Induction of labour – a misused blessing: Prospective study of factors influencing the success of induction and comparison of fetomaternal outcomes with spontaneous labour

V Vinod, MB BS, DGO, DNB (OBG)**; R G Bhat,** MB BS, MD (OBG); **P V Bhat,** MB BS, DGO, MD (OBG); **N Zahoor,** MB BS, MD (OBG) **S Bhat,** MB BS, MD (OBG)

Department of Obstetrics and Gynaecology, Manipal Academy of Higher Education, Kartnataka, India

Corresponding author: *V Vinod (vinuthakvinod@gmail.com)*

Background. Although most pregnant women experience spontaneous labour at term, induction of labour is indicated whenever continuation of pregnancy is detrimental to either the fetus or the mother.

Objectives. To study the factors associated with the successful induction of labour and to compare the maternal and fetal outcomes between induced and spontaneous labour**.**

Methods. We conducted a prospective observational and comparative study from September 2015 to December 2016 at Dr TMA Pai Hospital – a secondary level hospital at Manipal Academy of Higher Education (MAHE). Women with a singleton pregnancy, live fetus, vertex presentation and gestational age (GA) >36 weeks were included in the study, and those with antepartum haemorrhage, scarred uterus, anomalous fetus and intrauterine fetal demise were excluded.

Results. Out of 1 575 deliveries during the study period, 550 were induced (34%). A total of 300 inductions fulfilled the inclusion criteria and formed the study group. Multiparity, body mass index (BMI) <25 and GA >38 weeks were factors associated with successful induction. Among the components of the Bishop score, dilatation was a better predictor of vaginal delivery ($p<0.001$) and post-dated pregnancy was the most common indication (33.6%). The rates of caesarean section (CS) delivery (33% v. 12%) and neonatal intensive care unit (NICU) admissions (4% v. 1%) were more in the induced group compared with the spontaneous group.

Conclusion. Multiparity, BMI <25 and advancing GA are predictors of successful induction. Induction is safe but carries a high risk of CS delivery and NICU admissions.

Keywords. labour induction; successful induction; caesarean section.

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Induction of labour (IOL) is defined as the initiation of contractions in a pregnant woman who is not in labour to have a vaginal birth within 24 - 48 hours.[1] Although most pregnant women experience spontaneous labour at term, IOL is indicated whenever continuation of the pregnancy is detrimental either to the fetus or the mother. Public and private sector hospitals provide maternity care in India. The management, facilities and resources are varied among these. The rising caesarean section (CS) rates in developing countries are alarming. IOL is known to be associated with increased CS deliveries.[2,3] The IOL rate is increasing due to a rise in medically and obstetrically indicated inductions, as well as elective inductions. Elective induction is the IOL in the absence of acceptable fetal or maternal indications.[1] Increased public awareness regarding management of pregnancy and childbirth, obstetrician's prior experience with high-risk pregnancies, increased litigation and waning trust in the healthcare provider have forced obstetricians to play it safe by inducing pregnancy for borderline indications.

IOL is also associated with increased uterotonic use, perineal lacerations, hysterectomy, intensive care unit (ICU) and neonatal intensive care unit (NICU) admission, longer hospital stays, greater anaesthesia/analgesia requirements during labour and lower Apgar scores.[4,5]

Methods

This study was conducted at Dr TMA Pai Hospital, Udupi – a secondary level hospital at the Manipal Academy of Higher Education (MAHE). This was a prospective observational and comparative study conducted from September 2015 to December 2016. Women with a singleton pregnancy, live fetus, vertex presentation and gestational age (GA) >36 weeks were included in the study and those with antepartum haemorrhage, scarred uterus, anomalous fetus and intrauterine fetal demise were excluded.

Ethical clearance was obtained from the institutional ethics committee (ref. no. MUEC/13/2015-2016). To estimate a 25% incidence of induced labour at 95% confidence with a relative precision of 20%, a minimum of 288 antenatal women needed to be included in the study. A total of 300 women consented to participate in the study; they were induced, and their outcomes compared with women who had consecutive spontaneous labour. Method and number of inductions were documented, and the progress of labour

was plotted on the partograph. Mode of delivery, indications for operative delivery, morbidity in mother and fetus/neonate, if any, were noted.

Bishop score assessment was done post their consent. Patients were induced with intracervical prostaglandin E2 (PGE2) gel (0.5 mg) or vaginal misoprostol (25 µg). Pre- and post-induction cardiotocography was done.

The patients were reassessed after 6 hours and depending on the findings, they were either reinduced with PGE2 gel (maximum 3 doses) or misoprostol (maximum 5 doses), or labour was augmented with oxytocin or amniotomy.

Following induction, if the cervical dilatation was >3 cm (active phase), it was considered as the patient having responded to induction or had a successful induction. Failed induction was considered as failure to enter the active phase of labour.

Data analysis

Data were entered and analysed using SPSS 16 software (SPSS Inc., USA). The percentage was used to summarise categorical data, and mean and standard deviation (SD) or median and interquartile range (IQR) was used to summarise continuous data depending on the skewness. A χ^2 test was used to test for associations. Odds ratio (OR) or relative risk (RR) with 95% confidence interval (CI) was provided. Logistic regression was used to identify factors influencing the success of induction of labour.

Results

There were 1 575 deliveries and 550 were induced (induction rate of 34%) at the hospital during the study period. A total of 300 induced women were included in the present study.

Post-dated (>40 weeks) pregnancy (33.6%; *n*=101) was the most common indication for IOL, followed by indications such as intrauterine growth restriction (8.6%; *n*=26), oligohydramnios (21%; *n*=63), pre-labour rupture of membranes (14.3%; *n*=43) and medical disorders in pregnancy (18.2%; *n*=55), and some women (9%; *n*=27) were induced electively (Fig. 1). The indications were divided to absolute and relative for analysis. Absolute indications included medical disorders, growth-restricted fetuses, severe oligohydramnios and pre-labour rupture of membranes (42.7%; *n*=128), and relative indications included past-dated pregnancy, borderline oligohydramnios (48.3%; *n*=145) and elective induction (9%; *n*=27). The mean (SD) age of women who were induced was 27 (3) years. The majority of the women were induced with PGE2 (85%; *n*=255).

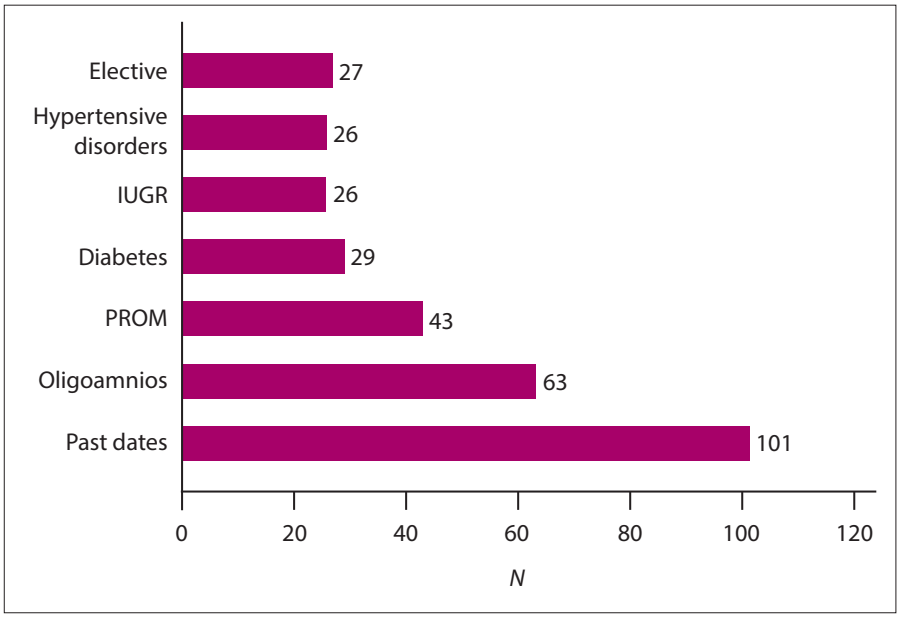

Fig. 1. Indications for induction of labour. N=315, as a few patients had multiple indications. (IUGR = intrauterine growth restriction; PROM = premature rupture of membranes.)

Response rate/ successful induction

The majority of the women (74.7%; *n*=224/300) responded to induction and entered the active phase of labour. Two-thirds of the women (66.3%; *n*=199/300) delivered vaginally and 33.7% (*n*=101) of women underwent CS.

The response rate was 94% (*n*=78/83) in multigravida and 67% (*n*=146/217) in nullipara women ($p<0.0001$). Women with BMI <25 kg/m^2 responded better (82%; *n*=142/172) compared with women with BMI >25.1 kg/m^2 (64% (*n*=82/128); $p=0.001$). The response rate was better when the GA was >38 weeks compared with GA <38 weeks (79% v. 62%; $p=0.009$) (Table 1). Women with a higher Bishop score (>6) showed a response rate of 83.8% (*n*=26/31), and 73.6% (*n*=198/269) of them responded when it was <5. When the individual components of the Bishop score were analysed, 89% (*n*=65/73) of the women with cervical dilatation >2 cm responded compared with 70% (*n*=159/227) of women with dilatation <1 cm ($p<0.001$). Women whose cervix was mid-positioned, soft and had a length <2 cm were more likely to respond to induction. Women with the station of fetal vertex below –2 were 1.13 times more likely to respond to induction compared with those with a higher station.

Vaginal delivery

The vaginal delivery rate in induced women was 66% (*n*=199/300). The median (IQR) induction to the delivery interval was 12.3 (8 - 24) hours. The vaginal delivery rate in multiparous women was 81% (*n*=67/83) and 59% (*n*=128/217) in nulliparous women. Women with BMI <25, advanced GA >38 weeks and Bishop score >6 had a good successful vaginal delivery rate (Table 2). We also analysed whether the indication for induction had any influence on the outcome of IOL. Women who were induced for post-dated pregnancies had the highest vaginal delivery rate (75.2%; *n*=76/101). Furthermore, 48% (*n*=13/27) of women who had elective induction had vaginal deliveries.

A multivariable logistic regression analysis was conducted to determine the influence of factors such as high-risk pregnancy, period of gestation, maternal height and parity on CS rate in induced women. It was observed that only parity (nullipara v. multipara) had a significant influence ($p<0.001$) with an adjusted OR (95% CI) of 4.2 (2.1 - 8.3). Obstetric and neonatal outcome of induced women were compared with those who had a spontaneous onset of labour. The demographic details are provided in Table 3. The number of primigravidae was high in the induced group.

Table 1. Factors influencing the success of induction (*N*=300)

Factor	*n*	Responded *n* (%)	RR (95% CI)	*p*-value
Age, years				
<34	285	213 (74.7)	1.02 (0.7 - 1.39)	0.922
>35	15	11 (73)		
Parity				
Multigravida	83	78 (94)	5.3 (2.2 - 12.6)	<0.001
Primigravida	217	146 (67)		
GA, weeks				
>38.1	218	171 (79.9)	2 (1.1 - 3.6)	0.009
<38	82	62 (53)		
BMI, kg/m²				
<25	172	142 (82)	1.3 (1.1 - 1.5)	<0.001
>25.1	128	82 (64)		
Bishop score				
>6	31	26 (83.8)	1.86 (0.7 - 6.45)	0.277
<5	269	198 (73.6)		
Position				
Anterior	12	8 (66.6)	0.8 (0.2 - 2.8)	0.718
Mid	126	101 (80.2)	1.7 (0.9 - 3)	0.068
Posterior	162	111 (70.9)		
Consistency				
Soft	214	61 (75.2)	2.1 (0.3 - 13)	0.414
Medium	81	60 (74.1)	1.9 (0.2 - 12)	0.496
Firm	5	3 (60)		
Length, cm				
<2	113	91 (80)	1.12 (0.97 - 1.27)	0.157
>3	187	133 (71)		
Dilatation				
<2	227	159 (70)	2.7 (1.3 - 5.4)	<0.001
>3	73	65 (89)		
Station				
–3	227	164 (72.2)	1.13 (0.9 - 1.3)	0.058
–2-1	73	60 (82)		

RR = relative risk; CI = confidence interval; GA = gestational age; BMI = body mass index.

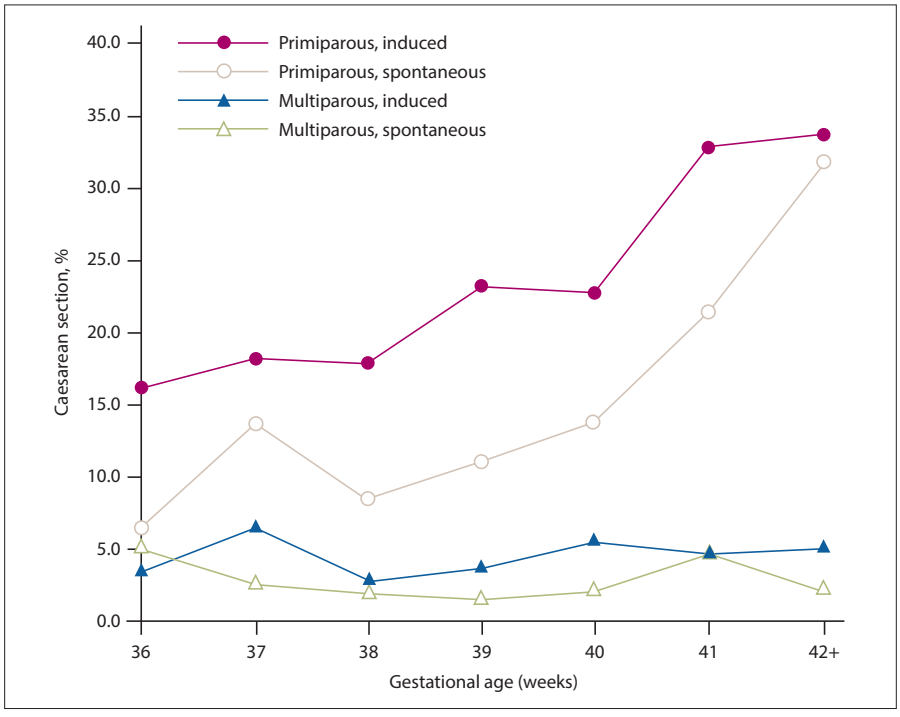

Fig. 2. Caesarean rates in induced and spontaneous groups.

The median duration of the latent, active and second stages of labour were comparable in both groups. The vaginal delivery rate in the spontaneous group was 87.3% (*n*=262/300) compared with 66.3% (*n*=199/300) in the induced group (*p*<0.001). The rate of CS delivery in the induced group was 33% (*n*=101/300) compared with 12% (*n*=38/300) in the spontaneous group (Table 4). The CS rate was higher in nulliparous than multiparous women in both groups (Fig. 2).

The most common indication for CS in the induced group was failed induction (46.5%; *n*=47/101). Fetal distress was observed more often in the induced group (11.6%; *n*=35/300) than in the spontaneous group (4%; *n*=13/300). Meconium staining of liquor was seen in 2.3% (*n*=7/300) of women in the induced group compared with 4% (*n*=12/300) in the spontaneous group. There was an arrest of dilatation in 5% (*n*=15/300) and 3% (*n*=10/300) of the induced and spontaneous groups, respectively. Instrumental delivery was low in the induced group. The mean birth weight and Apgar scores were similar in both groups (Table 4). The incidence of atonic postpartum haemorrhage was marginally higher in the induced group than in the spontaneous group (19 v. 12).

Less than a tenth of babies (4%; *n*=12) born from women in the induced group had morbidities such as sepsis (*n*=7), respiratory distress (*n*=2), meconium aspiration (*n*=2) and hypoglycaemia (*n*=1) compared with 1% (*n*=3) in the spontaneous group who had hypoglycaemia (*n*=1), respiratory distress (*n*=1) and meconium aspiration (*n*=1) (*p*=0.018). Women induced for pre-labour rupture of membranes had higher neonatal morbidity (50%; *n*=6/12).

The mean (SD) duration of stay in hospital was 6 (2) days in the induced group compared with 4 (1.7) days in the spontaneous group.

Discussion

A World Health Organization (WHO) global survey on maternal and neonatal health showed an induction rate of 12% in Asian countries.[5] The induction rate was higher in our study compared with studies by Zenzmaier *et al.*[6] and Abisowa *et al.*[3] who documented an induction rate of 19.7% and 16%, respectively. The higher rate of induction may be attributed to the number of medically indicated inductions (18.2%; *n*=54/300), our policy to

Table 2. Factors influencing vaginal delivery

Factor	*n*	Vaginal delivery, *n* (%)	RR (95 % CI)	*p*-value
Age, years				
>35	15	8 (53)	1.2 (0.7 - 2.0)	0.29
<34	285	191 (66.7)		
Parity				
Primigravida	217	128 (59)	2.3 (1.6 - 4.9)	<0.001
Multigravida	83	67 (81)		
BMI, kg/m^2				
>25.1	128	76 (59)	1.4 (1.0 - 1.9)	0.04
<25	172	123 (71.5)		
GA, weeks				
<38	85	45 (53)	1.3 (1.0 - 1.5)	0.002
>38	215	154 (72)		
Bishop score				
<5	269	175 (65)	1.5 (0.8 - 3.0)	0.228
≥6	31	24 (77)		

RR = relative risk; CI = confidence interval; BMI = body mass index; GA = gestational age.

Table 3. Demographic data comparison between spontaneous and induced group

Variable	Induction, *n* (%)*	Spontaneous, *n* (%)*
Age (weeks), mean (SD)	27 (3)	27 (3)
Parity		
Primigravida	217 (72)	189 (63)
Multigravida	83 (28)	111 (37)
GA (weeks), mean (SD)	39 (0.4)	38.4 (0.6)
BMI, mean (SD)	24.2 (4.6)	23.8 (4.29)

SD = standard deviation; GA = gestational age; BMI = body mass index.
*Unless otherwise specified.

Table 4. Comparison of outcome between spontaneous and induced labor groups

Variable	Induction, *n* (%)*	Spontaneous, *n* (%)*	*p*-value
Latent phase (h), median (IQR)	4.45 (3 - 8)	4 (3 - 8)	0.035
Active phase (h), median (IQR)	2.1 (1.3 - 4.0)	3 (2.0 - 4.3)	0.606
Second stage (min), median (IQR)	15 (0.1 - 0.3)	15 (0.12 - 0.25)	0.578
Mode of delivery			
Vaginal	199 (66.3)	262 (87.3)	<0.0001
LSCS	101 (33.7)	38 (12.7)	
Instrumental	14/199 (7)	22/262 (8)	0.597
Analgesia	89 (29)	73 (24)	0.141
Birthweight (g), mean (SD)	3 041 (395)	3 041 (406)	-
Apgar (>7)			
1 min	298 (99.3)	299 (99.6)	-
5 min	300 (100)	300 (100)	

IQR = interquartile range; LSCS = lower segment caesarian section; SD = standard deviation.
*Unless otherwise specified.

induce at 40 weeks of GA, inductions for minor indications such as borderline reduced amniotic fluid index and elective inductions.

The most common indication for induction in our study was post-dated pregnancy (33%; *n*=101/300), followed by oligohydramnios (21%; *n*=63/300). We induce at 40 weeks of GA as studies conducted in India[7,8] have shown that fetuses are more likely to mature early and the incidence of meconium staining of amniotic fluid increases when gestation crosses 280 days. We perform routine ultrasound for the growth of the fetus at 28 - 32 weeks and weekly amniotic fluid assessment for all women after 36 weeks of gestation. This could lead to overdiagnosis of growth restriction and oligohydramnios and, in turn, increase inductions for borderline indications.

The factors that influence the outcome of induction were studied and it was observed that women <34 years of age, multiparous, BMI <25 kg/m^2 and GA >38 weeks had successful inductions. Pevzner *et al.*[9] has also shown that all the above factors need to be considered for predicting successful induction.

The collagen of the cervix in multiparous women is damaged permanently by pregnancy, so ripening is more readily accomplished in subsequent pregnancies. Khan *et al.*[10] found that nulliparity had the strongest association with failed induction. Likewise, Dammer *et al.*[11] also showed that higher BMI had a negative influence on IOL at term. Bishop score has proven to be a good predictor of successful induction in many studies.[12,13] We noticed that women with a Bishop score >6 had a better success rate compared with women with a score <5 (p=0.272). Although Bishop score is an important predictor of the success of induction, the systematic review done by Kolkman *et al.*[14] concluded that Bishop score, individually, was a poor predictor of the outcomes of induced labour. When the individual components of the Bishop score were analysed, it was observed that dilatation of the cervix was a better predictor (p<0.001) compared with other factors of the Bishop score.[15] Increased maternal age, shorter maternal height, greater BMI, greater weight gain during pregnancy, and initial cervical dilation <3 cm are risk factors for CS after induction.[16]

The vaginal delivery and CS rates in the induced and spontaneous groups were similar to other studies.[3] A study by Fisher *et al.*[17] comparing the success rates of IOL over 3 phases in 20 years showed vaginal delivery rates of 79%, 72% and 71%, respectively. The CS rates were higher in the nulliparous than in multiparous women. Systematic reviews have clearly shown that the CS rate is higher in the induced group than in the spontaneous group. However, a study by Grobman *et al.*[8] concluded that when induction is done at 39 weeks in low-risk women, the rate of CS was reduced compared with expectant management.

Failed induction (46%), mostly seen in nulliparae was the most common indication for CS delivery. Nevertheless, it is not clear why certain cervices failed to dilate in primigravidae. Excluding failed induction, the common indications for CS delivery in both groups was fetal distress (35 v. 13). Fetal distress is comparatively higher in the induced group than the spontaneous group because pregnancies may have been interrupted for compromised fetuses owing to growth restriction, oligohydramnios, maternal hypertension or diabetes. Despite excluding the inductions for fetal compromise, the fetal distress rate was relatively higher (10%; *n*=13/128) compared with 4% (*n*=13/300) in spontaneously labouring women. Continuous electronic monitoring of the fetal heart in induced women is partially responsible for increased CS delivery for fetal distress.

Other factors that contributed to increased CS rates included a lack of a clear and objective definition of failed induction,[18] patient's agony because of a prolonged process of induction, apprehension

of the family and undue pressure on obstetricians to speed up the delivery also partially contributed to increased caesarean rates.

Surprisingly, there were more cases with meconium-stained liquor in the spontaneous group than in the induced group (12 v. 7), and similar observations were made by Macer *et al.*[19]

In third-stage complications, atonic postpartum haemorrhage was more prevalent in the induced group compared with the spontaneous group (6.3% v. 4%). A study by Abisowa *et al.*[3] reported similar findings (4.5% v. 2.3%). Other complications that were comparable in both groups included retained placenta, perineal tear, puerperal fever and wound infections.

NICU admissions were more prevalent in the induced group than in the spontaneous group (4% v. 1%). There were no neonatal deaths in either groups in the present study.

Conclusion

Multiparity, GA >38 weeks, BMI <25 kg/m^2 and cervical dilatation are important predictors of successful vaginal delivery following induction.

It is a challenging task to strike a balance between reducing CS rates while ensuring the safety of mother/fetus from the assumed dangers of continuation of pregnancy. This can be accomplished by carefully selecting patients for induction, especially those with borderline indications and avoiding elective inductions. Factors that influence the success of induction can be used to counsel women with borderline and elective indications and their relatives in making decisions about mode of delivery as our study clearly showed an association between CS deliveries and the IOL, especially in nulliparous women.

All obstetric centres must periodically assess their CS rates, IOL indications, successful inductions and what factors affect these rates to reduce primary CS rates.

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