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Vibration Considerations in Antenatal Care of High Risk Pregnancies

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OBJECTIVE - To develop a simple model to assess the loads bearing on the cervix during high risk pregnancy **METHODS -** The masses of the fetus, uterus, ammiotic fluid and placenta in combination and the pregnant mother have been chosen to give representative average value. Certain values for these were assumed. The amplitude of the road excitation was assumed to be 10 cm. A three degree of freedom biomechamical model was developed for the fetus, uterus and human body. **RESULTS -** The dynamic load on the cervix was calculated to be 21.5 N and the static load 44.15N. The total load was almost 1.4 times the static load. **CONCLUSION -** Dynamic loads falling on the cervix during pregnancy in a women with history of preterm labour is a serious concern.

Key words : biomechanical model, preterm labour, cervical loads, vibrations, antenatal care

Introduction

In the field of obstetrics and gynecology, preterm labor is a serious problem. Infants weighing between 1550 and 2000 gms at birth have an 80% chance of survival. Postponing delivery to 33 weeks of gestation greatly improves the chances of survival of the baby after birth. Even a small increase in the period of gestation can significantly improve the survival rate of the neonate[1].

Etiopathogenetic factors that influence preterm labor, particularly in high risk pregnancies, are, i) infection, ii) inflammation and iii) stress. All these factors, in general, cause an increase in the number of white blood corpuscles and interlukins which in turn result in the elevation of prostaglandin, oxytonin and receptor concentration. Such increases provoke contractions of the uterus and cervical changes that lead to preterm labor.

The occupation and nature of pregnant women in relation to preterm labor has been studied extensively[1]. The results indicate that working during pregnancy, in general, does not have adverse effects, however, the specific conditions of a given work are more relevant. Prolonged standing, longer hours of work and physical exertion are strong predictors of preterm labor[2]. Moreover, work at home is a risk factor as important as work outside the home[3]. However, working long hours in a stressful occupation has little effect on pregnancy outcome[4].

Of the three factors that contribute either individually or collectively to preterm labor, the stress depends very much on the static and dynamic loads on the strategic parts of the body, in general, and in the vicinity of and inside the uterus in particular. Preterm labor is strongly dependent on the loads incident on the cervix. In rural areas, regular visits to the gynecologist involving vehicle rides in cars or buses on the rough roads is a potential risk to a pregnant mother with a history of preterm labor. Bed rest is the treatment regimen that has been used in preterm labor cases. In some cases of bed rest, the foot end has been raised at 45° angle. This minimizes the static loads on the cervix, which decreases the chances of preterm labor.

Biomechanical Model

A three degree of freedom biomechanical model has been developed for the fetus, uterus and human body as shown in Fig. 1. The uterus is supported on the body through the broad and round ligaments providing stiffness and damping properties. The fetus is connected to the uterine wall by the umbilical cord, and is supported by the amniotic fluid and the cervical tissue bearing on the cervix. The dynamic excitation come through the body which is excited by the base excitation due to road roughness and vehicle dynamics.

The masses of the fetus, uterus, amniotic fluid placenta in combination and the pregnant mother h been chosen to give representative average values f for these quantities are scare and the only experimental data available are for sheep and mice . The syste parameters assumed in this study are :

m_1 = 3.5 kg, for the fetus, m_2 = 2.5 kg, for the uteru + amniotic fluid + placenta.

m_3 = 65 kg, for the pregnant mother , k_1 552.8 k_2 = 395.0 N/m

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k = 10264.4 N/m, c_1 = 61.6 Ns/m, c_2 = 43.98 Ns/m, c_3 = 1143.6 Ns/m

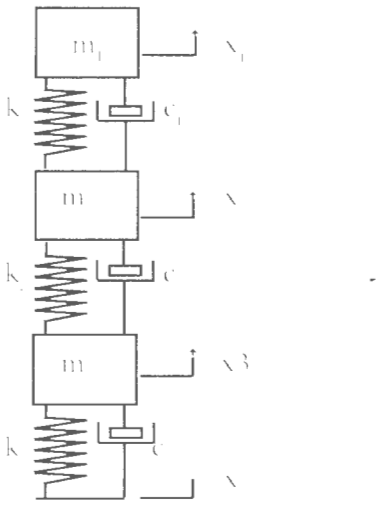

Fig. 1: Biomechanical model of the fetus, uterus and human system

Discussion of the Results

Strictly, the ride vibrations are random in nature. However, in order to simplify the analysis, the excitation from the road is assumed to be harmonic. The amplitude of the road excitation was assumed in this study to be 10 cm. The dynamic load on the cervix is calculated to be 21.5 N. The static load on the cervix is due to the fetus and the weight of the amniotic fluid, which will be approximately 4.5 kg or 44.15 N. The total load will be the sum of the two loads and is (65.55 N). The total load is almost 1.4 times the static load.

The results indicate that the dynamic loads falling on to the cervix can be of serious concern, particularly when the mother has a past history of preterm labour. It would be extremely difficult to obtain any test data for the system parameters. Any other forms of experiments also would be difficult in view of the risks that are inherent in such experiments. However, with careful synthesis of the existing data with a biomechanical model as the one formulated here it would be possible to obtain some measure of predictable system behavior.

References

1. Arias F. Practical Guide to High Risk Pregnancy and Delivery, Ch. 4. 1993. *Mosby Year Book, Chicago pg. 71 – 99.*
2. Mamelle N, Laumon B, Lazar P. Prematurity and Occupational Activity During Pregnancy. *Am J Epidemiol 1984; 119: 309 – 22.*
3. Launer LJ, Villar J, Kestler E. The Effect of Maternal Work on Fetal Growth and Duration of Pregnancy: a Prospective Study. *Br J Obstet and Gynecol 1990; 97: 62 – 70.*
4. Klebanoff MA, Shiono PH, Rhoads GG. Outcomes of Pregnancy in a National Sample of Resident Physicians. *N Eng J Med 1990; 323: 1040 – 5.*
5. Bantle JA. Effects of Mechanical Vibrations on the Growth and Development of [illegible]. *Aerospace Medicine, October 19[illegible].*
6. Abrams R M, Peters AJM, Huang X et al. Response of the Uterus to Abdominal Vibrations in Sheep. *J Sound and Vibration 2000; 230: 725 – 8.*