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ELECTIVE INDUCTION OF LABOR

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Elective induction of labor has secured a strong foothold in American obstetrics. It offers many advantages to the mother, the infant, and the obstetrician when properly carried out and deserves continued study and development, subject to critical evaluation of its hazards and pitfalls. Although its use at times has been indiscriminate, and problems thereby created, it remains a useful part of the obstetrician's armamentarium. The procedure has been gaining increasing acceptance since the early 1930's. While intrauterine pressure and other physiologic research studies have contributed much to our understanding of labor, both induced and spontaneous, the increasing use of induction techniques and the avalability of improved oxytocic agents have made elective induction safer for the mother and the infant.

Earlier reports[2,3,10,15,16,17,19] enumerate potential and actual hazards to the mother and the infant. It is now recognized that small doses of oxytocin are physiologic and that marked individual sensitivity to oxytocin necessitates careful titration of the oxytocin dosage and attentive monitoring of labor. Knowledge of the potential dangers of induction, whether by oxytocin infusion or artificial rupture of the membranes, should make maternal hazards minimal.[2,6,11]

The dangers to the fetus attributable to parturition, whether spontaneous or induced, have not yet been clarified despite considerable study.[1,4,5] At present, although the fetal morbidity and mortality incidental to the elective induction of labor are low,[1,5] few reports include better results than those of a control group made up of patients at term undergoing spontaneous labor.[5,11] Some reports cite results which are distinctly worse.[3,4]

In this paper an attempt is made to delineate some of the pertinent factors of elective induction of labor which may adversely affect the mother and the infant. It is a preliminary report of a continuing study which covers the experience gained in the period from January 1960, to January 1962. During this period there were 2,417 deliveries. Of these, 301 were elective inductions and 117 indicated inductions, giving an incidence of 12.5 per cent and 4.8 per cent respectively. Indicated inductions will not be considered in this paper.

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Elective inductions were divided into two categories "false" labor and "planned" labor. The "false" labor group consists of those patients admitted to the hospital with vague signs and symptoms as bloody show, false labor, and painful Braxton Hicks contractions, and who failed to show progress of labor during a six hour period of observation. The "planned" labor group represents patients selected by the obstetrician as being suitable for elective induction and includes consideration of such factors as an infant of term size, a "favorable cervix", a vertex presentation, and other factors individually deemed necessary. These details may not appear on the hospital admission record and are therefore difficult to assess in a retrospective study. However, their importance cannot be questioned.[11,12,13]

The following are considered for their effect upon the success or failure and morbidity of induction: parity, gestational age, induction technique, duration of labor, birth weight and Apgar rating of the infant. The factors pertaining to failed induction were also appraised.

Parity:

Of the 301 patients subjected to elective induction, 47 were primigravidas (15.6 per cent) and 254 were multigravidas (84.4 per cent). Of 220 "planned" inductions, 189 were multigravidas (85.9 per cent), while of the 81 "false" labors 65 were multigravidas (80.2 per cent).

Table I

PARITY				
	PLANNED		FALSE LABOR	
	1960	1961	1960	1961
0	14	17	6	10
1-6	99	90	27	36
Over 6	0	0	0	2
Total 1960	113	—	33	—
Total 1961	—	107	—	48

Gestational Age at Time of Delivery:

Induction was successful in 11 patients three to five weeks before the expected date of confinement, nine in the "planned" group, two in the "false" labor group. Thus, 3.7 per cent were premature by gestational age. However, none of these patients had premature infants by weight definition, i.e. 5½ lbs. or less. There are six patients in this group with birth weights between 5½ and 6 lbs., three with birth weights between 6 and 8 lbs., and two with birth weights over 8 lbs. Although one infant in this group was moderately depressed (Apgar rating) at birth, all of these infants ultimately did well.

Table II
GESTATIONAL AGE AT TIME OF DELIVERY

	PLANNED				FALSE LABOR				
	Primigravid		Multigravid		Primigravid		Multigravid		
	1960	1961	1960	1961	1960	1961	1960	1961	
Under 35 Weeks	0	0	0	0	0	0	0	0	
35 Weeks	0	0	1	0	0	0	0	1	
36 Weeks	0	0	1	0	0	0	0	0	
37 Weeks	0	0	6	1	0	0	0	1	
38 to 41 Weeks	13	16	88	83	6	10	26	34	
Over 41 Weeks	1	1	3	4	0	0	1	2	
Total 1960	14	—	99	—	6	—	27	—	146
Total 1961	—	17	—	90	—	10	—	38	155

Induction Technique:

In general the "planned" induction group receive either oxytocin alone, artificial rupture of the membranes alone, or the two in combination. The "false" labor group received oxytocin stimulation initially to evaluate uterine sensitivity. If the initial oxytocin infusion is unsuccessful, the decision is made to repeat a second course of oxytocin, to rupture the membranes or to discharge the patient.

Of the 301 inductions, 202 patients (67.1 per cent) had oxytocin infusion as the only modality, or as the primary technique followed by artificial rupture of the membranes. Eighty-two patients (27.2 per cent) had artificial rupture of the membranes alone, or as the primary technique followed by oxytocin infusion. Seventeen patients (5.7 per cent) had initial oxytocin infusion alone without success and returned in spontaneous labor on a subsequent admission.

In the "planned" group, 145 patients (65.9 per cent) had oxytocin infusion alone or with subsequent artificial rupture of the membranes. Sixty-nine patients (31.4 per cent) of this group had artificial rupture of the membranes alone, or as the primary technique followed by oxytocin.

In the "false" labor group, 57 patients (70.4 per cent) had oxytocin alone, or as the primary technique followed by artificial rupture of the membranes, while 13 patients (16 per cent) had artificial rupture of the membranes alone, or as the primary technique followed by oxytocin.

Considering both groups together, 10 infants (4.9 per cent), were depressed in the group having oxytocin infusion alone, or with subsequent artificial rupture of the membranes. Four infants (4.9 per cent) were depressed in the group having artificial rupture of the membranes alone, or as the primary technique followed by oxytocin.

Table III
INDUCTION TECHNIQUE

	PLANNED			FALSE LABOR		
	1960	1961	Total	1960	1961	Total
*ARM	22	15	37	3	7	10
ARM & Oxy	2	30	32	3	0	3
Oxytocin	6	7	13	6	3	9
**Oxy & ARM	79	53	132	20	28	48
Spontaneous	4	2	6	1	10	11
Total	113	107	220	33	48	81

*ARM — Artificial Rupture of the Membranes
**Oxy — Oxytocin

Duration of Labor:

Since the patient is aware of and sustains the contractions of oxytocin, the duration of actual labor and of oxytocin infusion are considered as the measurement of labor. The latent period between artificial rupture of the membranes and the onset of labor is not included in these statistics. If it were, the duration of labor would have been increased one to three hours in 11 patients only, since oxytocin is begun within one to two hours after artificial rupture of the membranes should labor not supervene. This technique has been adopted to avoid a prolonged latent period and the increased danger of intrauterine and fetal infection. In the entire study there were no uterine or fetal infections, although this complication has been emphasized in other studies.[3,10]

The duration of labor pertains only to the successful induction, and fruitful labor which terminates with the birth of the infant. Thus, the failed inductions as defined elsewhere are not included in these statistics.

There were 46 multigravidas who had labors ranging from 6 to 14 hours. Possibly this represents an increase over the expected average duration of spontaneous labor. The remainder had labors shorter than 6 hours. In other series[1,11] the total duration of labor is shorter than would be expected of a control group undergoing spontaneous labor. This is not surprising since the majority of patients induced have completed most or all of the prelabor phase, and can proceed without delay into the active phase of cervical dilatation.

Only three primigravidas had labors which exceeded 14 hours. One patient who was in labor for 19 hours was found to have cephalopelvic disproportion. She was delivered by Cesarean section of a 9 lb. 8 oz. somewhat depressed infant. Two other primigravidas had labors of 16 and 18 hours respectively, followed by uneventful vaginal deliveries. Fourty-two primigravidas had labors under 14 hours.

Table IV
DURATION OF LABOR (Contractions and/or oxytocin)

	PLANNED				FALSE LABOR			
	1960		1961		1960		1961	
Length of labor	Primi*	Multi**	Primi	Multi	Primi	Multi	Primi	Multi
Under 1 hr.	0	5	0	3	0	1	0	3
1 — 3 hrs.	0	29	0	41	0	3	0	5
3 — 6 hrs.	2	48	8	32	0	14	3	22
6 — 10 hrs.	6	14	7	11	4	8	3	8
10 — 14 hrs.	4	3	2	1	5	1	4	0
Over 14 hrs.	2	0	0	0	1	0	0	0
Totals	14	99	17	90	10	27	10	38

*Primigravida
**Multigravida

Birth Weight of Infant:

Eleven infants weighed under 5½ lbs. and were premature by weight definition. However, all of these were 38 to 41 weeks by gestational age. In the "false" labor group, three infants weighed less than 5½ lbs. (3.6 per cent), while in the "planned" group there were eight such infants (3.6 per cent). The smallest infant weighed 4 lbs. 15 oz., and the others ranged between 5 lbs. 3 oz and 5 lbs. 7½ oz. These infants had good Apgar ratings at birth and ultimately did well. The incidence of prematurity, as noted in most reports, is less than the usual obstetrical incidence; this was the case in this series.

Table V
BIRTH WEIGHT OF INFANT

	PLANNED		FALSE LABOR		
	1960	1961	1960	1961	TOTAL
5 - 5½ lbs.	3	3	1	2	9
5½ - 6 lbs.	14	5	1	4	24
6 - 7 lbs.	21	24	8	9	62
7 - 8 lbs.	37	48	18	17	120
Over 8	38	27	8	16	89
Total 1960	113	—	36	—	149
Total 1961	—	107	—	48	155

Apgar Ratings at Birth:

In the total group of 304 infants, there were 14 depressed infants, an incidence of 4.6 per cent. Five of these were in the "false" labor group (6 per cent), while nine were in the "planned" labor group ((4 per cent). Five of these infants were delivered of primigravidas (10.8 per cent), and nine were delivered of multigravidas (3.5 per cent).

In 1961, the Apgar rating of the newborn infant replaced the poor, fair, and good condition scoring system. This system is based upon a numerical value which places emphasis on such factors as the color of skin, muscle tone, heart rate,

respiratory effort, and reflex irritability. These factors are recorded twice, first at one minute and then at five minutes, after birth and have prognostic value for the newborn.[7,8] A depressed infant is one who has an Apgar rating of six or less; but in this series includes those infants considered fair, or as having an Apgar rating of seven or less.

A wide variety of problems occurred in the group showing low Apgar ratings. Two infants were premature by dates at 35 and 37 weeks respectively. One was postmature at 42 weeks. One infant weighed 5 lbs. 7½ oz and was slightly depressed. However, two infants previously delivered of these patients were also premature by weight definition and both born at term after spontaneous labors. The primigravida having cephalopelvic disproportion and delivered by Cesarean section had a 9 lbs. 8 oz infant who was somewhat depressed at birth. There were four other large infants weighing over 8 lbs. One depressed infant was delivered following four days of successive induction efforts. Two deliveries were classified as mid-forceps and "difficult". One patient suffered from bilateral sulcus tears of the vagina following two attempts at delivery by suction extraction. The relationship between difficult forceps delivery and depressed Apgar rating has been established.[20]

In the infants with low Apgar ratings the length of labors included three in the 1 to 3 hour group, three in the 3 to 6 hour group, three in the 6 to 10 hour group, four in the 10 to 14 hour group, (three primiparas), and one in the over 14 hour group. All of these patients were miltiparas with the exception of the three primigravidas mentioned. The numbers in each group are much too small to assess this factor statistically.

There was one fetal death in this series. The autopsy of this infant showed numerous congenital anomalies including a patent ductus arteriosis, the total being "incompatible with life."

Table VI

APGAR RATING AT BIRTH

	FALSE LABOR		PLANNED		
Rating	1960	1961	1960	1961	
5	0	0	0	1	
6	1	0	0	0	
Poor	1	0	0	0	
7	0	1	0	1	
Fair	5	1	2	1	
8	0	5	0	0	
9	1	33	0	6	
10	3	29	1	23	
Good	102	38	33	16	
Total 1960	113	—	36	—	149
Total 1961	—	107	—	48	155
					304

Failed Induction:

By definition in this series, induction was considered to have failed if the patients were not in labor within two hours after completion of a course of oxytocin, either alone, or in combination with artificial rupture of the membranes. Hendricks[6] dislikes the term failed induction, feeling that the work done by the administration of a course of oxytocin helps to ripen the cervix and to bring true labor nearer. He considers partial induction a more proper term.

In the total group there were 343 induction efforts made in 301 patients. In the "planned" labor group 17 of the 220 patients failed on the first attempt (7.7 per cent). Six patients returned in spontaneous labor during a subsequent hospital admission. The remainder were successfully induced on one or more subsequent attempts. Two patients were successfully induced on the third, and two on the fourth attempt. In the "false" labor group 18 of 81 patients failed on the first induction attempt (22.2 per cent). Nine of the 18 patients returned in spontaneous labor after the first induction attempt, two after a second attempt.

Table VII
FAILED INDUCTIONS

	PLANNED		FALSE LABOR	
	1960	1961	1960	1961
Primigravid	3	2	1	3
Multigravid	7	5	2	12
Total 1960	10	—	3	—
Total 1961	—	7	—	15

Complications of Labor and Delivery:

Maternal complications were rare and in this series were statistically not significant. They include such factors as two "difficult" deliveries, four cervical and vaginal lacerations, occasional prolongation of labor (as mentioned previously), or other maternal complication. There were two cases of uterine atony and excessive bleeding following delivery of the placenta. The incidence of this complication is now minimized by continuing the oxytocin drip during the immediate postpartum phase. The low incidence of maternal complications has been noted in other series.

Other factors such as maternal age, past history, parity, color or race, and postpartum complications were reviewed but did not contribute significantly or adversely in the patients under study.

COMMENT

In some reports[1,10] reluctance to induced primigravidas is expressed because the pelvis is unproven and because of the longer labors. There is no significant increase in the duration of labor in this series among primigravidas: the longest labor was 19 hours, complicated by cephalopelvic disproportion and was terminated by Cesarean

section. Two grand multigravidas (over six) were included in this study but acted in all respects as multigravidas of lower parity and are not separately considered.

All failures of induction occurred with oxytocin infusion alone. The complete success with artificial rupture of the membranes suggests careful selection of patients and emphasizes the recognized effectiveness of this technique in patients meeting the proper criteria.[9,14]

The high failure rate in the "false" labor group is neither surprising nor alarming. Many patients are often given a course of oxytocin infusion during the current admission to determine uterine sensitivity. Those factors stress in "planned" induction such as the size of the fetus, cervical favorability, etc. may not be as carefully evaluated in the "false" labor group. If the uterus is found to be sensitive to intravenous oxytocin in doses ranging from 1 to 10 mU per minute, the induction tends to be successful. If not, the patient is discharged.

In the "planned" group, better choice of patients with uterine sensitivity and cervical favorability gave a higher initial success rate. Once labor is initiated, amniotomy assured success.

However, it is apparent if the first attempt is unsuccessful, the patient, or doctor, or both, whether by inappropriate desire or by implication of a failed promise may wish to persevere.

In nineteen patients two or more days of oxytocin infusion was administered before the successful induction or before failure of induction was acknowledged and attempts discontinued. Fields states that "ripening" the cervix should not be attempted by repeated courses of oxytocin in elective induction and should be limited to indicated inductions only.[11]

It appears that perseverance in induction efforts may have contributed a number of undesirable effects, i.e. psychic trauma attending failure, low Apgar ratings, longer labors, a significant number of infants weighing under 6 lbs., difficult deliveries. Twenty-two of the 34 infants weighing under 6 lbs. followed induction by artificial rupture of the membranes alone, or in combination with oxytocin infusion. Many of these complications occurred in the "false" labor group.

In the author's opinion such need for perseverance is a warning of possible complications, it indicates that the optimal time for labor may not be imminent, and that induction attempts should be discontinued or postponed.

It is the policy of our department not to perform amniotomy until the cervix is well effaced and two to three centimeters dilated with the vertex deep in the pelvis in good apposition to the cervix. When the cervix is of questionable favorability, oxytocin is administered first, to achieve sufficient effacement and dilatation. By this technique uterine sensitivity is established, and artificial rupture of the mem-

branes can be performed safely. Stone and others point out the value of intravenous oxytocin in physiologic dosage as a test of uterine sensitivity, the progress in labor indicating gestational maturity. He feels with this technique a decreased incidence of prematurity can be expected.

This series of induced labors is to small too make sweeping statistical conclusions. However, it seems essential in subsequent and larger studies to identify further the various induction techniques as they affect fetal morbidity. It has been suggested that artificial rupture of the membranes alone or in conjunction with oxytocin may lead to increased fetal morbidity.[3,4] Until further statistical analysis of induction techniques are studied, conclusions regarding the relationship of fetal morbidity and specific induction techniques will remain unresolved.

Thus, it is clear that for a successful induction a patient must be selected carefully and this initial selection must be followed by appropriate induction and delivery techniques. The obstetrician who electively induces patients must be a well-trained obstetrician and have satisfactory follow through or the success and safety of the induction will be compromised. Any break in the continuity of care will decrease the safety and effectiveness of induction and contribute unfairly to the reputation of elective induction.

Several factors were found which may adversely affect elective induction. Three sets of twins were present, two unknown at the onset of induction. Three breech presentations were induced, two unknown at the onset. Two grand multiparas were also included in this series. These obstetrical situations are generally considered to be contra-indications to elective induction and suggest more careful pre-induction selection in both groups. The two Cesarean sections represent 0.66 per cent versus 4.7 per cent for the total obstetrical experience during these two years. Abdominal delivery following spontaneous or induced labors is always possible in that the relative size of the infant, adequacy of the pelvis, and the forces of labor represent unknown factors that the parturient encounters during a specific labor.

Summary

1. Elective induction of labor at this hospital has proven to be a safe, though not always satisfactory procedure for the mother and fetus.

2. The significant incidence of failed inductions, occasional premature infants, presence of obstetrical complications such as twins or breech presentation indicate the necessity for careful pre-induction assessment.

3. With careful pre-induction evaluation, induction and delivery techniques, elective induction of labor is a safe procedure and offers significant advantages to the mother and the fetus.

4. Intravenous oxytocin infusion in physiologic doses to establish uterine sensitivity, followed by artificial rupture of the membranes when effacement is complete and the cervix has started to dilate is our procedure of choice.

5. Artificial rupture of the membranes is an effective means of inducing labor. It should be utilized alone or in conjunction with oxytocin infusion, only when the cervix is well effaced, the vertex deep in the pelvis, and in close apposition to the cervix.

6. Continued assessment of induction techniques, as they relate to maternal and fetal well being, is vital to a clear understanding of the advantages and hazards of elective induction.

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