Fetal Macrosomia

Suspected fetal macrosomia is encountered commonly in obstetric practice. As birth weight increases, the likelihood of labor abnormalities, shoulder dystocia, birth trauma, and permanent injury to the neonate increases. The purpose of this document is to quantify those risks, address the accuracy and limitations of methods for estimating fetal weight, and suggest clinical management for a pregnancy with suspected fetal macrosomia.

Background

Definition

Two terms are applied to excessive fetal growth: 1) large for gestational age and 2) macrosomia. The term “large for gestational age” generally implies a birth weight equal to or greater than the 90th percentile for a given gestational age. The term fetal macrosomia implies growth beyond an absolute birth weight, historically 4,000 g or 4,500 g, regardless of the gestational age, although establishing a universally accepted definition for macrosomia has been challenging. For years, clinicians have relied on popular birth weight curves to identify weight cutoffs for the 90th percentile for a given gestational age (1–3). A revised national reference for neonatal birth weight is now available. A study using the 2011 U.S. Live Birth File of the National Center for Health Statistics reported data for birth weight references based on the best obstetric estimate of gestational age for more than 3.2 million births (4). The 50th, 90th, and 95th percentiles for birth weight from 37 completed weeks to 42 completed weeks of gestation are shown in Table 1.

Although the risk of morbidity for infants and women when birth weight is between 4,000 g and 4,500 g is greater than that of the general obstetric population, it increases sharply when the birth weight is more than 4,500 g (5–7). A large cohort study of 8.3 million births in the National Center for Health Statistics analyzed live-birth and infant death files for the United States and demonstrated that labor abnormalities and newborn complications (e.g., a 5-minute Apgar score of less than 4, assisted ventilation longer than 30 minutes, birth...
injuries) increase within birth weight category 4,000–4,499 g, newborn morbidity increases significantly within birth weight category 4,500–4,999 g, and newborn mortality increases significantly with birth weights greater than 5,000 g (Fig. 1) (8). In another cohort study based on 6 million U.S.-linked stillbirths, live-birth and infant death records demonstrated remarkably similar findings; perinatal outcomes were no different in the group weighing 4,000–4,499 g compared with those weighing less than 4,000 g, but morbidity and mortality, including stillbirth, increased significantly in those weighing 4,500 g or greater and dramatically in those weighing 5,000 g or greater (9). Recent reports suggest that customized growth curves using ultrasound-estimated fetal weights based on ethnicity or individual characteristics may improve precision in evaluating fetal growth (10) and that customized classification of large-for-gestational-age fetuses may better define a particular birth weight associated with increased maternal and neonatal morbidity and mortality (11, 12). However, neither of these methods is clearly superior to the large, population-based reports (13). At this time, it seems reasonable to recognize a continuum of risk and to divide macrosomia into three categories:

1. Birth weight of 4,000–4,499 g with increased risk of labor abnormalities and newborn complications
2. Birth weight of 4,500–4,999 g with additional risk of maternal and newborn morbidity
3. Birth weight of 5,000 g or greater with additional risk of stillbirth and neonatal mortality

**Frequency of Occurrence**

Data from the National Center for Health Statistics show that 8% of all live-born infants in the United States weigh 4,000 g or more (14). Only 1.1% weigh more than 4,500 g. The most serious complication of fetal macrosomia is shoulder dystocia, but the risk of occurrence is low, complicating only 0.2–3.0% of all vaginal deliveries (15). When birth weight is at least 4,500 g, however, the risk of shoulder dystocia is increased, with rates reported from 9% to 14% (7, 16, 17). In the presence of maternal diabetes, birth weight of 4,500 g or greater has been associated with rates of shoulder dystocia from 20% to 50% (7, 17). Figure 2 shows the relationship between birth weight, maternal diabetes status, spontaneous or assisted vaginal delivery, and the mean frequency of shoulder dystocia based on a study of more than 175,000 deliveries in California in 1992 (7).

The American College of Obstetricians and Gynecologists (the College) defines the diagnosis of shoulder dystocia as a failure of delivery of the fetal shoulder(s) after initial attempts at downward traction, which requires additional maneuvers to effect delivery (18). Several issues complicate attempts to define precisely the incidence of shoulder dystocia among macrosomic infants. First, the extent of reporting by clinicians is variable (15, 19). Second, the incidence of shoulder dystocia and the likelihood of subsequent fetal injury vary depending on the criteria used to assign a diagnosis of dystocia (20). Studies relying on definitions similar to the College definition (21) report a lower overall incidence of shoulder dystocia (but greater proportional fetal morbidity) than studies with less precise definitions (16). Finally, although macrosomia clearly increases risk, most instances of shoulder dystocia occur unpredictably among infants of normal birth weight (22).

**Risk Factors for Macrosomia**

A variety of factors predispose a newborn to macrosomia, including preexisting maternal diabetes, uncontrolled gestational diabetes, maternal prepregnancy obesity, excessive gestational weight gain, maternal interpregnancy weight gain, a prior macrosomic infant, postterm pregnancy, and
It has been suggested that it is this altered fetal body shape that is responsible for the higher incidence of shoulder dystocia seen among infants of women with diabetes (36). Regardless of birth weight, infants of women with diabetes have an increased risk of shoulder dystocia, clavicular fracture, and brachial plexus injury (7, 21, 37).

The relative contributions of maternal diabetes and obesity to fetal macrosomia remain controversial. One study reported that the risk of fetal macrosomia associated with unrecognized gestational diabetes persisted after controlling for maternal body mass index and maternal weight gain (34). In a study among women with diet-controlled gestational diabetes, adjusting for maternal weight decreased the relative risk of large infants (size greater than the 90th percentile) from 2.5 to 1.5 (38). Although diabetes and obesity increase the risk of fetal macrosomia, because of the increasing prevalence and relative frequency of maternal obesity compared with diabetes, maternal obesity plays a greater role in macrosomia at a population level (6, 23, 30).

The interaction of maternal weight, weight gain during pregnancy, and newborn macrosomia is complex. There is little doubt that birth weight, in general, increases with maternal body mass index (23, 25, 26). Although obese women are more likely than women of normal weight to have large infants, several issues confound this observation (23, 25, 26, 39). First, obese women are more likely to have diabetes mellitus (39). Second, excess weight gain during pregnancy is itself a risk factor for excessive fetal growth (25, 40), and the risk of newborn macrosomia associated with excessive maternal nonsmoking status (8, 23–27). The interplay of these risk factors is complex and varies by prepregnancy body mass index, race, and ethnicity (23, 28, 29). A large case–control study examined the relative contributions of proposed risk factors for macrosomia, excluding preexisting diabetes (30). In decreasing order of importance, these risk factors included a prior history of macrosomia, maternal prepregnancy weight, weight gain during pregnancy, multiparity, male fetus, gestational age greater than 40 weeks, ethnicity, maternal birth weight, maternal height, maternal age younger than 17 years, and a positive 50-g glucose screen with a negative result on the 3-hour glucose tolerance test.

Pregestational diabetes and gestational diabetes are associated with fetal macrosomia. Observational cohort studies demonstrate that graded increases in maternal glucose levels are associated with increases in newborn birth weight (31, 32). A study reported that 6% of women with untreated borderline gestational diabetes gave birth to infants exceeding 4,500 g, compared with only 2% of women with normal blood glucose tolerance (33). If gestational diabetes is unrecognized and untreated, the risk of macrosomia may be as high as 19% (34).

Anthropometric studies suggest that the macrosomia produced by maternal glucose intolerance is different from macrosomia associated with other predisposing factors (35, 36). Infants who are macrosomic because of maternal glucose intolerance tend to have greater total body fat, greater shoulder and upper-extremity circumferences, greater upper-extremity skin-fold measurements, and smaller head-to-abdominal-circumference ratios compared with macrosomic infants of women without diabetes. It has been suggested that it is this altered fetal body shape that is responsible for the higher incidence of shoulder dystocia seen among infants of women with diabetes (36). Regardless of birth weight, infants of women with diabetes have an increased risk of shoulder dystocia, clavicular fracture, and brachial plexus injury (7, 21, 37).

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maternal weight gain is greater for obese than for non-obese women (25, 26, 39).

Gestational age influences birth weight and the risk of macrosomia. Among all races in the United States, the risk of macrosomia increases from 1.3% at 39–40 weeks of gestation to approximately 2.0% when gestational age exceeds 41 weeks (14).

A number of maternal historic factors and habits also influence infant birth weight. A woman who previously has given birth to an infant weighing more than 4,000 g is 5–10 times more likely to deliver an infant weighing more than 4,500 g than a woman without such a history (5, 30, 41). To a degree, maternal birth weight may predict newborn weight. Women whose own birth weight exceeded 8 lbs (approximately 3,600 g) are twice as likely to deliver infants weighing more than 4,000 g than are women whose birth weight was between 6 lb and 7.9 lb (approximately 2,700–3,500 g) (42). Finally, two cohort studies show that multiparity and grand multiparity (five or more deliveries) increase the risk of macrosomia (9, 41).

Genetic, racial, and ethnic factors also influence birth weight and the risk of macrosomia. Male infants typically weigh more than female infants at any gestational age and, therefore, constitute a greater proportion of infants with birth weights exceeding 4,500 g (9, 17). The risk of macrosomia varies with race and ethnicity as well (29). Genetic factors such as parental phenotype, race, and ethnicity play a role in determining newborn birth weight, but these factors interact in a complex manner with environmental factors during pregnancy (29, 43).

**Diagnosis**

An accurate diagnosis of macrosomia can be made only by weighing the newborn after delivery. The prenatal diagnosis of fetal macrosomia is imprecise. Methods used to predict birth weight include assessment of maternal risk factors, clinical examination, and ultrasound measurement of the fetus. Although ultrasonography enables the direct measurement of various fetal body parts, its accuracy in predicting macrosomia has been imprecise (44, 45). Although significant differences in fetal growth by self-identified maternal race and ethnicity among low-risk women have been demonstrated (10), longitudinal ultrasound examinations and individual growth-curve modeling do not appear to improve the detection of fetal macrosomia (46). The use of customized growth curves to detect fetal overgrowth and its complications has proved to be no better than the use of population-based growth curves (47). Studies comparing the accuracy of ultrasonography with that of physical examination for the detection of macrosomia also have been inconsistent, and none have proved that ultrasonography is superior to physical examination in a clinically meaningful way (48, 49). Indeed, parous women appear to be able to predict the weight of their newborns as well as clinicians who use ultrasound measurements or clinical palpation maneuvers (50, 51).

**Risks Associated With Macrosomia**

**Maternal Morbidity**

The primary maternal risk associated with macrosomia is an increased risk of cesarean delivery. Studies show that with birth weights greater than 4,500 g, the risk of cesarean delivery for women attempting a vaginal delivery is at least double that of controls (5, 6). Almost all of the increased risk is attributed to labor abnormalities (5, 16). Not surprisingly, studies have consistently demonstrated that the inaccurate ultrasound prediction of macrosomia predisposes women to the diagnosis of labor abnormalities and cesarean delivery independent of actual birth weight (52–54). One group reported that, as an indication for cesarean delivery, fetal macrosomia was responsible for 10% of the overall increase in cesarean delivery rates over the 7-year study period despite no change in the true rate of newborn macrosomia during that time (55).

The risks of postpartum hemorrhage and significant vaginal lacerations are elevated with macrosomia. A case–control study of risk factors for major obstetric hemorrhage (estimated blood loss greater than 1 liter) reported that a birth weight greater than 4,000 g increased the risk of significant maternal blood loss (odds ratio [OR], 1.9; 95% confidence interval [CI], 1.38–2.6) (56). The risk of third-degree and fourth-degree lacerations is increased twofold to threefold with macrosomia (17, 57, 58); this is especially true if delivery is complicated by shoulder dystocia (59).

**Fetal Morbidity and Mortality**

The fetal injuries most commonly associated with macrosomia and shoulder dystocia are fracture of the clavicle and damage to the nerves of the brachial plexus, specifically C5 and C6, which can produce Erb–Duchenne paralysis. Fracture of the clavicle complicates 0.4–0.6% of all deliveries and usually resolves without permanent sequelae (60, 61). For macrosomic infants, the risk of clavicular fracture is increased approximately 10-fold (61). The risk of brachial plexus injury is low, with an incidence among all vaginal deliveries in the United States of approximately 1.5% (22). Case–control studies demonstrate that the risk of brachial plexus injury among infants delivered vaginally is increased 18-fold to 21-fold when birth weight exceeds 4,500 g (37, 61, 62). For
macroscopic infants delivered vaginally, reports place the occurrence of brachial plexus injury between 2.6% and 7% (63, 64). Even though shoulder dystocia has variation in the reported incidence (19), the occurrence of brachial plexus injury in the absence of documented shoulder dystocia is well described (7). Brachial plexus injury can occur with cesarean delivery (22). As with clavicular fracture, most brachial plexus injuries resolve without permanent disability. Among 59 confirmed brachial plexus injuries described in the Collaborative Perinatal Project, only six were still evident by age 4 months (65). By age 2 years, all but four had resolved. Other large case series confirm that 80–90% of brachial plexus injuries will resolve by age 1 year (66, 67). Persistent injury is more common with higher birth weights, and birth weights greater than 4,500 g in particular (68, 69).

Macrosomia is associated with a number of other risks to the newborn. These infants face an increased risk of depressed 5-minute Apgar scores and increased rates of admission and prolonged admission (greater than 3 days) to a neonatal intensive care unit (63, 70). It is not clear whether most of this risk is the result of complications of the birth process or an increased risk of nonmeasuring status during labor (5, 70). Macroscopic newborns are more likely to be overweight and obese later in life than normal-weight newborns (71, 72).

Clinical Considerations and Recommendations

► How accurate are clinical estimates of fetal weight?

The diagnosis of fetal macrosomia is imprecise. For suspected fetal macrosomia, the accuracy of estimated fetal weight using ultrasound biometry is no better than that obtained with clinical palpation. The principal method of clinical estimation of fetal weight is by abdominal palpation. In several prospective studies, clinical palpation alone, irrespective of the level of clinical training of the obstetric care provider, predicted fetal macrosomia as accurately as any reported ultrasound method using either traditional formulas for estimated fetal weight or the addition of fetal soft tissue markers (73–76).

Measurement of the symphysis–fundal height alone is a poor predictor of fetal macrosomia. Although fundal height measurement has a greater sensitivity for fetuses exceeding 4,500 g, the utility of this measurement alone is questionable (77). Retrospective studies suggest that the sensitivity of fundal height measurement alone for the detection of macrosomia is well below 50% (77) and incorporating abdominal palpation maneuvers does not improve accuracy (78, 79). The effect of maternal obesity on the accuracy of clinical estimates of fetal weight is unclear, but most studies suggest a tendency to overestimate fetal weight when pregnancy is complicated by maternal obesity (79, 80). Prospective studies designed to evaluate abdominal palpation maneuvers with fundal height measurement for the detection of macrosomia report sensitivities of 10–43%, specificities of 99.0–99.8%, and positive predictive values between 28% and 53% (48, 81). Ultrasound measurements of those women with suspected fetal macrosomia on the basis of clinical examination alone decreased sensitivity and positive predictive value without measurably affecting specificity (81). Prospective studies among women with diabetes also have shown that clinical estimates of macrosomia are as predictive as those derived with ultrasonography (82).

Simply asking a parous woman for her estimate of the fetal weight may provide an estimate as accurate as any other. In two studies, a parous woman’s ability to predict birth weight greater than 4,000 g was as accurate as that of clinicians using clinical palpation maneuvers alone (50, 51).

► How accurate is ultrasound measurement in determining fetal weight?

Ultrasonography-derived estimates of fetal weight are obtained by entering the measurements of various fetal body parts, usually including the abdominal circumference, into one of several popular regression equations (83, 84). Most commercially available ultrasound units have one or more of these equations already programmed into the system’s software, allowing immediate calculation of estimated fetal weight. However, most of the regression formulas currently in use are associated with significant errors when the fetus is macrosomic. For example, the Hadlock formula to predict fetal weight has a mean absolute percent error of 13% for infants greater than 4,500 g, compared with 8% for nonmacrosomic infants (85).

Ultrasonography is poor at identifying the infant with a birth weight over 4,500 g. Among women without diabetes, ultrasound biometry used to detect macrosomia has a sensitivity of 22–44%, a specificity of 99%, a positive predictive value of 30–44%, and a negative predictive value of 97–99% (86, 87). Reports demonstrating greater accuracy generally rely on less stringent criteria for macrosomia, such as birth weight greater than 4,000 g or weight exceeding the 90th percentile for a given gestational age (88). However, when birth weight exceeds 4,500 g, only 50% of fetuses weigh within 10% of the
ultrasonography-derived estimate (89). Using existing formulas, an estimated fetal weight would have to exceed 4,800 g for the fetus to have more than a 50% chance of being macrosomic (86, 90). These observations suggest that the usefulness of ultrasonography for obtaining estimated weights is limited, and these limitations are neither operator dependent nor equipment dependent (89).

Similarly, no one formula based on ultrasound biometry performs significantly better than others for the detection of macrosomia over 4,500 g. One study compared the accuracy of 36 different published formulae for estimating fetal weight with ultrasonography, and none was superior to the others in a clinically meaningful way (91). In this study, the sensitivity of ultrasonography for the detection of birth weight over 4,500 g was only 22%, and the false positive rate was 7%. Ultrasound estimates based on three or four biometric parameters tend to perform better than estimates based on the abdominal circumference alone (92). However, for suspected fetal macrosomia, the accuracy of estimated fetal weight using ultrasound biometry is no better than that obtained with clinical palpation maneuvers.

As aforementioned, reports have shown that ultrasound estimation of fetal macrosomia predisposes women to the diagnosis of labor abnormalities and cesarean delivery independent of actual birth weight. As with clinical estimates of fetal weight, the true value of ultrasonography in the management of expected fetal macrosomia may be its ability to rule out the diagnosis, which may help to avoid maternal morbidity. A randomized controlled trial comparing women who received routine ultrasound examinations at 18 weeks of gestation and an additional ultrasound examination at 33 weeks of gestation with women who received a single routine ultrasound examination at 18 weeks demonstrated a slight reduction in induction of labor and elective cesarean delivery for suspected fetal macrosomia (93). However, this study failed to demonstrate any significant differences in perinatal outcomes.

▶ Are there effective interventions for treating or preventing suspected fetal macrosomia?

For women without diabetes, there are no proven interventions to treat suspected macrosomia. Despite the aforementioned well-known associations between maternal weight gain and macrosomia, randomized trials of diet with lifestyle modification (94) and of exercise (95) failed to demonstrate significant differences in the rates of large-for-gestational-age infants. A recent randomized clinical trial of supervised aerobic exercise for 1 hour 3 days a week from 9–11 weeks of gestation to near term demonstrated a slight reduction in newborns with birth weights of more than 4,000 g (96). Women who did not exercise had a 4.7% risk of infant birth weight over 4,000 g compared with 1.8% in the exercise group (OR, 2.5; 95% CI, 1.03–6.20; P=.04). These results suggest that moderate levels of exercise initiated in the first trimester of pregnancy could prevent macrosomia, but additional trials are needed.

For pregnancies that are complicated by diabetes mellitus, control of maternal hyperglycemia clearly decreases the risk of fetal macrosomia. One clinical trial suggests that the addition of insulin to diet therapy may treat early macrosomia diagnosed between 29 weeks and 33 weeks of gestation (97). This study randomized 98 women with gestational diabetes and a fetal abdominal circumference exceeding the 75th percentile for gestational age to either diet therapy alone or diet therapy with twice-daily insulin. The addition of insulin therapy decreased the likelihood of birth weight greater than the 90th percentile from 45% among those treated with diet only to 13% among those receiving insulin (P<.01) (97). These results are consistent with larger trials designed to determine the effects of treatment of mild gestational diabetes on newborn outcomes. In the Australian Carbohydrate Intolerance Study in Pregnant Women trial, the risk of a birth weight greater than 4,000 g was reduced from 21% to 10% (relative risk [RR], 0.47; 95% CI, 0.34–0.64; P=.001) (98). Similarly, in a large multicenter randomized trial of the treatment of mild gestational diabetes, the risk of a birth weight greater than 4,000 g was reduced from 14.3% to 5.9% (RR, 0.41; 95% CI, 0.26–0.66; P=.001) (99). Together, these trials confirm that control of maternal hyperglycemia is important in the prevention of macrosomia among women who have been diagnosed with gestational diabetes.

▶ When should cesarean delivery be considered for suspected macrosomia at a particular estimated fetal weight?

Although the diagnosis of fetal macrosomia is imprecise, prophylactic cesarean delivery may be considered for suspected fetal macrosomia with an estimated fetal weight of at least 5,000 g in women without diabetes and at least 4,500 g in women with diabetes. However, planned cesarean delivery for suspected fetal macrosomia is controversial. Cesarean delivery reduces but does not eliminate the risk of birth trauma and brachial plexus injury associated with fetal macrosomia (6, 37, 100). The clinical effectiveness of offering prophylactic cesarean delivery to women with any specific estimated fetal weight has not been established in randomized clinical trials. To date, only one observational study has evaluated a policy of using ultrasonography-derived fetal
weight estimates to determine the route of delivery (101). In this study, 1,337 women with diabetes were offered scheduled cesarean delivery based on ultrasonography-derived fetal weight estimates greater than 4,250 g and induction of labor if ultrasound measurements resulted in a prediction of a large-for-gestational-age infant with an estimated fetal weight less than 4,250 g (101). The study cohort was compared with a historic control group of 1,227 women with diabetes who were managed without intervention for accelerated fetal growth during the 3 years preceding implementation of the study protocol. The overall incidence of shoulder dystocia was 2.8% during the control period and 1.5% after implementation of the study protocol (OR, 1.9; 95% CI, 1.0–3.5). A significant increase in the institutional cesarean delivery rate from 21.7% in the control group to 25.1% in the intervention group (P<.04) was reported, with nearly one half (47%) of the infants delivered by scheduled cesarean delivery based on ultrasonography-derived fetal weight estimates of at least 4,250 g having a birth weight of less than 4,000 g. Although the sample size was insufficient for comparison, the risk of birth trauma was not eliminated (two versus one brachial plexus injury and 10 versus six fractures in the control versus study cohort, respectively). The use of historic controls, the nonrandomized design of the study, the use of multiple interventions, and the small sample size severely limit the usefulness of the conclusions from the study.

Large cohort and case–control studies demonstrate the safety of allowing a trial of labor for estimated birth weights of more than 4,000 g (17, 102). Among a group of 2,924 infants with birth weights of at least 4,000 g, 48 injuries (1.6%) were noted. Among the 22 brachial plexus injuries with documented follow-up, five were clinically evident at 6 months (69). A second study reported 27 occurrences (11.4%) of shoulder dystocia and three instances (1.3%) of brachial plexus injury in a group of 236 neonates weighing at least 4,200 g (103). In an additional series of 87 infants with birth weights greater than 4,500 g who were delivered vaginally, investigators reported five cases (5.7%) of Erb–Duchenne palsy. By 3 months of age, all affected infants were without evidence of brachial plexus paralysis (102). A fourth study reported that among 157 infants delivered vaginally with birth weights greater than 4,500 g, no permanent sequelae were identified by age 2 months (17). The risk of short-term morbidity associated with vaginal delivery in this group is low, and that of permanent injury is even lower. Pregnant women with suspected fetal macrosomia should be provided individualized counseling about the risks and benefits of vaginal and cesarean delivery based on the degree of macrosomia.

Despite the poor predictive value of an estimated fetal weight of more than 5,000 g and a lack of evidence supporting cesarean delivery at any estimated fetal weight, most, but not all, authors agree that consideration should be given to cesarean delivery in this situation (6, 63, 102). With an estimated fetal weight of greater than 4,500 g, a prolonged second stage of labor or arrest of descent in the second stage is an indication for cesarean delivery. Among all infants with birth weights exceeding 5,000 g, there are reports of cesarean delivery rates of 35–60%, brachial plexus injury rates of 7–11%, and a neonatal death rate as high as 1.9% (6, 8, 63, 102). In contrast, despite reporting a 7% absolute rate of brachial plexus injury among vaginally delivered infants weighing more than 5,000 g, some investigators suggest that ultrasonography-derived fetal weight estimates alone should not be used to determine the route of delivery because of the poor accuracy of ultrasonography for determining prenatally if this threshold has been exceeded (37, 45).

► Is there a role for induction of labor in the management of term patients with suspected fetal macrosomia?

Suspected fetal macrosomia is not an indication for induction of labor because induction does not improve maternal or fetal outcomes. Evidence from retrospective cohort studies examining a policy of induction of labor in term patients with suspected fetal macrosomia is inconsistent. Some reports show that induction of labor increases the risk of cesarean delivery without reducing shoulder dystocia or newborn morbidity (104–106). Others suggest a slight decrease or no effect on the risk of cesarean delivery and no difference in the rate of shoulder dystocia with induction of labor (107, 108). Some of these studies are limited by sample size and all are compromised because of possible bias introduced by their retrospective nature.

Two randomized clinical trials have examined the effect of a policy of induction of labor at term for ultrasonography-estimated fetal weight greater than the 90th percentile. In the first trial, a total of 273 women at 38 weeks of gestation or later with ultrasonography-derived estimated fetal weights between 4,000 g and 4,500 g were randomized to either planned induction of labor or expectant management (109). The cesarean delivery rates were similar: 19.4% for the induction group and 21.6% for the expectant group. There were 11 cases of shoulder dystocia: five in the induction group and six in the expectant group. All were managed without brachial plexus injury or other trauma. In a second European trial, a total of 822 women with estimated fetal...
weights above the 95th percentile for gestational age at 37 weeks to 38 weeks of gestation were randomized to induction of labor within 3 days or to expectant management (110). With induction of labor, the risk of shoulder dystocia was reduced from 4% to 1% (RR, 0.32; 95% CI, 0.12–0.85). Importantly, there were no instances of brachial plexus injury in either group, and the cesarean delivery rates were similar: 28% in the induction group and 32% in the expectant management group (RR, 0.89; 95% CI, 0.72–1.09). The only significant difference in newborn outcomes was an increase in neonatal hyperbilirubinemia and the need for phototherapy, especially in the group delivered before 38 completed weeks of gestation.

A meta-analysis including these trials and two smaller unpublished ones involving a total of 1,190 women with suspected fetal macrosomia (a heterogeneous cohort of nulliparous, multiparous, diabetic, and nondiabetic women) has been published (111). Compared with expectant management, induction of labor for suspected fetal macrosomia reduced the risk of shoulder dystocia (RR, 0.60; 95% CI, 0.37–0.98) and any type of fracture (RR, 0.20; 95% CI, 0.05–0.79) with no change in the risk of cesarean delivery (RR 0.91, 95% CI 0.76–1.09) or instrumental delivery (RR, 0.86; 95% CI, 0.65–1.13). However, there were no differences between the groups for brachial plexus injury, although this outcome was infrequent (RR, 0.21; 95% CI, 0.01–4.28).

The College and the American Academy of Pediatrics recommend against delivery before 39 0/7 weeks of gestation unless it is medically indicated. Whether intervention is better than expectant management for suspected large-for-gestational-age infants, and the gestational age at which delivery should be performed are unclear (112). Although the meta-analysis of available trials is provocative and raises questions for further study, it is not clear that a reduction in shoulder dystocia would be seen with induction of labor after 39 0/7 weeks of gestation (111). At this time, and until additional studies are reported, the College continues to recommend against induction of labor for a suspected large-for-gestational-age infant at any gestational age.

**How many cesarean deliveries for suspected fetal macrosomia would have to be performed to prevent one case of brachial plexus injury?**

The cost-effectiveness of cesarean delivery for fetal macrosomia usually is expressed as the number of cesarean deliveries required to prevent one brachial plexus injury or the cost, in dollars, of each brachial plexus injury avoided. A case–control study demonstrated that 51 cesarean deliveries would be needed to prevent one case of brachial plexus injury if the cutoff for cesarean delivery was 4,500 g among patients who do not have diabetes (37). For a cutoff of 5,000 g, this number decreased to 19 cesarean deliveries. Assuming rates for persistent brachial plexus impairment are between 5% and 22%, the authors of the study suggested that to prevent a single permanent brachial plexus injury, the number of cesarean deliveries increases to between 233 and 1,026 for a birth-weight cutoff of 4,500 g and to between 85 and 373 for a cutoff of 5,000 g (37). Another study using similar methods concluded that between 155 and 588 cesarean deliveries would be needed to prevent a single permanent injury using a cutoff of 4,500 g for infants of women who do not have diabetes (63). However, because the authors did not consider the imperfect predictive values of ultrasonography for macrosomia, they likely underestimated the number of cesarean deliveries that would be needed to implement such a policy.

In two reports analyzing a policy of prophylactic cesarean delivery for macrosomia that took into account the reported sensitivity and specificity of ultrasonography for the detection of macrosomia (4,500 g or greater), it was calculated that 3,695 cesarean deliveries would be required to prevent one permanent injury at an additional cost of $8.7 million for each permanent injury avoided (113, 114). For pregnancies complicated by diabetes, the estimated ratios of cesarean deliveries and cost per permanent injury avoided were more favorable, although these figures were still high at 443 cesarean deliveries performed at a cost of $930,000 for each permanent injury avoided. Because of the lack of well-designed and well-executed randomized clinical trials, a policy of prophylactic cesarean delivery for suspected fetal macrosomia of less than 5,000 g would be economically unsound for pregnancies in the absence of maternal diabetes.

Another cost-effectiveness study compared the strategies of expectant management, induction of labor, and cesarean delivery to prevent permanent brachial plexus injuries among nondiabetic women with an estimated fetal weight of 4,500 g (115). The cost per injury-free newborn was $4,014 for expectant management, $5,212 for cesarean delivery, and $5,165 for induction of labor, which suggests that the expectant management is the preferred approach (115).

**How should a diagnosis of suspected fetal macrosomia affect the management of labor and vaginal delivery?**

A clinician’s suspicion of a large fetus on prenatal examination and communication of fetal size concerns to the patient has been associated with increased labor
and delivery interventions. In a nationally representative survey of U.S. women who gave birth between July 2011 and June 2012 (N=1,960), women with “suspected large babies” had increased adjusted odds of medically induced labor (adjusted OR, 1.9; 95% CI, 1.4–2.6) and were more likely to ask for cesarean deliveries (adjusted OR, 4.6; 95% CI, 2.8–7.6) and have planned cesarean deliveries (adjusted OR, 1.8; 95% CI, 1.0–4.5). Yet only 20% gave birth to an infant weighing 4,000 g or more (116). Obstetrician–gynecologists may not be aware of the effect of communicating fetal size concerns to patients on their perceptions about the likely course of labor and delivery and the need for certain perinatal interventions.

Perhaps the most important consideration for labor and delivery with suspected fetal macrosomia is the decision of whether to conduct a midpelvic operative vaginal delivery. Figure 2 shows that the risk of shoulder dystocia increases with assisted vaginal delivery. Case–control and cohort studies consistently demonstrate an increased risk of shoulder dystocia when the macrosomic fetus is delivered using forceps or vacuum extraction, especially with a midpelvic delivery for a prolonged second stage (7, 117). Rates of shoulder dystocia with midforceps deliveries of infants larger than 4,500 g have been reported to be more than 50%. Barring unusual circumstances, cesarean delivery should be performed for midpelvic arrest of the fetus with suspected macrosomia.

Suspected fetal macrosomia is not a contraindication to a trial of labor after cesarean (TOLAC). Women undergoing TOLAC with a macrosomic fetus have a lower likelihood of vaginal birth after cesarean delivery (VBAC) than women attempting TOLAC who have a nonmacrosomic fetus (118, 119). Although success rates of TOLAC decrease the more the infant’s birth weight exceeds 4,000 g (118, 119), this effect does not decrease absolute VBAC success rates to less than 50% in women who have had a previous vaginal delivery or previous VBAC (119). Studies have shown mixed results when examining the incidence of uterine rupture during a TOLAC with neonatal birth weights greater than 4,000 g. Three studies report finding no association (118, 120, 121), whereas a fourth suggests an increased risk of uterine rupture (RR, 2.3; P<.001) for women undergoing TOLAC who have not had a prior vaginal delivery (119). These studies used actual birth weight as opposed to estimated fetal weight, thus limiting the applicability of these data to making decisions regarding mode of delivery before labor (122). It is appropriate for patients and obstetrician–gynecologists and other obstetric care providers to consider past and predicted birth weights when making decisions regarding TOLAC, but suspected macrosomia alone should not preclude the possibility of a TOLAC.

Summary of Recommendations and Conclusions

The following conclusion is based on good and consistent scientific evidence (Level A):

- The diagnosis of fetal macrosomia is imprecise. For suspected fetal macrosomia, the accuracy of estimated fetal weight using ultrasound biometry is no better than that obtained with clinical palpation.

The following recommendations and conclusions are based on limited or inconsistent scientific evidence (Level B):

- Suspected fetal macrosomia is not an indication for induction of labor because induction does not improve maternal or fetal outcomes.
- With an estimated fetal weight of greater than 4,500 g, a prolonged second stage of labor or arrest of descent in the second stage is an indication for cesarean delivery.
- Barring unusual circumstances, cesarean delivery should be performed for midpelvic arrest of the fetus with suspected macrosomia.
- As with clinical estimates of fetal weight, the true value of ultrasonography in the management of expected fetal macrosomia may be its ability to rule out the diagnosis, which may help to avoid maternal morbidity.

The following recommendations and conclusions are based primarily on consensus and expert opinion (Level C):

- Although the diagnosis of fetal macrosomia is imprecise, prophylactic cesarean delivery may be considered for suspected fetal macrosomia with an estimated fetal weight of at least 5,000 g in women without diabetes and at least 4,500 g in women with diabetes.
- Pregnant women with suspected fetal macrosomia should be provided individualized counseling about the risks and benefits of vaginal and cesarean delivery based on the degree of macrosomia.
- It is appropriate for patients and obstetrician–gynecologists and other obstetric care providers to
consider past and predicted birth weights when making decisions regarding TOLAC, but suspected macrosomia alone should not preclude the possibility of a TOLAC.

References


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The MEDLINE database, the Cochrane Library, and the American College of Obstetricians and Gynecologists’ own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1985–January 2015. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

I Evidence obtained from at least one properly designed randomized controlled trial.

II-1 Evidence obtained from well-designed controlled trials without randomization.

II-2 Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.

II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.

III Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.

Level B—Recommendations are based on limited or inconsistent scientific evidence.

Level C—Recommendations are based primarily on consensus and expert opinion.