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Breed, litter and parity effects on placental weight and placentome number, and consequences for the neonatal behaviour of the lamb

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Abstract

Lamb survival is impaired in low birth weight lambs, and those that are slow to stand and suck. Many of the factors that influence lamb vigour, such as parity, litter size, and breed, may exert their effects, at least partially, before birth by influencing placenta development. Our hypothesis was that retarded lamb behavioural development was due to differences in placentation in these animals. Data were collected from Blackface and Suffolk lambs in the first 2 h after birth and placentas were collected when delivered. Suffolk lambs, which were behaviourally slower and had lower rectal temperatures than Blackface lambs, were associated with larger but less efficient placentas (placental efficiency defined as foetal weight supported per g placenta) with fewer foetal cotyledons than Blackface placentas. Triplet lambs were significantly slower than twin or single lambs to suck and had lower rectal temperatures. Although placenta efficiency increased with litter size, placenta and cotyledon weight, and cotyledon number increased with twinning but not thereafter. It seemed likely that triplet lambs suffered some placental insufficiency in comparison to other litter sizes. Lambs born to first parity mothers were slower to stand and reach the udder than lambs of more experienced ewes, and first parity ewes also had smaller and less efficient placentas although cotyledon number was not affected. Male lambs tended to be slower than female lambs for most behaviours, although rectal temperatures were not affected. The sire of the lamb also influenced lamb behaviour and rectal

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temperature. Both lamb sex and lamb sire influenced the average weight of placental cotyledons, thus some of the sire effect on the behaviour and birth weight of his progeny might be mediated through placental development. Lamb neonatal vigour was correlated with placental efficiency suggesting that lamb behaviour immediately after birth is related to placental development and function.

Keywords: Lamb; Neonatal behaviour; Placenta; Breed; Litter; Parity

1. Introduction

Many studies have shown that lamb survival is impaired in low birth weight lambs [1–7], and in lambs that are slow to stand and suck after [8–11]. Poor lamb vigour is associated with both environmental factors (e.g. litter size, ewe parity, maternal nutrition: [12,13]) and genetic effects [11,14–17]. In general, lambs of hill and mountain breeds are quicker to stand and suck than lowland lambs (e.g. [14]). However, we have also shown that hill and mountain ewes carry heavier foetuses as a proportion of their own body weight than do lowland ewes [17]. This suggests that hill ewes are more efficient at partitioning nutrients to their developing foetuses than lowland animals, and this may function as an adaptation to deal with the impoverished nutritional conditions encountered in hill environments. Alternatively, the lowland breeds tend to have received greater artificial selection pressure for growth characteristics, which may lead the ewes to partition nutrients more to their own bodily reserves and less to their foetuses. Thus, the apparent breed effect seen in lamb behaviour might be partially a consequence of altered nutritional partitioning to the foetus. Similarly, the effects of litter size and ewe parity on lamb behaviour may be a consequence of inadequate nutrition reaching the foetuses, through placental constraint, even in well-fed ewes.

In the last third of pregnancy ovine foetal growth is affected by maternal nutrient supply [18], by uterine blood flow to the placenta [19] and by the placental capacity for nutrient transport [20]. The weight of the placenta becomes increasingly important in explaining the variation in foetal weight in late gestation compared to mid pregnancy [21], demonstrating the importance of placental function for sustaining the growth of the foetus in late gestation. In addition to its effects on growth rate, placental insufficiency (induced by carunclectomy of ewes prior to conception) is known to affect the development of the foetal brain, influencing the development and complexity of brain structures [22]. Placental insufficiency can lead to a reduction in cell numbers and myelination of axons, and to decreased synaptogenesis in the hippocampus [23–27]. These effects may be the cause of the impaired neuromotor development demonstrated in prenatally undernourished young in several species (sheep: [13]; humans: [28]; rodents: [29–31]; cats: [32]). These studies show that undernutrition impairs both vigour and the ability to carry out complex behaviours. Thus, the placenta plays a pivotal role not only in ensuring good foetal growth in late gestation, but also in the development of the foetal brain, with likely consequences for neonatal behaviour.

The ovine placenta is polycotyledonary, consisting of placentomes composed of maternal and foetal tissues where exchange between the maternal and foetal circulations occurs. Foetal attachment to the uterine wall and the development of foetal cotyledons