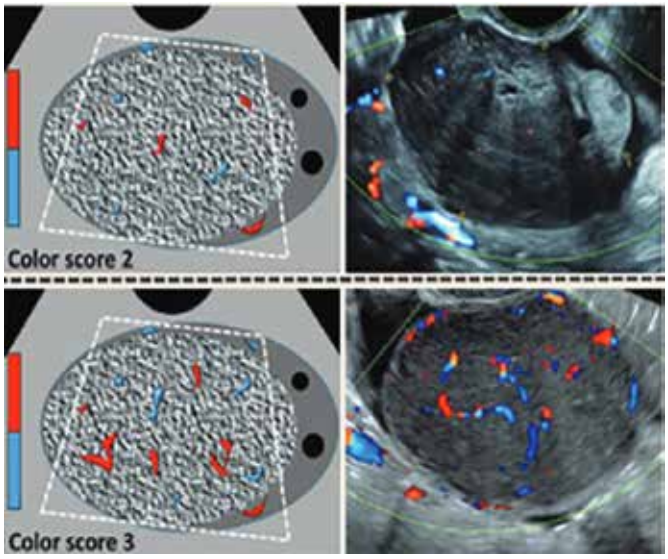
Any size. Smooth inner wall. Color score 4.



Any size. Irregular inner wall or papillary projections <03mm in height. Any color score.

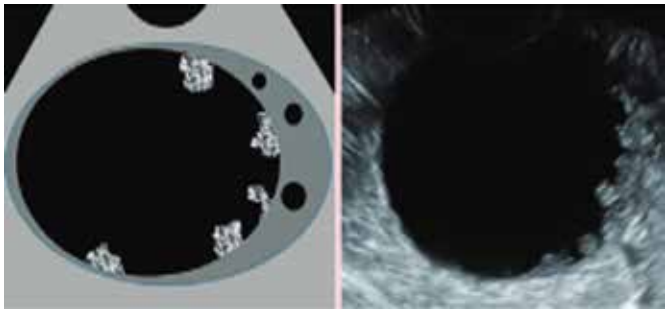


Solid lesion. Smooth outline. Any size. Color score 2-3.

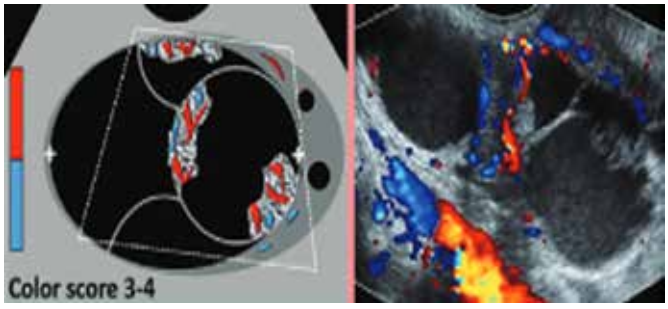


O-RADS 5 - Lesions with a high risk of malignancy (≥50%)

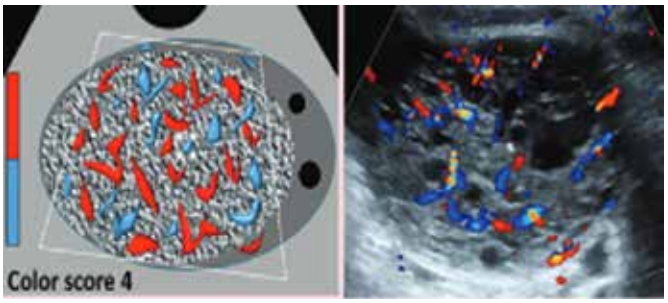
Unilocular cyst with four or more papillary projections. Any size. Color score.



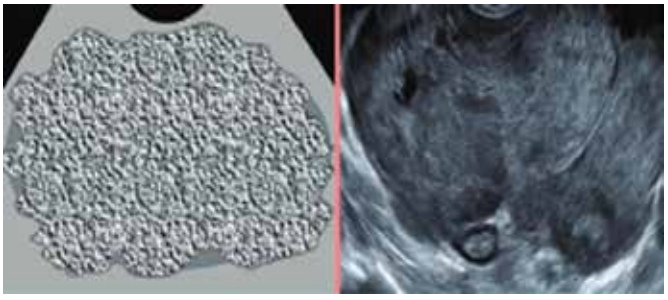
Multilocular cyst with solid component.



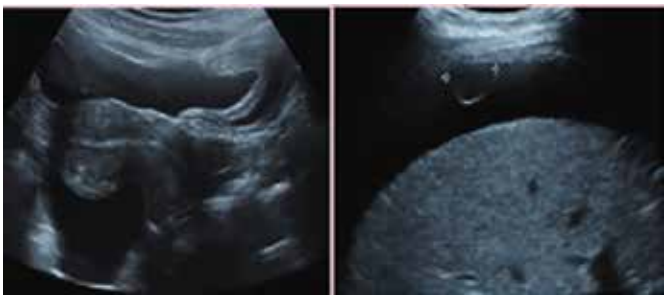
Solid lesion, Smooth outline. Any size. Color score 4.



Irregular solid lesions of any size.

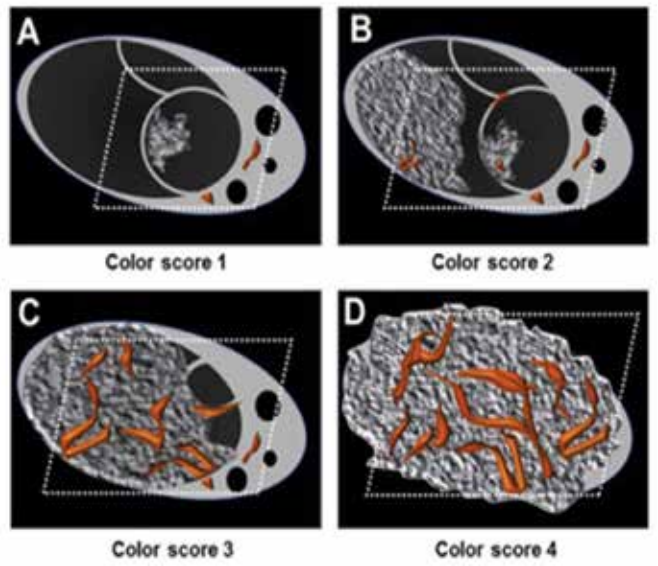


Presence of ascites or peritoneal nodularity.



Color score indicator

O-RADS: color score 1 to 4 (subjective evaluation of blood flow by the International Tumor Analysis Group adopted as part of the O-RADS Lexicon: (A) Color score 1 is given when no blood flow is detected in the tumor wall. cyst, septa or solid component. (B) Color score 2 is given when only minimal flow is detected. (C) Color score 3 is given when moderate flow is present. (D) Color score 4 is given when the adnexal lesion is highly vascularized with increased blood flow.



The presence of flow on Doppler is diagnostic of solid tissue, but its absence is less informative, and the lesion should then be considered solid in appearance.

Papillary projection (PP) is a type of solid component with a height greater than or equal to 3mm that arises from the cyst wall or septum and projects into the cyst cavity. When < 03mm in height, it should not be called PP.

Solid lesions are thus considered when they have a solid component > 80%.[5]

O-RADS MODEL TEST EVALUATION

One study evaluated the diagnostic accuracy of the ACR O-RADS scoring system among radiologists with no prior experience with the system. After being trained with thirty cases, radiologists evaluated 50 pelvic ultrasound scans using the O-RADS system. The results showed excellent specificity and negative predictive value and variability in sensitivity and positive predictive value. Individual reader AUC values ranged from 0.94 to 0.98 and overall reader agreement was "very good". The study concluded that even without specific training, radiologists can achieve excellent diagnostic performance and high reliability among readers with self-directed review of guidelines and cases. The study highlights the effectiveness of ACR O-RADS as a stratification tool for radiologists and supports its continued use in practice. However, the study identified some common errors in the system, which can be avoided with greater familiarity and training with the O-RADS system [6].

Another study assessed interobserver agreement in assigning imaging features and classifying adnexal masses using simple IOTA rules versus O-RADS lexicon and identifying causes of discrepancy. Pelvic ultrasound examinations were performed on 114 women with 118 adnexal masses who were evaluated by eight blinded radiologists for the final diagnosis, using simple IOTA rules and the O-RADS lexicon. Each characteristic category was analyzed for interobserver agreement using the intraclass correlation coefficient (ICC)

for ordinal variables and free marginal kappa for nominal variables. The two-tailed significance level was set at 0.05.) with k values of 0.80-0.82 and 0.68-0.69, respectively. Interobserver agreement was nearly perfect for two categories of benign features (B2, B3), substantial for two (B4, B5) and moderate for one (B1) with k values of 0.81-0.90, 0.69-0.70 and 0.60, respectively. For O-RADS, interobserver agreement was nearly perfect for two of the ten feature categories (ascites and peritoneal nodules) with k values of 0.89 and 0.97. Interobserver agreement ranged from fair to substantial for the remaining eight resource categories with k values of 0.39-0.61. Fellows and participants had ICC values of 0.725 and 0.517, respectively. The authors concluded that the O-RADS showed variable interobserver agreement with good overall agreement. Simple IOTA rules had more uniform interobserver agreement with excellent overall agreement. Greater reader experience did not improve interobserver agreement with O-RADS.

A diagnostic accuracy study was carried out with the aim of applying the simple rules (SR) of the International Ovarian Tumor Analysis (IOTA), the IOTA Simple Rules risk assessment (SRR), the IOTA assessment of different neoplasms in the adnex model (ADNEX) and the ovarian-adnexal data and reporting system (O-RADS) in the same cohort of US patients and compare their performance in preoperative discrimination between benign and malignant adnexal lesions. The study included 150 women with adnexal injury. Using the ADNEX model, lesions were classified prospectively, while the SR, SRR and O-RADS assessment were applied retrospectively. Surgery with histological analysis was performed up to six months after the ultrasound examination. Sensitivity and specificity were determined for each test modality and the performance of different modalities was compared [8].

Of the 150 women, 110 (73.3%) had a benign ovarian tumor and 40 (26.7%) had a malignant tumor. The mean risk of malignancy generated by the ADNEX model without CA 125 was significantly higher in malignant versus benign lesions (63.3% versus 11.8%) and the area under the curve of receptor operating characteristics (AUC) of the ADNEX model to differentiate between benign lesions and malignant adnexal masses at the time of ultrasound examination was 0.937. The mean risk of malignancy generated by the SRR assessment was also significantly higher in malignant versus benign lesions (74.1% versus 15.9%) and the AUC was 0.941. To compare the ADNEX model, SRR assessment, and O-RADS, the malignancy risk threshold was set at ≥ 10%. This cutoff differentiates low-risk O-RADS categories (Category ≤ 3) from intermediate-to-high-risk categories (Categories 4 and 5). At this cutoff point, the sensitivity of the ADNEX model was 97.5% (95% CI, 85.3%-99.9%) and the specificity was 63.6% (95% CI, 53.9%- 72.4%) and, for the SRR model, the sensitivity was 100% (95% CI, 89.1%-100%) and the specificity was 51.8% (95% CI, 42.1%-61.4%). In the 113 cases in which SR could be applied, the sensitivity was 100% (95% CI, 81.5%-100%) and the specificity was 95.6% (95% CI, 88.5%-98 .6%). If the remaining 37 cases, which were inconclusive under SR, were designated as 'malignant', the sensitivity remained at 100%, but the specificity was reduced to 79.1% (95% CI, 70.1%-86.0%). The 150 cases fell into the following O-RADS categories: 17 (11.3%) injuries in category 2, 34 (22.7%) in category 3, 66 (44.0%) in category 4 and 33 (22 .0%) in category 5. There were no histologically proven malignant lesions in category 2 or 3. There were 14 malignant lesions in category 4 and 26 in category 5. O-RADS sensitivity using a malignancy risk threshold of ≥ 10% was 100% (95% CI, 89.1%-100.0%) and the specificity was 46.4% (95% CI, 36.9%-56.1%) [8] – see data summaries in table 1 below.

Teste	Sensibilidade	Especificidade	Intervalo de Confiança (95%)
ADNEX	97,5%	63,6%	(85,3%-99,9%)
Avaliação SRR	100%	51,8%	(89,1%-100%)
RS (113 casos)	100%	95,6%	(81,5%-100%)
RS (150 casos)	100%	79,1%	(70,1%-86,0%)
O-RADS	100%	46,4%	(89,1%-100%)

Table 1. Displays the tests used with their sensitivity, specificity and confidence interval.

COMMENTS

• ADNEX and SRR Assessment have high sensitivity but low specificity.

• SR has high sensitivity and specificity when applied to all cases, but specificity is reduced when inconclusive cases are considered malignant.

• O-RADS has high sensitivity but low specificity.

The results indicate that, when IOTA terms and techniques are used, the performance of IOTA models in a North American patient population is in line with published IOTA results in other populations. The IOTA SR, SRR, ADNEX and O-RADS models have similar sensitivity in preoperative discrimination of malignant from benign pelvic tumors. However, IOTA models have higher specificity and the algorithm does not require the use of MRI [8].

The study evaluated the diagnostic performance and interobserver agreement of the American College of Radiology (ACR) Ovarian-Adnexal Reporting and Data System Ultrasound (O-RADS US) ultrasound data reporting system. Data from 1035 patients with a total of 1054 adnexal lesions categorized according to O-RADS criteria were analyzed.

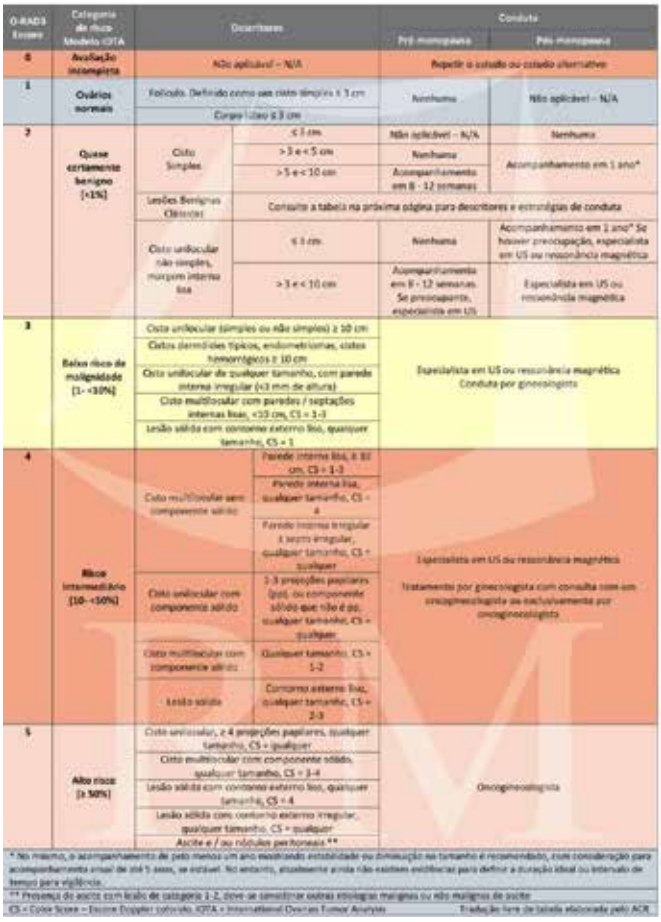
Of the 1054 adnexal lesions, 750 were benign and 304 were malignant. The malignancy rates of lesions classified as O-RADS 5, O-RADS 4, O-RADS 3 and O-RADS 2 were 89.57%, 34.46%, 1.10% and 0.45%, respectively. . The area under the receiver operating characteristic curve was 0.960, indicating a good performance of O-RADS in the diagnosis of adnexal lesions.

The ideal cutoff value to predict malignancy was > O-RADS 3, with sensitivity and specificity of 98.7% and 83.2%, respectively. The subgrouping of O-RADS 4 lesions into two groups (O-RADS 4a lesions and O-RADS 4b le-

sions) showed a malignancy rate of 17.02% and 42.57%, respectively, allowing for better risk stratification. Interobserver agreement between a less experienced radiologist and an O-RADS expert radiologist was good ($\kappa = 0.714$).

Therefore, the results indicate that O-RADS US is an effective tool for stratifying the risk of malignancy in adnexal lesions, with high reliability for radiologists with different levels of experience. Furthermore, the subclassification of O-RADS 4 lesions into two groups may facilitate a better stratification of intermediate risk [8].

Summary table



O-RADS Escore	Categoria de risco Modelo IOTA	Descritores		Conduta	
				Pré-menopausa	Pós-menopausa
0	Avaliação incompleta	Não aplicável – N/A		Repetir o estudo ou estudo alternativo	
1	Ovários normais	Folículo. Definido como um cisto simples ≤ 3 cm		Nenhuma	Não aplicável – N/A
		Corpo lúteo ≤ 3 cm			
2	Quase certamente benigno (<1%)	Cisto Simples	≤ 3 cm	Não aplicável – N/A	Nenhuma
			> 3 e < 5 cm	Nenhuma	Acompanhamento em 1 ano*
			> 5 e < 10 cm	Acompanhamento em 8 - 12 semanas	
		Lesões Benignas Clássicas	Consulte a tabela na próxima página para descritores e estratégias de conduta		
		Cisto unilocular não simples, marcam interna lisa	≤ 3 cm	Nenhuma	Acompanhamento em 1 ano* Se houver preocupação, especialista em US ou ressonância magnética
			> 3 e < 10 cm	Acompanhamento em 8 - 12 semanas. Se preocupante, especialista em US	Especialista em US ou ressonância magnética
3	Baixo risco de malignidade (1- <10%)	Cisto unilocular (simples ou não simples) ≥ 10 cm		Especialista em US ou ressonância magnética Conduta por ginecologista	
		Cistos dermóides típicos, endometriomas, cistos hemorrágicos ≥ 10 cm			
		Cisto unilocular de qualquer tamanho, com parede interna irregular (<3 mm de altura)			
		Cisto multilocular com paredes / septações internas lisas, <10 cm, CS = 1-3			
		Lesão sólida com contorno externo liso, qualquer tamanho, CS = 1			
4	Risco intermediário (10- <50%)	Cisto multilocular sem componente sólido	Parede interna lisa, ≥ 10 cm, CS = 1-3	Especialista em US ou ressonância magnética Tratamento por ginecologista com consulta com um oncoginecologista ou exclusivamente por oncoginecologista	
			Parede interna lisa, qualquer tamanho, CS = 4		
			Parede interna irregular à septo irregular, qualquer tamanho, CS = qualquer		
		Cisto unilocular com componente sólido	1-3 projeções papilares (pp), ou componente sólido que não é pp, qualquer tamanho, CS = qualquer		
		Cisto multilocular com componente sólido	Qualquer tamanho, CS = 1-2		
		Lesão sólida	Contorno externo liso, qualquer tamanho, CS = 2-3		
5	Alto risco (≥ 50%)	Cisto unilocular, ≥ 4 projeções papilares, qualquer tamanho, CS = qualquer		Oncoginecologista	
		Cisto multilocular com componente sólido, qualquer tamanho, CS = 3-4			
		Lesão sólida com contorno externo liso, qualquer tamanho, CS = 4			
		Lesão sólida com contorno externo irregular, qualquer tamanho, CS = qualquer			
		Ascite e / ou nódulos peritoneais **			

* No mínimo, o acompanhamento de pelo menos um ano mostrando estabilidade ou diminuição no tamanho é recomendado, com consideração para acompanhamento anual de até 5 anos, se estável. No entanto, atualmente ainda não existem evidências para definir a duração ideal ou intervalo de tempo para vigilância.

** Presença de ascite com lesão de categoria 1-2, deve-se considerar outras etiologias malignas ou não malignas de ascite

CS = Color Score – Escore Doppler colorido; IOTA = International Ovarian Tumor Analysis — Tradução livre de tabela elaborada pelo ACR

FINAL CONSIDERATIONS

The American Ovarian-Adnexal Reporting and Data System (O-RADS) risk stratification and management system is designed to provide consistent interpretations, to decrease or eliminate ambiguity in US reports, resulting in a greater likelihood of accuracy in assigning risk of malignancy to ovaries and other adnexal masses and provide a management recommendation for each risk category. For risk stratification, the US O-RADS system recommends six categories (O-RADS 0–5), incorporating the normal to high risk range of malignancy. O-RADS US is the only lexicon and classification system that covers all risk categories with their associated management schemes.

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