Induction of Labor: A Review

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ABSTRACT

Induction of labor is a common procedure in modern obstetrics and accounts for 20% of all deliveries. The goal of induction of labor is to preempt the natural process of labor by initiating its onset artificially by stimulating cervical ripening and uterine contractions before these occur spontaneously. The favorability of the cervix assessed by Bishop score has a substantial impact on the potential success of any labor induction. There is a consensus that the success of induced labor is directly related to the status of the cervix, with higher cesarean section rates in those with an unfavorable cervix. The review overviews about various methods, indications and contraindications, and predictors of induction of labor outcome.

Keywords: Bishop score, Cesarean section, Induction of labor, Labor.

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INTRODUCTION

Induction of labor is a common procedure in day-to-day practice of obstetrics and accounts for 20% of all deliveries.[1] In the United States, the rate of labor induction has increased over the years from 9.5 to 19.4%.[2] The reasons could be widespread availability of cervical ripening agents, pressure from patients, convenience for physicians, logistic factors, psychosocial reasons, and fear of litigation.[3]

Labor involves painful uterine contractions leading to dilatation of cervix and descent of the fetus through birth canal resulting in delivery.[4] Prior to this, there are extensive changes in the form of remodeling of cervix, increased responsiveness of myometrium, ripening, effacement, and loss of integrity of cervix. The most important changes in the cervix begin a few weeks before the uterine contractions. The composition of proteoglycans, glycosaminoglycans, and collagen undergoes changes. The cervical stroma is also invaded by inflammatory cells which produce mediators resulting in the softening of cervix. This is called cervical ripening.

Induction of labor is defined as artificial termination of pregnancy after the period of viability but before the spontaneous onset of labor with or without ruptured membranes.[5] The need for induction arises when it is likely to be associated with better outcome compared to the process being left alone. Centuries ago labor was induced mainly to deliver a dead fetus or to avoid cephalopelvic disproportion. Initially mechanical methods and artificial rupture of membranes were practiced but since the middle of 20th century oxytocin and subsequently prostaglandins have been extensively used along with other previously mentioned methods.

Rates of Induction of Labor

The rates of induction of labor have increased during the last few decades. The rate of induction depends on the availability of resources. Now many agents are available for cervical ripening. The rates of induction are higher in developed countries compared to developing countries.[6] Rate of induction of labor was 20% in the United States and United Kingdom.[7,8] In India, the rates are widely variable depending on private/government facility and nonteaching and teaching/tertiary care hospitals. In Pune, it ranged from 6.5[9] to 23.9%.[10]

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Indications for Induction of Labor

The indications may vary from country to country and institution to institution. Common maternal indications include postterm pregnancy, prelabor rupture of membranes (PROMs), gestational hypertension, preeclampsia, eclampsia, hemolysis, elevated liver enzymes and low platelets (HELLP) syndrome, fetal demise, chorioamnionitis, placental abruption, diabetes mellitus, chronic hypertension, renal disease, chronic pulmonary disease, antiphospholipid syndrome, etc. Fetal indications include severe fetal growth restriction, Rh isoimmunization, oligohydramnios.[7]

The common indications for induction are discussed below.

Postterm Pregnancy

When the expected date of delivery is exceeded by 2 weeks or more[11] it is called postterm pregnancy. Postterm pregnancies need to be terminated because they are associated with increased risk of uteroplacental insufficiency which leads to fetomaternal complications.[12] According to The American College of Obstetricians and Gynecologists (ACOG), Royal College of Obstetricians and Gynaecologists (RCOG), and World Health Organization guidelines, induction of labor in postterm pregnancy is done at 41 weeks of gestation.[11,13] Induction of labor at 41 weeks of gestation in uncomplicated pregnancies is acceptable because cesarean delivery rates are less in these women; and after 41 weeks, the chances of meconium-stained liquor and uteroplacental insufficiency are high.[14–16] Perinatal morbidities that are associated if the pregnancy

extends beyond 41 weeks include meconium aspiration, low Apgar score, neonatal acidemia, and birth injuries.[17,18] It is also associated with risk of neonatal encephalopathy and death in the first year of life.[19] According to some studies, the perinatal mortality rate is twice at 42 weeks of gestation compared to 41 weeks and it increases 4-fold at 43 weeks and 5- to 7-fold at 44 weeks.[19,20]

Prelabor Rupture of Membranes

It is defined as spontaneous rupture of amniotic sac before the onset of labor. If the rupture occurs after 37 completed weeks of gestation, then it is called PROM; and if rupture occurs before 37 weeks, it is called preterm prelabor rupture of membranes (PPROM). It occurs in 4–18% of pregnancies, mostly after 37 completed weeks of gestation.[21] Even though the etiology of PROM is not known exactly, risk factors that lead to PROM are urinary tract infections, genital tract infections, polyhydramnios, multiple pregnancies, cervical incompetence, placenta previa, abruptio placentae, and amniocentesis. According to some authors, PROM can happen in women with nutritional deficiencies such as deficiency in zinc, copper, and vitamins C and E.[22,23] Prelabor rupture of membrane occurs due to the weakening or thinning of epithelium of the membranes which can be due to altered collagen metabolism or increase in intra-amniotic pressure.[22] There is a high chance for maternal and fetal complications if it involves prolonged rupture of membranes. If the latency period exceeds 24 hours, then it is called prolonged rupture of membranes.[24] The major maternal complication is sepsis and it can develop in postpartum period as endometritis. The major fetal complication includes fetal and neonatal sepsis which is more common if there is prolonged rupture of membranes. Other fetal complications include fetal distress, meningitis, pneumonia, pyoderma, umbilical sepsis, and conjunctivitis.[25] Since there is increase in perinatal morbidity if the period of latency is long after the rupture of membranes, early action such as induction of labor should be taken.[26] Induction of labor should be done when the women does not go into labor even after 4–6 hours after rupture of membranes. In a study done by Kappy et al., it was found that cesarean delivery rate was high in women who had labor stimulation for preterm rupture of membranes compared with women who are under expectant observation.[27]

Oligohydramnios

It is defined as amniotic fluid index of less than 8 cm. It is also sonographically defined as absence of fluid pocket 2–3 cm in depth.[28] Amniotic fluid is mainly produced by fetal urine. Absence or reduction in production of fetal urine results in oligohydramnios. It causes fetal abdomen compression leading to pulmonary hypoplasia due to limited movement of diaphragm. The incidence of oligohydramnios ranges from 0.5 to 5%.[29,30] Oligohydramnios is associated with increased risk of perinatal morbidity because of umbilical cord compression leading to uteroplacental insufficiency and meconium-stained liquor. According to Schwartz et al., oligohydramnios in term pregnancy is considered as a solid indication for induction of labor.[31] It is also associated with increased risk of cesarean delivery because of fetal distress.[32]

Hypertensive Disorders in Pregnancy

In India, hypertensive disorders are the third most common cause of maternal mortality. They can lead to perinatal mortality and morbidity. They can lead to fetal complications such as intrauterine growth restriction due to uteroplacental insufficiency, low-birth-weight babies, and intrauterine fetal death. Maternal and perinatal complications are more with preeclampsia and eclampsia. So in such patients continuation of pregnancy beyond 37 weeks is not advisable. Accordingly it is considered to induce hypertensive patients after they cross 37 weeks of gestation.[33]

Gestational Diabetes Mellitus

It is one of the most common obstetric complications and it affects about 3–5% of all pregnancies.[34,35] The increased incidence is due to the risk factors such as obesity, hypertension, and elderly pregnancies (women over 35 years of age). In cases of uncontrolled diabetes and fetal macrosomia, time for induction is 38 completed weeks of gestation. Boulvain et al. opined that induction of labor at 37–39 weeks of gestation has positive outcomes in women with gestational diabetes mellitus.[36]

Contraindications for Induction

These include pelvic structural deformities and gross cephalopelvic disproportion (CPD), abnormal fetal lie or presentation (e.g., transverse lie or footling breech), placenta previa, vasa previa or cord presentation, previous rupture uterus, prior classical or inverted T uterine incision, significant prior uterine surgery (e.g. full thickness myomectomy), active genital herpes, invasive cervical cancer, etc.

Risks/complications of Induction

Failure to achieve active labor, tachysystole, fetal heart rate abnormalities, cord prolapse, chorioamnionitis, increased vaginal operative delivery, and increased cesarean section rate.[37] Rarely, uterine rupture (especially of scarred uterus) can also occur.

Predictors of Successful Induction of Labor

Many factors have been identified to be associated with the successful outcome of induction of labor. They include maternal age, parity, gestational age at induction, body mass index (BMI), and cervical status. Some of the factors are discussed below.

Maternal Age

Many studies have shown that maternal age is associated with outcome of induction of labor. The cesarean section rates increase with increase in maternal age. Rayamajhi et al. observed that there is failure rate with maternal age >30 years.[38] One study showed vaginal delivery rate of 51.32% and the mean age was 22.3 years.[39] Yet another study concluded that there is higher cesarean section rate with advanced maternal age.[40]

Parity

Bueno et al. concluded that the success of induction of labor depends on parity of the women.[41] Cesarean section rates are higher in nulliparous women as was shown in a few studies.[42–44] Admani et al.[45] observed that vaginal delivery rates are higher in multiparous women than in primiparous women.

Gestational Age

Park found that the cesarean section rates were higher in earlier gestational age.[46,47] But a few studies have observed that cesarean section rates are higher in greater gestational age.[48–50] So gestational age is a strong predictor of successful outcome of induction of labor.

Body Mass Index

Obesity is associated with increased risk of failed induction and cesarean section. Crane et al. concluded that higher BMI women

are associated with increased risk of failed induction and cesarean section rates.[48] Similarly, recently others showed that women with lower BMI had successful outcome of induction of labor.[39,40,51]

Then the most important factor for predicting the success of induction of labor is assessment of cervix. The status of cervix plays an important role in the outcome of induction of labor.

Cervical Assessment Methods

In 1964, Bishop introduced a scoring to predict whether induction will be successful.[49] Initially it had five components, i.e., position of cervix, consistency, effacement, dilatation of cervix, and station of presenting part, each with a score of 0 to 2 or 0 to 3. Subsequently in modified Bishop scoring, effacement was assessed more objectively by cervical length in centimeters, the total score being 13. This is now followed extensively. Transvaginal ultrasound for cervical length measurement was also used for prediction of successful induction of labor.[52]

Modified Bishop Score[53]

Cervical feature	Modified Bishop score			
	0	1	2	3
Dilatation (cm)	<1	1–2	2–4	>4
Length of cervix (cm)	>4	2–4	1–2	<1
Station	−3	−2	−1/0	+1/+2
Consistency	Firm	Average	Soft	–
Position	Posterior	Mid/anterior	–	–

Methods of Induction

Induction of labor can be achieved through several methods. Some commonly used methods are discussed below.

Mechanical Methods

Stripping of Membranes

It is the oldest method for cervical ripening.[50] It is done by introducing index finger through internal cervical os and sweeping the membranes 360° to separate the membranes from lower uterine segment. This process causes release of prostaglandins, results in spontaneous onset of labor, and thus reduces the chances of pharmacological methods of induction. Complications of this procedure are infection, accidental rupture of membranes, and bleeding in case of placenta previa or low lying placenta. This procedure cannot be done if cervix does not allow one finger.

Osmotic Dilators

Balloon Catheters

Single-balloon and double-balloon catheters are available for cervical ripening. The mechanism of cervical ripening by the balloon catheters is by mechanical stretching of cervix and lower uterine segment. It stimulates the production of endogenous prostaglandins by separation of chorionic membrane and deciduas.[54,55] It also helps in production of hyaluronic acid thus causing cervical swelling and softening.[56] The myometrial stretching caused by balloon catheter results in increased activation of cyclooxygenase 2, thus increasing the production of prostaglandins.[57] It also stimulates the secretion of inflammatory cytokines such as interleukins and matrix metalloproteins.[58]

Insertion of a balloon catheter may cause some discomfort for the women who are nulliparous with poor Bishop score.[59] Few studies have shown that digital insertion is better than instrumental insertion.[60] Cervical bleeding can occur while inserting the catheter in 2–6% of women.[59,61] Increase in cervical dilatation with increase in balloon volume was observed but with no difference in the mode of delivery.[62,63] Very few limitations such as maternal infection and bleeding from cervix are observed. These catheters cannot be used in cases of ruptured membranes because of the increased risk of infection.

Surgical Method

Amniotomy

It is artificial rupture of membranes and is an iatrogenic rupture of membranes done by Kocher's clamp. It is usually performed in those women with favorable cervix (good Bishop score). To avoid the risk of cord prolapse, amniotomy should be done when cervix is well applied to vertex. Fetal heart rate should be checked before and after the procedure. The color and character of amniotic fluid should be checked and are documented.

Pharmacological Agents

Prostaglandin Analogs

The use of prostaglandin analogs as intravenous infusion was first reported in 1968. But later prostaglandin E2 (PEG2) was reported as an agent for cervical ripening, and a few studies also showed that small dose of PGE2 applied locally resulted in improvement of Bishop score and with very few side effects.[50] Now two prostaglandin analogs are available for cervical ripening: dinoprostone (PGE2) and misoprostol [prostaglandin E1 (PEG1)]. Both the prostaglandin analogs have good efficacy. But improvement of obstetric outcome using these agents is unclear.[64–66]

Oxytocin

It is an agent for induction but usually not for cervical ripening. It is synthesized in the paraventricular neurons and supraoptic nuclei of hypothalamus and is stored in neurohypophysis. Its half-life is 3–10 minutes. Its mechanism of action involves increasing the activity of phosphodiesterases in the myometrial cells. This decreases cyclic AMP concentration and causes the release of calcium from endoplasmic reticulum, thus increasing the level of intracellular calcium leading to contraction of myometrial cells. Oxytocin also forms gap junctions for propagation and synchronization of uterine contractions.

It should be given as a continuous intravenous drip to deliver small amounts of oxytocin. It is administered in cases of good Bishop score (favorable cervix). It causes periodic uterine contractions and the responsiveness to oxytocin increases with increase in gestational age. The disadvantage of oxytocin is that it causes hyponatremia and hypotension if administered in large quantities. It can cause uterine hyperstimulation if coadministered with prostaglandin analogs. And in such cases it can cause fetal asphyxia. The risk of infection is also increased in women with prolonged duration of induction to delivery interval.

COMPLICATIONS

Maternal Complications

Cesarean Delivery

Cochrane review (2009) of randomized controlled trials (RCTs) showed that there is not much difference in the cesarean section rates in women undergoing induction of labor and women who

underwent expectant management. Cesarean section rates were more in women with unfavorable cervix and with prolonged pregnancy.

Operative Vaginal Delivery

In the RCTs (Cochrane, 2009), much statistical significance is not observed in women who underwent instrumental delivery in the induction group.

Length of Labor

According to Greenberg et al., the length of labor varies with ethinicity.[67] A number of authors found that the length of labor can vary with maternal weight and BMI and gestational age and maternal age.[68–70]

Maternal Infections

In 1996, Hannah et al. found that the maternal infection rates were more in women in vaginal PGE2 group compared to the oxytocin infusion group.[71] This may be due to repeated vaginal examination which can be avoided. Induction is associated with increased risk of chorioamnionitis.

Postpartum Hemorrhage

A Cochrane review conducted in 2009 showed no significant difference between induction group and expectant group. But postpartum hemorrhage is common in multiparous women. Women in prolonged latent phase and women on prolonged oxytocin infusion were associated with PPH.

Uterine Hyperstimulation

This condition is seen in women induced with prostaglandins and can be managed by giving tocolytics. It can also occur in women with oxytocin infusion. In such cases, oxytocin infusion can be stopped. It can be avoided by monitoring the women and uterine contractions and by starting low-dose oxytocin infusion.

Fetal Complications

Meconium-stained Liquor

This is common in women with postdated pregnancy and in women in prolonged latent phase of labor. It can also occur in women with uterine hyperstimulation. This condition can be avoided by carefully monitoring the contractions.

Fetal Distress

This can occur in women with meconium-stained liquor and those with uterine hyperstimulation. No statistical significance is observed between women with induction and women with expectant management.

Neonatal Jaundice

No significance of neonatal jaundice is observed in women undergoing induction of labor.

Risks Associated with Induction of Labor

Maternal risks include maternal discomfort and increased need for analgesia, failure of induction and need for operative delivery, water retention and hyponatremia with prolonged use of oxytocin, uterine rupture, abruption, and postpartum hemorrhage. Fetal risks include iatrogenic prematurity, fetal compromise due to uterine hyperstimulation, cord prolapse, chorioamnionitis, and neonatal jaundice with prolonged use of oxytocin.

Conclusion

Induction of labor is the safest alternative to spontaneous onset of labor. The obstetrician and the patient must understand the need for induction, risk of induction, methods of induction, and the risk associated with the chosen method. The need for other modes of delivery in case of failed induction should be emphasized. The goal of induction of labor is always to achieve the best maternal and fetal outcome.

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