INTRODUCTION

The labor is a unique experience for the mother and she anxiously waits for the labor pain to come naturally. But when this fails to happen, she undergoes a procedure that artificially initiates the labor which is called induction of labor. The familiarity of the procedure is slowly rising in every setting from rural to well-equipped urban hospital. There is a demand in reducing the rate of unnecessary cesarean section and improvement of fetal outcomes. This is considered when delivery is thought to be safer option than continuing the pregnancy [1]. Prostaglandins are lipids, found in cervical fluid, and deciding that reduce the inflammatory process and dilate the cervix [2,3]. Prostaglandin E2 and its group of drugs when used for ripening of cervix in case of favorable or unfavorable cervix, was effective in bringing cervical favorability and with good progress of labor by successful induction with vaginal delivery within 24 hrs without much operative delivery [4-7]. The reasons for considering induction are many and vary from obstetrician to obstetrician and from country to country [8]. The most common indication that requires induction of labor is postdated pregnancy [9-22]. Another frequently cited indication is term premature rupture of membrane [12,13,23,24]. Nevertheless, the hypertensive disorder remains a rare indication, rather this requires induction in higher rate [14,20,21,25,26]. The less frequent indications are oligohydramnios, IUGR, gestational diabetes, fetal distress, macrosomia, fetal death, decreased fetal movement, uncomplicated twins, polyhydramnios, Rh isoimmunization, choioamnionitis, heart disease, and other fetal indications [9-14]. In a meta-analysis, it is also observed that the common indications cited by many researchers are post-term pregnancy, PROM, oligohydramnios, twins, macrosomia, pre-eclampsia, diabetes, and IUGR [23]. The outcomes of induction of labor are comparatively better than the spontaneous labor as reviewed from certain studies, while other studies found higher adverse outcomes associated with induction than the spontaneous labor. The causes for failure are mostly failed induction, fetal distress, undiagnosed CPD, meconium stained liquor, nonprogress of labor, and prolonged latent phase [10-13,27,28].

METHODS

To collect a good number of quality studies with best recommendations, many electronic data bases were searched. The literature was collected from databases such as Pubmed, Scopus, Science Direct, and Google Scholar. The search was based on the keywords such as induction of labor, induction of labor, induction and c-section, Predictors of successful induction. Various standardized databases, such as Pub Med, Scopus, and Google Scholar, were used to collect the scientific studies, where prostaglandin was used as drug of choice for induction of labor. The key words used were induction of labor, indications of induction, induction by misoprostol, induction and risk of cesarean section, etc. The survey spans over 22 years of study articles published from the year 1995-2017.

Result: A total of 112 studies have been included to analyze the indications and risk of cesarean section. The most common indication found in most of the studies was post-term pregnancy. The risk of cesarean section varied from 3% to 48.7%. The common reasons for which the cesarean section was planned were, failed induction, nonprogress of labor, fetal distress, and undiagnosed CPD.

Conclusion: Most of the studies recommend induction of labor as a safer option with lower risk of c-section.

Keywords: Induction of labor, Indication of induction, Induction and c-section, Predictors of successful induction.
Chirwa found all three, hypertension (69.3%), PROM (15.0%), and postdated (12.6%) as common indications. Similarly, Sanchez-Ramos et al observed 80% of indications for post-term pregnancies and rest for pregnancy induced hypertension and PROM [42]. Mozurkewich et al. and Abdul and Guerra et al. reported both postdated and PROM are the common indications for induction with high-quality evidence from various studies, whereas oligohydramnios was found with moderate evidence [26,43]. The induction of labor is commonly indicated in prevention of prolonged pregnancy, prelabour rupture of membranes after 34 weeks, intrauterine fetal death, placental abruption, chorioamionitis, and hypertensive disorders as stated by NICE and ACOG [44,45]. Folasade and Orijimi also recorded 25% of indications for postdates and 26% for premature rupture of labor [24]. Lawani et al. found the major indications as postdates (45.8%), term PROM (31.9%), pre-eclampsia (4.7%), and preterm PROM (3.7%) [13].

The common causes for which the induction were carried out in the United States were pre-eclampsia and postdates pregnancies and in few cases the premature rupture of membrane [46]. When the pregnancy over 41 weeks is induced, it is associated with fewer cesarean sections compared to expectant management [47]. Similarly, Mishanina et al. reported that the postdates pregnancy is associated with a reduced risk of cesarean delivery [48]. When labor was induced in term PROM, the rate of cesarean section remained almost same as the compared group [32]. However, the induction in pre-eclamptic group, studied by Xenakis et al. shows higher rate of cesarean section (Table 2) [49].

The data reviewed gives a conflicting picture that there is a trends toward decreased cesarean section with good cervical dilatation after misoprostol administration and the same time it is evident that there is an increased cesarean delivery for fetal distress and undiagnosed CPD. Many studies revealed that the prostaglandin and its group of drugs when used for ripening of cervix in case of favorable or unfavorable cervix was effective in bringing cervical favorability, good progress of labor with a successful vaginal delivery within 24 hrs [34].

The rate of cesarean section was lowered by induction has been reported in many research studies. The successful vaginal delivery after induction was 70% [69], 75% [70], 89.1% [6]. Bueno et al. found that the vaginal delivery occurred in 73.5% of women in the induction group, and the rate of cesarean delivery was 26.5% [18]. Sahanz et al. reported vaginal delivery of 78.9% and 21.1% of cesarean section after induction of labor [56,71]. However, Admani found in her study the success rate of 50% with similar rate of failure. The similar rate was observed in the study of Pravati et al. [33]. Bello and Akinjotu found induction failed with cesarean section in about 36.5% of women. Boulvain et al. demonstrated higher cesarean section with adverse perinatal outcomes after induction of labor [30]. Induced women had significantly higher cesarean rate than the spontaneous group [5,72]. However, Boulvain et al. did not get any clear risk of c-section after induction [73]. Sometime it was observed that there are no significant differences in CS rates between the groups of vaginal misoprostol or dinoprostone after induction [74]. In other instances, there is a significant difference and it was found in CS rate between in the induction group and the spontaneous group both in nulliparous women (25.3% vs. 8.6%, p<0.001) and multiparous women (3.8% vs. 0.3%, p=0.002) [10]. Similarly, the induction is associated with a significant increase in the risk of C-section than those who delivered spontaneously [59]. Boulvain et al. demonstrated higher cesarean section with adverse perinatal outcomes after induction of labor [30]. Clader reported little higher (28%) rate of cesarean section than the vaginal delivery (11%) after induction of labor with misoprostol [75]. However, many studies reported higher rate of vaginal delivery after induction (70% [69], 75% [70], 89.1% [6]). The success rate for vaginal delivery was 70% and this rate varied little in accordance with the country or the method used [58]. Alfirevic et al. study revealed that though the vaginal prostaglandins increase the chance of uterine hyperstimulation but this increase the likelihood of vaginal birth within 24 hrs [76]. Whereas other studies shows the risk of cesarean delivery was 12% lower with labor induction than with expectant management (pooled relative
risk [RR] 0.88, 95% confidence interval [CI] 0.84-0.93; I²=0%) [48]. Wennerholm et al also confirmed higher c-section by expectant management rather in the induction method [77]. The cesarean delivery rate in the induction group was 36.5% compared to 34.4% in the expectant management group [78]. Women undergoing induction of labor at 39 weeks without an acute obstetric medical indication were more likely to deliver vaginally than those managed expectantly [79]. Caughey found whether it is 37 or 39, there is no difference in cesarean section but at 40 and 41 weeks of gestation the women had a lower risk of cesarean delivery [80].

The reason of cesarean section is described by Pravati et al. as poor progress, fetal distress, cephalo-pelvic disproportion, oligohydramnios, and meconium staining [33]. Dr Rashida found the reasons for cesarean

### Table 2: The rate and causes of cesarean section after induction and its’ predicting factors

| Author                        | Year | Rate of c-section (%) | Causes of cesarean section                                      | Predictors of cesarean section                                                                 |
|-------------------------------|------|-----------------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Chirwa [25]                   | 2014 | 17                    | Failed induction, fetal distress, CPD                           | No misoprostol                                                                                |
| Tolcher et al. [37]           | 2015 | 29.4                  | Nonreassuring heart rate                                        | Advanced age, short height, greater BMI, weight gain, hypertension, diabetes, meconium stained liquor <3 cm |
| Verhoeven et al. [22]         | 2013 | 3                     | Failure to progress and fetal distress                         | History of preterm birth, maternal height and initial dilatation                              |
| Bueno et al. [18]             | 2007 | 26.5                  | Induction failure, nonreassuring fetal monitoring, pelvic disproportion, failure to progress | Cervical length, Bishop score and parity                                                     |
| Admani [10]                   | 2014 | 32                    | Fetal distress, failed induction, nonprogress of labor and meconium stained liquor | Favorable Bishop score and average-sized infants                                              |
| Lee et al. [50]               | 2015 | 25.3                  | Induction failure                                               | Maternal age, BMI, Bishop score and parity                                                   |
| Park [51]                     | 2007 | 14                    | Previous obstetric history, previous mid-trimester loss and preterm delivery | Earlier gestational age, previous obstetric history, and preterm delivery                    |
| Soni et al. [36]              | 2017 | 30.3                  | Failed induction, fetal distress, nonprogress of labor and undiagnosed CPD, malposition | Favorable Bishop score and average-sized infants                                              |
| Ezechi et al. [28]            | 2004 | 27.92                 | Fetal distress, pro-long labor, and ante-partum hemorrhage      | Maternal age, BMI, Bishop score and parity                                                   |
| Lawani et al. [13]            | 2014 | 24.1                  | Fetal distress, pro-long labor, and ante-partum hemorrhage      | Maternal age, BMI, Bishop score and parity                                                   |

BMI: Body mass index
as failed induction (52%), fetal distress (23%), and CPD (18%) [10].
Ezechi et al. reported the reasons for failed induction with misoprostol
include cephalopelvic disproportion, fetal distress, prolong labour, and
antepartum haemorrhage [28]. Lawani et al. also described about fetal
distress, prolonged labour, cephalopelvic disproportion as reasons for
cesarean section [13]. From the study of Bueno et al., it is understood that
the major reasons for cesarean section are induction failure (34%), non reassuring fetal monitoring (28.9%), pelvic disproportion (17%), and failure to progress (14.9%) [18].

The major predicting factor for a successful vaginal delivery after
induction is the cervical factor [20, 43, 52, 55, 60, 61, 81, 82]. Tekie et al. found in their meta-analysis, the Bishop score as greater determinant of successful induction [61]. Danileisen et al. stressed that a Bishop score of more than seven should be considered before induction as Bishop score is very good predictor of successful induction [55]. Vrouwenraets et al. reported that a Bishop score of 5 or less is a significant risk factor for a cesarean delivery [83]. Selo-Ojeme et al. viewed that regardless of membrane status, the CS rates were high in unfavorable cervix after induction of labor [84]. Dean Leduc highlighted that induction of labor among women with poor cervical dilatation is associated with higher rate of cesarean section [16]. Bello and Akinyotu found the predicting factors for risk of cesarean section are higher parity, later gestation and misoprostol ripening. Lee et al. observed the association of the higher CS rate with lower Bishop score, advanced maternal age, nulliparity and higher body mass index (BMI). Rashida reported the success rate induction with vaginal delivery that increased with increase of age. Rebecca Dekker found interestingly the rate is rising by age that is 29.5% in age 25-29 years to 33.0% in 30-34 years and 38.5% in 35-39 years and so on [85]. Rayamaji et al. also noticed failure rate of 53.8% with advanced maternal age >30 years [31]. Gerl et al. also viewed that age is directly related to risk of cesarean section after a induction [96]. Hurissa et al. reported about the risk of cesarean section in association with advanced age, primiparity, unfavorable bishop score, later gestation, PROM, and bad obstetric history. The success was again related independently to cervical factors and parity [18]. Hatfield et al., Grobman, Tokher et al. found older maternal age, shorter maternal height, greater BMI, greater weight gain during pregnancy, older gestational age, hypertension, diabetes mellitus, and initial cervical dilation as independent risk factors for increased risk of cesarean delivery [37, 62, 63]. Similarly, Crane reported the predictive factors as maternal age, weight, height, BMI, ethnicity, and socioeconomic status. Whereas Park found a single factor that is gestational age as a predictor of successful labor. Sometimes the failed induction was dependent on drug doses and cervical dilation [65-68]. Dublins reported increased cesarean delivery was associated with nulliparous rather than multiparous women with increased risk of instrumental delivery and shoulder dystocia [19]. Admani found higher rate of vaginal delivery in multipara than primipara. Lisa revealed that both the nulliparas (27%) and multiparas (15%) had an increased cesarean rate compared to spontaneous labor [87]. Compared to spontaneous onset of delivery, induction of labor is associated with an increased risk for emergency cesarean section among nulliparous and multiparous women [88]. Alicia ault cited that the major risk associated with a failed induction at 39 weeks is cesarean delivery [89]. Park reported earlier gestational age as a significant predictive factor for failed IOL [51]. The highest chance of success was observed after induction of labor where there are prior vaginal delivery and Fashionable cervix [90]. Timothy et al. in their systematic review found few researcher reporting about slower labors even after using higher doses of vaginal misoprostol [91] while other reported that high doses of oral or vaginal misoprostol are quite effective at achieving vaginal delivery. Pevzner et al. revealed that duration of labor, oxytocin requirements, and cesarean delivery rates are significantly higher with increasing BMI in prostaglandin-induced women (Table 3) [72].

The studies by meta-analysis, RCT and many other methods found different rate of risk of cesarean section at the end of the induction of labor. The risk of cesarean section depends on maternal factors such as age, parity, BMI, cervical score, baby size, medical, and obstetrical conditions complicating pregnancy. However, most of the studies found the induction is associated with more cervical ripening and successful vaginal delivery [6, 14, 69-70, 7, 69-98]. While few studies found the induction results in higher rate of cesarean delivery compared to expectant management [22, 19, 104].

Summary
This study tried to highlight various indications for which an induction of labor is decided for a woman. The common indications were post-term pregnancy, term PROM, hypertensive disorders, intrapartem fetal distress, fetal death, gestational diabetes, and other fetal indications. Among these, the most common indication was postdated pregnancy. The failure of induction with cesarean section was varied from 3% to 48.7%. However, most of the studies found higher rate of successful delivery after induction. The reason for which cesarean section was

Table 3: The net outcome after induction of labor

| Author             | Year | Research design         | Net outcome (rate of cesarean section) |
|--------------------|------|-------------------------|----------------------------------------|
| Mishanina et al.   | 2014 | Systematic review and meta-analysis | Decreased                               |
| Hofmeyr and Gulmezoglu [92] | 2001 | Systematic review | Decreased                               |
| Wood et al. [93]   | 2014 | Meta-analysis            | Decreased                               |
| Gulmezoglu et al. [47] | 2006 | Systematic review        | Decreased                               |
| Sanchez Ramos et al. [29] | 2003 | Systematic review        | Decreased                               |
| Allirevic et al. [76] | 2014 | Systematic review        | Decreased                               |
| Allirevic et al. [95] | 2000 | Systematic review        | Decreased                               |
| Boulvain et al. [30] | 2008 | Systematic review        | Decreased                               |
| Vogel et al. [35]  | 2013 | Systematic review        | Decreased                               |
| Crowley [96]       | 2000 | Systematic review        | No difference                           |
| Boulvain et al. [73] | 2016 | Systematic review        | Not clear                               |
| Guerra et al. [26] | 2009 | Secondary analysis       | Decreased                               |
| Cheng [97]         | 2008 | RCT                     | Decreased                               |
| Koopmans et al. [98] | 2009 | RCT                     | Decreased                               |
| Pennel et al. [99] | 2009 | RCT                     | Increased                               |
| Bhutto et al. [100] | 2013 | RCT                     | Nil                                     |
| Hermus et al. [101] | 2009 | Cohort                  | No difference                           |
| Marry et al. [37]   | 2015 | Cohort                  | Decreased                               |
| Yeast et al. [102] | 1999 | Cohort                  | Decreased                               |
| Noah et al. [103]  | 2005 | Retrospective           | Decreased                               |
| Dubline et al. [19] | 2000 | Cohort                  | Increased                               |
| Johnson et al. [104] | 2003 | Cohort                  | Increased                               |
| Verhoeven et al. [22] | 2012 | Case control            | Increased                               |
done were failed induction, fetal distress, meconium stained liquor, undiagnosed CPD, and nonprogress of labor. The factors independently predicted the risk of cesarean section were age of mother, parity, BMI, cervical factors, indications, doses of drug and weight of baby. Most of the systematic reviews showed decreased rate of c-section after induction in term pregnancy. Hence, it is clear from the findings that induction of labor is beneficial in reducing the risk of cesarean section with better perinatal outcomes.

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