



Evaluating the efficacy of IV administration of flunixin meglumine or oral meloxicam at reducing post-surgical pain in sheep

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Introduction

Many production procedures cause pain in livestock species which, when left untreated, can cause hyperalgesia—a severe welfare issue^{1,2}. Growing emphasis on improved welfare pushes the industry to ensure accessible analgesia³. Flunixin meglumine, a non-steroidal anti-inflammatory drug (NSAID), is the only approved livestock analgesic used to treat pain associated with foot rot in cattle^{4,5}. Other NSAIDs have shown efficacy in reducing pain associated with husbandry procedures in cattle and preliminarily in sheep through cyclooxygenase inhibition and reduction of inflammatory mediators^{1,6,7}. As producers look for ways to conduct non-invasive, rapid pain assessment, research to address possibilities like vocalization in addition to well-known options like infrared thermography (IRT) and mechanical nociceptive threshold (MNT) for stoic species like sheep has become even more important^{1,8,9}.

Objectives and Hypothesis

This study aims to determine the efficacy of flunixin meglumine (IV; 2.2 mg/kg prior to and at 24h and 48h post-operatively) or meloxicam (PO; 2.0 mg/kg prior to surgery and 1.0 mg/kg at 24h and 48h post-operatively) at relieving pain in sheep after a laparotomy. *It is hypothesized that both analgesics will effectively manage pain associated with soft-tissue surgery in sheep.*

Materials and Methods

Ewes were originally enrolled in a research study under Dr. Timothy Rozell (Title: *Impact of Nutritional Flushing on Ovarian Physiology in Ewes*).

Study Population: Ewes (n=30) from Dr. Rozell's group and the KSU Sheep and Meat Goat Research Center were used and randomly assigned to one of three treatment groups (Table 1), balanced across breed (Rambouillet, Hampshire, and Polypay; n=10/breed).

Treatment	Morning of Laparotomy	24h and 48h Post-Laparotomy	Route of Administration
Control (n=6)	Sedated only— did not receive NSAID		
Meloxicam (n=12)	2 mg/kg	1 mg/kg	PO
Flunixin meglumine (n=12)	2.2 mg/kg	2.2 mg/kg	IV

Table 1: Treatment group dosage and administration route

Laparotomy: MEL and FLU ewes underwent a laparotomy as described in Dr. Rozell's protocol at the KSU Sheep and Meat Goat Research Center.

Data Collection and Outcome Variables: All outcome variables were collected at timepoints -24h (baseline), 4h, 6h, 24h, 30h and 48h with hour "0" being surgery. Outcome variables were collected in the order and manner as noted in Figure 2.

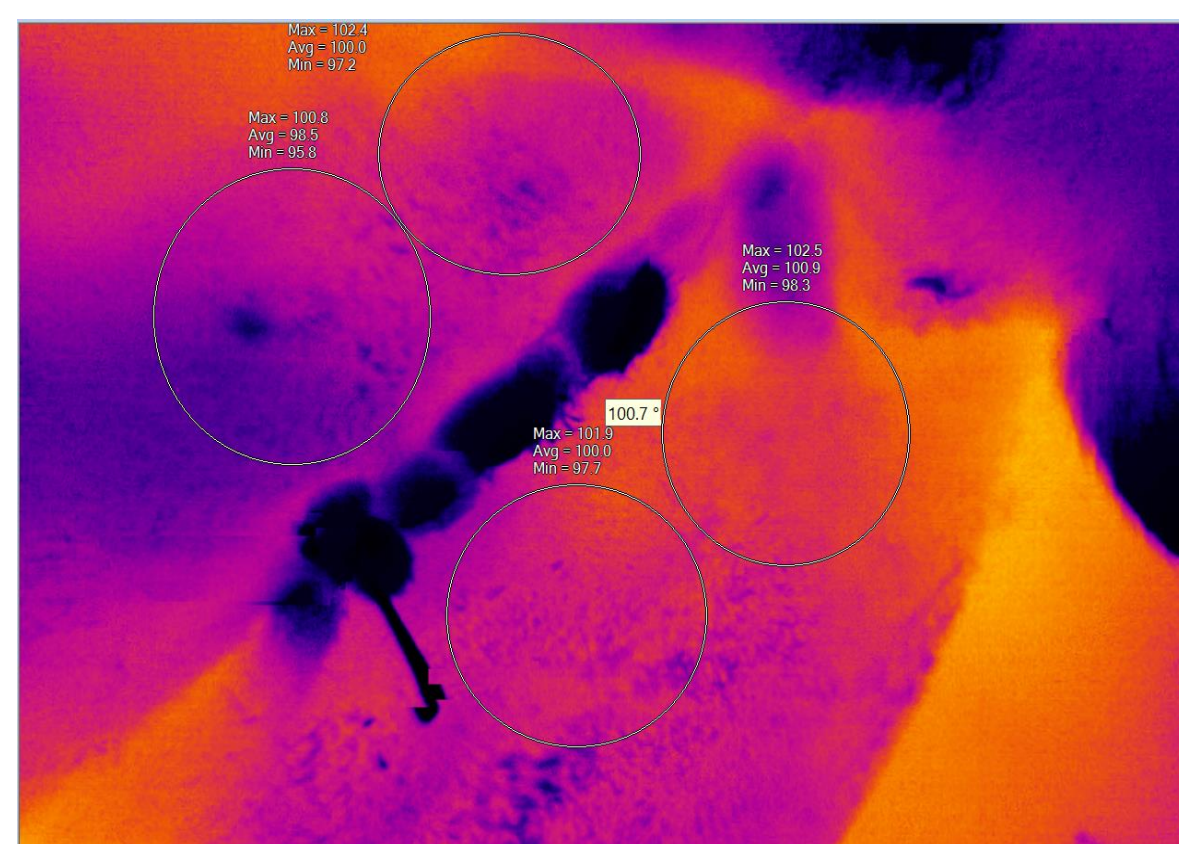


Figure 1: An IRT image of a ewe highlighting sample sites for both IRT and MNT.

IRT

- FLUKE Ti850 IR Imager collected an image showing the incision site (Figure 1)
- Images analyzed with SmartView (v 4.3, FLUKE, Fluke Corp., Everett, WA) to determine temperature at four sites around the incision and then the average temperature around incision site

MNT

- Hand-held pressure algometer (Wagner Instruments, Greenwich, CT) collected MNT data at four consistent collection sites (Image 1)
- Each site was tested three times in the same order and values were averaged

Vocalizations

- A stationary microphone collected ewe vocalizations as they crossed a pressure mat
- Maximum frequency, amplitude and energy was determined with Raven Pro software (v 1.6, Cornell Lab of Ornithology, Ithaca, NY)

Figure 2: Outcome variables in order of collection at each time point

Results

IRT

Average IRT temperature of CON ewes was significantly lower compared to FLU and MEL ewes ($p < 0.0001$ for both). All time points except 24h and 48h had significantly higher average temperatures than baseline (-1h) ($p \leq 0.04$ for all). Rambouillet ewes had significantly higher average IRT temperatures than both Polypay and Hampshire ewes ($p = 0.0016$ and 0.0044 respectively). Time by treatment interactions can be seen in Figure 3.

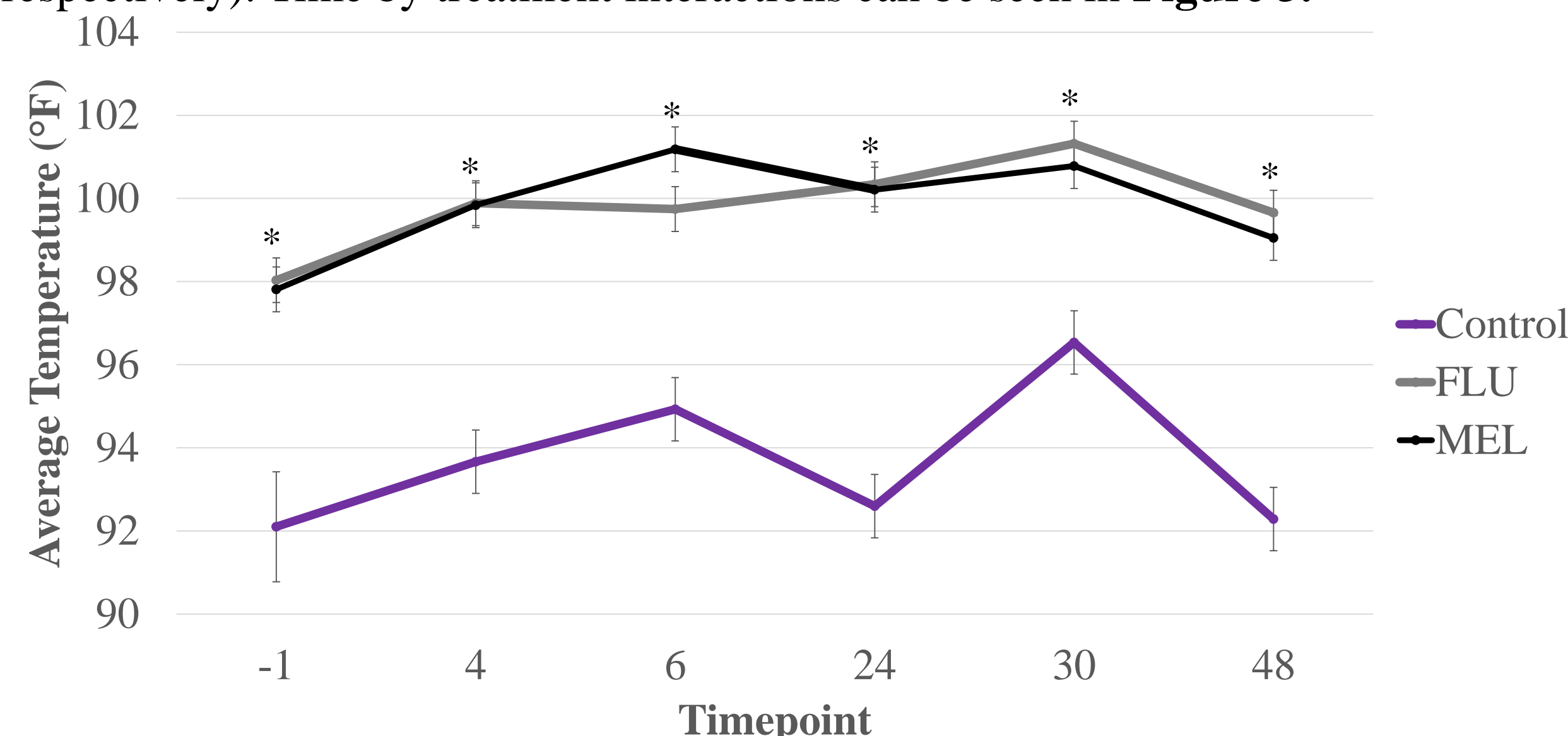


Figure 3: Average IRT temperature as affected by time and treatment. *Denotes significance between the CON group and the FLU/MEL groups at the designated timepoint ($p \leq 0.0115$ for all).

MNT

CON ewes had significantly higher MNT at all test sites except the control (non-pain) site when compared to FLU and MEL ($p \leq 0.0003$). FLU and MEL were not significantly different from each other at any site ($p > 0.05$).

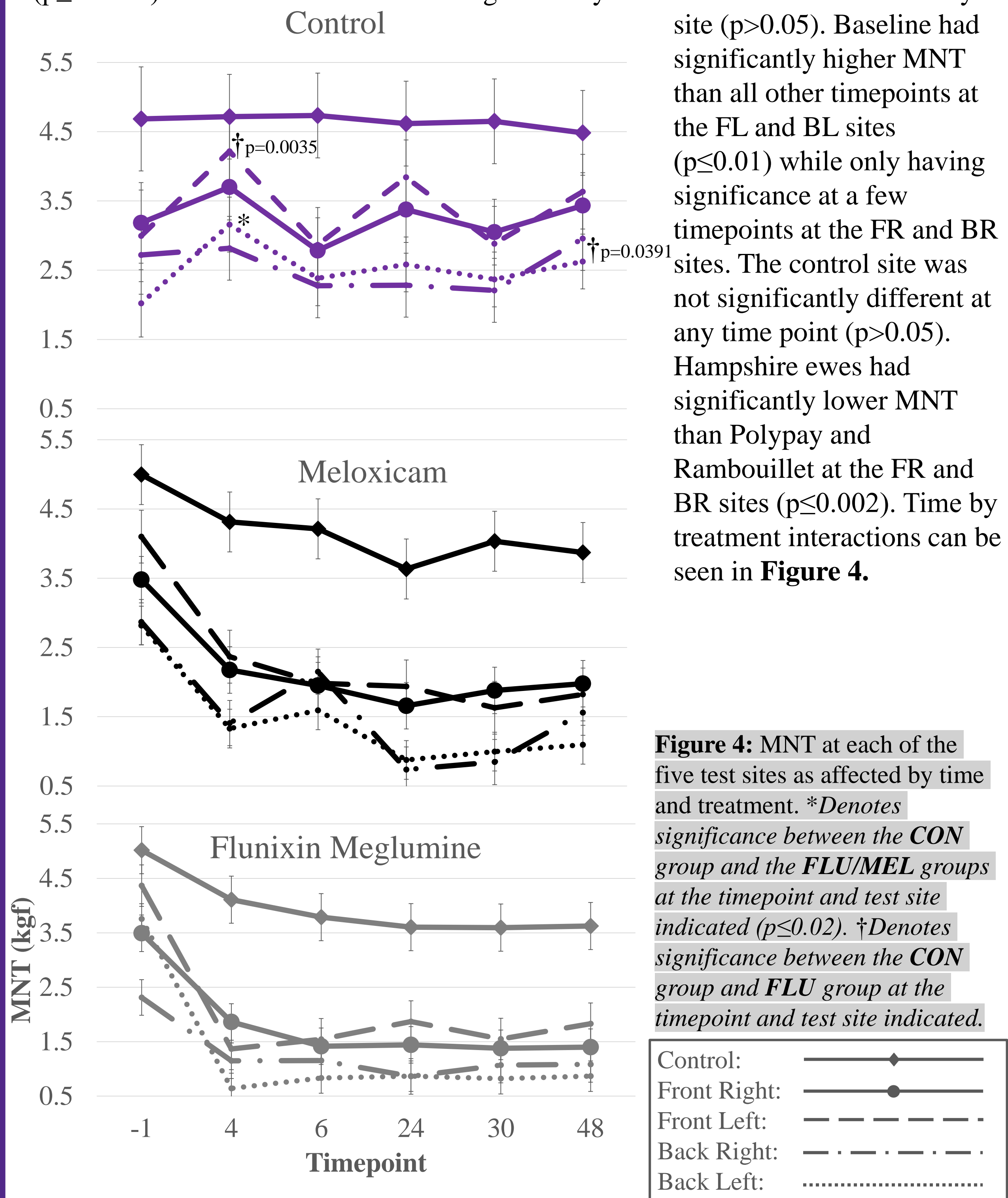


Figure 4: MNT at each of the five test sites as affected by time and treatment. *Denotes significance between the CON group and the FLU/MEL groups at the timepoint and test site indicated ($p \leq 0.02$). †Denotes significance between the CON group and FLU group at the timepoint and test site indicated.

Control: —●—
Front Right: —●—
Front Left: - - -●- - -
Back Right: - · - · -●- · - ·
Back Left: ······●·····

Results (cont'd)

Vocalizations

There were no significant difference in frequency, amplitude or energy based on treatment, time or breed. Vocalization energy tended to be lower in FLU ewes than in MEL ewes ($p = 0.0529$), but there was no difference between FLU/MEL and CON. Figure 5 displays these results.

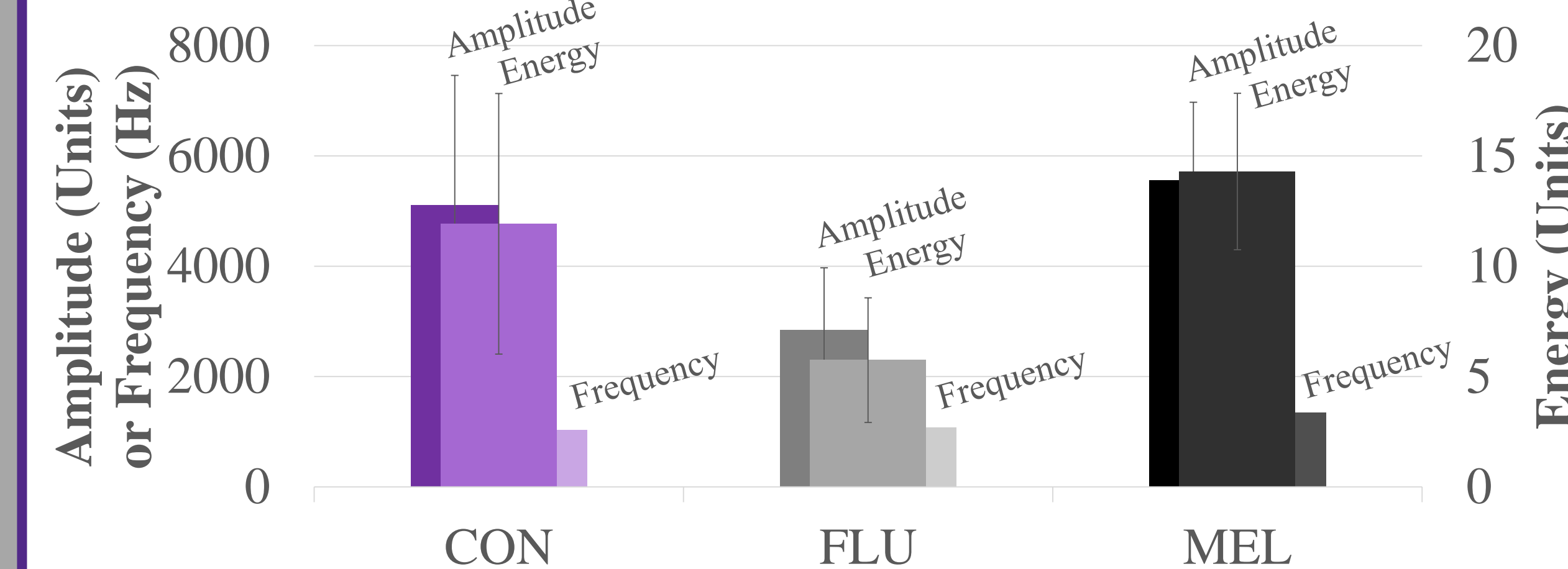


Figure 5: Representation of vocalization data as it was affected by treatment ($p > 0.05$).

Discussion and Conclusion

- Neither flunixin meglumine or meloxicam allowed for greater pressure tolerance or reduced inflammation at the surgical site in sheep, suggesting comparable efficacy
- Neither NSAID was able to eliminate post-surgical pain in sheep; therefore, a multimodal approach may be more effective in completely addressing surgical and procedural pain
- Vocalization may not be a good pain indicator for sheep, as they are a stoic species and are not prone to vocalize when in pain
- Future research should look into adding opioids or alpha 2 agonists to NSAID administration for addressing pain in sheep
- Alternative pain indicators, like facial grimacing or behavior, should be considered for use in production settings

The outcome measures presented here are preliminary results, and further analysis of plasma cortisol, behavior, gait assessment and facial grimace analysis will be used to confirm these findings.

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