INTRODUCTION

Induction of labor is a common and essential element of contemporary obstetric practice with an incidence of approximately 20% of pregnancies ***(Zhanget al., 2002).***

Induction of labor is indicated when benefits to the mother or the fetus outweigh those of continuing the pregnancy ***(Anishet al., 2007).*** Indications include immediate conditions such as ruptured membranes with chorioamnionitis or severe preeclampsia. The more common indications include membrane rupture without labor, gestational hypertension, non-reassuring fetal status, post-term pregnancy, and various maternal medical conditions such as chronic hypertension and diabetes ***(Anishet al., 2013).***

Several studies have shown that induction, compared to expectant management, is associated with a substantial reduction in perinatal mortality 2–4%. However, approximately 20% of women having induction of labor end up having a Cesarean delivery ***(Arukumaran et al., 1985).*** The traditional method of predicting whether an induced labor will result in successful vaginal delivery is based on the preinduction ‘favorability’ of the cervix as assessed by the Bishop score. However, this assessment is subjective and several studies have shown a poor predictive value for the outcome of induction ***(Friedman etal., 1966&Haghey et al., 1976).***

Some recent studies have reported that transvaginal sonographic Ultrasound of the cervix may provide a more sensitive prediction of successful induction, compared to the Bishop Score. ***Hatfield and associates (2007)*** **performed** a meta-analysis of 20 trials in which cervical length was assessed by transvaginal ultrasonography (TVUS) and used to predict successful induction of labor. Because of the heterogeneity of study criteria the authors concluded that the question was still unanswered.

Complications of induction of labor include uterine hyper stimulation, failed induction, umbilical cord prolapse and uterine rupture. 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. A Bishop Score of 9 conveys a high likelihood for a successful induction. A Bishop Score of 4 or less identifies an unfavorable cervix and may be an indication for cervical ripening ***(Bishop, 1964).***

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 ***(Selhiet al.,2010).***

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 ***(Bouyreret al., 1986).***

However transvaginal ultrasonographic measurement of cervical length may be a more objective method for assessing cervical status ***(Pandiset al., 2001& Romanhet al., 2004).***

Aim of the Work

To compare between preinduction sonographically measured cervical length and the Bishop Score in the prediction of successful vaginal delivery within 24 hours.

Research Question

In women undergoing induction of labor, does measurement of cervical length by ultrasound predict the success of induction is equal to that measured by Bishop Score?

Research Hypothesis

In women undergoing induction of labor measurement of cervical length by ultrasound may predict the success of induction equally like that of Bishop score.

Chapter (I)

ANATOMY OF THE CERVIX

Gross Anatomy of the Cervix:

(The cervix is divided into two portions: the portiovaginalis, which is the part protruding into the vagina and the portio-supravaginalis, which lies above the vagina and below the corpus. The portiovaginalis 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 palm and therefore called plicae palmate. The endocervical canal is about 2 to 3cm 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 portiovaginalis to the columnar epithelium of endocervical canal ***(Johanthan et al., 2002).***

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 certainly whether a given woman has born children by vaginal delivery.

Relations of the cervix:

The external end of the cervix bulges into the anterior wall of the vagina, which divides it into supravaginal and vaginal regions. The supravaginal part of the cervix is separated in front from the bladder by cellular connective tissue "the parametrium" which also passes to the sides of the cervix and laterally between the two layers of the broad ligaments ***(Susan et al., 2005).***

The uterine arteries flank the cervix in this tissue and the ureters descend forward about 2 cm from the cervix, curving under the arch formed by the uterine arteries ***(Susan et al., 2005).***

The supra vaginal part of the cervix is covered posteriorly by the peritoneum, which continues caudally onto the posterior vaginal wall and is then reflected onto the rectum via the recto uterine recess. Posteriorly, it is related to the rectum from which it may be separated by a terminal ileum. The vaginal part of the cervix projects into the vaginal cavity forming grooves termed vaginal fornices (***(Susan et al., 2005).***

Cervical ligaments:

1- Cardinal ligaments (Transverse cervical ligament) (Mackenrodt ligament):

It extends from the side of the cervix and lateral fornix of the vagina to attach extensively on the pelvic wall at the level of the cervix ***(Susan et al., 2005).***

At the lateral margin of each broad ligament, the peritoneum is reflected onto the side of the pelvis. The thick base of the broad ligament is continuous with the connective tissue of the pelvic floor, the deepest portion is usually referred to as the cardinal ligament, and is composed of connective tissue that is medially united firmly to the supravaginal portion of the cervix ***(Cunningham et al., 2005).***

2- Pubocervical ligament:

It passes forward from the anterior aspect of the supravaginal cervix to diverge around the urethra and attach to the posterior aspect of the pubic bone ***(Cunningham et al., 2005).***

3- **Uterosacral ligament:**

It extends from an attachment poster laterally to the supravaginal portion of the cervix to encircle the rectum and insert into the fascia over the sacrum. These ligaments are composed off connective tissue and some smooth muscles and are covered by peritoneum. They form the lateral boundaries of the pouch of Douglas ***(Cunningham et al., 2005).***

Diameters of the cervix:

The normal diameter of the cervix in the nulliparous is about 2.5 to 3cm in length, 2 to 2.5 cm in its antero posterior diameter and 2.5 to 3 cm in its lateral diameter. This difference is due to the shape of the cervical canal, which is straight in its sagittal plane and spindle shaped in the frontal plane. The wall of the cervix is about 1 cm thick throughout its length ***(Baggish et al., 2011)***

Histology of the Cervix

Types of epithelium in the cervix:

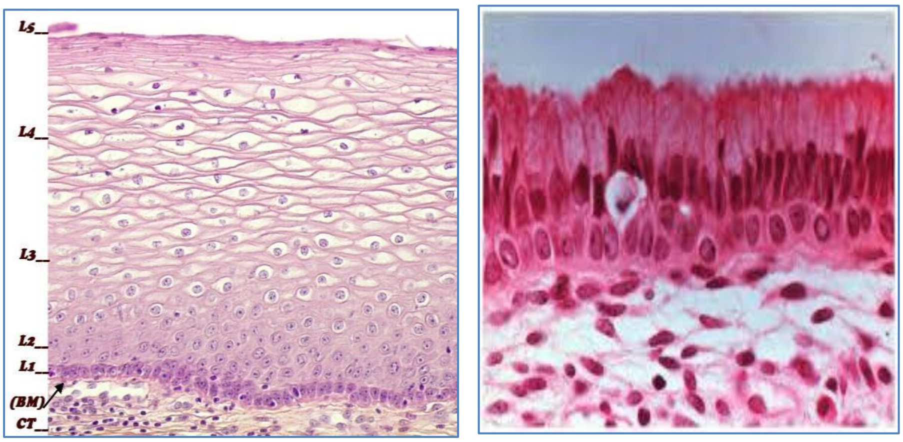

Fig. (1): Simple columnar and stratified squamous epithelium ***(Ramanah et al., 2012).***

The epithelium of the cervix is varied. The ectocervix is composed of non-keratinized stratified squamous epithelium; the endocervix is composed of simple columnar epithelium. However, the intersection where these two epithelia meet (the squamo columnar junction) is geographically variable and dependent on hormonal stimulation. It is the dynamic interface; this transformation zone is the most vulnerable to the development of squamous neoplasia ***(Johnanthan et al., 2002).***

During the reproductive age, the cervical epithelium is high and well differentiated. It consists of a basal cell layer with elongated nuclei perpendicular to the basal membrane, one or several layers of small Para basal cells, a broad intermediate cell zone with abundant cytoplasmic glycogen, and a covering layer of narrow superficial cells ***(Gisela Dallenbach et al., 2006).***

The mucosa of the cervical canal is composed of a single layer of a very highly 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 secretion ***(Cunningham et al., 2005).***

Cervical Connective Tissue:

The extracellular matrix is made up of collagen fibers and elastin separated by tissue elasticity.

1- The cervical stroma:

The underlying cervical stroma is composed mainly of fibrous connective tissue, which is demonstrated by contrast stain to be almost entirely collagen. 50% of the total weight of the cervix is formed of collagen fibers. Collagen fibers of the cervix represent 82% of total cervical proteins ***(Ramanah et al., 2012)***

The non-pregnant cervix contains collagen fibers that have a definite cable-like structure and form fibril bundles. These fibrils appear wavy when viewed with a light microscope. During pregnancy, the uterine cervix rearranges its collagen fibers ***(Phyllis and Leppert, 1995).*** The basic molecule has a molecular weight of about 300.000 Dalton. It consists of three parallel individual polypeptide chain, wrapped around each other in "super-helix" much like the strands of a rope ***(Uldbjerg et al., 1983).***

2- Elastin:

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

Leppert &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.

Elastic fibers were difficult to demonstrate in cervical tissue. Elastic fibers are found only in the walls of the larger blood vessels that constituted a fraction of 1% of total fibrous issue of the cervix ***(Ramanah et al., 2012).***

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 ***(Kumar et al., 2009)***

3- Glycosaminoglycan:

Glycosaminoglycan's (GAGs) are large un branched polysaccharide chains composed of disaccharide repeating units that contain lexosamine (glucosamine or galactosamine) residue and usually an uronic acid (glucuronic acid or induronic acid) residue. Cervical GaGs constitute about 1% of the dry defatted tissue, which is similar to other connective tissues. The glycosaminoglycan dominate quantitatively, dermaton sulphates being the most common (52- 73%) ***(Uldbjerg et al., 1983b).***

Chondroitin sulphate has been detected in studies of cervical GAGs and the previous analyses were confused by the complexity of the dermaton sulphate (as they contain "chondroitin sulphate like segments") ***(Uldbjerg, 1989).***

Hyaluronic acid found in smaller amounts (8- 22%). The heparin sulphate found in the cervix (6- 13%) has characteristics similar to that of heparin sulphate from the human aorta and thus probably represents blood vessels connective tissue, chondroitin sulphate had not been detected in cervical connective tissue ***(Uldbjerg et al., 1983b).***

4- Proteoglycans:

A proteoglycan is made up of one or several GAGs connected to a protein core. A cervical dermaton sulphate proteoglycan has been isolated ***(Ramanah et al., 2012).***

The average molecular weight of Proteoglycan ranges from 73000 to 110500 Oltan. The amino acid compositions is characterized by high contents of aspartic acid, glutamic acid and leucine ***(Uldbjerg, 1989).***

5- Glycoproteins:

The protein cores of glycoproteins are combined with different amounts of oligosaccharides. Glycoproteins have been reported to be present in the uterine cervix ***(Uldbjerg at al., 1983b).*** It has been suggested that these glycoproteins originate from the mucus localized intra-cellular and in crypts ***(Uldbjerg et al., 1983b).***

- The fibro muscular 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 color between myometrium red and the collagenous cervix (green in trichon, blue in Masson), Microscopic examination is usually needed to determine the exact point of transition from predominantly muscle, to predominantly collagen ***(Ramanah et al., 2012)***

- Muscle:

The outer muscle layer is the extrinsic muscle of the cervix forming the bulk of cervix. It contains scattered muscle bundles which are referred to as intrinsic muscle of the cervix. The cervix consists of an outer narrow contractile layer and an inner broad from non-contractile mass ***(Ramanah et al., 2012)***

In normal cervix, smooth muscle accounts for 10 - 15% of the normal cervical substances ***(Danforth and Buckingham, 1973).***

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 the 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 or six weeks of gestation the cervix undergoes ripening, which consist of a change in the shape and consistency of the cervix so it becomes shorter (effaced) and begins to dilate while the tissue itself softens and become more complaint in preparation for labor. Although significant ripening may occur only within days or even hours of the onset of labor ***(Mclnnes 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 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 remodeled by collagenases, secreted from both cervical cells and neutrophils in an apparently slow and precise fashion. Collagen is degraded by collagenases both intracellular, to remove structurally defective procollagen to prevent the formation of weak structural collagen, and extracellular, to slowly weaken (so-called softening or ripening) the collagen matrix to allow delivery of pregnancy. As gestation advances, degradation and extraction of collagen from cervical tissue (a phenomena not observed in non-pregnant state), by collagenase now called matrix metalloproteinase helps to maintain balance between newly synthesized collagen and degraded collagen thus regulating total collagen concentration in the cervix ***(Phyllis & 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 cervices, the elastin may be important, for example, in regaining the shape of the organ immediately after delivery ***(Word et al., 2007)***