ORIGINAL RESEARCH PAPER

Health Science

KEY WORDS: Blastocyst development, Chromosomal abnormalities, IVF, chromosomal abnormalities, embryo selection.

CHROMOSOMAL ABNORMALITIES IN EMBRYOS

Anila Mathew Department of Botany, St. Joseph's College (Autonomous) 36, Lalbagh Road, Bengaluru 560027.

Aparna K Department of Botany, St. Joseph's College (Autonomous) 36, Lalbagh Road, Bengaluru 560027.

Dilmi Kathreena Department of Botany, St. Joseph's College (Autonomous) 36, Lalbagh Road, Bengaluru 560027.

Vishnumaya C Department of Botany, St. Joseph's College (Autonomous) 36, Lalbagh Road, Bengaluru 560027.

Jayarama Reddy* Department of Botany, St. Joseph's College (Autonomous) 36, Lalbagh Road, Bengaluru 560027. *Corresponding Author

ABSTRACT

From patients with a poor prognosis of pregnancy, 1620 embryos generated in vitro and chromosomal analysis was performed on these embryos. The result was yielded in 1596 embryos, out of them 536(34%) were euploid and 1060(66%) carried chromosomal abnormalities. In addition, 92% of embryos with multinucleated cells were diagnosed mosaics whereas the 86% of chromosomal abnormalities were associated to the presence of cytoplasmic concentration. For the derivation of the normal embryonic stem cell (ESC)lines and developmental modelling aneuploid embryos have been used. Genetic diagnosis at the cleavage or blastocyst stage could be partly abnormal because during the preimplantation diploid- aneuploid mosaic embryos was most frequently observed. From a single cell of a particular embryo the chromosomal status of that embryo can be determined, thus the prevalence of mosaicism. Detection of aneuploidy in single cells have been developed recently. After conducting research methods, it was confirmed that aneuploidy is a common feature of human oocytes and preimplantation embryos. The detection of segmental aneuploidy is currently considered problematic for embryo diagnosis and patient counselling, so the data are of great relevance for preimplantation genetic testing. The first major milestone in early mammalian embryogenesis was the formation of a totipotence blastocyst which is capable of implantation. The whole chromosomal abnormalities, or aneuploidy, determines whether the human embryos will arrest or reach the blastocyst stage. Certain embryos can still form blastocyst depending on the type of chromosomal abnormalities and that can be morphologically indistinguishable from chromosomally normal embryos.

INTRODUCTION

Chromosomes are made up of nucleic acid and protein which form a thread like structure (Fig.1a). It is present inside the nucleus of a cell and it contain genetic information in the form of genes. There are two types of chromosomes, that are autosomes and sex chromosomes. Each cell of human generally contains 23 pairs of chromosomes. Chromosomes play a vital role in cell division, heredity, variation, mutation, repair and regeneration. A gene is considered as a unit of heredity which is transferred from parents to offspring. Gene contains information that tell our cells to make some molecule called proteins. These proteins are vital for life. They involved in building of tissues and muscles, production of hormones, enzymes and energy. Also play a major role in immune function. If a human embryo contains 46 chromosomes in 23 pairs, then it is considered as normal embryo. Embryologists called them as euploid embryos (Fig.1a and Fig.1b). Aneuploid embryos that do not have the correct number of chromosomes can lead to birth defects, increased rates of miscarriages, and IVF failure. There are different conditions of aneuploidy. First one is monosomy(2N-1).45 chromosomes are present instead of 46. Next one is trisomy(2N+1),presence of 47 chromosomes. Third one is tetrasomy(2N+2).In this condition 48 chromosomes are present. Fourth is nullisomy (2N-2).IN this condition 44 chromosomes are present. These chromosomal abnormalities leads to different genetic disorders which causes malformation to the embryo. There is no complete cure to these kind of abnormalities. Down syndrome and Turners syndrome are some of the examples. These abnormality can lead to birth defects, increased rates of miscarriages, and IVF failure. Mosaic embryos are embryos which possess both normal and abnormal cells during preimplantation genetic screening testing. The testing, typically completed in the fifth day of embryo development, is completed by taking a tiny biopsy of the embryo and examining the genetic makeup of the cell.

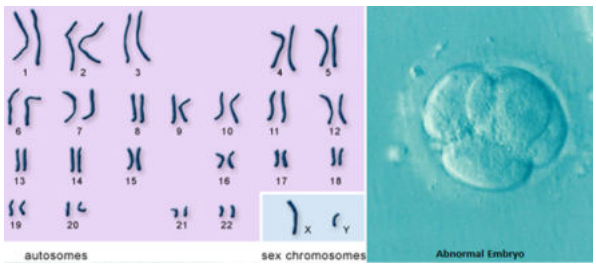

Fig.1a- Human chromosomes and Fig.1b-Abnormal Embryos

METHODOLOGY

Systematic review and meta-analysis of studies on the body constitution of human preimplantation embryos. In 36 studies, out of 2117 citations that met our search criteria, knowledge were provided extensively enough to permit classification of every analysed embryo with prespecified criteria for its body makeup. the most outcome of this classification was the prevalence of body condition in human preimplantation embryos. Whole ordination amplification (Sureplex, Illumina) was performed on cells biopsied from oocytes and embryos of IVF patients UN agency requested body screening. The samples were later on processed and analyzed for his or her body complement exploitation microarray comparative genomic mating (aCGH), (Illumina, Cambridge, UK). commonly the hatching of fertile oocytes on day three, and that they area unit polite to the blastula stage and on day five or half dozen, these 3-7 celled structure area unit herniating from zone is then biopsied. The embryos once diagnostic test were glassy

and by endocrine replacement frozen embryo transfer cycle elect embryos were later on elect. The embryos biopsied on day five and half dozen shows that the euploidy rate was considerably high. These embryos area unit smart and truthful in quality and therefore the likelihood of in progress physiological condition is high. betting on the morphology of the blastula among an equivalent cohort, euploidy rate has important variations. copy technology is increasing these days and therefore the applications and indications are increasing. however solely once scrutiny and thorough thought each new approach is conducted. the information regarding the clinical use of mosaic preimplantation embryos have conferred, by bound consultants at the blastula stage.

RESULT AND DISCUSSION

From the result a strong association between percentage of fragmentation, cellular stage and chromosomal abnormalities was obtained. From the result it suggest that to guarantee the best embryo selection in patients these morphological criteria alone are not sufficient. For self correction of aneuploidies during their later stages of development several reasons have been proposed. They are primary misdiagnosis, allocation of the aneuploidy in the trophectoderm, cell growth advantage of diploid cell in mosaic embryos, aneuploid cell division lagging, aneuploid chromosome extrusion or duplication proliferation of DNA repair gene products. In the human preimplantation embryos after IVF diploid-aneuploid mosaicism is the typical chromosomal constitution. After analysing a single cell the ploidy status of a cleavage-stage embryo can be determined. The emergence and developmental potential of mosaic embryos will be determined in future results. By various corrective mechanisms containing multi-polar division, fragment resorption, endoreduplication and blastomere exclusion, the possibility of aneuploidy resolution in embryos was discussed. This led to a conclusion for IVF success and human fecundity by examining the potential implications. Chromosomal mosaicism complicated the cytogenetic prenatal diagnosis on chorionic villi. Chromosomal abnormalities were the main issue of the first trimester cytogenetic prenatal diagnosis. Because the foetal tissues are not extended by the detected abnormal mosaic lines, hence the prediction of foetal involvement is challenging. Foetal aneuploidy risk assessment is mainly derived from the chorionic villi cells, because the cell-free foetal DNA is targeted by new technologies. Into the clinical field, the same challenges which are related to chromosomal mosaicism can be transferred. The incident of fetoplacental mosaicism, detection of such a biological phenomenon which complicates the management of prenatal diagnosis cases, the effects of its presence for the management of high risk complementary DNA testing results for foetal aneuploidies were demonstrated in this review.

REFERENCES

1. Al-Asmar N, Peinado V, Vera M, Remohí J, Pellicer A, Simón C, Hassold T, Rubio C. Chromosomal abnormalities in embryos from couples with a previous aneuploid miscarriage. Fertil Steril. 2012 Jul;98(1):145-50. does: 10.1016/ j.fertnstert.2012.03.035. Epub 2012 Apr 21. PMID: 22521156.
2. Barash OO, Ivani KA, Willman SP, Rosenbluth EM, Wachs DS, Hinckley MD, Pittenger Reid S, Weckstein LN. Association between growth dynamics, morphological parameters, the chromosomal status of the blastocysts, and clinical outcomes in IVF PGS cycles with single embryo transfer. J Assist Reprod Genet. 2017 Aug;34(8):1007-1016. doi: 10.1007/s10815-017-0944-0. Epub 2017 May 30. PMID: 28560610; PMCID: PMC5533677.
3. Bouba I, Hatzi E, Ladias P, Sakaloglou P, Kostoulas C, Georgiou I. Biological and Clinical Significance of Mosaicism in Human Preimplantation Embryos. J Dev Biol. 2021 May 7;9(2):18. doi: 10.3390/jdb9020018. PMID: 34066950; PMCID: PMC8162329.
4. Chen J, Jia L, Li T, Guo Y, He S, Zhang Z, Su W, Zhang S, Fang C. Diagnostic efficiency of blastocyst culture medium in noninvasive preimplantation genetic testing. F S Rep. 2020 Sep 15;2(1):88-94. doi: 10.1016/ j.xfre. 2020. 09.004. PMID: 34223278; PMCID: PMC8244311.
5. Dang TT, Phung TM, Le H, Nguyen TB, Nguyen TS, Nguyen TL, Nga VT, Chu DT, Hoang VL, Nguyen DB. Preimplantation Genetic Testing of Aneuploidy by Next Generation Sequencing: Association of Maternal Age and Chromosomal Abnormalities of Blastocyst. Open Access Maced J Med Sci. 2019 Dec 20;7(24):4427-4431. doi: 10.3889/oamjms.2019.875. PMID: 32215107; PMCID: PMC7084032.
6. Daughtry BL, Chavez SL. Time-Lapse Imaging for the Detection of Chromosomal Abnormalities in Primate Preimplantation Embryos. Methods Mol Biol. 2018;1769:293-317. doi: 10.1007/978-1-4939-7780-2_19. PMID: 29564832.
7. Grati FR, Malvestiti F, Branca L, Agrati C, Maggi F, Simoni G. Chromosomal mosaicism in the fetoplacental unit. Best Pract Res Clin Obstet Gynaecol. 2017 Jul;42:39-52. doi: 10.1016/j.bpobgyn.2017.02.004. Epub 2017 Feb 17. PMID: 28284509.
8. Hara T, Katsuki T, Kusuda T, Ohama K. Pregnancy rate, multiple pregnancy rate, and embryo quality: Clues for single blastocyst transfer from double blastocyst transfer in an unselected population. Reprod Med Biol. 2005 May 3;4(2):153-160. doi: 10.1111/j.1447-0578.2005.00094.x. PMID: 29699218; PMCID: PMC5906893.
9. Levy B, Hoffmann ER, McCoy RC, Grati FR. Chromosomal mosaicism: Origins and clinical implications in preimplantation and prenatal diagnosis. Prenat Diagn. 2021 Apr;41(5):631-641. doi: 10.1002/pd.5931. Epub 2021 Mar 22. PMID: 33720449; PMCID: PMC8176867.
10. Li L, He Z, Huang X, Lin S, Wu J, Huang L, Wan Y, Fang Q. Chromosomal abnormalities detected by karyotyping and microarray analysis in twins with structural anomalies. Ultrasound Obstet Gynecol. 2020 Apr;55(4):502-509. doi: 10.1002/uog.20287. Epub 2020 Feb 28. PMID: 30977228.
11. Liu D, Chen C, Zhang X, Dong M, He T, Dong Y, Lu J, Yu L, Yang C, Liu F. Successful birth after preimplantation genetic testing for a couple with two different reciprocal translocations and review of the literature. Reprod Biol Endocrinol. 2021 Apr 20;19(1):58. doi: 10.1186/s12958-021-00731-2. PMID: 33879178; PMCID: PMC8056626.
12. Mourad A, Antaki R, Bissonnette F, Al Baini O, Saadeh B, Jamal W. Evidence-based clinical prioritization of embryos with mosaic results: a systematic review and meta-analysis. J Assist Reprod Genet. 2021 Nov;38(11):2849-2860. doi: 10.1007/s10815-021-02279-x. Epub 2021 Sep 2. PMID: 34472017; PMCID: PMC8609000.
13. Tšuiko O, Vanneste M, Melotte C, Ding J, Debrock S, Masset H, Peters M, Salumets A, De Leener A, Pirard C, Kluyskens C, Hostens K, van de Vijver A, Peeraer K, Denayer E, Vermeesch JR, Dimitriadou E. Haplotyping-based preimplantation genetic testing reveals parent-of-origin specific mechanisms of aneuploidy formation. NPJ Genom Med. 2021 Oct 7;6(1):81. doi: 10.1038/s41525-021-00246-0. PMID: 34620870; PMCID: PMC8497526.
14. Twisk M, Mastenbroek S, van Wely M, Heineman MJ, Van der Veen F, Repping S. Preimplantation genetic screening for abnormal number of chromosomes (aneuploidies) in in vitro fertilisation or intracytoplasmic sperm injection. Cochrane Database Syst Rev. 2006 Jan 25;(1):CD005291. doi: 10.1002/14651858.CD005291.pub2. Update in: Cochrane Database Syst Rev. 2020 Sep 8;9:CD005291. PMID: 16437524.
15. Zhang S, Lei C, Wu J, Xiao M, Zhou J, Zhu S, Fu J, Lu D, Sun X, Xu C. A comprehensive and universal approach for embryo testing in patients with different genetic disorders. Clin Transl Med. 2021 Jul;11(7):e490. doi: 10.1002/ctm2.490. PMID: 34323405; PMCID: PMC8265165.