

10 practical, evidence-based recommendations for improving maternal outcomes of cesarean delivery

Recent studies shed light on anesthesia, postoperative adhesions, infectious morbidity, and the risk of bladder and ureteral injuries in cesarean delivery

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Cesarean delivery is not risk-free, despite its high prevalence (30% overall, but almost 100% in women who have more than two prior cesareans). It increases the risks of adhesions, severe blood loss, and injury to the bowel, bladder and ureters, particularly among women undergoing the procedure for the second or third time.

Morbidly obese women (i.e., those who have a body mass index [BMI] of 40 or above) are in a particular bind: They have an elevated risk of cesarean delivery, and when they undergo the procedure, they have a significantly heightened risk of cardiopulmonary complications, anesthetic complications, wound complications, thromboembolism, and prolonged skin incision-to-delivery time.

A number of studies have described the technical aspects of cesarean delivery, but debate continues about a number of issues:

- the risks and benefits of types of skin incision
- whether the rectus muscle should be separated bluntly or sharply
- whether or not to close the peritoneum
- the best method of closing the skin (i.e., subcuticular sutures or staples).

In this review, I offer 10 practical, evidence-based recommendations that help clarify these issues, including several that focus on the morbidly obese population.

1 Anticipate anesthetic complications

In morbidly obese pregnant women, plan for potential complications

Vricella LK, Lois JM, Mercer BM, Bolden N. Anesthesia complications during scheduled cesarean delivery for morbidly obese women. Am J Obstet Gynecol. 2010;203(3):276.e1-5.

Knight M, Kurinczuk JJ, Spark P, Brocklehurst P; UK Obstetric Surveillance System. Extreme obesity in pregnancy in the United Kingdom. Obstet Gynecol. 2010;115(5):989-997.

In a national cohort study of 665 women who had a BMI of 50 or above, 11% experienced problems with epidural anesthesia, including failure; 6% required general anesthesia; and 3% required admission to intensive care. A similar, but retrospective, study

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of 142 morbidly obese women found an anesthesia complication rate of 8.5%.

These studies suggest that planning and antenatal consultation with anesthesiologists are important to help avert anesthetic complications during cesarean delivery. Requirements include detailed evaluation at admission, early placement of an epidural catheter, preparation for general anesthesia in case of failure of regional anesthesia, and ensuring the availability of an anesthesiologist who has expertise in this population.

2 Reduce the interval from decision to delivery

Plan, implement, and rehearse a protocol to move from decision to incision and delivery in 30 minutes in morbidly obese women

Lucas DN. *The 30-minute decision to delivery time is unrealistic in morbidly obese women.* *Int J Obstet Anesth.* 2010;19(4):431–435. Comment by: Dresner M. *Int J Obstet Anesth.* 2010;19(4):435–437.

Although several national bodies recommend a decision-to-incision or delivery interval of 30 minutes or less, this approach is not backed by definitive data. Moreover, the 30-minute goal poses major challenges to the nursing, anesthesia, and surgical teams that provide care to morbidly obese women who require emergent cesarean delivery. This is especially true in cases that involve catastrophic events, such as abruptio placentae, cord prolapse, uterine rupture, or vasa previa—where minutes matter.

Nevertheless, efforts to reduce this interval are vital. Consider four phases:

- how long it takes to transfer the patient to the operating room
- the time it takes to position and prepare the patient for surgery
- the time required to administer anesthesia
- how long it takes to move from skin incision to delivery of the fetus.

Because all four phases will be prolonged in morbidly obese patients, it is prudent for obstetric units to develop protocols to identify

and flag women who are at risk, and to have policies and procedures in place to reduce these times. This will necessitate drills for rehearsal and testing of response times and skills of the various providers. In addition, whenever emergent cesarean is performed, the actual response time and effectiveness of interventions should be evaluated.

3 Consider a transverse skin incision

In morbidly obese women who undergo emergent cesarean delivery, a transverse skin incision may provide benefit

Wylie BJ, Gilbert S, Landon MB, et al; Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units Network (MFMU). *Comparison of transverse and vertical skin incision for emergency cesarean delivery.* *Obstet Gynecol.* 2010;115(6):1134–1140.

Bell J, Bell S, Vahratian A, Awonuga AO. *Abdominal surgical incisions and perioperative morbidity among morbidly obese women undergoing cesarean delivery.* *Eur J Obstet Gynecol Reprod Biol.* 2011;154(1):16–19.

No randomized trials have compared the benefits and risks of vertical and transverse skin incisions during cesarean delivery. In general, a vertical incision is believed to shorten the time to delivery, but is associated with a greater need for transfusion, greater postoperative pain, and higher rates of wound dehiscence and infection, compared with a transverse incision.

A prospective cohort study of all emergent cesarean deliveries performed at 13 medical centers compared maternal and neonatal outcomes between 2,498 women who had a vertical incision and 1,027 who had a transverse incision. The use of a vertical incision shortened the median incision-to-delivery interval by 1 minute (3 vs 4 minutes; $P < .001$) for primary cesarean and by 2 minutes (3 vs 5 minutes; $P < .001$) for repeat cesarean. However, a vertical incision was associated with higher rates of endometritis



When the mother is morbidly obese, ensure the availability of an anesthesiologist with expertise in this population

(15% vs 11%; $P = .006$) and postpartum transfusion (7% vs 5%; $P = .01$) for primary cesarean, as well as a higher rate of postpartum transfusion (15% vs 8%; $P = .02$) for repeat cesarean. No differences in the rates of wound hematoma and infection were noted.

A retrospective cohort study in 424 morbidly obese women compared maternal morbidity between 41 women who had a vertical skin incision and 383 women who had a transverse incision for cesarean delivery. A vertical incision was associated with a dramatic increase in the risk of a classical uterine incision (65.9% vs 7.3%; $P < .001$), but there were no differences in the rates of blood transfusion or wound breakdown or infection between the two groups. However, these findings should be interpreted with caution because women who received a vertical incision were older (31.0 ± 6.2 years vs 27.1 ± 6.7 years; $P < .001$), and there was no mention of the type of vertical skin incision in relation to the umbilicus or the use of drains. A randomized trial is needed to determine the optimal skin incision in morbidly obese women.

4 Use blunt, not sharp, expansion of the uterine incision

Blunt expansion is associated with less blood loss

Sekhvat L, Firouzabadi RD, Mojiri P. Effect of expansion technique of uterine incision on maternal blood loss in cesarean section. Arch Gynecol Obstet. 2010;282(5):475-479.

A prospective, randomized trial explored the rate of lateral extension of the uterine incision and estimated blood loss in 200 full-term primiparas undergoing cesarean delivery. Women were assigned to blunt expansion ($n = 100$) or sharp expansion ($n = 100$). Blunt expansion was associated with lower estimated blood loss (375 ± 95 mL vs 443 ± 86 mL; $P < .05$) but no differences in the rate of lateral extension (5% vs 6%). These findings reveal that blunt expansion of the

uterine incision in primiparas is safer and easier than sharp expansion.

5 Close the peritoneum

Nonclosure after cesarean delivery is associated with a higher rate of adhesion formation

Cheong YC, Premkumar G, Metwally M, Peacock JL, Li TC. To close or not to close? A systematic review and a meta-analysis of peritoneal non-closure and adhesion formation after caesarean section. Eur J Obstet Gynecol Reprod Biol. 2009;147(1):3-8.

Shi Z, Ma L, Yang Y, Wang H, et al. Adhesion formation after previous caesarean section—a meta-analysis and systematic review. BJOG. 2011;118(4):410-422. doi: 10.1111/j.1471-0528.2010.02808.x.

A systematic review and meta-analysis that included two randomized trials and one prospective study compared the rate of adhesions after cesarean delivery between women who had peritoneal closure ($n = 110$) and those who did not ($n = 139$). Nonclosure was associated with a substantial increase in the rate of subsequent adhesion formation (adjusted odds ratio, 4.23; 95% confidence interval [CI], 2.06–8.69). However, this review did not consider risk factors such as creation of a bladder flap or type of uterine incision.

A subsequent systematic review ($n = 4,423$) compared the rate of adhesions associated with closure and nonclosure of the peritoneum according to cesarean technique (Stark's, modified Stark's, or classic lower-segment). The classic lower-segment technique involves dissecting the bladder off the uterus and closure of both peritoneal layers (visceral and peritoneal). Neither Stark's technique nor the modified Stark's technique dissects the bladder from the uterus; both techniques use single-layer closure of the uterine incision. Stark's technique leaves the peritoneal layer open, whereas the modified Stark's technique closes the peritoneal layer. This review revealed that closing the peritoneum in modified Stark's cesarean delivery



Blunt expansion of the uterine incision in primiparas is safer and easier than sharp expansion

was associated with a lower rate of subsequent adhesions—both in terms of total adhesions and individual grades of adhesions.

6 Use double-layer uterine closure

Despite its lack of effect on maternal morbidity, double-layer closure reduces risk of rupture during VBAC

The CAESAR study collaborative group. Cesarean section surgical techniques: a randomised factorial trial (CAESAR). BJOG. 2010;117(11):1366-1376. doi: 10.1111/j.1471-0528.2010.02686.x.

This large multicenter, randomized trial evaluated maternal infectious morbidity in women undergoing single- (n = 1,483) and double-layer (n = 1,496) closure of the uterine incision. The total rates of maternal infectious morbidity (16.1% vs 16.9%), wound infection (12.8% vs 12.7%), severe morbidity (0.5% vs 0.7%), and readmission within 6 weeks (2.6% vs 2.7%) were similar between groups for single- and double-layer closure, respectively. However, retrospective and case-control studies reveal that double-layer closure is associated with lower rates of uterine dehiscence and rupture during vaginal birth after cesarean (VBAC).

7 Keep the risk of adhesions in mind

Closing the peritoneum may reduce long-term adhesion formation

The CAESAR study collaborative group. Cesarean section surgical techniques: a randomised factorial trial (CAESAR). BJOG. 2010;117(11):1366-1376. doi: 10.1111/j.1471-0528.2010.02686.x.

According to the findings of this large, multicenter, randomized trial, the rate of maternal infectious morbidity did not change whether or not a drain was used or the peritoneum was closed. The study evaluated only maternal infectious morbidity related to peritoneal closure—not long-term adhesion formation.

Nevertheless, it appears that closure of the peritoneum at the time of cesarean delivery is associated with a lower rate of long-term adhesion formation.

8 Forget adhesion barriers

Their use to prevent intra-abdominal adhesions is ill-advised

Albright CM, Rouse DJ. Adhesion barriers at cesarean delivery: advertising compared with the evidence. Obstet Gynecol. 2011;118(1):157-160.

After cesarean delivery, there is a potential for intra-abdominal adhesions to form, which can lead to pain, small bowel obstruction, and injury during repeat surgery. A review of the literature suggests that the use of adhesion barriers at cesarean delivery is not cost-effective. Randomized trials are needed.

9 Be vigilant for bladder and ureteral injuries

Know the risk factors and preventive strategies for these injuries

Gungorduk K, Asicioglu O, Celikkol O, et al. Iatrogenic bladder injuries during cesarean delivery: a case control study. J Obstet Gynaecol. 2010;30(7):667-670.

Karram M. Avoiding and managing lower urinary tract injury during vaginal and abdominal deliveries. In: Sibai BM, ed. Management of Acute Obstetric Emergencies. Philadelphia, Pa: Elsevier-Saunders; 2011:179-187.

The reported incidence of bladder injury at the time of cesarean delivery ranges from 0.13% to 0.31% during primary cesarean and reaches 0.6% during repeat cesarean. During primary cesarean, bladder injury usually occurs during entry into the peritoneal cavity and involves the high extraperitoneal aspect of the bladder. In repeat cesarean, it usually occurs during dissection of the bladder flap and involves the intraperitoneal aspect of the bladder (dependent portion).

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Double-layer uterine closure is associated with lower rates of uterine dehiscence and rupture during vaginal birth after cesarean

Risks of lateral and downward extension



Avoid lateral and downward extension of the uterine incision, which may injure the blood vessels or ureter.

Source: Sibai BM, ed. *Management of Acute Obstetric Emergencies*. Philadelphia, Pa: Elsevier-Saunders; 2011.

Bladder and ureteral injuries are more likely to occur in the presence of one or more of the following risk factors:

- emergency or crash cesarean delivery
- cesarean delivery after prolonged pushing
- history of uterine or abdominal surgery
- central placenta previa or accreta
- lateral or downward extension of the uterine incision
- uterine rupture
- need for hysterectomy.

Inadvertent bladder injury during entrance into the peritoneum should be managed with layered closure of the cystotomy. Because such injury occurs high in the bladder, it requires only a short period of postoperative drainage. In contrast, injury to the base of the bladder requires appropriate mobilization of the bladder off any adherent structures to allow tension-free closure of the injury. Since this type of injury lies in the dependent portion of the bladder, it requires postoperative drainage for 10 to 14 days. Close the injury in two layers, using fine, delayed, absorbable suture in interrupted or running fashion, with the first layer approximating the mucosa and the second layer imbricating the muscularis.

Ureteral injury is rare during cesarean delivery. When it does occur, it usually occurs during repair of lacerations from the uterine incision or control of excessive bleeding from the lower segment or broad

ligament (FIGURE). The most common site of injury from uterine lacerations is at the level of the uterine vessels, whereas the most common site of injury at cesarean hysterectomy is the lower portion of the ureter near the uterosacral ligaments.

If you suspect injury, confirm ureteral patency by making a cystotomy in the bladder dome to visualize the orifices, and attempt to pass a ureteral catheter or pediatric feeding tube through the orifice into the ureter until you reach a point above the area of concern. If there is an obstruction, kinking, or transection, consult a urogynecologist or urologist.

10 Close the skin with subcuticular suture

This approach is associated with lower risk of wound separation and infection than is closure with staples

Tuuli MG, Rampersad RM, Carbone JF, Stamilio D, et al. Staples compared with subcuticular suture for skin closure after cesarean delivery: a systematic review and meta-analysis. Obstet Gynecol. 2011;117(3):682-690.

Wound complications following cesarean can include hematoma, seroma, complete separation, or infection (superficial or deep). Wound complications may be more likely with staple closure of a transverse skin incision than with subcuticular suture. Other issues to consider when choosing a type of skin closure include postoperative pain, cosmesis, and how long it takes to deliver the infant.

This systematic review and meta-analysis of five randomized trials and one prospective study compared outcomes after skin staple closure (n = 803) with those after subcuticular suture closure (n = 684) in women who had a transverse incision. Staple closure was associated with a higher rate of wound infection or separation (13.4% vs 6.6%; pooled odds ratio, 2.06; 95% CI, 1.43-2.98). Staple closure was associated with a shorter operating time (range, 3.3-9.3 minutes). Both techniques were similar in terms of postoperative pain, cosmetic appearance, and patient satisfaction. 



Bladder and ureteral injuries are more likely when the cesarean delivery follows prolonged pushing