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SYMPOSIUM

Invited Review: Use of ultrasonography to make reproductive management decisions[1,2]

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ABSTRACT

Transrectal ultrasonography has been available for making reproductive management decisions since the mid 1980s. This technology allows for the real-time visualization of internal structures (i.e., ovary and fetus) that are otherwise difficult to evaluate. The use of this technology in making reproductive management decisions can be divided into 3 key areas: (1) selection of animals to be kept in the breeding herd, (2) increasing the likelihood of reproductive success, and (3) pregnancy determination. When selecting replacement animals, ultrasonography can be used to assess antral follicle counts in females. Antral follicle counts have a direct effect on animal fertility. Prior to the start of the breeding season, transrectal ultrasonography can be used to determine puberty status, reproductive tract score, and estrous cycling status. In addition it can be used to determine response to synchronization protocols (presence of a dominant follicle, ovarian cyst, and follicle diameter), or if other assisted reproductive technologies are being used, it can be used to predict success (superovulation response or presence of a corpus luteum for embryo transfer). Following insemination this technology can be used to determine pregnancy status as early as 28 d after insemination, fetal age and sex, and presence of multiple offspring. The largest limitations to the use of ultrasonography include the time and technical skills required, strain on the arm and shoulder, and cost of equipment. Whereas probe handles can be used for pregnancy diagnosis exams, measurements on the ovary require consistent placement of the transducer that to date can only be accomplished manually. Future improvements that may overcome some of these limitations include better imaging software, larger hard drives allowing the storage of video clips, and improved diagnostic capabilities of the machine (i.e., software that will be able to use pixel density to categorize ovaries). Color Doppler and 3-dimensional images are being explored for earlier pregnancy diagnosis and for blood flow and health of the corpus luteum and follicles. Thus, transrectal ultrasonography has and will have a role in the successful reproductive management of cattle herds.

Key words: ultrasonography, reproductive management, cattle, pregnancy diagnosis, follicle

INTRODUCTION

Transrectal ultrasonography has been available for basic research since the early 1980s (Ginther, 2014). This technology allows for the real-time visualization of internal structures such as ovaries, endometrium, and embryos or fetuses that are otherwise difficult to evaluate (Ginther, 2014). Thus, the basic research discoveries that have been made possible through the use of transrectal ultrasonography can be translated to the producer to assist with making reproductive management decisions. These reproductive

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management decisions can be divided into 3 key categories: (1) selection of animals to be kept in the breeding herd, (2) increasing the likelihood of reproductive success, and (3) pregnancy determination.

SELECTION OF REPLACEMENT ANIMALS

Future fertility of cows and heifers has been associated with ovarian characteristics including the ovarian reserve. The ovarian reserve is the total number of follicles (primordial through antral) present in the ovaries, and the size of this ovarian reserve has been correlated with fertility in cattle (Cushman et al., 2009; Mossa et al., 2010). In most mammalian species (including cattle), follicular formation and growth begins during fetal development. In the bovine fetal ovary, the cortex and medulla can be identified by 40 to 70 d after conception. Oogonia enter meiosis between d 75 and 80, and meiosis continues until around d 150 after conception (Erickson, 1966a). In cattle, between d 90 and 170 after conception, the cortical cords (ovigerous cords) become disrupted (Erickson, 1966a). The surviving oocytes are surrounded by a single layer of flattened granulosa cells (pregranulosa cells) and become enclosed in a basement membrane to form primordial follicles (Van Voorhis, 1999). The newly formed primordial follicles can be found in the ovarian cortex directly under the surface epithelium and surrounding the entire ovary (van Wezel and Rodgers, 1996). The pool of quiescent bovine primordial follicles remains constant (around 133,000 per animal) until the animal is 4 to 6 yr old, after which the follicular pool is slowly reduced through atresia and ovulation to close to zero around age 20 (Erickson, 1966b).

Within the bovine ovary there is extreme variation between individuals in the ovarian reserve. Erickson (1966b) approximated that the number of primordial follicles in beef heifers at birth ranged from 14,000 to 250,000, and in 12-mo-old heifers, the number of healthy follicles ranged from 1,920 to 40,960 (Ireland et al., 2008). However, the ovarian reserve can be approximated using transrectal ultrasonography by counting the total number of antral follicles (antral follicle count; **AFC**) present on the ovary. Within a follicular wave AFC is highly variable among animals but highly repeatable within individual animals (Burns et al., 2005; Ireland et al., 2007; Ireland et al., 2008).

Cushman et al. (2009) reported that heifers with low AFC (<15 follicles) had smaller ovaries, decreased birth weight, and decreased heifer pregnancy rate when compared with heifers with a high AFC (>25 follicles). Similarly, young adult cattle with low AFC had smaller ovaries, a marked reduction in their ovarian reserve, and fewer morphologically healthy follicles and oocytes compared with females with high AFC (Ireland et al., 2011). Maurer and Echternkamp (1985) reported that repeat-breeder cows (cows that did not conceive in 2 consecutive breeding seasons) had fewer antral follicles in their ovarian cortex compared with those females that conceived in their first breeding season. Furthermore, among dairy cows (Mossa et al., 2010) and beef heifers (Cushman et al., 2009), pregnancy success has been correlated with AFC; animals with greater AFC had greater pregnancy success compared with animals with low AFC. Increased numbers of antral follicles in heifers and cows were associated with increased fertility, decreased calving date, and fewer inseminations per conception (Cushman et al., 2009; Mossa et al., 2012; Cushman et al., 2014). Calving day in heifers is important because earlier calving heifers have increased reproductive longevity in beef herds (Burris and Priode, 1958; Lesmeister et al., 1973; Cushman et al., 2013). Because there is a positive relationship between the number of antral follicles and the number of primordial follicles (Erickson, 1966b; Cushman et al., 1999; Ireland et al., 2008), in a production setting, the best method to evaluate the ovarian reserve is to perform a transrectal ultrasonographic evaluation of the ovaries and count the number of antral follicles present. Thus, assessing the ovarian reserve may help predict future fertility (Cushman et al., 2009).

INCREASING THE LIKELIHOOD OF REPRODUCTIVE SUCCESS

Around the start of the breeding season, transrectal ultrasonography can be used to determine puberty status, reproductive tract score, and estrous cycling status. In addition it can be used to determine response to synchronization protocols (presence of a new follicular wave or dominant follicle, ovarian cyst, and follicle diameter), or if other assisted reproductive technologies are being used, it can be used to predict success [superovulation response or presence of a corpus luteum (**CL**) for embryo transfer].

Are Cows Ready for the Breeding Season?

Previous research has reported that reaching puberty before the start of the breeding season increased pregnancy success and response to synchronization (Patterson and Bullock, 1995; Leitman et al., 2008; Bridges et al., 2014) compared with heifers that are prepubertal at the start of the breeding season. Puberty in the female occurs when ovulation is accompanied by visual signs of estrus and normal luteal function (Moran et al., 1989). A practical on-farm method that has been developed to determine pubertal status is reproductive tract scoring (Andersen et al., 1991). Reproductive tract scoring can use rectal palpation or transrectal ultrasonography to determine size of the uterine horns and what structures are present on the ovary (1 = no palpable follicles, 2 = 8-mm follicles, 3 = 8- to 10-mm follicles, 4 = >10-mm follicles and possibly a CL, 5 = CL present).

The use of reproductive tract scores to determine pubertal status has demonstrated that heifers with infantile tracts (tract score 1) have decreased conception rates following estrous