Resuscitation Compression for Newborn Sheep

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KEYWORDS

• APGAR • Lamb • Madigan squeeze • Time to stand • Time to suckle

KEY POINTS

- The use of resuscitation compression is a highly valuable method for improving abnormal behavior in newborns.
- In lambs with prolonged time to suckle and/or signs of neonatal maladjustment syndrome, resuscitation compression resulted in significantly improved behavioral scores and reduced time to stand, time to search, and time to suckle.
- Resuscitation compression has no side effects in healthy lambs.
- Resuscitation compression should be considered as a treatment for lambs with neonatal maladjustment syndrome-like symptoms or to stimulate nursing in lambs without a suckle reflex.

Video content accompanies this article at http://www.vetfood.theclinics.com.

INTRODUCTION

Neonatal maladjustment syndrome (NMS), or neonatal encephalopathy, is a central nervous system disorder characterized by lack of interest in the dam, reduced awareness in general, and inability to suckle, which can progress to more severe neurologic signs, including seizures.[1] Although NMS has been described in several species, NMS has been studied extensively in foals, where the prevalence is estimated at 1% to 2%.[2–4] Resuscitation compression (squeezing) has been used successfully in newborn foals and calves to reduce the behavioral symptoms of NMS.[5] The response to resuscitation compression is thought to be due to the release of neurohormones, which simulates compression like that occurring in the birthing process.[2] Weak newborn lambs demonstrate abnormal behaviors like those seen with NMS, and these lambs are at an increased risk for death within the first 48 hours after birth. In this report, the use of resuscitation compression in lambs was critically evaluated to

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determine if this technique would reduce the time to stand, time to search, and time to stand.

MATERIALS AND METHODS

Polypay lambs (n = 86) born at the Oregon State University Sheep Research Center in Corvallis, Oregon were included in this research. All procedures were approved by the Oregon State University Institutional Animal Care and Use Committee (Protocol #5152). Lambs were assessed within 5 minutes of birth using a modified APGAR scoring system[6] (**Table 1**). The time to stand, time to search, and time to suckle were recorded in minutes. At 40 minutes after birth, lambs were categorized into 3 groups based on total APGAR score, time to stand, and time to suckle. Group 1 lambs had an APGAR score of ≥3.6, a time to stand of less than 32.1 minutes, and a time to suckle of less than 40.7 minutes. Group 2 lambs had an APGAR score of ≥3.6 (like group 1) but had a time to stand of ≥32.1 minutes and a time to suckle of ≥40.7 minutes. Group 3 lambs had an APGAR score of less than 3.6 and/or symptoms characteristic of NMS.

A 21-point behavioral scoring system (21P-BSS; **Table 2**) was designed to assess all lambs at 45 minutes after birth and after lambs had suckled or been bottle fed. The 21P-BSS was performed on each lamb before treatment and within 60 minutes after treatment. There were 3 treatment groups: compression (n = 51), placebo (n = 17), and control (n = 18). Treatment was administered between 45 and 120 minutes of birth. Time to stand, time to search, and time to suckle were recorded again for lambs receiving the compression treatment.

The compression treatment was applied to lambs in group 1 (n = 20), group 2 (n = 28), and group 3 (n = 3) to evaluate differences in responses between normal lambs (group 1), susceptible lambs (group 2), and compromised lambs (group 3). The compression treatment was administered by tying a soft cotton rope (1/2-inch diameter and approximately 9 feet in length) around the chest of the lamb following the same procedure as described by Toth and colleagues[7] (**Fig. 1**). Approximately 1 lb of pressure was applied to the rope to tighten the loops and place the lamb into a sleepy, depressed state of movement (Video 1). The pressure was applied continuously for 5 minutes before the rope was removed, and the lambs were stimulated by rubbing their rump and sides (Video 2).

Table 1
The APGAR scoring system described by Flora and coworkers[7] was used to evaluate vitality of newborn lambs

Parameter	0 Points	1 Point	2 Points
Appearance (mucous membrane color)	Cyanotic	Pale	Pink
Pulse (beats/min)	<100	100–175	>175
Grimace (nasal stimulation)	No response	Moves head slightly	Sneezes/moves away/ shakes head
Attitude (rump stimulation)	No response	Moves with no attempt to stand	Attempts to stand
Respiration (oxygen saturation; Spo_2), %	<45	45–65	>65

The pulse and oxygen saturation were measured using a pulse oximeter (#CMS60D-VET, Contec Medical Systems Co, ltd, Qinhuangdao, China) attached to the lamb's dried ear or tail.

Table 2
A 21-point behavioral scoring system was developed to evaluate lambs before and after treatment

Parameter	Observation	Points Assigned
Standing	Not standing	1
	Standing but shaky	2
	Standing strongly	3
Seizure activity	Strong convulsions	1
	Mild convulsions	2
	No convulsions	3
Fear response	No movement away from humans	1
	Aware of humans/moves slightly away	2
	Avidly avoids humans	3
Attention to dam	Ignores dam, no attempt to be near her	1
	Aware of dam's presence but not staying close	2
	Attempts to stay close to dam, calls to her when she is far away	3
Interest in suckling	No interest in finding the teat	1
	Looks for teat when opportunistic timing	2
	Avidly searches for teat, attempting to suckle on dam	3
Attempt to stay warm	Lamb lays by itself	1
	Lamb attempts to lay close to others	2
	Lamb lays next to dam or siblings	3
Stargazing	Lamb stares off up into space/stares into corners	1
	Lamb stares/looks at odd items for several minutes	2
	Lamb does not stare up/into space/at odd objects	3

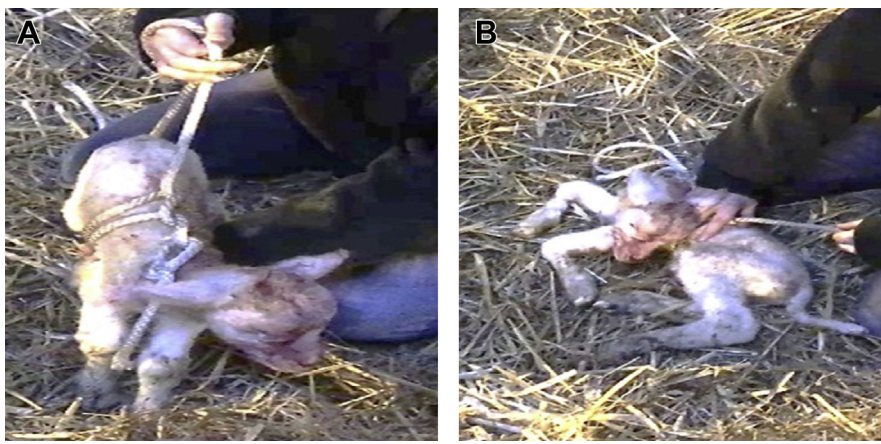

Fig. 1. (*A*) The compression treatment was administered by tying a soft cotton rope around the chest of the lamb following the same procedure as described by Toth and colleagues.7 (*B*) Approximately 1 lb of pressure was applied to the rope to tighten the loops and place the lamb into a sleepy, depressed state of movement. The pressure was applied continuously for 5 minutes before the rope was removed, and the lamb's rump and side were stimulated.

The placebo treatment was applied to lambs in all 3 groups (group 1: n = 6; group 2: n = 10; and group 3: n = 1). The placebo treatment was administered by placing hands around the ribcage of the lamb (in the same region the rope would apply compression) and restraining the lamb continuously for 5 minutes. After the lambs were released, they were stimulated in the same manner as described for the compression treatment. The control treatment was also applied to lambs in all 3 groups (group 1: n = 10; group 2: n = 7; and group 3: n = 1) and involved administration of no treatment or human interaction with the lamb for 5 minutes.

Data were presented as mean ± standard deviation and analyzed using Microsoft Excel software (Redmond, Washington, USA). APGAR scores were compared with time to stand, time to search, and time to suckle using simple linear regression. The effects of treatment on time to stand, time to search, time to suckle, and behavioral score were compared within groups using a paired Student *t* test. Significance was defined as $P<.05$.

RESULTS

Before any treatment, time to stand, time to search, and time to suckle for all lambs was 24.2 ± 20.8, 26.5 ± 22.1, and 43.6 ± 19.8 minutes, respectively. There was no correlation ($R^2 < 0.2$) between APGAR score and the time to stand, time to search, and time to suckle for lambs with total APGAR scores ≥3.6 (groups 1 and 2; **Table 3**). The sample size for lambs with APGAR scores less than 3.6 was not large enough (n = 5) to perform the correlation.

During compression treatment, lambs maintained a sleeplike state for most of the treatment duration. Some lambs kicked and vocalized during compression treatment, and a few lambs defecated and urinated during the compression treatment. Somnolence and these other behaviors were not apparent in lambs receiving the placebo or control treatments. After compression treatment, there was a significant reduction in the time to stand, time to search, and time to suckle in both group 1 and group 2 lambs (**Table 4**). In addition, group 3 lambs that received the compression treatment had a significant reduction in the time to search and time to suckle, such that all group 3 lambs receiving the compression treatment were suckling unassisted within 21 minutes of treatment (see **Table 4**).

Compression treatment improved behavior scores in group 2 ($P = .047$) and group 3 lambs ($P = .013$), and there was a trend for compression treatment to improve

Table 3
Before treatment, there was no correlation between APGAR score and to time to stand (STAND), time to search (SEARCH), and time to suckle (SUCKLE) for lambs with total APGAR scores ≥3.6

	Group 1 (n = 36)			Group 2 (n = 45)		
	STAND	SEARCH	SUCKLE	STAND	SEARCH	SUCKLE
*A*ppearance	$R^2 = 0.00$	$R^2 = 0.03$	$R^2 = 0.01$	$R^2 = 0.01$	$R^2 = 0.01$	$R^2 = 0.02$
*P*ulse	$R^2 = 0.02$	$R^2 = 0.02$	$R^2 = 0.18$	$R^2 = 0.00$	$R^2 = 0.00$	$R^2 = 0.01$
*G*rimace	$R^2 = 0.03$	$R^2 = 0.01$	$R^2 = 0.00$	$R^2 = 0.07$	$R^2 = 0.03$	$R^2 = 0.00$
*A*ttitude	$R^2 = 0.02$	$R^2 = 0.00$	$R^2 = 0.01$	$R^2 = 0.01$	$R^2 = 0.00$	$R^2 = 0.00$
*R*espiration	$R^2 = 0.05$	$R^2 = 0.00$	$R^2 = 0.00$	$R^2 = 0.01$	$R^2 = 0.05$	$R^2 = 0.00$
Total	$R^2 = 0.03$	$R^2 = 0.00$	$R^2 = 0.02$	$R^2 = 0.02$	$R^2 = 0.00$	$R^2 = 0.00$

Group 1 lambs had a time to stand of less than 32.1 min and a time to suckle of less than 40.7 min, whereas group 2 lambs had a time to stand of ≥32.1 min and a time to suck of ≥40.7 min.

Table 4
Mean ± standard deviation (in minutes) for time to stand, time to search, or time to suckle measured in lambs before and after receiving compression treatment

	Group (n)	1 (20)	2 (28)	3 (3)
Time to stand	Before	15.5 ± 8.5	26.9 ± 11.3	88.3 ± 37.4
	After	4.00 ± 5.9	7.3 ± 9.6	8.3 ± 6.8
	P	.000[a]	.000[a]	.059
Time to search	Before	18.6 ± 8.74	25.8 ± 13.5	144.3 ± 20.8
	After	6.0 ± 6.3	10.2 ± 10.5	7.3 ± 5.0
	P	.000[a]	.000[a]	.003[a]
Time to suckle	Before	30.6 ± 6.8	47.9 ± 15.6	137.0 ± 38.0
	After	12.0 ± 10.5	15.4 ± 14.1	16.7 ± 3.7
	P	.000[a]	.000[a]	.022[a]

[a] Compression treatment significantly decreased time to stand, time to search, or time to suckle for lambs receiving compression treatment, with the exception of group 3 lambs in which there was a trend toward a reduction in time to stand.

behavior scores in group 1 lambs ($P = .068$) (Table 5). Placebo treatment did not affect behavior scores in group 1 or group 2 lambs, and no treatment did not affect behavior scores in group 2 lambs (see Table 5). However, behavior scores improved in group 1 lambs that received no treatment.

DISCUSSION

Application of physical stimulation to newborns has been shown to elicit a wide variety of behavioral responses.[8–13] Swaddling produces a tranquil state in most human infants.[11] Deep pressure techniques have been used to improve mood and adaptation to the environment in children with autism.[14] In addition, the use of a squeeze machine on both autistic and normal adults has a relaxing effect.[12] In rabbits, application of skin pressure was followed by "deactivated" EEG patterns, relaxed muscle tone, narrow lid aperture, and constriction of pupils.[8] Another study in rabbits found that positioning newborns on their abdomen with all limbs extended induced a state of "hypnosis."[15]

Table 5
Mean ± standard deviation for behavioral scores taken before and after each treatment for lambs in each group

Treatment	Compression			Placebo			Control		
Group (n)	1 (20)	2 (28)	3 (3)	1 (6)	2 (10)	3 (1)	1 (10)	2 (7)	3 (1)
Before	18.3 ± 2.1	17.8 ± 2.6	11.3 ± 1.2	18.8 ± 1.1	17.3 ± 2.87	15.0	17.2 ± 2.6	17.3 ± 1.9	14.0
After	19.3 ± 1.8	18.3 ± 2.6	20.0 ± 0.8	18.8 ± 1.2	17.9 ± 2.3	18.0	18.7 ± 1.8	18.0 ± 2.3	14.0
P	.068[b]	.047[a]	.013[a]	.500	.321	—	.003[b]	.285	—

[a] Compression treatment significantly improved behavior scores for lambs with either delayed time to stand or time to suckle (group 2) or low APGAR scores at birth (group 3).
[b] The behavior score in lambs with a normal APGAR score at birth and normal time to stand or time to suckle (group 1) improved significantly without treatment (control group), and there was a trend for improvement with compression treatment.

This report is the first to evaluate the use of resuscitation compression for the treatment of abnormal behavioral presentations in lambs. Group 1 lambs that received compression treatment showed no difference in behavioral scores, which indicates normal lambs neither benefit nor are harmed by this treatment. These results are similar to what was reported for normal foals and calves.[5,7] Lambs with prolonged time to stand or time to suckle and/or abnormal behavior (group 2 and group 3 lambs) showed a significant improvement in behavior after resuscitation compression. These results are similar to what was reported for foals and calves with NMS, in which all newborns stood immediately and approached their dam after the compression treatment.[2,5,7] This differed from what was seen in lambs. Of the 51 lambs squeezed, 8 (15.7%) stood immediately and another 13 (25.5%) stood within 1 minute of cessation of treatment. For all lambs receiving resuscitation compression, the time to stand, time to search, and time to suckle after cessation of treatment were 6.0 $\pm$ 8.3, 8.3 $\pm$ 8.9, and 14.3 $\pm$ 12.4 minutes.

Both foals and calves demonstrated depressed or dreamlike behavior during compression treatment,[5,7] like the lambs in the current study. It is of interest to note that it appeared that group 3 lambs kicked harder and more frequently during compression treatment when compared with lambs in group 1 and group 2. Although the sample size for group 3 lambs was small (n = 5), these results suggest that resuscitation compression is a valid method for improving abnormal behavior characteristic of NMS. Of the group 3 lambs that received compression treatment (n = 3), 2 lambs presented with no suckle reflex and 1 lamb had a minimal suckle reflex, whereas all lambs were unable to stand and showed disinterest in their dam. After compression treatment, lamb behavior improved markedly, and all lambs suckled from their dams within 21 minutes. The behavioral scores of these lambs improved from 11.3 $\pm$ 1.2 before treatment to 20.0 $\pm$ 0.8 after the treatment. The lamb behavior remained improved after treatment and did not regress.

SUMMARY

The use of resuscitation compression is a highly valuable method for improving abnormal behavior in newborns. In lambs with prolonged time to suckle and/or showing signs of NMS, resuscitation compression resulted in significantly improved behavioral scores and reduced time to stand, time to search, and time to suckle. The compression treatment also produced no side effects in healthy lambs. Resuscitation compression should be considered as a treatment for lambs with NMS-like symptoms or to stimulate nursing in lambs without a suckle reflex.

CLINICS CARE POINTS

- Neonatal resuscitation compression is a quick treatment that can be performed easily on the farm. However, care must be exercised while performing the procedure to avoid injuring the lamb.
- Neonatal resuscitation compression showed no negative effects when performed on normal lambs. However, when administered to lambs with abnormal behavior at birth, neonatal resuscitation compression markedly improves behavioral scores and vigor.
- It is important to note that neonatal resuscitation compression had no effect on the lamb acceptance by dams that had previously rejected them. Therefore, lambs experiencing dam rejection will still require additional care to ensure access to nourishment.

DISCLOSURE

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.cvfa.2020.10.006.

REFERENCES

1. Hess-Dudan F, Rossdale PD. Neonatal maladjustment syndrome and other neurological signs in the newborn foal: part 2. Equine Vet Educ 1996;8:79–83.
2. Aleman M, Weich KM, Madigan JE. Survey of veterinarians using a novel physical compression squeeze procedure in the management of neonatal maladjustment syndrome in foals. Animals 2017;7:69.
3. Rossdale PD, Leadon DP. Equine neonatal disease. J Reprod Fertil 1975;23:658–61.
4. Bernard WV, Reimer JM, Cudd T. Historical factors, clinicopathologic findings, clinical features, and outcome of equine neonates presenting with or developing signs of central nervous system disease. Proc Am Assoc Equine Pract 1995;41:222–4.
5. Stilwell G, Mellor DJ, Holdsworth SE. Potential benefit of a thoracic squeeze technique in two newborn calves delivered by caesarean section. N Z Vet J 2020;68:65–8.
6. Flora T, Smallman M, Kutzler M. Developing a modified Apgar scoring system for newborn lambs. Theriogenology 2020;157:321–6.
7. Toth B, Aleman M, Brosnan RJ, et al. Evaluation of squeeze-induced somnolence in neonatal foals. Am J Vet Res 2012;73:1881–9.
8. Kumazawa T. "Deactivation" of the rabbit's brain by pressure application to the skin. Electroencephalogr Clin Neurophysiol 1963;15:660–71.
9. Melzack R, Konrad KW, Dubrovsky B. Prolonged changes in central nervous system activity produced by somatic and reticular stimulation. Exp Neurol 1969;25:416–28.
10. Harlow HF, Zimmerman RR. Affectional response in the infant monkey. Science 1959;130:421–32.
11. Lipton EL, Steinschneider A, Richmond JB. Swaddling, a childcare practice: historical, cultural, and experimental observations. Pediatrics 1965;35:521–67.
12. Grandin T. Calming effects of deep touch pressure in patients with autistic disorder, college students and animals. J Child Adolesc Psychopharmacol 1992;2:63–72.
13. Giacoman SL. Hunger and motor restraint on arousal and visual attention in the infant. Child Dev 1971;42:605–14.
14. Bestbier L, Williams TI. The immediate effects of deep pressure on young people with autism and severe intellectual difficulties: demonstrating individual differences. Occup Ther Int 2017;7534972. https://doi.org/10.1155/2017/7534972.
15. Galashina AG, Kulikov MA, Bogdanov AV. Effects of "animal hypnosis" on a rhythmic defensive dominant. Neurosci Behav Physiol 2008;38:23–30.