Labor Induction Techniques: Which Is the Best?

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KEYWORDS

• Labor induction • Bishop score • Prostaglandins • Foley balloon • Oxytocin • Amniotomy

KEY POINTS

- A modified Bishop score of 6 or less is the generally accepted threshold to define an unfavorable cervix, which will benefit from cervical ripening before induction of labor.
- The most effective cervical ripening agent to achieve delivery in 24 hours is vaginal misoprostol; oral misoprostol is the most likely to achieve vaginal delivery overall.
- The combination of Foley catheter and misoprostol may be more effective than single-agent cervical ripening agents.
- The combination of amniotomy and intravenous oxytocin the most effective induction method for a favorable cervix.

INTRODUCTION

Induction of labor is the artificial stimulation of labor before its spontaneous onset to promptly achieve vaginal delivery. It is a commonly performed procedure, with approximately 1 in 5 gravid women undergoing induction of labor in both the United States and Canada in recent years.[1,2]

Induction of labor may be advisable whenever the risks of continuing the pregnancy outweigh the risks associated with induced labor and delivery. When labor induction is undertaken for appropriate reasons and with a safe and efficient approach, this procedure can greatly benefit the health of the both mothers and newborns. The indications, contraindications, and various other considerations that factor into the decision to induce labor are complex and beyond the scope of this article.

The first description of artificial induction of labor dates back to 1948 when a posterior pituitary extract of oxytocin was administered by intravenous drip for the purpose of

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inducing labor.[3] Since then, multiple methods have been developed to recreate parturition artificially. Some methods, such as administration of ergot alkaloids, vaginal and uterine douches, and stimulant injections, have since been abandoned owing to ineffectiveness and adverse side effects, whereas other methods have withstood the test of time and continue to be used successfully in modern obstetric practice.

The modern techniques of labor induction can be divided into the following 2 broad categories depending on the status of the cervix before induction of labor.

- *Cervical ripening agents for the unfavorable cervix*: This category includes the local administration of medication, which softens and opens the cervix (prostaglandins) as well as mechanical methods, including insertion of catheters or dilators directly into the cervix.
- *Induction methods for the favorable cervix*: Administration of systemic medications that stimulate uterine contractions (ie, synthetic oxytocin) and mechanical methods such as amniotomy.

Each technique of labor induction has associated advantages and disadvantages, and as a result there is no single method that is uniformly superior for labor induction. Instead, the approach to labor induction should be tailored to the clinical scenario, with consideration given to gestational age, prior uterine surgery, fetal status, and the presence or absence of spontaneous contractions. Additionally, system factors, such as cost and the availability of immediate emergency cesarean delivery, may also weigh on the decision. Finally, an induction of labor should consider individual needs and preferences, and allow women the opportunity to make informed choices in partnership with health care providers.

ASSESSING THE CERVIX

Before starting a labor induction, the clinician must first assess the cervix to determine whether or not it is ready to start the labor process. A cervix is termed "favorable" or "ripe" to begin labor when it has softened or thinned out, making it pliable for stretching and subsequent dilation. Accurate assessment of the cervix is essential, because the selection of induction method is typically centered on the cervical status.

Bishop Score

Developed in 1964, a cervical scoring system, referred to as the Bishop score, is the most commonly used method to assess the ripeness of the cervix before induction. This system takes into account the position, consistency, effacement (shortening), and dilation of the cervix, as well as the station (location) of the presenting fetal part relative to ischial spines (**Table 1**). A modified Bishop score has also been developed that replaces effacement with cervical length.[4] In these systems, each category is assigned a score from 0 to 3, with a total maximum score of 13. A higher score reflects a cervix that is more "ripe" or "favorable" for labor induction. Traditionally, a score of 6 or less is used as a threshold to classify an "unfavorable" cervix that would benefit from cervical ripening agents during an induction of labor.[1]

In addition to determining cervical favorability, the Bishop score can also be used to predict the likelihood of vaginal delivery with induction of labor. Used in this way, a score of 6 or less is associated with a higher probability of failed induction. With a score of greater than 8, the probability of a vaginal delivery is the same for induced or spontaneous labor.[1] Aiming to make the Bishop score even more convenient, a recent study validated a simplified Bishop score using only dilation, station, and effacement. Compared with the original Bishop score cutoff of greater than 8, a

Table 1
Modified Bishop scoring system

	0	1	2	3
Dilation, cm	Closed	1–2	3–4	5–6
Effacement, %	0–30	40–50	60–70	≥80
Station	−3	−2	−1, 0	+1, +2
Cervical consistency	Firm	Medium	Soft	—
Position of the cervix	Posterior	Midposition	Anterior	—

From Stock SJ, Calder AA. Induction of labour. In: Baskett TF, Calder AA, Arulkumaran S, editors. Munro Kerr's operative obstetrics. 12th edition. Edinburgh (Scottland): Elsevier; 2014. p. 71–9; with permission.

simplified Bishop score of greater than 5 has similar or better predictive ability of successful induction in a modern obstetric cohort.[5]

Transvaginal Ultrasound Imaging

Transvaginal ultrasound imaging is also used to assess cervical favorability and predict the likelihood of vaginal delivery with induction of labor. Ultrasonographic identification of a short cervical length and the presence of cervical "wedging" (any triangle "V pattern" at the area of the internal os) are considered signs of a favorable cervix. The ability of ultrasound examination to detect these early changes in the cervix, which occur before dilation, is advocated as an advantage over digital cervical assessment.[6] Additionally, transvaginal ultrasound imaging is reportedly associated with higher patient satisfaction.[7]

Using ultrasonographic signs to identify a favorable cervix may also enable providers to be more selective in their use of cervical ripening agents without adversely effecting induction outcome. Instead of using traditional Bishop score cutoffs, when a cervical length measurement of greater than 28 to 30 mm and less than 30% wedging are used as criteria for cervical ripening, the use of prostaglandins is significantly reduced without influencing vaginal delivery rates.[8,9] Ultrasound assessment, therefore, holds promise to reduce the use of cervical ripening during induction of labor, although more data are needed to confirm these results before transvaginal ultrasound imaging can be routinely recommended over the standard digital vaginal assessment.[10]

Ultrasonographic cervical length is also proposed as a method to predict mode of delivery with labor induction in term gestations, although the results are inconsistent and conflicting. The use of this modality for this purpose is, therefore, not recommended at this time.

Fetal Fibronectin

An elevated fetal fibronectin (fFN) concentration is another proposed tool to predict the duration and success of labor induction. Fibronectin is an extracellular matrix protein located in amniotic fluid and fetal membranes at the choriodecidual interface. When this interface becomes disrupted or inflamed (ie, during transformation of the cervix and membranes preceding labor) fFN "leaks" through the cervix into the vagina. Detection of this protein in cervicovaginal secretions is, therefore, associated with proximity to the onset of labor.[11–13] More recently, an elevated fFN concentration in cervicovaginal secretions at term has been associated with a shorter duration of cervical ripening and decreased time to delivery during labor induction,[11,14,15] but notably, fFN does not seem to be predictive of vaginal delivery.[15,16] Given the high cost of the fFN assay, its clinical usefulness for selecting suitable candidates for induction is limited at this time.

Summary: Cervical Assessment

- A modified Bishop score of 6 or less is the generally accepted threshold to define an unfavorable cervix, which could benefit from cervical ripening before induction of labor. A transvaginal cervical length of greater than 28 mm may also predict the need for cervical ripening.
- A simplified Bishop score of greater than 5 based on dilation, effacement, and station is predictive of vaginal delivery with induction of labor.
- The high cost and poor predictive value of fFN limit its use for predicting successful induction.

CERVICAL RIPENING WITH PHARMACOLOGIC METHODS

If the cervix is considered "unfavorable," a ripening process is generally used before labor induction. In the early 1970s, the introduction of cervical ripening methods, particularly synthetic prostaglandins, revolutionized the success of the induction process. Although considered less effective, oxytocin can also be used as a cervical ripening agent in certain clinical scenarios. Each of these options for pharmaceutical cervical ripening have distinct advantages and disadvantages in labor induction.

Prostaglandins

The administration of synthetic prostaglandins leads to changes in the cervix that mimic the natural cervical ripening process, including dissolution of collagen fibrils and increased water content that cause the cervix to swell.[17] As a result, the cervix becomes softened and distensible, and therefore more amenable to the process of thinning and dilation.[18] There are 2 synthetic prostaglandins used routinely for induction of labor: prostaglandin E1 and prostaglandin E2.

Prostaglandin E1

Misoprostol (Cytotec) is a prostaglandin E1 analog approved by the US Food and Drug Administration for the treatment and prevention of gastric ulcers related to chronic nonsteroidal antiinflammatory drug use. Administration of this drug for cervical ripening and labor induction is considered an off-label use in the United States. However, both the American College of Obstetricians and Gynecologists and Society of Obstetricians and Gynecologists of Canada consider misoprostol to be both safe and efficacious when used as a cervical ripening agent.[1,2]

Administration of prostaglandin E1 Misoprostol can be administered by vaginal, oral, and buccal/sublingual routes.

- *Vaginal administration*—The optimal dose and timing intervals of intravaginally applied misoprostol are unknown.[19–23] A metaanalysis reported that the 50-μg dose was more effective than 25 μg (eg, higher rates of delivery after a single dose, delivery within 24 hours, and a lower rate of oxytocin use), but the 25-μg dose was safer (lower rates of tachysystole, cesarean deliveries for fetal concern, neonatal intensive care unit admissions, and meconium).[24]

Recommended dosing: Lower doses, such as 25 μg, should be used initially, with redosing intervals of 3 to 6 hours.[19,25,26] The World Health Organization suggests 25 μg every 6 hours.[27]

- *Oral administration*—Oral administration of misoprostol is another option that has been evaluated in several trials. The concentration of orally administered

misoprostol peaks sooner and decreases more rapidly than with vaginal administration, leading to regimens with more frequent dosing intervals.

Recommended dosing: A conservative regimen would be 50 μg tablets orally no more frequently than every 4 hours, with a maximum of 6 consecutive doses. The World Health Organization and 2 systematic reviews suggest 25 μg tablet fragments every 2 hours.[27–29]

- *Buccal or sublingual administration*—Other novel approaches to use of misoprostol, including buccal and sublingual administration, espoused for a more rapid uptake than oral or vaginal administration, have been described and have similar efficacy to vaginal routes of administration.[30–33] However, they are associated with a higher side effect profile. Therefore, more data are needed before these routes of delivery can be recommended for clinical use.

Comparisons of misoprostol use by route of delivery

- *Efficacy*: In several randomized trials, all 3 routes of administration have similar efficacy for achieving vaginal delivery within 24 hours.[30,32,34]
- *Safety*: A large systematic review found no difference in serious maternal and neonatal morbidity or death between oral and vaginal misoprostol.[28] Rates of tachysystole are similar with all 3 routes of administration. However, oral misoprostol may have a safety advantage over other routes owing to a higher consistency in dosing.
- *Patient satisfaction:* Two studies suggest that the ability to defer a digital cervical examination is considered an advantage of sublingual and oral administration,[35,36] but patient satisfaction with the various routes of administration has not been evaluated in any systematic manner.

Future prospects for misoprostol A retrievable misoprostol vaginal insert (Misodel) that delivers 200 μg over 24 hours has been developed and is available in some countries. The insert would overcome the challenges of inconsistent misoprostol dosing and allow for rapid removal with uterine tachysystole or abnormal fetal heart rate patterns. Additionally, in a large randomized trial it decreased time to onset of active labor and time to vaginal delivery compared with the dinoprostone vaginal insert.[37] Cesarean delivery rates were similar with both treatments.

Prostaglandin E2

Two prostaglandin E2 preparations containing dinoprostone are commercially available in the United States and Canada, Prepdil and Cervidil.

Prepidil This prostaglandin gel contains 0.5 mg of dinoprostone in a 2.5-mL syringe for endocervical application. If cervical change is inadequate and uterine activity is minimal after the first dose, it can be repeated every 6 to 12 hours, with no more than 1.5 mg of dinoprostone administered within a 24-hour period. Oxytocin administration should be delayed 6 to 12 hours after the final dose to avoid overstimulating the uterus.

Cervidil Cervidil is a controlled-release hydrogel pessary containing 10 mg of dinoprostone in a timed release formulation (released at a rate of 0.3 mg/h). The insert can be left in place for up to 12 hours, but should be removed if active labor begins. Oxytocin infusion can begin starting at 30 minutes after removal of the insert.

Comparison of efficacy of preparations of prostaglandin E2 A systematic review concluded that both the vaginal insert and cervical gel formulations of prostaglandin E2 have similar effectiveness in achieving active labor and vaginal delivery.[38] If regular

uterine contractions are noted before the start of the induction or there is concern about the fetal heart rate pattern, use of the vaginal insert would be favored over the gel formulation because it can be discontinued if uterine tachysystole or abnormal fetal heart rate patterns develop.

Side effects of prostaglandins

Side effects of prostaglandins include tachysystole, fever, chills, vomiting, and diarrhea.

Contraindications of prostaglandins

- *Prior uterine surgery:* Prostaglandins should not be used in term pregnancies with a prior hysterotomy (ie, prior cesarean birth or myomectomy) because of the increased risk for uterine rupture.[39]
- *Preexisting uterine activity:* Baseline uterine activity is a relative contraindication to the use of prostaglandins because the addition of an exogenous uterotonic agent could lead to excessive uterine activity.
  - Consider delaying or avoiding administration in a woman with frequent, low amplitude, painless contractions or 2 or more painful contractions per 10 minutes, particularly if a uterotonic has already been administered.
  - If uterine tachysystole occurs while using prostaglandins:
    - With prostaglandin E2 (dinoprostone) vaginal insert: Remove the insert immediately.
    - With prostaglandin E1 (misoprostol) or prostaglandin E2 (dinoprostone) vaginal gel: The medication will be absorbed completely and its effect cannot be altered.
- *Concern for fetal status:* Clinicians should refrain from use of nonretrievable prostaglandins E1 and E2 vaginal gel in pregnancies with fetal heart rate abnormalities, because increased uterine activity can further compromise fetal status.

Oxytocin

Oxytocin is the most commonly used drug used to induce labor worldwide. Synthetic oxytocin is analogous to the natural oxytocin that is released from the posterior pituitary during labor, and can also promote favorable changes in the cervix. In a review of 61 studies of more than 12,000 women, oxytocin was found to be a safe method for inducing labor.[40] However, the clinical usefulness of oxytocin as a cervical ripening agent is limited by a prolonged induction time and low efficacy in achieving vaginal delivery. When comparing oxytocin with vaginal prostaglandins for third trimester cervical ripening, oxytocin leads to a lower rate of vaginal delivery within 24 hours.[40] Importantly, prolonged oxytocin use is associated with an increased risk of peripartum complications, most notably postpartum hemorrhage.[41]

Despite these disadvantages, oxytocin is the only induction agent that can be used in parturients with prior uterine surgery who desire trial of labor when mechanical methods are not feasible (ie, closed cervix). In this scenario, oxytocin can be used for cervical ripening until the cervix is dilated enough for mechanical methods.

CERVICAL RIPENING WITH MECHANICAL METHODS

Mechanical methods of induction were developed centuries ago and several of these techniques are still used commonly in modern obstetrics. These methods initiate labor by stretching the cervix, and continue to be favored owing to their low cost and lower incidence of side effects compared with other induction agents. However, the

disadvantages of these techniques include discomfort with the procedure, bleeding, and risk of accidental rupture of membranes.

Membrane Stripping

In this approach, the health care provider sweeps a gloved finger over the membranes that connect the amniotic sac to the wall of the uterus. The action causes the release prostaglandins, which soften the cervix and may initiate the process of labor.[42] A systematic review found that sweeping the membranes reduced duration of pregnancy and frequency of pregnancy beyond 41 weeks.[43] This technique is therefore primarily used as a preventative strategy to avoid a formal induction of labor rather than as an induction technique itself.

Balloon Catheter

A Cook double balloon catheter specifically designed for cervical ripening is commercially available in the United States. Single balloon Foley catheters (typically #16 or #18) are also commonly used for cervical ripening. Randomized trials demonstrate similar efficacy of both single and double-balloon catheters, although the Foley catheter's low cost is a distinct advantage.

Procedure

Balloon catheters are placed using aseptic technique with continuous fetal monitoring. After placing a sterile speculum, ring forceps can be used to pass the deflated balloon catheter tip through the internal cervical os and into the extraamniotic space. If there is difficulty in passing the catheter through a narrow opening, a urologic sound can be placed inside of the catheter to direct placement. The single Foley balloon catheter is typically inflated with 30 to 60 mL of sterile water. Caution should be exercised when inflating the balloon to a high volume, because there have been sporadic reports of balloon rupture. An extraamniotic saline infusion of 30 to 40 mL/h can also be run through the catheter into the space between the internal os and placental membranes (**Fig. 1**). Data are mixed on the optimal balloon inflation volume[44,45] and appropriate duration of Foley ripening (12 vs 24 hours).[45] It is generally recommended to remove the catheter after 24 hours if it has not been spontaneously expelled.

Risk of infection

Although the balloon catheter was originally suspected to pose an increased risk of infection owing to the prolonged presence of a foreign body in the cervix, a recent large metaanalysis involving 5563 women demonstrated no increased risk of infectious morbidity associated with this technique.[46]

Future prospects for the Foley balloon catheter

Several investigators have pointed to the potential advantages of using outpatient Foley balloon ripening in uncomplicated term inductions, where the parturient returns to the hospital after a prespecified time period or when the Foley balloon is expelled. In 1 small randomized trial, the outpatient group avoided 9.6 hours of hospitalization and had similar neonatal outcomes as the group that had the Foley catheter placed while inpatient.[47] Further studies on safety and patient satisfaction are needed before this procedure can become widely implemented.

COMPARISON OF METHODS FOR CERVICAL RIPENING

When planning a labor induction, there are a multitude of available options. Taking into account considerations such as clinical history, baseline uterine activity, cervical

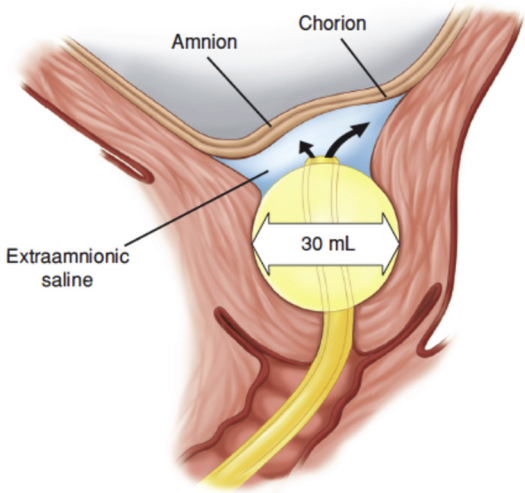

Fig. 1. Intracervical Foley balloon with extraamniotic saline infusion. (*From* Corton MM. Labor induction. In: Cunningham FG, Leveno KJ, Bloom SL, et al, editors. Williams Obstetrics, 23rd edition. New York: McGraw Hill Education; 2010; p. 504 with permission.)

examination, and fetal status should guide clinicians toward selection of the optimal cervical ripening agent (Fig. 2). Additionally, there is extensive research comparing the effectiveness and side effect profile of cervical ripening agents (Table 2).

Single-agent Methods for Cervical Ripening

When comparing methods for cervical ripening, 3 parameters are commonly used:

- Effectiveness—achieving vaginal delivery in 24 hours;
- Mode of delivery—vaginal or cesarean delivery; and
- Adverse side effects—uterine tachysystole with abnormal changes in the fetal heart rate pattern.

In a 2016 review of 96 randomized trials, the authors compared single-agent methods for cervical ripening and concluded that no method of cervical ripening demonstrates superiority in every parameter.[48] Instead, a different agent excelled in each of the 3 categories. Vaginal misoprostol was the most effective agent, with the highest likelihood of achieving vaginal delivery in 24 hours. Meanwhile, oral misoprostol was associated with the highest likelihood of vaginal delivery overall. These 2 findings were confirmed in another recent systematic review and network metaanalysis of 611 studies.[49]

In these systematic reviews, vaginal and sublingual/buccal misoprostol had the highest incidence of uterine hyperstimulation.[49] In contrast, the induction agent with the least adverse side effects was the Foley catheter.[48] Therefore, the preferred induction agent should be selected based on relative preference for effecting delivery within 24 hours, minimizing tachysystole and other fetal side effects, and avoiding a cesarean delivery.

Combination Methods for Cervical Ripening

Given that mechanical and pharmacologic cervical ripening agents have different mechanisms of action, it is plausible that using these methods simultaneously could produce synergistic effects. Combination methods typically use Foley catheter with simultaneous administration of either prostaglandins or oxytocin infusions.

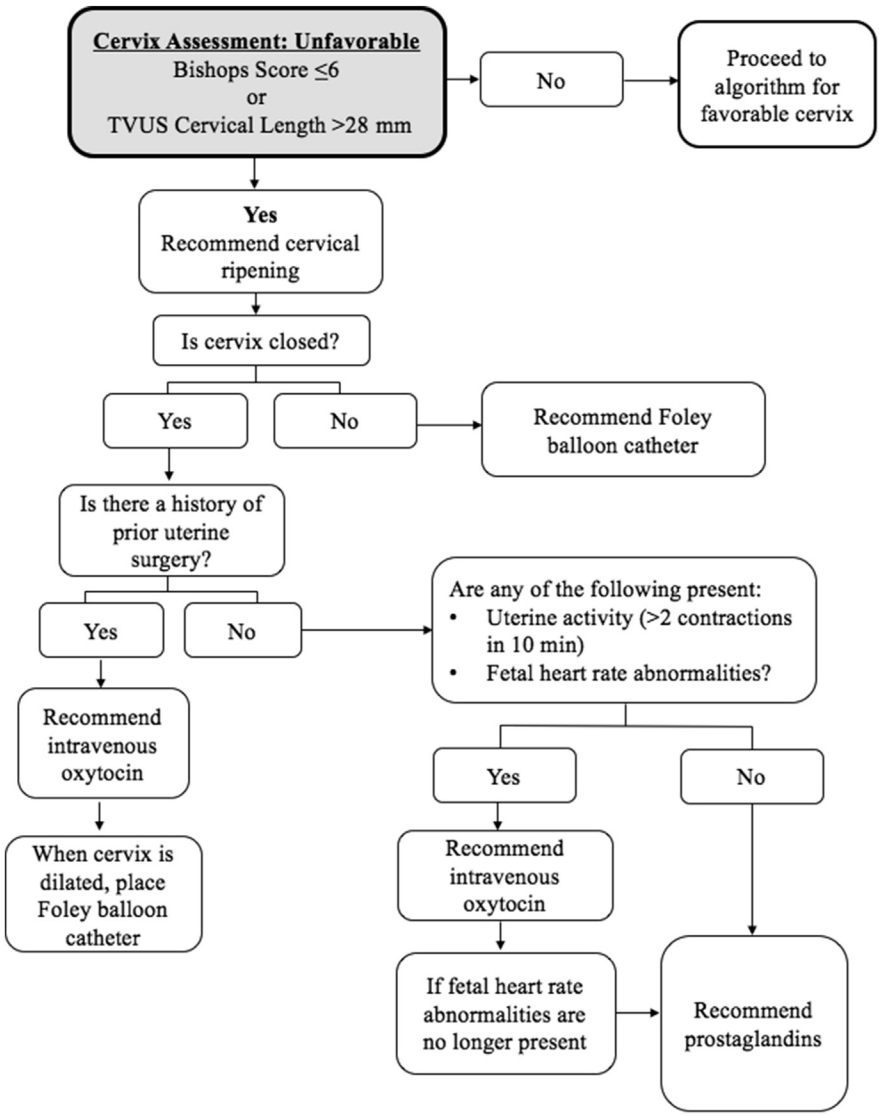

Fig. 2. Guidelines for labor induction with an unripe cervix. TVUS, transvaginal ultrasound imaging.

The most promising combination method for cervical ripening is Foley catheter and misoprostol. Although preliminary studies did not detect an advantage to using Foley catheter and prostaglandins together over using these agents individually, these trials were limited by small sample size, different dosing of misoprostol, and heterogeneous labor management.[50–52] More recently, 2 large randomized studies demonstrated that the combination of Foley and either oral or vaginal misoprostol reduced time to delivery compared with vaginal misoprostol alone.[53,54] In another recent randomized study, women who received both Foley catheter and vaginal misoprostol were twice as likely to deliver earlier than women who received Foley or vaginal misoprostol alone.[55]

Table 2
Comparison of cervical ripening agents

Agent	Advantages	Disadvantages	Best Practice	Cost[a]
Oxytocin	• Ability to titrate dosage quickly with abnormal fetal heart rate pattern • Ability to precisely titrate its effect	• Increased time from induction to vaginal delivery compared with other agents	• Cervical ripening in trial of labor after cesarean when cervix is closed.	10-mL ampule $53.31
Prostaglandin E1 (misoprostol)	• Decreased time to delivery • Highest rates of vaginal delivery overall	• Contraindicated in the setting of prior uterine surgery • Higher rates of uterine tachystole • Avoid use in the setting of preexisting uterine activity or concern for potential fetal decompensation owing to inability to reverse uterine stimulation	• Cervical ripening with closed cervix • Adjunct to mechanical methods	100-μg tab = $1.09
Prostaglandin E2 vaginal insert (Cervidil)	• Ability to reverse uterine stimulation after administration • May be used in cases where fetus is stable but there is concern for potential decompensation	• Increased time from administration to delivery • Discouraged in the setting of preexisting uterine activity or abnormal fetal status	• Cervical ripening in a closed cervix when fetus is stable but there is concern for potential decompensation	$218.94
Mechanical methods (Foley balloon, Cooks Foley balloon)	• Ability to reverse uterine stimulation after administration • May be used in cases where fetus is stable but there is concern for potential decompensation	• Discomfort with procedure	• Cervical ripening in cervix that is minimally dilated • May consider adding vaginal misoprostol simultaneously	Foley balloon $3.00 Cook Foley balloon $41.00

[a] This cost in US dollars is an estimate of the wholesale cost and does not include the cost of the entire induction or the hospital markup.

The other option for dual cervical ripening, Foley catheter and oxytocin infusion, has not demonstrated consistent benefit over Foley catheter alone. In two older randomized trials, the addition of oxytocin to Foley catheter did not significantly reduce likelihood of delivery within 24 hours, total time to delivery, or vaginal delivery rate.[55,56] In contrast, three more recent large randomized trials demonstrated reduced time to delivery with Foley catheter induction when oxytocin infusion was infused simultaneously.[55,57,58] Due to these conflicting reports, more studies are needed to confirm efficacy before this combination cervical ripening method can be recommended universally.

Only one randomized study compared the two dual cervical ripening regimens head-to-head; this study demonstrated that the misoprostol and Foley combination significantly reduced time to delivery compared to combining Foley catheter and oxytocin together.[55]

Summary: Comparison of Cervical Ripening Methods

- Most effective agent: Vaginal misoprostol.
- Most likely to achieve vaginal delivery: Oral misoprostol.
- Least adverse side effects: Foley catheter.
- The combination of Foley catheter and misoprostol appears to be more effective than single-agent cervical ripening in several randomized controlled trials.

INDUCTION TECHNIQUES FOR THE FAVORABLE CERVIX

If the cervix is favorable, cervical ripening agents are not typically necessary, and instead the use of intravenous oxytocin and artificial rupture of membranes is preferred. Several clinical considerations, such as parity and fetal station, should factor into the decision for which method should be used first—oxytocin, amniotomy, or a combination of the both methods simultaneously (**Fig. 3**).

Mechanical Methods for Induction in the Favorable Cervix: Amniotomy

Artificial rupture of membranes is a procedure used to intentionally rupture the chorioamniotic membranes with the goal to induce or augment labor. To rupture membranes, the cervix must be dilated, typically to at least 3 cm. To minimize the risk of umbilical cord prolapse after rupture of membranes, the fetal vertex should not be floating and must be well-applied to the cervix. The amniotomy procedure is typically carried out by an Amnihook, which is used to create a small opening in the membranes. The fetal heart rate should be monitored before and after membrane rupture.

Timing of amniotomy

There is concern that earlier rupture of membranes will lead to an overall longer exposure to ruptured membranes during labor, which has the potential to increase risk of chorioamnionitis. Therefore, the appropriate timing of artificial rupture of the membranes that balances the risk of infection with the benefits of expedited labor induction is debated. In a randomized trial of nulliparous women undergoing induction of labor, women randomized to rupture of membranes at 4 cm (vs >4 cm) had shortened time to delivery without an increase in maternal or neonatal infectious complications.[59] However, early amniotomy did not decrease the risk of cesarean delivery.

Addition of oxytocin to amniotomy

When amniotomy is used to induce labor, the combination of amniotomy with intravenous oxytocin is more effective than amniotomy alone.[60] For women with a favorable cervix, this combination is more successful than other agents in achieving vaginal delivery in 24 hours.[49]

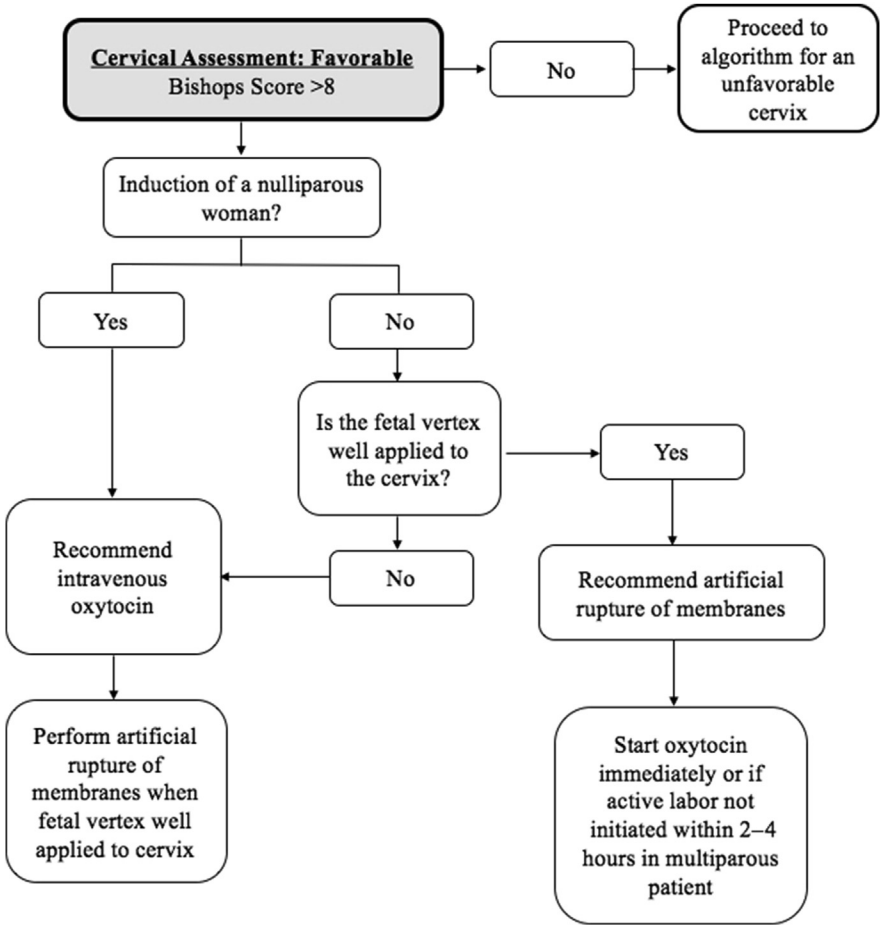

Fig. 3. Guidelines for labor induction with a favorable cervix.

However, there may be clinical scenarios, such as an induction of labor for a multiparous woman with a favorable cervix, where amniotomy alone may also be effective.[61] We recommend either starting oxytocin immediately with artificial rupture of membranes, or if active labor does not start within 2 to 4 hours after amniotomy in a multiparous patient.

Summary: amniotomy

- Artificial rupture of membranes should only be performed when the fetal vertex is well-applied to the cervix. Performing amniotomy at 4 cm may shorten time to delivery without increasing the risk of infection.
- The combination of amniotomy and intravenous oxytocin is the most effective induction method for a favorable cervix.

Pharmacologic Methods in the Favorable Cervix: Oxytocin

Oxytocin induces biochemical changes in uterine myofibrils and increases local prostaglandin production to further stimulate uterine contractions. Its synthetic analog Pitocin or Syntocinon is typically administered by intravenous infusion for labor induction with a favorable cervix. A commonly used strategy is to begin the induction with oxytocin until artificial rupture of membranes is feasible and the vertex is well-applied to the cervix.

Table 3
Oxytocin protocols

	Starting Dose (mU/min)	Incremental Dose Increase (mU/min)	Dosage Interval (min)
Low dose	0.5–1	1	30–40
Alternative low dose	1–2	2[a]	15–30
High dose	6	6	15–40
Alternative high dose	4	4	15

[a] The incremental increase should be reduced to 3 mU/min if tachysystole is present, and reduced to 1 mU/min if recurrent hyperstimulation. Some clinicians limit to a maximum cumulative dose of 10 U and a maximum duration of 6 hours.

Oxytocin protocols

The goal of oxytocin infusion is to stimulate sufficient uterine activity to dilate the cervix and produce fetal descent without causing hypertonic contractions of the uterus, which can decrease oxygenation of the fetus and, rarely, result in uterine rupture. To achieve this delicate balance, several protocols for oxytocin administration have been developed (Table 3). The aim of these protocols is to increase oxytocin dosing until strong contractions occurring every 2 to 3 minutes are achieved, or uterine activity the reaches 200 to 250 Montevideo units, as measured by an intrauterine pressure catheter. These regimens seem to be similar in achieving vaginal delivery in 24 hours.[62] Although the high-dose regimen may decrease time to delivery, it is also associated with higher rates of tachysystole (albeit without an increase in maternal and perinatal complications).[62]

The plasma half-life of oxytocin is short, with a uterine response in 3 to 6 minutes, and a steady concentration of oxytocin in plasma is achieved by 40 minutes with continuous infusion.[63] This allows for relatively quick titration to achieve adequate uterine stimulation and also enables the clinician to abruptly discontinue uterine stimulation if tachysystole an abnormal fetal heart rate pattern develop.

SUMMARY

This article presented an evidence-based overview of contemporary methods available for labor induction. Familiarity with the advantages and disadvantages of these methods for various clinical scenarios will guide clinicians toward an induction plan that is safe, effective, and patient centered, and achieve the overall goal of a healthy mother and newborn.

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