

Introduction

Induction of labour is defined as an intervention designed to artificially initiate uterine contractions leading to progressive dilatation and effacement of the cervix and birth of the baby (***RCOG Evidence-based Clinical Guide-line Number 9, 2001***).

Induction of labor is indicated when benefits to the mother or the fetus outweigh those of continuing the pregnancy such as post-dated pregnancy, preclampsia or fetal growth restriction (***Anish K et al, 2007***).

Induction of labour is performed in about 20% of all pregnancies and successful induction is reported to be related to cervical characteristics, or ‘ripeness’ (***Groeneveldt Y et al, 2010***).

The traditional method of predicting whether an induced labor will result in a successful vaginal delivery is based on the digital examination of the cervix. The most widely accepted and used is the scoring system described by Bishop in 1964 (***Bishop 1964***).

To date, Bishop score remains the standard method to predict the duration and outcome of induced labor. However, the preinduction ‘favorability’ of the cervix as assessed by the Bishop score is very subjective and several studies have demonstrated a poor predictive value for the outcome of induction especially in women with a low Bishop score (***Selhi et al, 2010***).

As The supra-vaginal portion of the cervix makes up about 50% of the cervical length and varies from one woman to another. This portion of the cervix is difficult to estimate digitally and it makes assessment highly subjective (*Bouyer et al,1986*).

Although cervical ripeness can be established with the Bishop score, this frequently used method shows a high inter-and intra-observer variability (*Bishop, 1964; Vrouwenraets et al., 2005; laencina et al., 2007*). Alternatively, transvaginal ultrasonographic measurement of cervical length may be a more objective method for assessing cervical status (*Rozenberg, 1999; Pandis et al., 2001; Roman et al., 2004*).

The measurement of cervical length and the presence of cervical funneling by transvaginal ultrasonography have been used widely for the prediction of preterm delivery in patients at risk for or with preterm labor (*Leitich et al, 1992*).

However, it is still controversial whether the ultrasonographic assessment of the cervix is valuable in term or postterm gestation for the prediction of successful vaginal delivery (*Reis et al, 2003*).

Therefore, we hypothesized that prediction of the success rate of induction of labour might lead to a reduction in caesarean delivery and thereby its complications Results of studies comparing the usefulness of the Bishop score versus transvaginal cervical ultrasonography in predicting the success of labour induction are conflicting (*Pandis et al., 2001; Rane et al., 2003; Rozenberg et al.,2005; strobel et al., 2006; Tan et al., 2007*)

Aim of The Work

To examine the relationship between preinduction sonographically measured cervical length and the Bishop score and to compare the two measurements in the prediction of successful vaginal delivery within 48 hours.

THE CERVIX

Anatomy

The cervix (Neck in Latin) is the narrowed, most caudal portion of the uterus. Some what conical, it has a truncated apex that is directed downward, it measures approximately 2.5 to 3.0 cm in the adult nulligravida and contact with the inferior aspect of the uterine corpus, the point of junction is known as the isthmus (*Sheets et al., 1995*).

The cervix is divided into two portions the portio-vaginalis, which is the part protruding into the vagina and the portio-supravaginalis, which lies above the vagina and below the corpus. The portion of the cervix exposed to the vagina is the exocervix or portio-vaginalis. (**Johanthan et al., 2002**)

The portio-vaginalis is covered by non-keratinizing squamous epithelium, its canal is lined by a columnar mucous secreting epithelium that is thrown into a series of V shaped folds that appear like the leaves of a palm and therefore called plicae palmatae. The endocervical canal is about 2 to 3 cm in length and opens proximally into the endometrial cavity at the internal os. The upper border of the cervical canal is marked by the internal os, where the narrow cervical canal widens out into the endometrial cavity. The lower border of the canal, the external os, contains the transition from squamous epithelium of the portio-vaginalis to the columnar epithelium of the endocervical canal (**Howard et al., 2003**).

Before childbirth, the external cervical os is small, regular, oval opening. After childbirth, the orifice is converted into a transverse slit that is divided such that there are the so-called anterior and posterior lips of cervix. If torn deeply during delivery, it might heal in such a manner that it appears to be irregular, nodular or stellate. These changes are sufficiently characteristic to permit an examiner to ascertain with some certainty whether a given woman has borne children by vaginal delivery. Anteriorly, the upper boundary of the cervix is the internal os, which corresponds to the level at which the peritoneum is reflected upon the bladder. The supra vaginal segment is covered by peritoneum on its posterior surface. This segment is attached to the cardinal ligaments anteriorly, and it is separated from the overlying bladder by loose connective tissue. The other segment is the lower vaginal portion of the cervix, also called the portio-vaginalis (**Cunningham et al., 2005**).

Cervical Ligaments:

The cervix is held in its position by its ligaments namely:

The pubocervical ligaments:

Extends to the posterior surface of the pubic bone surrounding the urethra to the front of the supravaginal cervix. (**Cunningham et al., 2005**).

The Mackenrodt ligament:

The cardinal ligament or the transverse cardinal ligament:

At the lateral margin of each broad ligament, the peritoneum is reflected on to the side of the pelvis. The thick base of the broad ligament

is continuous with the connective tissue of the pelvic floor. The densest portion is usually referred to as the cardinal ligament also called the transverse cardinal ligament or the Mackenrodt ligament and is composed of connective tissue that medially is united firmly to the supravaginal portion of the cervix. **(Cunningham et al., 2005).**

The uterosacral ligaments:

Each uterosacral ligament extends from an attachment poster laterally to the supravaginal portion of the cervix to encircle the rectum and inserts into the fascia lata over the sacrum. The ligaments are composed of connective tissue and some smooth muscle and are covered by peritoneum. They form the lateral boundaries of pouch of Douglas. These cervical ligaments stabilize the cervix in approximately the centre of the pelvis in non-pregnant women, while during pregnancy, they are the "guy ropes" the uterus pulls upon to expel the baby in the second stage of labour **(Cunningham et al., 2005).**

Microscopic Anatomy of The Cervix:

The Cervical Mucosa :

The cervical mucosa generally contains stratified squamous epithelium, characteristic of the exocervix and mucous-secreting columnar epithelium characteristic of the endocervical canal. However, the intersection where these two epithelia meet (the squamo-columnar junction) is geographically variable and dependent on hormonal stimulation. It is this dynamic interface, the transformation zone that is most vulnerable to the development of squamous neoplasia **(Johanthan et al., 2002).**

The mucosa of the cervical canal is composed of a single layer of very high ciliated columnar epithelium that rests on a thin basement membrane. Numerous cervical glands extend from the surface of the endocervical mucosa directly into the subjacent connective tissue. These glands furnish the thick cervical secretions (**Cunningham et al., 2005**).

Cervical connective tissue:

1- Collagen:

The most abundant protein in the body that determines the tensile strength of fibrous connective tissues collagen type I and III are the main types found in the human cervix (**Vonder Mark, 1981**).

Kleissel et al. (1978), found 62-80 %type I collagen and 20-30 %type III collagen.

Type IV collagen has been demonstrated in cervical basement membranes (**Frappart et al., 1982**).

Danforth and Buckingham, (1973), demonstrated that collagen fibres of cervix represent 82% of total cervical proteins.

2- Elastin:

There is a reduction in cervical elastin during pregnancy and elastin may also be important in returning the cervix to a non pregnant shape following delivery (**Leppert et al., 1987**).

Leppert and Yus, (1992), demonstrated that the ratio of elastin to collagen is highest at the area of the internal os, meaning that there is

more elastin fibers compared with collagen at the internal os, these elastin fibers are very thin compared with elastin fibers of other tissues.

Elastin is the major component in elastin fibers, which can be stretched several times to their length and then rapidly return to original size and shape when the tension is released. Elastase may be important for catabolism (*Uldbjerg et al., 1983a*).

Elastin fibers act as lubricant to allow the collagen fibers to slide by each other if stress is applied. Changes of the cervix during pregnancy cause a rearrangement of collagen fibrils so that the tissues assume the characteristic for soft easily distensible tissue (*Phyllis and Leppert, 1995*).

This occurs due to increased concentration of hyaluronic acid which attracts water molecules and contributes to softening of the tissue (*Leppert, 1992*).

3- The fibromuscular junction:

The transition from myometrium of the corpus to connective tissue of the cervix is quite variable from one specimen to another. Gross examination of the stained slide show the contrast in colour between myometrium red and the collagenous cervix (green in trichone, blue in Masson), microscopic examination is usually needed to determine the exact point of transition from predominantly muscle to predominantly collagen (*Danforth, 1983*).

4- Muscle:

Smooth muscle constitutes only 10-15% of cervical tissue. The distribution of smooth muscles is predominantly in the outer one third to one quarter of the cervix with variable amounts of muscle located closer

to the endocervical mucosa. **Tiltman 1998** has described the presence of a different group of smooth muscle bundles, found within the endocervical submucosa. These fibers are morphologically and immuno-histochemically distinct from the inherent muscle deeper in the cervix. They possess more cytoplasm, are arranged in bundles unseparated by collagen and lack estrogen and progesterone receptors. These bundles are found in 25% of uterine cervix, usually residing in the region of the transformation zone. At present their significance remains a source of speculation (**Jordan A & Singer A 2006**).

Mechanical and Histological Changes of The Cervix During Pregnancy :

Connective tissue containing collagen and elastin has incredible ability to rearrange its structure in response to mechanical stress or force. So, the cervical tissue appears as a rigid aligned tissue, which retains the fetus during pregnancy. But in late pregnancy mechanical pressure of the presenting part on the cervix lead to passive dilatation of the cervix (**Leppert, 1986**).

During pregnancy, the length of the cervix remains relatively unchanged but it varies in width by about 1 to 2 cm. During the last four to six weeks of gestation the cervix undergoes ripening, which consists of a change in the shape and consistency of the cervix it becomes shorter (effaced) and begins to dilate while the tissue itself softens and became more compliant in preparation for labor although significant ripening may occur only within days or even hours of the onset of labor (**McInnes et al., 1980**).

A threat to pregnancy due to incompetent cervix manifests itself by shortening of the cervix and in most cases this occurs even before dilatation. The external os usually remains firmly closed up to the 15th week of pregnancy. From the 15th to 20th week it dilates in 30% of primigravidas and in 39 % of multigravidas. In the subsequent course of pregnancy, the external os dilates in a further number of women. During pregnancy the cervix becomes metabolically active; water is an important component of the cervix, which increases in pregnancy (**Leppert, 1992**).

Throughout pregnancy, collagen is actively synthesized. It is also continuously remodelled by collagenases, secreted from both cervical cells and neutrophils in an apparently slow and precise fashion. Collagen is degraded by collagenases both intracellularly, to remove structurally defective procollagen to prevent the formation of weak structural collagen, and extracellularly, to slowly weaken (so-called softening or ripening) the collagen matrix to allow delivery of the pregnancy. As gestation advances, degradation and extraction of collagen from cervical tissue (a phenomenon not observed in non-pregnant state), by collagenase now called matrix metalloproteinases helps to maintain balance between newly synthesized collagen and degraded collagen thus regulating total collagen concentration in the cervix (**Phyllis and Leppert, 1995**).

The elastic fibers of the cervix at term are more disorganized and separated than in the non-pregnant state. In spite of relatively low concentrations in both pregnant and non-pregnant cervixes, the elastin may be important, for example, in regaining the shape of the organ immediately after delivery (**Pinto et al, 1965**).

Cervical assessment

The cervix usually undergoes a process called "ripening" in which the cervix shortens, dilates and effaces. These changes result in decreased cervical resistance to dilatation and provide physical characteristics that serve as the basis for standardized pelvic or cervical scoring (*Armando and Williams, 1995*).

The duration of both first and the second stages of labor is the product of the labor pains on one hand and the resistance of the soft tissue on the other hand (*Calkins, 1930*).

The science of cervical scoring was advanced by **Calkins** who noted that cervical resistance is a factor of great importance in determining the length of first stage of labor (*Calkins, 1941*).

In 1941 **Calkins et al.** recommended that the consistency of the cervix ,its thickness, and the length of the cervical canal should be determined accurately and recorded before the onset of labor as early as possible and he noted that assessment of cervical softness and labor intensity on scales of 1 to 5 seemed to have clinical merit.

Cervical assessment has progressed from qualitative to quantitative, numerically based system (*Bishop, 1955*).

Calkins, (1941) considered effacement, consistency and dilatation as signs of a ripe cervix. The ripe cervix was associated with first stage of labor. Durations those were 30-50 % shorter than those of women with unripe cervix.

In 1955 Cocks classifies 5 types of cervical presentation:

- Type I:** Soft cervix, some what effaced, cervical canal admitting one finger.
- Type II:** Soft cervix, minimally effaced, with closed internal os and external os admitting one finger.
- Type III:** Firm cervix, not effaced, closed internal os and external os.
- Type IV:** Firm cervix, some what effaced, internal os was effaced and external os admitting one finger.
- Type V:** Cervix with congenital malformation such as pin hole os or cervical duplications.

Type I and II were designed as ripe where as type III, IV and V were unripe. **Cocks** classification was limited to an evaluation of the ripeness of a cervix, defined by dilatation, consistency and length. All these characteristics were adequate, qualitative measures of the cervical state but not sufficiently quantitative.

In 1964 **Bishop** proposed a quantitative description of the cervix using a scoring of 5 different qualities; station of the presenting part, dilatation, consistency, effacement and position of the cervix. Bishop scoring system of cervical evaluation has gained acceptance for several reasons, it was the first quantitative method, simple, clinically applicable and composed of five factors easily evaluated during pelvic examination. Each factor is given a numerical value and the values were summed. The higher the score number, the greater the ripeness of the cervix. The pelvic score ranged from 0 to 13 and the data for scoring method grew out on his experience with Oxytocin induction (**Bishop, 1964**).

**TRANSVAGINAL ULTRASONOGRAPHIC MEASUREMENT
OF CERVICAL LENGTH**

Ultrasound of the cervix during pregnancy has been the focus of much research, and significant advances have been made in understanding the proper role of this procedure. Initial attempts at evaluating the cervix used transabdominal ultrasound (TAU). Unfortunately, this technique was found to be imperfect, because of (1) fetal parts obscuring the cervix, especially after 20 weeks, (2) the requirement of bladder filling, which can elongate the cervix and mask funneling, and (3) long distance from the probe to the cervix. Translabial (also known as transperineal) ultrasound, first used in France in the early 1980s, proved to be more useful. This technique involves having the patient lie on table with the hips and knees flexed, while a gloved transducer is positioned on the perineum in a sagittal orientation between the patient's labia majora. Elevation of the patient's hips with a cushion is sometimes used to improve visualization. Compared with TAU, this technique is not impaired by obstruction by fetal parts, and does not require bladder filling, achieving close to 100% visualization (**Vincenzo et al 2003**).

Other advantages of this technique are that the transducer is closer to the cervix, but does not enter the vagina (so no pressure can be exerted on the cervix), it does not require an additional transducer, and it is well accepted by patients. The main drawback of the transperineal approach is that gas in the rectum can hamper visualization of the cervix, especially the external os. The first studies of the human cervix using transvaginal ultrasound (TVU) also date back to the 1980s. The technique shares the advantages of translabial ultrasound, but the probe is even closer to the cervix, and the problem of obscuring bowel gas is eliminated. It has thus

become the preferred, gold standard method of evaluating the cervix in most clinical settings (**Vincenzo et al 2003**).

Technique of Transvaginal US Examination for Assessment of The Cervix:

Colombo et al., 2000 defined a standard protocol that can be used to measure the cervical length consistently. The total examination time is usually between 5 and 12 minutes.

1. Ask the patient to void.
2. Insert the vaginal probe using direct visualization.
3. Identify bladder, amniotic fluid, and fetal presenting part. Be certain to identify any findings such as placenta previa or absence of fetal heart motion.
4. Find the midline sagittal plane of the cervix and look in the proximal one-third of the image for the internal os.
5. Pull back the probe until the lightest touch provides a good image of the cervical canal.
6. Angle the probe slightly to get the best long axis of the cervix.
7. Measure the cervical length three times by placing the calipers appropriately and recording the distance between the internal os and external os.
8. Record the measurement of the best image and make a hard copy of the photo.
9. Record any evidence of funneling, dilatation, and membrane protrusion.

10. Apply gentle upward pressure on the lower uterine segment or transfundal pressure for approximately 15 seconds. Measure the cervix again in the same manner as described previously if it shortens or if a funnel becomes apparent.