Laparoscopic observations of follicular rupture in the Japanese macaque (*Macaca fuscata*)

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The development of laparoscopic techniques has facilitated serial observations of ovaries without damage to the animals. However, direct observations of the process of ovulation in primates are limited because of the difficulty of determining the exact moment of ovulation. Laparoscopic techniques have been applied to study of the Japanese macaque (Nigi, 1977) and the present paper describes the two types of ovulation which have been observed.

The moment of follicular rupture was observed during 6 cycles in 5 macaques (*Macaca fuscata*) which were over 6 years old and weighed 6.8–11.3 kg. All details of the husbandry and laparoscopy procedures were as described by Nigi (1977). The first laparoscopy was carried out in the morning and the second 2–4 h later depending on the follicular appearance. Anaesthesia was induced and maintained by injections of ketamine hydrochloride, the longest period of anaesthesia being 5 h. In all cases, the observations were conducted with as little manipulation of the ovary as possible to avoid the possibility of induced rupture of the follicle.

Observations

Ovulation occurred in the afternoon in all 6 cycles, and two types of rupture were distinguished.

Type I. This was observed in 3 cycles in 2 monkeys and was characterized by a rapid exudation of follicular fluid. In all instances, the translucent preovulatory follicle protruded from the ovarian surface through a discontinuity of the tunica albuginea (Pl. 1, Figs 1 and 2). Full protrusion was achieved in only 10 sec in one monkey, and in 3 and 110 min in the 2 cycles of the other. There was no increase in the size of the whole ovary; the part covered with the tunica appeared to be diminishing in size whilst the clear follicle was enlarging. The follicular surface was smooth and taut. In one follicle the follicular fluid abruptly became haemorrhagic just before the rupture, but in the other two there was no change. At rupture the follicular fluid, mixed with blood, left the apex of the follicle so quickly (within 1–2 sec) that no cumulus mass was detected. The ruptured follicle and the ovary then collapsed (Pl. 1, Fig. 3), but began to swell again 80 min after rupture in one case, and 120 min in the other two.

Type II. In the 3 examples of this type of rupture the follicular fluid was exuded gradually through one of the reddish diffuse areas which appeared on the surface of the preovulatory follicle (Pl. 1, Fig. 4). In one follicle, several reddish diffuse spots appeared on the surface of the translucent, protruding follicle 40 min after the start of protrusion, and each spot spread irregularly. After a further 10 min, clear follicular fluid began to exude through one of the spots and continued to flow very slowly during the next 45 min. The cumulus mass was not detected. In the other two instances, the preovulatory follicle was covered with the tunica albuginea until the follicular fluid began to flow, although the tunica appeared to have thinned considerably. The follicular surface was smooth and tense. Several diffuse spots appeared at the apex of one of these follicles (A) and 7 min later the spots amalgamated to form two large diffuse areas; the follicular fluid exuded slowly from one of these areas (Pl. 1, Figs 4, 5 and 6). In the other follicle (B) one irregular diffuse spot gradually spread and 52 min later the fluid began to run out from the central part. The outflow continued for 3 min 20 sec from Follicle A and for 28 min from Follicle B. The fluid from both follicles was at first clear, but after 2 min 30 sec (Follicle A) and 15 min (Follicle B) it became reddish. A mass assumed to be the cumulus mass left Follicles A and B at 3 min and 20 min respectively after the beginning of the fluid outflow. In all 3 examples of Type II rupture, the ovaries began to swell again 55–75 min after collapse.

In the 6 ovaries in which follicular rupture was observed a clear and round ovulation point was distinguished on the surface of the follicle which became fully swollen again 18–24 h after rupture.

Discussion

No significant effect of laparoscopy and anaesthesia on ovulation has been reported in previous laparoscopic studies of primates (Jewett & Dukelow, 1973; Rawson & Dukelow, 1973a; Dukelow, 1975; Nigi, 1977). Because manipulation to the ovary was avoided as much as possible in the present study, I believe that the follicular ruptures observed were not surgically induced but occurred spontaneously. Follicular rupture and release of the ovum have been reported to take approximately 30 sec in *Macaca fascicularis* (Rawson & Dukelow, 1973b; Dukelow, 1975). Similarly rapid ovulation was observed in this study, but a slower process was also seen. Such differences may be correlated with morphological variations in the preovulatory follicles (Nigi, 1977). The smooth and tense surface of the preovulatory follicle in *Macaca fuscata* suggests that the intrafollicular fluid may exert pressure on the follicular membrane. However, the round ovulation point does not suggest an abrupt rupture due to internal pressure, as has been stated by Asdell (1962). Moreover, in other species there is no significant increase in the intrafollicular pressure at ovulation (Blandau & Rumery, 1963; Espey & Lipner, 1963; Blandau, 1966; Stähler, Spätling, Bethge, Daume & Buchholz, 1974). The reddish diffuse area typical of the Type II ruptures apparently differs from the 'stigma' (a circumscribed area edged by a definite ring of vessels) observed in the rat (Blandau, 1955, 1966), and has never been reported for other primate species. The diffuse area is presumably closely related to ovulation and may be a weakened section of the follicular wall, although the cause of its appearance cannot yet be explained.

This study was supported by a grant-in-aid for the Special Project Research (Experimental Animals: No. 012205) from the Ministry of Education, Science and Culture of Japan.

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Received 14 January 1977

Follicles of the Japanese macaque at the time of ovulation, illustrating rupture of Type I (Figs 1, 2 and 3) and Type II (Figs 4, 5 and 6).

Fig. 1. A preovulatory follicle on the 13th day of the cycle. A clear follicle is beginning to protrude through a discontinuity of the tunica albuginea (arrow).

Fig. 2. Same ovary as Fig. 1, about 3 min later. The protrusion is more developed and immediately after being photographed reddish follicular fluid flowed quickly from the area arrowed.

Fig. 3. Same ovary as Fig. 2, about 10 sec later when the ovary had collapsed.

Fig. 4. Preovulatory follicle on 13th day of the cycle. Note the two diffuse areas (D). Just after this photograph was taken the follicular fluid began to flow from the upper diffuse area. V, blood vessels.

Fig. 5. Same ovary as Fig. 4, about 3 min later just after the cumulus mass had left the follicle.

Fig. 6. Same ovary as Fig. 5, 1 min later showing the collapsed appearance of the ovary.