Control age of Puberty in Heifers

Physiological events leading up to puberty

Endocrine and morphological events in peri-pubertal heifers are similar to the resumption of cyclicity post-partum in mature cows.

- Decreased negative feedback of oestradiol
- Maturation of the hypothalamus
- Increased frequency of release of LH pulses
- Enhanced development of ovarian follicles
- Enough oestradiol produced to induce behavioural oestrus and a preovulatory surge of gonadotrophins

Puberty is attained with the first behavioural oestrus that is accompanied by ovulation and development of a corpus luteum with a typical lifespan.

What influences the onset of puberty in heifers?

Factors that can influence the pubertal rise in release of LH pulses are:

- genotype
- season of year when pubertal age is attained
- growth or nutritional intake
- social cues
- treatment with exogenous hormones

Endocrinology of Puberty

It is believed that components of the hypothalamic–pituitary–ovarian axis of the various farm animals are functional for some time before the normal onset of puberty, although little is known of the mechanisms within the brain which bring these various components into an appropriate temporal relationship to initiate puberty. The 'gonadostat' hypothesis is one of the most widely accepted theories dealing with neuroendocrine mechanisms controlling the onset of puberty; according to this theory, there is a decline in sensitivity to estrogen negative feedback on GnRH secretion from the hypothalamus, which leads to an increase in the secretion of LH from pituitary gland, and final growth and maturation of ovarian follicles, leading to the first ovulation.

The 40- to 60-day period before first ovulation when a majority of these dynamic changes occur is referred to as the peripubertal period.

We have proposed that the period from birth to puberty in heifers can be divided into four periods, beginning with an infantile period (birth to 2 months of age),

developmental period (2 to 6 months of age), a static phase (6 to 10 months of age), and the peri-pubertal period .

Genetic Control of Puberty

Genetic selection is another approach to alter age at puberty.

Puberty in heifers is attained after a period of 6 to 24 months postnatal maturation, which, from a teleological standpoint, may be said to allow the process of natural selection to delay weaker animals from reproducing.

The use of genetic selection can decrease age at puberty and potentially lead to reduction in the age at first calving to 2 years of age in Nelore heifers, although the economic and management impacts of this practice are still under debate in countries that rely on breeds of this nature for a majority of their beef production.

Clearly, genetics has a primary role when the aim is to decrease age at first ovulation.

Pharmacological Treatments

The most common approaches to induction of puberty in heifers are centered around the use of an exogenous treatment with the hormone progesterone (normally produced by the ovary of females), either alone or in combination with other compounds such as estradiol, GnRH, or equine chorionic gonadotropin (eCG) that aid in inducing ovulation.

These induction protocols rely on the fact that progesterone treatment can re-program central control of the immature reproductive systems so that it operates in a mature manner. During and after the progesterone treatment, secretion of crucial hormones such as LH will increase, ovarian follicles are stimulated to grow, and the female ovulates spontaneously or in response to a second exogenous stimulus.

It is important to consider that hormonal induction of puberty is most effective in heifers that are approaching their spontaneous occurrence of puberty.

In other words, there are age limits before which it is not possible to effectively induce the first ovulation with pharmacological manipulation. Use of these technologies needs to be in conjunction with proper nutritional management, genetic selection, and other management alternatives to reduce age at puberty, rather than as a substitute for them.

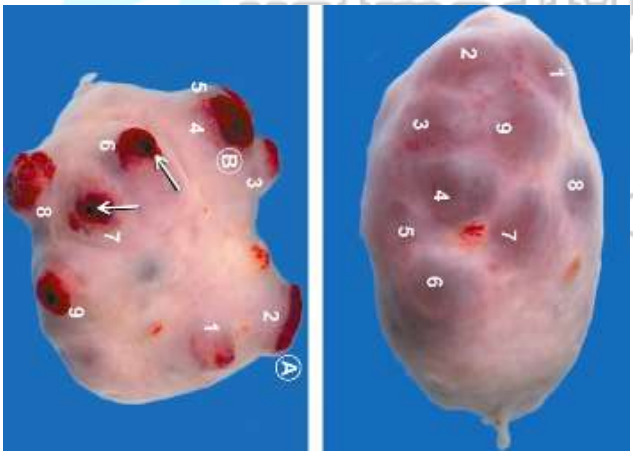
SUPEROVULATION

INTRODUCTION

The stimulation of cattle to induce additional ovulations (i.e. superovulation) has been the subject of much research during the past 50 years; the technique has always been an important consideration in the development of commercially accceptable ET technology in cattle.

Purpose:

Superovulation, also called superstimulation, is a treatment intended to increase the ovulation rate and number of available oocytes in the donor animal, without disrupting the physiological and endocrinological processes associated with oocyte maturation, ovulation, fertilization and embryonic and fetal development. Superovulation is a prerequisite for successful application of embryo transfer, particularly in species with a physiologically low ovulation rate (cattle, sheep and horses) and the description of superovulation will focus on these species. A close synchrony of oestrus between the donor and the recipient is crucial for obtaining optimal pregnancy rates, and is obviously an important part of the entire embryo transfer planning process.



Hormones

Follicular stimulation :

Two distinct groups of follicle-stimulating hormones have been used for superovulation.

1- The original hormone used for superovulation in ruminants was pregnant mare's serum gonadotrophin (PMSG), now designated equine chorionic gonadotrophin (eCG), which is a glycoprotein produced by the endometrial cups of pregnant mares. It can be purified from serum and has both a follicle-stimulating hormone (FSH)- and luteinizing hormone (LI-1)-Iike effect. Following injection in cattle, it has a half-life of approximately 5 days. eCG has both advantages and disadvantages.

The advantage is that the drug is relatively cheap and has to be administered only once. **The disadvantage** is a variable and unpredictable FSH : LH ratio and that the residual amount of eCG may have a continuous superstimulatory effect after ovulation and thus cause development of postovulatory oestrogen-producing follicles. The prolonged and elevated oestrogen production may disrupt fertilization and early emb1yonic development and, therefore, attempts have been made to reduce the allegedly adverse effects of residual amounts of circulating eCG by injecting eCG antiserum approximately at the time of oestrus. Nevertheless, other data in cattle have shown that this does not improve embryo numbers or embryo.

2- The second generation of superovulatory hormones is FSH, a pituitary gonadotrophin purified from the pituitary glands of pigs (pFSI-1), sheep (oFSH) or horses (eFSH). In contrast to eCG, pituitary gonadotrophin has a short half-life of approximately 6 hours and must be administered twice daily for 3-4 days in order to obtain the desired effect.

Compared with eCG it is expensive, but most FSH preparations have a more consistent FSH : LH ratio.

Mechanism of action:

The basis of their action is to bind to and activate FSH receptors on granulosa cells of small and medium sized follicles, and to stimulate the continued growth of these follicles, likely by inhibiting apoptosis

1- The biological half-life of FSH in the cow has been estimated to be 5 h or less so it must be injected twice a day to successfully induce superovulation.
The usual regimen is:
   a- 4 or 5 days, twice daily treatments of FSH with a total dose of 28 to 50 mg (Armour) of a crude pituitary extract (FSH-P).
   b- Forty-eight or 72 h after initiation of the treatment, PGF is injected to induce luteolysis.
   c- Estrus occurs between 36 and 48 h, with ovulation 24 and 36 h later.
2- Equine chorionic gonadotrophin is a complex glycoprotein with both FSH and LH activity. It has been shown to have a half-life of 40 h in the cow and persists for up to 10 days in bovine circulation;
   a- injected eCG once followed by a PGF injection, 48 h later.
   b- Recommended doses of eCG range from 1500 to 3000 IU, with 2500 IU by intramuscular injection commonly chosen.