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INTERACTION OF SEMEN WITH UTERUS

(A Review)

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Sperma ile uterus etkileşimi (Derleme).

ÖZET

Koyunlar esas olmak üzere evcil hayvanların uterusu, sperma ile uterus etkileşiminde çift role sahiptir. Bunlardan birisi, uteus kontraksiyonlarının spermatozoitleri uterusa doğru taşıması, diğeri ise fazla spermatozoitleri uterustan uzaklaştırmasıdır. Sperm ve seminal plazma muhtemelen uterus kontraksiyonlarını uyarır. Seminal plazma, uterusta immun sistemi baskılayıcı etkiye sahiptir. Sperma-uterus etkileşimi, tohumlama tipi, motilite, motil sperm yoğunluğu ve seminal plazmanın varlığı ya da yokluğu tarafından değiştirilebilir. Sperma ile uterus arasındaki etkileşimin bilinmesi gelecekteki in vitro fertilizasyon ve embriyo transferi gibi çalışmalara ışık tutacaktır.

ANAHTAR KELİMELER: Etkileşim, koyun, sperma, uterus.

SUMMARY

The uterus of domestic animals, including the sheep, has yoke of roles in the interaction of the uterus and semen. On one hand, uterine contractions carry sperm towards the oviduct, and the other hand the uterus eliminates excessive sperm. Sperm and seminal plasma probably provoke uterine contractions. Seminal plasma has immuno-suppressive effects in the uterus. The semen-uterine interaction can be modified by the type of the inseminate, motility, motile sperm concentration and absence or presence of seminal plasma. It also highlights specific are as for future research, such as in vitro fertilization and embryo transfer, towards understanding the interactions between uterine and semen.

KEY WORDS: Interaction, semen, sheep, uterus.

INTRODUCTION

The reproductive functions are controlled by complex neuroendocrine mechanisms. The immune system plays a key role under physiological conditions and in reproductive disorders. The processes leading to sperm formation have some immunologic prerogatives. Spermatozoa and their precursors exhibit quite strong antigenic traits. A wide spectrum of antigenic structures is being expressed in the testes during spermatogenesis towards which, ontogenetically, autotolerance mechanisms are inactive. Protection against autoimmunity is provided by the hemotesticuler barrier composed predominantly of Sertoli cells isolating the tubular content from the vasculature, and limited lymphatic drainage of the testes. Several other immunoregulatory mechanisms also play a role, e.g. immunosuppressive factors of seminal plasma and both systemic nonspecific and specific factors (De Cesaris et al. 1992, Kalaydjiev et al. 2002, Katila 1997, Lombardo et al. 2001, Nouza et al. 1992, Windsor 1997a).

The antisperm antibody formation can be induced primarily during infectious and noninfectious inflammations, or by obstruction of testicular efferent duct. This practice is generally accepted even though there is still some disagreement about the meaning of antisperm immunity and a good deal of controversy about the test regarded as the most suitable for the detection of antibodies directed against sperm antigens (Fayemi et al. 1992, Gandini et al. 1995, Jessop and Ladds 1995, Wicher et al. 1987, Zhang et al. 1990). However, the interactions between the sperm antigens and uterus are not completely known.

Motility is not required for the rapid transport of sperm into the oviducts in cows, pigs, or rabbits, as dead sperm also have been found in the oviducts of these species (Bourke and Lindsay 1988, Crane and Martin 1991, Jones and Gillan 1996a, Overstreet and Tom, 1982). There is no information regarding sheep, but fewer sperm were recovered from the oviducts 24

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h after artificial insemination (AI). Presumably, sperm motility is not required in the uterus, but it may be necessary for transport in the utero-tubal intersection (UTI) and oviducts (Fazeli et al. 1999, Gillan et al. 1999, Goldman et al. 1998).

Dead, damaged, or immotile sperms are removed from the uterus by phagocytosis (Fazeli et al. 1999, Harper 1988). Coating of the sperm head IgG probably serves the purpose of labelling spermatozoa for destruction. In the uterus, morphologically altered sperm increased with time ranging from 30% to 90% (Bader 1982, Gillan and Maxwell 1999, Gillan et al. 2000, Kotilainen et al. 1994, Sidhu et al. 1998). Neutrophiles, the uterus or the UTI may exert selection against altered sperm.

Seminal plasma has important functions in the interaction with the uterus. In rabbits, non-motile sperm did not reach the oviducts when they were suspended in saline. However, when non-motile sperm were suspended in seminal plasma for AI, rapid sperm transport to the oviducts was observed in every animal (De las Heras et al. 1996, Gutierrez et al. 1993, Maxwell et al. 1993, Overstreet and Tom, 1982). A greater number of boar sperm reached the oviducts in 4 h when sperm where thawed in seminal plasma as compared to buffer solution. These studies (Jones and Gillan 1996a, Jones and Gillan 1996b, Jones et al. 1995) suggest that seminal plasma has a role in facilitating transport of sperm or in protecting them in the genital tract and thereby extending their survival time. Oxytocin was detected in semen, in extracts from the testes and epididymis of male animals (Alexander et al. 1995, Rigby et al., 1999, Watson et al., 1999). This has previously been described in other species. Seminal plasma is also rich in prostaglandins, e.g. in humans (Kalaydjiev et al., 2002). Oxytocin and prostaglandins are potent stimulators of uterine contractions. Removal of accessory reproductive glands from male rats showed that induction of myometrial activity required constituents from the vasa deferens, seminal vesicles and coagulating glands (Crane and Martin 1991, Lombardo et al. 2001, Watson et al. 1999). It hasn’t been known what kind of role seminal plasma has in sperm transport in the sheep yet.

Seminal plasma is removed during semen freezing, and its proportion is greatly reduced in shipped semen, which usually contains more extender than semen. Pregnancy rates of sheep after frozen-thawed semen inseminations are still disappointingly low. If sperm do not have good progressive motility, they might need assistance to reach the oviducts (Gomez et al. 1997, Gomez et al. 1998, Maxwell et al. 1993, Paulenz et al. 2002, Tilbrook and Pearce 1986). Oxytocin injections immediately after AI improved pregnancy rates of some females inseminated with fresh semen from subfertile males. The effect may be different from the endogenous levels of oxytocin. It remains to be seen if deep intrauterine inseminations would improve pregnancy rates of frozen semen AI (Gillan et al. 2000, Jabbour and Evans 1991, Maxwell et al. 1996, Sanchez-Partida et al. 1999, Windsor 1997b). Using this technique the sperm do not have to travel the long journey trough the potentially hostile uterus and are not dependent on uterine contractions. The role of seminal plasma in transport of semen in the sheep needs to be studied.

It has been shown that when equal numbers of sperm are in a small volume versus a larger volume of extended semen, the uterine polymorphonuclear leukocyte (PMN) response is higher for the concentrated samples (Gutierrez et al. 1993, Jomes et al. 1988, Kotilainen et al. 1994, Sidhu et al. 1998, Voglmayr et al. 1983). It is possible that the strong neutrophile response provoked by highly concentrated semen eliminates sperm so efficiently that only traces of the reaction are detected 48 h later. Uterine inflammatory response after natural mating does not differ from fresh semen AI. After AI with fresh semen, the majority of spermatozoa are eliminated within 4 h and hardly any sperm are left after 48 h (Gillan et al. 1997, Gutierrez et al. 1993, Katila 1997).

Seminal plasma fractions caused a greater suppression of PMN-chemotaxis compared to heat inactivation of blood plasma, suggesting that mechanisms other than complement inactivation are involved in the suppressing effect of seminal plasma. A decrease of inflammatory response in post-breeding endometritis may have positive and negative effects. Suppression of phagocytosis may slow down elimination of bacteria and sperm. If frozen sperm are more readily recognized and engulfed by PMN because of damaged heads or decreased motility, it would be advantageous to limit PMN function. Frozen semen seems to provoke a strong PMN response, either because of the high sperm concentration (Kotialinen et al. 1994) or because of the lack of seminal plasma, and this may hasten the removal of frozen sperm. A delay or suppression of PMN-influx by seminal plasma may temporarily protect sperm from phagocytosis (Marshburn et al. 1992).

Volume of the inseminate

The effect of the total number of motile sperm inseminated on the fertility is more important than inseminated volume. The low motile sperm concentration in per insemination dose brings on the low fertility (Jabbour and Evans 1991, Marshburn et al. 1992). Semen doses of 20 to 40 x10^6 sperm for an ewe provided satisfactory on embryo recovery rates. The increase of inseminate doses to 160 x10^6 sperm for an ewe failed to improve fertility, actually tending to decrease lambing rates (D’Alessandro et al. 2001, Jabbour and Evans 1991, Paulenz et al. 2002). Adequate sperm numbers also are needed because more semen is likely to be expelled trough the open cervix when the insemination volume is high.

Distribution and cervical loss of fluid following intrauterine infusion of different volumes of PBS (30, 60, 120 or 250 ml) during estrus and diestrus was studied with ultrasonography. It was concluded that after intrauterine infusion, fluid does not distribute uniformly throughout the uterus, but tends to pool in the uterine body and at the junction of body and horns. The uterus is an expandable organ suspended by the broad ligament so that the tips of uterine horns and midhorn areas are elevated (Jasco et al. 1992, Nikolakopoulos and Watson 1997, Nikolakopoulos and Watson 2000).

Katila (1997) obtained slightly different results in a scintigraphic study. When a 5-10 ml volume of radio labeled sperm was inseminated, frequent uterine contractions carried sperm back and forth in the mare's uterus, effectively distributing it throughout the uterus including the tips of the horns. In cows, similar results have been published on uterine contractions after AI which were followed by a fiberoptic endoscope (Bourke and Lindsay, 1988). In the other study (Zraly et al. 2002), cows were inseminated with a food dye alone or together with live or killed frozen sperm in the uterine body and at selected sites in the uterine horns. In comparison with intra-cornual deposition, a much greater cervical reflux was observed following deposition of dyed inseminate at the recommended AI site, just anterior to the internal of the cervix. Frequent redistribution to the contralateral horn occurred within 5 min when cows were inseminated in a uterine horn. These results obtained in cows support the hypothesis presented earlier that perhaps deep intrauterine AI would be beneficial when mares are inseminated with frozen semen. Slightly faster redistribution and reflux throughout the cervix occurred when killed sperm were deposited as compared to live (Armstrong and Evans 1984, Bourke and Lindsay, 1988, Windsor 1997b). It is needed to comparatively carry out these findings in sheep.

Relaxation of the cervix is necessary during estrus for movement of sperm into and out of the uterus. If the cervix does not open up properly, elimination of sperm and inflammatory by-products is hindered. The degree of cervical relaxation and elimination of sperm during estrus was not correlated to the reflux of fluid (Gillan et al. 1997, Katila 1997).

CONCLUSIONS

Sperm motility probably is not essential to sperm transport throughout the uterus, but myometrial contractions carry sperm towards the oviduct. The contact of ewe with the rams induces the onset of oxitocin release and myometrial contractions. The inflammed sheep uterus contains large amounts of prostaglandins, which stimulate uterine activity. Inflammation after breeding is induced by sperm. They activate complement, which results in chemotaxis and migration of PMN into the uterine lumen. Damaged sperm may become more readily phagocytized by PMN. The selection process is not known, but only a minority of sperm escapes phagocytosis. Seminal plasma is presumably important in the transport of sperm, since it contains oxytocin and prostaglandins. Seminal plasma inhibits PMN-chemotaxis and phagocytosis and thereby may protect sperm in the sheep's uterus. Insemination volume does not have an effect on the distribution and elimination of sperm or on pregnancy rate. A very low sperm concentration and inadequate sperm numbers decrease pregnancy rates. On the contrary, motility and motile sperm concentration have an affect on recovery embryo.

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