ELECTRICAL ACTIVITY RECORDED FROM OVARIAN TISSUE IN PERFUSED HUMAN UTERO-TUBO-OVARIAN UNIT

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(Received 30th January 1975)

Histochemical and electron microscopic studies have disclosed that muscular tissue is embedded in the mammalian ovary (Jacobowitz & Wallach, 1967; O'Shea, 1971; Okamura *et al.*, 1972), and the contractility of that tissue has also been reported as a possible mechanism in the process of ovulation (Rocereto *et al.*, 1969; Palti & Freund, 1972; Virutamasen *et al.*, 1972; Gimeno *et al.*, 1973; O'Shea & Phillips, 1974). During the course of perfusion experiments on the uterus–Fallopian tube–ovary complex of women, we found that spike potentials could be recorded from a part of the ovary. In the present study, the ovarian electrical activity is compared to that separately recorded from uterine muscular tissue in a single perfused complex, and it is shown that the ovarian and uterine tissues are independently active under various experimental conditions.

The uterus was removed as a unit with the Fallopian tube and ovary unilaterally or bilaterally from fourteen patients with uterine carcinoma or uterine myoma. Eleven units were taken from patients with a normal menstrual cycle, two from pregnant women and one from a menopausal patient. The units were kept in a specially designed perfusion apparatus and perfused at 37°C with pulsatile flow using diluted blood of the identical blood type (Tojo *et al.*, 1970, 1972, 1974). Two needle electrodes, 'W-20' (0.25 × 24 mm: Nihon Kohden Co.) were used to pick up the electrical activity. One electrode was inserted into the ovary at a site distant from its hilus and the other into the uterus at the utero-tubal junction of the same side. The electrical activity was amplified and recorded with a Multipurpose Recorder Polygraph (Nihon Kohden Co.).

Spike potentials were observed in 9/11 ovaries from patients with a normal menstrual cycle. Augmenting spike bursts were seen in three cases and short grouped discharges or abortive spikes were seen in the other. In the ovaries from pregnant women, infrequent abortive spikes were seen. When 15 µg prostaglandin F_{2α} were injected into the arterial side of the perfusion unit, these abortive spikes appeared more frequently and with increased size, i.e. similar to the grouped discharges. In the ovary from the menopausal patient, no appreciable spike was at first observed, but augmenting spike bursts were seen after the injection of 15 µg prostaglandin F_{2α}.

TEXT-FIG. 1. Electrical activity recorded from the ovary and uterus of a uterus-Fallopian tube-ovary complex removed on the 28th day of the menstrual cycle from a 44-year-old woman with a myomatous uterus. Prominent spike bursts were recorded from the ovary and the uterus, but there was no synchronized activity.

TEXT-FIG. 2. Electrical activity recorded from the ovary and uterus removed on the 2nd day of the menstrual cycle from a 44-year-old woman with a myomatous uterus. (a) A wick dipped into 2 M-KCl was placed between the ovarian hilus and the uterine cornu. Spike potentials occurred independently in the ovary and the uterus; (b) 10 μ g prostaglandin $F_{2\alpha}$ injected into the ovary resulted in a prolonged spike burst in the ovary; (c) a prolonged burst of activity occurred in the uterus several minutes after the injection of prostaglandin $F_{2\alpha}$.

Simultaneous recordings from the ovary and uterus showed no correlation of activity (Text-fig. 1). Further, when a wick, dipped into 2 M-KCl, was placed in the area between the ovarian hilus and the uterine cornu to eliminate propagated activity, the independent spike potentials were still observed in both tissues. When 10 µg prostaglandin F_{2α} were injected into the ovary at this time, the prolonged spike burst appeared in the ovary immediately and in the uterus several minutes later. The spike bursts in the ovary and uterus were not synchronized (Text-fig. 2). The delayed activation of uterine tissue can be explained by transportation of prostaglandin F_{2α} by the perfusing blood.

The results show that perfused ovarian tissue is electrically active independently from uterine tissue, and that the activity is further accelerated by the action of prostaglandin F_{2α}. There are no concomitant artifacts due to pulsatile flow. Our results strongly suggest that the electrical activity recorded from the ovary in this study originated from ovarian muscular tissue. The presence of marked electrical activity in the ovary from the menstruating woman suggests that ovarian muscular tissue may contribute in the process of ovulation.

We wish to express our sincere thanks to Dr H. Takahira, Department of Physiology, Tokai University, for his advice in this study. This work was supported in part by Scientific Research Grant No. 948138 from the Ministry of Education of Japan.

REFERENCES

- GIMENO, M.F., BORDA, L.S., RETTORI, V., BORDA, E. & GIMENO, A.L. (1973) *In vitro* contractile activity of rat and guinea-pig ovaries. Effects of oxytocin and electrical stimulation. *Acta physiol. latinoam.* **23**, 363–370.
- JACOBOWITZ, D. & WALLACH, E.E. (1967) Histochemical and chemical studies of the autonomic innervation of the ovary. *Endocrinology* **81**, 1132–1139.
- OKAMURA, H., VIRUTAMASEN, P., WRIGHT, K.H. & WALLACH, E.E. (1972) Ovarian smooth muscle in the human being, rabbit, and cat. *Am. J. Obstet. Gynec.* **112**, 183–191.
- O'SHEA, J.D. (1971) Smooth muscle-like cells in the theca externa of ovarian follicles in the sheep. *J. Reprod. Fert.* **24**, 283–285.
- O'SHEA, J.D. & PHILLIPS, R.E. (1974) Contractility of ovarian follicles from sheep *in vitro*. *J. Reprod. Fert.* **36**, 457.
- PALTI, Z. & FREUND, M. (1972) Spontaneous contractions of the human ovary *in vitro*. *J. Reprod. Fert.* **28**, 113–115.
- ROCERETO, T., JACOBOWITZ, D. & WALLACH, E.E. (1969) Observations of spontaneous contractions of the cat ovary *in vitro*. *Endocrinology* **84**, 1336–1341.
- TOJO, S., MOCHIZUKI, M., NIHA, T., KANAZAWA, S., SAKAI, T., TSUCHIYA, K., MIURA, S., ANNO, G. & ONO, H. (1970) Studies on the new organ survive device for uterus and placenta. *Acta obstet. gynaec. jap.* **17**, 263–273.
- TOJO, S., SAKAI, T., KANAZAWA, S. & MOCHIZUKI, M. (1972) Perfusion of the isolated human uterus. *Acta obstet. gynec. scand.* **51**, 265–273.
- TOJO, S., MOCHIZUKI, M., KANAZAWA, S., MIKAMI, K., TSUCHIHASHI, T. & SHIMURA, T. (1974) *In vitro* perfusion of the human utero-tubo-ovarian unit. *Am. J. Obstet. Gynec.* **118**, 119–129.
- VIRUTAMASEN, P., WRIGHT, K.H. & WALLACH, E.E. (1972) Effects of catecholamines on ovarian contractility in the rabbit. *Obstet. Gynec.* **39**, 225–236.