ULTRASOUND VELOCITY IN CERVIX UTERI IN CORRELATION WITH STRUCTURAL CHANGES FOR DIAGNOSIS OF INCOMPETENCE

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ABSTRACT

It is evident that the uterine cervix structure determines its elastic nature, and hence its degree of competence. An increased water content changes the tissue density, and hence changes the sound velocity in the cervix. In vitro measurement of the sound velocity has been carried out using the so-called Beam Tracking technique. A correlation has been derived between the measured velocity and the histological configuration of the cervix. The aim of this paper is to report the feasibility of using sound velocity to predict the cervical changes that could diagnose the structural development of cervical incompetence, regardless of the past history.

INTRODUCTION

The diagnosis of cervical incompetence can be achieved retrospectively by evaluating the clinical history of multigravid patients. If the typical history of incompetence is not noted, the clinician may rely on observing the appearance of symptoms which are usually observed late in the course of this condition.

The condition is more complex for a primigravid patient with congenital incompetence, the diagnosis is almost always missed entirely [1].

THE STRUCTURE OF THE CERVIX IN PREGNANCY

Until the eighth week of pregnancy the structural configuration of the body, isthmus and cervix is the same as in the nonpregnant uterus. Until the twelfth week there is hypertrophy with consequent lengthening and thickening of the isthmus, as takes place in the rest of the uterine body. The cervix consists mainly of fibrous tissue with varying quantities of smooth muscle; the inner part of the cervix is mainly collagenous, with some scattered non-functional muscle fibers.

During labor, elevation of the proportion of mucopolysaccharide to collagen above a critical level is associated with an influx of water into the tissues. This produces an imbalance between the cohesive and dispersive forces interacting between collagen structural units. Immediately postpartum the excess water is absorbed, and the cervical collagen structure returns to its prepartum level of compliance [2].

It is thus clear that the uterine cervix structure determines its elastic nature, and hence its degree of competence. An increased water content changes the tissue elasticity and density, and hence changes the sound velocity of the cervix.

MATERIALS AND METHODS

Measurement of the sound velocity in an elastic tissue will give information about its density and elasticity. This is because the speed of propagation in that kind of tissue is

$$c = \sqrt{\frac{E}{\rho}\,\frac{1-\delta}{(1-\delta)(1-2\delta)}}$$

where E is Young's modulus of elasticity, p the density, and δ Poisson's ratio [3].

In vitro measurement of the sound velocity in the cervix has been carried out using the so-called Beam Tracking technique. The details are presented in Ref. [4].

The measurements were performed on in vitro cervical specimens after total hysterectomies for multiparous women with no history of incompetence. After estimation of the speed of sound in vitro, histological studies of the collected specimens and the distribution of the constituents of the cervix at the level of the isthmus (fibromuscular junction) were conducted to find out the relative amounts of smooth muscle, elastic fibers and collagen [5].

DISCUSSION

It is evident from the above equation that the sound velocity is proportional to the square root of the elastic modulus.

The consistency of the uterine cervix is different in non-pregnant and pregnant women. The non-pregnant cervix usually has a firm consistency. During pregnancy, however, the cervix gradually softens as the hygroscopic quality of the cervical connective tissue increases and the binding substance becomes looser. An increased water content changes the tissue elasticity and density and, hence the sound velocity of the cervix [3]. In the incompetent cervix the binding tissue becomes even looser, and the velocity is markedly reduced late in the first trimester. The situation is shown in Fig. 1.

As stated before there is no reported structural change whether in the isthmus, body or cervix during the first eight weeks, and since incompetence is completely assessed by the end of the first trimester, we can dramatically predict whether a cervix is competent or not by the anatomical and histological changes the cervix undergoes during the eighth to twelfth week (see Fig. 1).

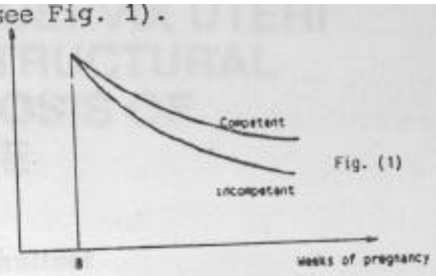

Fig. (1)

Because of the elevated water content, as pregnancy progresses, the cervix becomes considerably hypoechogenic, and consequently the mean grey level for a selected ROI on a conventional B scan is depressed (cf. Fig. 2). In our new approach, the mean grey level has also been correlated to the velocity.

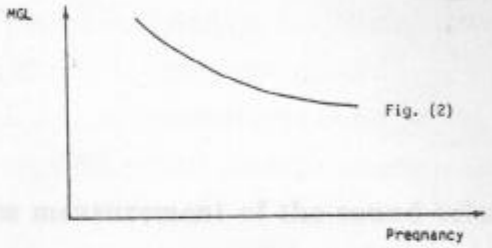

Fig. (2)

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