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Effect of surgical castration treatments on blood parameters and behavioral characteristics in Korean native cattle (Hanwoo)

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Abstract

The animal welfare issues in cattle breeding include breeding environment, elimination, and castration. Among these, castration is unavoidable because it decreases cattle aggressiveness, improves meat quality, and enhances feed efficiency. In this study, the degree of stress associated with various methods of castration treatment was investigated for animal welfare in Hanwoo breeding. Cortisol levels dramatically increased right after castration in both the SoF and SoV groups. However, the increase in the SoF group was significantly ($P<0.05$) higher than that in the SoV group, and the range of decrease was also smaller. Among the behavioral characteristics, standing was significantly ($P<0.05$) higher in the SoV (374.93±21.51) and SoF (379.93±21.30) groups based on the behavioral time (min/12 hours) compared to that in the NC group (359.37±19.69). The SoF and SoV groups did not show any significant ($P<0.05$) difference. In terms of behavioral frequency, the NC group demonstrated a significantly ($P<0.05$) high frequency of drinking, self-grooming, scratching, and rubbing, and a significantly ($P<0.05$) less frequency of fighting behavior. The feeding time significantly ($P<0.05$) decreased in the SoV and SoF groups, and their frequencies of pairwise grooming were significantly ($P<0.05$) less. Based on the results, the cattle experienced less stress during castration by a veterinarian than during treatment using a move-stop.

Key words : Castration, Hanwoo, Animal welfare, Blood parameters, Behavioral characteristics

INTRODUCTION

The World Organisation for Animal Health (OIE) has defined animal welfare as the state in which animals are healthy and comfortable, enjoy sufficient nutrition, are able to express their natural behavior in a safe environment, and do not experience unpleasant situations such as pain, fear, or distress. However, with the productivity-based approach to breeding and reproduction management, and the aim of ensuring optimum nutrition efficiency during feed management, prioritizing the welfare of animals may be difficult. As a result, introduction of the concepts of increasing productivity and pursuing profits to animal welfare, which considers the psychology of social farm animals and their environment, is highly difficult (Yoon and Kim, 2013). However, the enhancement of animals' quality of life, along with continuous income growth, has a major influence on the improvement in public dietary patterns and animal product purchase. The consumer demand for environmentally friendly and safe beef is increasing (Yoon, 2008). The major issues in animal welfare for Hanwoo cattle are breeding environment, elimination, and castration. In particular, castration has been utilized for a long time to improve aggressive behaviors of cattle and enhance the quality of meat (Kiley, 1976). It decreases daily gain and growth rate, but increases fat content and the marble score, which are favored by Koreans (Hart, 1980). Nonetheless, castration has become a topic of debate worldwide in terms of its impact on animal welfare

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(Moberg, 1987; Mellor, 1991). The two types of castration treatment are endovascular surgery and non-surgical (bloodless) (Noordsy, 1994). There are two widely applied surgical methods. First, an expert veterinarian surgically makes an incision into the scrotum after applying local anesthesia to expose the testis. The spermatic cord, which includes the vas deferens, testicular artery, and testicular vein, is ligated, and the testis is removed. The second method is elastic band castration; it is a bloodless castration method performed using the Burdizzo device. In Korea, however, anesthetics or sedatives are not used. Instead, a method that goes against animal welfare principles is practiced, in which a move-stop (electronic rod) is inserted into the anus and temporary paralysis of nerves and muscles is induced for surgery. This approach causes stress to the cattle (Blackshaw, 1986). The type of stress can be verified through hematological testing, including assessments of cortisol level (Fisher et al., 1996; Fisher et al., 1997; Fell and Shutt, 1989; Lester et al., 1991; King et al., 1991; Chase et al., 1995) together with behavioral characteristics testing (Wood et al., 1991; Molony and Kent, 1997). It is also possible to verify this through the amount of feed consumed and feed efficiency (Fisher et al., 1996; Fisher et al., 1997). The National Institute of Animal Science has recently implemented systems to certify livestock breeding for farm animal welfare. The systems involve the establishment of breeding plans based on animal welfare, countermeasures, analysis and measures on the OIE international standards on animal welfare. However, studies on stress testing during the Hanwoo castration treatments have so far been insufficient. Therefore, this study investigated the stress experienced by Hanwoo cattle by comparing the blood parameters and behavioral characteristics during different methods of castration treatment.

MATERIALS AND METHODS

Test animals and study period

Nine (average weight 148.1±5.9 kg) aged 6～7 months bred in a resource recycling breeding system were studied for analysis. Three animals each were allocated to 3 stables, and a preliminary experiment was conducted for 10 days prior to the stress adaptation. Three animals were castrated using anesthetics and sedatives by an expert veterinarian (SoV group), three were castrated using a move-stop for paralysis (without anesthetics and sedatives) by a farmer (SoF group), and the remaining three were not castrated (NC group); animals of each group were bred separately in 3 different stables (5.0×10.0 m). The feeding experiment was performed for 15 days.

Experimental diets and feeding management

For the experiment, 1.2～1.4% of feeds and straw to the weight was provided as concentrated feeds according to the feeding management program. Feeds were provided twice a day at 8 am and 5 pm. Mineral blocks and water were given ad libitum. The experimental diets were analyzed using AOAC (AOAC (2000)), and the mix ratio and chemical composition of the experimental diets are shown in Table 1.

Blood parameters

A preliminary experiment was performed on the selected animals for 10 days. Blood was sampled from the jugular veins at 2 hours pre-castration and 12 hours post-castration. The blood sample was placed into a vacutainer without heparin and then kept overnight at 4°C. Subsequently, it was centrifuged at 2000 rpm for 15 minutes, and the serum was stored in a deep freezer at

Table 1. Chemical composition of experimental diets

Item	Rice straw	Concentrate
Dry matter, %	87.6	88.4
Crude protein	4.3	13.1
Crude fiber	26.3	3.6
Crude fat	1.8	2.8
Crude ash	8.2	6.2
Nitrogen free extract	49.2	60.9
Calcium	0.3	1.0
Phosphorus	0.1	0.6
Neutral detergent fiber	65.1	25.3
Acid detergent fiber	41.6	11.0
Total digestible nutrients	44.9	68.2

−70°C. The sample for blood analysis was placed in reagent bottles with EDTA 2Na (2 mL). The white blood cell (WBC) and red blood cell (RBC) counts and hemoglobin (HGB), albumin, and globulin levels were analyzed using fresh blood samples and an automatic blood cell counter (Serono System 9000, Switzerland). The levels of the stress hormone cortisol in serum were analyzed with a γ-counter (Cobra 5010 Quantum, Packard, USA).

Behavioral measurement

A video system (Panasonic camera Model WV-CP412 and Panasonic video cassette recorder Model 6730) was installed in each stable, and the recordings were analyzed. For the behavioral data collection from each stable, the behaviors were categorized per stable based on the method suggested by Ha et al. (2016). The daytime behaviors for 12 hours daily (7 am～7 pm) were compared on the basis of the list of behavioral classification in Table 2.

The observed behaviors were "standing" for standing straight, "lying down" for the position in which the animal's body touches the ground, "feeding" when the animals bring their head into the feed box or watering trough, and "walking" when the body was moving. The following behaviors were defined as follows: "drinking" as drinking water, "self-grooming" as grooming their own body with their tongue, "scratching" as scratching their body using their rear legs, "rubbing" as rubbing their body against a pall or object, "pairwise grooming" as grooming the body of other animals, and "fighting" as fighting against other animals. The behaviors were recorded each time they were expressed based on the frequency data of collection method, and the behavioral characteristics were compared and analyzed.

Statistical analysis

The scores obtained in this experiment were analyzed using the SAS package (2004). Variance analysis and t-test were conducted to investigate the significance ($P<0.05$) of the stables.

RESULTS AND DISCUSSION

Blood parameters

The analysis of the blood parameters (WBC, RBC, HGB, albumin, and globulin) according to the methods of castration treatment is shown in Table 3. At 12 hours post-castration, the WBC count ($10^3/mm^3$) in the SoV group significantly ($P<0.05$) increased from 7.45±0.87 right before castration to 9.58±1.03. The WBC count in the SoF group also significantly ($P<0.05$) increased from 7.73±0.16 to 10.30±0.73. The RBC count ($10^6/mm^3$) in the SoV group significantly ($P<0.05$) increased from 8.38±0.51 right before castration to 10.93±1.15. The RBC of the SoF also significantly ($P<0.05$) increased from 8.21±0.28 to 11.44±1.29. The levels of HGB and albumin did not demonstrate any significant ($P<0.05$)

Table 2. List of behavioral classification

Observed behaviors		Description
At 2-min intervals (time sampling)	Feeding	Head over or in the bunk, and drinking as the head over or in the water trough.
	Standing	Inactive upright posture (no locomotion)
	Lying down	Body contact with the ground
	Walking	Any change of body location within the pen
Frequency (serial)	Drinking	Muzzle in water cup
	Self grooming	Licking a part of body
	Scratching	Repetitive ipsilateral hind paw scratching of flanks, neck, and head
	Rubbing	Pressing some portion of the body against a blunt object and generating friction by moving one or the other while they are in sustained contact
	Pairwise grooming	Licking a part of other body, allogrooming
	Fighting	Where two animals push their heads against each other while planting their feet on the ground with both exerting force against each other

Table 3. Comparison of surgical castration treatments on blood parameters

Items	SoV§		SoF‖		NC**	
	Before castration	After 12 hours	Before castration	After 12 hours	Before castration	After 12 hours
WBC* (10^3/mm^3)	7.45±0.87	9.58±1.03	7.73±0.16	10.30±0.73	7.55±1.17	7.75±1.06
RBC† (10^6/mm^3)	8.38±0.51	10.93±1.15	8.21±0.28	11.44±1.29	8.51±0.36	8.48±0.46
HGB‡ (g/dL)	13.21±0.76	12.99±0.82	13.44±1.19	12.98±1.41	13.47±0.49	13.26±0.48
Albumin (g/dL)	4.53±0.21	4.26±0.18	4.74±0.16	4.39±0.32	4.33±0.15	4.29±0.26
Globulin (g/dL)	2.99±0.27	2.10±0.32	3.10±0.27	1.69±0.19	3.02±0.28	2.96±0.29

Values are mean±standard deviation.
*White blood cell, †Red blood cell, ‡Hemoglobin, §Surgery by a veterinarian, ‖Surgery by a farmer, **No castration.

Table 4. Effect of surgery castration treatments on behavioral characteristics in Hanwoo

Items	Time (minute/12 hours)		
	SoV*	SoF†	NC‡
Feeding	49.17±2.75	48.17±2.71	51.52±4.07
Standing	374.93±21.51	379.93±21.30	359.33±19.69
Lying down	289.20±20.42	285.67±20.13	302.67±19.65
Walking	6.30±0.69	6.23±0.49	6.48±0.49

Values are mean±standard deviation.
*Surgery by a veterinarian, †Surgery by a farmer, ‡No castration.

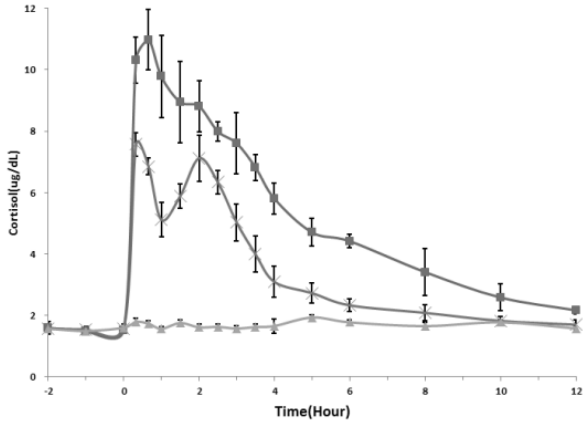

Fig. 1. Change in cortisol levels according to the types of castration treatment. -■- : surgery by a farmer (use of move-stop), -▲- : no castration, -X- : surgery by a veterinarian.

difference. The globulin level (g/dL) significantly ($P<0.05$) decreased from 2.99±0.27 right before castration to 2.10±0.32 in the SoV group, and those in the SoF group also significantly ($P<0.05$) decreased from 3.10±0.27 to 1.69±0.19. The cortisol level drastically increased right after castration in the SoF and SoV groups as shown in Fig 1. However, the level in the SoF group was significantly ($P<0.05$) higher than that in the SoV

Table 5. Effect of surgical castration treatments on behavioral characteristics in Hanwoo

Items	Count (number/12 hours)		
	SoV*	SoF†	NC‡
Drinking	10.20±1.56	9.07±1.00	10.80±1.28
Self grooming	32.67±4.21	30.20±3.17	33.33±3.61
Scratching	11.13±2.06	10.20±1.97	11.47±2.47
Rubbing	9.73±1.91	8.47±1.45	10.40±2.27
Pairwise grooming	13.07±2.95	11.80±1.90	13.80±2.61
Fighting	2.20±1.11	1.87±0.88	3.13±1.41

Values are mean±standard deviation.
*Surgery by a veterinarian, †Surgery by a farmer, ‡No castration.

group, and its range of decrease was also lower. In case of the SoV group, the level decreased 40 minutes after the surgery, and it slightly increased after 2 hours. This result is probably due to the pain experienced when the effect of anesthesia faded, and the level gradually reduced. The cortisol level in the SoF group gradually decreased, but it was still higher compared to that in the SoV group. In addition, when the cortisol level increased, the globulin level decreased and the WBC and RBC counts increased. The cortisol level showed a dramatic increase right after the castration corresponding to the results reported by Ting et al. (2005). The WBC and RBC counts also slightly increased, which is similar to the results reported by Chase et al. (1995).

Behavioral measurement

The behavioral characteristics of castrated calves are shown in Tables 4 and 5. Standing was significantly ($P<0.05$) higher in the SoV (374.93±21.51) and SoF groups (379.93±21.30) compared to that in the NC

group (359.37±19.69) based on behavioral time (min/12 hours). The results of the SoF and SoV groups were not significantly different ($P<0.05$). In terms of behavioral frequency, the NC group showed significantly ($P<0.05$) high rates of drinking, self-grooming, scratching, and rubbing, and a significantly ($P<0.05$) low rate of fighting. The feeding time in the SoV and SoF groups significantly ($P<0.05$) decreased, and the frequency of pairwise grooming was significantly ($P<0.05$) low. This result was similar to that obtained by Eicher et al. (2000), in which tail docking was performed on cattle, and the times for lying down and walking decreased, and the standing time reduced.

CONCLUSION

Enhanced quality of life, along with growth in incomes, has had an influence on the improvement in the diet and animal product purchase. In this context, purchase of animal products produced based on animal welfare is also increasing, and international organizations including the OIE are publishing guidelines for animal welfare. In Korea, certain animal policies for farm animals were established and are in effect. However, these policies are still in their initial phase, and studies that fit Korean conditions are not adequate. The use of electronic move-stop without anesthetics or sedatives is preferred due to its cost and convenience. Therefore, the present study aimed to suggest a Hanwoo breeding method based on animal welfare principles which correspond to the global trend. In this study, the differences in blood parameters and behavioral characteristics were analyzed to investigate the stress levels according to the different types of castration treatment. Nine Hanwoos (male calves) aged 6～7 months were categorized into SoV (Hanwoos which were castrated using anesthetics and sedatives by an expert veterinarian), SoF (Hanwoos which were paralyzed in the anus area with a move-stop and castrated by a farmer), and NC (Hanwoos which were not castrated). They were allocated in different stables and fed according to the Hanwoo feeding management program. For data collection, blood analysis was performed at 2 hours pre-castration and 12 hours post-castration. Behavioral characteristics data were recorded for 15 days for analysis based on the multiple individual tracking and selective behavioral observation. At 12 hours post-castration, the results of the blood parameters showed that the WBC count ($10^3/mm^3$) significantly ($P<0.05$) increased from 7.45±0.87 right before the castration to 9.58±1.03 in the SoV group, and that of the SoF group also significantly ($P<0.05$) increased from 7.73±0.16 to 10.30±0.73. The RBC count ($10^6/mm^3$) of the SoV group significantly ($P<0.05$) increased from 8.38±0.51 right before the castration to 10.93±1.15, and that of the SoF group also significantly ($P<0.05$) increased from 8.21±0.28 to 11.44±1.29. The levels of HGB and albumin were not significantly ($P<0.05$) different. The globulin level (g/dL) significantly ($P<0.05$) decreased in the SoV group from 2.99±0.27 right before the castration to 2.10±0.32, and that of the SoF group also significantly ($P<0.05$) decreased from 3.10±0.27 to 1.69±0.19. Cortisol level rapidly increased right before the castration in the SoF and SoV groups. The SoF group showed a significantly ($P<0.05$) higher rate compared to the SoV group, and the decreasing range was also less. In terms of behavioral characteristics, standing was significantly ($P<0.05$) higher in the SoV (374.93±21.51) and SoF groups (379.93±21.30) compared to that in the NC group (359.37±19.69) based on the behavioral time (min/12 hours). No significant ($P<0.05$) difference was found between the SoF and SoV groups. In terms of behavioral frequency, the NC group showed significantly ($P<0.05$) high rates of drinking, self grooming, scratching, and rubbing. The fighting behavior was significantly ($P<0.05$) low. The feeding time significantly ($P<0.05$) decreased in both the SoV and SoF groups, and the frequencies of pairwise grooming and were significantly ($P<0.05$) low. Based on the results, we conclude that the castration by a veterinarian is less stressful than the treatment using a move-stop. The results suggest that no castration is the best welfare. However, if castration is unavoidable for commercial purposes, the best treatment is castration by a veterinarian.

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