A COMPARATIVE STUDY OF TRANSVAGINAL ULTRASOUND AND BISHOP'S SCORE FOR PREINDUCTION CERVICAL ASSESSMENT

DISSERTATION SUBMITTED FOR

BRANCH - II M.S (OBSTETRICS & GYNAECOLOGY)

APRIL 2017

THE TAMILNADU
DR.M.G.R.MEDICAL UNIVERSITY
CHENNAI

CERTIFICATE

This is to certify that the dissertation entitled **"A COMPARATIVE STUDY OF TRANSVAGINAL ULTRASOUND AND BISHOP'S SCORE FOR PREINDUCTION CERVICAL ASSESSMENT''** is the bonafide work of **Dr. N.SRI PRATHIBA MAHALAKSHMI** in partial fulfillment of the university regulations of the Tamil Nadu Dr. M.G.R. Medical University, Chennai, for M.S (Branch II) Obstetrics and Gynaecology examination to be held in April 2017.

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This is to certify that the dissertation entitled "**A COMPARATIVE STUDY OF TRANSVAGINAL ULTRASOUND AND BISHOP'S SCORE FOR PREINDUCTION CERVICAL ASSESSMENT**" is a bonafide research work done by **Dr.N.SRI PRATHIBA MAHALAKSHMI.,** Post Graduate Student, Department of Obstetrics & Gynaecology, MADURAI MEDICAL COLLEGE AND GOVERNMENT RAJAJI HOSPITAL, MADURAI, under the guidance and supervision of **Associate Prof.DR.M.GAYATHRI, M.S(OG).,D.G.O.,** Professor Department of Obstetrics & Gynaecology, MADURAI MEDICAL COLLEGE AND GOVERNMENT RAJAJI HOSPITAL, MADURAI.

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DECLARATION

I, **Dr.N.SRI PRATHIBA MAHALAKSHMI** hereby declare that, I carried out this work on "**A COMPARATIVE STUDY OF TRANSVAGINAL ULTRASOUND AND BISHOP'S SCORE FOR PREINDUCTION CERVICAL ASSESSMENT"** at the department of Obstetrics & Gynaecology, Govt. Rajaji Hospital, Madurai, under the guidance of **Associate Prof.DR.M.GAYATHRI, M.S(OG).,D.G.O.,** ASSOCIATE PROFESSOR OF OBSTETRICS & GYNAECOLOGY, during the period of MARCH 2016 to AUGUST 2016. I also declare that this bonafide work has not been submitted in part or full by me or any others for any award, degree or diploma to any other university or board either in India or abroad.

This is submitted to the Tamilnadu DR. M.G.R. Medical University, Chennai in partial fulfilment of the rules and regulations for the M.S(OG) degree examination in OBSTETRICS AND GYNAECOLOGY (Branch II) to be held in April 2017.

Place: Madurai

Date: (Dr.N.SRI PRATHIBA MAHALAKSHMI)

ACKNOWLEDGEMENT

At the outset, I wish to thank our Dean **Dr.M.R.VAIRAMUTHURAJU M.D.,(GM)** for permitting me to use the facilities of Madurai Medical College and government Rajaji Hospital to conduct this study.

I thank sincerely**, PROF.DR.C.SHANTHI, M.S(OG).,D.G.O.,FICOG.**, Professor and Head of the Department, Department of Obstetrics & Gynaecology for her valuable advice and cooperation in completing this study.

My guide Associate Prof**.DR.M.GAYATHRI, M.S(OG).,D.G.O.,** ASSOCIATE PROFESSOR OF OBSTETRICS & GYNAECOLOGY has always guided me, by example and valuable words of advice and has given me her moral support. I will be ever grateful to her.

I offer my heartfelt thanks to my other Professors

PROF.DR.K.S.CHITRA.,MS(OG).,D.G.O.,

PROF.DR.N.SUMATHI MS(OG).,D.G.O.,

PROF.DR.P.JYOTHISUNDARAM MS(OG),DGO,

PROF.DR.N.K.MAHALAKSHMI MS(OG).,D.G.O., for their guidance.

I am indebted to our assistant professors without whose immense help and support this work will not have ended successfully.

I thank Professor, Department of Radiology, Assistant professors and post graduates who have rendered their support and guidance and whose contribution has helped me in this venture.

I would like to extend my sincere gratitude to my patients, who form the most integral part of the work, were always kind and cooperative.I would like to thank Dr.N.PUKAZHENTHI M.sc(statistics)., M.Phil.,PhD for guiding me in statistical analysis.

I would like to thank my parents, husband and THE ALMIGHTY for being with me throughout the study providing moral support.

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INTRODUCTION

Induction of labour, one of the most common obstetric procedures, is the technique of artificially stimulating uterine contractions, before the onset of labour, resulting in progressive effacement and dilatation of cervix, to achieve vaginal delivery.

Throughout the world, in upto 20% of women, labour is being induced by one method or the other. There is an increase in the rate of obstetrically and medically indicated inductions, where the fetal and maternal risks of early delivery is relatively less than the risk of prolonging the pregnancy.

Whatever be the indication for induction of labour assessment of preinduction cervical ripening is essential. There are several methods available for this assessment and newer methods are also being sought to.

'The Bishop score' described by Bishop in 1964 is the traditional cervical scoring system being used. There are several studies with controversial results regarding the efficacy of Bishop's score in preinduction cervical assessment.

Subsequently, other methods were evaluated and in the search of an objective method, transvaginal ultrasonography was introduced.

The parameters like cervical length, posterior cervical angle and percentage of funneling measured by transvaginal ultrasonography may be used to assess the preinduction cervical status in a more objective way.

Since 1960, prostaglandins have been used to induce labour. As per ACOG 2009, intracervical PGE2 as a gel preparation is being widely used for induction of labour.

It is well known fact worldwide, that there is no universally accepted criteria for failure of induction, though a time frame of 24 hours is often used for the same.

Prediction of outcome of labour induction is essential to avoid unnecessary induction and preventable cesarean section.

AIM OF THE STUDY

To compare the efficacy transvaginal ultrasound and Bishop's score in predicting the cervical status before pharmacological induction of labour

OBJECTIVE:

1. To find the efficacy of transvaginal ultrasound in predicting the cervical status before pharmacological induction of labour.
2. To compare the efficacy of transvaginal ultrasound and Bishop's score in preinduction cervical assessment.

MATERIALS AND METHODS

1. DESIGN OF STUDY : PROSPECTIVE STUDY

2. PERIOD OF STUDY : 6 months

3. COLLABORATING DEPARTMENT : RADIOLOGY

4. SELECTION OF STUDY SUBJECTS : All antenatal patients with term singleton gestation selected for induction of labour with intact membranes at Govt Rajaji Hospital,Madurai.

5. DATA COLLECTION : Data regarding history, clinical examination, Bishop's score,transvaginal ultrasound examination, outcome.

6. METHODS : Prospective comparison study

1. The study to be conducted in women admitted in GRH,Madurai with term gestation planned for induction of labour.

2. Informed and written consent from the participant.

3. Counselling and communication about the needs and method of study.

4. History, age, parity, BMI, Indication for induction of labour, method of induction,mode of delivery, Bishop's score, induction delivery interval, reason for cesarean section.

5. Investigations:- transabdominal ultrasound,transvaginal ultrasound for measurement of cervical length and posterior cervical angle

METHODOLOGY

The number of subjects under study is calculated based on the sensitivity of modified Bishop's score.

Sample size calculation:

Overall by various studies it has been estimated that Bishop score has a sensitivity of 65%, and specificity of 95%. Based on this, the sample size of the study was calculated,

$$N=\{Z^2 * Sn * (1-Sn)\}/\{L^2 * P^2\}$$

Based on this the sample size taken for a significant result is 150.

Selection of candidates:

The subjects for study were selected according to the inclusion and exclusion criteria mentioned earlier. The height, weight, BMI, gestational age of the subjects for study were evaluated and recorded. The findings of the recently done transabdominal ultrasound regarding estimated fetal weight and amniotic fluid index were also recorded.

The reason for induction of labour and the method of induction and time of induction also recorded.

Bishop's score estimation.

The Bishop's score as given by the obstetrician is taken.

TRANSVAGINAL SONOGRAPHY:

With the consent of the patient, under strict aseptic precautions, with the probe of the machine covered with male condom, the 5 Hz probe is gently inserted into the vagina.

CERVICAL LENGTH

The examination should not be carried out with full bladder, If the bladder is full it falsely increases the cervical length by 4mm. Undue pressure will distort the architecture of the cervix, so the probe should be away from the fornix.

The urinary bladder, fetal presenting part are identified on either side of the probe. This helps to ensure correct placement of the probe. The cervix is focused in the sagittal plane and the image is magnified so that it occupies 50-70% of the screen. The cervical canal is identified.

The cervical canal is identified. Some echoeic mucous may be present at times in the cervical canal and that indicates the cervical secretion. Sometimes the cervical canal may be curved and difficult to measure. The external os, internal os, anterior lip and posterior lip of cervix are identified. Cervical length is measured from the internal to external os. Even when the cervix is curved, it is measured as a straight line.

Since the cervix is not a static structure and the length of a cervix can vary due to uterine contractions or different positions of the patient, the duration of examination should be three to five minutes.

The length of the cervix is measured by placing calipers at external and internal ora. The difference in measurement obtained at different times by the same sonographer or by different sonographers is about 4 mm in 95 % of cases.

POSTERIOR CERVICAL ANGLE

Once the image of cevix is fixed on the usg screen, the posterior cervical angle which is the angle between posterior uterine wall and the cervical canal is measured using the calipers available such as alpha angle measurement

When the posterior cervical angle more than or equal to 120 degrees, it is taken as a good predictor of successful induction of labour. Studies have shown that median preinduction posterior cervical angle of sixty degrees was associated with caesarean deliveries than vaginal deliveries.

PERCENTAGE OF FUNNELING

Funneling which is the presence of membranes within the endocervical canal, if present is noted and the distance is measured with the calipers. Its percentage of the total cervical length is calculated.

If there is presence of funneling there is higher chance of successful outcome following induction. A funneling of more than 40 percentage is taken as positive predictor. The image is saved in the ultrasound machine and data is transferred for future reference and calculation.

Presence of mucus within the endocervical canal must be differentiated from funneling.

All the trans vaginal parameters are given scores based on cervical length less than 3 cm. posterior cervical angle greater than or equal to 120 degrees and the percentage of funneling greater than or equal to 40% and a comprehensive score is obtained.

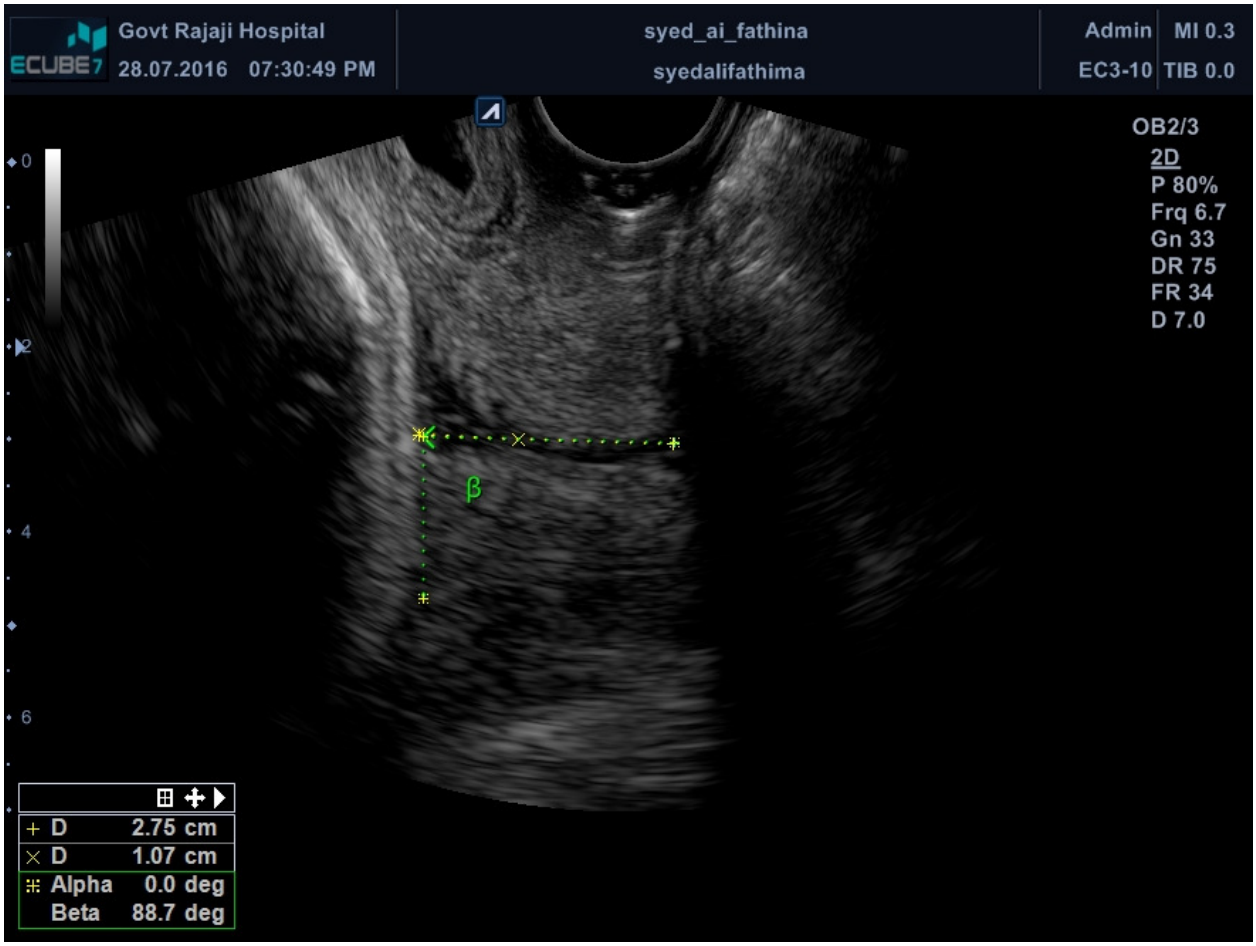


Figure 1:Transvaginal sonographic measurement

INDUCTION OF LABOUR:

Then the women undergoes induction of labour as per the indication using dinoprostone gel.

She is followed up till delivery of the baby and the mode of delivery, time taken to achieve active labour and induction delivery interval are noted.

The Bishop's score, transvaginal measurements, outcome of labour are recorded and significance compared with IBM SPSS Version 20.

REVIEW OF LITERATURE

Human labour is a complex process. It is characterized by coordinated effective uterine contractions that bring about progressive effacement and dilatation of cervix and this results in expulsion of the products of conception including the fetus, placenta and membranes.

STAGES OF LABOUR:

The clinical stages of labour include,

Stage 1 : from onset of pain to full cervical dilatation

Stage 2 : full cervical dilatation to delivery of the fetus

Stage 3: delivery of the placenta with membranes

STAGE 1:

The extrusion of mucus plug that had previously plugged the cervical canal during pregnancy is known as 'show'.

Labour contractions:

It is associated with

- distinct lower and upper uterine segment differentiation
- changes in uterine shape

- cervical effacement

STAGE 2:

It is associated with

- fetal descent
- pelvic floor changes

the fetal descent occurs by the following cardinal movements:

- engagement
- descent with flexion
- internal rotation
- extension
- complete extension with delivery of head
- restitution
- delivery of anterior shoulder
- delivery of posterior shoulder

STAGE 3:

It includes delivery of placenta and membrane. Associated with fetal membrane separation and placental extrusion.

PHYSIOLOGICAL AND BIOCHEMICAL PROCESSES REGULATING PARTURITION:

Two school of thoughts are present regarding initiation of labour

1. functional loss of pregnancy maintenance factor
2. synthesis of factors that induce parturition

MYOMETRIAL ACTION:

This includes

- regulation of myometrial contraction and relaxation
- actin- myosin interaction
- increasing levels of intracellular calcium
- increased number and responsiveness of myometrial gap junctions
- transcription of cell surface receptors

CERVICAL DILATATION:

Sakamoto et al proved that enormous influx of leucocytes occurs into the cervical stroma resulting in cervical dilation. Scientific proof of leucocyte chemoattractants like IL-8 are increased just after delivery.

Hazel et al in 2006 and Havelock et al in 2005 states that ‘dilation and early stages of postpartum repair are aided by

- inflammatory response
- apoptosis
- protease activation'.

CHANGES DURING LABOUR:

Labour is characterized by changes in both myometrium and the cervix mediated by many hormones and substances like prostaglandins.

It consists of four important phases:

Phase 1- Quiescence

Phase 2 – activation

Phase 3 – stimulation

Phase 4 – involution

These phases are described based on the uterine activity

Phase 1 Quiescence	Phase 2 Activation	Phase3 Stimulation	Phase4 Involution
Prelude to parturition	Preparation for labour	Processes of labour	Parturient recovery
Contractile unresponsiveness, cervical softening	Uterine preparedness for labour. Cervical ripening	Uterine contraction. Cervical dilation, fetal and placenta expulsion	Uterine involution, cervical repair, breast feeding

The key factors that acts in different phases include

1. **PHASE 1**
    a. progesterone
    b. prostacyclin
    c. relaxin
    d. PGDH
    e. Nitric oxide
2. **PHASE 2:**
    a. Estrogen- progesterone withdrawal
    b. Uterine stretch

c. Gap junction receptors

d. Relaxin

e. Increases hyaluronan

3. **PHASE 3**:

a. Prostaglandin

b. Oxytocin

c. Relaxin

4. **PHASE 4:**

a. Oxytocin

b. Inflammatory cell activation

Mediated by any of the factors like interleukin 6, CRH, prostaglandins, the common pathway of parturition passes through three cardinal events, cervical ripening, activation of myometrium and activation of fetal membranes.

UTERINE QUIESCENCE:

It is associated with uterine tranquility along with maintenance of cervical structural integrity. The inherent nature of myometrium is contraction. But even before implantation, there is abeyance and the uterine musculature does not respond to the natural stimuli. Also there occurs extensive changes in the uterine size and vascularity to accommodate for the pregnancy. This unresponsive state of uterine musculature that occurs in phase 1 continues until the near end of pregnancy. But even in this phase, some low

intensity myometrial contractions occur but they are not accompanied by cervical dilatation. These are referred to as the Braxton Hicks contractions or false labour.

CERVICAL SOFTENING:

The functions of cervix during pregnancy include:

- Barrier to protect the reproductive tract from infection
- Maintenance of the cervical competence against the increasing gravitational force
- Orchestration of the extracellular matrix changes that permit progressive increase in tissue compliance

Non pregnant women have a cervix that is firm in consistency, comparable to nasal cartilage. But by the end of pregnancy, the consistency of the cervix changes and is similar to lip of the oral cavity. This phenomenon of remodeling of the cervix is called 'softening'. It is characterized by increasing tissue compliance.

In 1895, Hegar pointed out that there is palpable softening of the lower uterine segment at 4 to 6 weeks' gestation .

According to Iams et al, preterm cervical dilatation. Structural incompetence or both may forecast delivery.

Structural changes with cervical softening:

The changes in the cervix include:

- Increased vascularity
- Stromal hypertrophy
- Glandular hypertrophy
- Glandular hyperplasia
- Slow, progressive compositional or structural changes in the extracellular matrix

the conformational changes are:

- Alteration in collagen processing
- Alteration in the number or type of covalent cross-links between collagen triple helices
- Formation of unstable fibrils
- Decreased cross links between newly synthesized collagen monomers
- Reduced expression and activity of the crosslinking forming enzymes like – lysyl oxidase and lysyl hydroxylase
- Reduced expression of matricellular proteins thrombospondin 2 and tenascin C
- Gradual increase in compliance of the cervix during pregnancy

PHASE 2 OF PARTURITION:

These is suspension of the uterine tranquility of phase 1 and occurrence of uterine awakening that occurs during the last 6 to 8 weeks of pregnancy.

It is associated with changes in the

- Myometrium
- Endocervical epithelia
- Cervical connective tissue
    - Collagen
    - Glycosaminoglycans
    - Proteoglycans
    - Inflammatory changes

<u>MYOMETRIAL CHANGES</u>:

There is alteration and increased expression of key proteins of contractility

- Contraction- associated proteins(CAPs) that include
    - Oxytocin receptor
    - Prostaglandin F receptor
    - Connexin 43

- Uterotonins

There is increases responsiveness and irritability to uterotonins

Another important change that occurs is the formation of lower uterine segment that is associated with 'lightening', that is , descent of the head into or through the pelvic inlet.

CERVICAL RIPENING:

Before the onset of contractions, there is extensive remodeling of the cervix that eventually result in yielding and dilatation upon initiation of forceful uterine contraction. These cervical tissue changes that principally involve connective tissue changes are called cervical ripening.

This transition from cervical softening to cervical ripening occurs weeks or days before the onset of contractions. During this, there is alteration in the total number of proteoglycans and glycosaminoglycans. These are almost controlled by the same hormones that control uterine contractions. The corpus uteri predominately consists of smooth muscle cells, whereas the cervix is predominantly connective tissue. The cellular components of the cervix include fibroblasts, epithelia and few smooth muscle cells.

ENDOCERVICAL EPITHELIA:

During pregnancy there is proliferation of the endocervical glands that occupy a significant percentage of the cervical mass. The nucosal epithelia function as sentinels against microbial invasion by

- Expression of Toll- like receptors to recognize the pathogens
- Expression of antimicrobial peptides
- Inhibition of protease
- Signalling the underlying immune cells

They also

- Regulate hydration of tissues
- Maintenance of barrier function

They do this by expression of

- Aquaporins – water channel proteins
- Claudin 1 and 2 – tight junction proteins

CERVICAL CONNECTIVE TISSUE:

COLLAGEN:

Collagen is largely responsible for the structural disposition of the cervix. It has a complex biosynthesis that involves atleast six enzymes and chaperons to accomplish maturation.

Each collagen molecule is composed of three alpha chains that are wound over each other to form procollagen, multiple collagen triple-helical molecules are cross-linked to one another by the action of lysyl oxidase to form fibrils that interact with the

small proteoglycans such as thrombospondin2. The fibril size, packing and organization is influenced by these interactions, that ensure that uniform sized collagen are packed together.

At the onset of cervical ripening, there is increase in the diameter of the collagen fibrils and increase in spacing between them, which may be due to accumulation of poorly cross-linked collagen and reduced expression of matricellular proteins. This dispersion of the collagen fibrils, decreases the integrity and increases their tissue compliance.

Matrix metalloproteinases, are the proteases that are capable of degrading the extracellular matrix proteins.

Zhang et al, propose that dynamic changes in the collagen structure are responsible for the cervical ripening rather than collagen content. It is also supported by studies that have proven the polymorphisms of genes required for collagen assembly are associated with an increased incidence of cervical insufficiency.

GLYCOSAMINOGLYCANS:

Hyaluronan, is one example of the glycosaminoglycans that complex with proteins to form proteoglycans. The synthesis of hyaluronan is mediated by the enzyme, hyaluronan synthase isoenzyme. During cervical ripening, the expression of this enzyme is increased.

Spacilli et al in 2007 reported the importance of regulated changes in hyaluronan size that occurs with cervical ripening and dilatation. Also with activation of intracellular signaling cascades, these is interaction with HA-binding proteins such as versican.

PROTEOGLYCANS:

They are glycoproteins, i.e., they have a protein core and GAG chains. Proteoglycans expressed in the cervix include, the leucine rich

- Decorin
- Biglycan
- Fibromodulin

The proteoglycans are also expressed in the fetal membranes ad uterus and they regulate fetal membrane tensile strength and uterine function.

INFLAMMATORY CHANGES:

There is marked invasion of the cervical stroma with inflammatory cells. There is also increased expression of chemokines and collagenase/ protease activity.

Microarray studies comparing gene expression patterns at term before and after cervical ripening report little increase in expression of proinflammatory genes.

Activation of the neutrophils also occurs in the postpartum period.

CERVICAL RIPENING:

Though the cervix is composed of both smooth muscle fibres and fibrous connective tissue, the connective tissue formed by fibroblasts and extracellular ground matrix, predominate. Collagen, glycosaminoglycans and glycoproteins are produced by the fibroblasts themselves. These substances undergo classical structural changes mediated by collagenase produced during term gestation and early labour, that bring about increased levels of hyaluronic acid which being a hydrophilic molecule imbibes water and becomes more malleable to the pressure exerted by the presenting part. This process is called cervical ripening.

Cervical ripening is a combination of biochemical, endocrine, mechanical and inflammatory events. The biochemical change includes replacement of the negatively charged hydrophobic chondroitin and dermatan sulphate by the hydrophilic hyalorunic acid. As it imbibes water it undergoes conformational changes and along with action of collagenase that degrades collagens type I, II and III, the number and type of covalent cross links between collagen triple helix loose stability.

As stated by Akins, Drewes and Ozasa, there is reduced expression and activity of cross link forming enzymes like lysy hydroxylase and lysyl oxidase resulting in unstable collagen monomers. Concurrently, the matricellular proteins like thrombospondin 2 and tenascin C are also less expressed.

In 2012, Hari Kishore proved that expression of a transcription factor, microphthalmia- associated transcription factor by the cervical stromal cells represses the expression of genes involved in cervical dilation and parturition.

ROLE OF PROSTAGLANDINS:

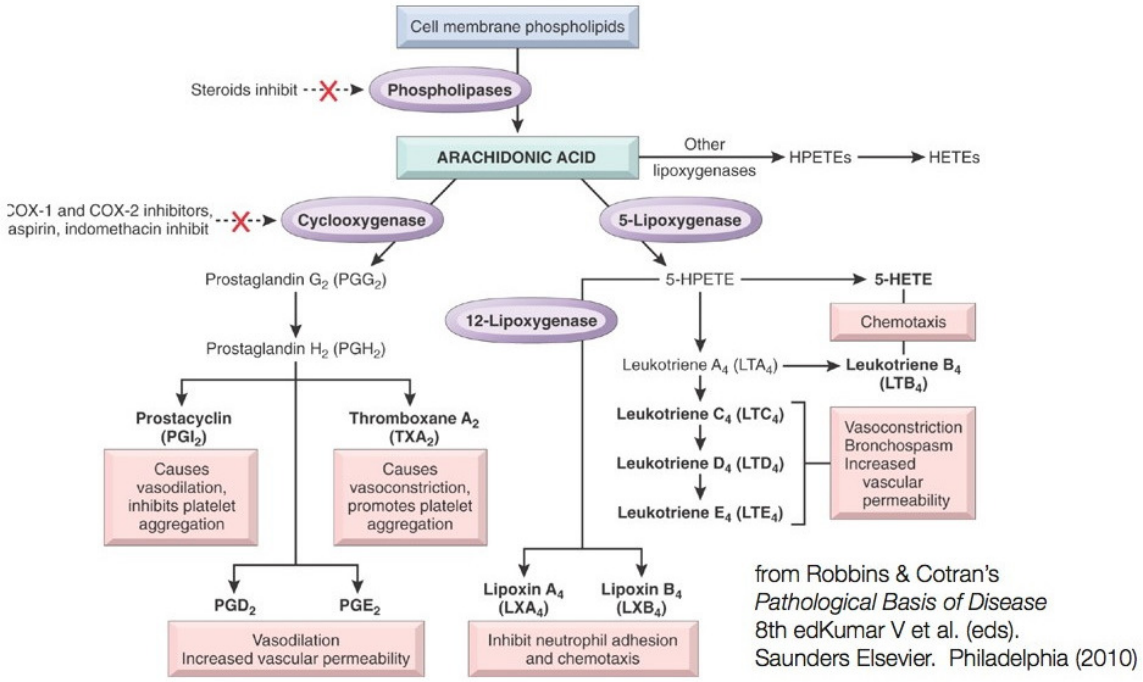


Figure 2: Prostaglandin synthesis.

Prostaglandins are arachidonic acid metabolites. Arachidonic acid are eicosanoids present in the cell membrane. Under the influence of phospholipases A2 or C, these are degraded and according to the tissue and the trigger, they are modified as different prostaglandins that have varying action.

Prostaglandin E2, also known as dinoprostone is represented biochemically as,

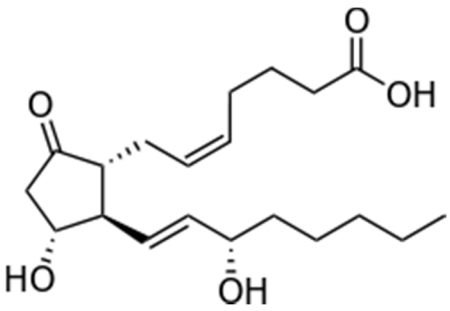


Figure 3: Structure of PGE2

The trigger for the process of cervical ripening that precludes labour is being investigated for. Von Malliot et al, MacLennan and McMurty et al stated that relaxin produced during labour by bringing about proliferation of fibroblasts and promoting secretion of collagenase brings about cervical ripening. Fuchs et al stated that oxytocin acts on the uterine decidua and thereby promotes release of prostaglandins like PGE2 and PGF2α. In a study by Johnston et al in 1993, it is evident that PGE2 has a predominant effect on the cervix, as there is a peak of its metabolites prior to onset of labour and it also correlates directly with duration of labour.

In 1988, Gowhowaki et al showed that prostaglandins have a direct effect in the production of procollagenase, a precursor of collagenase. Both collagenase and elastase peak at the onset of labour.

Based on current evidence, it is clear that both relaxin and prostaglandins bring about structural and biochemical changes in the cervix resulting in remodeling and cervical ripening.

Prostaglandins also induce formation of gap junctions in the myometrium and potentiate oxytocin induced contractions. The synergy between oxytocin and prostaglandin at the decidual and myometrial level brings about progress of labour. This is evident from the fact that atosiban, an oxytocin antagonist effective as a treatment for preterm labour, acts on the decidual sites of oxytocin as stated by Ivanisevic et al in 1989.

Thus prostaglandins play a role in initiation and progression of labour in synergy with other hormones

FUNCTIONS OF DINOPROSTONE:

- Initiation and progression of labour by softening the cervix and causing uterine contractions
- Stimulates osteoblasts, to release factors that stimulate bone resorption by osteoclasts
- May induce fever
- Suppresses T-cell receptor signaling pathway
- Vasodilatation
- Relaxation of smooth muscles
- Inhibits the release of noradrenaline

INDUCTION OF LABOUR:

In conditions where the fetal and maternal risks of early delivery is relatively less than the risk of prolonging the pregnancy, induction of labour is being practiced.

Prostaglandin E2 available as a gel in a 2.5 ml preloaded syringe, used for intracervical instillation is recommended for induction of labour by ACOG and RCOG.

Figure 4: Dinoprostone Gel

With the woman in the dorsolithotomy position, under strict aseptic precautions, the cervix is exposed and the tip of the cannula that contains 0.5mg of dinoprostone is placed intracervically and the gel is deposited just below the internal cervical os. Then the woman is advised to remain reclined for atleast 30 minutes.

The dose may be repeated in 6 hours and a maximum cumulative dose of 7.5 ml of the gel may be used.

Intracervical PGE2, ripens the cervix and induces labour by action on the cervix and myometrium.

INDICATIONS FOR INDUCTION OF LABOUR:

1. **MATERNAL INDICATIONS**
    a. Hypertensive disorders of pregnancy
    b. Diabetes mellitus in pregnancy
    c. Premature rupture of membranes
2. **FETAL INDICATIONS**
    a. Postdated pregnancy
    b. Oliigohydromnios
    c. Intrauterine growth restriction
    d. Isoimmunisation
    e. Intrauterine fetal demise

POSTDATED PREGNANCY:

It is the commonest indication, throughout the world for induction of labour. Though the gestational age for induction of labour in a postdated pregnancy is still debatable, the workgroup with representatives form ACOG, The Societyfor Maternal-Fetal Medicine and the Eunice Kennedy Shriver National Institute of Child Health and Human Development have concluded, increased adverse outcomes after 40 6/7 weeks of gestational age.

MEDICAL DISORDERS OF PREGNANCY:

In conditions like hypertensive disorders and diabetes mellitus, it is a common practice to terminate pregnancy before the expected date of delivery in view of the adverse maternal and fetal outcome that may ensue with continuation of pregnancy.

PRELABOUR RUPTURE OF MEMBRANES:

According to ACOG 2007, 8% of pregnancies have reported prelabour rupture of membranes at term. Merrill et al in 1999, in their large randomized study have concluded that oxytocin induction significantly reduced the rupture of membranes to delivery interval,, thus improving neonatal outcome and reduced frequency of chorioamnionitis and postpartum febrile morbidity. Also, there is reduction in rate of cesarean delivery.

ISOLATED OLIGOHYDROMNIOS:

Isolated oligohydromnios is not an absolute indication for induction of labour as suggested by a case control study by Conway et al (1998). The fetus with isolated oligohydromnios tolerate labour similar to fetuses with normal fluid volume.

INTRAUTERINE GROWTH RESTRICTION:

It is the failure to achieve the genetic growth potential. Identified by growth below 10^{th} percentile, associated with umblical artery Doppler abnormalities and decreased amniotic fluid volume. These fetuses are at higher risk of perinatal morbidity and

mortality. This is because of increased uteroplacental insufficiency during labour that these compromised fetuses are unable to tolerate. Therefore the NICE guidelines (RCOG 2008) does not recommend induction of labour in the presence of fetal growth restriction.

INTRAUTERINE FETAL DEMISE:

In case of intrauterine fetal demise that occurs in 1% of all pregnancies, 90% of women go into spontaneous labour within three weeks. But many women do not prefer to wait and there is 25% risk of disseminated intravascular coagulation. Hence, induction of labour is preferred.

RISKS ASSOCIATED WITH INDUCTION OF LABOUR:

Though induction of labour is very commonly practiced, it is also associated with risks, that include prolonged labour, increased rate of cesarean delivery, postpartum hemorrhage, fetal distress, uterine dystocia and chorioamnionitis, In any patient for whom induction of labour is being carried out, these risks should be balanced with the risk of prolonging the pregnancy and attempting other means of termination of pregnancy.

CONTRAINDICATIONS FOR INDUCTION OF LABOUR:

These are similar to that for spontaneous labour and vaginal delivery. Prior uterine incision, abnormal placentation and presence of active genital herpes, multiple gestation, severe hydrocephalus, malpresentation, presence of a non-reassuring non stress test are all contraindications for induction of labour.

RISK OF CESAREAN DELIVERY:

There is lot of controversy regarding the risk of cesarean delivery following induction of labour. Though there are Cochrane reviews suggesting two fold increase in cesarean delivery following induction, the groups used were incomparable. Bailit et al, in a retrospective cohort trial has shown no significant difference between elective induction in women with no comorbid condition and spontaneous labour, for the risk of cesarean delivery.

FACTORS AFFECTING SUCCESSFUL INDUCTION:

Kominiarek and collegues in 2011 found a relation between body mass index and induction delivery interval. Based on this, multiparity, birthweight <3500 g, body mass index <30 increases the probability of successful induction. The investigators of Consortium of Safe Labour, reported that induction was successful often with a ripe cervix. Also several studies make it evident that the rate of cesarean section increases with induction done for an unfavourable cervix. Hence the cervical status is essential before planning for induction of labour.

ASSESSMENT OF CERVICAL STATUS:

With all these evidences, assessment of cervical status is of paramount importance before planning induction of labour. Some estimates of favourability are highly

subjective. In those cases, preinduction cervical ripening can be done with pharmacological methods.

BISHOP'S SCORE (BISHOP 1964)

Bishop's pelvic scoring system was developed by Dr.Edward Bishop and published in 1964. It is a prelabour scoring system. It assists in predicting whether induction of labour is essential. In this scoring system, the following five components are assessed on vaginal examination and the total score is given.

- Cervical dilatation
- Effacement
- Cervical consistency
- Cervical position
- Fetal station

BISHOP'S SCORE

	0	1	2	3
Dilatation cms	0	1-2	3-4	5-6
Effacement %	0-30	40- 60	60-70	80+
Station cms	-3	-2	-1/0	+1/+2
Consistency	Firm	Medium	Soft	
Position	Posterior	Mid position	Anterior	

This scoring system was modified by Calder in which effacement was replaced by cervical length. **MODIFIED BISHOP'S SCORE**

	0	1	2	3
Dilatation cms	<1	1-2	2-4	>4
Cervical length cms	>4	2-4	1-2	<1
Station cms	-3	-2	-1/0	+1/+2
Consistency	Firm	Average	Soft	
Position	Posterior	Mid Anterior		

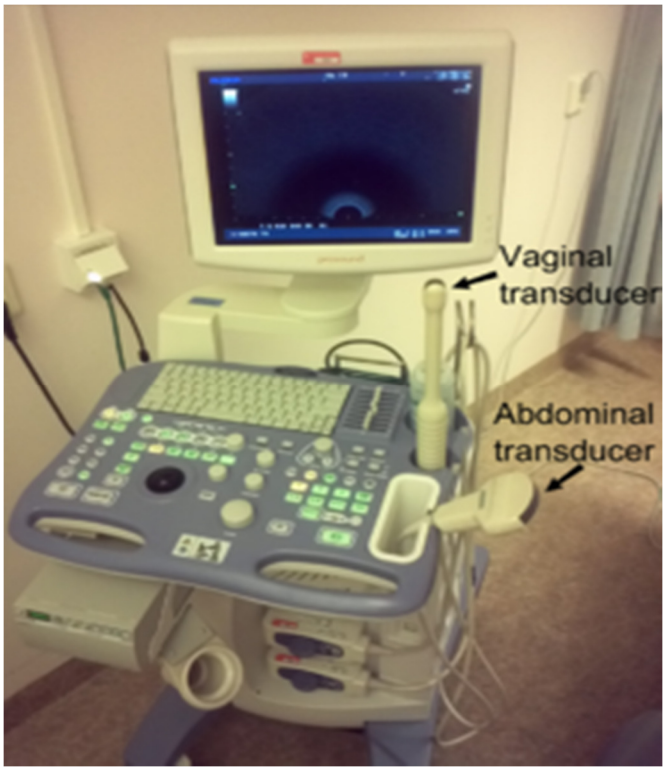
Other modifications made to the bishop's score is the modifiers. Points were added or subtracted according to following situations

According to most randomized control trials, total score of >8 has high probability of vaginal delivery, comparable to spontaneous onset of labour. But a Bishop's score of 6 or less, indicates an unfavourable cervix. The maximum score by Bishop's scoring system is 13 and by modified Bishop's scoring is 12.

If the score is high, it means the cervix is ripe and hence successful induction of labour is expected. In a study by Harrison et al, 81 % of women who had Bishop's score of atleast 7, delivered within 9 hours, whereas only 44 % of women, with score of 4 or less, delivered in the same time frame.

Though this method is simple, several questions arise regarding objective assessment of cervical ripening by this method. Also a few studies suggest, that it is a poor predictor, hence researchers search for alternative methods that are more objective. Another pitfall is that when the internal os is closed, it may be difficult for the fingers to reach the part of cervix beyond the vaginal fornices and hence exact measurement of cervical length is not feasible.

Figure 5. TRANSVAGINAL ULTRASOUND AND PROBE:



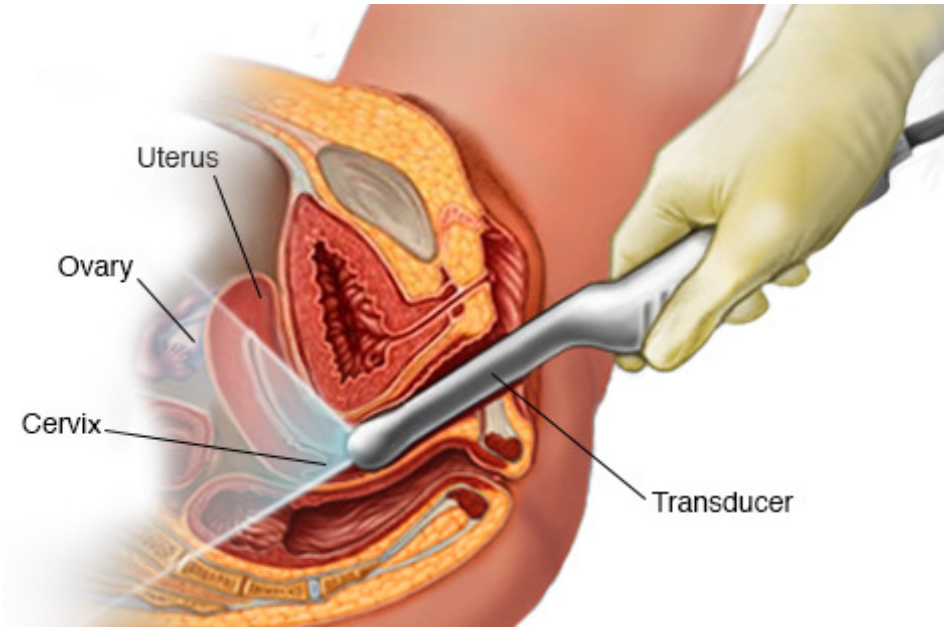
Radiology is a field that evolved greatly and extended its limits since the advent of ultrasound. The transvaginal ultrasound is the sonography of the cervix and uterus.

PRINCIPLE OF TRANSVAGINAL ULTRASOUND:

It transmits high frequency sound pulses into the body using a probe. These sound pulses are reflected as they encounter different surfaces. Some pulses are reflected back to the probe while some are reflected away. Those reaching the probe are picked by it and relayed to the machine.

The machine is inbuilt to calculate the distance from the probe to the tissue using speed of sound of various known substances.

Figure 6. TRANSVAGINAL SONOGRAPHY



Transvaginal Ultrasonography is an essential part for measuring cervical length. It has few advantages over digital examination for determining cervical length. As preinduction cervical status is very important to determine the outcome of induction of labour and since the objectivity and consistency of modified bishop's score is being contested, Transvaginal Ultrasonography as an alternative method has been used by researchers worldwide. TVUS can assess the full cervical length including supravaginal portion and also the status of internal os without invading the endocervical canal more accurately. It is also less invasive, more objective, easily reproducible and with less inter observer variation. Also it can be documented and the pictures be stored and reproduced anytime later.

Parameters measured in transvaginal ultrasonography:

There are many parameters that have been assessed independently and combined for their superiority over Bishop's Scoring system in predicting the preinduction cervical status. The parameters commonly studied include:

- Cervical length – it is also a component of bishop's score
- Length of cervical funneling
- Funnel width
- Position of cervix
- Posterior cervical angle or progression angle
- Distance of the presenting part from the external os
- Occipito posterior position

- Consistency of cervix

CERVICAL LENGTH:

It is the distance between the external and internal os of the cervix. Measurement of cervical length in different gestational age has different uses as follows:

- In the first trimester in women with recurrent miscarriage, it may be used to predict spontaneous preterm labour
- In the mid-trimester to differentiate threatened preterm labour from spontaneous preterm labour
- In term gestation to exactly predict the distance of placental margin from internal os in a case of placenta previa
- At the onset of labour or prior to induction for assessment of cervical status.

The cutoff for cervical length also varies accordingly with gestational age. In singleton pregnancy the distribution of cervical length follows a normal distribution.

- The mean cervical length is 36mm
- In midtrimester in women with threatened preterm labour, a cervical length of 15 mm or less is associated with higher chance of preterm labour
- At term gestation, in nulliparous women the chance of failure of normal labour is 90% when cervical length is less than 2mm and in multipara it is 60%.

There are several studies with controversial results evaluating the efficacy of cervical length against Bishop's score for predicting cervical status, but many studies and randomized control trials have established that it is useful in predicting spontaneous onset of labour.

Advantages of transvaginal cervical length measurement:

- Easy to measure
- Needs less expertise
- Objective
- Reproducibility
- Documentation

POSTERIOR CERVICAL ANGLE:

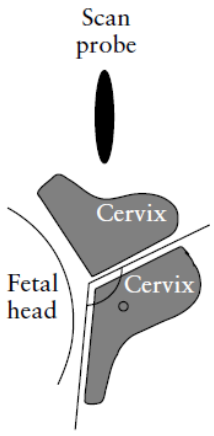


Figure 7. MEASUREMENT OF POSTERIOR CERVICAL ANGLE

Another parameter in study is the posterior cervical angle that corresponds to the position of cervix in the Modified Bishop's Scoring system.

With collagen degradation, synthesis of hyaluronic acid, increased expression of aquaporins and stromal invasion with inflammatory cells, the cervix undergoes ripening at the onset of labour. In those women who undergo induction of labour, these changes are brought about by the prostaglandin that is being used. As these changes occur the cervix becomes soft and is slowly and progressively taken up into the lower uterine segment with the initiation of myometrial contractility. Thence the cervix that was initially in a posterior position slowly moves anterior. This change in position of cervix also marks myometrial activation.

The modified Bishop's score has position of cervix as a criteria and a more anterior position is more favourable and associated with better outcome of induction.

By transvaginal ultrasonography, posterior cervical angle or the progression angle is measured between the cervical canal and the posterior wall of uterus in the image taken in saggital plane of the cervix.

Initially this angle was measured using protractor in the hard copy of the image, but with recent advances and more sophisticated ultrasound machines, it can measured in the ultrasound machine itself and stored.

The major pitfall is when the cervix is curved. During this time, it is measured from the axis used for cervical length measurement and the posterior uterine wall.

PERCENTAGE OF FUNNELLING:

Cervical funelling or wedging is the presence of membranes in the endocervical canal. It also is a predictor of preterm labour.

Based on wedging the cervix may be described as

- T shaped,
- Y shaped,
- V shaped and
- U shaped.

Wedging occurs only when the internal os is open and also when the fetal presenting part is ready to enter the brim. So presence of wedging indicates imminent preterm labour.

Similarly it also indicates a favourable sign in predicting preinduction cervical status. The major disadvantage of Modified Bishop's score is the inability to assess the internal os status when the external os is closed. This difficulty is overcome by transvaginal ultrasonography.

Though studies suggest that cervical wedging or funneling is not an independent predictor of successful induction, when combined with cervical length , it helps significantly. Hence instead of just looking for presence or absence of cervical wedging, the percentage of the cervix that has been dilated by the membranes is taken as

the percentage of funneling. <30 % funneling is often associated with cesarean section following induction.

OUTCOME OF INDUCTION:

There is no universally accepted definition for successful or failed induction. That is why many studies have not been validated.

Inability to achieve onset of labour within 24 hours of the RCOG recommended, one cycle of PGE2 induction is taken as failed induction and the converse is taken as successful induction.

But arbitrarily many studies use 24 hours as the cut off, and labour ending up in cesarean section due to fetal distress are excluded from the study.

METHODS OF INDUCTION OF LABOUR:

This includes

- Nonpharmacological methods
    - Sexual intercourse
    - Breast and nipple stimulation
    - Foley's cathether – intracervical
- Pharmacological methods
    - Prostaglandin E2
    - Oxytocin

- Prostaglandin E1

NONPHARMACOLOGICAL METHODS:

- Sexual intercourse and breast stimulation

  Benvold et al documented that a natural prostaglandin present in semen concentrate, induces labour in a receptive cervix. But no significant benefit was observed in Cochrane review. Breast and nipple stimulation by oxytocin release brings about uterine contractions and also reduces the incidence of postpartum hemorrhage.

PHARMACOLOGICAL METHODS:

- **Prostaglandin E2:**

  Intracervical dinoprostone gel ripens the cervix and also induces labour. Further induction is not needed in 40% of women.it has been concluded from several studies that dinoprostone gel has successfully reduced the number of women requiring cesarean section and increased the number of successful vaginal deliveries.

- **Oxytocin:**

  It was the commonest induction agent before the advent of prostaglandins. Recently, it may be used alone or in conjuction with other methods like amniotomy, or other induction methods.

- **Misoprostol:**

  It is a synthetic analogue of prostaglandin E1. The dosage not greater than 25 mcg 4 hourly, had similar effectiveness and risk of hyperstimulation of uterus as with other standard inducing agents. Though ACOG 2009 also recommends this dose, the biggest challenge is getting the exact dose. Misoprostol may be given orally, vaginally or sublingually.

- **Mifepristone :**

  Because a fall in progesterone level is the initial even in initiation of labour, Mifepristone, a progesterone receptor antagonis may be used. But clinical trial to support the evidence are still lacking.

- **Other methods:**
  - Sweeping of membranes
  - Artificial rupture of membranes
  - Intracervical foley induction

COMPLICATIONS OF INDUCTION OF LABOUR:

Maternal:

- Uterine hypercontractility
- Uterine rupture
- Hyponatremia

- Operative delivery
- Postpartum hemorrhage

FETAL :

- Fetal distress
- Umblical cord prolapse
- Hyperbilirubinemia

UTERINE HYPERSTIMULATION:

Inadverdent use of oxytocin for induction of labour may result in uterine hyperstimulation that may end up in uterine tachysystole, uterine tetany, uterine hypertonicity.

UTERINE RUPTURE:

It is very unusual in induction of unscarred uterus. But it is associated with high morbidity and mortality.

FAILED INDUCTION:

Failed induction is the failure to establish labour. RCOG estimated 15% of failed induction and that results in operative delivery in the presence of an unfavourable cervix.

CONTRAINDICATIONS FOR INDUCTION OF LABOUR:

- Gross degrees of contracted pelvis and cephalopelvic disproportion
- Transverse lie
- Major degrees of placenta previa
- High risk pregnancy with severely compromised fetus
- Pregnancy following classical cesarean section
- Presence of active genital herpes

RISKS ASSOCIATED WITH CESAREAN DELIVERY:

The risks associated with cesarean delivery include:

- Blood loss
- Operative difficulty

Risks associated with post cesarean pregnancy:

- Blood loss

- Adherent placenta
- Chance of scar dehiscence
- Scar rupture

The common saying is ‘once a cesarean section, always a cesarean section ‘.

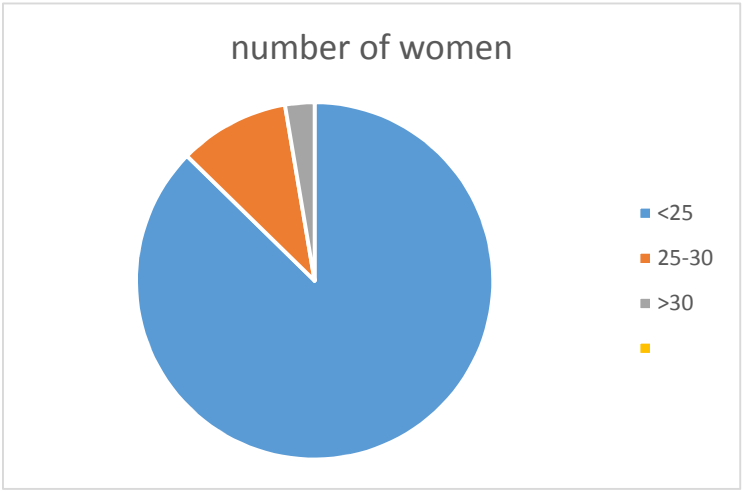
Failed induction is one of the common indications for cesarean section. Therefore judicious selection of patients for induction of labour by an objective method becomes essential.

RESULTS

AGE DISTRIBUTION

TABLE I

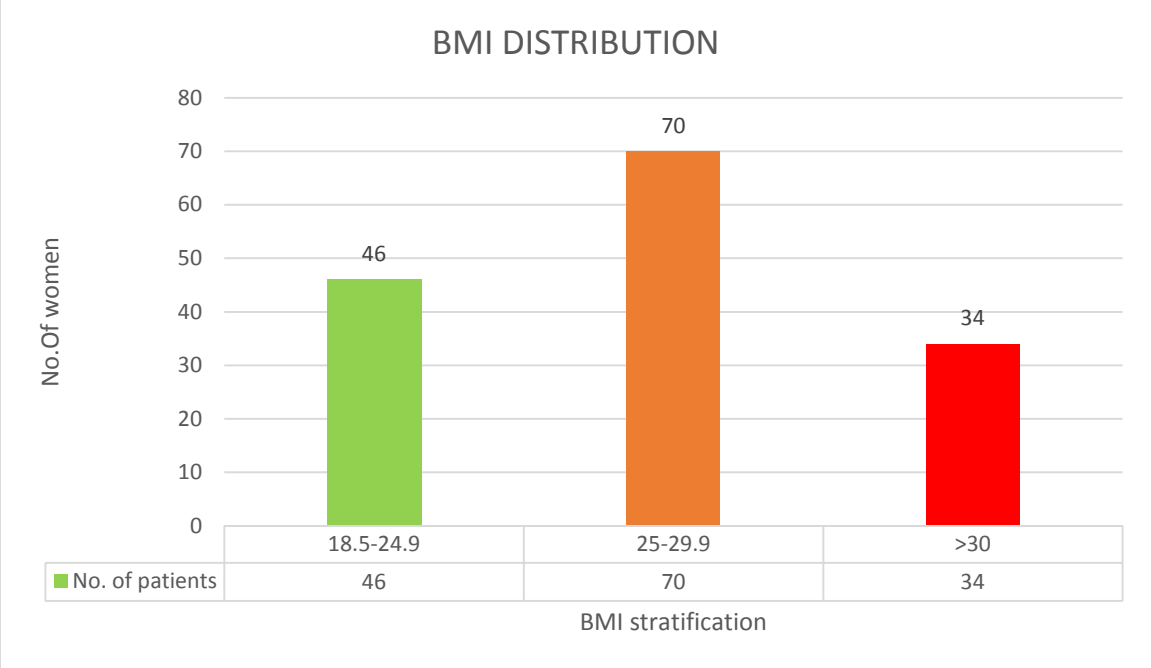
S.No	Age of the patient (years)	No. of patients	Percentage
1	<25	131	87.3
2	25-30	15	10
3	>30	4	2.6



BMI

TABLE 2

S.No	Body mass index	No. of patients	Percentage
1	18.5-24.9	46	30.6
2	25-29.9	70	46.6
3	>30	34	22.6



RELATIONSHIP BETWEEN AGE AND OUTCOME OF INDUCTION OF LABOUR

TABLE 3

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.402[a]	2	.818
Likelihood Ratio	.418	2	.811
Linear-by-Linear Association	.020	1	.886
N of Valid Cases	150		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .75.

Inference : Age does not influence the outcome of induction of labour

RELATIONSHIP BETWEEN BMI AND OUTCOME OF INDUCTION OF LABOUR

TABLE 4

bmi * outcome Crosstabulation

Count

		outcome		
		women who had active labour	women who had failed induction	Total
bmi	18.5-24.9	33	13	46
	24.9-29.9	61	9	70
	>30	28	6	34
Total		122	28	150

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.368[a]	2	.113
Likelihood Ratio	4.229	2	.121
Linear-by-Linear Association	1.876	1	.171
N of Valid Cases	150		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.35.

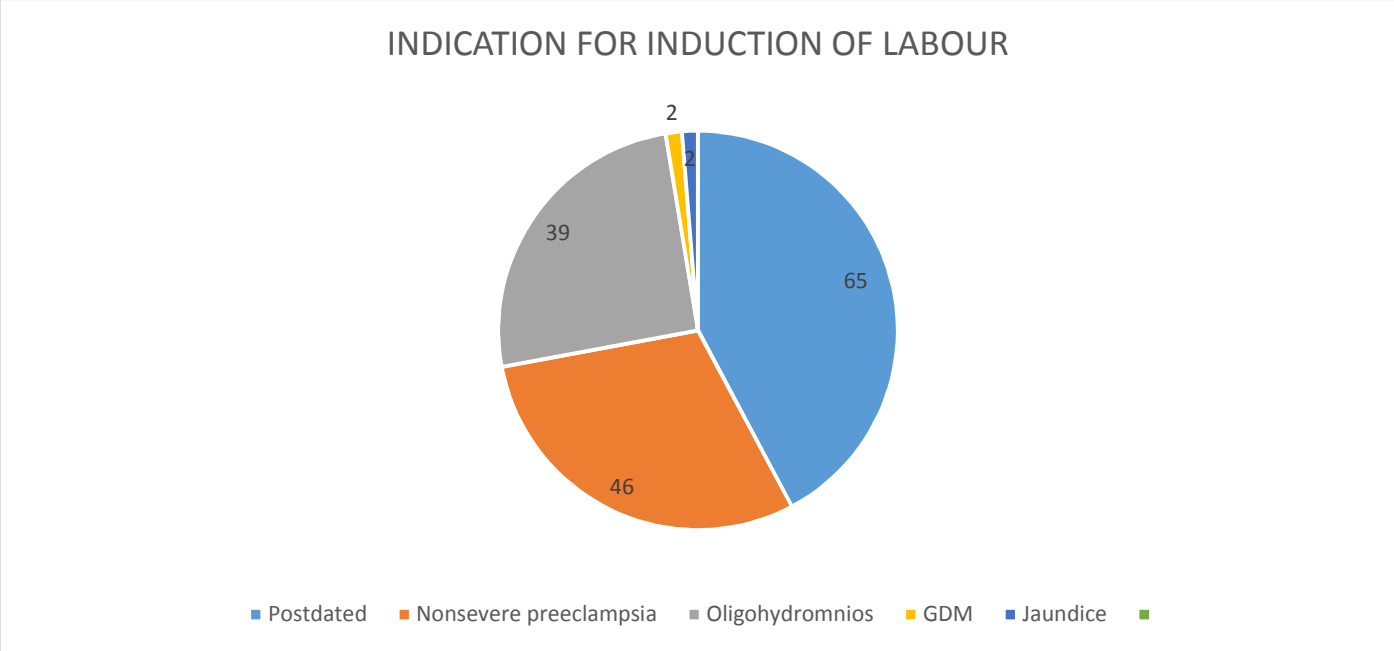
Inference : as the p-value is >0.005, BMI has no influence on the outcome of induction of labour.

Therefore, even if we donot take a age and BMI matched population, as these two factors do not influence the outcome of induction of labour, they need not be considered as confounding factors.

INDICATION FOR INDUCTION OF LABOUR

TABLE 5

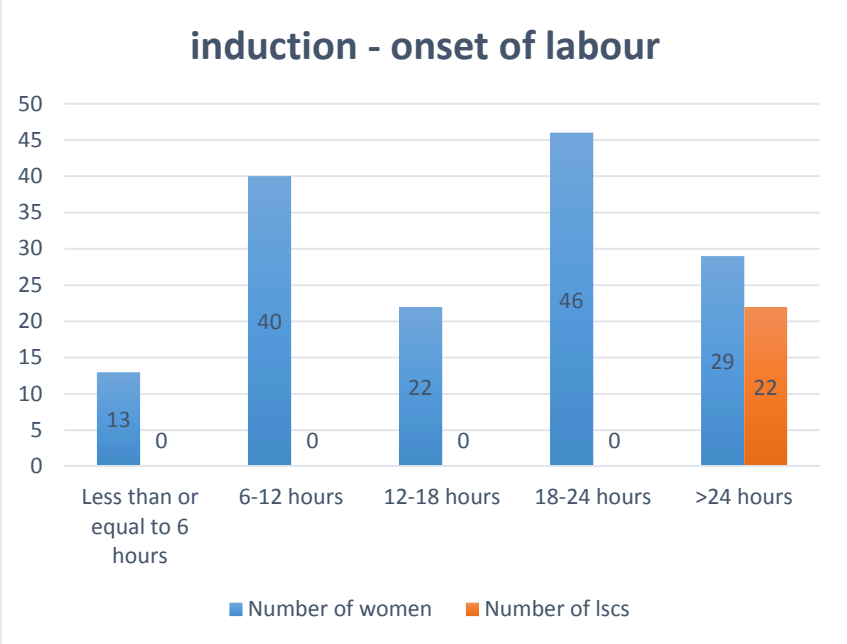
S.No	Indication	No. of patients	Percentage
1	Postdated	65	43.33
2	Nonsevere preeclampsia	46	30.66
3	Oligohydromnios	39	26
4	GDM	2	1.33
5	Jaundice	2	1.33



DISTRIBUTION OF INDUCTION – ONSET OF LABOUR INTERVAL

TABLE 6

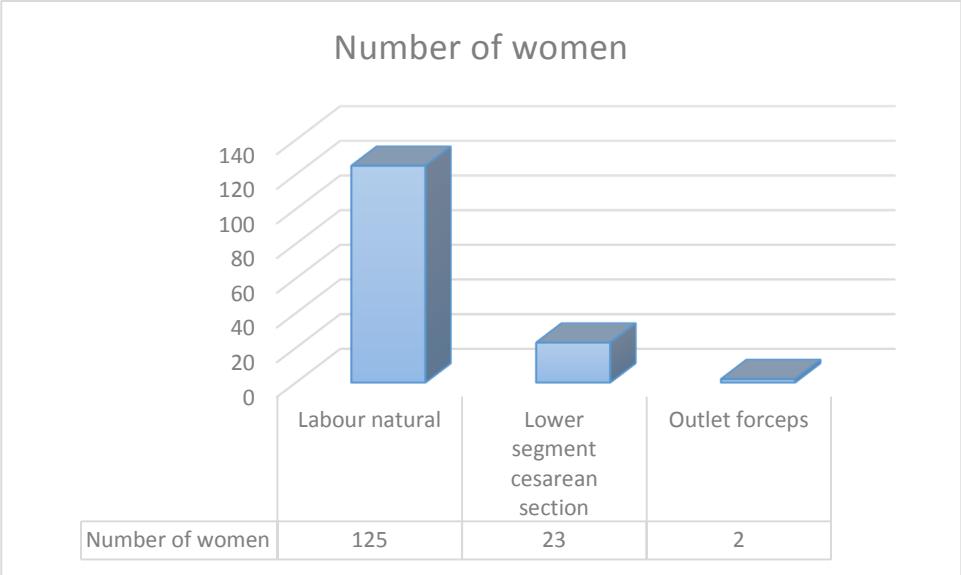
Induction to onset of labour interval	Number of women	Percentage
Less than or equal to 6 hours	13	8.66
6-12 hours	40	26.66
12-18 hours	22	14.66
18-24 hours	46	30.66
>24 hours	29	19.33



COMPARISON OF OUTCOME OF LABOUR

TABLE 7

Outcome of labour	Number of women	Percentage
Labour natural	125	83.33
Lower segment cesarean section	23	15.33
Outlet forceps	2	1.33



KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF LABOUR PREDICTED BY BISHOP SCORE

TABLE 8

The mean delivery time when the Bishop's score is less than 4 is 22.523 hours to 32.107 hours (95% confidence interval) and when the Bishop's score is more than or equal to 4 it is 16.205 hours to 20.274 hours(95% confidence interval)

As the chi-square p-value is 0.005, there is significant variation in the induction delivery interval as predicted by Bishop's score

Means and Medians for Survival Time

Bishop	Mean[a]				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
less than 4	27.315	2.445	22.523	32.107	19.000	2.624	13.856	24.144
greater than or equal to 4	18.240	1.038	16.205	20.274	16.000	1.805	12.462	19.538
Overall	21.921	1.219	19.531	24.311	18.000	1.750	14.571	21.429

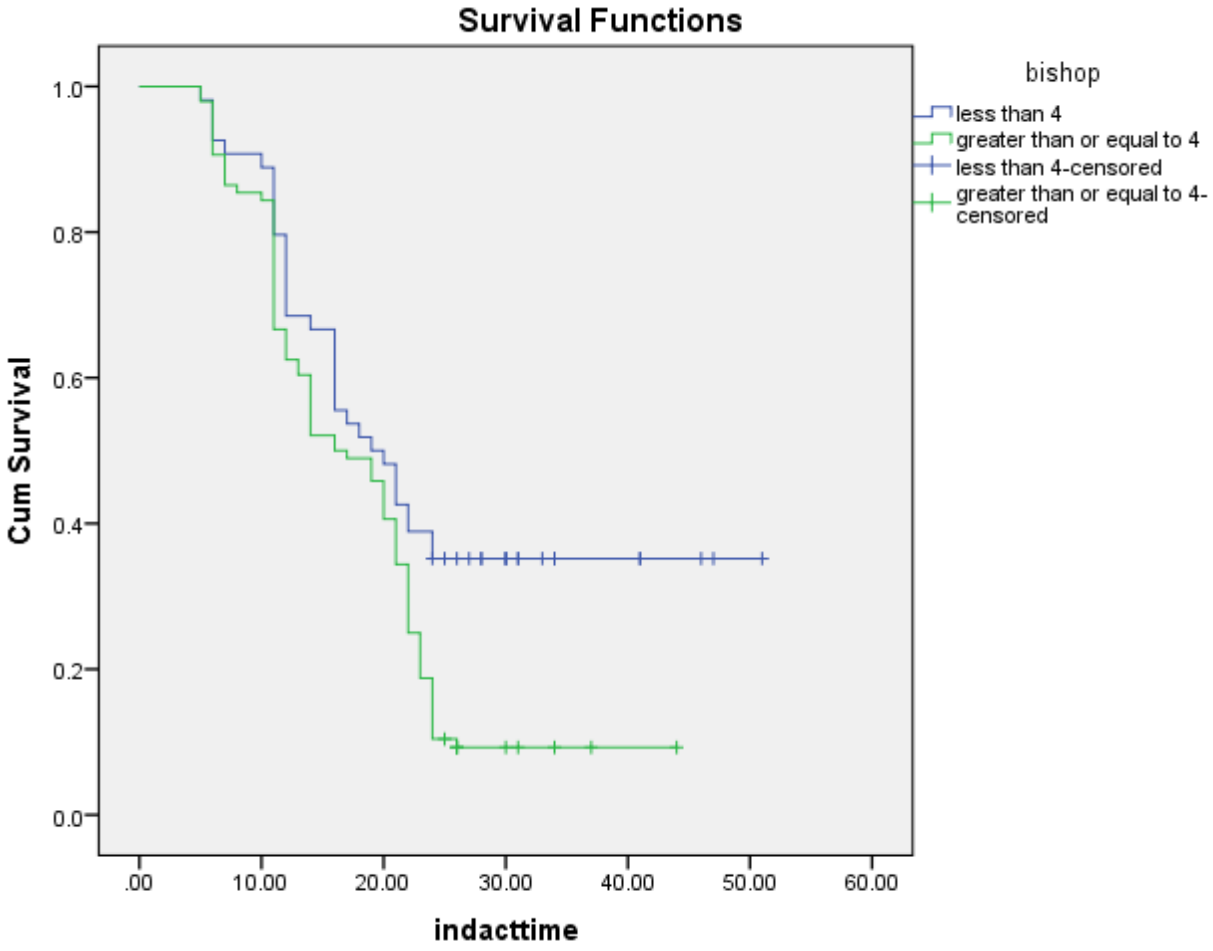
a. Estimation is limited to the largest survival time if it is censored.

Overall Comparisons

	Chi-Square	df	Sig.
Log Rank (Mantel-Cox)	7.962	1	.005

Test of equality of survival distributions for the different levels of bishop.

KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF LABOUR PREDICTED BY BISHOP SCORE



KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF LABOUR PREDICTED BY CERVICAL LENGTH

TABLE 9

Means and Medians for Survival Time

CI	Mean[a]				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
greater than 30mm	34.645	2.679	29.394	39.897	24.000	.	.	.
less than 30 mm	18.016	1.063	15.933	20.099	14.000	1.145	11.756	16.244
Overall	21.921	1.219	19.531	24.311	18.000	1.750	14.571	21.429

a. Estimation is limited to the largest survival time if it is censored.

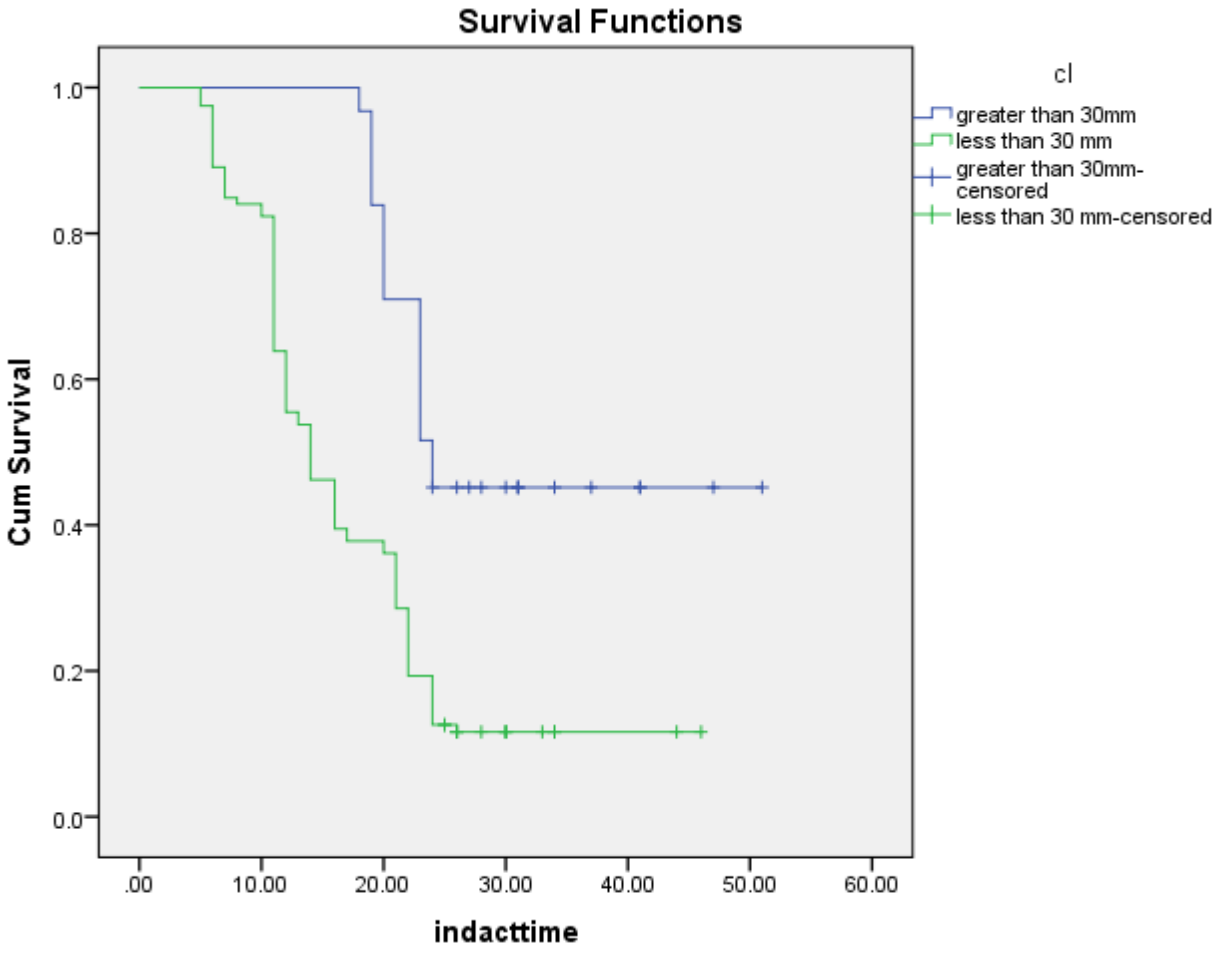
Overall Comparisons

	Chi-Square	df	Sig.
Log Rank (Mantel-Cox)	21.384	1	.000

Test of equality of survival distributions for the different levels of cl.

When the cervical length is less than 3 cm, the mean duration of induction to onset of labour interval is 15.933 hours to 20.099 hours (95% confidence interval) and when it is more than or equal to 3, the mean induction delivery interval is 29.394 hours to 39.897 hours (95% confidence interval). Hence cervical length (chi square p-value <0.0001) is highly significant in preinduction cervical assessment.

KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF LABOUR PREDICTED BY CERVICAL LENGTH



KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF INDUCTION OF LABOUR PREDICTED BY POSTERIOR CERVICAL ANGLE

TABLE 10

Means and Medians for Survival Time

PCA	Mean[a]				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
less than 120 degrees	24.816	1.399	22.074	27.558	21.000	.773	19.485	22.515
greater than or equal to 120 degrees	10.806	.989	8.869	12.744	10.000	1.391	7.273	12.727
Overall	21.921	1.219	19.531	24.311	18.000	1.750	14.571	21.429

a. Estimation is limited to the largest survival time if it is censored.

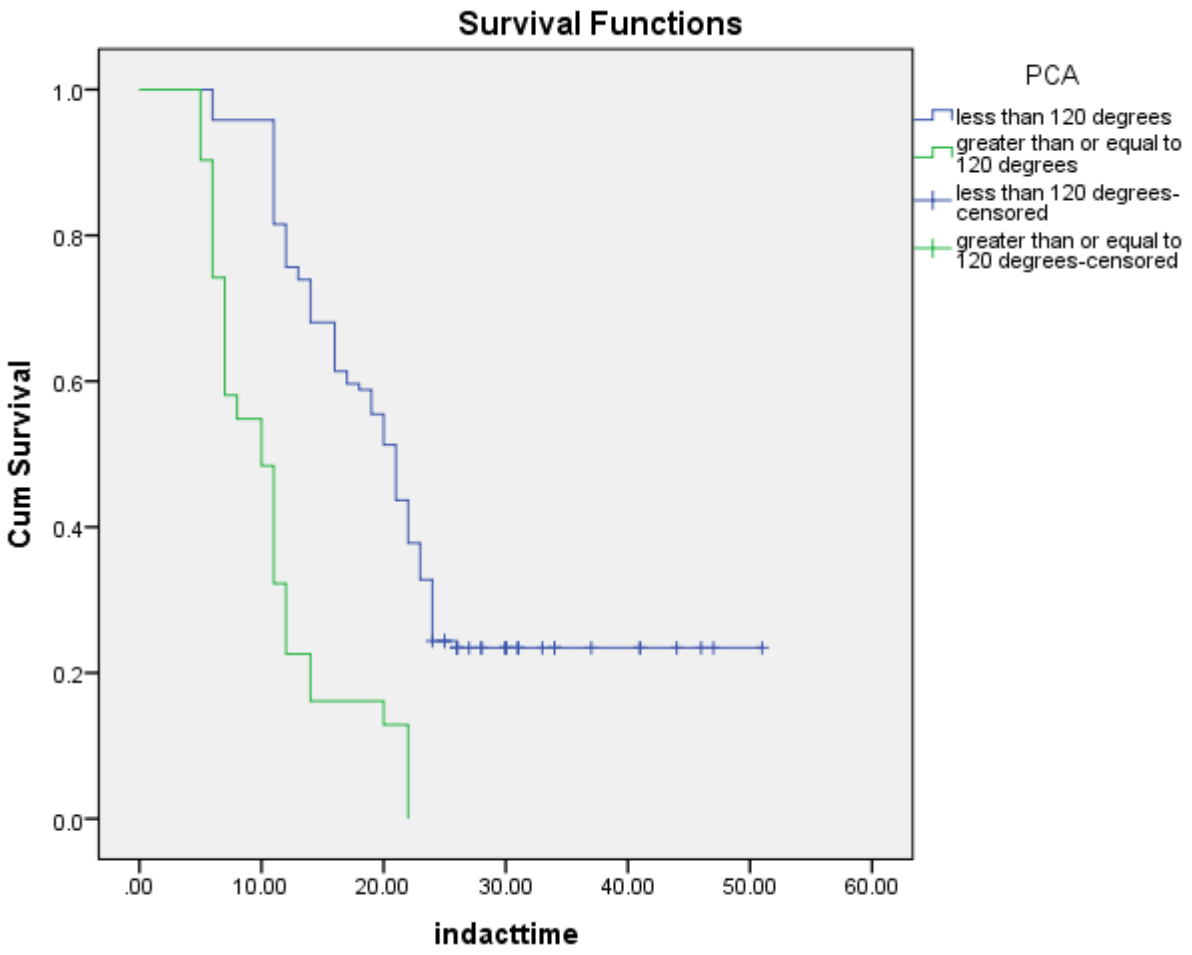
Overall Comparisons

	Chi-Square	df	Sig.
Log Rank (Mantel-Cox)	47.976	1	.000

Test of equality of survival distributions for the different levels of PCA.

Using the cut off of posterior cervical angle as 120, when the angle is greater than 120, the induction to onset of labour interval is 8.869 hours to 12.744 hours (95% confidence interval). When the angle is less than or equal to 12, the induction delivery interval is 22.074 hours to 27.558 hours (95% confidence interval). The chi square p-value is <0.0001, therefore posterior cervical angle significantly predicts the induction delivery interval.

KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF INDUCTION OF LABOUR PREDICTED BY POSTERIOR CERVICAL ANGLE



KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF INDUCTION OF LABOUR PREDICTED BY PERCENTAGE OF FUNNELING

TABLE 11

Means and Medians for Survival Time

Fun	Mean[a]				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
less than 40 percent	26.480	1.704	23.140	29.821	22.000	.909	20.218	23.782
greater than or equal to 40 percent	14.776	.956	12.902	16.650	12.000	1.020	10.000	14.000
Overall	21.921	1.219	19.531	24.311	18.000	1.750	14.571	21.429

a. Estimation is limited to the largest survival time if it is censored.

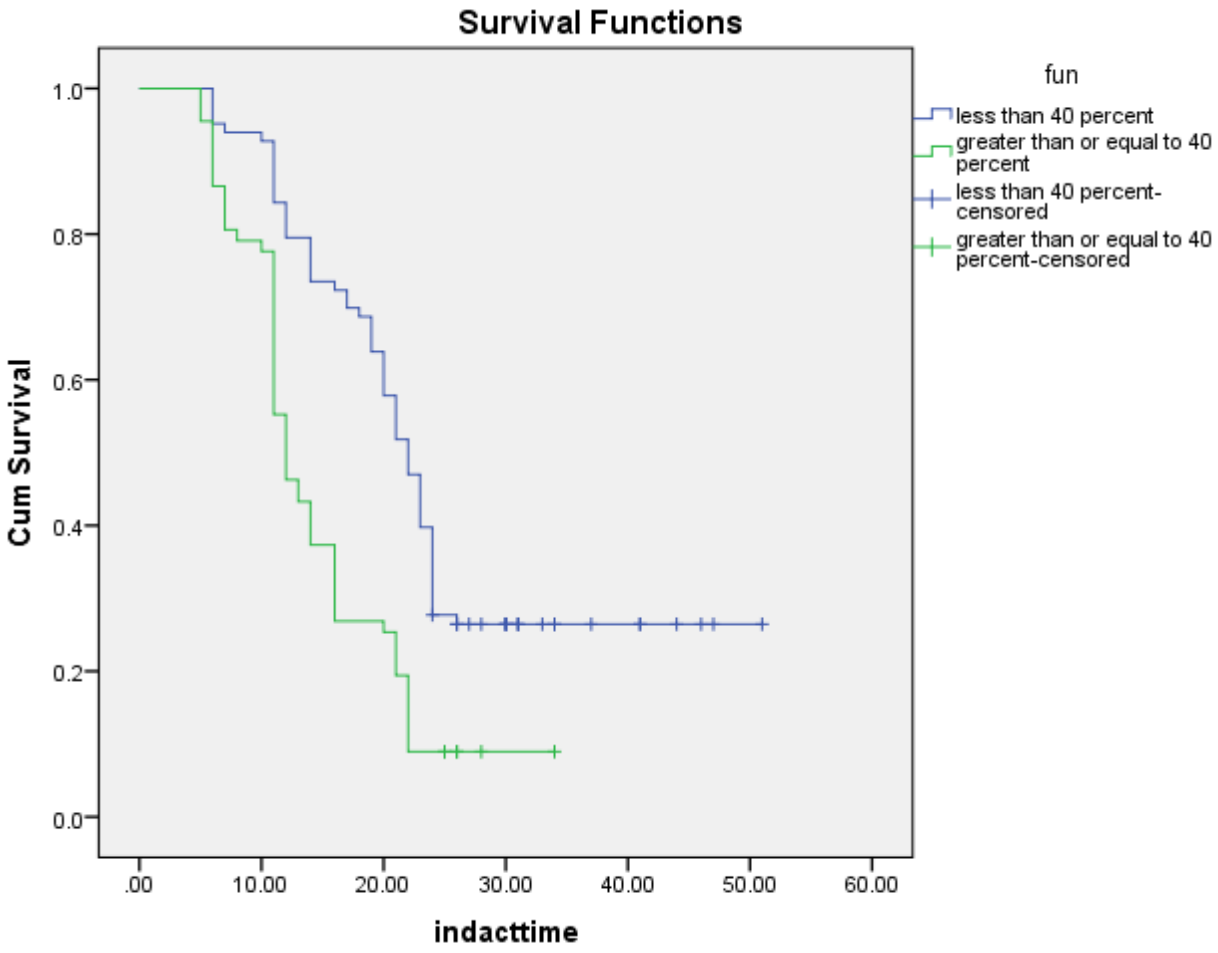
Overall Comparisons

	Chi-Square	Df	Sig.
Log Rank (Mantel-Cox)	24.482	1	.000

Test of equality of survival distributions for the different levels of fun.

When the percentage of funneling is less than 40%, the induction delivery interval ranges between 23.140 hours to 29.821 hours(95% confidence interval). When the percentage of funneling is more than or equal to 40%, the induction delivery interval is between 12.902 hours to 16.650 hours (95% confidence interval). The cutoff of 40% for the percentage of funneling significantly influences the induction delivery interval.

KAPLAN-MEIR SURVIVAL ANALYSIS SHOWING MEAN DURATION OF INDUCTION OF LABOUR PREDICTED BY PERCENTAGE OF FUNNELING



KAPLAN MEIR ANALYSIS- TRANSVAGINAL ULTRASOUND SCORING

TABLE 12

Means and Medians for Survival Time

Ctvs	Mean[a]				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
.00	30.935	1.868	27.273	34.597	24.000	.480	23.060	24.940
1.00	14.047	.774	12.530	15.563	12.000	.295	11.421	12.579
Overall	21.921	1.219	19.531	24.311	18.000	1.750	14.571	21.429

a. Estimation is limited to the largest survival time if it is censored.

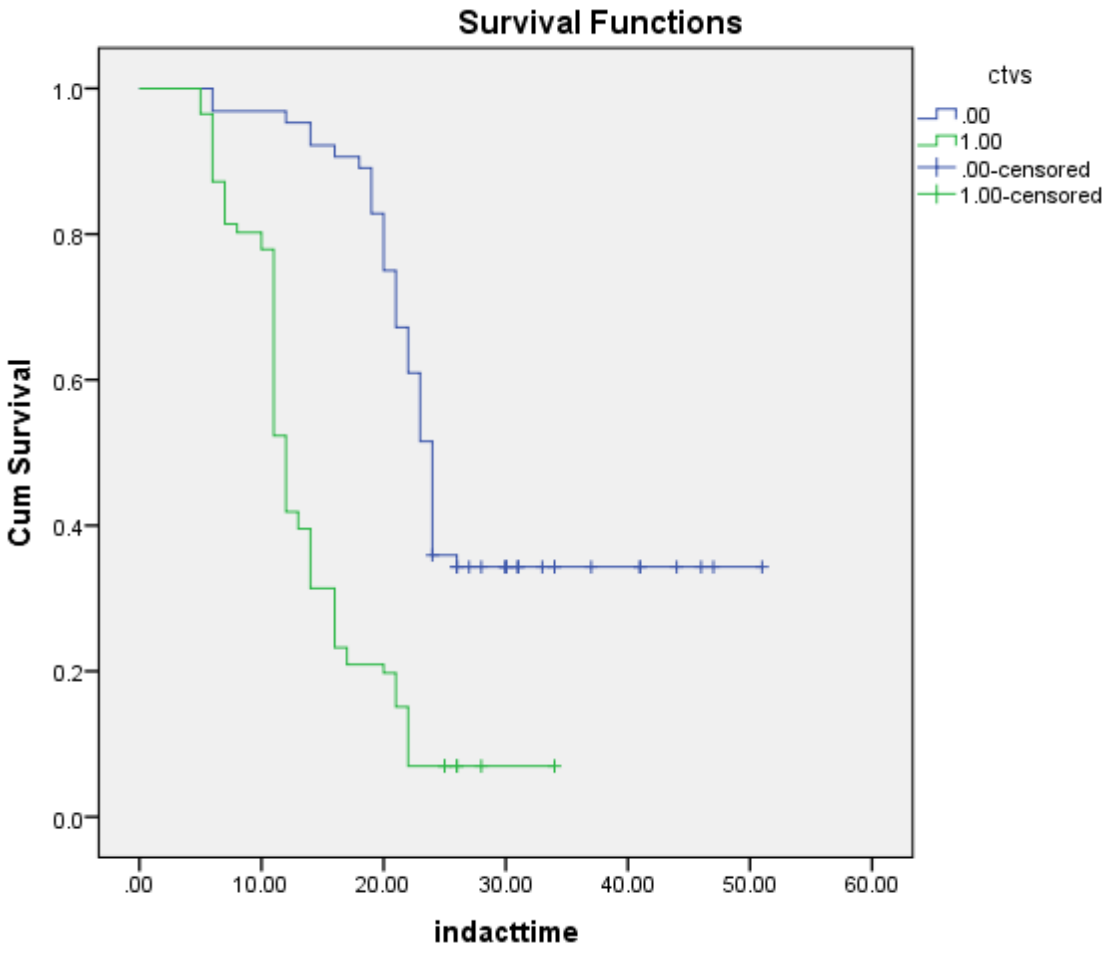
Overall Comparisons

	Chi-Square	df	Sig.
Log Rank (Mantel-Cox)	55.248	1	.000

Test of equality of survival distributions for the different levels of ctvs.

The comprehensive scoring system combining the parameters measured by transvaginal sonography, is significant in predicting the outcome of labour following induction ($P<0.001$)

KAPLAN MEIR ANALYSIS- TRANSVAGINAL ULTRASOUND SCORING



PREDICTIVE VALUE OF BISHOP'S SCORE

TABLE 13

	Value	95% confidence interval
Sensitivity	71.67	62.72-79.51
Specificity	65.52	45.67-82.06
Positive likelihood ratio	2.08	1.24-3.48
Negative likelihood ratio	0.43	0.29-0.63
Positive predictive value	89.58	81.68-94.89
Negative predictive value	35.85	23.14-50.20
Prevalence	80.54	73.26-86.56

The sensitivity of bishop's score is 71.67% and the specificity is 65.52%

PREDICTIVE VALUE OF CERVICAL LENGTH

TABLE 14

	Value	95%confidence interval
Sensitivity	85.95	78.46-91.60
Specificity	48.28	29.45-67.47
Positive likelihood ratio	1.66	1.16-2.38
Negative likelihood ratio	0.29	0.16-0.52
Positive predictive value	87.39	80.06-92.77
Negative predictive value	45.16	27.32-63.97

The sensitivity of cervical length in predicting the outcome of induction of labour is 85.95% and the specificity is 48.28%

PREDICTIVE VALUE OF POSTERIOR CERVICAL ANGLE

TABLE 15

	Value	95%confidence interval
Sensitivity	25.62	18.12-34.35
Specificity	96.55	82.24-99.91
Positive likelihood ratio	7.43	1.06-52.21
Negative likelihood ratio	0.77	0.68-0.87
Positive predictive value	96.88	83.78-99.92
Negative predictive value	23.73	16.38-32.44

The sensitivity of posterior cervical angle in predicting the outcome following induction of labour is 25.62% and the specificity is 96.55%

PREDICTIVE VALUE OF PERCENTAGE OF FUNNELING

TABLE 16

	Value	95%confidence interval
Sensitivity	50.41	41.18-59.63
Specificity	79.31	60.78-92.01
Positive likelihood ratio	2.44	1.17-5.08
Negative likelihood ratio	0.63	0.48-0.81
Positive predictive value	91.04	81.52-96.64
Negative predictive value	27.71	18.45-38.62

The sensitivity and specificity of percentage of funneling in predicting the outcome following induction of labour is 50.41% and 79.31% respectively.

PREDICTIVE VALUE OF PARAMETERS OF TRANSVAGINAL ULTRASONOGRAPHY

TABLE 17

	Value	95%confidence interval
Sensitivity	66.12	56.95-74.47
Specificity	79.31	60.28-92.01
Positive likelihood ratio	3.20	1.55-6.59
Negative likelihood ratio	0.43	0.31-0.58
Positive predictive value	93.02	85.43-97.40
Negative predictive value	35.94	24.32-48.90

The sensitivity and specificity of comprehensive transvaginal scoring in predicting the outcome following induction of labour is 66.12% and 79.31% respectively.

ROC COMPARING THE EFFICACY OF THE DIFFERENT TRANSVAGINAL PARAMETERS MEASURED AS COMPARED WITH BISHOP'S SCORE

TABLE 18

Area Under the Curve

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Bishop	.696	.056	.001	.585	.806
Cl	.680	.062	.003	.559	.801
PCA	.627	.051	.036	.528	.727
Fun	.643	.055	.019	.535	.750

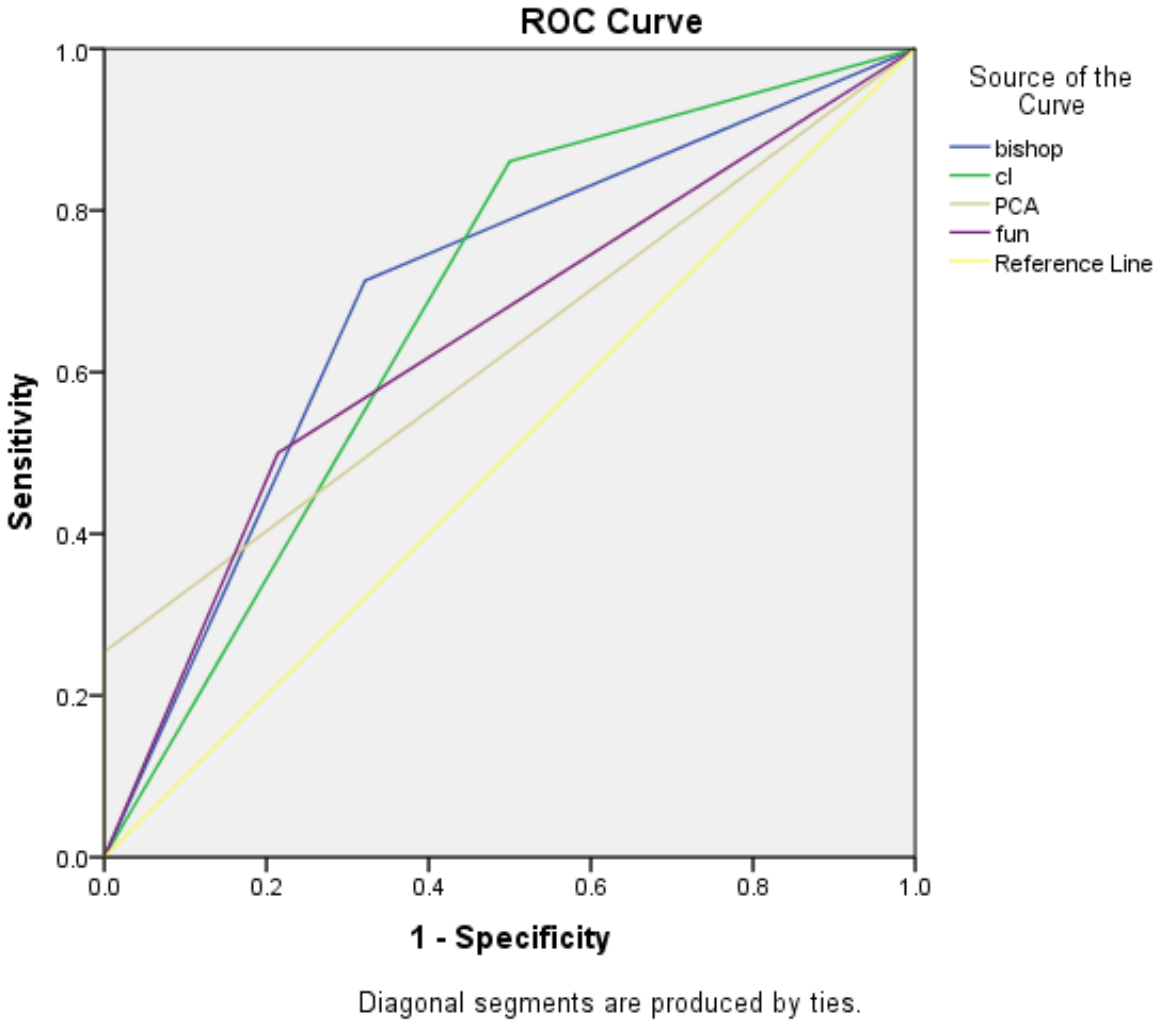
The test result variable(s): bishop, cl, PCA, fun has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

When comparing the predictive values of the parameters of transvaginal sonography with Bishop's score, it is evident that Bishop'score is more predictive than the individual parameters.

ROC COMPARING THE EFFICACY OF THE DIFFERENT TRANSVAGINAL PARAMETERS MEASURED AS COMPARED WITH BISHOP'S SCORE



ROC OF BISHOP'S SCORE WITH THE COMPREHENSIVE TRANSVAGINAL SCORE

TABLE 19

Area Under the Curve

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Bishop	.696	.056	.001	.585	.806
Ctvs	.721	.052	.000	.619	.823

The test result variable(s): bishop, ctvs has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

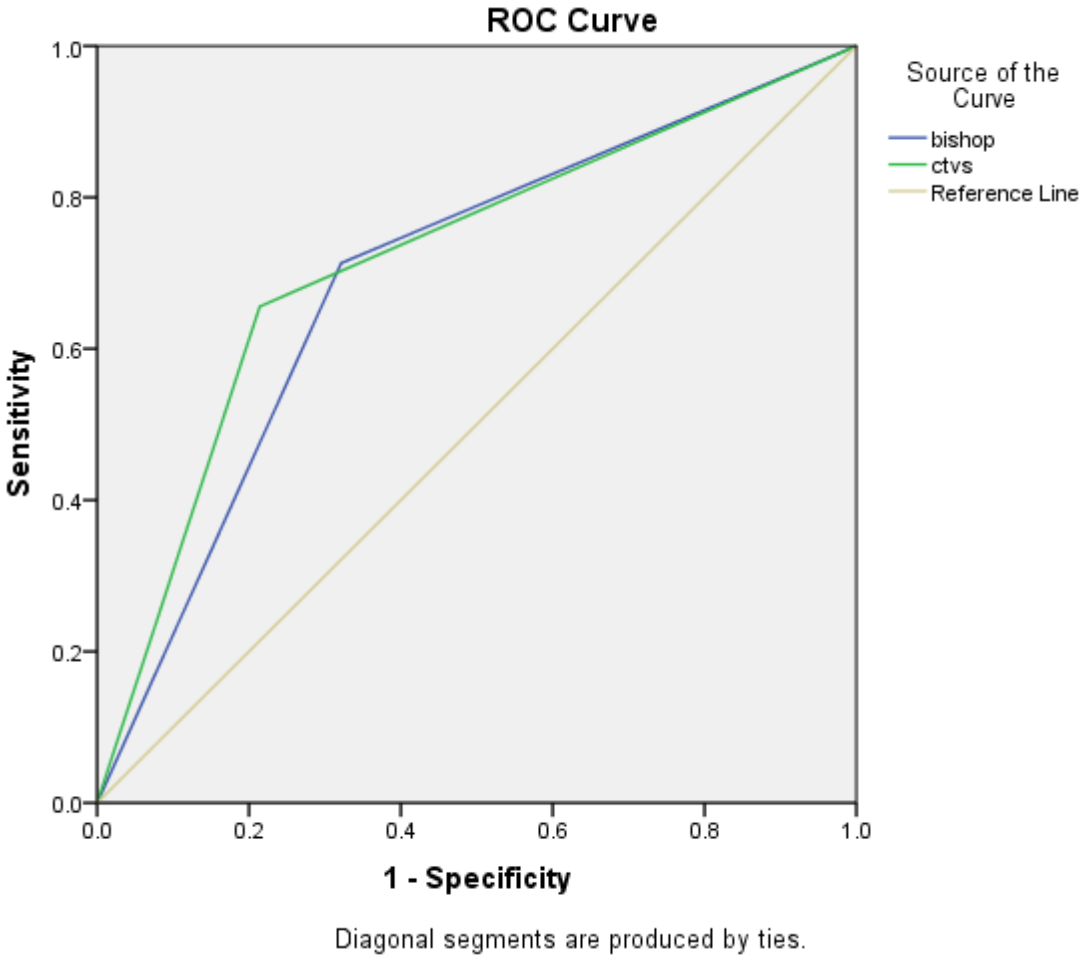
b. Null hypothesis: true area = 0.5

Area Under the Curve

Test Result Variable(s)	Area
Bishop	.696
Ctvs	.721

Hence, comprehensive transvaginal sonography is a better diagnostic modality than Bishop's score

ROC OF BISHOP'S SCORE WITH THE COMPREHENSIVE TRANSVAGINAL SCORE



DISCUSSION

Bishop's scoring system is the traditionally used method for predicting outcome of induction of labour. To overcome the limitations of this method, transvaginal sonography has been studied as an alternative.

In our study we compare the efficacy of transvaginal sonographic parameters like cervical length, posterior cervical angle and percentage of funneling with that of Bishop's score.

In our study 87.3% of women belong to age <25 years similar to that by Neha Baipai et al where 93% belonged to this age group.

The maximum distribution of BMI is between 25-29.9, 46.6% and this is in contrast to that by Neha Bajpai et al with maximum distribution of 83.7% in the group 18.5-24.9.

The confounding factors that may be present in our study are parity, age and BMI. Since we consider only nulliparous women, parity is ruled out. Since the p-value for age and BMI in predicting the outcome of induction of labour is >0.05, nul hypothesis is considered and is evident that age and BMI do not influence the outcome of induction of labour.

In a study by Bartha et al, prolonged pregnancy and oligohydromnios are the most common causes for induction of labour each contributing to 32.5% cases respectively.

In our study, postdated pregnancy is the leading cause contributing to 43.33% followed by nonsevere preeclampsia 30.66% and oligohydromnios 26%.

Pandis et al compared cervical length and bishop sore in 240 women who underwent induction of labour for various indications. In this vaginal delivery occurred in 80.8% of women comparable to our study where vaginal delivery is the most common outcome of induction of labour contributing to 84.66% of which 1.33% is outlet forceps delivery and cesarean section due to failure of induction contributes to 15.33%.

In the same study, 78% delivery occur within 24 hours of induction of labour, In our study 80.66% of delivery occur within 24 hours of induction of labour.

The median induction delivery interval is 2-107 hours in multipara and 4-114 hours in nullipara by a study by pandis et al. Neha Bajpai et al stated a mean dutation when Bishop score was less than 4 as 14.53 hours to 15.78 hours and when the Bishop's score was greater than or equal to 4 as 14.03 to 15.45 hours with a p-value of 0.005.

In our study with 150 nulliparaous women, the median delivery time is 19.531 hours to 24.311 hours. The mean duration when Bishop score was less than 4 as 22.523 hours to 32.107 hours and when the Bishop's score was greater than or equal to 4 as 16.205 hours to 20.274 hours with a p-value of 0.005.

In a study by Bansiwal et al, the mean induction delivery interval when the cervical length cut off of 3 cm is taken was, 11.6 to 23.8 hours. In our study the mean induction delivery interval when cervical length is less than or equal to 3 cm was 15.933

hours to 20.099 hours and when the cervical length was more than 3 cm 29.394 hours to 39.897 hours. The overall mean induction delivery interval predicted by cervical length was 19.531 hours to 24.311 hours with a significant p-value of <0.001

. In our study the mean induction delivery interval when posterior cervical angle was less than 120 degrees was 22.074 hours to 27.558 hours and when posterior cervical angle was greater 120 degrees was 8.869 hours to 12.744 hours. The overall mean induction delivery interval predicted by posterior cervical angle was 19.531 hours to 24.311 hours with a significant p-value of <0.001.

. In our study the mean induction delivery interval when percentage of funneling was less than 40 was 23.140 hours to 29.821 hours and when percentage of funneling was greater than or equal to 40 was 12.902 hours to 16.650 hours. The overall mean induction delivery interval predicted by percentage of funneling was 19.531 hours to 24.311 hours with a significant p-value of <0.001.

In a study by Neha Bajpai et al the mean induction delivery interval with a comprehensive transvaginal score less than 4 was 18-18.9 hours and with a score greater than or equal to 4 was 13.63 to 14.52 hours. In our study the mean induction delivery interval comprehensive transvaginal score less than 4 was 27.273 hours to 34.597 hours and with a score greater than or equal to 4 was 12.530 hours to 15.563 hours The overall mean induction delivery interval predicted by comprehensive transvaginal score was 19.531 hours to 24.311 hours with a significant p-value of <0.001.

Verhoeven et al has stated that in a subgroup analysis of studies conducted over nulliparous women with a cervical length cutoff of 3 cm, the sensitivity and specificity were 70% and 74% respectively with positive likelihood ratio of 2.7 and negative likelihood ratio 0.4. In our study the sensitivity and specificity are 85.95 and 48.28 respectively with positive likelihood ratio and negative likelihood ratio 1.72 and 0.28 respectively.

In our study, posterior cervical angle has a specificity of 96.55 and percentage of funneling has a sensitivity 50.41, specificity 79.31, positive likelihood ratio 2.44, negative likelihood ratio 0.63 which is comparable with that of Bishop's score.

In our study, though the sensitivity and specificity of comprehensive scoring system is less than Bishop's score, it has higher negative predictive value and hence the area under the curve in ROC is greater than that of Bishop's score with a significant p-value <0.001.

LIMITATIONS

The Bishop's score estimation is not done by the same obstetrician for all patients, whereas the transvaginal sonographic assessment is done by the same researcher for all patients, hence the role of subjective error in Bishop'score and the advantage of objective assessment in Transvaginal sonography could not be estimated exactly.

Bishop'score is a comprehensive scoring system comprising of five parameters, hence comparing it with a single parameter in tranvaginal sonography may not be ideal.

Recently, many other transvaginal parameters like transperineal head distance, cervical gland area and angle of head progression are all being studied to predict the success of induction and timing of delivery.

No definitive criteria for failure of induction has resulted in bias in various studies.

SUMMARY

1. 150 random patients were selected according to the inclusion criteria, who underwent induction of labour at Government Rajaji Hospital, Madurai, and were taken up for the study.
2. Majority belonged to the age group of less than 25 years
3. Majority had a BMI between 25 to 29.9
4. Age and BMI did not influence the outcome of induction of labour as they have p-value>0.05.
5. The leading reason for induction of labour was postdated pregnancy , followed by nonsevere preeclampsia and isolated oligohydromnios.
6. 86.5% of pregnant women who underwent labour induction had vaginal delivery
7. Failure of induction occurred in 11.7% of the study population.
8. Bishop's score, cervical length, posterior cervical angle and percentage of funneling are all significant in predicting the outcome of induction of labour.
9. The sensitivity of cervical length in predicting the outcome of induction of labour is 85.95% and the specificity is 48.28%

10. The sensitivity of posterior cervical angle in predicting the outcome following induction of labour is 25.62% and the specificity is 96.55%.
11. The sensitivity and specificity of percentage of funneling in predicting the outcome following induction of labour is 50.41% and 79.31% respectively.
12. The sensitivity and specificity of comprehensive transvaginal scoring in predicting the outcome following induction of labour is 66.12% and 79.31% respectively.

CONCLUSION

- Transvaginal sonography is an ideal alternative for Bishop's score to predict the outcome of induction of labour in nulliparous women with tern gestation with intact membranes.
- The transvaginal sonographic parameters even as individual parameters are statistically more significant in preinduction cervical assessment than Bishop's score
- Cervical length measurement by transvaginal sonography has the highest sensitivity followed by Bishop's scoring system
- Posterior cervical angle has the highest specificity followed by percentage of funneling, both measured by transvaginal sonography
- The comprehensive transvaginal sonography is therefore highly sensitive and specific than Bishop's score in preinduction cervical assessment.
- As transvaginal sonography is an easy, less time consuming method, it may be used as an alternative for cases where there is subjective variation in assessment of Bishop's score.