VALIDATION OF REAL-TIME ULTRASOUND TECHNOLOGY FOR PREDICTING FAT THICKNESSES AND RIBEYE AREAS OF BRANGUS BULLS FROM FOUR MONTHS TO TWO YEARS OF AGE[1]

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Summary

Sixty Brangus bulls were evaluated live with two real-time ultrasound instruments to estimate ribeye area (REA) and 12th rib fat thickness (FT) every 4 mo beginning at 4 mo and 12 mo of age, respectively, and continuing until 24 mo of age. At each evaluation period 10 bulls were slaughtered to determine actual REA and FT. Scanned mean FT was accurate ($P < .05$) at 16 mo and was not different ($P = .09$) from the actual mean FT. Scanned mean REA was accurate ($P < .05$) at 12 mo. Absolute differences between scanned and actual mean FT and REA were different ($P < .05$) from zero for all main effects. Increased level of operator (scanner) skill did not improve accuracy of FT or REA measurements, whereas increased level of interpreter (reader) skill improved accuracy of REA measurements. There was no difference ($P > .05$) between the two ultrasound units in accuracy of estimating FT or REA. Scanned measurements overestimated bulls with less than .20 in FT and greater than 13.6 in^2 REA and underestimated bulls with more than .40 in. FT and less than 12.0 in^2 REA. We conclude that REA scanned at 12 mo and FT at 12 or 16 mo were sufficiently accurate to characterize <u>groups</u> of young bulls; however, <u>individual</u> scans were inaccurate. Scanning at other months was not accurate for either individuals or groups of young bulls.

(Key Words: Bulls, Ultrasound, Ribeye Area, Fat Thickness.)

Introduction

Ultrasound technology appears to have considerable potential as a non-destructive, practical, and relatively inexpensive method for determining muscle and fat development in live animals. Some researchers have found ultrasound measurements of fat thickness (FT) and ribeye area (REA) to be quite accurate, whereas other researchers have concluded otherwise. Differences in equipment, operator skill, hide, haircoat, weight, and fat level have all been suggested as possible contributors to these varied results and have led some researchers to determine that many ultrasound instruments are not accurate or consistent enough for use in research or industry application.

The objectives of our study were: 1) to validate real-time ultrasound instruments and technicians for accuracy and(or) precision in measuring REA and FT in Brangus bulls of varying ages; 2) to determine the age to most accurately measure REA and FT; and 3) to determine the compositional changes that occur in the first 2 years of bulls' lives.

Experimental Procedures

Sixty Brangus bulls were evaluated live with

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real-time ultrasound to estimate REA and 12th rib FT every 4 mo beginning at 4 mo and 12 mo of age, respectively, and continuing until 24 mo of age. At each evaluation time, 10 bulls were slaughtered to determine actual REA and FT. Bulls were scanned with both Aloka "Technicare" 210DX (TC) and Equisonics LS-300A (EQ) real-time, B-mode, ultrasound scanners. Slaughter groups were scanned by four technicians (identified as A, B, C, and D) with various levels of experience. Scans for REA and FT were taken by each technician on each individual slaughter animal, using both the TC and EQ instruments. Images of REA and FT were recorded on video tape. Each technician interpreted all images he or she made. Fat thickness was measured directly utilizing the internal caliper on the ultrasound units at a point interpreted by each technician to be three-fourths the length of the ribeye.

Hip height (HH) and weight (LW) of each animal were recorded every 2 mo. Only REAs were obtained on the 4 mo and 8 mo slaughter cattle because FT at those ages were essentially nil. Both REA and FT were evaluated on all subsequent slaughter groups. Carcass data were obtained by experienced personnel who were not involved in the ultrasound evaluations. Mean actual differences and absolute (average difference from actual ignoring whether the difference was above or below the actual) differences between scanned REA and FT and actual REA and FT were determined. These values were then analyzed over all bulls to obtain least squares means for the main effects and interactions.

Results and Discussion

Estimation of Fat Thickness. In the analysis of actual differences between scanned and actual FT, there were significant differences among all four scan periods (Table 1). Estimation of FT was most accurate ($P < .05$) at 16 mo; estimation at 12 mo was next in accuracy. Month 16 was the only month in which the mean difference of the scanned versus actual carcass measurements was not significantly different from zero ($P = .09$). When the actual differences were plotted against actual FT, there was a trend to overestimate bulls with less than .20 in. FT; as FT increased above .40 in., FT was increasingly underestimated. Therefore, it appears that ultrasound-scanned FT was most accurate in the range of .20 to .40 in., which corresponds to 12 to 16 mo in these bulls. When absolute differences between the scanned and actual carcass measurements for FT were taken into account, all months were significantly different from zero. These data point out that, although real-time ultrasound accurately estimated the average FT at 16 mo for a group of bulls, the measurement can be quite inaccurate for any one animal.

Increased level of operator skill in obtaining images did not improve accuracy of FT estimates. There were no differences ($P < .05$) between EQ and TC units for either actual or absolute differences. At 12 and 16 mo, the most accurate time to measure FT in this study, ultrasound FT was within .12 in of actual FT 95% of the time, whereas over all slaughter periods, ultrasound FT was within .40 in of actual FT 96% of the time (Table 2).

Estimation of REA. In the analysis of actual differences between scanned and actual REA, estimation of REA was accurate ($P = .115$) at 12 mo; at all other months, measurements were inaccurate (Table 3). Except for month 16, when actual differences are plotted against actual REA, bulls with less than about 12.0 in^2 of REA were underestimated, whereas bulls with greater than about 13.6 in^2 of REA were overestimated. Therefore, ultrasound scanned REA was most accurate in the range of 12.0 to 13.6 in^2, which corresponds to 12 mo for these bulls. When absolute differences between scanned and actual REA were analyzed, all months were different ($P < .001$) from zero. These data suggest that real-time ultrasound can be used to accurately estimate the average REA only at 12 mo of age for a group of bulls; however, the estimate can be quite inaccurate for any one animal. Increased level of skill of the operator obtaining images did not improve the accuracy of REA estimates. Interpreter effects are somewhat confounded in that interpreter B (experienced) and interpreter D (inexperienced) were not significantly (P > .05) different from each other for actual differences; however, only interpreter B was not significantly different from zero (P = .602). Interpreter D, however, had greater variation in measurements as exhibited by a greater absolute difference and was different (P < .05) from the other interpreters. All interpreters were significantly different from zero for absolute differences. The EQ unit appeared to be more accurate (P < .05) than the TC unit for measuring REA and was not significantly different from zero for actual differences (P = .395) However, when absolute differences were taken into account, there was no difference between instruments, and both were significantly different from zero. At 12 mo, the most accurate time to measure REA, ultrasound REA was within 3.0 in^2 of actual REA 95% of the time, whereas over all slaughter periods, ultrasound REA was within 4.0 in^2 of actual REA 95% of the time (Table 4).

We conclude that REA scanned at 12 mo and FT at 12 or 16 mo were sufficiently accurate to characterize groups of bulls, but individual measurements were quite inaccurate. Measurements at other months should not be considered accurate for either individual bulls or groups of bulls.

Table 1. Probabilities that Actual and Absolute Differences for Scanned vs Actual Fat Thickness Are Equal to Zero for Month, Operator, and Instrument

Trait	Actual FT, in	Scanned FT, in	Actual difference	Probability actual difference = 0	Absolute difference	Probability absolute difference = 0
Month						
12	.20	.17	-.03[b]	.000	.05[a]	.000
16	.16	.17	.01[a]	.093	.05[a]	.000
20	.46	.33	-.13[c]	.000	.15[b]	.000
24	.76	.43	-.26[d]	.000	.26[c]	.000
Operator						
A	.37	.25	-.12[b]	.000	.14[b]	.000
B	.37	.39	-.09[a]	.000	.12[a]	.000
C	.37	.39	-.09[a]	.000	.12[a]	.000
D	.37	.39	-.09[a]	.000	.12[a]	.000
Instrument						
Equisonics	.37	.39	-.10[a]	.000	.12[a]	.000
Technicare	.37	.38	-.11[a]	.000	.13[a]	.000

[abcd]Differences within a trait and within a column with a different superscript letter are significantly different (P < .05).

Table 2. Percentage of Time that Fat Thickness Is within Designated FT Values over All Slaughter Groups and for 12 and 16 Mo Groups

	Cumulative percent		
± Inches	All groups	12 mo	16 mo
.04	49	39	38
.08	67	71	78
.12	80	95	95
.16	85	100	99
.20	86		100
.24	89		
.28	91		
.32	92		
.36	93		
.40	96		
> .40	100		

Table 3. Probabilities that Actual and Absolute Differences for Scanned vs Actual REA (in^2) are Equal to Zero for Month, Operator, Interpreter, and Instrument

Trait	Actual LM area	Scanned LM area	Actual difference	Probability actual difference = 0	Absolute difference	Probability absolute difference = 0
Month						
4	6.24	4.78	-1.44[c]	.000	1.47[b]	.000
8	7.70	6.56	-1.18[c]	.000	1.62[bc]	.000
12	11.44	11.34	0.13[a]	.115	1.22[a]	.000
16	13.84	12.18	1.60[c]	.000	1.78[c]	.000
20	14.67	15.39	0.70[b]	.000	1.71[c]	.000
24	15.92	17.37	1.38[d]	.000	2.40[d]	.000
Operator						
A	11.55	11.44	-0.19[a]	.002	1.66[a]	.000
B	11.55	11.14	-0.54[c]	.000	1.71[a]	.000
C	11.55	11.14	-0.46[bc]	.000	1.74[a]	.000
D	11.55	11.34	-0.30[ab]	.000	1.67[a]	.000
Interpreter						
A	11.55	10.82	-0.80[b]	.000	1.44[a]	.000
B	11.55	11.65	0.03[a]	.602	1.62[b]	.000
C	11.55	12.16	-0.94[b]	.000	1.54[ab]	.000
D	11.55	11.86	0.19[a]	.004	2.19[c]	.000
Instrument						
Equisonics	11.55	11.65	-0.05[a]	.395	1.74[a]	.000
Technicare	11.55	11.92	-0.72[b]	.000	1.65[a]	.000

[abcde]Differences within a trait and within a column with a different superscript letter are significantly different ($P < .05$).

Table 4. Percentage of Time that Ribeye Area Is within Designated Values of Actual REA for All and 12 Mo Groups

	Cumulative percent	
± $Inches^2$	All groups	12 mo
.25	12	15
.50	22	31
.75	29	40
1.00	38	53
1.25	46	62
1.50	56	73
1.75	63	77
2.00	71	83
2.50	81	90
3.00	88	95
3.50	92	98
4.00	95	99
> 4.00	100	100