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Freemartin - A Small Review

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Abstract: ***Freemartin is an infertile genetic female born with a normal fertile male with which it has exchanged blood and antigens characteristics that are unique to female and male. Freemartin or Martin Heifer is an unproductive female animal that the cattleman should identify it at birth and save feed and development costs. Several researchers made the discovery that a freemartin results when a female fetus has its chorion fuse in the uterus with that of a male twin. If both fetuses are the same sex this is of no significance, but if they are different this condition will occur. When a heifer twin shares the uterus with a bull fetus, they also share the placental membranes connecting the fetuses with the dam. A joining of the placental membranes occurs at about the fortieth day of pregnancy, and thereafter, the fluids of the two fetuses are mixed. This causes exchange of blood and antigens carrying characteristics that are unique to each heifers and bulls. Male hormones pass from the male twin to the female twin and these affect each other in a way that causes each to develop with some characteristics of the other sex. Because of a transfer of hormones or a transfer of cells, the heifer's reproductive tract is severely underdeveloped and sometimes even contains some elements of a bull's reproductive tract. The ovaries of the freemartin do not develop correctly, and they remain very small. Also, the ovaries of a freemartin do not produce the hormones necessary to induce the behavioral signs of heat. Freemartinism cannot be prevented; however, it can be diagnosed in a number of ways ranging from simple examination of the placental membranes to chromosomal evaluation. Freemartins are occasionally used in stem cell and immunology research.***

Keywords: United Placental Membranes, Female fetus, Freemartin

1. Introduction

Freemartin is an infertile genetic female born with a normal fertile male with which it has exchanged blood and antigens characteristics that are unique to female and male. Freemartin or Martin Heifer is an unproductive female animal that the cattleman should identify it at birth and save feed and development costs.

2. History

The 18th-century physician John Hunter discovered that a freemartin always has a male twin (Hunter and John, 1779). It was hypothesized early in the 20th century that masculinizing factors travel from the male twin to the female twin through the vascular connections of the placenta because of the vascular fusion and affect the internal anatomy of the female (Nelson and Randy, 2005).

Several researchers made the discovery that a freemartin results when a female fetus has its chorion fuse in the uterus with that of a male twin (Tandler and Keller, 1916). The discovery was made independently by American biologist Frank R. Lillie, who published it in Science in 1916 (Lillie, 1916). Both teams are now credited with the discovery (Freeman, 2007).

3. Mechanism

In most cattle twins, the blood vessels in the chorions become interconnected, creating a shared circulation for both twins. If both fetuses are the same sex this is of no significance, but if they are different this condition will occur. When a heifer twin shares the uterus with a bull fetus, they also share the placental membranes connecting the fetuses with the dam. A joining of the placental membranes occurs at about the fortieth day of pregnancy, and thereafter, the fluids of the two fetuses are mixed. This causes exchange of blood and antigens carrying characteristics that are unique to each heifers and bulls. Male hormones (testosterone and anti-Müllerian hormone) pass from the male twin to the female twin and these affect each other in a way that causes each to develop with some characteristics of the other sex. The male hormones then masculinize the female twin, and the result is a freemartin (Padula, 2005). The degree of masculinization is greater if the fusion occurs earlier in the pregnancy – in about ten percent of cases no fusion takes place and the female remains fertile. The male twin is largely unaffected by the fusion, although the size of the testicles may be slightly reduced. Testicle size is associated with fertility, so there may be some reduction in bull fertility. Freemartins behave and grow in a similar way to castrated male cattle (steers).

Genetically the animal is chimeric: karyotyping of a sample of cells shows XX/XY chromosomes. The animal originates as a female (XX), but acquires the male (XY) component in utero by exchange of some cellular material from a male twin, via vascular connections between placentas. Externally, the animal appears female, but various aspects of female reproductive development are altered due to acquisition of anti-Müllerian hormone from the male twin (Rota *et.al.*, 2002).

A freemartin is the normal outcome of mixed twins in all cattle species which have been studied. It does not normally occur in most other mammals, though it has been recorded in sheep (Wilkes *et.al.*,1978), goats (Ilbery and Williams, 1967) and pigs (Bruere *et.al*., 1968). It does not occur in human twins because the arrangement of human fetuses in the placenta does not allow for hormone or fetal blood intermingling.

Gross Appearance of Freemartin

Although the male twin in this case is only affected by reduced fertility, in over ninety percent of the cases, the female twin is completely infertile. Because of a transfer of hormones or a transfer of cells, the heifer's reproductive tract is severely underdeveloped and sometimes even contains some elements of a bull's reproductive tract. The ovaries of the freemartin do not develop correctly, and they remain very small. Also, the ovaries of a freemartin do not produce the hormones necessary to induce the behavioral signs of heat. The gonads are undifferentiated, uterus is small and incomplete and cervix is usually absent. The external vulvar region can range from a very normal looking female to a female that appears to be male. Usually, the vulva is normal except that in some animals an enlarged clitoris and large tufts of vulvar hair exist (Padula, 2005).

4. Diagnosis

Freemartinism is one of the most extreme forms of secual abnormality in cattle. Freemartinism cannot be prevented; however, it can be diagnosed in a number of ways ranging from simple examination of the placental membranes to chromosomal evaluation. The cattleman can predict the reproductive value of this heifer calf at birth and save the feed and development costs if he is aware of the high probability of freemartinism. In some cases, there are no symptoms of freemartinism because the male twin may have been aborted at an earlier stage of gestation. Physical examination of the calf may also reveal differences: many (but not all) freemartins have a short vagina compared with that of a fertile heifer (Eldridge and Blazak, 1977)

Genetic Marker Test: Researchers developed a DNA based test to identify the presence of the Y chromosome in some circulating white blood cells of the subject. Genetic testing for the Y-chromosome can be performed within days of birth and can aid in the early identification of a sterile female. A positive test result for a heifer born twin to a bull indicates the freemartin condition. The number of cells containing the Y chromosome will be greatest at birth.

5. Uses

Though Freemartin calf is usually considered a negative in the industry, some scientists are working to discover how these can be beneficial to cattle producers. Freemartins are occasionally used in stem cell and immunology research (Niku *et.al.*,2004). Up to 95 percent of the freemartin's blood cells can be derived from those of its twin brother. Male-derived cells and their progeny can be easily visualized in the freemartin tissues, as only they contain the male Y chromosome. This model allows scientists to analyze perfectly healthy and non-manipulated animals, without resorting to transplantation often used in stem cell research.

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