American College of Radiology
ACR Appropriateness Criteria®
Placenta Accreta Spectrum Disorder

Variant: 1 Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US pregnant uterus transabdominal	Usually Appropriate	O
US duplex Doppler pregnant uterus	May Be Appropriate	O
US pregnant uterus transvaginal	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O

Variant: 2 High risk for placenta accreta spectrum disorder. Initial Imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pregnant uterus	Usually Appropriate	O
US pregnant uterus transabdominal	Usually Appropriate	O
US pregnant uterus transvaginal	Usually Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O

Variant: 3 Follow-up of placenta accreta spectrum disorder.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pregnant uterus	Usually Appropriate	O
US pregnant uterus transabdominal	Usually Appropriate	O
US pregnant uterus transvaginal	Usually Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O

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Summary of Literature Review

Introduction/Background

Placenta accreta spectrum disorder (PASD) is the current terminology recommended by the International Federation of Obstetrics and Gynecology (FIGO) and should replace terms such as abnormally adherent/invasive placenta or morbidly adherent placenta [1]. PASD refers to a variety

of potential clinical complications, which may result from abnormal placental implantation. More specifically, placenta accreta refers to a defect in the decidua basalis in which the chorionic villi adhere directly to the myometrium with trophoblastic invasion. More invasive placentation includes placental increta, in which placental villi invade into the myometrium, and placenta percreta, in which the placenta villi invade through the myometrium and into the serosa and adjacent structures [2].

A single placenta can demonstrate varying degrees of invasiveness, and a decidual defect may be accompanied by focal loss of myometrium, often related to prior surgery or trauma. The pathology and underlying mechanism for placenta accreta is not well understood but is thought to be related to a defect in trophoblastic function versus a failure of normal decidualization or a combination of both [1,3,4]. The risk of severe and even life-threatening hemorrhage is greatest at the time of delivery when a portion of the placenta does not separate in the usual fashion.

The incidence of PASD has increased over past decades from approximately 1 in 2,500 to 1 in 500 deliveries, obtained from large cohort studies, with increasing incidence over past decades attributed to the increased rate of cesarean deliveries [4-6]. In a prospective cohort study, the Nordic Obstetric Surveillance Study [7] reported that placenta previa was the single most important risk factor for PASD and was present in 49% of cases. Additionally, the reported risk of PASD increases 7-fold after one prior cesarean delivery to 56-fold after ≥3 cesarean deliveries. The risk of placenta previa is also increased with a prior cesarean delivery. Of note, only 70% of these cases were identified antenatally despite a history of a prior cesarean delivery in 39% of cases and placenta previa in 33% of cases. Enhanced antenatal clinical suspicion and surveillance in high-risk populations is therefore justified, given the increased morbidity and mortality, which occurs when PASD is not suspected prior to delivery [8-10]. Additional risk factors include advanced maternal age, high gravidity or parity, in vitro fertilization, prior uterine surgery and trauma, prior postpartum hemorrhage, Asherman syndrome, uterine anomalies (congenital or acquired), smoking, and hypertension [3,4,7].

Accurate antenatal diagnosis is needed to plan for an appropriate delivery strategy at an experienced center in order to reduce maternal morbidity [11].

Management of delivery is variable; however, the American Congress of Obstetricians and Gynecologists (ACOG) and FIGO recommend planned cesarean delivery with or without hysterectomy depending on the suspected severity of PASD around 34 to 38 weeks. There is currently insufficient evidence to determine the exact optimal time of delivery. The timing of the delivery is planned carefully on a case-by-case basis at around 34 to 38 weeks to achieve optimal fetal maturity and avoid the chance of spontaneous labor. Given that the majority of PASD are associated with placenta previa, they are at increased risk of prepartum hemorrhage as gestational age increases, which in turn is associated with increased risk of unscheduled delivery [11,12]. Although a planned delivery is preferred, a contingency plan for emergent delivery should be in place [4]. Obtaining radiologic and clinical data when PASD is first suspected can play a significant role in formulating an appropriate delivery strategy and contingency plan. Ideally after initial diagnosis, high-risk patients should be followed closely by experienced centers where emergent mobilization of a multidisciplinary team needed for a scheduled or unscheduled delivery is feasible [13].

Discussion of Procedures by Variant

Variant 1: Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.

Women who do not have any clinical risk factors and no evidence of previa during an 18- to 22-week anatomy scan can be followed per ACOG clinical guidelines [4].

Variant 1: Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.
A. MRI Abdomen and Pelvis (Without and With IV Contrast)

There is no relevant literature to support the use of MRI without or with intravenous (IV) contrast in the initial imaging evaluation for low-risk pregnancy unless concerning findings are present on routine ultrasound (US) [13].

Variant 1: Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.
B. MRI Abdomen and Pelvis (Without IV Contrast)

There is no relevant literature to support the use of MRI without IV contrast in the initial imaging evaluation for low-risk pregnancy unless concerning findings are present on routine US [13].

Variant 1: Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.
C. US Duplex Doppler Pregnant Uterus

Doppler evaluation should be considered if any abnormalities of placental tissue or in the placental myometrial interface are detected on grayscale imaging regardless of placental location [4,14].

Variant 1: Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.
D. US Pregnant Uterus Transabdominal

Routine transabdominal US evaluation of placental location, appearance, and its relationship to internal os is done as documented in the ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound [15].

Variant 1: Low risk for placenta accreta spectrum disorder. No known clinical risk factors. Initial Imaging.
E. US Pregnant Uterus Transvaginal

Transvaginal (or transperineal) US views may be helpful in visualizing the internal cervical os and its relationship to the placenta if not clear on transabdominal US [15].

Variant 2: High risk for placenta accreta spectrum disorder. Initial Imaging.

The main risk factors for PASD include prior uterine surgery, including myomectomy, dilatation, and curettage, most notably cesarean delivery with concomitant anterior placenta previa, followed by advanced maternal age and in vitro fertilization. As many as 40% of women with placenta previa and three prior cesarean deliveries will develop PASD [8-10]. Women with high risk based on clinical history and/or US findings should be considered for referral for specialist imaging to confirm or exclude this diagnosis.

Numerous studies have evaluated the use of US for the diagnosis of placenta accreta. US sensitivities have been reported to range from 77% to 97% with specificities of 96% to 98%, positive predictive value of 65% to 93%, and negative predictive value of 98% for PASD [16-21]. A

meta-analysis of over 3,500 patients showed US to have high accuracy for diagnosing abnormal placentation, which improved with the addition of color Doppler [3]. These results are mainly applicable for the anterior placenta (either low lying or previa) in patients with previous cesarean delivery [3].

As per the recently updated SMFM-ACOG-SGO consensus document, US evaluation is important, but the absence of US findings does not preclude a diagnosis of PASD [13].

In patients with known history of prior cesarean delivery and/or low placenta or placenta previa, special attention should be paid on first trimester or nuchal translucency scanning to determine if there is a low implantation or cesarean section scar pregnancy that has been associated with increased risk for PASD [6,10,22-25].

Variant 2: High risk for placenta accreta spectrum disorder. Initial Imaging.
A. MRI Abdomen and Pelvis (Without and With IV Contrast)

There is insufficient evidence to support the use of gadolinium based contrast agents in MRI for this indication because there is no literature clearly establishing improved delineation of placenta and myometrium and the use of gadolinium based contrast agents remains controversial in pregnancy [26,27]. One series using gadolinium contrast compared imaging findings to pathology and reported good accuracy of US, with sensitivity for placenta accreta of 77%, specificity of 96%, but improved accuracy with MRI with corresponding sensitivity of 88% and specificity of 100% [20]. Gadolinium-based contrast agents are considered category C drugs, and their use should be considered only if the benefits outweigh the risks to the fetus. For example, IV contrast may be considered as an exception immediately prior to delivery or, in rare cases, in circumstances in which termination is planned [14].

Variant 2: High risk for placenta accreta spectrum disorder. Initial Imaging.
B. MRI Abdomen and Pelvis (Without IV Contrast)

MRI without IV contrast may play a complementary or selective role in situations in which US is equivocally nondiagnostic, severely abnormal in the setting of posterior placentation, or limited by obesity that limits US assessment [14,20,28-34]. MRI may be used to assist with surgical planning, such as choosing between hysterectomy and a more conservative surgery. The knowledge of the precise topography, including depth or laterality of invasion based on the MRI findings, can alter the surgical approach with regard to a need for ureteral stenting, vascular clamping, and/or embolization [3,35]. It has been suggested that MRI is particularly valuable in detecting placental invasion to parametrium [11].

Because MRI is also associated with both false-positive and false-negative diagnoses [36], the examination may be complementary to the US evaluation. The earliest recommended timing for a diagnostic quality MRI scan after a suspicious US is after 24 weeks [32]. An earlier MRI may be useful in a limited setting, such as preoperative planning for termination of the pregnancy or in the setting of severe disease for staging. Interobserver agreement has been shown to improve with extent of placental invasion [28]. At least four studies have performed direct comparison of MRI with US and found sensitivity of 93% and specificity of 94% for MRI compared with 88% and 96%, respectively, for US [37-40]. Warshak et al [20] advised a 2-stage protocol, starting with US and followed by MRI. Pregnant patients can be informed that there are no known deleterious effects on the fetus performed in 1.5T or 3.0T magnets [41].

Similar to US, the imaging findings suggestive of an invasive placenta include abnormal intraplacental heterogeneous signal, focal myometrial interruption, thinning or absence of the myometrium at the site of placental implantation, loss of the retroplacental clear space, lower uterine segment bulging, bulging of the placenta into the internal os, tenting of the urinary bladder, and frank invasion into nearby organs [14,28,33]. Presence of intraplacental T2 dark bands is a unique MRI finding that is thought to represent areas of fibrin deposition secondary to repetitive intraplacental hemorrhage and or infarcts. Increasing number and size of intraplacental T2 dark bands has been associated with depth of placental invasion and is considered most sensitive MRI feature for PASD [42]. The presence of a placental recess accompanied by a T2 dark band has been described recently [43,44]. Dark T2 intraplacental bands and focal myometrial interruption have also been shown to have higher sensitivities for predicting disease. Sensitivities range from 77% to 88%, and specificity ranges from 96% to 100% [20,26,33]. One MRI finding or "sign" should not be interpreted in isolation because the observation of one is likely to lead to the detection of others.

Variant 2: High risk for placenta accreta spectrum disorder. Initial Imaging.
C. US Duplex Doppler Pregnant Uterus

The addition of Doppler imaging can improve both detection and progression of the presence of increased placental vascular flow, subplacental vascularity, and vascularity at the bladder uterine-serosal interface, with vessels seen crossing or bridging from placenta to bladder. The presence of multiple vascular lacunae in the placenta is thought to be related to the exposure to pulsatile blood flow, high-velocity blood flow from myometrium to lacunae. The presence of placental lacunae in the second trimester scan has been shown to have the highest sensitivity and positive predictive value for placenta accreta [37]. Comstock et al [37] observed lacunae in a majority of placenta accreta patients in second trimester scans. When lacunae are multiple, large, and irregular, they are highly suggestive of placenta accreta, but placenta accreta can occur in their absence.

In summary, placental lacunae and abnormal color Doppler imaging patterns are the most helpful US markers [14]. Three-dimensional color Doppler has been reported to aid in diagnosis and showed "numerous coherent vessels" involving the placental base was found to be 97% sensitive and 92% specific [45].

Variant 2: High risk for placenta accreta spectrum disorder. Initial Imaging.
D. US Pregnant Uterus Transabdominal

In conjunction with the identification of clinical risk factors, US is the primary antenatal modality used for diagnosis of PASD. Typically, screening is performed at the second trimester anatomy scan at 18 to 22 weeks [10]. A high-frequency (5–9 MHz) linear probe can be used if body habitus allows, permitting a focused evaluation of the uterine and placental morphology. The retroplacental clear zone should be assessed without excessive probe pressure to prevent artefactual loss of retroplacental clear zone. The bladder must be at least moderately full (200–300 mL) to better identify and evaluate lower uterine segment and presumed area of cesarean section delivery scar. An empty bladder prevents appropriate evaluation for bladder wall interruption, placental bulge, and uterovesical hypervascularity [11].

On grayscale transabdominal US, the imaging findings that suggest placenta accreta include the presence of intraplacental lacunae (sonolucent spaces that can have slow-moving to more suspicious turbulent moving flow, also called intraplacental lakes), loss of the normal hypoechoic

retroplacental zone or clear space, reduced myometrial thickness of <1 cm, placental bulging (ballooning of the uterus containing placenta from its expected plane into surrounding tissue, usually into the urinary bladder), and the presence of bladder wall abnormalities. Interruption, thickening, or irregularity of the uterine serosa-bladder line interface has been reported to have high sensitivity and specificity for accreta, more striking as the depth of invasion progresses [2]. Sensitivity of US has been reported to range from 77% to 93%, with positive predictive value of 65% to 93%, and prevalence of 9% to 44% [6,16,37,38,46]. As an isolated finding, loss of the normal retroplacental zone has a reported sensitivity of only 52% and specificity of 57%, with a high false-positive rate of 21% because the normal retroplacental zone may also be absent in normal anterior placentas as well [2,46-48]. Another limitation in the assessment for placental invasion is when the placenta is not low lying. Recognition of a history of prior surgery in these cases may be helpful, as well as meticulous attention to placental morphology and structure.

Variant 2: High risk for placenta accreta spectrum disorder. Initial Imaging.
E. US Pregnant Uterus Transvaginal

Transvaginal US scanning should be used in conjunction with transabdominal US scanning, particularly to evaluate the anterior lower uterine segment myometrium, placenta, and myometrial-placental interface because it can provide more detailed higher-resolution evaluation [15].

Variant 3: Follow-up of placenta accreta spectrum disorder.

Women at high risk for PASD or with a known diagnosis of PASD should undergo a follow-up US to re-evaluate the evolving relationship between placental and umbilical vessel location, internal cervical os, placental edge thickness, internal architecture and morphology, and cervical length. These findings may highlight which patients are at highest risk for developing symptoms and complications and may need closer monitoring for potential earlier delivery.

Variant 3: Follow-up of placenta accreta spectrum disorder.
A. MRI Abdomen and Pelvis (Without and With IV Contrast)

Regarding the use of MRI with IV contrast, there is no evidence to support gadolinium benefits and its ability to improve the delineation of placenta and myometrium because its use in pregnancy remains controversial, and currently there is no clear evidence to support its use for PASD [26,27]. One series using gadolinium contrast compared imaging findings to pathology and reported good accuracy of US, with sensitivity for placenta accreta of 77%, specificity of 96%, but improved accuracy with MRI with corresponding sensitivity of 88% and specificity of 100% [17]. Gadolinium-based contrast agents are considered category C drugs, and use should be considered only if benefits outweigh the risks to the fetus. For example, contrast may be considered as an exception immediately prior to delivery or rare cases and circumstances in which termination is planned [14].

In summary, use of MRI in the diagnosis of this disorder is to be more supportive in the setting of a limited, difficult, or equivocal US study. It also may play a role in defining the distribution of placental invasion and defining uterine vascular territory involved and may help with the decision for intervention. When US and MRI are used together but differ in terms of their findings, the more invasive level of PASD should be used to guide management.

Variant 3: Follow-up of placenta accreta spectrum disorder.
B. MRI Abdomen and Pelvis (Without IV Contrast)

Currently, there is limited evidence to support follow-up MRI if initial diagnosis was clearly established. If follow-up assessment with noncontrast MRI is being considered, there is some

debate and paucity of data regarding a recommended optimal timing for repeat imaging. MRI before 24 weeks is considered suboptimal because of unacceptable accuracy, sensitivity, and positive predictive values [32]. If US findings are suspicious, it is best to wait until after 24 weeks, with the suggested optimal time at 30 to 35 weeks. After 35 weeks, physiologic myometrial thinning is greatest and, at this time, can limit accurate assessment [32]. If US findings prior to 24 weeks are severely abnormal and suggestive of percreta, an earlier MRI could still be considered to confirm the extent of suspected disease in preparedness for counseling patients of their risk for preterm delivery or bleeding and aid with future delivery planning. A follow-up MRI could then be performed in the ideal window to assess for interval change, any progression of depth of invasiveness, and help with surgical decisions at the time of delivery. D'Antonio et al [49] suggest serial follow-up scans in the third trimester starting at 28 weeks of gestation to accurately predict the extent of the invaded area and to plan for the best surgical approach. However, there are little data specially evaluating the ideal timing for MRI.

Variant 3: Follow-up of placenta accreta spectrum disorder.
C. US Duplex Doppler Pregnant Uterus

Duplex Doppler imaging should be performed whenever possible. The addition of Doppler imaging can improve detection and evaluation of progression if previously noted of the presence of increased placental vascular flow, subplacental vascularity, and vascularity at the bladder uterine-serosal interface, with vessels seen crossing or bridging from placenta to bladder as mentioned above [14]. Three-dimensional color Doppler has been reported to aid in diagnosis and showed "numerous coherent vessels" involving the placental base that were found to be 97% sensitive and 92% specific [45]. Placental lacunae and abnormal color Doppler imaging patterns are the most helpful US markers [14].

Variant 3: Follow-up of placenta accreta spectrum disorder.
D. US Pregnant Uterus Transabdominal

As per the Society for Maternal-Fetal Medicine recommendations, all women with placenta previa overlaying a uterine scar or "low-lying" over the uterine scar early in pregnancy should have an early third trimester follow-up at 28 to 32 weeks [5]. Asymptomatic patients with placenta previa may undergo weekly or biweekly US cervical length and placental edge thickness measurements in order to predict antepartum bleeding and need for early cesarean delivery [10]. Likewise, follow-up US imaging for PASD is useful to assess for interval change and possible progression of the depth of invasion, as well as to help guide decisions regarding patient management on the optimal time and type of delivery. However, there are little data establishing an optimum timing for follow-up US imaging. The imaging will be driven by patient symptoms, such as vaginal bleeding, as well as by delivery planning.

Variant 3: Follow-up of placenta accreta spectrum disorder.
E. US Pregnant Uterus Transvaginal

Transvaginal US should accompany transabdominal US whenever possible. If placenta is located near lower uterine segment, a high-resolution transvaginal US scan provides a more detailed evaluation of placental myometrial and bladder interface and areas of potential invasion. If placenta is distant from lower uterine segment, transvaginal US is unlikely to be of any additional benefit [15].

Summary of Recommendations

- **Variant 1:** US pregnant uterus transabdominal is usually appropriate for the initial imaging of PASD in low-risk patients with no known clinical risk factors.
- **Variant 2:** US duplex Doppler pregnant uterus, US pregnant uterus transabdominal, and US pregnant uterus transvaginal are usually appropriate for the initial imaging of PASD in high-risk patients. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).
- **Variant 3:** US duplex Doppler pregnant uterus, US pregnant uterus transabdominal, and US pregnant uterus transvaginal are usually appropriate for the follow up imaging of patients with PASD. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

· ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI)
· ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation
· ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound
· ACR Manual on Contrast Media
· ACR Manual on MR Safety

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit

		ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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