

ACR Appropriateness Criteria[®]

Multiple Gestations: 2024 Update

Expert Panel on GYN and OB Imaging: *Priyanka Jha, MD^a, Vickie A. Feldstein, MD^b, Liina Poder, MD^c, Loretta M. Strachowski, MD^d, Dorothy I. Bulas, MD^e, Ingrid Burger, MD, PhD^f, Sherelle L. Laifer-Narin, MD^g, Edward R. Oliver, MD, PhD^h, Eileen Y. Wang, MDⁱ, Carolyn M. Zelop, MD^j, Stella K. Kang, MD, MS^k*

Abstract

The incidence of twin pregnancies has been rising, largely attributable to increasing use of artificial reproductive techniques. Ultrasound plays a critical role in establishing the chorionicity and amnionity of multiple gestations, a key predictor of the expected risk and complications, along with guiding future clinical and imaging follow-up examinations and intervals. People carrying multiple gestations will typically undergo more ultrasound examinations (and occasionally fetal MRI) than those carrying singletons, at minimum including a first trimester dating scan, nuchal translucency scan at 11 to 14 weeks, an anatomy scan at 18 to 22 weeks, and other scans in the second and third trimesters for growth and surveillance. This document clarifies the most appropriate imaging guidelines for multiple

^aStanford University School of Medicine, Stanford, California.

^bUniversity of California San Francisco, San Francisco, California.

^cPanel Chair, University of California San Francisco, San Francisco, California.

^dPanel Vice-Chair, University of California San Francisco, San Francisco, California.

^eChildren's National Hospital and George Washington University, Washington, District of Columbia.

^fKaiser Permanente, Los Angeles, California.

^gColumbia University Medical Center, NY Presbyterian Hospital, New York, New York.

^hChildren's Hospital of Philadelphia and Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania.

ⁱHospital of the University of Pennsylvania, Philadelphia, Pennsylvania; American College of Obstetricians and Gynecologists.

^jValley Hospital, Ridgewood, New Jersey and NYU School of Medicine, New York, New York; American College of Obstetricians and Gynecologists.

^kSpecialty Chair, New York University Medical Center, New York, New York.

Corresponding author: Priyanka Jha, MD, 300 Pasteur Dr, Rm S056, Stanford CA, 94305; e-mail: jjhap@stanford.edu.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document. Reprint requests to: publications@acr.org.

Carolyn M. Zelop, MD, reports grants or contracts from AHA/Merck for Moms CVD in pregnancy and interconception care 12 K grant donated to

Valley health system GME research pro; royalties or licenses from royalties for authorship from Uptodate; support for meetings from AHA/Merck for Moms CVD and interconception care health initiative; leadership roles as AHA/Merck for Moms AHA health initiative; as mentioned above, grant money donated to GME research at Valley Health system. Dorothy I. Bulas, MD, reports royalties or licenses from Wolters Kluwer for Up to Date chapters; payments or honoraria from lecture honorarium from Univ of Indiana; leadership roles as World Federation of Pediatric Imaging board, ACR board. Eileen Y. Wang, MD, reports grants or contracts from Materna—pelvic floor device; patents from provisional IP for IUD-related device. Priyanka Jha, MD, reports grants or contracts from SRU Research Grant from Society of Radiologists in Ultrasound; payments or honoraria from Honorarium for speaking from World Class CME, American Institute of Ultrasound in Medicine. Stella K. Kang, MD, MS, reports grants or contracts from NIH/NCI, NIH/NIDCR; royalties or licenses from Wolters Kluwer; payments or honoraria from New York State Radiological Society honorarium for speaking; RSNA for teaching, ARRS for editorial board work; support for meetings from RSNA travel support; leadership roles as ACR incidental findings steering committee Chair. Vickie A. Feldstein, MD, reports payments or honoraria from World Class CME—honorarium for lecture, payment made to me; support for meetings from reimbursement for travel to Society of Radiologists in Ultrasound (SRU) annual meeting. The other authors state that they have no conflict of interest related to the material discussed in this article. Ingrid Burger, MD, PhD, and Liina Poder, MD are partners and all other authors are non-partner/non-partnership track/employee.

The ACR Appropriateness Criteria documents are updated regularly. Please go to the ACR website at www.acr.org/ac to confirm that you are accessing the most current content.

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.

gestations for seven clinical scenarios/variants, which range from initial imaging, follow-up imaging, growth and surveillance for uncomplicated multiple gestations, and those complicated by a known abnormality or discordance between fetuses.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision process support the systematic analysis of the medical literature from peer reviewed journals. Established methodology principles such as Grading of Recommendations Assessment, Development, and Evaluation or GRADE are adapted to evaluate the evidence. The RAND/UCLA Appropriateness Method User Manual provides the methodology to determine the appropriateness of imaging and treatment procedures for specific clinical scenarios. In those instances where peer reviewed literature is lacking or equivocal, experts may be the primary evidentiary source available to formulate a recommendation.

Key Words: Appropriateness Criteria, appropriate use criteria, AUC, dichorionic, Doppler ultrasound, monochorionic, multiple gestations, twin pregnancy, ultrasound

J Am Coll Radiol 2024;21:S413-S432. Copyright © 2024 American College of Radiology

ACR Appropriateness Criteria® Multiple Gestations: 2024 Update. [Variants 1 to 7](#) and [Tables 1 and 2](#).

Variant 1. Known or suspected multiple gestations. Monochorionic or dichorionic. First trimester. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US pregnant uterus transabdominal	Usually Appropriate	O
US pregnant uterus transvaginal	Usually Appropriate	O
US assessment for TTTS	Usually Not Appropriate	O
US cervix transvaginal	Usually Not Appropriate	O
US duplex Doppler fetal middle cerebral artery	Usually Not Appropriate	O
US duplex Doppler fetal umbilical artery	Usually Not Appropriate	O
US echocardiography fetal	Usually Not Appropriate	O
US pregnant uterus biophysical profile	Usually Not Appropriate	O
MRI fetal without and with IV contrast	Usually Not Appropriate	O
MRI fetal without IV contrast	Usually Not Appropriate	O

Variant 2. Multiple gestations. Monochorionic or dichorionic. First trimester ultrasound performed. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
US pregnant uterus transabdominal	Usually Appropriate	O
US pregnant uterus transvaginal	Usually Appropriate	O
US cervix transvaginal	May Be Appropriate	O
US echocardiography fetal	May Be Appropriate	O
US assessment for TTTS	Usually Not Appropriate	O
US duplex Doppler fetal middle cerebral artery	Usually Not Appropriate	O
US duplex Doppler fetal umbilical artery	Usually Not Appropriate	O
US pregnant uterus biophysical profile	Usually Not Appropriate	O
MRI fetal without and with IV contrast	Usually Not Appropriate	O
MRI fetal without IV contrast	Usually Not Appropriate	O

Variant 3. Multiple gestations. Dichorionic twins or multichorionic higher-order multiples. Second trimester anatomy examination. Follow-up imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US cervix transvaginal	Usually Appropriate	0
US echocardiography fetal	Usually Appropriate	0
US pregnant uterus transabdominal	Usually Appropriate	0
US duplex Doppler fetal umbilical artery	May Be Appropriate	0
US pregnant uterus transvaginal	May Be Appropriate	0
US assessment for TTTS	Usually Not Appropriate	0
US duplex Doppler fetal middle cerebral artery	Usually Not Appropriate	0
US pregnant uterus biophysical profile	Usually Not Appropriate	0
MRI fetal without and with IV contrast	Usually Not Appropriate	0
MRI fetal without IV contrast	Usually Not Appropriate	0

Variant 4. Multiple gestations. Monochorionic twins. Second trimester anatomy examination. Follow-up imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US assessment for TTTS	Usually Appropriate	0
US cervix transvaginal	Usually Appropriate	0
US duplex Doppler fetal umbilical artery	Usually Appropriate	0
US echocardiography fetal	Usually Appropriate	0
US pregnant uterus transabdominal	Usually Appropriate	0
US duplex Doppler fetal middle cerebral artery	May Be Appropriate	0
US pregnant uterus transvaginal	May Be Appropriate	0
MRI fetal without IV contrast	May Be Appropriate	0
US pregnant uterus biophysical profile	Usually Not Appropriate	0
MRI fetal without and with IV contrast	Usually Not Appropriate	0

Variant 5. Multiple gestations. Dichorionic twins or multichorionic higher-order multiples. Growth and antepartum surveillance.

Procedure	Appropriateness Category	Relative Radiation Level
US pregnant uterus transabdominal	Usually Appropriate	0
US cervix transvaginal	May Be Appropriate	0
US duplex Doppler fetal middle cerebral artery	May Be Appropriate	0
US duplex Doppler fetal umbilical artery	May Be Appropriate	0
US echocardiography fetal	May Be Appropriate	0
US pregnant uterus biophysical profile	May Be Appropriate	0
US pregnant uterus transvaginal	May Be Appropriate	0
US assessment for TTTS	Usually Not Appropriate	0
MRI fetal without and with IV contrast	Usually Not Appropriate	0
MRI fetal without IV contrast	Usually Not Appropriate	0

Variant 6. Multiple gestations. Monochorionic twins. Growth and antepartum surveillance.

Procedure	Appropriateness Category	Relative Radiation Level
US assessment for TTTS	Usually Appropriate	O
US duplex Doppler fetal middle cerebral artery	Usually Appropriate	O
US duplex Doppler fetal umbilical artery	Usually Appropriate	O
US pregnant uterus transabdominal	Usually Appropriate	O
US cervix transvaginal	May Be Appropriate	O
US echocardiography fetal	May Be Appropriate	O
US pregnant uterus biophysical profile	May Be Appropriate	O
US pregnant uterus transvaginal	May Be Appropriate	O
MRI fetal without IV contrast	May Be Appropriate	O
MRI fetal without and with IV contrast	Usually Not Appropriate	O

Variant 7. Multiple gestations. Dichorionic or multichorionic higher-order multiples or monochorionic gestations. Known abnormality or discordance between fetuses (fluid, size, weight). Growth and antepartum surveillance.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler fetal middle cerebral artery	Usually Appropriate	O
US duplex Doppler fetal umbilical artery	Usually Appropriate	O
US pregnant uterus biophysical profile	Usually Appropriate	O
US pregnant uterus transabdominal	Usually Appropriate	O
US assessment for TTTS	May Be Appropriate	O
US cervix transvaginal	May Be Appropriate	O
US echocardiography fetal	May Be Appropriate	O
US pregnant uterus transvaginal	May Be Appropriate	O
MRI fetal without IV contrast	May Be Appropriate	O
MRI fetal without and with IV contrast	Usually Not Appropriate	O

Table 1. 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.

Table 2. Relative radiation level designations

RRL	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
0	0	0
⊕	<0.1	<0.03
⊕⊕	0.1-1	0.03-0.3
⊕⊕⊕	1-10	0.3-3
⊕⊕⊕⊕	10-30	3-10
⊕⊕⊕⊕⊕	30-100	10-30

Note: Relative radiation level (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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “varies.”

SUMMARY OF LITERATURE REVIEW

Introduction/Background

The incidence of twin pregnancies has been rising, largely attributable to the increasing use of artificial reproductive techniques [1]. Compared with singletons, twin pregnancies carry a higher risk of complications [2]. These include maternal hypertensive disorders, growth disturbances, preterm labor, premature rupture of membranes, and other conditions, some of which are unique to monochorionic (MC) twins such as twin-twin transfusion syndrome (TTTS) [3-5]. Compared with singletons, twins face an approximately 5-fold increase in fetal death and a 7-fold increase in neonatal death, primarily due to complications of prematurity [2]. Multiple gestations are also at a higher risk for congenital anomalies, placenta previa, and vasa previa. Importantly, chorionicity determines the prognosis of multiple gestations [2].

Twin pregnancies may be monozygotic or dizygotic [5]. Dizygotic twins result in dichorionic (DC) pregnancies. Depending upon the timing of separation after fertilization, monozygotic twins may be DC diamniotic (1-3 days), MC diamniotic (4-8 days), or MC monoamniotic (MA) (8-13 days). Rarely, later splitting (>13 days) results in conjoined twins [5]. Although MC twins represent 20% of twin pregnancies, they account for 30% of all-cause complications [5]. Among multiple pregnancies, the stillbirth rate, neonatal mortality rate, and frequency of structural anomalies affecting 1 fetus are significantly higher in MC than DC twins [6,7]. Careful assessment and monitoring of multiple gestations, particularly MC pregnancies, is warranted. MC diamniotic pregnancies have an overall mortality rate of approximately 10%, primarily related to TTTS and discordant fetal anomalies [3,5,8,9]. In TTTS, there is net flow via arterio-venous connections in the shared placenta from the donor twin (with oligohydramnios) to the recipient twin (with polyhydramnios) [9]. Twin anemia-polycythemia syndrome (TAPS) occurs spontaneously in approximately 5% of MC diamniotic twins [3,9]. Twin reversed arterial

perfusion (TRAP) sequence is a rare complication of MC twinning, in which a “pump” fetus perfuses an anomalous acardiac mass [9]. Approximately 1% of monozygotic twin pregnancies are MC MA [10]. These pregnancies undergo preterm cesarean delivery to avoid cord compromise and fetal demise. Studies have shown survival rates of >90% in MC MA twins with early diagnosis, serial sonograms, and antenatal surveillance [9-12].

People carrying twin or higher-order multiple pregnancies will typically undergo more ultrasound (US) examinations than those carrying singletons [9]. Most will, at minimum, undergo a first trimester dating scan, a nuchal translucency (NT) scan at 11 to 14 weeks, an anatomy scan at 18 to 22 weeks, and 1 or more scans in the third trimester to assess growth. MC pregnancies undergo more frequent follow-up, influenced by the presence of complications and institutional practice [2,9,13]. Some of these high-risk pregnancies will be candidates for fetal intervention.

Special Imaging Considerations

First trimester fetal anatomy evaluation and fetal echocardiography are available at many institutions [14-16]. Advancement of US technology has allowed improved imaging at earlier gestational ages making this feasible. Indications for detailed first trimester obstetric US were summarized by American Institute of Ultrasound in Medicine (AIUM) and endorsed by other key societies, with relevant International Classification of Diseases, 10th Revision (ICD-10) codes provided [15,16].

Fetal Doppler can include umbilical artery (UA), middle cerebral artery (MCA), and ductus venosus. At some institutions, all 3 are performed together as an obstetric Doppler evaluation. Ductus venosus evaluation is performed as a part of fetal echocardiography evaluation.

Fetal imaging with MRI is being increasingly used for pregnancies complicated by congenital anomalies or complications related to MC gestations [17,18]. Both neurologic and nonneurologic indications exist for fetal imaging. In

MC twins, fetal MRI is helpful for assessing intracranial injury that may occur following spontaneous single fetal demise or after an in utero intervention such as laser ablation of intertwin vascular connections [18,19].

Details on risk to the fetus, guidelines on screening for pregnancy, minimizing radiation exposure, and risk assessment can be found in the ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation [20]. Gadolinium contrast is a relatively contraindicated in pregnancy, which is discussed in detail in the ACR Manual on Contrast Media [21] and the ACR Gadolinium Pregnancy Screening Statement [22]. Most importantly, there are currently no established indications for using gadolinium for MRI evaluation of twin pregnancy or fetal conditions, in general.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)
- OR
- There are complementary procedures (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).

DISCUSSION OF PROCEDURES BY VARIANT

The variants discussed are presented in approximate order of gestational age. This discussion is almost entirely focused on twin pregnancies because twins represent 98% of multiple gestations, and the vast majority of data relate to twins. It is recognized that higher risks occur in the setting of triplets and higher-order multiples [23].

Variant 1: Known or suspected multiple gestations. Monochorionic or dichorionic. First trimester. Initial imaging

In this variant, the patient is clinically known or suspected to be pregnant with twins or higher-order multiples. Multiple gestation pregnancies are most often detected in the first trimester. Sometimes a point-of-care US may have been performed. At the time of this evaluation, the most important assessments include ascertaining the location of the pregnancy, identifying the number of gestational sacs, and determining the chorionicity and amnionicity [24]. An NT sonogram performed between 11 and 14 weeks has

been incorporated into many practices. If not previously imagined, multiple gestations can sometimes be detected on that examination.

MRI Fetal Without and With IV Contrast. Fetal MRI without and with intravenous (IV) contrast is not useful as an initial imaging modality for the evaluation of known or suspected multiple gestations. Gadolinium contrast administration is avoided during pregnancy and is used only in exceptional circumstances. There is no relevant literature regarding the use of fetal MRI without and with IV contrast in these patients. Sometimes a gestational sac may be identified incidentally during imaging for other reasons. These patients are usually referred to US for further evaluation.

MRI Fetal Without IV Contrast. Fetal MRI without IV contrast is not useful as an initial imaging modality for the evaluation of known or suspected multiple gestations. There is no relevant literature regarding the use of fetal MRI without IV contrast in these patients. Sometimes a gestational sac may be identified incidentally during imaging for other reasons. These patients are usually referred to US for further evaluation.

US Assessment for TTTS. Complications affecting MC twins such as TTTS and other conditions related to a single shared placenta usually develop after 14 weeks and do not occur in the first trimester [9]. Hence, US assessment for TTTS is not useful in the first trimester [9]. However, embryonic crown-rump length (CRL) measurements are performed during transabdominal and transvaginal imaging of the pregnant uterus. If there is an intertwin discrepancy in CRL or NT measurements, this may be an early marker for TTTS [9].

US Cervix Transvaginal. Transvaginal US (TVUS) of the cervix can be performed to confirm that the cervix is closed and is done along with TVUS of the pregnant uterus. An open cervix indicates a high risk for miscarriage. Cervical length measurement is not recommended in the first trimester. In studies specifically evaluating twin pregnancies, routine TVUS assessment of cervical length in the first trimester (as a component of standard management of low-risk twins) has not been shown to predict preterm labor or to be associated with improved outcomes [25,26]. In an asymptomatic and low-risk twin population, a single transvaginal cervical length between 16 and 20 weeks was not predictive of spontaneous preterm birth before 34 weeks, and hence cervical length measurement in the first trimester is of limited value [25,26].

US Duplex Doppler Fetal Middle Cerebral Artery. US Doppler of the fetal MCA is not useful as an initial imaging

modality for the evaluation of known or suspected multiple gestations. Fetal organogenesis is usually completed by 11 to 12 weeks, at which time identifiable fetal anatomic parts have developed. Until organogenesis completion around 12 weeks, a separate fetal MCA is not identifiable, and hence fetal MCA Doppler cannot be performed. Hence, this examination is not useful in the first trimester.

US Duplex Doppler Fetal Umbilical Artery. US duplex Doppler of the fetal UA is not useful as an initial imaging modality for the evaluation of known or suspected multiple gestations [9]. In the early first trimester, an identifiable UA cannot reliably be assessed. An identifiable UA is present in the late first trimester; however, there is still no role for UA assessment in the first trimester [9].

US Echocardiography Fetal. US echocardiography has no role in the initial imaging in the first trimester [9].

US Pregnant Uterus Biophysical Profile. Biophysical profile (BPP) is performed in the second and third trimesters, and there is no role for this in the first trimester.

US Pregnant Uterus Transabdominal. In the first trimester, the main goal of imaging is to confirm the presence and location of the gestational sacs, determine chorionicity and amnionicity, provide pregnancy dating, and document embryonic or fetal cardiac activity [9]. This is accomplished using transabdominal and TVUS. Once the in utero location of the gestational sac(s) is confirmed, recognition of possible multiple pregnancy is made and gestational age is determined [9]. Gestational age assessment is most accurate at the first US imaging and can be done using mean sac diameter or CRL measurements. In multiple gestations, all attempts should be made to establish the chorionicity and amnionicity at the earliest imaging encounter [9]. TVUS has the highest accuracy for this assessment. In a DC diamniotic gestation, 2 separate gestation sacs each with surrounding echogenic chorionic reactions are identified. A single gestation sac with peripheral chorionic reaction is seen with MC multiple gestations. The presence of thin intertwin membrane corresponds to diamniotic pregnancy. Very early on, the amnion may not yet have formed or be visible. Thus, lack of identification of an intertwin membrane does not necessarily indicate monoamnionicity. The intertwin membrane is typically identified by 10 weeks on TVUS. Although it has been suggested that the number of yolk sacs can be used as an indicator for assessing amnionicity, this determination can sometimes be erroneous [27]. Hence, attempt should be made to demonstrate a thin intertwin membrane as an indication of diamniotic pregnancy, which can more often be achieved by TVUS imaging or at the next US examination [9,27].

After 10 weeks, other sonographic features that may be helpful for determining chorionicity include the number of placentas, a “lambda” or “twin peak” sign (seen in DC gestations, as opposed to the “T” sign seen in MC gestations), and, to a lesser degree, the thickness of the dividing membrane [9,24,28]. At the 11 to 14 weeks’ scan, chorionicity was correctly assigned by US in 612 of 613 pregnancies, for an accuracy of 99.8% [28]. It is important to use a combination of features to most accurately determine chorionicity.

Authors have reported significant correlation between intertwin CRL discrepancy and outcomes including birth weight discordance, small for gestational age birth weight, preterm delivery, chromosomal abnormalities, structural anomalies, and spontaneous fetal loss [29-32]. Severe CRL discordance (>16%) can be associated with higher rates of structural anomalies, stillbirth, birth weight discordance, and small newborns [31,33]. In 1 study, DC twins with CRL discordance $\geq 10\%$ were associated with preterm delivery before 34 weeks’ gestation, birth weight discordance, and overall smaller mean birth weight [29]. In MC twin pregnancies, there was an association between CRL discordance $\geq 10\%$ and birth weight discordance and mean birth weight [29]. Some studies have noted significant correlation between CRL discrepancy and birth weight discordance in spontaneously conceived MC pregnancies but not in pregnancies resulting from in vitro fertilization. This may be related to the small proportion of in vitro fertilization pregnancies in this cohort [30]. Intertwin discordance in CRL $\geq 10\%$ has been shown to be significantly associated with pregnancy loss [34,35], which highlights the importance of measuring CRL and noting intertwin discrepancy in CRLs in the first trimester.

US Pregnant Uterus Transvaginal. In addition to transabdominal US of the pregnant uterus, TVUS can be performed, especially earlier in gestation, to confirm the number of sacs, to assess chorionicity and amnionicity [24]. When an intertwin membrane is not seen transabdominally, TVUS can be attempted because of superior resolution [9].

Variant 2: Multiple gestations. Monochorionic or dichorionic. First trimester ultrasound performed. Next imaging study

In this variant, the patient is known to be carrying a multiple gestation pregnancy and is in the first trimester. The chorionicity has likely been established at a prior US. Often, the amnionicity has also been identified; however, in some cases, definitive confirmation of amnionicity needs to be done. This can be achieved by demonstrating the intertwin membrane at the next imaging study. NT US measurements and first trimester anatomy screening evaluation can be

performed at the next imaging study [9,14]. NT measurements for twins are specific screening unique to each twin, whereas cell-free DNA testing techniques cannot separate the genetic information specific to each twin. Documentation of the presence of embryonic cardiac motion and assessment of complications such as early pregnancy failure or subchorionic hemorrhage can also occur.

MRI Fetal Without and With IV Contrast. Fetal MRI without and with IV contrast is not useful as a next imaging study for the evaluation of known or suspected multiple gestations. There is no relevant literature regarding the use of fetal MRI without and with IV contrast for evaluation of patients with multiple gestations in the first trimester.

MRI Fetal Without IV Contrast. Fetal MRI without IV contrast is not useful as a next imaging study for the evaluation of known or suspected multiple gestations. There is no relevant literature regarding the use of fetal MRI without IV contrast for the evaluation of patients with multiple gestations in the first trimester.

US Assessment for TTTS. Pathologic conditions afflicting MC gestations such as TTTS and other complications related to the shared placenta usually develop after 16 weeks and do not occur in the first trimester. Hence, US assessment for TTTS is not useful in the first trimester [9]. Discrepant embryonic CRL measurements noted during transabdominal or transvaginal imaging of the pregnant uterus may be an early marker for TTTS [33]. Early referral to a specialist is encouraged if there is CRL discrepancy of $\geq 10\%$ or NT discordance $\geq 20\%$. NT discordance $\geq 20\%$ is found in approximately 25% of MC twins, with an associated risk of severe TTTS or early intrauterine fetal demise up to 30% [33,36].

US Cervix Transvaginal. US cervix transvaginal can be performed as the next imaging study to assess the cervix. In studies specifically evaluating low-risk twin pregnancies, routine TVUS assessment of cervical length in the first trimester (as a component of standard management) has not been shown to predict preterm labor or to be associated with improved outcomes [25,26].

US Duplex Doppler Fetal Middle Cerebral Artery. US Doppler of the fetal MCA is not useful as the next imaging study for the evaluation of known or suspected multiple gestations. Early in pregnancy, a discrete fetal MCA is not identifiable, and fetal MCA Doppler cannot be performed. Hence, this examination is not useful in the first trimester [9].

US Duplex Doppler Fetal Umbilical Artery. US Doppler of the fetal UA is not routinely used as the next

imaging study for the evaluation of known or suspected multiple gestations. An identifiable UA is present in the late first trimester [9]. There is no established role for UA assessment at this gestational age, and hence this examination is not indicated in the first trimester.

US Echocardiography Fetal. US echocardiography can be performed in the first trimester between 12 weeks 0 days and 13 weeks 6 days. Indications for detailed first trimester obstetric US and fetal echocardiography were summarized by AIUM and endorsed by other key societies and include both maternal and fetal indications. These include but are not limited to previous fetus or child with a congenital, genetic, or chromosomal anomaly; known or suspected fetal abnormality detected by US in the current pregnancy; and fetus at increased risk for a congenital anomaly based on the following: 35 years of age or older at delivery, maternal pregestational diabetes, pregnancy conceived via in vitro fertilization, multiple gestations, teratogen exposure, enlarged NT, positive screening test results for aneuploidy including cell-free DNA screening and serum only, or combined first trimester screening [15,16].

US Pregnant Uterus Biophysical Profile. BPP is performed in the second and third trimesters, and there is no role for this in the first trimester.

US Pregnant Uterus Transabdominal. In this setting, when a second imaging study is performed in the first trimester, indications include confirming cardiac motion, demonstrating the intertwin membrane (if not previously visualized), and NT measurements [9]. As with initial imaging studies in the first trimester, these are done using transabdominal and TVUS of the pregnant uterus. Some practices perform a detailed first trimester obstetric US between 12 weeks 0 days and 13 weeks 6 days [33]. Indications for detailed first trimester obstetric US and fetal echocardiography were summarized by AIUM and endorsed by other key societies, with relevant ICD-10 codes provided [14-16]. D'Antonio et al [33] demonstrated that first trimester detection of structural abnormalities in twin pregnancies is possible in 27.3% of cases. The anomalies most commonly found included defects of the cranial vault, midline brain, and abdominal wall. Monochorionicity and increasing intertwin discrepancy in CRL and NT measurements were associated with fetal structural abnormalities [33]. Some complications unique to MC twins such as TRAP may become evident at this imaging study in the first trimester [5].

As in singleton pregnancies, increased NT measurements are associated with an increased risk of aneuploidy and structural anomalies; markedly increased NT is associated with a greater risk of subsequent demise [33]. In MC

twin pairs, markedly discordant NT can be a marker for early-onset TTTS [37]. However, normal fetal anatomy and karyotype were the most common outcomes among MC diamniotic twins with discordant NTs [38]. Some studies of MC diamniotic twins have shown that NT discordance is more predictive of adverse fetal outcomes than CRL discordance [39]. Others, including Allaf et al [40], found that NT and CRL discordances were not predictive of overall adverse outcomes in MC diamniotic twin pregnancies, although this varies with the severity of discordance. Both parameters (NT and CRL discrepancy) had high negative predictive value; thus, the absence of discordance is reassuring [39].

US Pregnant Uterus Transvaginal. As with transabdominal US of the pregnant uterus, a next TVUS study in the first trimester can be performed for confirming cardiac motion, demonstrating the intertwin membrane (if not previously visualized) and NT measurements. TVUS imaging is routinely performed in some institutions or can be done as needed, when the transabdominal evaluation is considered incomplete or suboptimal. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

Variant 3: Multiple gestations. Dichorionic twins or multichorionic higher-order multiples. Second trimester anatomy examination. Follow-up imaging

In this variant, the patient is known to be pregnant with DC twins or multichorionic higher-order multiples. The twins have been demonstrated to each have their own placenta. Per American College of Obstetricians and Gynecologists recommendations, a fetal anatomy scan should be performed at 18 to 22 weeks' gestation [41]. A list of necessary views (including fetal anatomy, placenta, amniotic fluid assessment, and cervix) to be obtained at this evaluation has been supported by multiple societies [41]. Complications faced by MC twins related to the shared placenta do not affect DC twins or multichorionic higher-order multiples. Multiple gestation pregnancies are at an increased risk for premature delivery. If there are concerns regarding fetal growth or clinical suspicion for fetal anemia, appropriate Doppler evaluation can be performed [42].

MRI Fetal Without and With IV Contrast. MRI fetal without and with IV contrast does not have a role in the second trimester anatomy evaluation. Gadolinium contrast is usually not administered for fetal indications.

MRI Fetal Without IV Contrast. MRI fetal without IV contrast does not have a role in the initial second trimester anatomy evaluation. MRI fetal without IV contrast can be

considered for multiple gestations if an abnormality is noted in the second trimester anatomy US. It can also be considered when maternal factors, such as soft tissue attenuation, limit sonographic evaluation of the fetus. In all cases, anatomy evaluation with MRI without IV contrast is performed after an US examination has been performed.

US Assessment for TTTS. With very rare exceptions, DC twins with separate placentas do not develop TTTS or other complications associated with placental sharing and vascular connections. Hence, US assessment for TTTS is not useful for DC or multichorionic twins.

US Cervix Transvaginal. Cervix evaluation at second trimester US is done to measure cervical length and to detect placenta previa or vasa previa. Cervical pathology, such as myoma, that may inform decision making regarding mode of delivery should be assessed. In twin pregnancies, cervical length measuring <1.5 cm in the gestational age period of 15 weeks to 24 weeks and 6 days has been shown to be predictive of preterm labor, regardless of clinical management strategies [43]. The Society for Maternal-Fetal Medicine recommends that routine transvaginal cervical length screening not be performed for patients with multiple gestations after 25 to 26 weeks' gestational age [44].

US Duplex Doppler Fetal Middle Cerebral Artery. US duplex Doppler fetal MCA is not useful for complications of multiple pregnancies at the second trimester anatomy scan. If there is a risk for fetal anemia or if hydrops is noted during evaluation, fetal MCA Doppler can be performed and interpreted using established nomograms [45].

US Duplex Doppler Fetal Umbilical Artery. US duplex Doppler fetal UA is not useful for complications of multiple pregnancies at the second trimester anatomy scan. However, if growth restriction is noted during evaluation, fetal UA Doppler can be performed.

US Echocardiography Fetal. Multiple gestations are at higher risk for cardiac defects, and echocardiography is very useful in the second trimester. This is particularly relevant for DC twin pregnancies conceived using assisted reproductive technologies because these groups are at increased risk of congenital heart disease [46].

US Pregnant Uterus Biophysical Profile. BPP is performed in late second and third trimesters, and there is no role in the first trimester. There is no role for BPP at the time of second trimester anatomy scan.

US Pregnant Uterus Transabdominal. As pregnancy advances into the second trimester, transabdominal US of the pregnant uterus becomes the mainstay for evaluation. A fetal anatomy scan is recommended at 18 to 22 weeks'

gestation to evaluate for congenital malformations [41]. Society guidelines include a detailed list of views to be obtained at the time of this evaluation [41]. The estimated fetal weight should be calculated and documented at each scan from 20 weeks onward. Vasa previa and velamentous cord insertion are more common in multiple gestations. These conditions are associated with adverse pregnancy outcome, and dedicated evaluation is warranted at this point in pregnancy [47].

If chorionicity and amnionicity have not been determined, attention should be paid at the second trimester anatomy examination. In general, demonstration of 2 separate placental masses helps establish dichorionicity [5]. By the second trimester, there may be thinning of the intertwin membrane, loss of the “lambda” sign, and apparent fusion of adjacent placentas. Thus, reliable determination of chorionicity of a twin pregnancy may be difficult. Detection of discordant external genitalia (1 male and 1 female) would indicate dizygotic, and therefore DC, gestation [5]. The assessment of chorionicity by first trimester US when other reliable signs can be observed is crucial. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

US Pregnant Uterus Transvaginal. Transvaginal examination of the pregnant uterus and cervix can be performed as an adjunct for limited transabdominal fetal evaluation. Additional indications include assessment of the cervix and placenta and detection of vasa previa. Typically, TVUS imaging is performed only if transabdominal evaluation is considered suboptimal or incomplete and never as the only approach for second trimester anatomy evaluation. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

Variant 4: Multiple gestations. Monochorionic twins. Second trimester anatomy examination. Follow-up imaging

In this variant, the patient is known to be pregnant with MC multiple gestations. The fetuses have been demonstrated to have a shared placenta. As with DC gestation, per American College of Obstetricians and Gynecologists recommendations, a fetal anatomy scan should be performed at 18 to 22 weeks’ gestation [9,41]. A major structural anomaly affecting only 1 fetus is present in approximately 1 in 15 MC diamniotic twin pregnancies and 1 in 6 MA twin pregnancies [6]. The risk of congenital anomalies appears to be higher for monozygotic twins that separate later, with conjoined twins representing the most extreme example [5].

Additionally, MC twins may develop various complications related to the shared placenta. These complications include TTTS, TRAP, TAPS, and selective fetal growth restriction (sFGR) [9]. Many of these complications can appear as early as late first trimester and early second trimester, and hence, it is recommended that imaging surveillance of MC twins be performed starting at 16 weeks’ gestation, occurring at least every 2 weeks, and more frequently as clinically appropriate [9,12,17].

MRI Fetal Without and With IV Contrast. MRI fetal without and with IV contrast does not have a role in the second trimester anatomy evaluation. Gadolinium contrast is usually not administered for fetal indications.

MRI Fetal Without IV Contrast. MRI fetal without IV contrast does not have a role in the second trimester anatomy evaluation. MRI fetal without IV contrast can be considered for the next imaging after an abnormality is noted on the second trimester anatomy sonogram. It can also be considered when maternal factors such as soft tissue attenuation limit evaluation of the fetus on US. In all cases, anatomy evaluation with MRI without IV contrast is performed after an US has previously been done.

US Assessment for TTTS. US assessment for TTTS in MC twins begins at 16 weeks’ gestation with surveillance imaging evaluating amniotic fluid and urinary bladder performed every 2 weeks [9,12]. This evaluation need be performed at the time of anatomy scan with special attention to amniotic fluid pockets and intertwin discrepancy in fluid, presence of fluid-filled urinary bladder, pleural effusions, ascites or frank hydrops, placental cord insertions, and UA Doppler evaluation [9].

US Cervix Transvaginal. Cervix evaluation at second trimester US is essential for assessing cervical length, vasa previa, and placenta previa. Any cervix pathology, such as a myoma or other masses, that may preclude vaginal delivery should also be assessed. A baseline cervical length assessment can be performed using TVUS. In twin pregnancies, cervical length measuring <1.5 cm in the gestational age period of 15 weeks to 24 weeks and 6 days has been shown to be predictive of preterm labor, regardless of clinical management strategies [43]. The Society for Maternal-Fetal Medicine recommends that routine transvaginal cervical length screening not be performed for patients with multiple gestations after 25 to 26 weeks’ gestational age [44].

MC diamniotic twin pregnancies had a higher rate of spontaneous preterm birth than gestational age-matched DC diamniotic pregnancies. In a study by Roman et al [48], for any given cervical length measured between 18 and 23 gestational weeks, gestational age at delivery for MC diamniotic pregnancies was approximately 2 weeks earlier

compared with DC pregnancies. Overall, the mean transvaginal cervix length was significantly lower in the MC diamniotic group (32.8 ± 10.1) compared with the DC group (34.9 ± 8.6) (mean diameter 2.10 mm, 95% confidence interval [CI], -3.91 to -0.29). Transvaginal cervix length measurement <30 mm was calculated to have an incidence of 16.6% (29/175) in the MC group and 11.9% (48/405) in the DC group (adjusted odds ratio 1.48, 95% CI, 1.03-2.43). MC diamniotic twin pregnancy had a significantly higher incidence of spontaneous preterm birth (53.1%) compared with 44.9% for DC pregnancy.

Historically, reports suggested measuring cervical length at each visit to triage for risk of preterm labor. However, more recent literature has questioned the significance and usefulness of this practice because of a lack of proven effective interventions. In twin pregnancies, cervical length measuring <1.5 cm has been shown to be predictive of preterm labor, regardless of management strategies [43].

Vasa previa and velamentous cord insertion are more commonly present in MC multiple gestations. Both of these conditions are associated with adverse pregnancy outcome and deserve dedicated evaluation at this point in pregnancy [47]. There is also a higher frequency of vasa previa when velamentous cord insertion is found; if overlooked, this may result in acute fetal hemorrhage, distress, and potential demise at the time of delivery. For this reason, examiners should be aware of the possibility of vasa previa, especially in MC pregnancies [49].

US Duplex Doppler Fetal Middle Cerebral Artery. Fetal MCA Doppler assessment is performed to detect the presence of TAPS [3,20,50,51]. In contrast to evaluation for TTTS, there are no clear established guidelines addressing whether evaluation for TAPS should be part of routine second trimester anatomy evaluation. This may be optionally considered on a case-by-case basis, for example, when imaging signs of TTTS are present [9]. Some authors are advocating for routine antenatal screening for TAPS in MC gestations [50].

US Duplex Doppler Fetal Umbilical Artery. US duplex Doppler fetal UA is essential for second trimester evaluation of MC twins and should be performed at the time of anatomy evaluation [9]. This is helpful for the staging of TTTS, TAPS, and growth discordant twins.

US Echocardiography Fetal. Multiple gestations are at higher risk for cardiac defects, and an echocardiogram is recommended in the second trimester. The risk of cardiac anomalies has been reported to be 2% in uncomplicated MC twins and 5% in cases of TTTS, particularly among recipient twins [52,53]. The risk of a structural congenital cardiac anomaly in at least 1 of an MC MA twin pair is 8

times that of a MC diamniotic twin pair [9]. In addition, if 1 MC twin is affected, the risk of the co-twin having a cardiac anomaly is higher. For these reasons, fetal echocardiography should be considered in MC gestations [9].

US Pregnant Uterus Biophysical Profile. BPP is performed in late second and third trimesters. There is no role for BPP at the time of second trimester anatomy scan.

US Pregnant Uterus Transabdominal. As with DC and multichorionic gestations, transabdominal US of the pregnant uterus is the mainstay for evaluation in the second trimester. A fetal anatomy scan is recommended at 18 to 22 weeks' gestation to evaluate for any congenital malformations [9,41]. Sonographic surveillance of MC twins usually starts at 16 weeks and may undergo preliminary assessment at this time [9]. An anatomy scan at 18 to 22 weeks is still indicated and mostly required for complete evaluation. Society guidelines include lists of views to be obtained at the time of this evaluation [41]. The estimated fetal weight discrepancy should be calculated and documented at each scan [9].

Placental cord insertion of each twin should be documented in the second trimester. Marginal or velamentous cord insertion are common among MC pregnancies, with velamentous cord insertion present in up to 22% of MC twins [54]. Velamentous cord insertion in MC twins increases the risk of adverse outcome, including small for gestational age and sFGR, lower gestational age at birth, and intrauterine fetal demise [55]. There is also a higher frequency of vasa previa when a velamentous cord insertion is found, especially in MC pregnancies [49]. Velamentous cord insertion in 1 or both twins is associated with increased risk of TTTS, and the risk of discordant growth is determined by both discordance in insertion sites and velamentous cord insertion in 1 twin [56,57]. In a study by Saito et al [57], 27% of twin pairs with abnormal cord insertions (defined as twin pair with velamentous cord insertions and/or marginal cord insertion in 1 or both twins) developed TTTS compared with 7% of twin pairs with normal cord insertions in both.

If an MC gestation is complicated by TRAP sequence, the volume of the TRAP fetus should be measured because this is used to assess eligibility for intervention [58]. When the estimated weight of the perfused acardiac TRAP mass measures $\geq 50\%$ of the weight of the structurally normal "pump" twin, fetal intervention is indicated [58].

If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

US Pregnant Uterus Transvaginal. Transvaginal examination of the pregnant uterus and cervix can be performed

as an adjunct for limited transabdominal fetal evaluation. Additional indications include assessment of the cervix and placenta and detection of vasa previa. Typically, transvaginal imaging is performed only if transabdominal evaluation is considered suboptimal or incomplete and never as the only approach for second trimester anatomy evaluation. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

Variant 5: Multiple gestations. Dichorionic twins or multichorionic higher-order multiples. Growth and antepartum surveillance

In this variant, the patient is known to be pregnant with uncomplicated multiple gestations, which may be DC or multichorionic higher-order multiples. It has been demonstrated that each twin has a separate placenta, and no additional abnormalities were detected at the time of second trimester evaluation. Given the higher incidence of growth abnormalities, assessment of fetal size, interval growth, and antepartum surveillance for fetal well-being are indicated. A DC or multichorionic pregnancy without complications is commonly followed every 3 to 4 weeks. If there is discordance in fetal size or amniotic fluid, regardless of chorionicity, closer surveillance may be warranted and Variant 7 applies [12]. Studies have questioned the applicability of singleton weight nomograms to DC pregnancies [59-61]. Some have demonstrated that nearly 40% of twins would be classified as small for gestational age based on singleton growth standards [59]. The comparative asymmetric growth pattern in twin gestations, initially evident at 32 weeks' gestation, is consistent with the concept that the intrauterine environment becomes constrained in its ability to sustain growth in twin fetuses near term [59]. Follow-up of fetuses afflicted by congenital abnormalities can occur more frequently, based on fetal status.

MRI Fetal Without and With IV Contrast. MRI fetal without and with IV contrast does not have a role in growth and antepartum surveillance of DC or multichorionic gestations. Gadolinium contrast is usually not administered for fetal indications.

MRI Fetal Without IV Contrast. MRI fetal without IV contrast does not have a role in growth and antepartum surveillance of DC or multichorionic gestations. It is usually reserved for problem-solving when an anatomic abnormality is identified.

US Assessment for TTTS. DC twins with separate placentas do not develop TTTS or other complications associated with a single shared placenta. Hence, this evaluation

is not useful for growth and antepartum surveillance of DC or multichorionic twins.

US Cervix Transvaginal. US cervix transvaginal evaluation for antepartum surveillance is useful for assessing cervical length, vasa, and placenta previa. Any cervical pathology, such as a myoma or other masses, that may preclude vaginal delivery should also be assessed. Usually, a transabdominal examination is performed first, followed by transvaginal imaging if the initial evaluation is inadequate. Historically, reports suggested measuring cervical length at each visit to triage for risk of preterm labor. However, more recent literature has questioned the significance and usefulness of this practice, recommending against cervical length measurement after 26 weeks. In twin pregnancies, cervical length measuring <1.5 cm has been shown to be predictive of preterm labor, regardless of management strategies [43]. If placenta previa or low-lying placenta has been suggested previously, assessment of the location of placental edge can be performed on surveillance examinations.

US Duplex Doppler Fetal Middle Cerebral Artery. If there is a risk for fetal anemia or if fetal hydrops is noted during evaluation, fetal MCA Doppler can be performed and interpreted using established nomograms. US duplex Doppler fetal MCA is generally not useful for surveillance of uncomplicated DC or multichorionic gestations.

US Duplex Doppler Fetal Umbilical Artery. If growth restriction or amniotic fluid abnormalities (oligohydramnios) are noted during antepartum surveillance, fetal UA Doppler can be performed. US duplex Doppler fetal UA is generally not useful for surveillance of uncomplicated DC or multichorionic gestations.

US Echocardiography Fetal. Echocardiography can be performed for surveillance of DC or multichorionic gestations when cardiac defects or secondary cardiac decompensation is suspected or observed. Uncomplicated DC or multichorionic gestations do not need routine fetal echocardiographic follow-up.

US Pregnant Uterus Biophysical Profile. BPP can be performed in the late second and third trimesters for assessing fetal well-being. To date, there are insufficient data in the literature to suggest that antenatal surveillance of twins with BPP is beneficial in the setting of reactive non-stress test or in the absence of associated risk factors [62,63].

US Pregnant Uterus Transabdominal. Transabdominal US of the pregnant uterus remains the mainstay for the evaluation of DC or multichorionic gestations. At each US scan, the following should be assessed: fetal biometry, amniotic fluid volume, and key features of fetal anatomy. Due to variability and SDs in measurements, growth assessment,

and biometry are usually performed no more frequently than every 2 weeks. It is suggested that the discordance in estimated fetal weights be calculated and documented at each scan. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

US Pregnant Uterus Transvaginal. Transvaginal examination of the pregnant uterus and cervix can be performed as an adjunct for limited transabdominal fetal evaluation. Additional indications include assessment of the cervix and placenta and detection of vasa previa. Typically, transvaginal imaging is performed only if transabdominal evaluation is considered suboptimal or incomplete. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

Variant 6: Multiple gestations. Monochorionic twins. Growth and antepartum surveillance

In this variant, the patient is known to be pregnant with uncomplicated MC multiple gestation. The fetuses have been demonstrated to share a single placenta. Given the higher incidence of growth disturbance, congenital abnormalities, and complications unique to MC twinning, assessment of growth and surveillance for fetal well-being is indicated. In addition to monitoring fetal size and interval growth, ongoing evaluation includes amniotic fluid assessment and the search for possible development of TTTS, TAPS, or sFGR. Typically, surveillance begins at 16 weeks for MC twins, with fetal biometry performed every 2 to 3 weeks [9,12]. Assessment for potential TTTS or other complications of MC twinning is performed every 2 weeks [9,12]. If there is discordance in fetal size or amniotic fluid volume, shorter interval surveillance may be warranted [13].

MRI Fetal Without and With IV Contrast. MRI fetal without and with IV contrast does not have a role in growth and antepartum surveillance of MC gestations. Gadolinium contrast is usually not administered for fetal indications.

MRI Fetal Without IV Contrast. MRI fetal without IV contrast can be useful for antepartum surveillance for a known abnormality. In MC twins, fetal MRI has been used to assess for brain injury that may occur after fetal intervention or following spontaneous in utero demise of a co-twin [17]. This examination is usually not indicated for uncomplicated multiple gestations.

US Assessment for TTTS. US assessment for TTTS is useful for MC twins beginning at 16 weeks' gestation with surveillance imaging performed every 2 weeks [9,12]. Follow-up evaluation is performed with attention to

amniotic fluid measurements, presence of fluid-filled urinary bladder, detection of pleural effusions, ascites or frank hydrops, placental cord insertions, and UA Doppler evaluation [9].

In a study by Kawaguchi et al [13], the incidence of unexpected critical complications in patients with MC diamniotic twin pregnancies was significantly lower in those undergoing weekly US, suggesting that weekly sonographic evaluation for patients with MC diamniotic pregnancy may be more effective for the early detection of impending intrauterine fetal death and/or TTTS.

US Cervix Transvaginal. US cervix transvaginal evaluation for antepartum surveillance is useful for assessing cervical length, vasa, and placenta previa. Any cervical pathology, such as myoma or other masses, that may preclude vaginal delivery should also be assessed. Usually, a transabdominal examination is performed first, followed by transvaginal imaging if the initial evaluation is inadequate. Historically, reports suggested measuring cervical length at each visit to triage for risk of preterm labor. However, more recent literature has questioned the significance and usefulness of this practice, recommending against cervical length measurement after 26 weeks. In twin pregnancies, cervical length measuring <1.5 cm has been shown to be predictive of preterm labor, regardless of management strategies [43]. If placenta previa or low-lying placenta has been suggested previously, assessment of location of placental edge can be performed.

US Duplex Doppler Fetal Middle Cerebral Artery. Fetal MCA Doppler assessment is performed to detect the presence of TAPS [3,50,51]. This can be done at serial surveillance examinations, with US evaluation for TTTS and UA Doppler interrogation, as frequently as indicated by fetal status [9,50].

US Duplex Doppler Fetal Umbilical Artery. US duplex Doppler fetal UA is essential for antepartum surveillance of MC twins. This information is critical for the detection and staging of TTTS and for the evaluation of fetuses diagnosed with sFGR [9,42].

US Echocardiography Fetal. US echocardiography is useful to assess for and stage TTTS and TAPS in complicated MC gestations and to follow-up cardiac defects in the second trimester [9,12]. In MC gestations complicated by TRAP sequence, cardiac evaluation of the "pump" fetus is indicated to assess for signs of cardiac volume overload.

US Pregnant Uterus Biophysical Profile. BPP can be performed in the third trimester to assess fetal well-being. Frequency of BPP can be determined based on the presence of risk factors and impending complications [53,64].

To date, there are insufficient data in the literature to suggest that antenatal surveillance of twins with BPP is beneficial in the setting of reactive nonstress test or in the absence of associated risk factors [62,63].

US Pregnant Uterus Transabdominal. Transabdominal US of the pregnant uterus continues to be the mainstay for the evaluation and surveillance of MC twins. For MC twins, sonographic surveillance usually begins at 16 weeks and is done every 2 weeks thereafter [9,12]. Due to variability and SDs in measurements, growth and biometry is usually performed no more frequently than every 2 weeks. The discordance in estimated fetal weights should be calculated and documented at each scan. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

US Pregnant Uterus Transvaginal. Transvaginal examination of the pregnant uterus and cervix can be performed as an adjunct for limited transabdominal fetal evaluation. Additional indications include assessment of the cervix and placenta and detection of vasa previa. Typically, transvaginal imaging is performed only if transabdominal evaluation is considered suboptimal or incomplete. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

Variant 7: Multiple gestations. Dichorionic or multichorionic higher-order multiples or monochorionic gestations. Known abnormality or discordance between fetuses (fluid, size, weight). Growth and antepartum surveillance

In this variant, multiple gestations of all chorionicity and amnionicity have a known abnormality detected on a previous examination and are receiving surveillance imaging.

MRI Fetal Without and With IV Contrast. MRI fetal without and with IV contrast does not have a role in growth and antepartum surveillance of MC, DC, or multichorionic gestations. Gadolinium contrast is usually not administered for fetal indications.

MRI Fetal Without IV Contrast. MRI fetal without IV contrast can be useful for antepartum surveillance for a known abnormality. In DC and multichorionic twins, this can be indicated for multiple reasons, in particular, to evaluate neurologic, thoracic, and abdominal structural anomalies and associated complications.

In MC twins, fetal MRI has been useful in the assessment of intracranial injury that may occur related to TTTS after fetal intervention or following spontaneous in utero

demise of a co-twin. Cerebral injury can affect approximately 18% of co-twin survivors after single fetal demise in MC twin pregnancies, and follow-up evaluation of these cases can improve detection rate of such damage [65,66]. MRI evaluation of complicated MC multiple gestations can be useful for estimating neurologic injury associated with TTTS, TAPS, sFGR, and fetal interventions [65]. In a study, postnatal follow-up of all survivors shown to have normal fetal MRI demonstrated normal neurologic outcome, but only 1 of 3 survivors with cerebral lesions at fetal MRI demonstrated normal neurologic outcome [65]. Brain injury of the surviving co-twin after single fetal demise in MC pregnancies is usually of ischemic origin and spares the brainstem and cerebellum [67]. Focal brain lesions are more frequent in pregnancies complicated by TTTS or in those in whom an intervention has been performed [67]. Robinson et al [18] showed that MRI provided additional information over a prenatal US in 5 of 33 patients (15%) altering prognosis and patient counseling. Additional findings on MRI included occipital lobe infarction, hemispheric injury, dural sinus thrombosis, polymicrogyria, and intraventricular hemorrhage. In this series, US was normal in 2 patients and underrepresented parenchymal injury in the remaining 3 patients [18]. Kocaoglu et al [68] demonstrated that abnormal cerebral imaging findings on MRI due to hypoxic-ischemic injury or hemorrhage can be seen at the beginning of the second trimester and do not correlate with the current US staging system; however, they do correlate with decreased survival. Hence, it has been suggested that fetal MRI-based detection of cerebral abnormalities could be included in the TTTS staging system as an independent risk factor and incorporated in the prenatal evaluation of complicated MC gestations [68].

In a study including 49 MC multiple gestations with single fetal demise, median gestational age at time of co-twin death was 25 weeks and median interval between single fetal loss and live birth was 61 days, with median gestational age at delivery 36 weeks [17]. Severe cerebral injury was diagnosed in 26% of the survivors and was detected antenatally on MRI in 4 of 50 (8%) cases. Abnormal cerebral findings predominantly resulted from hypoxic-ischemic injury resulting in cystic periventricular leukomalacia, MCA infarction, or injury to basal ganglia, thalamus, and/or cortex [17]. Risk factors associated with severe cerebral injury were advanced gestational age at time of single fetal demise, development of TTTS before co-twin loss, and lower gestational age at birth [17].

US Assessment for TTTS. DC twins with separate placentas do not typically develop TTTS or other complications associated with a single shared placenta. Hence, this

evaluation is not useful for growth and antepartum surveillance of complicated DC or multichorionic twins.

US assessment for TTTS is useful for MC twins beginning at 16 weeks' gestation. In MC twin pairs complicated by TTTS, surveillance imaging is performed at shorter intervals. No specific guidelines exist regarding the interval for evaluating complicated MC twins; this may be performed as frequently as 2 to 3 days or weekly, influenced by the fetal status and findings [9,12]. Follow-up evaluation is performed with attention to amniotic fluid pockets and intertwin discordance, presence of fluid-filled urinary bladder, pleural effusion, ascites or frank hydrops, placental cord insertions, and UA Doppler evaluation [4,5,9,12].

Clinically significant TTTS affects 10% to 20% of MC twin pairs. Most severe cases are manifest before 20 weeks, whereas milder cases may not become apparent until 26 to 28 weeks. Untreated severe TTTS in the mid-second trimester carries a very poor prognosis for both twins with mortality rate in excess of 70% [69]. Recipient twins present with polyhydramnios and features of volume overload, whereas donor twins present with oligohydramnios and small or nonvisible urinary bladder [70]. A pathognomonic sign suggesting the diagnosis of TTTS is the appearance of the donor as a "stuck" twin, contained within its collapsed amniotic sac because of anhydramnios [5]. TTTS severity is classified based on the Quintero staging system. This consists of 5 stages, with stage 1 (oligo-polyhydramnios sequence) associated with the best outcome and stage 5 defined as in utero demise of 1 or both twins [70]. Cincinnati classification incorporates echocardiographic findings in the staging of TTTS [71]. Doppler studies may show absence or reversal of end diastolic flow (EDF) in the UA, decreased ventricular function with tricuspid regurgitation, or A-wave reversal on ductus venosus waveforms. Cardiac chamber enlargement in the recipient can be seen in more advanced stages of TTTS [70,71].

US Cervix Transvaginal. US cervix transvaginal evaluation for antepartum surveillance for all multiple gestations is useful for assessing cervical length, vasa, and placenta previa. Any cervical pathology, such as myoma or other masses, that may preclude vaginal delivery should also be assessed. Usually, a transabdominal examination is performed first, followed by transvaginal imaging if the initial evaluation is inadequate. Historically, reports suggested measuring cervical length at each visit to triage for risk of preterm labor. However, more recent literature has questioned the significance and usefulness of this practice, recommending against cervical length measurement after 26 weeks. In twin pregnancies, cervical length measuring <1.5 cm has been shown to be predictive of preterm labor, regardless of management

strategies [43]. If placenta previa or low-lying placenta has been suggested previously, assessment of the location of placental edge can be performed.

US Duplex Doppler Fetal Middle Cerebral Artery. For DC twins and multichorionic multiples, if there is a risk for fetal anemia or fetal hydrops is noted during surveillance, fetal MCA Doppler can be performed and interpreted using established nomograms. US duplex Doppler fetal MCA can be useful for surveillance of complicated DC or multichorionic gestations when there is concern for fetal anemia.

In MC gestations, fetal MCA Doppler assessment is performed to detect TAPS [3,51]. TAPS may develop spontaneously in up to 5% of MC twins or after laser therapy (done to treat TTTS) in 10% of cases [51]. This condition can be monitored by assessing peak systolic velocity (PSV) of the MCA, with fetal anemia associated with elevated velocity [3]. Criteria for diagnosing TAPS have been determined by expert consensus as follows: donor MCA-PSV >1.5 multiples of the median (MoM) and recipient MCA-PSV <0.8 MoM, or PSV MoM discrepancy (Δ MoM) of ≥ 1.0 [51,72,73]. There is some variability in the published literature regarding the Δ MoM threshold for diagnosing TAPS, with a lower threshold Δ MoM of ≥ 0.5 proposed as more accurate by some authors [72]. In fact, in the consensus statement, the authors state that the optimal threshold for MCA-PSV discordance was agreed to be ≥ 0.5 MoM by 49% (16/33) of the experts and ≥ 1.0 MoM by 33% (11/33). Therefore, given the >80% agreement for intertwin MCA-PSV discordance ≥ 1.0 MoM, this was selected as the cutoff value [51,72]. The severity can also be graded by Doppler and echocardiographic assessment [3,51]. When isolated TAPS is identified, surveillance is recommended at least weekly based on consensus opinion [51]. Otherwise, surveillance can be performed along with US assessment of TTTS and UA Doppler, as frequently as dictated by fetal status.

Prognostic importance of MCA-PSV for outcome after laser ablation for TTTS has been reported. In a study by Trieu et al [74], there was no correlation between the incidence of elevated MCA-PSV before laser and fetal survival up to 7 days after laser. In contrast, the presence of an MCA-PSV above 1.5 MoM in the former donor twin 48 hours following laser was associated with higher risk for intrauterine fetal demise of the former donor within a week after surgery [74].

US Duplex Doppler Fetal Umbilical Artery. When growth restriction or amniotic fluid abnormalities (oligo-hydramnios) are present, fetal UA Doppler can be performed. US duplex Doppler fetal UA is generally not useful

for surveillance of uncomplicated DC or multichorionic gestations. Correlation with UA Doppler can help predict the outcome of growth restricted fetuses [75]. sFGR is classified into 3 types based on Doppler findings in the growth restricted twin: type 1 shows constant EDF in the UA, type 2 shows constant absent or reversed EDF, and type 3 shows intermittent absent or reversed EDF [42,75]. In a prospective study evaluating the perinatal outcome of MC twins with sFGR, Weisz et al [76] compared growth restricted twins with abnormal Doppler findings to those with normal Doppler findings. The authors found an overall higher incidence of neonatal complications (sepsis, central nervous system abnormalities, respiratory distress, and neonatal death) in sFGR twins with absent or reversal EDF in the UA [76]. Ishii et al [77] reported that the additional finding of severe oligohydramnios or “stuck twin” phenomenon was a significant predictor of mortality in the growth restricted twin with abnormal Doppler waveforms. Rustico et al [42] showed that Doppler flow patterns could change over the course of pregnancy. Compared with type I, the risk of intrauterine fetal demise (adjusted for estimated fetal weight discordance and amniotic fluid deepest vertical pocket) was highest when the pregnancy was or became type II reversed or type II absent waveforms. Mild neurological impairment was more prevalent in the growth restricted twin than in the larger co-twin (7% versus 1%; $P = .02$).

US duplex Doppler fetal UA is essential for antepartum surveillance of complicated MC twins. This information is critical for detecting and staging TTTS and for evaluating fetuses diagnosed with sFGR. Doppler studies may show absence or reversal of EDF in the UA of the donor, information that is used in staging TTTS [70].

US Echocardiography Fetal. Echocardiography can be performed for surveillance of DC or multichorionic gestations when cardiac defects or secondary cardiac decompensation is expected or observed.

US echocardiography is useful to assess and stage TTTS and TAPS in complicated MC gestations and follow-up cardiac defects. The presence of TTTS increases the risk for congenital cardiac disease in MC twins, particularly in the recipient twin. Hence, development of TTTS may be an indication for fetal echocardiography in later gestation, if not performed previously [52], or for functional cardiac assessment after development of TTTS [78]. Reports have shown that the recipient twin may demonstrate cardiac functional abnormalities, and structural abnormalities leading to right ventricular outflow obstruction may develop later in gestation in 3% to 10%—either before or after laser ablation done to treat TTTS [32,79]. Some

studies have shown high incidence of recipient-twin cardiomyopathy even in early-stage TTTS [79]. In addition, the more advanced the recipient-twin cardiomyopathy, the more likely there will be progression to higher stages of TTTS [79]. Right ventricular outflow obstruction may develop in the donor twin and in MC twins affected by sFGR. These potentially high-risk groups may be candidates for fetal intervention. Fetoscopic laser ablation of placental vascular anastomoses can help reverse cardiac dysfunction, even in the most severe cases of TTTS [80]. Finneran et al [80] showed that laser treatment for TTTS causes rapid improvement in the cardiac function of recipient fetuses and that preoperative recipient myocardial performance index does not correlate with survival of either twin postoperatively. Hence, monitoring of cardiac function should be continued even after fetal intervention has been performed [80-82].

In MC gestations complicated by TRAP, cardiac evaluation of the “pump” fetus is indicated to assess for features of volume overload [22,58,79]. In addition to monitoring cardiac function of the pump fetus, echocardiography is useful to assess for congenital heart disease, which can be seen in up to 10% of cases [58].

US Pregnant Uterus Biophysical Profile. BPP can be performed in late second and third trimesters for assessing fetal well-being for all multiple pregnancies.

US Pregnant Uterus Transabdominal. Transabdominal US of the pregnant uterus continues to be the mainstay for surveillance imaging of complicated multiple gestations. Complicated multiple gestations require sonographic surveillance at frequent intervals varying between 2 to 3 days to 2 to 3 weeks based on the abnormality and fetal status [9]. Higher-risk gestations merit frequent surveillance. Due to variability and SDs in measurements, growth and biometry is usually performed no more frequently than every 2 weeks [9]. The discordance in estimated fetal weights should be calculated and documented at each scan in which growth and fetal weight estimates are performed.

Using the modified Delphi criteria, Khalil et al [83] established the following definitions of sFGR. Irrespective of chorionicity, 1 solitary parameter (estimated fetal weight of 1 twin <3rd centile) was agreed as a criterion for sFGR [83]. For MC twin pregnancy, at least 2 out of 4 contributory parameters (estimated fetal weight of 1 twin <10th centile, abdominal circumference of 1 twin <10th centile, estimated fetal weight discordance of $\geq 25\%$, and UA pulsatility index of the smaller twin >95th centile) were agreed [83]. For sFGR in DC twin pregnancy, at least 2 out of 3 contributory parameters (estimated fetal weight of 1 twin <10th centile, estimated

fetal weight discordance of $\geq 25\%$, and UA pulsatility index of the smaller twin >95 th centile) were agreed [83].

MC multiple gestations are at risk for TTTS, TAPS, and TRAP. TTTS and TAPS have been discussed in the sections above [4]. TRAP sequence is a rare condition, occurring in approximately 1 in 30,000 pregnancies. A structurally normal pump fetus perfuses, via anomalous arterio-arterial placental connections, a TRAP fetus with reversed flow in its UA. The acardiac TRAP can grow in size supported by the pump fetus and is markedly anomalous—often acephalic, lacking upper extremities, with marked edema. In the absence of intervention, the mortality rate of the pump twin is high (approximately 50%) due to cardiac overload. Volume of the TRAP fetus should be calculated at each imaging. When the estimated weight of the TRAP fetus is $\geq 50\%$ of the weight of the pump or when features of cardiac decompensation are seen in the pump fetus, fetal intervention can be performed [58]. Treatment is based on interruption of flow in the communicating vessels or the umbilical cord of the anomalous twin [58]. Techniques to ablate flow in the umbilical cord of the acardiac twin after 16 weeks have been reported to be effective. Because of the risk of spontaneous cessation of flow in the acardiac twin before planned intervention at 16 to 18 weeks with subsequent brain injury in survivors, some authors suggest that optimal outcome, particularly if the TRAP is large, may be earlier elective intervention [84].

If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

US Pregnant Uterus Transvaginal. Transvaginal examination of the pregnant uterus and cervix can be performed as an adjunct for limited transabdominal fetal evaluation. Additional scenarios include assessment of the cervix and placenta and detection of vasa previa. Typically, transvaginal imaging is performed only if transabdominal evaluation is considered suboptimal or incomplete. If prior history of cesarean delivery or uterine instrumentation is present, assessment for placenta accreta spectrum can be performed.

SUMMARY OF RECOMMENDATIONS

- **Variant 1:** US pregnant uterus transabdominal and US pregnant uterus transvaginal is usually appropriate as the initial imaging during the first trimester for known or suspected multiple gestations, which are MC or DC. 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 2:** US pregnant uterus transabdominal and US pregnant uterus transvaginal is usually appropriate as the next imaging study for first trimester multiple gestations, which are MC or DC and first trimester US has been performed. 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 pregnant uterus transabdominal is usually appropriate as the follow-up imaging of multiple gestations, which are DC twins or higher-order multiples as a second trimester anatomy examination. US cervix transvaginal and US echocardiography fetal 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) to US pregnant uterus transabdominal.

- **Variant 4:** US pregnant uterus transabdominal is usually appropriate as the follow-up imaging for MC twin multiple gestations as a second trimester anatomy examination. US assessment for TTTS, US cervix transvaginal, US duplex Doppler fetal UA, and US echocardiography fetal 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) to US pregnant uterus transabdominal.

- **Variant 5:** US pregnant uterus transabdominal is usually appropriate for growth and antepartum surveillance in multiple gestations with DC twins or multichorionic higher-order multiples.

- **Variant 6:** US pregnant uterus transabdominal is usually appropriate for growth and antepartum surveillance for multiple gestations that are MC twins. US assessment for TTTS, US duplex Doppler fetal MCA, and US duplex Doppler fetal UA 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) to US pregnant uterus transabdominal.

- **Variant 7:** US pregnant uterus transabdominal is usually appropriate for the growth and antepartum surveillance with multiple gestations, which are DC or multichorionic gestations or MC gestations and have a known abnormality or discordance between fetuses (fluid, size, weight). US duplex Doppler fetal MCA, US duplex Doppler fetal UA, and US

pregnant uterus BP 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) to US pregnant uterus transabdominal.

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 go to www.acr.org/ac.

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) [85]
- ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation [20]
- ACR–ACOG–AIUM–SMFM–SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound [86]
- ACR Manual on Contrast Media [21]
- ACR Manual on MR Safety [87]

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 2).

Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [88].

REFERENCES

1. Kulkarni AD, Jamieson DJ, Jones HW Jr, et al. Fertility treatments and multiple births in the United States. *N Engl J Med* 2013;369:2218-25.
2. American College of Obstetricians and Gynecologists' Committee on Practice Bulletins-Obstetrics, Society for Maternal-Fetal Medicine. Multifetal gestations: twin, triplet, and higher-order multifetal pregnancies: ACOG Practice Bulletin, Number 231. *Obstet Gynecol* 2021;137:e145-62.
3. Slaghekke F, Pasman S, Veujoz M, et al. Middle cerebral artery peak systolic velocity to predict fetal hemoglobin levels in twin anemia-polycythemia sequence. *Ultrasound Obstet Gynecol* 2015;46:432-6.
4. Washburn EE, Sparks TN, Gosnell KA, Rand L, Gonzalez JM, Feldstein VA. Polyhydramnios affecting a recipient-like twin: risk of progression to twin-twin transfusion syndrome and outcomes. *Am J Perinatol* 2018;35:317-23.
5. Jha P, Morgan TA, Kennedy A. US evaluation of twin pregnancies: importance of chorionicity and amnionicity. *Radiographics* 2019;39:2146-66.
6. Baxi LV, Walsh CA. Monoamniotic twins in contemporary practice: a single-center study of perinatal outcomes. *J Matern Fetal Neonatal Med* 2010;23:506-10.
7. Lewi L, Jani J, Blickstein I, et al. The outcome of monochorionic diamniotic twin gestations in the era of invasive fetal therapy: a prospective cohort study. *Am J Obstet Gynecol* 2008;199:514.e1-8.
8. Fichera A, Prefumo F, Stagnati V, Marella D, Valcamonica A, Frusca T. Outcome of monochorionic diamniotic twin pregnancies followed at a single center. *Prenat Diagn* 2015;35:1057-64.
9. Hoskins IA, Combs CA. Society for Maternal-Fetal Medicine special statement: updated checklists for management of monochorionic twin pregnancy. *Am J Obstet Gynecol* 2020;223:B16-20.
10. Dias T, Mahsud-Dorman S, Bhide A, Papageorgiou AT, Thilaganathan B. Cord entanglement and perinatal outcome in monoamniotic twin pregnancies. *Ultrasound Obstet Gynecol* 2010;35:201-4.
11. Cordero L, Franco A, Joy SD. Monochorionic monoamniotic twins: neonatal outcome. *J Perinatol* 2006;26:170-5.
12. McDonald R, Hodges R, Knight M, et al. Optimal interval between ultrasound scans for the detection of complications in monochorionic twins. *Fetal Diagn Ther* 2017;41:197-201.
13. Kawaguchi H, Ishii K, Muto H, Yamamoto R, Hayashi S, Mitsuda N. The incidence of unexpected critical complications in monochorionic diamniotic twin pregnancies according to the interval period between ultrasonographic evaluations. *J Obstet Gynaecol Res* 2019;45:318-24.
14. Syngelaki A, Cimpoca B, Litwinski E, Akolekar R, Nicolaides KH. Diagnosis of fetal defects in twin pregnancies at routine 11-13-week ultrasound examination. *Ultrasound Obstet Gynecol* 2020;55:474-81.
15. AIUM practice parameter for the performance of detailed diagnostic obstetric ultrasound examinations between 12 weeks 0 days and 13 weeks 6 days. *J Ultrasound Med* 2021;40:E1-16.
16. Bat F, Fisher BM, Malisch T, Jain V. Fetal echocardiogram and detailed first trimester obstetric ultrasound: ICD-10 indications. *Am J Perinatol* 2023;40:25-7.
17. van Klink JM, van Steenis A, Steggerda SJ, et al. Single fetal demise in monochorionic pregnancies: incidence and patterns of cerebral injury. *Ultrasound Obstet Gynecol* 2015;45:294-300.
18. Robinson A, Teoh M, Edwards A, Fahey M, Goergen S. Fetal brain injury in complicated monochorionic pregnancies: diagnostic yield of prenatal MRI following surveillance ultrasound and influence on prognostic counselling. *Prenat Diagn* 2017;37:611-27.

19. Aertsen M, Van Tieghem De Ten Berghe C, Deneckere S, Couck I, De Catte L, Lewi L. The prevalence of brain lesions after in utero surgery for twin-to-twin transfusion syndrome on third-trimester MRI: a retrospective cohort study. *Eur Radiol* 2021;31:4097-103.
20. American College of Radiology. ACR-SPR practice parameter for imaging pregnant or potentially pregnant adolescents and women with ionizing radiation. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf>. Accessed March 29, 2024.
21. American College of Radiology. ACR Committee on Drugs and Contrast Media. Manual on contrast media. Available at: https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf. Accessed March 29, 2024.
22. American College of Radiology. Gadolinium pregnancy screening statement. Available at: <https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Gadolinium-Pregnancy-Screening-Statement—FINAL.pdf>. Accessed March 29, 2024.
23. Sassoon DA, Castro LC, Davis JL, Hobel CJ. Perinatal outcome in triplet versus twin gestations. *Obstet Gynecol* 1990;75:817-20.
24. Maruotti GM, Saccone G, Morlando M, Martinelli P. First-trimester ultrasound determination of chorionicity in twin gestations using the lambda sign: a systematic review and meta-analysis. *Eur J Obstet Gynecol Reprod Biol* 2016;202:66-70.
25. Gordon MC, McKenna DS, Stewart TL, et al. Transvaginal cervical length scans to prevent prematurity in twins: a randomized controlled trial. *Am J Obstet Gynecol* 2016;214:277.e1-7.
26. Hester AE, Ankumah NE, Chauhan SP, Blackwell SC, Sibai BM. Twin transvaginal cervical length at 16-20 weeks and prediction of preterm birth. *J Matern Fetal Neonatal Med* 2019;32:550-4.
27. Park SY, Chung JH, Han YJ, Lee SW, Kim MY. Prediction of amnionity using the number of yolk sacs in monochorionic multifetal pregnancy. *J Korean Med Sci* 2017;32:2016-20.
28. Dias T, Arcangeli T, Bhide A, Napolitano R, Mahsud-Dornan S, Thilaganathan B. First-trimester ultrasound determination of chorionicity in twin pregnancy. *Ultrasound Obstet Gynecol* 2011;38:530-2.
29. Johansen ML, Oldenburg A, Rosthoj S, Cohn Maxild J, Rode L, Tabor A. Crown-rump length discordance in the first trimester: a predictor of adverse outcome in twin pregnancies? *Ultrasound Obstet Gynecol* 2014;43:277-83.
30. Ben-Ami I, Daniel-Spiegel E, Battino S, et al. The association of crown-rump length discrepancy with birthweight discordance in spontaneous versus IVF monochorionic twins: a multicenter study. *Prenat Diagn* 2015;35:864-9.
31. Grande M, Gonce A, Stergiotou I, Bennasar M, Borrell A. Intertwin crown-rump length discordance in the prediction of fetal anomalies, fetal loss and adverse perinatal outcome. *J Matern Fetal Neonatal Med* 2016;29:2883-8.
32. Eschbach SJ, Boons L, Van Zwet E, et al. Right ventricular outflow tract obstruction in complicated monochorionic twin pregnancy. *Ultrasound Obstet Gynecol* 2017;49:737-43.
33. D'Antonio F, Familiari A, Thilaganathan B, et al. Sensitivity of first-trimester ultrasound in the detection of congenital anomalies in twin pregnancies: population study and systematic review. *Acta Obstet Gynecol Scand* 2016;95:1359-67.
34. D'Antonio F, Khalil A, Pagani G, Papageorgiou AT, Bhide A, Thilaganathan B. Crown-rump length discordance and adverse perinatal outcome in twin pregnancies: systematic review and meta-analysis. *Ultrasound Obstet Gynecol* 2014;44:138-46.
35. Litwinska E, Syngelaki A, Cimpoca B, Sapantoglou I, Nicolaides KH. Intertwin discordance in fetal size at 11-13 weeks' gestation and pregnancy outcome. *Ultrasound Obstet Gynecol* 2020;55:189-97.
36. Kagan KO, Gazzoni A, Sepulveda-Gonzalez G, Sotiriadis A, Nicolaides KH. Discordance in nuchal translucency thickness in the prediction of severe twin-to-twin transfusion syndrome. *Ultrasound Obstet Gynecol* 2007;29:527-32.
37. Cimpoca B, Syngelaki A, Litwinska E, Muzaferovic A, Nicolaides KH. Increased nuchal translucency at 11-13 weeks' gestation and outcome in twin pregnancy. *Ultrasound Obstet Gynecol* 2020;55:318-25.
38. Edlow AG, Reiss R, Benson CB, Gerrol P, Wilkins-Haug L. Monochorionic diamniotic twin gestations discordant for markedly enlarged nuchal translucency. *Prenat Diagn* 2011;31:299-306.
39. Zipori Y, Reidy K, Gilchrist T, Doyle LW, Umstad MP. The outcome of monochorionic diamniotic twins discordant at 11 to 13+6 weeks' gestation. *Twin Res Hum Genet* 2016;19:692-6.
40. Allaf MB, Vintzileos AM, Chavez MR, et al. First-trimester sonographic prediction of obstetric and neonatal outcomes in monochorionic diamniotic twin pregnancies. *J Ultrasound Med* 2014;33:135-40.
41. AIUM-ACR-ACOG-SMFM-SRU practice parameter for the performance of standard diagnostic obstetric ultrasound examinations. *J Ultrasound Med* 2018;37:E13-24.
42. Rustico MA, Consonni D, Lanna M, et al. Selective intrauterine growth restriction in monochorionic twins: changing patterns in umbilical artery Doppler flow and outcomes. *Ultrasound Obstet Gynecol* 2017;49:387-93.
43. Qureshey EJ, Quinones JN, Rochon M, Sarno A, Rust O. Comparison of management options for twin pregnancies with cervical shortening. *J Matern Fetal Neonatal Med* 2022;35:39-45.
44. McIntosh J, Feltovich H, Berghella V, Manuck T. The role of routine cervical length screening in selected high- and low-risk women for preterm birth prevention. *Am J Obstet Gynecol* 2016;215:B2-7.
45. Nardoza LM, Simioni C, Garbato G, et al. Nomogram of fetal middle cerebral artery peak systolic velocity at 23-35 weeks of gestation in a Brazilian population: pilot study. *J Matern Fetal Neonatal Med* 2008;21:714-8.
46. Vink J, Wapner R, D'Alton ME. Prenatal diagnosis in twin gestations. *Semin Perinatol* 2012;36:169-74.
47. Hubinont C, Lewi L, Bernard P, Marbaix E, Debieve F, Jauniaux E. Anomalies of the placenta and umbilical cord in twin gestations. *Am J Obstet Gynecol* 2015;213:S91-102.
48. Roman A, Saccone G, Dude CM, et al. Midtrimester transvaginal ultrasound cervical length screening for spontaneous preterm birth in diamniotic twin pregnancies according to chorionicity. *Eur J Obstet Gynecol Reprod Biol* 2018;229:57-63.
49. Papathanasiou D, Witlox R, Oepkes D, Walther FJ, Bloemenkamp KW, Lopriore E. Monochorionic twins with ruptured vasa previa: double trouble. *Fetal Diagn Ther* 2010;28:48-50.
50. Nicholas L, Fischbein R, Aultman J, Ernst-Milner S. Dispelling myths about antenatal TAPS: a call for action for routine MCA-PSV Doppler screening in the United States. *J Clin Med* 2019;8:977.
51. Khalil A, Gordijn S, Ganzevoort W, et al. Consensus diagnostic criteria and monitoring of twin anemia-polycythemia sequence: Delphi procedure. *Ultrasound Obstet Gynecol* 2020;56:388-94.
52. Pettit KE, Merchant M, Machin GA, Tacy TA, Norton ME. Congenital heart defects in a large, unselected cohort of monochorionic twins. *J Perinatol* 2013;33:457-61.
53. Bahtiyar MO, Emery SP, Dashe JS, et al. The North American Fetal Therapy Network consensus statement: prenatal surveillance of uncomplicated monochorionic gestations. *Obstet Gynecol* 2015;125:118-23.
54. Yonetani N, Ishii K, Kawamura H, Mabuchi A, Hayashi S, Mitsuda N. Significance of velamentous cord insertion for twin-twin transfusion syndrome. *Fetal Diagn Ther* 2015;38:276-81.
55. Costa-Castro T, De Villiers S, Montenegro N, et al. Velamentous cord insertion in monochorionic twins with or without twin-twin transfusion syndrome: does it matter? *Placenta* 2013;34:1053-8.
56. Couck I, Mourad Tawfic N, Deprest J, De Catte L, Devlieger R, Lewi L. Does site of cord insertion increase risk of adverse outcome, twin-to-twin transfusion syndrome and discordant growth in monochorionic twin pregnancy? *Ultrasound Obstet Gynecol* 2018;52:385-9.

57. Saito M, Tokunaka M, Takita H, et al. Impact of first trimester determination of abnormal cord insertion on twin-to-twin transfusion syndrome and other adverse outcomes in monochorionic diamniotic twins: a retrospective cohort study. *Prenat Diagn* 2020;40:507-13.
58. Jelin E, Hirose S, Rand L, et al. Perinatal outcome of conservative management versus fetal intervention for twin reversed arterial perfusion sequence with a small acardiac twin. *Fetal Diagn Ther* 2010;27:138-41.
59. Grantz KL, Grewal J, Albert PS, et al. Dichorionic twin trajectories: the NICHD Fetal Growth Studies. *Am J Obstet Gynecol* 2016;215:221.e1-16.
60. Gabbay-Benziv R, Crimmins S, Contag SA. Reference values for sonographically estimated fetal weight in twin gestations stratified by chorionicity: a single center study. *J Ultrasound Med* 2017;36:793-8.
61. Wilkof Segev R, Gelman M, Maor-Sagie E, Shrim A, Hallak M, Gabbay-Benziv R. New reference values for biometrical measurements and sonographic estimated fetal weight in twin gestations and comparison to previous normograms. *J Perinat Med* 2019;47:757-64.
62. Kennelly MM, Sturgiss SN. Management of small-for-gestational-age twins with absent/reversed end diastolic flow in the umbilical artery: outcome of a policy of daily biophysical profile (BPP). *Prenat Diagn* 2007;27:77-80.
63. Booker W, Fox NS, Gupta S, et al. Antenatal surveillance in twin pregnancies using the biophysical profile. *J Ultrasound Med* 2015;34:2071-5.
64. Emery SP, Bahtiyar MO, Moise KJ, North American Fetal Therapy N. The North American Fetal Therapy Network consensus statement: management of complicated monochorionic gestations. *Obstet Gynecol* 2015;126:575-84.
65. Jatzko B, Rittenschober-Bohm J, Mailath-Pokorny M, et al. Cerebral lesions at fetal magnetic resonance imaging and neurologic outcome after single fetal death in monochorionic twins. *Twin Res Hum Genet* 2015;18:606-12.
66. Lanna MM, Consonni D, Faiola S, et al. Incidence of cerebral injury in monochorionic twin survivors after spontaneous single demise: long-term outcome of a large cohort. *Fetal Diagn Ther* 2020;47:66-73.
67. Conte G, Righini A, Griffiths PD, et al. Brain-injured survivors of monochorionic twin pregnancies complicated by single intrauterine death: MR findings in a multicenter study. *Radiology* 2018;288:582-90.
68. Kocoglu M, Kline-Fath BM, Calvo-Garcia MA, Zhang B, Nagaraj UD. Magnetic resonance imaging of the fetal brain in monochorionic diamniotic twin gestation: correlation of cerebral injury with ultrasound staging and survival outcomes. *Pediatr Radiol* 2020;50:1131-8.
69. De Paepe ME, Luks FI. What-and why-the pathologist should know about twin-to-twin transfusion syndrome. *Pediatr Dev Pathol* 2013;16:237-51.
70. Quintero RA. Twin-twin transfusion syndrome. *Clin Perinatol* 2003;30:591-600.
71. Zaretsky MV, Tong S, Lagueux M, et al. North American Fetal Therapy Network: timing of and indications for delivery following laser ablation for twin-twin transfusion syndrome. *Am J Obstet Gynecol* 2019;174:81.
72. Tollenaar LSA, Lopriore E, Middeldorp JM, et al. Improved prediction of twin anemia-polycythemia sequence by delta middle cerebral artery peak systolic velocity: new antenatal classification system. *Ultrasound Obstet Gynecol* 2019;53:788-93.
73. Tavares de Sousa M, Fonseca A, Hecher K. Role of fetal intertwin difference in middle cerebral artery peak systolic velocity in predicting neonatal twin anemia-polycythemia sequence. *Ultrasound Obstet Gynecol* 2019;53:794-7.
74. Trieu NT, Weingertner AS, Guerra F, et al. Evaluation of the measurement of the middle cerebral artery peak systolic velocity before and after placental laser coagulation in twin-to-twin transfusion syndrome. *Prenat Diagn* 2012;32:127-30.
75. Batsry L, Matatyahu N, Avnet H, et al. Perinatal outcome of monochorionic diamniotic twin pregnancy complicated by selective intrauterine growth restriction according to umbilical artery Doppler flow pattern: single-center study using strict fetal surveillance protocol. *Ultrasound Obstet Gynecol* 2021;57:748-55.
76. Weisz B, Hogen L, Yinon Y, et al. Perinatal outcome of monochorionic twins with selective IUGR compared with uncomplicated monochorionic twins. *Twin Res Hum Genet* 2011;14:457-62.
77. Ishii K, Murakoshi T, Hayashi S, et al. Ultrasound predictors of mortality in monochorionic twins with selective intrauterine growth restriction. *Ultrasound Obstet Gynecol* 2011;37:22-6.
78. Zanardini C, Prefumo F, Fichera A, Botteri E, Frusca T. Fetal cardiac parameters for prediction of twin-to-twin transfusion syndrome. *Ultrasound Obstet Gynecol* 2014;44:434-40.
79. Habli M, Michelfelder E, Cnota J, et al. Prevalence and progression of recipient-twin cardiomyopathy in early-stage twin-twin transfusion syndrome. *Ultrasound Obstet Gynecol* 2012;39:63-8.
80. Finneran MM, Pickens R, Templin M, Stephenson CD. Impact of recipient twin preoperative myocardial performance index in twin-twin transfusion syndrome treated with laser. *J Matern Fetal Neonatal Med* 2017;30:767-71.
81. Van Mieghem T, Martin AM, Weber R, et al. Fetal cardiac function in recipient twins undergoing fetoscopic laser ablation of placental anastomoses for stage IV twin-twin transfusion syndrome. *Ultrasound Obstet Gynecol* 2013;42:64-9.
82. Delabaere A, Leduc F, Reboul Q, et al. Prediction of neonatal outcome of TTTS by fetal heart and Doppler ultrasound parameters before and after laser treatment. *Prenat Diagn* 2016;36:1199-205.
83. Khalil A, Beune I, Hecher K, et al. Consensus definition and essential reporting parameters of selective fetal growth restriction in twin pregnancy: a Delphi procedure. *Ultrasound Obstet Gynecol* 2019;53:47-54.
84. Chaveeva P, Poon LC, Sotiriadis A, Kosinski P, Nicolaides KH. Optimal method and timing of intrauterine intervention in twin reversed arterial perfusion sequence: case study and meta-analysis. *Fetal Diagn Ther* 2014;35:267-79.
85. American College of Radiology. ACR-SPR practice parameter for the safe and optimal performance of fetal magnetic resonance imaging (MRI). Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/mr-fetal.pdf>. Accessed March 29, 2024.
86. American College of Radiology. ACR-ACOG-AIUM-SMFM-SRU practice parameter for the performance of standard diagnostic obstetrical ultrasound. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/us-ob.pdf>. Accessed March 29, 2024.
87. American College of Radiology. ACR Committee on MR Safety. ACR manual on MR safety. Version 1.0. Available at: <https://www.acr.org/-/media/ACR/Files/Radiology-Safety/MR-Safety/Manual-on-MR-Safety.pdf>. Accessed March 29, 2024.
88. American College of Radiology. ACR Appropriateness Criteria® Radiation dose assessment introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed March 29, 2024.