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Biological Effects of Ultrasound on Fetal Outcome

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OBJECTIVE – To study the biological effects of antenatal ultrasound on fetal outcome and to compare the fetal outcome in the ultrasound exposed and unexposed groups. **METHODS** – A study was conducted on 150 antenatal women divided into two groups. Group I consisted of 75 women who had undergone ultrasound examination and who were further divided into group IA of 45 women who had their first diagnostic ultrasound during the embryonic period, and group IB of 30 women who had their first diagnostic ultrasound during the fetal period. Group II (controls) consisted of 75 women who were not exposed to ultrasound during their antenatal period. To study the effect of the number of ultrasound exposures, group I was divided into Ia of 27 women who were exposed to USG once or twice) and group Ib of 48 women who were exposed for three or more times. The new / born was subjected to thorough clinical examination and the gestation of the baby was clinically assessed using the Ballard scoring system. **RESULTS** – The mean birth weight and crown-heel length of the neonates exposed to ultrasonography in the embryonic period was less as compared to those of ones exposed in the fetal period and no such difference was observed in the mean head circumference. **CONCLUSION** - The time of first diagnostic ultrasound exposure and the number of exposure have some effect on the fetal outcome. Hence the ultrasound examination in pregnancy expecially in the first trimester should be performed for specific medical and obstetric indications.

Key words : biological effects, ultrasound, fetal outcome

Introduction

Ultrasonography has become a widely accepted diagnostic tool in almost all branches of medicine. It is basically a form of sound energy consisting of mechanical vibrations occurring at frequencies above those that can be appreciated by the human ear. It is important to consider the question of safety, particularly in pregnancy as the rapidly growing fetal tissues are most vulnerable to the onset of any type of energy. Damage caused by sonar, if any, since it is mechanically inflicted might be expected to be immediate and rapidly apparent. The biophysical effects of ultrasound have been classified into internal, cavitational and certain "direct" mechanisms of action. The possible types of damages that sonar can produce are structural damages to already formed organs and to organs not fully developed. There is also a possibility of genetic damage – teratogenesis and mutagenesis.

So far no adverse effects have been recorded from the use of sonar but the possibility exists that such biological effects may be identified in future. With the above facts in mind, the present study was planned for comparison of immediate postnatal problems affecting the neonates exposed to antenatal diagnostic ultrasound with those seen in neonates born without any ultrasound exposure in utero.

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Material and Methods

The study was conducted on 150 pregnant women who were divided into two groups :

Group I (subjects) : Seventy five pregnant women attending the obstetric OPD or admitted in the wards who had undergone ultrasound examinations. Exclusion criteria – any history of congenital malformations in the past or in the family, recurrent spontaneous abortions, late fetal death, x-ray exposure, viral fever in early pregnancy and any systemic disorder. Group II (controls) : Seventy five pregnant women who were not exposed to any sort of ultrasound examination with rest of the criteria remaining the same as in group A.

Group I women were further divided, to study the effect of time of first ultrasound exposure during pregnancy on fetal outcome, into group IA – 45 pregnant women (60%) who had their first diagnostic ultrasound during the embryonic period of upto 10 weeks of gestation and group IB –30 pregnant women (40%) who had their first diagnostic ultrasound during the fetal period viz., after 10 weeks of gestation.

To study the effect of the number of exposures of ultrasound on fetal outcome, the neonates of the pregnant women who were exposed to ultrasound once

or twice were labeled as group Ia [27 pregnant women (36%)] and those who were exposed to ultrasound for three or more times were labeled as group Ib [48 women (64%)].

Each pregnant woman was subjected to complete general physical examination, systemic examination, abdominal examination and routine antenatal investigations. The weeks of gestation at the first ultrasound examination, total number of ultrasound examinations and approximate time of ultrasound examination were recorded in all the women of group II.

At the time of delivery, the new born was subjected to thorough clinical examination. The gestation of the baby was clinically assessed using Ballard scoring system. All the anthropometric measurements were taken with the new born in the supine position. All the circumferences were measured to the nearest 0.10 cm using fiberglass tape. Standard anthropometric techniques were used. Weights of all the neonates were measured with no clothing within 24 hours of birth on an electronic weighing machine.

Crown heel length was measured with infantometer in supine position, knees extended, soles of the feet firmly against the foot board and head touching the fixed board.

The head circumference was measured with flexible fiberglass tape over the supra-orbital regions, glabella, and occiput. This reflects the brain growth.

The chest circumference was measured by a flexible fiberglass tape around the chest at the level of xiphisternum at right angle to the vertebral column in the recumbent position.

Abdominal girth was measured at the level of the umbilicus during quiet respiration.

Weight of the placenta, length of the umbilical cord, number of arteries and veins in the umbilical cord, any congenital malformation and infection in the newborn during the hospital stay were recorded. Audiological assessment of the neonates was made by crib-o-gram.

During the study, women were subjected to sonographic examination on RT 3600 machine using either linear or sector or both probes of 3.5 MHz frequency. The data were statistically analysed using z or t test where applicable.

Results

There was no statistical difference in the two groups with respect to age, socioeconomic status, urban and rural distribution, booked and unbooked cases, duration of amenorrhea and obstetric history.

The mean birthweight of the neonates of the groups I and II were 3.00 ± 0.37 kg and 3.12 ± 0.33 kg respectively, the difference being statistically significant (z-value 2.09.$p < 0.05$).

Table I shows that mean birthweight of the babies was significantly less if exposed to ultrasound in the embryonic period and also if the number of exposures was three or more as compared to the unexposed group.

The exposure range for one sitting varied from 3-15 minutes. The total duration of exposure ranged from 10 minutes to a maximum of 43 minutes. The mean total duration of the exposure was 22.33 ± 6.69 minutes. The number of the exposures ranged from one to a maximum of five.

The mean crown heel length in group I neonates (49.78 ± 1.46 cm, range 47.1 – 53cm) was not statistically different from that in group II neonates (50.08 ± 1.31 cm, range 47.8 – 53 cm).

Table II shows that the mean crown heel length of the neonates exposed in the embryonic period was less as compared to that of the neonates exposed in fetal period and of the unexposed neonates. However, it was not statistically different in the neonates exposed in the fetal period from that of the unexposed neonates. The mean crown-heel length of the neonates exposed to ultrasound for three or more times was not statistically different from that of neonates exposed for two times or less and of those not exposed.

Mean head circumference of the neonates of group I (33.97 ± 0.81 cm range 32.0 – 35.6 cm) was not statistically different from the mean head circumference of the neonates of group II (34.06 ± 0.69 cm, range 32.8 – 35.9 cm).

Table III shows that the mean head circumference of the neonates exposed in the embryonic period was significantly less as compared to that of those exposed in the fetal period and of those unexposed. However, the mean head circumference of the neonates exposed in the fetal period and of those unexposed was not statistically different. Head circumference of the neonates in the groups Ia and Ib was also not different statistically.

Mean chest circumference and abdominal circumference of the neonates in the groups I and II were not different statistically. There was no statistically significan.

Table I :Mean Birth Weight (kg) of the Neonates.

Group	number	Mean ± SD	Comparison
IA	45	2.83 ± 0.31	IA vs II Z = 4.84 P < 0.001
IB	30	3.23 ± 0.27	IB vs II Z = 1.76 Not significant
II	75	3.12 ± 0.33	IA vs IB Z = 6.51 P < 0.001
			Ia vs Ib Z = 2.87 P < 0.01
Ia	27	3.15 ± 0.27	Ia vs II Z = 0.46 Not significant
Ib	48	2.93 ± 0.39	Ib vs II Z = 2.795 P< 0.01

Table II : Mean Crown-Heel Length (cm) of the Neonates

Group	Number	Mean ± SD	Comparison
IA	45	49.30 ± 1.33	IA vs II Z = 3.00 P<0.01
II	75	50.08 ± 1.31	IA vs IB Z =4.34 P<0.00
IB	30	50.60 ± 1.23	IB vs II Z = 1.92 Not significant
Ia	27	50.06 ± 1.28	Ia vs II Z = 0.07 Not significant
			Ia vs II Z = 2.72 Not significant
Ib	48	49.62 ± 1.55	Ib vs II Z = 3.01 P< 0.01

Table III : Mean Head Circumference (cm) of the Neonates.

Group	Number	Mean ± SD	Comparison
IA	45	33.73 ± 0.78	IA vs II Z = 2.24 P< 0.01
II	75	34.06 ± 0.78	IA vs IB Z = 3.54 P < 0.05
IB	30	34.38 ± 0.78	IB vs II Z = 1.89 Not significant
Ia	27	34.19 ± 0.77	la vs II Z = 0.75 Not significant
			Ia vs Ib Z = 1.79 Not significant
Ib	48	33.85 ± 0.82	Ib vs II Z = 0.69 Not significant

difference in the length of the umbilical cord, sex and birth weight of the babies in the two groups. None of the newborns in a groups I and II had hearing complications as assessed by a crib test. Neonatal hyperbilirubinemia was not statistically different in the neonates of groups I and II (8% and 6.7% respectively).

Discussion

The widespread acceptance of ultrasonography is mainly due to its clinical usefulness, convenience and non invasiveness. As this technique is used to examine the human fetus, the topic of safety to the fetus is of fundamental importance. However so far very few randomized controlled trials have been conducted to elucidate the benefits, potential hazards[1,2] and costs of ultrasound screening in pregnancy.

Our observation that the mean birth weight and crown-heel length of the neonates exposed to ultrasounography in the embryonic period is less as compared to those exposed in the fetal period and no such difference is observed in the mean head circumference has also been reported earlier[3].

In a study of 6 years[4], no statistically significant differences in head circumference at birth or in the height and weight between birth and at six years of age were found between ultrasound exposed and unexposed

siblings. But the majority of women in this study were exposed in the second trimester and only 13% were exposed in the period of organogenesis in the first trimester. So it can be concluded that the time of the first diagnostic ultrasound exposure is very critical.

The time of the first diagnostic ultrasound exposure and the number of exposures do have some effect on the fetal outcome. Hence the ultrasound examination in pregnancy, especially in the first trimester, should be performed for specific medical and obstetric indications. It must be added, however, that all findings need to be collaborated by studies involving much larger number of women.

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