PREVALENCE OF CHROMOSOMAL ANOMALIES AND CORRELATION WITH INDICATIONSOF ULTRASOUND AND BIOCHEMICAL MARKERS IN HIGH-RISK PREGNANCIES

Brijesh Kumar[1*], Meenu Singh[2], Rakesh Kumar Verma[3], Navneet Kumar[4]

Abstract

A total of 200 prenatal samples were analyzed for chromosomal abnormalities by Karyotype and FISH technique. In these samples, chromosomal anomalies were observed in 31 cases (15.5%); out of which 19 cases (61.29%) were numerical anomalies and 12 cases (38.70%) were of structural anomalies. In present study, 2 cases have been observed for structural unbalanced abnormality and 10 cases for structural balanced abnormality. Also, autosomal trisomies (11 cases) of chromosomes 13, 18 and 21; 3 monosomy X chromosome, 1 XXY, 1 XXX with 21ps+ and one triploidy XXX chromosome were identified in the study. In addition, mosaic cell lines XY/XY+21 and XX/XXXX chromosome complement were observed.

Key words- amniotic fluid. chromosome abnormality. karyotype. microarray. prenatal diagnosis.

[1*]Department of Biotechnology, IILM College of Engineering and Technology, Gr. Noida, Uttar Pradesh, India
(Research Scholar) +91 97112 65499, Email: brijlpl@gmail.com
[2]Department of Biotechnology, IILM College of Engineering and Technology, Gr. Noida, Uttar Pradesh, India
Professor Mobile No. 9899046145, Email:meenu.sd2@gmail.com
[3]Department of Anatomy, King George Medical University, Lucknow, Uttar Pradesh, India
Additional Professor Mobile No.9455252213, Email:rkkgmu@gmail.com
[4]Department of Anatomy, King George Medical University, Lucknow, Uttar Pradesh, India
Professor & Head Mobile No. 9415083580, Email: navneetchauhan@hotmail.com

***Corresponding Author:**Brijesh Kumar
*Department of Biotechnology, IILM College of Engineering and Technology, Gr. Noida, Uttar Pradesh, India
(Research Scholar) +91 97112 65499, Email: brijlpl@gmail.com

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INTRODUCTION

Chromosomal abnormalities are common causes of fetal birth defects, characterized by intellectual disability (ID), multiple malformations, intrauterine growth restriction (IUGR) etc. First trimester prenatal screening is done with the maternal serum to measure the concentration of free β- human chorionic gonadotropin (hCG) and pregnancy-associated plasma protein (PAPP-A), combined with ultrasound measurements of the nuchal translucency (NT). Other pregnancy tests include maternal age, including maternal serum alpha-fetoprotein (AFP) and human chorionic gonadotropin levels. These biochemical parameters, together with maternal age, indicate a 60% probability of Down syndrome and a 5% false positive rate (Lewis et al. 1991). However-execution of early combined screening enables the identification up to 90% of Down syndrome cases with 5 % false positive results (Spencer et al. 2003; Borrell et al. 2004). Therefore, invasive techniques viz amniocentesis and chorionic villus sampling are used for prenatal analysis. Previous studies have reported some serious chromosomal abnormalities with altered chromosome numbers, such as Down syndrome (trisomy 21), Turner syndrome (45, X), and Klinefelter syndrome (47, XXY). Other than these syndromes, heteromorphic variants were diagnosed in 22 (1.3%) cases and 563 (3.66%) out of 15, 381 cases were found to have abnormal fetus chromosomes in Korea (Kim et al. 2013). Sheth et al. (2015) have found 125/1,728 (7.2%) abnormal karyotypes from western Indian population, out of which 46 cases were (2.7%) of trisomy 21, 11 cases were showing (0.6%) trisomy 18, 3 cases (0.1%) were of trisomy 13, 7 (0.4%) were found to have turner syndrome and 6 cases were (0.34%) of inversions in the Y chromosome. Chromosomal abnormalities are known to contribute significantly to genetic diseases leading to fetal loss, infertility, stillbirth, birth defects, abnormal sexual development, cerebral edema, and malignancies. In addition, chromosomal abnormalities are associated with more than 60 symptoms. They account for 50 % of unintended abortions, 6% of stillbirths, about 5% of couples with two or more pregnancies, and about 0.5 % of newborns. In women aged 35 years and older, chromosomal abnormalities account for about 2 % of all pregnancies (Frederick et al. 2001). Canadian study (1977) showed an 82 % reproductive success rate at less than 15 weeks' gestation, compared with 94 % at 16 weeks or later. An additional incentive for early sampling is the belief that the large amount of amniotic fluid expected in early pregnancy can cause orthopedic and respiratory problems in the baby (Menasha et al. 2005).

Currently, there is no effective treatment for the fetal disease, which places a heavy financial and emotional burden on parents and society (Templado et al. 2005). Prenatal screening is helpful for the families as it aids to reduce the birth rate of children with chromosomal abnormalities. Genetically abnormal born baby holds significance worldwide that poses challenge to both clinicians and parents. Furthermore, the main method for examination of amniotic fluid cells are karyotype, FISH, and microarray. Studies have demonstrated that, karyotyping is the gold standard cytogenetic technique to detect fetal chromosomal abnormalities. Important prenatal diagnoses include maternal age, de novo chromosome of the first child, presence of parental structural chromosome abnormality, genetic disease in families that can be detected and excluded by biochemical or DNA testing, and family history like risk of X-linked diseases, muscular dystrophies, maternal blood serum tests and ultrasound tests (Nussbaum et al. 2007).

Prenatal diagnosis was first performed by Steele and Berg in 1996 using karyotype analysis of cultured amniotic cells. Amniotic fluid and chorionic villus sampling are the main sources of samples used for the prenatal test. Apart from this, major aneuploidies as well as the structural rearrangements were identified (Shaffer et al. 2012) using conventional cytogenetic studies. Cytogenetic study has begun to work hard to ensure good banding quality, chromosomal-specific and diagnostic molecular analysis to solve 50 % of the concern serious problems. In addition, it can be found out more information using new screening tests that can be identified for risk. Today, new techniques such as microarrays are used in scientific studies.As a result, various techniques have been developed for rapid and accurate prenatal diagnosis (Park et al. 2011; Fiorentino et al. 2011; Lee et al. 2012). It was observed that autosomal aneuploidy was the utmost common pattern occupying 64.53 % and its finding rate was 5.51 %, out of which 48.32 % (173 cases) were 21-trisomy, which was the important type of anomalous karyotypes, surveyed by 18-trisomy. There were 38 samples with chromosome aneuploidy, including 47XXY, 47XXX, 47XYY, XXX and 45X0 which accounts for 10.61 % and the recognition %age was 0.91 % (Huafeng et al. 2018). On one hand, Chromosome

physical syndromes occupied 10.61 % of the chromosomal anomalies including Robertsonian translocation in 16 cases, balance translocation in 14 cases, inversion in 3 cases, deletion in 3 cases and on other hand, chromosome polymorphism occupied 10.61 %. Other unusual anomalous karyotypes such as mosaicism were observed in 11 cases out of 358 and marker chromosome in 1.3 % cases. The progressive age and serologic screening for high threat were the foremost pre-natal investigative suggestions for pregnant females with chromosomal anomalies (Huafeng et al. 2018).

This study examined 200 high-risk pregnancies using the diagnostic procedures of amniocentesis and chorionic villus sampling (CVS). Present study summarizes the relationship between chromosomal abnormalities during pregnancy and various symptoms of prenatal diagnosis. Therefore, this study has been planned to screen the chromosomal abnormalities using karyotyping and fluorescent *in situ* hybridization (FISH) with available probes for chromosome (13, 18, 21, X, Y, etc.). The finding of this study will be an addition to the knowledge and scope to simplify accurate genetic diagnosis of unborn fetuses as well as it will help in genetic counseling.

Objectives

Prenatal diagnosis holds great importance for pregnant females with high-risk pregnancies. It can be done by the maternal serum screening, ultrasonography, non-invasive and invasive methods. Therefore, the current study emphasizes on investigating and analyzing the type of fetal chromosomal anomalies in prenatal samples for high-risk pregnancies by conventional and molecular cytogenetic analysis.

MATERIAL AND METHODS

Sample Selection

The selection criteria for samples were constructed on the observation of maternal screening, ultrasonography and clinical history of the patient for high-risk pregnancies. A well-informed written consent was obtained from the patients and the clinicians. A total of 200 prenatal samples were cultured for karyotype and FISH analysis to ascertain the chromosomal (structural and numerical) aberrations. The gestational age of the pregnancy was calculated based on the ultrasound. The prenatal diagnosis was performed by invasive method CVS and amniocentesis in which chorionic villus sampling was collected at the average gestational period of 11-13 weeks and amniotic fluid was collected at the average gestational period of 14-22 weeks respectively. The study of patients who underwent prenatal testing were as per the norms of Institutional Ethics Committee and Pre–Conception and Pre-Natal diagnostic Techniques Act, 1994. All pregnant women received genetic counselling and Informed Consent was signed by them. The indications of prenatal diagnostic include but not limited to advanced maternal age, high-risk serological screening, abnormal non-invasive prenatal DNA test, ultrasonographic abnormal indications, paternal/maternal carrying chromosome abnormality, a history of intrauterine fetal death or aborted fetuses.

Culture of Prenatal Sample and Analysis for Karyotype and FISH

The prenatal samples were transported in sealed and sterile sample collection vials by the clinician who observed the high-risk pregnancies by the maternal serum screening and ultrasonography at first trimester and second trimester. Thereafter, the samples were processed for culture and FISH. Prenatal samples (Amniotic fluid and CVS) were centrifuged and cultured in T-Flask containing Amniomax (GIBCO) media. Afterward, the appropriate confluency of the culture gives the impression using standard cytogenetical procedures (Jobanputra et al. 2002).

Amniotic Fluid and CVS Cell Culture and Karyotype Analysis

Amniotic fluid (20 mL) was obtained (discarding the first 1–2 mL of amniotic fluid) and collected in two sterile disposable centrifuge tubes, and in the case of CVS, samples were washed with media and collected in two tubes for centrifugation at 1000 rpm for 10 min. Then, after centrifugation, the supernatant was removed and 0.5 mL of the cell suspension was inoculated into 4 mL of Gibco Amniomax-II (Thermo Fisher Scientific Inc.) amniotic fluid medium under sterile conditions for stationary culture for 7 days at 37 °C and 5 % CO_2. Cell growth was monitored daily after medium (4.0 mL media used for transformation) recovery. When amniotic fluid cells attach to the bottom of the flask and grow rapidly, and metakinetic cells reveal multiple clones under an inverted microscope, the fluid in each centrifuge tube is collected and tested against amniotic fluid as described below:

300 µL Colcemid solution (Thermo Fisher Scientific Inc.) was added to the culture flask and incubated for a further 1 h at 37˚C. The medium

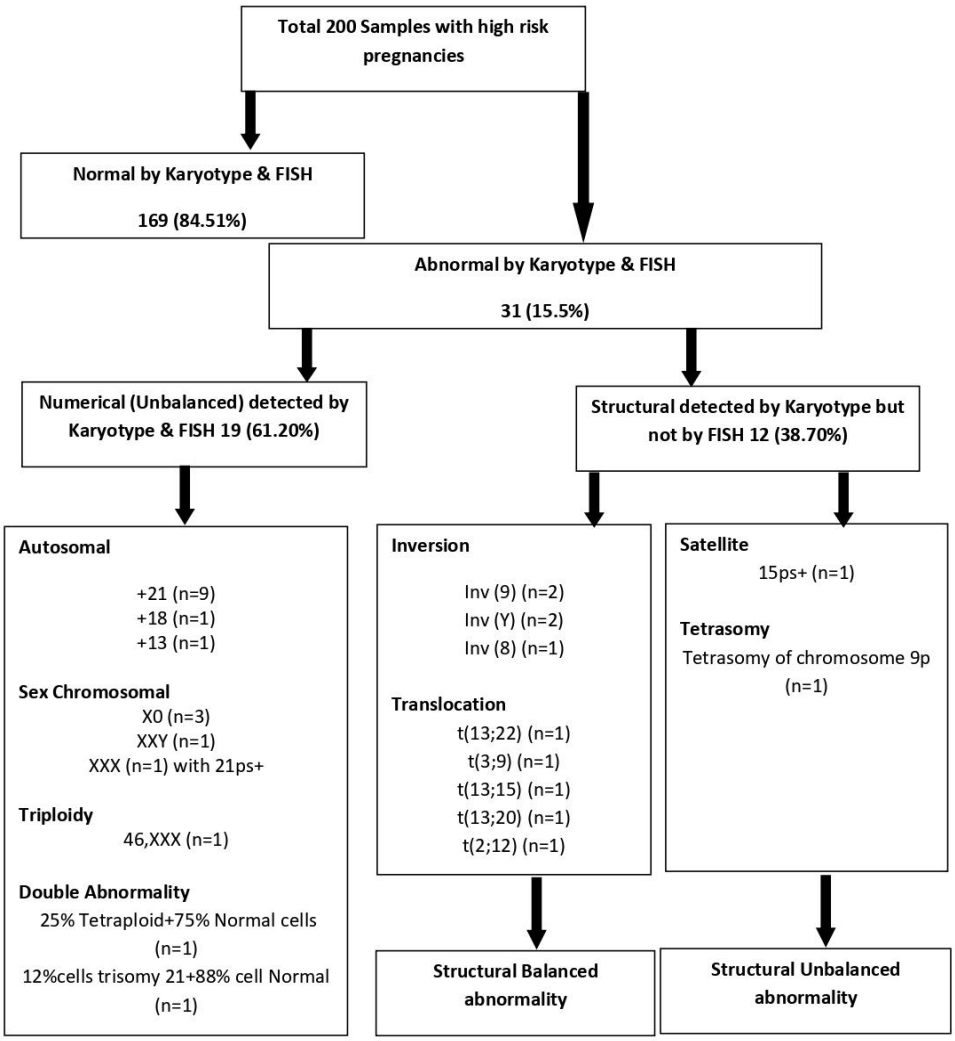
was removed from the culture flask and saved in a prelabeled centrifuge tube. Trypsin-EDTA (2 mL) was mixed to the culture flask and the cells were washed by taping the flask from bottom. The cells were detached from the flask and 2.0 mL of additional trypsin-EDTA solution was added to it and transferred in to centrifuge tube. The cultured tubes were centrifuged at 1000 rpm for 10 minutes and the supernatant was discarded from tube and 7 mL hypotonic solution (0.56 %) of potassium chloride was supplemented to the cultured cell, resuspended and kept for 25 minutes at 37˚C temperature. Freshly made fixing solution was added to every test-tube and assorted softly by inverting the test-tubes twice then centrifuged at 1000 rpm for 10 minutes and the supernatant discarded and the fixative step repeated thrice. Now, the cultured cells were put off in a slight volume of fixative to give a somewhat impervious suspension and 3 to 4 drops were placed consistently on a cold wet slide and allow to dry. The G-band staining technique was used to prepare the chromosome specimens. Every sample was examined under a light microscope in accordance with the International System for Human Cytogenomic Nomenclature 2013 (Shaffer et al. 2013). When the abnormal karyotype (mosaicism) was recognized, the investigation was accomplished for a total of 50 karyotype images.

FISH Analysis

Interphase FISH was performed on uncultured cells using a set of aneuploidy FISH probes (Vysis; Abbott Molecular, Abbott Park, USA) for chromosomes 13, 18, 21 and X, Y to ascertain the common aneuploidies (Jobanputra et al. 2002). Human chromosomes were stained by 4'-6-diamidino-2-phenylindole (DAPI) for 10-15 min at room temperature in the dark and displayed bright fluorescence at subordinate constriction sections of chromosomes 13, 18, 21, X and Y.

Statistical Analysis

The data analysis has been done using MS excel software**.**



Flow chart for karyotype and abnormality detection

RESULTS AND DISCUSSION

Classification and Detection Rate of Abnormal Cases

In the present investigation, a total of 200 cases were enrolled between 2016 and 2019. All the cases were analyzed by karyotype as well as by FISH simultaneously. In which, 31 cases were identified as abnormal by karyotype and 19 cases were abnormal by FISH (Table 1, 2 and 3).

TABLE 1- LIST OF TOTAL ABNORMAL CASES (31/200) OF THE STUDY

S. No.	*Age (yrs)*	*Test performed*	*Type of sample*	*Results*		*Interpretation*	*Clinical indications*
				Karyotype	*FISH*		
1	30	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Triploidy	Severe IUGR
2	31	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Abnormal Moasic	Abnormal fetal ultrasound findings
3	38	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Mosaic Trisomy 21	Advanced Maternal age, Abnormal Maternal serum screening
4	35	Karyotype + FISH	CVS	Abnormal	Normal	Balanced Translocation (13and22)	Mother carrier of balanced translocation (13and22)
5	35	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Triple test positive
6	35	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 13	Holoprosencephaly
7	36	Karyotype + FISH	CVS	Abnormal	Abnormal	Monosomy X	IncreasedNuchal translucency
8	38	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Abnormal Maternal serum screening
9	30	Karyotype + FISH	CVS	Abnormal	Normal	Translocation between hromosome 3and 9	Father carrier for balanced translocation
10	37	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Inversion 9Normal Variant	Triple marker positive
11	33	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Robertsonian carrier	Abnormal Maternal serum screening
12	42	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 18	Abnormal Maternal serum screening
13	28	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Abnormal Maternal serum screening
14	40	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Abnormal Maternal serum screening
15	24	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Monosomy X	Fetus with cystic hygroma
16	38	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Positive Quadruple Marker
17	28	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Inversion Y Normal variant	Inversion
18	33	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Inversion Y Normal variant	Abnormal Maternal serum screening
19	41	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Hypoplastic Nasal Bone
20	35	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Inversion 9Normal Variant	High Risk on Screening
21	28	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	15ps+ Normal variant	Double marker risk
22	29	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Tetrasomy 9p	Polyhydramnios
23	32	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Atrioventricular septal defect (AVSD)
24	42	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	46,XXY	Advanced maternal age
25	27	Karyotype + FISH	CVS	Abnormal	Normal	Balanced translocation chr. 13 and 20	Mother have balanced translocation chr. 13 and 20
26	30	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Balanced translocation chr.2 and 12	Abnormal Maternal serum screening
27	24	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Monosomy X	18 weeks fetus with cystic hygroma
28	36	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Triple XXXand 21ps+	Positive Triple Marker
29	31	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Absent Nasal Bone
30	28	Karyotype + FISH	Amniotic Fluid	Abnormal	Normal	Inversion 8	Mother have inversion 8
31	37	Karyotype + FISH	Amniotic Fluid	Abnormal	Abnormal	Trisomy 21	Advanced maternal age

In karyotype study; 11 cases for trisomy [9 for trisomy 21 (Case# 30, 61, 109, 120, 131,154,174,193,200), one case for trisomy 13 (Case# 41) and one case for trisomy 18 (Case# 84)], three cases for monosomy X (Case# 48,125 and 187), two cases for chromosome inversion 9 (Case# 80 and 157), two cases for chromosome inversion Y (Case# 128 and 151), two cases of abnormal mosaic (Case# 5, 25 % cell tetraploid and 75 % cells normal; and Case# 12 in which 12 % cells trisomy 21 and 88 % cells are normal), four cases for balanced translocation {(chromosome 13 and 22, Case#17 in which mother is carrier and another case (Case# 64) for chromosome 3 and 9, in which father is carrier; Case#181 balanced translocation for chromosome 13 and 20 in which mother is carrier; Case#182 balance translocation for chromosome 2 and 12 in which fetus was effected but parents were not screened)}, one case for triploidy (Case# 4), one case for Robertsonian translocation (Chromosome 13 and 15, Case No. 81) and one case for chromosome 15ps+ (Case# 163), one case for chromosome tetrasomy 9p (Case# 171), one case for Klinefelter syndrome (Case#177), one case for super female with 21ps+ (Case#190), one case for inversion chromosome 8 (Case#197) were observed. In FISH study; eleven cases were found for trisomy in which three cases were of monosomy X, two were of abnormal mosaic and one was showing triploid, one case was of Klinefelter, and one was of super female with 21ps+.

TABLE 2- CLASSIFICATION AND DETECTION RATE OF 31 CHROMOSOMAL ABNORMAL KARYOTYPES

Chromosomal karyotype	*Number (n)*	*% occupancy (n/31)*
47,XX/XY,+21	9	29.08
47,XX+18	1	3.22
47,XX+13	1	3.22
47,XXX	1	3.22
47,XXY	1	3.22
45,X	3	9.67
69,XXX	1	3.22
Structural Abnormality	12	38.70
Mosaic	2	6.45
Total	31	100

TABLE 3- KARYOTYPES OF 12 STRUCTURAL DISORDERS OF CHROMOSOME

Type of chromosomal abnormality	*Numbers*
Balanced Translocation	5
Inversion	5
With Satellite	1
Tetrasomy 9p	1
Total	12

The study done by Huang et al. (2002) reported that 9.5 % of Turner syndrome cases were having a Y chromosome. Although 45, X/46, and XX phenotypes vary from normal females to full-blown Turner syndrome, the range of phenotypes at birth in prenatally diagnosed cases has been reported to be about 14% (Hsu, 1998). Furthermore, the occurrence of a Y chromosome or Y chromosome sequences can be linked with a danger of emerging neoplasia of the sex gland (gonadobalstoma), or masculinization and an incorrect fetal gender assessment. Additionally, molecular testing for the sex determining region on Y (SRY) gene must also be accomplished both during pre-natal analysis and afterward the birth (Gravholt et al. 2000; Huang et al. 2002). The investigations by Yang et al. (1999); Tseng et al. (2006) and Karaoguz et al. (2006), anomalous results showed the highest recognition %age for chromosomal anomalies in pre-natal analysis. In a study done by Wu et al. 2023, abnormal karyotypes were detected more frequent in cases diagnosed at ≤ 24 weeks (7.2%) than in the other groups. In pregnancies with a normal karyotype, SNP array technology showed a 4.2% increase in detection of clinical abnormality.

Distribution of Indications of Prenatal Diagnosis in Chromosomal Abnormalities

Correlation between Maternal Age(AdvancedMaternal Age) and Abnormal Fetal Chromosome

In the present study, 200 pregnant women were enrolled in which, 59 were with advanced

maternal age (≥35 years), that is 29.5% of the total cases. In advanced maternal age (≥35 years), 25.42 % were recorded abnormal while 8.19 %, 13.55 % and 9.52 % abnormal cases recorded for age group 31-34 years, 26-30 years and 20-25 years respectively.

TABLE 4- COMPARATIVE DISTRIBUTION OF TOTAL CASES BASED ON AGE GROUPS

S. No.	*Age*	*Cases*	*Normal*	*Abnormal*
1	20 - 25 years	21	19 (90.47 %)	2 (9.52 %)
2	26 - 30 years	59	51 (86.44 %)	8 (13.55 %)
3	31 - 34 years	61	56 (91.80 %)	5 (8.19 %)
4	35 and above	59	44 (74.57 %)	15 (25.42 %)
	Total	200	-	-

A similar study carried out by Sung-Hee et al. (2008) in Korea on 31,615 mid-trimester amniocenteses and reported that the most common age group (35.4 %) of maternal women was between 30 and 34 years and the chromosomal anomalies detected were in 3.1 % (973 cases), in which Down-syndrome was the most common anomaly.

Correlation between Positive Serum Screening Results and Abnormal Fetal Chromosomes

Among the 200 cases, 122 cases were reported for positive serum screening, where chromosomal abnormalities were observed in 14 cases by karyotype and 8 cases found by FISH. Chromosomal abnormalities are the common genetic disorders which causes neonatal birth defects. The occurrence of chromosomal anomalies is about 0.5 % in live newborns (Hook et al. 1984), which reached 5 to 13 % in stillbirths (Reddy et al. 2009). There is currently no effective treatment for birth defects. Analysis of the karyotype of amniotic cells in the second trimester is an important preventive method for prenatal diagnosis and early termination of abnormal pregnancy (Vaknin et al. 2008). According to cell genetics, if the gene is not in a balanced chromosomal structure, no clinical symptoms will occur, so it is recommended to continue pregnancy (Hulten et al. 2003). However, both men and women should pay attention to the possibility of teenage problems. Chromosomal mosaicism refers to the presence of two or more karyotypes in the same body. Mosaics can be divided into real mosaics and pseudo mosaics. Chromosome testing of the cord blood can eliminate false implantation and contamination in the mother's blood. The increased risk of fetal chromosomal abnormalities depends on the age of the mother's ovum and maternal chromosomal mismatch (Ogilvie et al. 2005). Ozdemir and others in 2022, Trisomy 21 is the most common chromosomal abnormality and has the best predictive value of the non-invasive test (NIPT), encouraging more NIPT research due to the discovery and scientific progress. Farladansky-Gershnabel et al. (2023) recommend that babies with chronic pyelectasis be evaluated after birth and followed closely until reflux, obstruction, or other complications resolve.

Correlation between Abnormal Ultrasonography Indicators and Abnormal Fetal Chromosomes

There were 58 cases with various abnormal ultrasonography indicators that included the following abnormalities- Severe IUGR, Holoprosencephaly, Increased NT, Fetus with cystic hygroma, Hypoplastic Nasal Bone, Polyhydramnios, hydrops, Ventriculomegaly, Congenital hernia in baby, fetus, Mild B/L hydronephrosis with cleft palate, Polyhydramnios with bilateral poly-fusion, Echogenic bowel, Microcephaly, Fetus growth restriction, Echogenic-intera ventricular focus, Occipital encephalocele, mega-cisterna present, baby with limb reduction defects, absent nasal bone. Chromosomal abnormalities were observed in 13 cases by karyotype and 11 cases by FISH. Chromosomal abnormalities observed in 13 out of 58 (22.41 %). Similarly, Huafeng et al. (2018) reported that autosomal aneuploidy was the utmost common pattern (64.53 %) in China. Shrivastava et al. (2021) report that balanced translocation carriers are affected by the non-disjunctive process of meiosis and that early detection of genetic abnormalities may be informative for parents who intend to conceive. After the first miscarriage, genetic analysis of the miscarriage can help to understand the cause of the miscarriage. Choi et al. (2022) reported that artificial abortions is carried out at a high rate, even for malformations or low malformations with a good prognosis,and suggested the need for a national study to develop treatment guidelines for real or speculative events. Eskandar (2022) suggests that the continuous development of genomic medicine, in other medical fields, affects prenatal testing and diagnosis, but these

innovations offer new opportunities for pregnant women as their moral responsibility.

Correlation between Parental Abnormal Chromosome Carriers and Abnormal Fetal Chromosome

Five out of 200 cases were reported as balanced translocations. Amongst these, 3 were known cases of parents with balanced translocation carriers. Whereas in 2 cases, the parents were having normal karyotype. One case was reported for balanced translocation between chromosome 13 and 22 in karyotype while the FISH and Microarray results were normal. In this case, mother showed 13 and 22 balanced translocation. In the second case, a translocation between chromosome 13 and 20 was found, the FISH was normal and the Microarray showed arr20q11.2(29,835,035-30,117,285)x3 with variant of uncertain significance. In this case also, the mother showed 13 and 20 balanced translocation. The third case was reported for balanced translocation between chromosome 3 and 9. Here the father was having a balanced translocation between chromosomes 3 and 9. The fourth case with balanced translocation between chromosome 13 and 15 and the fifth cases with balanced translocation between chromosome 2 and 20 were *De novo* as the parents were having a normal karyotype. He et al. (2020) suggests several screening strategies that can be used to differentiate a fetus from congenital anomalies or genetic disorders before birth. In addition, accurate genetic counseling should be provided to reduce the rate of birth defects and improve the health status of the population. Chen et al. (2023) reported that mosaic tetracytosis during pregnancy was associated with favorable fetal outcomes, premature cell growth, and cytogenetic inconsistency in various tissues during amniocentesis. Amniocentesis mosaic tetrasomy can be a transient and insidious condition and can be associated with a favorable fetal outcome and a decrease in prenatal aneuploidy cell lineage and cytogenetic imbalance in various tissues.

CONCLUSIONS

In a nutshell, it is observed that there is a correlation between future newborn's health and chromosomal abnormalities. Because of this, significant efforts have been made during the past few years to improve prenatal diagnosis and screening. The given data is about pregnancies with chromosomal anomalies and the diagnosis approach used are cytogenetics, molecular, biochemical and ultrasonography technique. Prenatal screening is a tool that helps to identify significant chromosomal abnormalities and rearrangements in unborn infants. Also, it generates complete data of chromosomes after the procedure and hence, it becomes useful at the time of genetic counselling. The complete data is obtained by karyotyping, a tool that is an integral part of the prenatal diagnosis. Before undergoing karyotyping, the first trimester sonographic examination enables the identification of various indicators, such as nuchal translucency, nasal bone absence, tricuspid regurgitation, or irregular blood flow through the ductus venosus, which are linked to a high risk for aneuploidy. On one hand, the major advantage of karyotype is that it is affordable by every parent. Moreover, it helps to decide if the couple can keep the child or not. On other hand, the drawbacks of karyotype (long-term culture and low resolution) are eliminated by Chromosomal Microarray Analysis, however it is expensive and hence may not be affordable for many parents. However, the introduction of prenatal screening and diagnosis has given many couples the chance to make an educated choice regarding the future of their unborn child.

RECOMMENDATIONS

The prenatal diagnosis helps make life better as it enables one to understand chromosomal abnormalities. Furthermore, it makes it easy to provide genetic counseling to parents, which helps them to decide about the ongoing and future child planning.

LIMITATIONS

There are many ways by which chromosomal abnormalities are generated. For systemic metabolic disorders, the most important factor is cell survival, which depends on the chromosome, abnormality and size of the defect. In some of these cases, additional testing is required, as it is necessary to get an idea about the complete identification of the genes. Genetic testing should be combined with ultrasound testing.

CONFLICT OF INTEREST

There is no conflict of interest.

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