
Proceedings Paper:
McKeegan, P orcid.org/0000-0002-5318-2317, Colucci, F, Espinilla Aguilar, C et al. (2 more authors) (2018) The metabolic and developmental impact of a novel microfluidic device for mammalian embryo culture. In: Fertility 2019 Abstract Book. Fertility 2019, 03-05 Jan 2019, Birmingham, UK. , p. 14.

Abstract Title:

The metabolic and developmental impact of murine embryo culture in a novel microfluidic device

Abstract text:

Mammalian embryos are exquisitely sensitive to the in vitro culture environment, which must support cell division, metabolism, and genetic and epigenetic development. Microfluidic devices offer a mechanism to control this environment, potentially improving in vitro embryo development and quality. We report the optimisation and developmental impact of a[1] recently developed polydimethylsiloxane microfluidic device for in vitro culture of murine embryos to the blastocyst stage

To test the impact of microfluidic culture on embryo developmental competence, cryopreserved C57BL/6N mouse zygotes (MRC Harwell, UK) were thawed and cultured in groups of 8-10 in 400nl chamber devices or control drops under oil (1 µl media/embryo) at 37°C, 5%CO_2/5%O_2/90%N_2. After 72hr, embryos were removed to individual 4µl drops for 24hr to profile glucose, pyruvate and lactate turnover[2]. Blastocysts were subsequently transferred to fibronectin-coated dishes for 72hr to evaluate attachment and outgrowth[3]. To define the limitations of microfluidic culture, parallel groups of 10-40 2 cell mouse embryos were cultured to the blastocyst stage before metabolic profiling.

Microfluidic culture was non-embryotoxic and similar blastocyst formation, hatching, attachment and outgrowth rates were achieved between devices and controls (n=15/15, p>0.05). However, individual blastocyst pyruvate consumption reduced following microfluidic culture (8.4±0.6, n=139) vs controls (10.9±0.5pmol/embryo/hr, n=144, p<0.0001), while glucose consumption significantly increased in device blastocysts (7.2±0.6pmol/embryo/hr, n=139) vs controls (5.2±0.5pmol/embryo/hr, n=144, p=0.004). Energy substrate turnover did not predict blastocyst outgrowth capacity in either system.

Blastocyst hatching rate in devices significantly decreased with increased group size (40/group: 2.2±2% compared to 10/group: 30±4%, n=4, p=0.02). Embryos cultured in groups of 40 had significantly reduced pyruvate (0.37±0.1pmol/embryo/hr) and glucose consumption (0.05±0.03pmol/embryo/hr, n=3) than groups of 10 (1.4±0.08pmol/embryo/hr, and 0.8±0.08pmol/embryo/hr, n=3, respectively p=0.02).

Murine embryo developmental competence and metabolism were comparable between novel microfluidic device and conventional drop culture systems. Further validation of microfluidic culture efficacy will be provided through ongoing embryo transfer trials.

References

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2 Guerif, F., McKeegan, P, Leese, H. J., & Sturmey, R. G. (2013); A simple approach for COnsumption and RElease (CORE) analysis of metabolic activity in single mammalian embryos. PloS One, 8(8), e67834. doi:10.1371/journal.pone.0067834

3 N. J. Hannan, P. Paiva, K. L. Meehan, L. J. F. Rombauts, D. K. Gardner & L. A. Salamonsen (2011); Analysis of Fertility-Related Soluble Mediators in Human Uterine Fluid Identifies VEGF as a Key Regulator of Embryo Implantation, Endocrinology, Volume 152, Issue 12, 1 December 2011, Pages 4948—4956, https://doi.org/10.1210/en.2011-1248