Original Article

Frequency of Hearing Defect and Ear Abnormalities in Newborns Conceived by Assisted Reproductive Techniques in Royan Institute

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Abstract

Background: Assisted reproductive techniques (ART) are used with increasing frequency worldwide. The present research was conducted to determine the effects of ART on hearing defects and ear abnormalities.

Materials and Methods: In a descriptive, cross-sectional, non-randomized study, the status of hearing and ear abnormalities was assessed in 300 newborns conceived by ART at Royan Institute, Tehran, Iran. This study was performed over a sixteen month period.

Data were collected from parents, otoscopic examinations and transiently evoked otoacoustic emissions (TEOAE) tests of the newborns. The external ear was assessed by otoscopic examination, followed by the TEOAE test (an objective test that does not need the infant's collaboration) which was performed by an audiologist. In this test, the OAE wave was registered after a click (stimulus) at 5-20 millisecond intervals with an 82 dB SPL altitude. Data were analyzed by statistical tests.

Results: Of the 300 cases examined by otoscopy, two cases (0.66%) had bilateral malformation in the auricle, two (0.66%) had unilateral perforation of the tympanic membrane, five (1.66%) had unilateral retraction of the tympanic membrane, eight (2.66%) had bilateral retraction of the tympanic membrane, one (0.33%) had unilateral tympanic membrane inflammation, one (0.33%) had bilateral tympanic membrane inflammation and one case (0.33%) had wax obstruction of the external ear canal.

A total of 289 out of 300 newborns undewent the TEOAE test. Of these, three cases (1.03%) did not have a bilateral registered wave and were diagnosed with bilateral hearing loss.

Conclusion: This study shows that hearing and ear screening in newborns conceived by ART is contemplative and emphasizes the profitability of continual check up in these infants.

Keywords: Newborn, Assisted Reproductive Techniques, Hearing, Ear

Introduction

Hearing defects are one of the most common congenital abnormalities of newborns. The prevalence is 28 times greater than phenylketonuria, 8 times more than hypothyroidism, 5 times more than cystic fibrosis and 20 times more than hemoglobinopathy (1). From 1000 live births, 1-6 cases present with some type of hearing defect (2). Hearing defects in infants result in severe disorders in communication, in addition to social, emotional, and cognitive development, and can lead to severe suppression of educational and academic activity. Eighty percent of lingual abilities develop by 18 months of age. Hearing loss must be diagnosed during the first months of childhood in order for interventional therapy to be initiated at designated and appropriate times (3). Thus, the Joint Committee on Infant Hearing emphasizes early hearing detection and intervention programs prior to the sixth month of infancy (1, 4).

Approximately one million children worldwide have been born through assisted reproduction

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techniques (ART) (5). In our country many children are born with the use of techniques such as *in vitro* fertilization (IVF) and intracytoplasmic sperm injection (ICSI) who present with evidence of multi-fetal gestation, low birth weight, premature delivery and congenital anomalies (6).

Follow-up studies on the health and the development of children conceived by ART are mandatory to assess the safety of these procedures (7).

Results of research conducted worldwide are controversial regarding congenital anomalies among ART conceived newborns. Some research studies have discovered a high prevalence of congenital disorders within these newborns whereas other studies indicate an equal prevalence of congenital anomalies in newborns conceived by ART in comparision with normally-fertilized newborns. According to a survey in the United States, the prevalence of anomalies in normal infants is 3–4% whereas anomalies in ART infants have been reported as 1.4 to 2 times higher (5).

In another study, there were 301 infants conceived by ICSI with 26 cases (8.6%) of congenital anomalies. In this study, out of 837 infants conceived by IVF, 75 cases (9%) had congenital anomalies; whereas 168 cases (4.2%) out of 4000 normally conceived infants were born with congenital anomalies (8).

A study in Finland determined that cleft palate and ear atresia were seen in approximately 0.3% of infants born by IVF which conform to prevalence of these abnormalities in normally-fertilized infants. They determined that the status of infants born by IVF may be worse when compared with normally-fertilized infants after adjusting for mother's age, number of gestations and socio-economics status (9).

Loft et al. have shown that at least one case affected by congenital disorders included cleft palate, facial nerve paralysis and shortening of the tongue frenulum (10).

According to research by Vernaeve et al. on the outcomes of ICSI, it has been reported that congenital malformations such as bilateral cleft lip and premature birth were more common (4%) in non-obstructive azoospermia (11).

In a review article by Lie et al. they concluded that the rate of severe anomalies in infants born by ICSI were 1.12 times more than infants born by IVF and no significant difference was seen in neural tube defect and cleft palate (12).

In another study by Bonduelle, five year-old children born by ICSI were compared with children of the same age who were born following spontaneous conception. In this study, surgery on the tympanic membrane and adenoidectomy were conducted on 39 out of 300 ICSI cases whereas the rate of these surgeries was 28 in the control group. In both groups, two cases underwent ear tag surgery and one case had a prominent ear. No difference was seen in the rate of hearing loss and no children had deep hearing loss. Common causes of hearing loss in both groups were otitis media and accumulation of fluid in the middle ear (13).

In a report issued by Ghasemi et al., 10016 normal infants (without any hearing loss risk factors) were evaluated with the OAE test from 2002 to 2004 in three Mashhad, Iran hospitals. A total of 9615 infants (96%) had healthy hearing and 401 cases (4%) were referred for complementary hearing tests (14).

This survey was conducted to evaluate and to determine both hearing and ear health conditions of newborns conceived by ART.

Materials and Methods

In a descriptive study, 300 newborns were non-randomly evaluated. Over a 16 month period begining on September, 2008, women who were Tehran, Iran residents who conceived by ART at Royan Institute were selected. The women were fully informed about the study and after delivery, they were referred to the Child Health and Development Research Center [affiliated with the Academic Center for Education, Culture and Research (ACECR)] for examination of their newborns (aged from zero to 28 days).

Demographic data was collected for each newborn. All newborns were examined by a pediatrician to evaluate their general health condition. All participating newborns, including healthy and non-healthy cases were examined by an audiologist. Both ears were examined otoscopically to evaluate the external ear and tympanic membrane. Transiently evoked otoacoustic emissions (TEOAE) which is an objective test that does not require the cooperation of the newborn (15) was performed to evaluate hearing status.

TEOAE has approximately 90% sensitivity and 95% specificity for evaluation and screening of hearing conditions in infants (16, 17).

In this test,when there was no evidence of obstruction, infection or inflammation in the ears, the TEOAE wave was registered after a click (stimulus) at 5-20 millisecond intervals with an 82 dB SPL altitude. Data were analyzed by statistical test, SPSS-16 and descriptive statistics were presented by fr quency tables. Analytical statistics were done by chi square and Fisher's exact tests.

If any hearing defects or ear anomalies were discovered, the newborns were subsequently referred to specialized centers.

Table 1: Frequency of tympanic membrane anomalies in newborns conceived by ART

Tympanic membrane	Left ear					Right ear				
	Obstructed by wax	Inflammation	Retracted	Perforated	Normal	Obstructed by wax	Inflammation	Retracted	Perforated	Normal
No (%)	1 (0.33%)	2 (0.66%)	11 (3.67%)	1 (0.33%)	285 (95.00%)	1 (0.33%)	1 (0.33%)	10 (3.34%)	1 (0.33%)	287 (95.67%)
Tympanic membrane	Both ears									
	Normal					Anomalies				
No (%)	284 (94.67%)					16 (5.33%)				

The Research Ethics Committee of ACECR and Royan's Institutional Review Board approved the study.

Results

In this study two cases (0.66%) had bilateral malformation in the auricle and no cases had external ear canal malformation.

There were two cases (0.66%) which had unilateral perforation of the tympanic membrane, three cases (1.00%) in the left ear and two (0.66%) in the right ear had unilateral retraction of the tympanic membrane, eight cases (2.66%) had bilateral retraction of the tympanic membrane, one (0.33%) had unilateral tympanic membrane inflammation, one (0.33%) had bilateral tympanic membrane inflammation and one (0.33%) case had bilateral wax obstruction of the external ear canal (Table 1).

A total of 289 out of 300 newborns underwent transiently evoked otoacoustic emission (TE-OAE) testing that three cases (1.03%) did not have a bilateral registered wave and were diagnosed as bilateral hearing loss (Table 2).

Discussion

According to most papers the best group of newborns to compare with ART newborns are those born from mothers with past histories of infertility who were untreated; however, these newborns are few in number and often unavailable.

Our study showed that two newborns (0.66%) had auricle anomalies but no cases had external ear canal defects. Wennerholm et al. who studied the incidence of congenital malformations in children born after ICSI determined that 7.6% of the cases had anomalies and a preauricular appendix (preauricular tag) (18).

In another study conducted by Bondulle, 300 children born after ICSI were compared with children born after spontaneous conception. There were two cases who underwent ear tag surgery and one case had a prominent ear, which was similar to the control group (13).

In our study, it was determined that one out of 300 cases had bilateral canal wax obstruction, two had inflammation of the tympanic membrane, 13 newborns had retracted tympanic membranes and two cases had perforated tympanic membranes. These findings reveal that 5.33% of newborns conceived by ART had a type of tympanic membrane defect and 94.67% of them were normal. Bonduelle reported that 39 children from 300 children born after ICSI had tympanic and adenoidectomy surgeries, whereas these surgeries were performed in 28 out of 266 children born after spontaneous conception (13). Due to the age differences of children in our study (0 to 28 days) versus those of Bonduelle's research (5 years old), there were no other histories of any surgical procedures in our study nine months after birth.

An infant born by ICSI had an auricle anomaly. There were 11 cases (4.52%) from the ICSI group who had tympanic membrane defects and two cases (0.82%) in this group had hearing loss. According to Bonduelle and Ludwig's reports, no significant difference was seen between hearing loss in children born after ICSI and children born after spontaneous conception (13, 19). The main cause of hearing loss was otitis media and accumulation of fluid in the middle ear, no deep hearing loss was found (13).

The mothers' ages in 225 cases (75.00%) was less than 35 years old. All newborns (three cases) with hearing loss belonged to this group. There was no significant association between hearing loss and mothers' ages ($p>0.05$).

In this study, 99.34% of the mothers had no history of any severe abdominal trauma or history of x-ray exposure during pregnancy. All newborns with hearing loss or auricle and tympanic membrane defects belonged to this group of mothers; these findings revealed no relationship between those disorders to abdominal trauma and x-ray exposure ($p>0.05$).

Table 2: Frequency of auricle, external ear canal, tympanic membrane anomalies and hearing loss by other study variables

		Number (percent) of newborns examined	Number (percent) of auricle and external ear canal anomalies	Number (percent) of tympanic membrane anomalies	Number (percent) of hearing loss
Sex	Female	137 (45.67%)	0 (0%)	6 (4.37%)	2 (1.45%)
	Male	163 (54.33%)	2 (1.22%)	9 (5.52%)	1 (0.61%)
ART technique	IVF	57 (19.00%)	1 (1.75%)	4 (7.01%)	1 (1.75%)
	ICSI	243 (81.00%)	1 (0.41%)	11 (4.52%)	2 (0.82%)
Mother's age	Less than 35 years old	225 (75.00%)	1 (0.44%)	13 (5.77%)	3 (1.33%)
	More than 35 years old	75 (25.00%)	1 (1.33%)	2 (2.66%)	0 (0%)
Abdominal trauma to mother	Yes	2 (0.66%)	0 (0%)	0 (0%)	0 (0%)
	No	298 (99.34%)	2 (0.67%)	15 (5.03%)	3 (1.00%)
Mother's contact with x-ray	Yes	2 (0.66%)	0 (0%)	0 (0%)	0 (0%)
	No	298 (99.34%)	2 (0.67%)	15 (5.03%)	3 (1.00%)
Family relation of parents	Yes	50 (16.66%)	1 (2%)	1 (2%)	2 (4%)
	No	250 (83.34%)	1 (0.04%)	14 (5.60%)	1 (0.04%)
Familial History of hearing loss	Yes	4 (1.34%)	0 (0%)	0 (0%)	0 (0%)
	No	296 (98.66%)	2 (0.67%)	15 (5.06%)	3 (1.01%)
Auto-toxic drug history	Yes	87 (29.00%)	1 (1.14%)	4 (4.59%)	2 (2.28%)
	No	213 (71.00%)	1 (0.47%)	11 (5.16%)	1 (0.47%)
Birth weight	< 2.5 Kg	100 (33.34%)	0 (0%)	2 (2.00%)	2 (2.00%)
	2.5 – 4 Kg	198 (66.00%)	1 (0.50%)	13 (6.56%)	1 (0.50%)
	> 4 Kg	2 (0.66%)	1 (0.5%)	0 (0%)	0 (0%)
Gestational age	Preterm	95 (31.67%)	1 (1.05%)	5 (5.26%)	2 (2.10%)
	Term	203 (67.67%)	1 (0.49%)	10 (4.92%)	1 (0.49%)
	Post-term	2 (0.66%)	0 (0%)	0 (0%)	0 (0%)
Tetanus and measles vaccination of mother before gestation	Yes	248 (82.66%)	1 (0.40%)	11 (4.43%)	2 (0.80%)
	No	52 (17.34%)	1 (1.92%)	4 (7.69%)	1 (1.92%)
Delivery technique	NVD	8 (2.67%)	0 (0%)	0 (0%)	0 (0%)
	Caesarian	292 (97.33)	2 (0.68%)	15 (5.13%)	3 (1.02%)
Multifetal gestation	Singleton	85 (28.33%)	0 (0%)	9 (10.58%)	2 (2.35%)
	Twin or more	215 (71.67%)	2 (0.93%)	6 (2.79%)	1 (0.46%)
History of mother's diseases	Yes	25 (8.33%)	0 (0%)	1 (4%)	0 (0%)
	No	275 (91.67%)	2 (0.72%)	14 (5.09%)	3 (1.09%)

Most parents did not have familial relationships and most tympanic membrane defects were seen in this group. None of the newborns had auricular, external ear canal defects or hearing loss in the group whose parents had a history of hearing loss ($p>0.05$).

There were 71% of the mothers who had no history of taking ototoxic drugs, one case (0.47%) in this group had hearing loss, 5.16% had tympanic membrane defects and only one newborn had an auricular anomaly.

One-third of the newborns had low birth weight (LBW). The least auricular defects and greatest hearing loss were seen in LBW newborns. Newborns of normal weight had the most tympanic membrane defects. There was no significant association between LBW and hearing loss ($p>0.05$).

In this study, 248 mothers (82.66%) were vaccinated against tetanus and measles prior to pregnancy. Two newborns (0.80%) of vaccinated mothers had hearing loss. There was no statistically significant relationship between vaccination and hearing loss ($p>0.05$).

Twenty-five mothers (8.33%) had histories of severe disease during pregnancy. No auricular anomalies, tympanic membrane defects or hearing loss belonged to newborns in this group, therefore it was determined that those defects were not related to histories of severe diseases ($p>0.05$).

In this study 1.03% of newborns had hearing loss. Hearing loss was seen in only 0.49% of term newborns which was similar to the prevalence of hearing loss in the general population of newborns who live in Tehran (5 in 1000 cases) (20).

Conclusion

This study shows that hearing and ear screening in newborns conceived by ART is contemplative. The present research emphasizes the profitability of continued examinations in these newborn infants. These findings emphasize that newborns born by ART (particularly those who are preterm) need early evaluation and screening for the diagnosis and treatment of hearing loss in order to prevent speech, communication and learning disorders.

1. Suggestion the most important problem in evaluating newborns conceived by ART is the inability to compare their condition to spontaneously conceived (SC) newborns due to the parents' conditions relating to a history of infertility and its treatments. The best comparisons are those newborns whose parents had history of infertility who became pregnant without the use of ART.

2. A small sample size is another problem for the evaluation of this group of newborns which may lead to bias in data collection and interpretation. Therefore, we suggest that a long-term follow-up study should be planned and conducted in order to achieve reliable and interpretable data.

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