J. Emb. Trans. (2009) Vol. 24, No. 4, pp. 249~251

〈Mini Review〉

Polar Body: Indicator of Oocyte's Maturation, Have Any Function on Oocyte?

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ABSTRACT

Polar body was usually used as a determinant of oocyte's maturation. Polar body morphology could reflect the embryo quality and implantation competence. This review only focuses on morphology of the first polar body and embryo developmental rate in the presence or absence of polar body. However, it is very difficult to describe whether polar body has any effects on embryo development *in vitro* or *in vivo*. Further intensive research is needed to determine its function on embryo development.

(Key words : first polar body, oocyte, maturation, SCNT, parthenogenesis)

INTRODUCTION

Polar bodies are the by-products of the egg's division during meiosis. As an egg matures, it goes through a two-step division process, dividing once at the time when ovulation would occur and again at the time of fertilization. The three haploid polar bodies are the by-products of this division, and are essentially discarded by the egg. By analyzing the polar bodies, it is possible to infer the genetic status of the egg. Therefore, polar body analysis allows us to test the mother's genetic contribution to the embryo. To conserve nutrients, the majority of cytoplasm is segregated into either the secondary oocyte or ovum, during meiosis I or meiosis II, respectively. Eventually, the polar bodies degenerate and never participate in embryo development (Gilbert, 1991; Evsikov and Evsikov, 1995).

There may be one or two polar bodies in the ovum. In human, the first polar body is one of the two products in the first stage of meiosis and is considered haploid, with 23 duplicated chromosomes (one of each pair of homologous chromosomes). The second polar body, which is extruded after fertilization or parthenogenetic activation has also haploid, with 23 unduplicated female chromosomes in human. Both are relatively small and contain little cytoplasm. Sometimes the first polar body undergoes the second meiotic cell division. Therefore, the second polar body has been extensively used to access the numerical or structural chromosomal abnormalities of the developing embryo in clinical and basic research (Dyban *et al.*, 1992; Wheeler *et al.*, 1995). In case of mice the second polar body chromosomes have the competence to full term embryo development (Wakayama *et al.*, 1997).

MORPHOLOGY OF THE POLAR BODY AND EFFICIENCY OF EMBRYO DEVELOPMENT

Without invasive technique first polar body morphology could be used as a marker for oocyte quality. Assessment of first polar body morphology could be used to determine the post ovulatory age of the oocyte and to predict the potential for embryo development and implantation. Different types of polar body morphology and grading system of oocytes have already been suggested by Ebner *et al.* (1999). In this grading system intact well-shaped first polar bodies yield higher fertilization rates and higher embryo quality for intracytoplasmic sperm injection (ICSI) of human oocytes compared to grade 4 or 5 (Ebner *et al.*, 2000). In case of human *in vitro* fertilization (IVF), there are contradictory data showing that fragmented first polar body had the higher developmental ability than those with an intact polar body but the fertilization rate and embryo quality was influenced by polar body morphology, while speed of development is not affected by the morphology of the first polar body (Fancsovits *et al.*, 2006). However, more recent data challenged that polar body morphology assessment is not predictive to oocyte quality (Ciotti *et al.*, 2004; De Santis *et al.*, 2005). Ciotti *et al.*, reported that there was no significant difference between the first polar body morphology and the fertilization and cleavage rates, embryo quality, and pregnancy

† This work was supported by the research grant of the Chungbuk National University in 2009.

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and implantation rates.

IS THERE ANY EFFECT OF POLAR BODY ON EMBRYO DEVELOPMENTAL COMPETENCE?

Under normal conditions, mouse first polar body degenerates quickly. More than half cases the first polar body degenerates within a few hours after ovulation, and the vast majority disintegrate during the next 12 hr (Evsikov and Evsikov 1995). In human, by contrast, the first polar body persists for more than 20 hr after ovulation (Ortiz *et al.*, 1983). Wakayama *et al.* (1998) showed that most first polar bodies had degenerated before or soon after ovulation and they found that the rate of first polar body degeneration was different among different strains of mice. Although degeneration of polar bodies (and of unfertilized oocytes as well) is likely to initiate an apoptotic process (Takase *et al.*, 1995; Choi *et al.*, 1996), but it was not understood whether it had any effect on preimplantation embryo development. Also, removal of first polar body had no any effect on subsequent fertilization rates or embryonic growth to the blastocyst stage (Verlinsky *et al.,* 1990), but there was no any comparative data.

It is difficult to clarify the polar body function on oocytes. From the very beginning either *in vivo* or *in vitro* study every time all embryos were used with polar body. Only some cases during ICSI or IVF, the polar body was used only for biopsy material for preimplantation diagnosis of common aneuploidies by FISH (Verlinsky *et al.*, 1996a; Verlinsky *et al.*, 1996b). But, for somatic cell nuclear transfer (SCNT) procedure the polar body and MII plate are always removed from the oocytes, but nobody attempt to investigate the effect of the presence of the polar body. The first polar body could have been used for generation of normal offspring in mice (Wakayama and Yanagimachi 1998). To compare the effect of the presence of the polar body, we performed the experiments as follows; the polar body was removed artificially in the SCNT group and parthenogenesis group, respectively. Interestingly our data showed that embryos derived from SCNT (Table 1) and parthenogenesis (Table 2) without polar body had the more developmental potential of embryo with regard to blastocyst formation. In SCNT embryos the fusion rate was significantly increased in the group without polar body (polar body-removal) compared to the group with polar body (Table 1). It might be due to smaller size of the donor cell than polar body because it needs close contact of donor to ooplasma membrane and zona pellucida during fusion. In shown in Table 2, it was interesting that intact oocytes's developmental abilities were significantly decreased compared to that of the polar body- removal. Although it was not clear the reason, the blastocyst formation rate was increased in both cases. Since the fate of polar body is degenerated in *in vitro* or *in vivo* study, it could be postulated that the secretion from the degenerated cell could initiate apoptosis

Table 1. Comparison of developmental potential of somatic cell nuclear transferred embryos with or without polar body and metaphase II plate

Group	Injected oocyte	No. of fused embryos (%)	No. of cleaved embryos (%)*	No. of BL (%)**	No. of evaluated BL	Cell number/ BL
Without PB	266	215(81.30 ± 2.57)[a]	141(65.49 ± 3.16)	19(8.90 ± 1.60)[a]	17	51.94 ± 4.75
With PB	197	139(67.34 ± 6.11)[b]	72(54.01 ± 6.94)	7(5.24 ± 0.73)[b]	7	42.57 ± 8.72

Within the same column, values with different superscripts letters (a,b) were different significantly ($p<0.05$)
* Percentage of number of oocytes fused, **Percentage of the number of oocytes fused, BL, blastocyst.

Table 2. Developmental potential of parthenogenetic embryos with or without polar body (PB)

Group	Total oocyte	No. of cleaved oocyte (%)	No. of BL (%)*	No. of evaluated BL	Cell number/ BL
Without PB	125	106 (84.66 ± 3.84)[a]	63 (50.15 ± 5.34)[a]	61	74.92 ± 4.90
With PB	133	76 (57.08 ± 3.79)[b]	35 (26.35 ± 2.60)[b]	30	64.30 ± 5.35

Within the same column, values with different superscripts letters (a,b) were different significantly ($p<0.05$).
* Percentage of the number of oocytes cultured, BL, blastocyst.

that may alter or disturb the microfilament distribution that reduced the blastocyst formation. It is clear that the fragmented first polar body could interfere with the embryo development. Therefore, it is noteworthy that morphology of the first polar body is useful marker for oocyte quality. Further research should clarify the detailed mechanism of function of polar body.

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(접수일: 2009. 12. 1 / 채택일: 2009. 12. 17)