Implant Programs and Philosophy

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Abstract

Veterinarians have considerable input into implant programs decisions by their clients. Much research has been conducted for the purpose of elucidating ideal implant programs. Despite great effort and expense, clear consensus has not been reached. Use of estrogens and androgens must be considered both separately and together because of possibilities for additivity and complementarity. Mechanisms of hormone action must be understood in order to properly design implant programs. Cattle, management, marketing and nutrition must also be considered.

Introduction

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Mechanism of Hormone Action

Implant products can be generally categorized as estrogenic or androgenic. Since the direct and indirect mechanisms of estrogen and androgen action differ, effects of estrogens and androgens are complementary and in some cases additive.

Estradiol (E), the naturally occurring estrogen is found in Synovex® S or Synovex® H, Implus® S or Implus® H, Compudose® and Revalor® implants. Estradiol is used either in the E_2(estradiol 17b) form or as estradiol benzoate, which is 70% (by weight) E_2 equivalent. Ralgro® contains zeranol, a synthetic steroid with estrogen-like activity. Estrogens exert direct effects on muscle cells through the classic steroid mode of delivery and action. Estrogens are bound to proteins to allow solubility in blood. After delivery to the cell, the steroid binds to specific intracellular (or intranuclear) receptors. The receptor-ligand complex interacts with DNA and disrupts its shape, exposing specific sites to transcriptional enzymes. After several processing steps, this results in translation of mRNAs specific for myofibrillar proteins and other proteins involved in synthesis of structural proteins.

Estrogens also exert indirect effects on muscle cells through alteration of blood levels of other hormones. Effects of somatotropin (ST) are increased three ways. Pituitary size is increased by direct estrogen action and the proportion of somatotrophs within the pituitary is increased, resulting in increased synthesis of ST. In addition, pituitary responsiveness to paracrine and endocrine signals is enhanced, resulting in greater release of ST.

Increased circulating ST, and a transient increase in rate of clearance of ST, contribute greatly to increases in growth when estrogen is used. Most estrogen-induced effects of ST are mediated by (and dependent on) changes in insulin-like growth factor I.

Estrogens also influence circulating levels of insulin and the thyroid hormones but the role of these changes in enhanced growth is unclear. The net effect of direct and indirect actions of estrogens is a significant increase in skeletal muscle protein synthesis and deposition.

Testosterone, the naturally occurring androgen, is found in Synovex® H and Implus® H. Trenbolone is a synthetic steroid with structural similarity to both testosterone and estradiol. Trenbolone, manufactured as trenbolone acetate (TBA), is an active ingredient in Finaplix® (S or H) and Revalor®. TBA is readily deacetylated in blood to produce the active compound, trenbolone, which binds to both testosterone and estrogen receptors in skeletal muscle.

Through mechanisms comparable to those of estrogens, this binding initiates events that alter protein degradation and synthesis resulting in a net increase in skeletal muscle protein accretion. At equal dosage, testosterone is less anabolic than trenbolone but works through similar mechanisms. In general, androgens increase protein deposition by reducing protein degradation, rather than increasing synthesis. Unfortunately, a considerable portion of androgen action results in increased deposition on non-muscle protein such as hides and internal organs.

Androgens further affect muscle growth through hindrance of the ACTH-induced stimulation of cortisol production. Reduced serum cortisol, a characteristic of bulls in comparison to steers, results in increased muscle deposition since cortisol is anti-anabolic. While increased ST levels are not a common result of androgen administration, ST secretion may be altered toward a

more effective pattern. With chronic usage, androgens may increase proliferation of satellite cells. Androgens have no direct effect on adipose tissue but could reduce fat deposition through altered nutrient partitioning.

The effects of implants on feed intake are considerable and must be thought of as a major component of the mechanism of action. Typically, estrogenic implants increase feed consumption by 1 to 1.5 lb/d for the entire feeding period. The mechanism of this is not known. Implantation with Synovex implants increase feed consumption within 24 hours, other estrogenic implants probably do so as well. The onset of increased feed intake occurs prior to many of the endocrine changes that are associated with estrogen use. Effects of androgens on feed consumption vary but implantation of steers with TBA+E may result in greater consumption than implantation with E alone. In heifers, TBA effects on intake range from negative to slightly positive.

Expected Response to Implants

Fifty-six controlled feedlot studies conducted in the U.S. have included TBA in one implant program or another. Within this database, use of Synovex® increased average daily gain (ADG) of steers by 15.9% and improved feed conversion (F/G) by 8.0%. Compared to negative control, Synovex increased steer hot carcass weight (HCW) by an average of 44.7 lb in 27 studies. Benefits of Synovex® implants are greatest if steers are reimplanted in feeding periods of 120 days or longer, heifer feeding periods may need to be longer to justify reimplanting. On average, estrogenic implants return approximately $20 for each dollar invested.

Compared to positive control (Synovex® or Synovex® reimplant), addition of a single dose of TBA increased ADG by 2.5% and improved F/G by 1.9%. These values are means with considerable variation. Positive responses to TBA can be much greater but are occasionally nonexistent. Because of higher cost than estrogenic implants, marginal return on TBA investment is low, compared to estrogen implant programs. Despite this, use of TBA can result in significant increases in profit in appropriate situations. In general, steer ADG responses to TBA are about twice as great as F/G responses (on a percent basis) due to altered feed intake. Use of two doses of TBA is uncommon but does result in further increases in performance. Addition of Finaplix® to heifer programs improves ADG by 2.1% and F/G by 3.1%, compared to combined positive control groups that included Synovex® H or Synovex® H+MGA.

Compared to negative control, use of a single TBA treatment in steers increased HCW 48.6 lb. In 70 treatment groups that were compared to positive control, single TBA use increased HCW 5.3 lb over positive control. Reported values range from -24 to 51. In 25 of 70 reported treatment groups HCW of TBA+E-implanted steers was unchanged or reduced compared to positive control. Use of TBA twice increased HCW by an average of 17.7 lb over positive control in 29 reported treatment groups.

Compared to negative control, Synovex® reduced percentage choice by 9.1% in steers. In virtually all studies reported, use of TBA+E reduced average quality grade, percentage of choice cattle or both, in comparison to nonimplanted or E implanted cattle. Typically, the percentage of choice cattle in a pen declined 5-15 percentage units with TBA+E use.

This has often occurred with little difference in fat thickness. On average, inclusion of TBA reduced percentage choice by 7.4% in steers and 3.8% in heifers, compared to estrogen only. In approximately 10% of treatment groups, TBA reduced quality grade by more than half, compared to non-implanted control. In steers, reduction in quality grade is more severe when TBA is used more than once in a feeding period.

Differential Implant Responses Based on Breed or Type

Because of differences among breeds in ability to deposit muscle and fat, differential responses to implants may exist. Syntex research has investigated effects of implants on steers of three distinct breed types: British, Brahman-crossbred and Limousin-crossbred. Response of crossbred Limousin steers to Synovex® was greater than response of British breed or crossbred Brahman steers to the same treatment (Table 1). Additional ADG, F/G and HCW responses to TBA-containing implant programs was much greater in Limousin steers than British or Brahman, which received little benefit from TBA. Negative response to TBA, reduced quality grade, was also greatest in Limousin steers.

The authors suggest that factors which affect response to implants can be placed in two general categories: the genetic capability of the cattle to deposit muscle and energy intake in excess of that required to meet maintenance requirements. These factors seem particularly useful in identifying situations where addition of TBA will be of benefit. Breed, frame, sex, and age of cattle, as well as weather, pen conditions, diet formulation, feed delivery, etc. contribute to determining these two factors.

Figure 1 depicts data from the TBA research database, sorted by carcass weight of the cattle. On average, studies in which the mean carcass weight of the cattle was 700 lb or less show no positive ADG response to TBA, compared to estrogen only programs. When cattle were slaughtered at higher weights, addition of TBA resulted in increased ADG. As depicted, the data reflect all studies reported however, data from steers only are similar. These results are not a function of slaughter endpoint of the cattle since mean quality grade of those cattle in the studies with light carcass

Table 1. Effect of Steer Breed Group on Response to Synovex and Additional Response to TBA

	ADG Increase	F/G Improvement	HCW	Choice, % Increase	Decrease
	response to Synovex, %				
English + Brahman	22.4	10.3	8.3	6.2	
Limousin	23.1	13.2	8.0	14.3	
	additional response to TBA, %				
English + Brahman	1.6	.9	.3	4.1	
Limousin	6.4	3.2	2.3	14.6	

Botts, 1992. Alteration of percent choice reported as increase or decrease in percentage units, other values are as percentage of nonimplanted control.

weights was not significantly different than those studies with heavier carcass weights.

As depicted in Figure 2, effects of estrogenic implants are relatively constant across varying ADG. On the other hand, additional effects of TBA are negligible at lower rates of gain and increase as rate of gain increases. The industry has a real need for a product or management practice that will make poor cattle average or better. TBA does not seem to fill that niche.

Effects of implants on Holstein steers are significant, but less than the effects on beef breeds. TBA use in Holsteins is low.

Risks Associated With Implant Use

Reduced quality grade is the most obvious risk associated with TBA use. There are two possible explanations for TBA effects on marbling. TBA may exert a marbling-specific effect, reducing marbling preferentially to other fat depots. To support this there are numerous accounts of reduced quality grade with equal external fat thickness, especially in European breed steers. It is likely that reduced quality grades are also partially a function of experimental design.

Since use of TBA+E increases muscle deposition, treated cattle slaughtered after the same number of days on feed may not have the same carcass composition as controls, even if external fat thickness was the same. In this circumstance, it makes little sense to expect treated cattle to have the same quality grade as controls, especially when it is considered that intramuscular fat is a late maturing fat depot. Since TBA+E increases muscle deposition, cattle treated with TBA+E will be heavier at any given quality grade than controls.

Will grade problems disappear if TBA+E-implanted cattle are fed to heavier weights? Several studies have been reported which were designed to address this issue. Cornell researchers utilized ultrasound to estimate marbling and slaughtered cattle when it was deemed that 70% in a pen would grade low choice. In Holstein steers, 46 lb greater final weight was required for TBA+E treated cattle to achieve quality grade equal to nonimplanted controls. At low choice, the difference between treated and control beef breed (Angus and Angus x Simmental) steers was 88 lb.

Additional weight required may be a function of cattle type. In Minnesota research, large framed steers implanted twice with TBA+E required up to 235 lb greater live weight to achieve the same quality grade as non-implanted controls.

Research at Iowa State University has shown that feeding cattle implanted with TBA+E for 19 days longer than cattle implanted with Synovex® will alleviate grade reduction due to TBA but will also wipe out ADG and F/G improvements for the entire feeding period.

A reduction in quality grade in response to TBA+E should be considered when selecting an implant program. A corollary problem would be excessive carcass size in large framed cattle treated with TBA+E and fed until they grade choice.

Cattle feeders have also reported increased masculinity of cattle implanted with TBA, especially when TBA is used more than once in the feeding period. Visual "bullock score" of carcasses from steers implanted with Revalor® or Synovex® + Finaplix® implants was increased in some studies. In other work, visual "masculinity score" of steers implanted with TBA+E was increased, compared to nonimplanted or implanted with E alone. Other researchers have reported increases in proportional head weight and weight of neck and shoulder muscles in steers implanted with TBA. Indeed, the TBA-induced increase in muscle deposition is unfortunately greater in the lower valued cuts of the chuck than in any other part of the carcass. To date, buyers have not considered this in their bids.

Research studies have not reported increased aggressive or sexual behavior but cattle feeders suggest that this can be a problem. A possible explanation for the discrepancy between feedlot experience and research studies is in the size of the pens utilized. Riding is typically reduced in small research pens, regardless of cattle type or treatment, while it may occur in large feedlot pens. If TBA increases riding or induces other behavioral changes, potential exists for both reduced performance and increased rate of injury.

Destructive behavior, often a problem with bulls, does not seem to be increased noticeably with TBA use. Improper implanting technique may be responsible for some of the reported behavioral problems.

Field studies and survey data suggest that the incidence of dark cutting carcasses is often increased

when TBA is added to a program. Typically dark cutters are increased approximately 70% in both steers and heifers with heifers having more dark cutters than steers regardless of implant program. TBA is not a direct cause of dark cutters. Indeed, millions of cattle have been implanted with TBA without cutting dark. However, the increased incidence of dark cutting carcasses with TBA suggests that presence of TBA may be a contributing variable, along with numerous environmental and management factors.

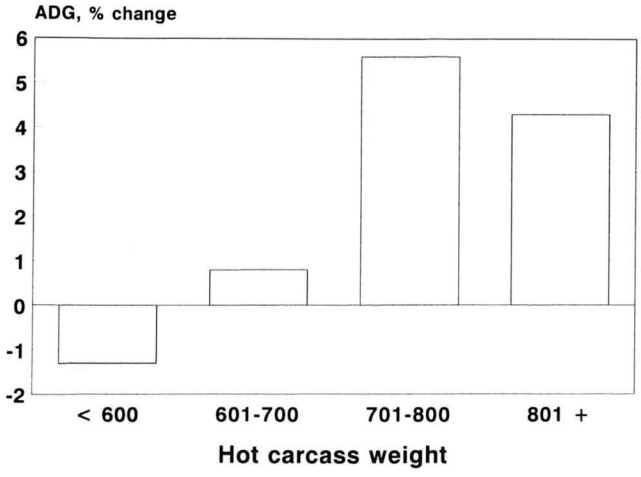
Kansas researchers have reported increased difficulty in mechanical removal of hides of TBA+E implanted steers, compared to other implants. Factors such as age at slaughter or length of TBA treatment may influence potential TBA effects on hide pulling and should be investigated. While hide pulling may be more difficult with TBA treated cattle in some instances, the incidence of hide or carcass damage is unknown but likely very low.

Strategic Implant Programs

Several factors must be considered in assembling strategic implant programs for cattle feeders. There are several implant products available for steers and heifers. While all are efficacious and will increase profit, these products vary in hormone content and dosage, duration of payout, ease of administration, abscess rate, compatibility with other implants, label claims and restrictions, product service and support and cost. The effects of implants on feedlot performance, as well as carcass weight, cutability and quality vary. Combined with possibility for side effects, it is clear that profitability and return on investment can differ greatly from one implant program to another.

Cattle within even the most uniform pen display considerable variation, of both genetic and non-genetic origin. Because of variable response to implants based on genetics, an assessment must be made regarding the ability of the pen to respond to various implant programs.

Figure 1. Effects of TBA+E



While genetic capability can be estimated based on frame size, weight, muscling and other attributes, ability (or desire) of the cattle to consume feed is all but impossible to predict and may be the most important genetic factor. Marbling capability is similarly impossible to predict and critical to implant program decisions.

Other factors which must be considered are based on differences between feedyards and feeding programs. Implant decisions will be affected by the balance between owned and customer cattle and by risk management and marketing capabilities. Desire to reimplant and ability to manage timely reimplanting are critical for success of some implant programs. Dietary factors such as energy density and protein type and quantity must be considered, as should the ability to mix and deliver diets properly and consistently.

Summary

It is clear that there is no implant program that is ideal for all situations. Veterinarians and others who advise cattle feeders must consider a number of factors, some of which have not been thoroughly researched. A close relationship between veterinarian and client will allow exchange of information required for assembling an implant program.

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Figure 2. Comparison of E vs TBA+E