SHOULDER DYSTOCIA – Facts, Evidence and Conclusions


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Introduction

The greatest nightmare an obstetrician is likely to face is shoulder dystocia. At an otherwise normal delivery, just after the baby's head has emerged, the neck suddenly retracts back against the mother's perineum causing the baby's cheeks to puff out. The experienced obstetrician knows at this point that the baby's anterior shoulder is caught on the mother's pubic bone and if he or she is unable to free up the shoulder within a few minutes the baby will suffer irreversible brain damage or death.

Shoulder dystocia occurs in approximately one half of one percent of all deliveries. Given that there are 4 million babies born each year in the United States, this delivery complication will be experienced by roughly 20,000 women a year. The larger the baby, the more likely it is to occur. However, even with very large babies shoulder dystocia occurs only occasionally and sporadically. Therefore a physician never knows when it will be encountered.

The most common serious complication following a shoulder dystocia delivery is brachial plexus injury. This is when the nerves in a baby's neck--the brachial plexus--are temporarily or permanently damaged. The nerves of the brachial plexus control the function of the arm and hand. Injury to the upper part of the brachial plexus is called Erb palsy while injury to the lower nerves of the plexus is called Klumpke palsy. Both can cause significant, lifelong disability.

Because of the gravity and unexpectedness of shoulder dystocia it has long been a major area of obstetrical concern. Yet despite the hundreds of published studies about shoulder dystocia there still are multiple, important unanswered questions:

Is shoulder dystocia predictable?

Can it be prevented?

Is there anything that can be done when it does occur to prevent brachial plexus nerve damage?

If there is an injury, was it caused by mismanagement on the part of the physician while attempting to resolve the shoulder dystocia or was it an inevitable consequence of the shoulder dystocia?

The interest obstetricians have in these questions has been heightened in the last two decades by the increasing influence of medical-legal issues on the practice of medicine. As regards shoulder dystocia, it is frequently the case that when a brachial plexus injury occurs, an obstetrician will be charged with negligence. Such claims are now so frequent that law suits related to shoulder dystocia deliveries result in the second largest category of indemnity payments in obstetrics, exceeded only by birth asphyxia.

In their defense, physicians contend that shoulder dystocia is a totally unpredictable event and that even with perfect management brachial plexus injuries will occur.

Where does the truth lie?

This web site represents an attempt to answer this and other questions about shoulder dystocia. By having thoroughly reviewed the published literature on shoulder dystocia and brachial plexus injury from 1965 to the present, it has been possible to frame comprehensive and consistent answers to the major questions that bedevil this area of obstetrics. It is the hope of the author that the information presented here about the cause, preventability, and culpability for shoulder dystocia and brachial plexus injuries will (1) aid in improving the care given to women and their babies and (2) will help adjudicate responsibility in medical liability cases in which a baby has been injured during a shoulder dystocia delivery.
History

The phenomenon of shoulder dystocia has long been recognized. Smellie, one of the earliest physicians specializing in obstetrics, described a situation he encountered in 1730 as follows:

Called to a gentlewoman in labor. The child's head delivered for a long time -- but even with horrid pulling from the midwife, the remarkably large shoulder prevented delivery. I have been called by midwives to many cases of this kind, in which the child was frequently lost.

Morris in 1955 gave what is now a classic description of shoulder dystocia:

The delivery of the head with or without forceps may have been quite easy, but more commonly there has been a little difficulty in completing the extension of the head. The hairy scalp slides out with reluctance. When the forehead has appeared it is necessary to press back the perineum to deliver the face. Fat cheeks eventually emerge. A double chin has to be hooked over the posterior vulvar commissure, to which it remains tightly opposed . . .

Time passes. The child's face becomes suffused. It endeavors unsuccessfully to breathe. Abdominal efforts by the mother and by her attendants produce no advance. Gentle head traction is equally unavailing. Usually equanimity forsakes the attendants -- they push, they pull. Alarm increases. Eventually, "by greater strength of muscle or by some infernal juggle," the difficulty appears to be overcome, and the shoulder and trunk of a goodly child are delivered. The pallor of its body contrasts with the plum-colored cyanosis of the face, and the small quantity of freshly expelled meconium about the buttocks. It dawns upon the attendants that their anxiety was not ill founded, the baby lies limp and voiceless, and only too often remains so despite all efforts at resuscitation.

Perhaps the most famous case of shoulder dystocia was that involving Prince William of Germany who subsequently became Kaiser Wilhelm II in 1888. It seems that William was in breech position at birth and was manipulated by several physicians and a midwife during delivery. Apparently the baby was not breathing when it emerged, but by "continuous rubbing . . . dousing in a hot bath, and a series of short, sharp slaps on his buttocks" the doctors managed to get the child to breathe. The third day after delivery the midwife noticed that William's left arm was slack. It was thought that the arm had been "wrenched out of the socket" and some of the muscle tissue torn. In addition it is suspected that there were several moments of asphyxia which might have caused slight brain damage. It has been postulated that this was the cause of William's later hyperactivity and emotional instability. He may also have suffered slight cerebral palsy. For the rest of his life, William's "withered" left arm was concealed from the public by careful posing for photographs.

What is shoulder dystocia?

Shoulder dystocia occurs when, after delivery of the fetal head, the baby's anterior shoulder gets stuck behind the mother's pubic bone. If this happens, the remainder of the baby does not follow the head easily out of the vagina as it usually does during vaginal deliveries.

This simple definition of shoulder dystocia, however, glosses over many complexities. For example, should a delivery be categorized as involving shoulder dystocia only when there is some time delay -- 60 seconds is often suggested in this context-between the delivery of a baby's head and shoulders? Or is shoulder dystocia present any time that a delivering physician finds that the shoulders cannot be delivered with the normal amount of downward traction on the fetal head? Some have suggested that the definition of true shoulder dystocia requires that an obstetrician had to perform special maneuvers in order to deliver the shoulders.
Exactly how shoulder dystocia is defined is more than just a semantic issue. It sets the parameters for the collection of statistics related to shoulder dystocia, a necessity for research aimed at decreasing shoulder dystocia related injuries. It also determines when a baby's injuries might be attributed to a physician's actions during labor and delivery.
Pelvic anatomy related to shoulder dystocia

It is necessary to know something about the anatomy of the fetus and the maternal pelvis in order to understand how shoulder dystocia comes about and how it causes the injuries it does.

As the accompanying diagram shows, the maternal pelvis is composed of a series of bones forming a circle protecting the pelvic organs. The front-most bone is the symphysis pubis. It is on this structure that a baby's anterior shoulder gets caught during a delivery complicated by shoulder dystocia. The bone at the back of the maternal pelvis is the sacrum. Because of its shape, it generally serves as a slide over which a baby's posterior shoulder can descend freely during labor and delivery. The side walls of the maternal pelvis, although very important in determining the ease of the process of labor in general, usually do not contribute to shoulder dystocia.

In normal vaginal deliveries the head of the baby, called the "vertex", emerges first. During labor, the soft, mobile bones of the fetal head can "mold"-alter their shape -- and, to a slight degree, overlap. This facilitates the fetal head fitting into and through the maternal pelvis. The baby's shoulders, likewise being flexible, usually follow the delivery of the baby's head quickly and easily. But for this to happen, the axis of the fetal shoulders must descend into the maternal pelvis at an angle oblique to the pelvis's anterior-posterior dimension. This position affords the shoulders the most room for their passage. If instead the shoulders line up in a straight front-to-back orientation as they are about to emerge from the mother's pelvis, there will often be insufficient room for them to squeeze through. The back of the mother's pubic bone then forms a shelf on which the baby's anterior shoulder can get caught. If this happens, the shoulders cannot deliver and a shoulder dystocia results.
Shoulder dystocia can also occur if the posterior shoulder of a baby gets caught on its mother's sacrum. This is a far less common cause of shoulder dystocia. The sacrum, having no protrusions equivalent to that of the pubic bone, is far less likely to impede the descent of the baby's posterior shoulder.

As can be readily appreciated, it is the relative sizes of the fetal head, shoulders, and chest compared to the shape and size of the maternal pelvis that determine how smoothly a delivery will go. Usually it is the fetal head that has the largest dimensions. Thus if it can pass through the maternal pelvis without difficulty, the rest of the baby usually follows easily. However, when the dimensions of the fetal shoulders or chest rival those of its head, the chances of a shoulder dystocia occurring are much increased. Such situations occur more frequently both in large babies and in babies of diabetic mothers.

In large babies, much of the excess growth that occurs is in the chest and abdominal areas. In these babies the dimensions of the shoulders and chest tend to be disproportionately larger than those of the head. This trend is exaggerated in babies of diabetic mothers. Multiple studies have shown that babies of diabetic mothers more frequently have larger ratios of shoulder circumference to head circumference than do their peers born of nondiabetic mothers. Babies of diabetic mothers also have greater arm circumference, larger triceps folds, and a higher percentage of body fat. Since larger babies are more likely to "get stuck", much of the work in the field of shoulder dystocia has been targeted at attempting to predict which babies will be larger than normal, especially when their mothers are diabetic.

Except in extraordinary circumstances, once the fetal head and shoulders have been delivered the remainder of the fetal trunk and legs slide out easily. Such extraordinary circumstances preventing easy delivery of the fetal body might be when:

- A fetus has a large abdominal or lower back tumor,
- The umbilical cord is wrapped tightly around the baby's neck, or
- There is a severe constriction of the uterine muscle -- "contraction rings" -- trapping the baby in the uterus.

The above applies only to vertex or headfirst deliveries. Breech deliveries, where the fetal legs and buttocks emerge first from the vagina, can also result in injury to the fetal arms and neck, producing the brachial plexus injuries discussed above. However, since these and other sorts of injuries to babies from vaginal breech deliveries occur at a relatively high rate, most breech babies in the United States are now delivered by cesarean section.

Incidence

The incidence of shoulder dystocia is generally reported to be between 0.5 % and 1.5% with scattered reports listing values both higher and lower. Those studies involving the largest number of deliveries have usually found the rate of shoulder dystocia in a general population to be 0.5% - 0.6%. The "true" incidence of shoulder dystocia, however, is very much dependent upon how it is defined, how it is reported, and the characteristics of the population being measured.

The accuracy of reporting is an important variable in shoulder dystocia statistics. Many obstetricians are reluctant to write down in their delivery notes that a shoulder dystocia has occurred for fear that this will be a red flag attracting a malpractice suit should it later turn out that the baby has suffered an injury. Some studies have shown that only 25% to 50% of shoulder dystocias -- as noted by objective observers in a delivery room -- are recorded by the delivering physician.

How one defines shoulder dystocia, of course, affects its reported incidence. Some obstetricians will only report a delivery as involving shoulder dystocia if they had to employ specific maneuvers to deliver the baby's anterior shoulder. Others will record shoulder dystocia
if there is any delay in the emergence of the shoulder following delivery of the head. In some cases a physician will only record "shoulder dystocia" when a fetal injury has occurred.

Finally, the characteristics of the delivery group being measured will affect statistics on shoulder dystocia. A study evaluating the incidence of shoulder dystocia utilizing only large babies or only infants of diabetic mothers as subjects will have a much higher reported incidence of shoulder dystocia than if the population were a general one containing both small and large babies and the normal percentage of mothers having diabetes.

Several of the more recent studies have shown a slightly higher incidence of shoulder dystocia than has been recorded in the past, reaching just above 1% of all deliveries. The question has therefore been asked, "Is the rate of shoulder dystocia increasing?" While there is as yet no definitive answer to this question, several hypotheses have been given to explain this possible trend:

1. On average babies are significantly larger then in years past. The percentage of very large baby's (>4000gms) in one study has gone up 300% between 1970 and 1988.

2. Over the last several decades there has been a marked increase in average maternal weight, average maternal weight gain during pregnancy, and the number of diabetic women having babies. All of these factors could be expected to increase the incidence of shoulder dystocia.

3. The increased focus of attention among obstetricians about shoulder dystocia deliveries may have heightened awareness about it and increased reporting of it.

Recurrent shoulder dystocia

The question as to whether or not women who have had a shoulder dystocia in a previous delivery are more likely to have one again in a subsequent delivery is an extremely important one. This information will help guide how future deliveries in these women are managed.

It appears from the literature that the risk of recurrent shoulder dystocia is substantial: 10 to 15%. Moreover, women who have had a shoulder dystocia delivery that resulted in injury to the fetus have an even greater risk of having a recurrent shoulder dystocia and subsequent fetal injury.

Fetal injuries following shoulder dystocia

Following shoulder dystocia deliveries, 20% of babies will suffer some sort of injury, either temporary or permanent. The most common of these injuries are damage to the brachial plexus nerves, fractured clavicles, fractured humeri, contusions and lacerations, and birth asphyxia.

Brachial plexus injury

The brachial plexus consists of the nerve roots of spinal cord segments C5, C6, C7, C8, and T1. (See accompanying diagram). These nerve roots form three trunks which divide into anterior and posterior divisions. The upper trunk is made up of nerves from C5 and C6, the middle trunk from undivided fibers of C7, and the lowermost trunk is made up of nerves from C8 and T1.
There are two major types of brachial plexus injury: Erb palsy and Klumpke palsy.

Erb palsy, the more commonly occurring of the two forms of brachial plexus injury, involves the upper trunk of the brachial plexus (nerve roots C5 through C7). This palsy affects the muscles of the upper arm and causes abnormal positioning of the scapula called "winging". The supinator and extensor muscles of the wrist that are controlled by C6 may also be affected. Sensory deficits are usually limited to the distribution of the musculo-cutaneous nerve. Together, these injuries result in a child having a humerus that is pulled in towards the body (adducted) and internally rotated. The forearm extended. Some have described this as the "waiters tip" position.

Klumpke palsy involves lower trunk lesions from nerve roots C7, C8, and T1. In this injury the elbow becomes flexed and the forearm supinated (opened up, palm-upwards) with a characteristic clawlike deformity of the hand. Sensation in the palm of the hand is diminished.

It has been traditionally thought that most brachial plexus injuries result from stretching of the nerves of the brachial plexus during delivery. While this likely accounts for many brachial plexus injuries, reports of such injuries following deliveries in which there was no shoulder dystocia has led investigators to question whether or not brachial plexus injuries might have other etiologies. Such etiologies might be intrauterine cerebrovascular accidents (strokes),
overstretching of the brachial plexus from fetal movement during the pregnancy, or basic maldevelopment of the brachial plexus.

In some brachial plexus injuries sympathetic nerve fibers that traverse T1 can be damaged. This can result in depression of the eyelid and drooping of the mouth on the affected side, a constellation of symptoms called Horner's Syndrome.

![Illustration of Shoulder Dystocia and Brachial Plexus]

**Incidence of brachial plexus injury**

Brachial plexus injury is the classic injury following shoulder dystocia. First described by Duchenne in 1872, it occurs following roughly 10% of all shoulder dystocia deliveries as reported in a variety of studies:

- Gherman (1998) 16.8%
- McFarland (1996) 8.5%
- Bofill (1997) 9.5%
- Baskett (1995) 13%
- Stallings (2001) 12.7%
- Nocon (1993) 15.1%

The incidence of shoulder dystocia rises with many factors, the most prominent of which are the size of the baby and maternal diabetes status. Given that roughly one half of 1% of all babies experience shoulder dystocia during delivery and that approximately 10% of shoulder dystocia deliveries result in brachial plexus injuries, the theoretical rate of brachial plexus injury following shoulder dystocia is roughly one in 2000 deliveries. This prediction is confirmed by observation.

Brachial plexus injuries can also occur without there having been a shoulder dystocia. There are multiple reports in the literature of brachial plexus injuries following vaginal deliveries without shoulder dystocia, subsequent to breech deliveries, and even after otherwise uncomplicated cesarean sections. In fact, the rate of brachial plexus injury in which no
shoulder dystocia was reported has been quoted to be as high as 40% to 50%. These findings are discussed in detail on subsequent pages on this site.

The natural history of brachial plexus injury

Fortunately, most brachial plexus birth injuries are transient. The majority of such injuries resolve by three months, with a range of two weeks to 12 months. Only 4 to 15% result in some degree of permanent injury:

Rate of brachial plexus injuries that persist permanently

- Eckert (1997) 5-22%
- Johnson (1979) 7.8%
- Graham (1997) 20%
- Sandmire (1988) 11.8%
- Nocon (1995) 4%
- Average: ~10%

Patients with upper lesions -- Erb palsy -- have a better prognosis than those with lower brachial plexus injuries-Klumpke palsy. Whereas upwards of 90 to 95% of all Erb palsies totally resolve, only 60% of Klumpke palsies do. Interestingly, those brachial plexus injuries associated with non-shoulder dystocia deliveries persist more often than those occurring following deliveries in which a shoulder dystocia was documented.

Brachial plexus injuries can also produce secondary effects. Muscle imbalances produced in the hand, arm, and shoulder may result in osseous deformities of the shoulder and elbow and in dislocations of the radial head. The development of the affected arm may be compromised, resulting in its being as much as 10 cm shorter than the nonaffected arm.

Treatment options and prognosis

As mentioned, the majority of brachial plexus injuries will resolve spontaneously over the course of several months to a year. Physical therapy is usually employed within weeks of birth to help strengthen muscles whose nerve supply has been damaged. For those injuries that are permanent there are two modes of therapy.

First, physical therapy can strengthen muscles that are only partially denervated, strengthen surrounding muscles to compensate for functional loss, and improve the range of motion of the affected shoulder, arm, elbow, or hand.

Second, surgical therapy in the form of nerve grafting or muscle transposition may be undertaken. There is, however, great controversy about the efficacy of such surgical procedures in improving the outcome of those with brachial plexus injuries. Several orthopedic and neurosurgeons from around the country who do this sort of surgery frequently report various degrees of improvement in many of their patients. Others in the field, however, refute these claims and feel that there is little or no benefit to such surgery.
Other physical injuries following shoulder dystocia deliveries

Fractured clavicle

The second most common injury suffered by infants following shoulder dystocia deliveries is a fractured clavicle. The incidence of this injury following shoulder dystocia is 10%.

If the fetal shoulders and chest are relatively large in relation to the maternal pelvis, significant pressure may be placed on them as they pass through the birth canal following delivery of the fetal head. In some infants, this pressure causes the clavicle to fracture. The overlapping of the ends of the broken clavicle reduces the diameter of the fetal chest and intra-shoulder distance and allows them to be delivered. This "safety valve" effect may in fact help reduce the incidence of severe brachial plexus injury.

The baseline clavicular fracture rate for all deliveries appears to be about 0.3%. Despite the fact that shoulder dystocia increases the risk of clavicular fracture 30 fold, approximately 75% of clavicular fractures are not associated with shoulder dystocia. Interestingly, although there are multiple reports of brachial plexus injuries following cesarean sections, clavicular fractures following cesarean sections are extremely rare.

Fractured humerus

This occurs in approximately 4% of infants with shoulder dystocia deliveries. Such injuries heal rapidly and are rarely result in litigation.

Contusions

The force with which the infant's shoulder is compressed against the maternal pubic bone and the pressure of the deliverer's hands on the fetus while performing various maneuvers to effect delivery will often result in bruises on the baby's body. Such bruising has often been cited by plaintiff attorneys as evidence that a baby has been handled roughly at delivery despite the fact that such bruises are common even in routine deliveries not involving shoulder dystocia or fetal injury.

Fetal asphyxia

The most feared complication of shoulder dystocia is fetal asphyxia. It has been frequently demonstrated in both animal experiments and in retrospective analyses of babies born following dramatic cessation of umbilical blood flow (placental abruption, uterine rupture, etc.) that if babies are not delivered within five to 10 minutes they will suffer irreversible neurologic damage or death. Wood, in an often-quoted article from 1973, showed that in the time between delivery of the head and trunk of an infant, the umbilical artery pH declines at a rate of 0.04 units per minute. This means that at the five-minute mark following delivery of the fetal head, the baby's pH may have dropped from 7.2 -- a common level after several hours of pushing -- to 7.0, the level that defines asphyxia. By 10 minutes the pH would have dropped to 6.8. Ouzounian (1998) reported that of 39 babies whose deliveries involved shoulder dystocia, 15 who suffered brain injury averaged a head-to-shoulder delivery interval of 10.6 minutes while the 24 babies also born following shoulder dystocia but without brain injury had a head-to-shoulder delivery interval of only 4.3 minutes. Cerebral palsy and fetal death are rare but unfortunately not unheard of consequences of prolonged head-to-shoulder delivery intervals following shoulder dystocia deliveries.

The reason for the increasing acidosis and asphyxia that occurs during a shoulder dystocia delivery is that once the fetal head emerges from the mother, the baby's umbilical cord becomes tightly compressed between its body and that of the mother's birth canal. This significantly decreases or totally cuts off blood flow between the mother and infant. If the pressure on the cord is not rapidly relieved, the consequences of cessation of lack of umbilical flow -- decreased delivery of oxygen to the fetus -- will occur.
Maternal injuries

The mother, too, is at some risk when shoulder dystocia occurs. The most common complications she may suffer are excessive blood loss and vaginal and vulvar lacerations.

Significant blood loss, which occurs in one quarter of all shoulder dystocia deliveries, may be seen either during the delivery or in the postpartum period. Its usual causes are uterine atony or lacerations of the maternal birth canal and surrounding structures. Such lacerations may involve the vaginal wall, cervix, extensions of episiotomies, or tears into the rectum. Uterine rupture has also been reported.

Because of the pressure directed upwards towards the bladder by the anterior shoulder in shoulder dystocia deliveries, post-partum bladder atony is frequently seen. Fortunately, it is almost always temporary. Occasionally the mother’s symphyseal joint may become separated or the lateral femoral cutaneous nerve damaged, most likely the result of overaggressive hyperflexion of the maternal legs during attempts at resolving the shoulder dystocia.

Ramifications

Even though shoulder dystocia occurs in only 0.5% to 1.0% of all deliveries, the fact that there are approximately 4 million deliveries a year in United States means that many thousands of mothers and babies will experience this obstetrical complication. A little math tells the story:

--If the rate of occurrence of shoulder dystocia is approximately 0.5%, and

--If the rate of brachial plexus injury is 10% in these deliveries, and

--If the rate of permanent injury is 10% of all brachial plexus injuries,

then the rate of permanent brachial plexus injury will be one in 10,000 to one in 20,000 deliveries.

This means that there will be approximately 200 to 400 babies born each year in the United States with permanent brachial plexus injuries following shoulder dystocia deliveries. In addition, there will be babies who will suffer severe central neurologic injury such as cerebral palsy from asphyxia. There will even be babies who will die following severe shoulder dystocias. It is for these reasons that shoulder dystocia injuries have become an important area of medical -- and medical-legal -- concern.

The medical concern involves trying to find ways of preventing shoulder dystocia related injuries. The best way to do this, of course, would be to prevent shoulder dystocia from occurring. If this is not possible, then it is necessary to try to find ways to resolve shoulder dystocias with minimal fetal injury when they do occur. However, since many brachial plexus injuries are seen following deliveries where there was no shoulder dystocia, even perfect prediction and prevention of shoulder dystocias would not entirely eliminate the occurrence of brachial plexus birth injuries.

The medical-legal implications of the above are obvious: Given a severely injured infant, if it can be shown that a physician was negligent either in allowing a shoulder dystocia to occur or in his or her handling of the shoulder dystocia once it did occur, then according to our legal system, that physician will be held liable for damages to the injured baby and his or her family.

Can shoulder dystocia be anticipated accurately?

There are some physicians who have claimed that the answer to this question is "Yes". Hassan (1988) stated,
"In the majority of cases shoulder dystocia can be anticipated. Risk factors include maternal obesity, diabetes, preeclampsia, prolonged gestation, and fetal macrosomia. A male infant is at a greater risk for macrosomia and dystocia."


However, this is overwhelmingly a minority opinion. The vast majority of obstetricians, including those who have done the most work on shoulder dystocia and brachial plexus injuries, have concluded that it is impossible with any degree of certainty to predict in which deliveries shoulder dystocia will occur. The key issue involved is "certainty". As will be shown, there are multiple "risk" factors for shoulder dystocia. Mothers and babies having these risk factors are, in an absolute sense, more likely than mothers and babies without these factors to experience shoulder dystocia. But whether the predictive value of such factors is high enough to be useful clinically, that is, to justify changes in labor management plans in hopes of avoiding shoulder dystocia, is what is at issue. Moreover, as with most statistical questions in medicine, the predictability of shoulder dystocia has to be looked at from two directions:

**Sensitivity:** Are the risk factors associated with shoulder dystocia able to accurately identify most babies who will have shoulder dystocia at birth?

**Positive predictive value:** What percentage of mothers and babies having these risk factors will, in fact, experience shoulder dystocia?

In the case of shoulder dystocia, its infrequent rate of occurrence (0.5%) and the low positive predictive value of risk factors for it severely impede the ability of obstetricians to utilize such information to advantageously alter clinical care.

The medical literature confirms this overwhelmingly. Gherman (2002), among current leaders in the study of shoulder dystocia, has said the following:

Most of these preconceptions and prenatal risk factors have extremely poor positive predictive values and therefore do not allow the obstetrician to accurately and reliably predict the occurrence of shoulder dystocia.

Resnick (1988), discussing the ability of obstetricians to predict when shoulder dystocias will occur, states that "the diagnosis [of shoulder dystocia] will often be made only after delivery of the fetal head."

Lewis (1998) noted that only 25% of shoulder dystocia cases had at least one significant risk factor.

Geary (1995) reported that when all antenatal risk factors for shoulder dystocia were taken into account, the positive predictive value was less than 2% for individual factors and less than 3% when multiple factors were combined.

**The bottom line is this: Nowhere in the literature are there studies that show that the sensitivity or positive predictive value for predicting shoulder dystocia are high enough to justify obstetrical interventions in hopes of avoiding it.**

**Categories of risk factors**

The risk factors for shoulder dystocia can generally be divided into three categories:

- **Preconceptual** -- before pregnancy
- **Antepartum** -- during pregnancy
Intrapartum -- during labor and delivery

Preconceptual risk factors for shoulder dystocia

1. Previous shoulder dystocia

Previous shoulder dystocia proves to be one of the most accurate predictors for recurrent shoulder dystocia. This makes perfect sense. The pelvic anatomy of a woman does not change in between pregnancies. Moreover, second and subsequent babies are likely to be larger than first or previous babies.

The risk of a woman having a repeat shoulder dystocia once having had one, as reported from various authors, is:

- Smith (1994) 12%
- Ginsburg (2001) 11%.
- Gherman (2002) 11.9%

This compares with the baseline risk for shoulder dystocia of 0.5%. Because of this significant increase in risk—approximately 20-fold—some obstetricians have proposed "once a shoulder dystocia, always a cesarean".

2. Maternal obesity

A mother's weight, likewise, proves to be significantly correlated with shoulder dystocia. Emerson showed (1962) that in his series shoulder dystocia occurred twice as often in obese women as it did in normal weight women: 1.78% versus 0.81%. Sandmire (1988) estimated that the relative risk of shoulder dystocia in women with a prepregnancy weight of greater than 82 kg (181 lbs) was 2.3.

However whether this is a primary effect or merely reflects the fact that obese women tend to have large babies is not clear. To answer this question would require a study evaluating the rates of shoulder dystocia correlated with both maternal and fetal weight categories. Given the fact that more pregnant women than ever are obese, and that obesity has a marked correlation with fetal macrosomia, it is likely that the rate of shoulder dystocia will be seen to increase over the next decade.

But there are major problems with attempting to use obesity as a predictor of shoulder dystocia. Although obese women do have an incidence of shoulder dystocia several fold higher than that of thinner women, even the most pessimistic reports -- such as that by Hernandez in 1990 -- show a rate of shoulder dystocia in women weighing over 250 lbs. of no more than 5%. Thus even in this high risk population, 95% of extremely obese women will not have a shoulder dystocia at delivery. Thus any intervention undertaken based solely on the relationship between maternal weight and macrosomia would be without justification for 19 of 20 of such women.

3. Maternal age

Some studies have claimed maternal age to be a risk factor for shoulder dystocia. But careful analysis reveals that maternal age is a risk factor for shoulder dystocia only in so far as maternal obesity, diabetes, excessive weight gain, and instrumental deliveries are all more common in older women. These, of course, are all themselves risk factors for shoulder dystocia. In one of the few studies looking at the correlation between maternal weight and shoulder dystocia in isolation, Bahar (1996) did not find any difference in shoulder dystocia based on maternal age alone.
4. Abnormal pelvis

O'Leary, in his book on shoulder dystocia, places great significance on the abnormal pelvis as a risk factor for shoulder dystocia—but offers no data to support his claim. Although it would make sense that a decrease in certain pelvic dimensions would increase the possibility of a baby's anterior shoulder getting caught on the maternal pubic bone, there are no reports in the literature demonstrating a relationship between shoulder dystocia and objectively-measured pelvic shape.

Moreover, the use of pelvimetry-x-ray or other measurement of pelvic dimensions-in obstetrics was discarded years ago, for several reasons:

1. Except in the very most extreme cases of congenital or pathological pelvic deformity, there is poor correlation between pelvic size and a woman's capacity to delivery vaginally.

2. The ability to more accurately monitor babies in labor enables obstetricians to safely allow labor itself to be the test of whether or not a baby will "fit" into and through the maternal pelvis.

5. Multiparity

In a 10-year series collected from Boston's Beth Israel Hospital covering the years 1975 to 1985, Acker (1988) showed that there were more Erb palsies in babies born to multiparous women then to primigravida women. He attributed this to a marked increase in precipitous labors in such women. In his series he noted that 31.8% of all babies with Erb palsy had experienced a precipitous delivery.

But as with maternal age, by the time a woman becomes "multiparous", she is old enough to have an increased risk of having other risk factors for shoulder dystocia such as larger babies, obesity, and diabetes. Moreover, only multiparous women could have the very significant risk factor of having had a previous shoulder dystocia. Thus most experts feel any relationship between multiparity and shoulder dystocia is secondary to other, more primary, risk factors.

Summary of preconceptual risk factors

- Previous shoulder dystocia significantly increases the risk of repeat shoulder dystocia
- Shoulder dystocia is seen more commonly with increased maternal age, obesity, and multiparity -- but in reality these are only markers for the increased risk of more primary risk factors
- There is no evidence linking the "abnormal pelvis" to shoulder dystocia

B. Antepartum factors risk factors for shoulder dystocia

1. Macrosomia

Macrosomia is far and away the most significant risk factor for shoulder dystocia. It is the factor that has been most studied and most often proposed as a potential target for manipulation in hopes of reducing the number of shoulder dystocia deliveries. Some authors go so far as to claim that no other risk factor has any independent predictive value for the occurrence of shoulder dystocia.

The most obvious confirmation of this relationship consists of those studies measuring the percentage of babies in different weight groups that experienced shoulder dystocia. What is vitally important to keep in mind when considering such data, however, is that these are the
weights ascertained after delivery. They were not available to the obstetrician before delivery in making his or her clinical decisions as to how the delivery should be conducted.

Acker (1985) found that babies weighing over 4500gms experienced shoulder dystocia 22.6% of the time. The shoulder dystocia rate in his general population was 2%. His report showed the following:

<table>
<thead>
<tr>
<th>Infant weight in Nondiabetic women</th>
<th>Percent shoulder dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4000 g</td>
<td>1.1%</td>
</tr>
<tr>
<td>4000g - 4499 g</td>
<td>10.0%</td>
</tr>
<tr>
<td>Greater than 4500 g</td>
<td>22.6%</td>
</tr>
</tbody>
</table>

More than 70% of all shoulder dystocias in his study occurred in infants weighing more than 4000 g.

Kolderup (1997), in a review of 2924 macrosomic deliveries at UCSF, reported that macrosomic infants have a six fold increase in significant injury from shoulder dystocia deliveries compared with controls.

Jackson (1988) showed in his series of 8258 deliveries that the average birth weight of babies who suffered brachial plexus injuries was 4029 g., whereas the average birth weight of all deliveries was 3160 g,

Lazer (1986) reported that the shoulder dystocia rate for infants weighing more than 4500 g was 18.5% while for "smaller babies" in his series the rate was 0.2%.

Nisbet (1998) published a chart showing similar data:

<table>
<thead>
<tr>
<th>Weight</th>
<th>Percent shoulder dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000-4250</td>
<td>5.2</td>
</tr>
<tr>
<td>4250-4500</td>
<td>9.1</td>
</tr>
<tr>
<td>4500-4750</td>
<td>14.3</td>
</tr>
<tr>
<td>4750-5000</td>
<td>21.1</td>
</tr>
</tbody>
</table>

Sandmire (1998) likewise showed that the incidence of shoulder dystocia significantly increased with birth weight:

<table>
<thead>
<tr>
<th>Infant weight</th>
<th>Rate of shoulder dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4000g</td>
<td>0.3%</td>
</tr>
<tr>
<td>4000-4500 g</td>
<td>4.7%</td>
</tr>
<tr>
<td>Greater than 4500 g</td>
<td>9.4%</td>
</tr>
</tbody>
</table>

What is macrosomia?

The definition of macrosomia has varied both through the years and according to the author writing about it. The various cutoff points used to define macrosomia have been 4000 g, 4500 g, and 5000 g. Often a distinction has been made between macrosomia in nondiabetic versus diabetic mothers, the bar being set lower for the fetuses of diabetic mothers. In general, in babies born to nondiabetic mothers 5% to 7% will weigh more than 4000 g; 1% will exceed 4500 g.

One of the most important factors about macrosomia is the differential rate of growth of the fetal head, chest, and trunk as gestation proceeds, both in the babies of diabetic and of nondiabetic mothers. Until 36-38 weeks, the fetal head generally remains larger than the trunk. Between 36 and 40 weeks, however, the relative growth of the abdomen, chest, and
shoulders begins to exceed that of the fetal head. This is especially the case in babies of diabetic mothers where glucose substrate levels are higher in both the mother and fetus. Thus both in prolonged gestation and in babies of diabetic mothers the size of a baby's trunk is likely to increase, increasing its chances of shoulder dystocia.

**How is fetal weight predicted and how accurate are these predictions?**

Although the correlation between fetal weight and shoulder dystocia is of great interest to obstetricians, knowing about this relationship is of no use unless fetal weight -- and the corresponding increased risk of shoulder dystocia -- can be predicted *prior to delivery*. How good, therefore, are our current techniques for estimating fetal weight?

Traditionally, fetal weight has been estimated by measurement of uterine height and by Leopold maneuvers. "Leopold maneuvers" is the name given to palpation of the maternal abdominal wall a series of four specific steps in order to determine fetal position, fetal presentation, and an estimate of the size of the baby.

Such estimates, however, are notoriously inaccurate. Studies have shown grave discrepancies between estimation of fetal weight by experienced obstetricians and actual fetal weight at delivery. Moreover these studies show that the same obstetrician will make different estimates of fetal weight on the same maternal abdomen when repeatedly checked at close intervals.

With the advent of ultrasonic fetal evaluation in the 1970's, it was hoped that a more accurate means of assessing fetal weight was at hand. Many papers were published presenting various formulas for ultrasound estimation of fetal size. Most of these involved some combination of measurements of fetal head and abdominal dimensions and fetal femur length. However comprehensive analyses of these various ultrasound formulas have concluded that none are consistently more accurate than being within 10 to 15% of actual birth weights. Chauhan in 1995 went so far as to say that in more than half of the models for ultrasound prediction, *clinical* predictions by obstetricians were as or more accurate. This was found to be especially true in larger babies:

> From these data it appears that sonographic models are not significantly superior to clinical examination in detecting newborns with birth weight's greater than or equal to 4000 g.

Another study by Chauhan (1992) showed that pregnant women themselves were more accurate than either ultrasound or physician clinical estimates in determining the birth weights of their infants.

There are many studies that confirm the inability of any current diagnostic technique to determine fetal weight prior to birth to any better than 10-15% above or below the true weight:

- **Delpapa (1991):** Only 48% of estimates of fetal weight as determined by ultrasound within three days of birth were within 500 g of the final fetal weight.

- **Benson (1987):** The use of ultrasound formulas to predict macrosomia was correct in only 47% of infants.

- **Jazayeri (1999):** Using a formula based on ultrasound abdominal circumference in an attempt to determine which babies would weigh over 4500gms she obtained a positive predictive value of only 9%.

**Shoulder/chest/abdomen ratios**
As discussed above, postterm growth and maternal diabetes result in the fetal trunk growing larger relative to the fetal head. The same pattern of disproportionate growth occurs with babies that are large for any reason, including inherent genetic predisposition. This is why macrosomic babies have a higher incidence of shoulder dystocia. In a normally proportioned baby, once the head is delivered the fetal shoulders and body usually deliver easily. With shoulders and trunk bigger than the fetal head, it is much more likely that they will get stuck.

Several investigators have sought to measure the differences in size between fetal shoulders, trunks, and head circumferences to see if there existed a certain ratio at which the risk of shoulder dystocia became prohibitively high. Hopwood (1982) proposed that when the transthoracic diameter is 1.5 cm larger than the biparietal diameter, shoulder dystocia would be significantly increased. Kitzmiller in 1987 developed a formula involving a CT scan of fetal shoulders by which he was able to predict fetal weight with good accuracy: a positive predictive value of 78% for predicting birth weights over 4200 g, with a negative predictive value of 100%.

However, several authors have refuted the utility of using the relationship between measurements of different anatomic structures to predict shoulder dystocia. Benson (1986), while acknowledging that femur length/abdominal circumference ratios differ in macrosomic vs. nonmacrosomic fetuses, claimed that there is too much overlap between the larger and smaller groups in any formula protocol to be clinically useful. He states in his paper that "for no cutoff value of these measurements is there a high sensitivity and high specificity."

**Thus the question: Can shoulder dystocia be reliably predicted by estimating fetal weight?**

The problems with attempting to estimate which fetuses will be macrosomic and using this information as a tool for predicting shoulder dystocia are twofold:

In the first place, it is the general conclusion of most obstetrical experts who have studied this issue that predicting macrosomia is unreliable. If macrosomia cannot be reliably determined, it is hard to try to use it to predict shoulder dystocia.

Secondly, only a very small percentage of babies, even of those who have macrosomia, go on to develop shoulder dystocia. This presents a significant obstacle to the use of estimates of fetal weight as a tool for deciding when to change clinical management in hopes of preventing shoulder dystocia deliveries.

These difficulties are highlighted in the data presented below:

Resnick (1980) found that shoulder dystocia occurred in only 1.7% of 1409 infants born at Johns Hopkins Hospital weighing more than 4000 g.

Acker (1986) pointed out that although the relative frequency of shoulder dystocia varied directly with increasing birth weight, almost half of the shoulder dystocias occurred in deliveries involving average and smaller babies. This is because there were so many more of them. Forty-seven percent of all shoulder dystocias at the Beth Israel hospital during the time of his study occurred in babies weighing less than 4000 g, a weight category which encompassed 91.2% of his total delivery population. Thus any attempt to use estimates of fetal weight to reduce the incidence of shoulder dystocia would miss half of all shoulder dystocias -- even if macrosomia could be accurately measured.

Gonen (2000) evaluated 17 babies with brachial plexus injuries from a population of 16,416 deliveries. Only three of these injured babies were macrosomic.

Geary (1995) found that the positive predictive value of a birth weight of more than 4000 g for predicting shoulder dystocia was only 3.3%.
Delpapa's 1991 study showed that, at his institution, 50% of babies estimated to weigh more than 4000gm in fact had birth weights below 4000gm -- a false positive rate for predicting macrosomia of 50%!

Levine in 1992 showed that if macrosomia was defined as the 90th percentile of fetal weight for a given gestational age, then sonographic prediction of macrosomia was wrong 50% of the time both in underestimating and overestimating fetal weight. Similar unsuccessful attempts to accurately ascertain fetal birth weight during the antenatal or intrapartum period have been published by:

    Sandmire (1993)
    Sacks DA (2000)
    Boyd (1983)
    Chauhan (1992)
    Levine (1992)

The American College of Obstetricians and Gynecologists bulletin on shoulder dystocia states that ultrasound has a sensitivity of only 22 to 44% and a positive predictive value of only 30 to 44% in predicting macrosomia.

Thus, as can be seen, it is the general consensus of obstetricians who have done research in the area of shoulder dystocia that **the occurrence of shoulder dystocia cannot be reliably predicted.**

El Madany sums up this issue well in his 1990 paper:

    "Even if certain combinations of risk factors exist which could with high likelihood isolate which babies experienced shoulder dystocia, the inability to predict macrosomia with the requisite degree of certainty on which such a clinical suspicion is based precludes making active action protocols. Until the macrosomic infant can be accurately identified, no reasonable risk factor profile can be established."

Sandmire, in his 1993 article, concludes:

    "Any approach using ultrasound would have to demonstrate that its use improves newborn or maternal outcome without disproportionate increases in morbidity and mortality. A barrier to achieving this goal is the inaccuracy associated with ultrasonic estimations of fetal weight. The current ultrasonic procedures for estimation of fetal weight are not accurate enough for detecting macrosomia defined by weight criteria. And even if clinicians could determine fetal weight accurately, the frequency of persistent fetal injuries associated with vaginal birth of the macrosomic fetus is so low that induction of labor or cesarean birth is not justified on that basis. Delivery decisions based on inaccurate estimated fetal weight should be avoided."

**Thus, while macrosomia is a major risk factor for shoulder dystocia, it is not possible to accurately predict shoulder dystocia by attempting prediction of macrosomia**
2. Diabetes

Next to macrosomia, the factor most closely associated with shoulder dystocia is maternal diabetes in pregnancy. One of the first clear-cut demonstrations of this was Acker's 1985 paper showing the following:

<table>
<thead>
<tr>
<th>Estimated fetal wt.</th>
<th>Nondiabetic % shoulder dystocia</th>
<th>Diabetic % shoulder dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4000 g</td>
<td>1.1%</td>
<td>3.7%</td>
</tr>
<tr>
<td>4000-4499 g</td>
<td>10.0%</td>
<td>30.6%</td>
</tr>
<tr>
<td>&gt; 4500 g</td>
<td>22.6%</td>
<td>50%</td>
</tr>
</tbody>
</table>

As can be seen, babies of diabetic mothers had a three to fourfold increase in the risk of shoulder dystocia compared to babies of nondiabetic mothers in each weight category.

Although diabetic mothers accounted for only 1.4% of the birth population in this study, they accounted for 4.9% of shoulder dystocias. Acker also showed that although the general rate of Erb palsy following shoulder dystocia is roughly 10%, 17% of babies born to diabetic mothers developed Erb palsy.

Other investigators have shown similar or larger correlations between diabetes and shoulder dystocia. In Al-Najashi's study (1989), the rate of shoulder dystocia in babies weighing over 4000gm born of diabetic mothers was 15.7%. Babies born to nondiabetic mothers had a shoulder dystocia rate of 1.6%.

Casey (1997), in a study of over 62,000 patients, found the shoulder dystocia rate in his general obstetrical population to be 0.9% while in his patients with gestational diabetes it was 3%.

Sandmire (1988) found a relative risk for shoulder dystocia in the babies of diabetic mothers of 6.5 compared to nondiabetic mothers.
There are two main reasons for this correlation between diabetes and shoulder dystocia. In the first place, diabetes in pregnancy shows a very strong correlation with macrosomia. The growth of diabetic babies represents not only their genetic potential for growth but also reflects the laying down of extra glucose substrates present in both the mother and baby. Secondly, as previously mentioned, the nature of the fetal growth differs in diabetic babies. Growth is not as evenly distributed between the head and trunk as it is in nondiabetic babies. Rather, babies of diabetic mothers show a pattern of greater shoulder, chest, and abdominal growth. As Ellis summarized in 1982:

"The infant of a diabetic mother has a different body configuration than the infant of a nondiabetic mother. Increased deposition of fat in various organs may be due to increased insulin secretion in response to hyperglycemia."

**Can shoulder dystocia be predicted in babies of diabetic mothers?**

In the 1980s several authors published studies purporting to show that they could predict which babies of diabetic mothers would be at high risk for shoulder dystocia.

Elliott (1982) claimed that by evaluating the chest-biparietal diameter in infants of diabetic mothers weighing more than 4000 g, he could reduce the incidence of traumatic morbidity at delivery from 27% to 9%.

Tamura (1986) found that in diabetic women fetal abdominal circumference values greater than the 90 percentile correctly predicted macrosomia in 78% of cases. In his study, when both the abdominal circumference and the estimated fetal weight exceeded the 90th percentile in pregnant women with diabetes, macrosomia was correctly diagnosed 88.8% of the time.

Mintz, in a promising study from 1989, published data showing that in his hands a combination of fetal abdominal circumference > the 90th percentile for gestational age and shoulder soft tissue width greater than 12 mm was the best predictor of macrosomia. His data reported a sensitivity of 96%, specificity of 89%, and "accuracy" -- positive predictive value -- of 93%. He also found a significant correlation between shoulder width and a high HgA1C, a blood test that measures blood sugar control over the preceding three months.

**Unfortunately, these results have not been supported or replicated by other investigators.** Multiple experts in the field of shoulder dystocia have published data from very large series that absolutely contradict the conclusions listed above. In addition, the results of these studies are not as powerful as might first be assumed.

In Elliott's study, for instance, although he was able to show that a large number of babies meeting certain chest-biparietal diameter criteria were macrosomic, 39% of babies with these same parameters -- chest/biparietal diameter ratio of > 1.4 -- were not larger than 4000 g. In Tamura's steady, although he was able to predict macrosomia in babies meeting certain abdominal circumference criteria, he still was unable to identify the vast bulk of macrosomic fetuses. As for Mintz's study, no one has yet been able to duplicate his results.

In fact, most studies have found that macrosomia cannot be reliably predicted in the babies of diabetic mothers. Acker (1985) showed that by using the criteria of large baby and diabetic mother he could predict 54.7% of shoulder dystocias -- but would miss 45.3% of them (false negatives). Delpapa (1991) stated that the predictive value of estimated fetal weight in babies of diabetic mothers for predicting shoulder dystocia was not sufficient to reliably identify them.

Moreover, most diabetic mothers do not have macrosomic babies and the overwhelming majority of macrosomic infants are not babies of diabetic mothers. **The bottom line is that macrosomia is as difficult to predict in diabetic mothers as it is in the nondiabetic population.**

There are two other studies of interest relating to this question.
Coen (1980) showed that although HgbA1C is a good marker for long-term monitoring of blood sugars in diabetic patients, it is not a good predictor of large-for-gestational age infants. The average HgA1C in mothers of large-for-gestational age infants in his study was 6.7; for mothers delivering normal sized babies the average HgA1C was 6.5-too close to be clinically useful.

Casey (1997) reported that although the rate of shoulder dystocia was in fact increased in mothers with gestational diabetes, this was not manifest in an increase in the rate of Erb palsy.

**The bottom line: Predicting macrosomia and shoulder dystocia in diabetic mothers is as difficult as it is in the nondiabetic population.**

**3. Maternal weight gain**

The data linking maternal weight gain and fetal birth weight are controversial.

Abrams (1995) and Langhoff-Roos (1987) both showed that total maternal weight gain was significantly correlated with infant birth weight. Dawes (1991), however, was not able to confirm this:

There was no apparent difference in correlation between maternal weight gain and birth weight between women giving birth to average for gestation or large for gestational age infants

Moreover, several investigators have reported conflicting information as to the effect of patterns of maternal weight gain on ultimate fetal weight. Some studies have found second trimester weight gain to be the major determinate whereas others have found that the weight gain in the last trimester was the most important factor. Given the contradictory and confusing data on this subject, Dawes' (1991) closing statement is probably the most apt:

"The variations in total (maternal) weight gain and incremental weight gain are so wide that these measurements are unlikely to be clinically useful."

**4. Fetal sex**

There is little data correlating fetal sex with macrosomia and shoulder dystocia. Although on average male babies do weigh slightly more than females, there is no data showing a significantly higher number of macrosomic male infants than female infants.

Resnick in his classic 1980 paper mentions fetal sex as a potential factor but does not supply data to substantiate his claim. El Madany (1990) showed that 59.2% of babies experiencing shoulder dystocia in his study were male -- statistically significant but not of much value as a clinical predictor.

**5. Multiparity**

Any relationship thus far observed between multiparity and either macrosomia or shoulder dystocia has been linked to the fact that multiparous women are, on average, older and heavier than primigravida women. They are therefore more likely to have larger babies and are more likely to have or develop diabetes, both of which would increase the risk of shoulder dystocia. In addition, by definition multiparous women have already had one or more babies. Thus they may already have experienced a shoulder dystocia which of course would place them at greater risk for recurrent shoulder dystocia.

The only primary association between multiparity and shoulder dystocia is the fact that multiparous women are more likely than primiparous women to have precipitous labors. This
has been linked by several investigators (Gonen [2000], Acker [1988]) to an increased risk of shoulder dystocia.

6. Post-dates

Even though fetal growth slows in the last several weeks of pregnancy, there is still some growth as long as pregnancy continues. Thus the longer the baby remains in utero, the larger the baby will be -- and the greater the risk of shoulder dystocia. Acker (1985) was one of the first to demonstrate this association. Chervenak confirmed this in 1989 when he reported that 25.5% of babies delivering at 41 weeks gestation were macrosomic while only 6% (risk ratio 4.2) were macrosomic in a group delivering between 38 and 40 weeks gestation. Hernandez (1990), too, found a direct correlation between post date babies and an increased risk of shoulder dystocia. He attributed this entirely to the increased tendency of post-date babies to be macrosomic.

Multiple risk factors

The greatest risk for shoulder dystocia occurs in those groups of women who have multiple risk factors. An obese woman with a large pregnancy weight gain and gestational diabetes will have a significantly greater likelihood of having a macrosomic baby and shoulder dystocia than will a woman who has just one of these risk factors. The worst possible combination of risk factors would be a mother with diabetes, an estimated large- for-gestational-age fetus, a prolonged second stage of labor, and a forceps delivery (to be discussed below). The rate of shoulder dystocia in such a situation approaches 40%.

Summary of antepartum risk factors

- Macrosomia and maternal diabetes are the main risk factors for shoulder dystocia
- Predicting fetal weight is extremely unreliable
- Other factors -- maternal weight gain, fetal sex, and post dates-are secondary risk factors. They do indicate an increased risk for shoulder dystocia but they are only relevant to the degree that they increase risk of fetal macrosomia
- Since multiparity increases the number of precipitous labors it may be a primary risk factor for shoulder dystocia

Intrapartum risk factors

Various characteristics of labor and delivery have been claimed to be useful in predicting whether or not a given mother-baby pair will end up with a shoulder dystocia and possible brachial plexus injury.

1. Instrumental delivery

Several studies have clearly shown that labors that end in instrumental vaginal deliveries -- vacuum or forceps -- show a higher rate of shoulder dystocia in each fetal weight group.

Nesbitit (1998), for example, reported the following data:

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>SD % in unassisted births</th>
<th>SD % in instrumental deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000-4250</td>
<td>8.4%</td>
<td>12.2%</td>
</tr>
<tr>
<td>4250-4500</td>
<td>12.3%</td>
<td>16.7%</td>
</tr>
<tr>
<td>4500-4750</td>
<td>19.9%</td>
<td>27.3%</td>
</tr>
<tr>
<td>&gt;4750</td>
<td>23.5%</td>
<td>34.8%</td>
</tr>
</tbody>
</table>
Baskett (1995) similarly showed a tenfold increase of shoulder dystocia and a fivefold increase in brachial plexus injury (BPI) with mid-forceps deliveries

<table>
<thead>
<tr>
<th></th>
<th>SD</th>
<th>BPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVD</td>
<td>0.3%</td>
<td>0.04%</td>
</tr>
<tr>
<td>Low forceps deliveries</td>
<td>0.9%</td>
<td>0.06%</td>
</tr>
<tr>
<td>Midforceps delivery</td>
<td>2.8%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Benedetti reported that in deliveries with the combination of a prolonged second stage of labor and a mid pelvic delivery there was a 4.6% rate of shoulder dystocia -- compared to 0.4% when there was neither prolonged second stage nor mid pelvic delivery.

McFarland (1986) showed that the relative risk of brachial plexus injury was 18.3 for midforceps deliveries and 17.2 for vacuum deliveries when compared to unassisted vaginal deliveries.

Thus it is clear that deliveries requiring instrumental assistance have a higher risk of shoulder dystocia and brachial plexus injury. It is not clear, however, that it is the instrumental deliveries themselves that are to blame for these shoulder dystocias. It may well be that the mother's inability to push the baby out without assistance is do to fetal macrosomia or an altered distribution of fat between the fetal head, chest, shoulders, and abdomen -- themselves major risk factors for shoulder dystocia.

### 2. Experience of the deliverer

Since the safe resolution of a shoulder dystocia involves specific obstetrical maneuvers and since shoulder dystocias occur relatively infrequently, it would seem that more experienced practitioners would have better outcomes in these situations merely by virtue of having seen more of them. Such an opinion would surely be voiced by most obstetricians and experienced labor and delivery nurses. However the data does not support this belief.

In the only study that has looked at the experience of the deliverer in relation to shoulder dystocia, that by Acker in 1988, the number of Erb palsies following shoulder dystocia deliveries did not vary with either the number of years a physician had been in practice or the number of deliveries that physician performed. As Acker stated,

> Most clinicians hardly gain expertise and confidence in the difficult

manipulations required to resolve shoulder dystocia due to the rarity of the condition.

### 3. Labor abnormalities

Several studies have shown a higher incidence of shoulder dystocia in labors in which the second stage of labor is prolonged. Nevertheless -- and paradoxically -- shoulder dystocias are not infrequently seen during labors with very rapid second stages.

Al-Natasha (1989) found that a delay in the second stage of labor and slowed descent of the fetal head in an obese multiparous woman greatly increased the possibility that a shoulder dystocia would occur.

Hopewood (1982) found that there was a deceleration phase of active labor from eight to 10 cm in 58% of shoulder dystocia deliveries.

Acker (1985) showed that arrest disorders significantly increase the chance of shoulder dystocia with larger babies
But the literature has sometimes contradicted itself on this issue.

Acker, in that same 1985 article referenced above, states:

No particular labor abnormality was predictive of an increased incidence of shoulder dystocia relative to that encountered with a normal labor pattern, a spontaneous delivery, or both.

Lurie (1995) also found no correlation between length of the stages of labor and shoulder dystocia. He showed that there was no difference in (1) the mean rate of dilatation, (2) the percentage of protracted labors, or (3) the mean duration of the second stage of labor in a group of mothers who experienced shoulder dystocia deliveries versus a group that delivered without complication. His conclusion was that protracted labor did not seem to be a risk factor for shoulder dystocia. As he says in his paper,

One could not identify shoulder dystocia in advance while analyzing the rate of cervical dilation or duration of the second stage of labor.

Hernandez (1990) reported that although there is a relationship between the length of various stages of labor and shoulder dystocia, 70% of patients who experienced shoulder dystocia had normal labor patterns.

McFarland (1975) likewise reported the same rate of labor abnormalities of the active phase of labor and of the second stage of labor in both shoulder dystocia and control groups. He concluded that labor abnormalities could not serve as clinical predictors for the subsequent development of shoulder dystocia.

Even if disorders of labor were found to be correlated with shoulder dystocia, it is not clear whether this would represent an independent risk factor. It might merely confirm that labor disorders are more common with macrosomic babies and that macrosomic babies more commonly experience shoulder dystocia. To date there has been no major study evaluating the length of various stages of labor broken down by weight category in relationship to shoulder dystocia deliveries.

To further complicate the issue, it is well known that shoulder dystocias and brachial plexus injuries are often seen with short second stages of labor:

Gonen (2000) reported that 7 of 17 patients (41%) with brachial plexus injury had second stages of labor shorter than 10 minutes

Acker (1988) found that 31.8% of all babies with Erb palsy were born after precipitate second stages of labor. As he explains,

The rapidity of descent may prohibit the fetal shoulders from entering the inlet in an oblique diameter, preclude adequate preparation for delivery, and add to nerve root trauma.

This phenomenon of shoulder dystocias with rapid second stages of labor will be discussed in further detail below.

4. **Oxytocin and anesthesia**

There does not appear to be any independent correlation between the use of either oxytocin or anesthesia and shoulder dystocia deliveries.

Oxytocin is generally used to increase the strength of uterine contractions. To the extent that oxytocin is used more frequently with macrosomic infants, it might have a secondary
correlation with shoulder dystocia deliveries. But there is no published data linking oxytocin use with the incidence of shoulder dystocia independent of fetal weight.

Likewise with anesthesia, there is no reported increase in shoulder dystocia deliveries in labors in which conduction anesthesia is employed.

5. Episiotomy

There is no statistically significant relationship between the absence of episiotomy, the frequency of shoulder dystocia, and any subsequent neonatal injury. That this is the case is perplexing given that almost all protocols for the resolution of shoulder dystocia advocate making a "generous episiotomy". This recommendation appears to be without support in the literature.

There are two possible reasons one might make an episiotomy in the case of a shoulder dystocia.

The first would be to make more room for the baby to emerge. In this situation the indications for making an episiotomy would be the same as in any delivery: alleviating soft tissue dystocia of the perineum. If the perineal tissue were tight, then an episiotomy might be helpful in delivering the baby. However, if the soft tissue is pliable and stretches easily, as in most multiparous women, then an episiotomy will not make it any easier to free the anterior shoulder from behind the pubic bone.

The second possible indication for an episiotomy during a shoulder dystocia would be to allow more room for the obstetrician's hand to move inside the pelvis in performing the Wood screw maneuver or in attempting to deliver the baby's posterior arm. An episiotomy might be helpful in accomplishing these maneuvers in a woman whose perineal tissues impede access to the fetal shoulders. However, in a woman in whom the perineal tissues are lax enough to allow these maneuvers to be performed, the automatic making of an episiotomy will not facilitate delivery and would be unnecessary.

Thus the almost universal recommendation that an episiotomy be made during a shoulder dystocia delivery is not only without literature support, but is theoretically unsupported as well.

So, can shoulder dystocia be reliably predicted?

Both the short and the long answer are: "No". Nowhere in the literature are there studies that show that the sensitivity or positive predictive value for predicting shoulder dystocia is high enough to justify interventions. While macrosomia, diabetes, prolonged second stage of labor, instrumental delivery, and other factors do indicate a statistically increased risk of having a shoulder dystocia, their low positive predictive value and high false positive rate make them clinically useless as tools for predicting -- and hence trying to prevent -- shoulder dystocia.

Below are the considered thoughts of various shoulder dystocia investigators on the predictability of this entity:

Basket (1995):
The profile of risk for shoulder dystocia -- prolonged pregnancy, prolonged second stage of labor, macrosomia, and assisted mid pelvic delivery -- were not clinically useful because the large majority of cases of shoulder dystocia occur in patients without these risk factors.

Resnick (1980):
Most babies with shoulder dystocia do not have risk factors.
German (2002):
Most of these preconception and prenatal risk factors have extremely poor positive predictive values and therefore do not allow the obstetrician to accurately and reliably predict the occurrence of shoulder dystocia.

Lewis (1998):
Only 25% of shoulder dystocia cases had at least 1 significant risk factor... the positive predictive value of pre-partum risk factors for shoulder dystocia is less than 2% individually, 3% when combined.

Can shoulder dystocia and brachial plexus injury be prevented?

Up until this point we have been looking for various ways of predicting which babies and which labors will experience shoulder dystocia and possible brachial plexus injury. But such predictions, even if they can be made, are useless if there is no way to alter labor and delivery management so as to prevent shoulder dystocia and brachial plexus injury from occurring. Thus a most important question is this: Given what we know about shoulder dystocia and brachial plexus injury, is there anyway to prevent them?

From the options available to obstetricians for intervening in labor and delivery, the only possible means for preventing shoulder dystocia would be:

- To perform elective cesarean sections for suspected macrosomia
- To induce labor in pregnant patients before their due dates in hopes of preventing babies from becoming macrosomic
- To attempt through diet or blood sugar control to limit maternal weight gain

There are some authors who feel that shoulder dystocia can be prevented. O’Leary, in his book on shoulder dystocia, states:

A well-prepared obstetrician or midwife can anticipate this problem [shoulder dystocia] as a result of routinely identifying those risk factors that predispose to shoulder dystocia. Thus prevention requires identification of risk factors, which leads to anticipation of the problem... Identification of critical risk factors will lead to anticipation, which in turn will lead to prevention.

O’Leary then boldly goes on to say:

The presence of macrosomia of 4500 g alone is justification for cesarean section in nonobese women. The presence of macrosomia of 4000-4500 g may in itself be sufficient to warrant abdominal delivery when other risk factors, especially a platypoid (flat) pelvis, diabetes and/or obesity, are present.

But despite the certitude of his statements, O’Leary presents no data to support his recommendations.

Other authors have also tried to articulate guidelines for avoiding shoulder dystocia. Anchor (1988) has said:

We advocate the abdominal mode delivery for infants of diabetic gravidas whose best estimated fetal weight exceeds 4000 g.

Langer (1991) stated that if all infants of diabetic mothers who weighed 4250 g or more were delivered by cesarean section, the overall cesarean section rate would increase by only 0.26% while shoulder dystocia would be reduced by 76%. He goes on to acknowledge, however, that in the nondiabetic group there is no weight that provides an optimal threshold for cesarean section to avoid shoulder dystocia.
But statements such as these represent the far fringe of obstetrical opinion. **It is the consensus of the vast majority of obstetricians who have studied the subject that there is no real way to figure out which babies are likely enough to have shoulder dystocia to warrant changes in the management of their labors.** The basic issue is this: One can suspect shoulder dystocia all one wants. But is there some combination of factors that predicts shoulder dystocia with an accuracy great enough to make doing cesarean sections, performing early inductions, or making other changes in management a reasonable course of action? The answer to this appears to be "No." Below is listed evidence that supports this conclusion:

Basket (1995) : The profile of risk for shoulder dystocia -- prolonged pregnancy, prolonged second stage of labor, macrosomia, and assisted mid-pelvic delivery -- were not clinically useful because "the large majority of cases of shoulder dystocia occur in patients without these risk factors"

Resnick (1980): Most babies with shoulder dystocia do not have risk factors. "The diagnosis will often be made only after delivery of the fetal head."

Gherman (2002): "Most of these preconception and prenatal risk factors have extremely poor positive predictive values and therefore do not allow the obstetrician to accurately and reliably predict the occurrence of shoulder dystocia."

Lewis (1998): Only 25% of shoulder dystocia cases had at least 1 significant risk factor.

Acker's (1986) : Almost half (47.6%) of all shoulder dyssticas occurred in babies weighing less than 4000 g.

Cunningham, author of *Williams Obstetrics*, reports that 99.5% of babies weighing 4000-4500 gms had a safe vaginal delivery without shoulder dystocia.

Al-Najashi (1989) stated that 41% of shoulder dystocia deliveries occurred in infants of average birth weight, that is 2500 to 3999 g.

Eckert (1997): The greatest number of injuries occurred in nondiabetic patients with birth weights of less than 4000 g.

It is certainly clear that there are risk factors which do increase the odds of shoulder dystocia and brachial plexus injury occurring. But so many babies with each of these risk factors do not encounter shoulder dystocia and brachial plexus injury that it is difficult to justify changes in management of all labors on the basis of these suspicions.

Despite his statements in his 1992 book, even O'Leary, in a 1990 paper, acknowledges the unpredictability of shoulder dystocia: He lists multiple risk factors for shoulder dystocia -- and then goes on to prove that the majority of macrosomic babies do not have these factors!

The entire issue is best summed up in Practice Bulletin #40 "Shoulder Dystocia" (2002) by the American College of Obstetricians and Gynecologists. They find the preponderance of current evidence consistent with the following positions:

3. Most cases of shoulder dystocia cannot be predicted or prevented because there are no accurate methods to identify which fetuses will develop this complication.

4. Ultrasonic measurement to estimate macrosomia has limited accuracy
5. Planned cesarean section based on suspected macrosomia is not a reasonable strategy.

6. Planned cesarean section may be reasonable for the nondiabetic with an estimated fetal weight exceeding 5000 g or the diabetic whose fetus is estimated over 4500 g.

**Would elective cesarean section for suspected macrosomia be a reasonable strategy for decreasing the number of shoulder dystocias and brachial plexus injuries?**

Many papers have been written trying to assess the utility of performing cesarean sections for suspected macrosomia in an attempt to reduce the risk of shoulder dystocia and permanent brachial plexus injury.

Gonen (2000) studied the use of physical examination and ultrasound during labor to identify babies suspected of being greater than 4500 g. His goal was to see if by performing cesarean sections in these cases he could reduce the rate of permanent brachial plexus injury. Macrosomia was suspected in 47 cases -- but was only confirmed at cesarean delivery in 21 of these (45% positive predictive value). Thus there were 26 unnecessary cesarean sections due to a false diagnosis of macrosomia. Moreover, over 84% of the macrosomic babies born from his subject population were missed. Of the 115 cases of macrosomia, only 21 were correctly identified in labor -- a dismal sensitivity rate of 18.3%. Of the 17 babies that developed brachial plexus injuries in his study, three were macrosomic -- but they were not identified prior to or during labor! The remaining 14 injured babies were not macrosomic. Thus, Gonen's attempt to decrease the brachial plexus injury rate by performing cesarean sections on suspected macrosomic babies missed most big babies and resulted in many unnecessary cesareans. He confirmed what is a major problem with any attempt to predict and prevent shoulder dystocia and brachial plexus injury: **The group in which they occur most often is that of normal sized babies.**

Many other studies have resulted in similar conclusions:

Rouse and Owen (1999) showed that prophylactic cesarean section would require more than 1000 cesarean sections and millions of dollars to avert a single permanent brachial plexus injury.

Basket (1995) stated that if in his series of patients all mid-forceps deliveries had been replaced by cesarean sections, 3268 cesarean section deliveries would have been performed to prevent 16 non-permanent brachial plexus injuries. Even if cesarean sections were performed only for babies suspected of being greater than 4500 g, 54 cesarean sections would have to be performed to prevent one case of non-permanent brachial plexus injury.

Eckert, in his 1997 paper, sums up the problem neatly:

In practice, only estimates of fetal weight, not actual weights, are available to practitioners seeking to predict the risk of birth injury. Weights estimated before delivery, whether by ultrasound or clinical estimation, are notoriously inaccurate. Even if we were able to identify a specific fetal weight that mandated cesarean section, any scheme that relied on estimated fetal weight to risk patients into cesarean delivery would result in the delivery of many infants appreciably smaller than the estimated fetal weight assigned them.

He points out that
The greatest number of injuries occurred in nondiabetic pregnancies with birth weights less than 4000 g. No protocol for managing macrosomia recommends cesarean delivery for estimated fetal weight of less than 4000 g.

In our opinion, the number of cesarean sections necessary to prevent a single birth injury in a normal glycemic population precludes our recommending mandatory cesarean delivery at any weight cutoff.

Delpapa (1991) studied nondiabetic women thought on ultrasound to have macrosomic fetuses. He concluded that he would have to do 76 cesarean sections to prevent five cases of shoulder dystocia:

Our study does not support the contention that elective cesarean section is justified in those women with fetuses suspected to be macrosomic as a means of preventing persistent infant mortality. A very large number of unnecessary cesarean sections would be performed without much preventive effect.

McFarland (1986) presented data by weight group showing how many cesarean sections would need to be performed to prevent even temporary brachial plexus injury:

<table>
<thead>
<tr>
<th>Estimated wt</th>
<th># C/S's</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;4500 g</td>
<td>165</td>
</tr>
<tr>
<td>4000-4500 g</td>
<td>1383</td>
</tr>
</tbody>
</table>

His conclusion is that even if a reliable means of estimating fetal weight were possible, by performing cesarean sections for all babies estimated to be greater than 4500 g only 32% of all shoulder dystocias would be avoided. At any lower weight cut off, there would be far too many cesarean sections for far too little gain.

Rouse also tried to quantify the effectiveness of a policy of elective cesarean section for ultrasound-diagnosed fetal macrosomia. He found that in women without diabetes, if a cesarean section were performed for each baby with a suspected weight of greater than 4500 g, 3695 cesarean sections would have to be performed at an additional cost of $8.7 million for each permanent brachial plexus injury prevented.

Bryant (1998) data showed that even assuming ultrasound diagnosis to be accurate in predicting fetal weight, between 155 and 588 cesarean sections would have to be performed to obviate a single case of permanent injury, depending on the weight cut-off selected:

Our data show that a policy of elective cesarean delivery in cases of suspected fetal macrosomia had an insignificant effect on the incidence of brachial plexus injury. Although the contribution of this policy to the cesarean delivery rate was small, the number of cesarean deliveries required to prevent a single case of permanent brachial injury was high and probably unjustified.

Gregory (1998) stated that if 5.5% of all brachial plexus injuries were permanent -- which his data demonstrated -- only one in 3833 macrosomic infants would have a persistent Erb palsy. Moreover, he found that one half of all of the shoulder dystocias in his series occurred in normal weight infants.

Kolderup (1997) found that a policy of elective cesarean section for macrosomia would necessitate 148 to 258 cesarean sections to prevent a single persistent injury. He feels that "these findings support a trial of labor and judicious operative vaginal delivery for macrosomia infants."

Sandmire (1993) discusses the difficulty in attempting to determine fetal size in utero:
Any approach using ultrasound would have to demonstrate that its use improves newborn or maternal outcome without disproportionate increases in morbidity and mortality. A barrier to achieving this goal is the inaccuracy associated with estimation of fetal weight. The current ultrasonic procedures for estimation of fetal weight are not accurate enough for detecting macrosomia defined by weight criteria.

And even if clinicians could determine fetal weight accurately, the frequency of persistent fetal injuries associated with vaginal birth of the macrosomic fetus is so low that induction of labor or cesarean birth is not justified on that basis. Delivery decisions based on inaccurate estimated fetal weights should be avoided.

He also composed a chart drawn from data in several other studies in which he evaluated the rate of permanent brachial plexus injuries and the number of cesarean sections that would be necessary to avoid them:

<table>
<thead>
<tr>
<th>Study</th>
<th>C/S to prevent BPI injuries</th>
<th>C/S to prevent permanent BPI injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gordon (1973)</td>
<td>526</td>
<td>10,520</td>
</tr>
<tr>
<td>Sandmire (1988)</td>
<td>(no data)</td>
<td>7403</td>
</tr>
<tr>
<td>McFarland (1986)</td>
<td>1922</td>
<td>39,840</td>
</tr>
<tr>
<td>Modaniou (1980)</td>
<td>588</td>
<td>11,700</td>
</tr>
</tbody>
</table>

Sandmire (1996) concludes that a policy of employing cesarean section for suspected macrosomia in hopes of preventing permanent brachial plexus injury will not work because of:

1. The inaccuracy of ultrasound in estimating fetal weight
2. The increases in morbidity and mortality that would occur from the very large numbers of cesarean sections so generated.
3. The many cesarean sections would have to be done to prevent one significant fetal injury

Sandmire also takes care to distinguish minor injuries, such as clavicular fracture and transient brachial plexus injury, from severe persistent fetal injuries. He admonishes anyone considering the issue of cost vs. benefit in the management of suspected macrosomia to make decisions based only on significant fetal injuries, such as permanent brachial plexus injuries and severe neurologic damage.

Summarizing, the major conclusion of most of the obstetrical literature discussing the strategy of performing cesarean sections for suspected macrosomia is that it would not be practical because it would require far too many unnecessary interventions for the benefits that would be obtained.

**Cesarean sections are not without risk, especially for diabetic and/or obese women**

Although cesarean section is one of the most commonly performed operations in the United States, it still carries much greater risk than does a vaginal delivery. These risks include blood loss, infection, damage to other pelvic organs, and respiratory emergencies. Moreover, the recovery period is longer and more painful and performing one cesarean section greatly increases the likelihood that a woman will have her next baby by cesarean section as well. Finally, total hospital care for women delivering a baby via cesarean section is 50%-100% more expensive than the cost of a vaginal delivery.
Thus in order to justify the increased risk, pain, and expense of performing cesarean section in hopes of avoiding shoulder dystocia and permanent brachial plexus injury, there has to be substantial evidence that this is an effective policy. As has been shown, such evidence is lacking. In fact, the available evidence is contrary to this supposition.

**What about early inductions as a means of avoiding shoulder dystocia and brachial plexus injury?**

Many have thought that by cutting off one to two weeks of growth of a fetus at term, a baby might be delivered small enough to avoid shoulder dystocia and the risk of permanent brachial plexus injury. The problem with this theory is that there is no data to support it.

In the first place, the growth rate of babies differs significantly, both between babies and at various points in pregnancy for each baby. Thus it is impossible to estimate how much additional growth is prevented by "early delivery".

Most importantly, studies looking at this means of attempting to prevent shoulder dystocia have never been successful in reducing the number of macrosomic babies or showing that such a program reduces the risk of shoulder dystocia:

Del Papa (1991) found that early induction did not decrease infant morbidity.

Gonen (1997) randomized patients suspected of macrosomia based on ultrasound examination to an early induction group -- 134 patients -- or a routine pregnancy follow-up group -- 139 patients. There was no statistically significant difference in shoulder dystocia between the two groups.

Several authors -- Leaphart (1997), Friesen (1995), Combs (1993) -- have even shown that this approach of early induction actually increased the cesarean section rate with no decrease in the incidence of shoulder dystocia.

**So, can shoulder dystocia be prevented?**

A review of the literature indicates that the answer to this question is, "No." Estimates of fetal weight are unreliable. It is impossible to accurately tell which babies will be macrosomic. It is impossible to reliably determine which babies will develop shoulder dystocia. As has been shown, a policy of prophylactic cesarean section would require huge numbers of operations to prevent a single case of permanent brachial plexus injury. It is also the case that a policy of elective induction does not decrease number of shoulder dystocias.

**Can shoulder dystocia be resolved without fetal injury when it does occur?**

The evidence from the literature on shoulder dystocia shows clearly that:

1. Shoulder dystocia cannot be predicted with any degree of accuracy and

2. Shoulder dystocia cannot be prevented by any specific strategies or maneuvers.

The question thus arises "How should shoulder dystocia be handled when it does occur? Can it successfully be resolved without injuring the baby or the mother?"

Much has been written on this subject. Multiple maneuvers claiming to be able to resolve shoulder dystocia have been described. We will now take a look at what these maneuvers are, how they work, and how effective they really are.
Recognition

The first step in treating shoulder dystocia is recognizing when it occurs.

There are two main signs that a shoulder dystocia is present:

1. The baby's body does not emerge with standard moderate traction and maternal pushing after delivery of the fetal head.

2. The "turtle sign". This is when the fetal head suddenly retracts back against the mother's perineum after it emerges from the vagina. The baby's cheeks bulge out, resembling a turtle pulling its head back into its shell. This retraction of the fetal head is caused by the baby's anterior shoulder being caught on the back of the maternal pubic bone, preventing delivery of the remainder of the baby.

Traction: "Excessive" or "Necessary" Force?

Babies rarely fall out of the pelvis -- nor should they. Especially in an age where conduction anesthesia (epidurals, spinals) is used routinely, often a mother must push several times in order to deliver the remainder of her baby after its head has been born. To facilitate the passage of the baby's anterior shoulder under mother's pubic bone, it is standard practice for the deliverer to deflect the baby's head downwards and to apply traction while the mother is pushing.

It is often said -- especially in court rooms -- that traction should never be applied to the fetal head during delivery. This is certainly not the case -- and is absolutely not the standard of care practiced by obstetricians across the United States. Such assisting of delivery of the head is necessary and is approved obstetrical practice as can be seen in any textbook of obstetrics.

Normal Delivery Traction

What about the slippery term "excessive force"? This term conveys an image of an obstetrician pulling with all his or her might, propping a leg against a delivery table for support, etc.
Students of shoulder dystocia have long sought to determine exactly what degree of force constitutes "excessive force". Some investigators, such as Allen (1991) and Gonik (2000), have even tried to determine this by using specially-constructed gloves with piezoelectric fingertip sensors to measure pressures at delivery.

It would seem on the face of it that the use of strong forces to attempt to deliver an impacted shoulder should be universally condemned. But one must take into account the circumstances involved. There are times when all maneuvers have been attempted to resolve a shoulder dystocia and when the only options left are either a maximal effort to extract the baby, including greater than desired forces, or fetal death. In such cases, faced with the ultimate catastrophe of the death of a baby, the risk of brachial plexus or other fetal injury must be accepted.

What the physician must not do when a shoulder dystocia occurs is to lose composure. Most shoulder dystocias occur unexpectedly. But by restraining panic, keeping a cool head, and employing a previously thought-out set of maneuvers, almost all shoulder dystocias can be resolved with excellent results for both baby and mother. The term "almost all" is used advisedly as sometimes, even in the most expert hands, and even with relatively mild shoulder dystocias, fetal or maternal injury will occur.
What to do when a shoulder dystocia occurs

Several things should be done as soon as a shoulder dystocia is recognized. The obstetrician should ask to have a second obstetrician called and should ask the nurses to make sure that extra personnel are available. The obstetrician should also stay informed of the time that has elapsed since delivery of the head. One means of doing this is to designate someone to call out the time since delivery of the head at fixed intervals -- perhaps every 30 seconds. Pediatric or neonatal assistance should be called so as to be available to evaluate and potentially resuscitate the baby after delivery. Anesthesia staff should be summoned. One person should be designated as a note taker to record the timing of events.

The Maneuvers

Once a shoulder dystocia is recognized, there are several specific obstetrical maneuvers that have been proven to be of benefit in assisting in the resolution of the dystocia.

McRoberts maneuver and suprapubic pressure

The first two maneuvers generally attempted in order to resolve a shoulder dystocia are (1) McRoberts maneuver and (2) suprapubic pressure. In fact both of these maneuvers are so benign and so effective that they are sometimes employed prophylactically in anticipation of a potential shoulder dystocia.

McRoberts maneuver is named for William A. McRoberts, Jr. who popularized its use at the University of Texas at Houston. It involves sharply flexing the legs upon the maternal abdomen. By doing this, the symphysis pubis is rotated cephalad and the sacrum is straightened. In a high percentage of cases this by itself suffices to free the impacted anterior shoulder.

Suprapubic pressure is the attempt to manually dislodge the anterior shoulder from behind the symphysis pubis during a shoulder dystocia. It is performed by an attendant making a fist, placing it just above the maternal pubic bone, and pushing the fetal shoulder in one direction or the other. Since shoulder dystocias are caused by an infant's shoulders entering the pelvis in a direct anterior-posterior orientation instead of the more physiologic oblique diameter, pushing the baby's anterior shoulder to one side or the other from above can often change its position to the oblique which will allow its delivery. As mentioned above, suprapubic pressure
In conjunction with McRoberts maneuver is often all that is needed to resolve 50-60% of shoulder dystocia.

In order to show more clearly how McRoberts maneuver aids in the resolution of a shoulder dystocia, Gherman (2000) performed a study in which he took x-rays of 36 women in the dorsal lithotomy position before and after McRoberts positioning. He found that there were no significant changes in the anterior-posterior and transverse diameters of the pelvic inlet, midpelvis, and pelvic outlet. There also was no increase in the obstetric, the true, and the diagonal conjugates of the pelvis. Thus, McRoberts maneuver does not change the actual dimensions of the maternal pelvis. What was seen, however, was a rotation of the symphysis pubis toward the maternal head that significantly changed the angle of inclination between the top of the symphysis and the top of the sacral promontory. This, in conjunction with the flattening of the sacrum, is often enough to allow stuck fetal shoulders to deliver.

A study by Gonik and Allen (1989) confirmed that this is the case. They showed that implementation of McRoberts maneuver can significantly reduce required fetal extractive forces and brachial plexus stretching in shoulder dystocia. In addition to allowing the anterior shoulder to slide more freely under the back of the symphysis, the flattening of the sacrum relative to the lumbar spine allows the posterior fetal shoulder to more easily pass over the sacrum and through the pelvic inlet.

How successful is McRoberts maneuver? Gherman (1997) observed 250 shoulder dystocia deliveries at USC from 1991 to 1994 and reported that McRoberts maneuver alone was successful in resolving 42% of them. Fifty-four percent of all shoulder dystocias were resolved by a combination of McRoberts maneuver, suprapubic pressure and/or procto-episiotomy without further maneuvers being necessary. McFarland (1996) reported similar findings: 39.5% of shoulder dystocias resolved with McRoberts maneuver alone while 58% resolved with a combination of McRoberts maneuver and suprapubic pressure.

Although McRoberts maneuver and suprapubic pressure are generally safe, it is possible to cause maternal injury by performing them. Symphyseal separations and transient femoral neuropathies from overly aggressive hyperflexing of the maternal thighs have been reported.
However neither McRoberts maneuver nor suprapubic pressure involves direct manipulation of the fetus, making it unlikely that either of these procedures will injure a baby.

**Wood's Screw maneuver**

First described in the literature in 1943, this procedure involves the progressive rotation of the posterior shoulder in corkscrew fashion to release the opposite impacted anterior shoulder. In its classic description, pressure is applied on the posterior shoulder's anterior surface. A variation of this -- the Rubin's maneuver -- involves pushing on the posterior surface of the posterior shoulder. In addition to the corkscrew effect, pressure on the posterior shoulder has the advantage of flexing the shoulders across the chest. This decreases the distance between the shoulders, thus decreasing the dimension that must fit out through the pelvis.

![Diagram of Wood's Screw maneuver](image)

**Delivery of the posterior shoulder**

Another effective maneuver for resolving shoulder dystocia is the delivery of the posterior arm. In this maneuver, the obstetrician places his or her hand behind the posterior shoulder of the fetus and locates the arm. This arm is then swept across the fetal chest and delivered. With the posterior arm and shoulder now delivered, it is relatively easy to rotate the baby, dislodge the anterior shoulder, and allow delivery of the remainder of the baby.

The major risk of this procedure is that of fracturing the humerus. Gherman (1998) reported 11 (12.4%) humeral fractures in 89 shoulder dystocia resolved by delivery of the posterior arm. However, since almost all humeral fractures heal quickly and without permanent damage, this would appear to be a small price to pay for the successful delivery of an infant in a life threatening situation when other maneuvers have not worked.

There have been multiple other techniques and procedures described over the years to resolve shoulder dystocia. None of these, however, have reached the level of "mainstream". Some of these are the Zavanelli maneuver, deliberate fracture of the clavicle, symphysiotomy, the "all-fours" maneuver, and fundal pressure.
Zavanelli maneuver

Although almost certainly performed by obstetricians and midwives in the past, this maneuver was first attributed in the literature to Dr. Zavanelli, an obstetrician in private practice in Pleasanton, California, in 1977. Dr. Zavanelli reported that during one difficult shoulder dystocia delivery, after having attempted all other maneuvers, he finally resorted to flexing the fetal head and pushing it back up into the vagina. By so doing, he was able to get the fetal head back into the pelvis, perform an emergency cesarean section, and deliver a live baby.

In this cephalic replacement maneuver -- now generally referred to as the Zavanelli maneuver -- the head must first be rotated back to its pre-restitution position -- that is, occiput anterior - - and then flexed. Constant firm pressure is applied while pushing the head back into the vagina. Tocolytic agents or uterine-relaxing general anesthesia may be administered to facilitate this process. Cesarean section must be performed immediately after replacement of the head.

The Zavanelli maneuver enjoys a mixed reputation. O'Leary (1993) reported on 59 women who had undergone replacement of the fetal head following unsuccessful attempts at vaginal delivery. All but 6 of these infants were successfully replaced and delivered by Cesarean section. He therefore suggested that the Zavanelli maneuver might not need to be used as a last resort maneuver but might be considered if any undue difficulty were encountered with a shoulder dystocia.

But a closer look at the data he reports is less reassuring. In his series, the delay of cephalic replacement following delivery of the head ranged from 5 minutes to greater than 30 minutes. He was unable to replace the fetal head in six instances and he reported replacement as "difficult" in five. Apgar scores at 5 minutes were less than 6 in 61% of these babies and were less than 3 in 27%. Four babies in his series had seizures in the nursery, two had permanent neurologic injury, five experienced a permanent Erb palsy, and two died. Three percent of the mothers experienced ruptured uterus and 5% suffered uterine lacerations.

Although Sanberg (1999) reported a much more optimistic experience with the Zavanelli maneuver, the data from O'Leary's large series is sobering. While it is incumbent upon all obstetricians to know about the Zavanelli maneuver and how to perform it when a difficult shoulder dystocia occurs, its significant potential for fetal and maternal injury must relegate it to the status of a "last ditch" procedure.
Deliberate fracture of the clavicle

Almost all detailed accounts of shoulder dystocia include deliberate fracture of the clavicle as one modality for resolving this situation. But there are few accounts of this procedure actually being performed. In practice, the clavicle poses a formidable obstacle to its fracture. It is a significant bone, even in a fetus. Although the fracture of the clavicle certainly would decrease the transverse diameter of the chest and shoulders, the potential of damaging the great vessels, fetal lungs, and other structures make this an extremely hazardous procedure even if it were possible to perform easily. In fact most descriptions of transection of the clavicle involve fetuses that are already dead and require the use of a large scissors or other sharp instrument for cutting the clavicle.

Symphysiotomy

Symphysiotomy is a procedure that had been performed in the past and is now performed only in areas remote from the ability to perform Cesarean sections on a rapid basis. However it has enjoyed something of a renaissance in the literature in recent years. The theory is that by transecting the firm ligaments joining the left and right symphyseal bones, an additional 2-3cm in pelvic circumference can be gained. In most cases this will allow the anterior shoulder to be delivered beneath the symphysis. The benefit of the procedure is that it can be performed rapidly -- it usually takes 5 minutes or less -- and can be done under local analgesia. In subsequent pregnancies a woman who has undergone a symphysiotomy has an intact uterus and a slightly enlarged pelvis.

The symphyseal separation obtained by symphysiotomy affects the transverse diameters of the pelvis, particularly those of the mid cavity and outlet. The area of the pelvic brim increases by 8% for every 1cm of joint separation.

The technique involves abducting the thighs to 80 degrees (but no further). A 2cm skin incision is made over the mons. With an index finger in the vagina displacing the urethra, the scalpel is inserted in the midline of the mons at the junction of the upper and middle thirds of the symphysis. If difficulty is experienced finding the ligament, a needle can be placed first. The blade is inserted until it impinges on the vaginal epithelium as determined by the finger in the vagina. Using the upper symphysis as a fulcrum, the knife is rotated, cutting the lower 2/3rds of the symphysis. The knife is then turned 180 degrees and the upper third of the symphyseal ligament is transected. Separation thus obtained is between 2 and 3cm -- the width of a thumb.

Following symphyseal separation, the bladder must be drained for five days. The patient is kept in bed on her side for three days. Sometimes the knees are tied together to enforce this position. On the fourth day the patient may sit in bed and on the fifth day walk. Results in terms of maternal recovery are uniformly excellent with return of full ambulation and pelvic stability.

The major risk is to maternal soft tissues including the bladder and urethra. As with many techniques, the more experience one obtains with procedure, the more quickly it can be performed and the lower the complication rate. Hartfield published a detailed description of symphysiotomy in 1973 in order to remind obstetricians that such a procedure exists. Although not advocating it in developed countries as a first step, he does state that it can be effected very quickly and may in some instances save a fetus' life when all other measures to resolve a shoulder dystocia have been exhausted. As he says in a second article he published on the subject in 1986,

The risk of maternal soft tissue trauma has to be weighed against the almost certain loss of the baby if other methods of vaginal delivery are proving unsuccessful.
All-fours maneuver

In 1976, Ina Mae Gaskin described a maneuver for the resolution of shoulder dystocia that involves placing the gravid mother on her hands and knees. Rinna (1998) used this procedure in 82 deliveries complicated by shoulder dystocia and was able to resolve it in 68 cases (82%) with this maneuver alone. The average time needed to move the mother into this position and to complete delivery was reported to be 2-3 minutes. Unfortunately, there was no detailed description of fetal and maternal outcome in this report. Also, reports about this procedure have generally been in the midwifery literature, involving a patient population less likely to have epidural anesthesia and thus more likely to be fully mobile.

It may be that the "all-fours maneuver" is merely another means of changing the angle of the symphysis in relation to the stuck shoulder, akin to McRoberts maneuver. Since the all-fours maneuver involves a gravid woman at the end of her pregnancy, exhausted by a long labor, often with an epidural in place, being moved quickly out of her delivery position onto all fours on her bed or on the floor, the practicality of this maneuver for a general obstetrical population is open to question. Unless more data is presented as to its efficacy and utility, it cannot be considered a standard procedure for the resolution of shoulder dystocia.

Which maneuvers should be performed first?

Many authors have proposed various protocols of prescribed maneuvers for the resolution of shoulder dystocia. Most are similar with only minor variations.

When a shoulder dystocia is recognized, it is generally agreed McRoberts maneuver and suprapubic pressure should be implemented rapidly and simultaneously. These by themselves will resolve more than half of all shoulder dystocias. If the shoulder dystocia persists, other maneuvers can be performed in any order. These include the Wood’s screw maneuver in either the clockwise or counter clockwise direction, attempting to deliver the posterior arm, and, in extremis, consideration of such techniques as the Zavanelli maneuver or symphysiotomy.

ACOG, in its bulletin on shoulder dystocia, proposed the following sequence of maneuvers for reducing a shoulder dystocia:

1) Call for help - assistants, anesthesiology, pediatrician. Initiate gentle traction of the fetal head at this time. Drain the bladder if distended.

2) Generous episiotomy.

3) Suprapubic pressure with normal downward traction on fetal head.

4) McRoberts maneuver.

Then, if these maneuvers fail,

5) Wood's screw maneuver.

6) Attempt delivery of posterior arm.

Harris in a 1984 paper recommended a similar protocol:

1) McRoberts maneuver.

2) Suprapubic pressure.

3) Large mediolateral episiotomy if above steps fail.
4) Wood's screw maneuver.
5) Attempt to free posterior arm.

Gherman (1998) discussed the protocol for managing shoulder dystocia utilized at that time at the University of Southern California:

- McRoberts maneuver
- Suprapubic pressure
- Procto-episiotomy
- Wood's corkscrew maneuver
- Posterior arm extraction.
- Zavanelli maneuver or symphysiotomy if all else fails.

McFarland (1996) reported that the use of two maneuvers alone -- McRoberts and suprapubic pressure -- resulted in the resolution of 58% of 276 cases of shoulder dystocia in his series. He found that the addition of the Wood's Screw maneuver and delivery of the posterior arm were sufficient to resolve the shoulder dystocia in all remaining cases. He also found that there was a direct correlation between the rate of brachial plexus injury and the number of maneuvers employed to resolve the shoulder dystocia. A second correlation he found was that as the fetal weight increased, the number of maneuvers required to resolve shoulder dystocia increased.
O'Leary, in his 1992 book, presented a much more elaborate protocol. His first step was to make a "truly adequate" episiotomy. He goes on to state that the slow rate of decline of pH per minute after occlusion of the umbilical cord -- 0.04units/min as reported by Wood (1973) -- allows plenty of time to resolve the shoulder dystocia in an organized manner. He distinguishes between mild, moderate and severe shoulder dystocia and those that are "undeliverable" and presented different delivery protocols for each category.

<table>
<thead>
<tr>
<th>Grade of shoulder dystocia</th>
<th>Treatment of shoulder dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild shoulder dystocia</td>
<td>Suprapubic pressure, which can be directed either posteriorly or to one side.</td>
</tr>
<tr>
<td></td>
<td>Wood maneuver.</td>
</tr>
<tr>
<td></td>
<td>Rubin maneuver (reverse of the Wood maneuver)</td>
</tr>
<tr>
<td>Moderate shoulder dystocia</td>
<td>Attempt delivery of posterior shoulder.</td>
</tr>
<tr>
<td></td>
<td>Hibbard technique -- pushing back on the head to displace the anterior shoulder.</td>
</tr>
<tr>
<td></td>
<td><em>(Note: This is a unique recommendation. The Hibbard maneuver is not generally considered a modern obstetrical technique because it involves further potential stretching of the brachial plexus and -- at least in the original description -- Hibbard recommends fundal pressure as the shoulder is sliding below the symphysis)</em></td>
</tr>
<tr>
<td>Severe shoulder dystocia</td>
<td>McRoberts maneuver</td>
</tr>
<tr>
<td></td>
<td>All of the above</td>
</tr>
<tr>
<td>Undeliverable</td>
<td>Cephalic replacement</td>
</tr>
</tbody>
</table>

O'Leary feels that delivery of the posterior arm is "the most efficacious and expeditious means of overcoming shoulder dystocia".

Dignam comments similarly: "I favor delivery of the posterior arm as the most efficacious and expeditious means of overcoming shoulder dystocia". His plan of action is as follows: Make a generous episiotomy, avoid fundal pressure, pull the baby's posterior hand down across the chest, and attempt to adduct the posterior shoulder as Rubin discusses.

As has been shown, different authors recommend different combinations of maneuvers in attempting to resolve shoulder dystocias. But what every author emphasizes, and what the ACOG bulletin stresses, is that the most important aspect of resolving a shoulder dystocia is for the obstetrician to have a clear-cut, well thought-out sequence of maneuvers in mind when a shoulder dystocia is encountered. The general consensus is that the best results in resolving shoulder dystocias are obtained when an obstetrician:

1. Recognizes the shoulder dystocia
2. Knows the different maneuvers involved in attempting to resolve shoulder dystocia
3. Implements them in a carefully controlled, calm, and organized fashion.
Is all brachial plexus injury caused by shoulder dystocia?

Introduction

In his 2002 paper, Pecorari states the following:

Unfortunately for obstetricians and midwives, in court Erb palsy has been causally connected with shoulder dystocia and errors in management, although it is not always true. Perhaps the lack of an obvious explanation has contributed to the identification of the birth attendant as a handy scapegoat.

When there is a permanent brachial plexus injury following shoulder dystocia, responsibility for this injury is often presumed to be with the obstetrician who supposedly did not foresee that a shoulder dystocia was likely to occur or mishandled it when it did. Yet a review of the literature does not substantiate such assumptions. Gherman in his 1998 paper summarizes the refutation to these claims:

We feel that some cases of brachial plexus injury are unavoidable events. Recent reports have noted that brachial plexus palsies occur:

(1) In the absence of characteristic risk factors
(2) In the absence of shoulder dystocia
(3) In the posterior arm of infants whose anterior shoulder was impacted behind the symphysis pubis
(4) In vertex-presenting fetuses delivered by atraumatic Cesarean section
(5) Without apparent relationship to the type or number of maneuvers used to disimpact the fetal shoulder
(6) In association with other peripheral nerve injuries
(7) With electromyographic evidence of muscular denervation during the immediate postpartum period [indicating pre-delivery injury].

Jennett commented in a similar vein in 1997:

Evidence continues to accumulate that renders a univariate theory of the causation of brachial plexus injury untenable . . . Intrauterine maladaptation is responsible for some instances of brachial plexus injury.

He notes that in his series of deliveries from 1977 to 1990, 22 of 39 (56%) brachial plexus injuries were not associated with shoulder dystocia. In that same paper he quotes Pearl (1993) and Gimovsky (1995), both of whom reported brachial plexus injuries in babies delivered from the occiput posterior position without shoulder dystocia. He further cites Walle (1993) who observed in his patient population that 1/3rd of 175 shoulder dystocia involved the posterior shoulder.

There are many other similar reports:

Hardy (1981) reported 36 infants with brachial plexus injuries of whom only 10 had shoulder dystocia noted at birth.
Gilbert (1990) initially published a study of 1000 infants with brachial plexus injury in which 39% did not have shoulder dystocia at delivery. In a supplementary article in 1999, he reported that 47% of babies with brachial plexus injury in his now larger series experienced deliveries in which no shoulder dystocia was noted. Even among macrosomic fetuses in this series, 26% of brachial plexus injuries occurred in the absence of shoulder dystocia.

Gram (1997) noted that only 8 babies had shoulder dystocia deliveries in a group of 15 who experienced brachial plexus injury. In the other seven cases, there had been no birth trauma.

In Gonik's 1991 paper, 71% of all injured infants in his series were the product of deliveries without recognized shoulder dystocia.

Ouzounian (1997) reported 4 babies with brachial plexus injury in which there was not even downward traction during delivery.

In Hillard's (1997) series of babies with Erb palsy, 15 of 51 babies had not experienced shoulder dystocia during delivery.

Sandmire (1996) reported 17 babies in his series of 36 with brachial plexus injuries whose deliveries did not involve shoulder dystocia. This article included his personal review of the literature concerning brachial plexus injury (BPI) with and without shoulder dystocia:

<table>
<thead>
<tr>
<th>Author</th>
<th># of deliveries greater than 4,500 grams</th>
<th>BPI with shoulder dystocia</th>
<th>BPI without shoulder dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipscomb (1995)</td>
<td>157</td>
<td>7/12</td>
<td>5/12</td>
</tr>
<tr>
<td>Acker (1985)</td>
<td>218</td>
<td>13/29</td>
<td>16/29</td>
</tr>
<tr>
<td>Sandmire (1996)</td>
<td>547</td>
<td>9/19</td>
<td>10/19</td>
</tr>
<tr>
<td>TOTALS</td>
<td>1,727</td>
<td>34/69 (49%)</td>
<td>35/69 (51%)</td>
</tr>
</tbody>
</table>

As can be seen, 51% of brachial plexus injuries in over 1727 deliveries of macrosomic babies did not involve shoulder dystocia.

**What does cause brachial plexus injuries?**

The standard explanation for brachial plexus injury is that it results from excessive downward traction by the obstetrician on the fetal head during the delivery of the anterior shoulder. This supposedly overstretches the brachial plexus thus injuring it.

It is in fact true that the majority of brachial plexus injuries, whether permanent or not, do follow shoulder dystocia. There also appears to be a correlation between the severity of the shoulder dystocia and the degree of brachial plexus injury. But there is also much evidence in the literature that brachial plexus injuries are caused by factors other than shoulder dystocia-related trauma.

What other than shoulder dystocia might cause brachial plexus injury?

**The tractor-trailer theory**

Sandmire (2000) and others have recently proposed an explanation for brachial plexus injuries that explains much of the data that has been collected over the years. Obstetricians have long sought to understand the mechanism of those brachial plexus injuries that occur following extremely rapid second stages of labor, some of which are as short as one or two contractions. Sandmire studied what happens to the various parts of the fetus during uterine contractions and maternal pushing. He noted that the forces of contractions and maternal pushing act on
the long axis of the fetus. If the fetus's anterior shoulder were to get stuck behind the maternal pubic bone and continued pressure were applied to the long axis of the fetus, the baby's brachial plexus would undergo considerable stretching.

This may be compared to what happens when a tractor-trailer truck approaches a low overpass at high speed. While the tractor may pass under the bridge, the trailer -- taller than the tractor -- will ram into the overpass with high impact. The momentum of the tractor will result in large forces acting to separate it from its attached trailer. Sandmire suggests that an equivalent force acts upon a baby's brachial plexus during some shoulder dystocia deliveries.

**Forces in deliveries**

Some investigators have actually used mechanical testing devices in an attempt to measure the pressure placed on the brachial plexus of an infant during shoulder dystocia deliveries -- with conflicting results.

Allen (1991) reported his use of tactile force sensing devices on the tips of gloves during a series of vaginal deliveries to measure the forces placed on a baby's head by an obstetrician's hands. The deliveries that were observed were categorized into three groups: Routine, difficult, and those involving shoulder dystocias. He found that twice as much force was applied to a baby's head during shoulder dystocia deliveries as compared with routine deliveries.

Gonik, however, one of Allen's co-investigators, subsequently published a mathematical model estimating the forces acting on the fetal neck overlying the roots of the brachial plexus. His findings mitigate the significance his and Allen's previous work. He showed that the forces applied by the clinician to the fetal neck were only 1/4 to 1/9 of those that resulted from uterine contractions and maternal pushing themselves in the second stage of labor.

**Posterior shoulder**

Most brachial plexus injuries occur to a baby's right arm (60%). This is because babies most commonly "present" into the mother's pelvis in the left occiput anterior position (LOA). The LOA position is when the back of the baby's head -- the occiput -- points towards the mother's left arm while the fetal face is oriented towards the mother's right buttck. In this fetal position the baby's right arm will be anterior -- and thus more likely to get caught under the mother's pubic bone. But brachial plexus injuries have also been reported in the posterior shoulder. It is thought that in these cases the posterior shoulder gets caught on and restrained by the sacral promontory while the remainder of the baby is being pushed forward by the mother's expulsive efforts or by her uterine contractions. The posterior brachial plexus would thus be stretched, potentially injuring it.

**Pre-delivery (in-utero) injury**

There are multiple reports of brachial plexus injuries which appear to have occurred sufficiently prior to delivery so as to not be causally related to it. The evidence for the timing of such in utero injuries comes from electromyelographic studies, the measurement of electrical transmission in muscle fibers.

It takes approximately ten days for a muscle to show an injury pattern on electromyography after the nerve innervation to that muscle is damaged. Therefore if muscle damage from a brachial plexus injury is measured by electromyography immediately after delivery, the injury had to have occurred at least a week or more before the delivery took place.

Koenigsberg's (1980) report of this phenomenon is the most detailed. He describes two cases of brachial plexus injury in which electromyelographic evidence suggested an intrauterine -- prior-to-birth -- origin. One 3,625 gram baby had a classic right Erb palsy at birth. But electromyelographic studies of this baby's deltoid, biceps and brachial radialis muscles shortly after birth revealed multiple fibrillations and positive injury waves in addition to a greatly
reduced numbers of active muscle units. Electromyelographic studies on the opposite arm were normal.

A second baby, a 3,180 gram term infant delivered via Cesarean section, was noted at birth to have left upper arm muscle weakness, loss of movement in the left hand, and Horner's syndrome -- classic for severe brachial plexus injury. Electromyelographic studies showed clear-cut evidence of muscle fiber damage in the left arm. All studies on the right side were normal.

Based on the electromyelographic evidence, Koenigsberg concluded that the injuries to the two babies had to have occurred prenatally rather than being caused by any injury associated with delivery. Such muscle injuries from brachial plexus damage measured electromyelographically at birth have also been reported by Philpot (1995), Jennett (1992), and others.

Brachial plexus injuries following Cesarean section

Reports of brachial plexus injury in the absence of shoulder dystocia are subject to the criticism that perhaps shoulder dystocias were under-reported or that "excess' traction might have been placed on the baby's head during the course of a routine delivery. But reports of brachial plexus injury following Cesarean section are less subject to criticism. There are many such reports in the literature:

Ecker (1997): Two infants born by Cesarean section who sustained brachial plexus injuries, one of a nondiabetic mother, the other of a diabetic mother.

Hardy (1981): Two infants born in vertex position at Cesarean section who sustained brachial plexus injuries.

Mcfarland (1986): Four patients delivered by Cesarean section who experienced brachial plexus injuries.

Graham (1997): Reported an Erb palsy from cesarean section.

Gilbert (1999): Evaluated data on all brachial plexus injuries from California in the years 1994 to 1995. Of the 1,094,298 babies born in those two years there were 1,611 brachial plexus injuries reported (0.15%). Of these, 60 were from Cesarean sections.

The phenomenon of brachial plexus injury following cesarean delivery -- and thus not related to shoulder dystocia -- is real. As has been shown, there is much evidence to suggest that not all instances of brachial plexus injury are due to shoulder dystocia deliveries or to the actions of a physician during such deliveries. Thus the automatic assignment of responsibility to an obstetrician or midwife for a brachial plexus injury whenever a shoulder dystocia delivery occurs is inappropriate and not supported by the literature.

Shoulder Dystocia Drill

A shoulder dystocia drill is a practice run-through by a labor and delivery unit of a mock shoulder dystocia delivery. It has been suggested both as a practice protocol and as a teaching technique for all members of the obstetrical team. Some authors have stated that it is the obligation of every delivery unit and every obstetrician to participate in routine shoulder dystocia drills as part of obstetrical readiness. There is an excellent video tape produced by the American College of Obstetricians and Gynecologists (ACOG) -- AVL 103 -- that describes and visually demonstrates a model shoulder dystocia drill.

Although practicing and preparing for any emergency is always a good idea, it is not clear whether a formalized drill performed at regular intervals is necessary to provide good care.
What is necessary, however, is that obstetricians, obstetrical nurses, and everyone involved with deliveries know that any vaginal delivery can suddenly turn into a shoulder dystocia emergency and that they are aware of the steps necessary to resolve this emergency in an orderly, efficient manner.

**Documentation**

Careful documentation of instances of shoulder dystocia and their resolution is extremely important for two reasons:

1) Obstetricians want to learn as much as possible from instances of shoulder dystocia in order to develop the best techniques for dealing with them.

2) Shoulder dystocia is so often the initiating cause of medical-legal actions.

Acker (1991) described what careful documentation of a shoulder dystocia delivery should include:

1) Exact times of events.

2) Description of the maneuvers used.

3) Estimation of the traction forces exerted.

The note must be legible and must be written or dictated shortly after the events so that it is a contemporaneous medical progress note. Acker also recommends that the note have a specific form. This would include comments on:

1) Delivery time both for head and body (the nurse should record this).

2) Episiotomy description and timing.

3) Whether or not anesthesia was present when the shoulder dystocia was recognized and any additional anesthesia given.

4) Nasopharyngeal suction.

5) Initial traction before shoulder dystocia is recognized, documenting force and duration.

6) Maneuvers used, listing them in the order employed.

7) The force used described in comparative terms such as average, maximal, etc.

8) Duration of maneuvers -- have the nurses know to record this.

9) Personnel -- identify all present.


Experience has shown that the best defense in a medical liability action, whether involving shoulder dystocia or any other situation, is thoughtful, articulate, timely documentation of each decision made in the course of treatment.
Conclusions

A thorough review of the literature on shoulder dystocia reveals the following:

1. It cannot be determined with any degree of accuracy which babies will be macrosomic and which babies will experience shoulder dystocia at delivery.

2. The various strategies thus far proposed to attempt to reduce the number of shoulder dystocia deliveries and brachial plexus injuries would all result in:
   a. Hundreds or thousands of cesarean sections to prevent a single case of permanent brachial plexus injury
   b. The potential medical complications from such interventions
   c. The economic costs of such interventions

3. Although there are various techniques for resolving shoulder dystocias when they occur, these will not totally eliminate the incidence of brachial plexus and other birth injuries.

4. Brachial plexus injuries are often caused by factors not related to delivery.

Bibliography


Shoulder Dystocia Resources

Web Sites

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American College of Obstetricians and Gynecologists
American College of Nurse Midwives
Association of Women’s Health, Obstetric, and Neonatal Nurses
Birth Source.com
Injured Newborn
Law and Policy Institutions Guide
Medical Legal Art (animation available)
Nucleus Medical Art (pictures available)

Nursing Spectrum

OBGYN.net

Pregnancy.about.com

Seif & Associates Medical Graphics

United Brachial Plexus Network

World Health Organization

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