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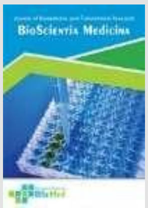

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Atlas of Human Oocyte: A Review in the Daily In Vitro Fertilization (IVF) Practices

Silvia W Lestari[1]*

[1]Department of Medical Biology, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia

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***Corresponding author:**
Silvia W Lestari

E-mail address:
finallysilvia@gmail.com

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A B S T R A C T

Background: Oocytes are gamete cells that play an important role in the daily practice of in vitro fertilization (IVF) laboratories. Oocyte morphology is important to study and assess in order to increase the success of IVF pregnancy. **Methods:** A computerized database search process in Pub med was performed to obtain data. Then, the most updated and relevant articles were selected. **Results:** Normal oocyte morphology should have normal-appearing cytoplasm, single polar body, appropriate zona pellucida (ZP) thickness, and appropriate perivitelline space (PVS). Abnormal oocyte morphology can be in the form of immature oocytes, large in size, ovoid or amorphous in shape, having fragment/double/multiple polar body I (PBI) and granular cytoplasm or smooth endoplasmic reticulum (SER). **Conclusion:** Abnormal oocyte morphology in the IVF laboratory can be seen by its maturity level, size, shape, condition of PBI, and cytoplasmic granularity. A better selection of oocytes can increase the performance of the IVF laboratory.

1. Introduction

Female gamete cells, namely oocytes, play an important role in embryo development, especially as a result of in vitro fertilization (IVF). The quality of the oocyte itself is influenced by the nuclear and mitochondrial genomes, as well as by the microenvironment of the pre-ovulatory follicle and ovary. In contrast to the in vivo process, in IVF, controlled ovarian stimulation is carried out, which goes through a selection procedure for the development of oocytes. This creates the maturation of many oocytes, with various consequences. Therefore, it is important to recognize oocyte morphological abnormalities to select oocytes better and obtain more good embryos and increase the reproductive success of assisted reproduction.

2. Methods

A computerized database search process in Pub med was performed to obtain data. The atlas of human oocytes, specifically the abnormal oocyte morphology, comprises the surf database. Words such as oocyte morphology, oocyte size, oocyte polar body, and oocyte granularity are applied in the process of database surfing. Then, the most recent and related articles are reassessed and chosen.

3. Results

Oocyte with normal morphology

Assessment of oocyte morphology in the IVF laboratory (conventional type) was according to cell appearance in the cumulus oophorus complex (COC). In mature oocytes, the COC will perform as a swollen and slimy layer. However, this cycle of controlled ovarian stimulation is characterized by an asynchronous state of oocyte nuclei maturation and expansion of the cell mass in the cumulus-corona. This is thought to be due to the distinctive receptivity of the oocyte and COC to stimulating substances.[1] After the elimination of COC by performing denudation, the evaluation of oocyte morphology is based on the status of nuclear maturation, cytoplasmic morphology, and appearance of extra-cytoplasmic structures so that it is more accurate.

In non-conventional IVF, namely IVF - intracytoplasmic sperm injection (ICSI), the assessment of a perfect adult human oocyte, based on the characteristics of a denuded oocyte (no cumulus complex) morphology, which must have normal smooth cytoplasm, single polar body, thickness suitable zona pellucida (ZP) and appropriate perivitelline space (PVS).[2] Nevertheless, the common oocytes resulting from controlled ovarian stimulation show disparities in the morphological criteria that have been described.[3]

Oocyte with abnormal morphology

The existence of a polar body I (PBI) is usually reflected as an indicator of oocyte maturity. Oocytes with intact PBI result in high implantation and pregnancy success rates associated with blastocyst formation.[4] However, recent studies have revealed that oocytes presenting polar bodies may be immature. Only oocytes that exhibit meiotic spindle (SM) can be reflected in metaphase II (MII) or mature oocytes. The existence and location of MS are thought to be associated with oocyte development. According to the most recent meta-analysis, only in vitro developments can be associated with MS morphology. Apart from MII or mature oocytes, which are around 85%, there are also immature oocytes, and the other 10% are oocytes that have germinal vesicles (GV) without PB as a type of prophase I of the first meiosis division. Then the other 5% are metaphase I (MI) oocytes which are shown as oocytes without PB and GV. (Figure 1) In this type of oocyte, the nuclear envelope is damaged already but does not develop into MI.

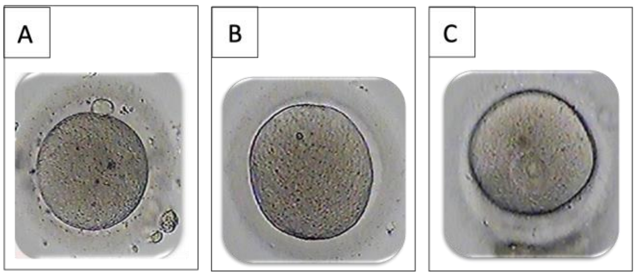

Figure 1. Oocyte A) Normal or mature in metaphase II (MII) phase; B) in metaphase I (MI) and C) in germinal vesicle (GV) phase.

Oocyte size is defined by the tight bond between the oolemma and the surface of the zone.[4] At the time of ovulation, some genes are activated to collect glycine proteins as osmolytes so that they form cell size.[5] Mature oocyte diameter (MII) varies and does not affect fertilization or embryo development. (Figure 2 A-B).[6] However, if the volume of oocytes is very large, also known as giant oocytes (Figure 2 C-D)[7,8] the consequences will be different. In this type of oocyte, the size is about two times that of a normal oocyte and is classified as tetraploid because, for example, there is neither cytoplasmic division in the oogonia nor cytoplasmic fusion of the two oogonia. Such oocytes usually cause digenic triploidy and should not be transferred, although other studies have reported that the existence of one giant oocyte is effectless on treatment outcome.[9] Other studies also explain that oocytes with extreme deformities can still be fertilized and can still cause the birth of healthy babies.[10,11]

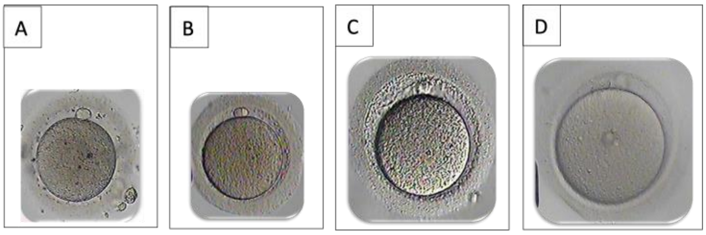

Figure 2. Oocyte A-B) Normal; C-D) large (Giant oocyte).

Until now, the influence of PBI morphology on IVF results is still debatable. Oocytes with intact PBI (Figure 3A) did result in higher implantation and pregnancy rates.[12] However, oocytes with an abnormal PBI have a poor prognosis.[13] Oocytes with abnormal PBI can be oocytes with PBI that are too large or too small (fragment) or double/multiple (Figure 3 B-D). Oocytes with PBI, as reported, did not affect embryo development but could affect implantation and pregnancy rates.[14,15]

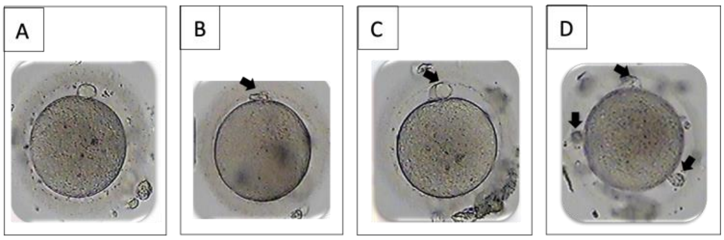

Figure 3. Oocyte A) Normal; B) with a fragmented and flat polar body (PB), C) with double PB, dan D) with multiple PB. Black arrow: PB abnormality.

Although in the literature so far, it is stated that oocytes with homogeneous cytoplasm are 'normal' oocytes, the relationship between the degree of heterogeneity of the oocyte cytoplasm and biological disturbances in the ooplasm is indefinite. (Figure 4A) According to the recently available evidence, the faintly heterogeneous cytoplasm may represent normal unevenness amid oocytes. (Figure 4B) These morphological aberrations in the form of cytoplasmic granularity must be distinguished by presences such as refractile or lipofuscin bodies[16] and specific organelle groupings. One of the most serious and important cytoplasmic disorders is a smooth endoplasmic reticulum (SER). (Figure 4C) The phase-contrast microscopy can be performed to acknowledge SER as a translucent vacuole-like structure in the cytoplasm. Studies have proven that embryos resulting from oocytes with SER are related to a significant and severe risk of anomalous results.[3] Therefore, it is suggested that oocytes with these abnormalities are banned from injection during the ICSI procedure.

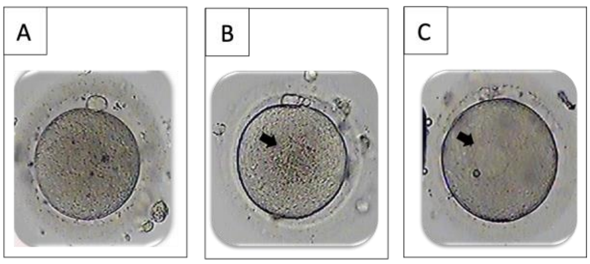

Figure 4. Oocyte A) Normal; B) with cytoplasmic granularity, and C) with smooth endoplasmic reticulum (SER). Black arrow: cytoplasmic granularity and SER.

Meanwhile, for oocytes with an elongated zone (ovoid), some researchers[15] state that the scopes of the shape abnormality do not correlate with fertilization or embryo quality. (Figure 5B) However, as the ovoid oocyte developed, the next day's embryo development showed an abnormal blastomeric state, and the after-next day's embryo development was delayed more frequently.[17] There are also rarer oocyte deformities, such as amorphous oocytes or double oocytes (there are two oocytes in one zone). (Figure 5C) There is a hypothesis suggesting that dizygotic twins can result from this type of oocyte. However, other studies have reported that this type of oocyte can also cause infrequent fertilization and no pregnancy.[18]

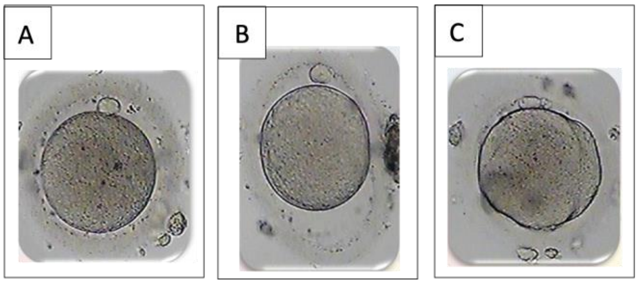

Figure 5. Oocyte A) Normal, with an ovoid shape, and C) with an amorph shape.

These are various morphological abnormalities of human oocytes. The author hopes that this review can help clinical embryology practitioners (embryologists) to better select oocytes so that they can obtain more good embryos and increase pregnancy success which is higher in the IVF lab where they work.

4. Conclusion

Abnormal oocyte morphology in the IVF laboratory can be seen by its maturity level, size, shape, PBI condition, and cytoplasmic granularity. A better selection of oocytes can improve IVF laboratory performance.

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