THE ROLE OF ENDORPHINS IN THE RESPONSE TO STRESS IN SHEEP AND CATTLE

D.A. SHUTT* and L.R. FELL*

SUMMARY

Significant increases in plasma kendorphin, an endogenous morphine, occurred in 6-7 months old wethers at 5 min and 15 min following mulesing, and behavioural observations indicated that this natural endorphin-induced analgesic response to mulesing lasted for about 1 h.

In Hereford steers a marked rise in plasma B-endorphin was also induced by exposing the steers to handling stress in a "pre-slaughter" situation. This was interpreted as a "non-pain" adaptive response to an intensively stressful situation, as perceived by individual steers.
Keywords: endorphins, sheep, cattle, mulesing, handling stress .

INTRODUCTION

Stress management in sheep and cattle is increasingly being discussed in the context of animal welfare and in relation to improving the quality of wool and meat production. In this regard increases in cortisol in saliva and plasma have been found to be potentially useful as an indicator of the relative stress of a range of management situations (Fell et al. 1985; Fell and Shutt 1986). It is also known that the pituitary releases β-endorphin along with other peptide hormones into the blood circulation in response to acute stress (Guillemin et al. 1977), and this endogenous morphine has important analgesic properties (Tseng et al. 1976).

Preliminary observations have shown stress-induced increases in plasma concentrations of β-endorphin following routine surgical procedures in 3-5 weeks old lambs (Shutt et al. 1987a), and the present paper extends these observations to mulesing of Merino wethers and to handling stress in cattle.

MATERIALS AND METHODS

In experiment 1, 20 Merino wethers, aged 6-7 months and weighing 25-34 kg, were divided into two groups of 10, matched for weight. One group of 10 was used as controls and underwent similar handling procedures to the second group which were mulesed. The mules treatment incorporated standard breech cuts commencing level with and next to the base of the tail. Cuts were also made on the tail so a V of wool-bearing skin remained. Jugular vein blood samples were collected into 10 ml heparinized vacutainers from all wethers prior to treatment, and at 5 min, 15 min and 60 min post-treatment, before releasing the wethers into a paddock. The blood was centrifuged, and the plasma was stored frozen until assayed for β-endorphin by radioimmunoassay as previously described (Shutt et al. 1987a).

In experiment 2, three adult Hereford steers were placed in a crush and intra-venous catheters inserted to facilitate blood sampling. Jugular blood samples were collected into 10 ml vacutainers containing EDTA as the anticoagulant. The steers were then walked across a paddock 30 min later, and through a race to a second crush in an experimental abattoir where stunning would normally take place. Further blood samples

Department of Agriculture, Hawkesbury Agricultural Research Unit, P.O. Box 217, Richmond, N.S.W. 2753.

were then collected at times equivalent to 1 min "pre-stun", and 3 min, 5 min, and 30 min "post-stun". In this preliminary trial the steers were not stunned. The blood was then centrifuged and the plasma stored frozen prior to radioimmunoassay for β-endorphin.

RESULTS

The results from experiment 1 show that, in response to mulesing, significant increases ($P<0.01$) in plasma β-endorphin concentrations (mean ± S.E.) in wethers occurred at 5 min, and 15 min, in comparison with concentrations of β-endorphin in control wethers (Fig. 1). Peak concentrations of β-endorphin of 209 ± 28 pg/ml were found at 5 min after mulesing compared with 77 ± 20 pg/ml in the controls at 5 min. No significant differences in β-endorphin concentrations were apparent between the two groups of wethers at 60 min after mulesing.

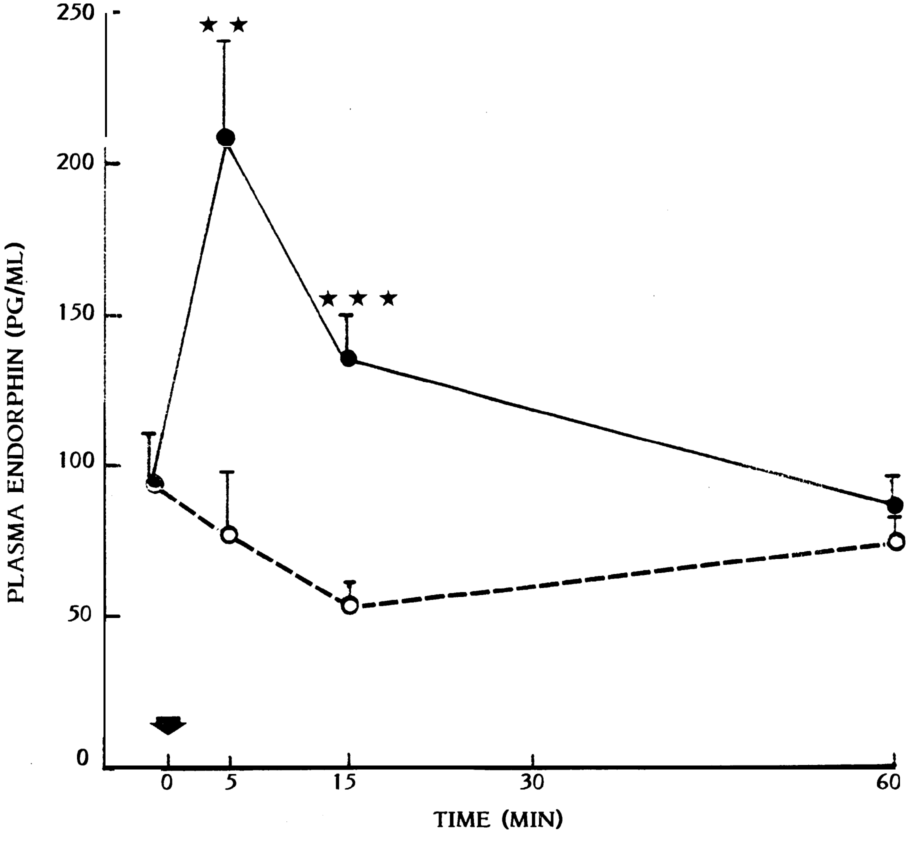

Fig. 1. Changes in plasma immunoreactive β-endorphin concentrations (mean ± S.E.) in 10 Merino wethers in response to mulesing (●), and in 10 controls (○). Statistical significance indicated $P<0.01$ (★★); $P<0.001$ (★★★) using Students t-test. Arrow indicates the time of mulesing.

The results of experiment 2 show that handling stress in a pre-slaughter situation can cause a marked release of β-endorphin into the blood circulation of steers (Fig. 2). In steer No. 1 β-endorphin concentration increased from 260 pg/ml in the first crush to a peak of 1000 pg/ml after 3 min in the second crush. Steer No. 2 showed no reaction to blood sampling in the first crush but responded to handling and blood sampling with a rise in plasma β-endorphin from 130 pg/ml to 350 pg/ml after 5 min in the second crush. Steer No. 3 responded the least to handling with plasma β-endorphin being 90 pg/ml in the first crush and 180 pg/ml at 3 min in the second crush.

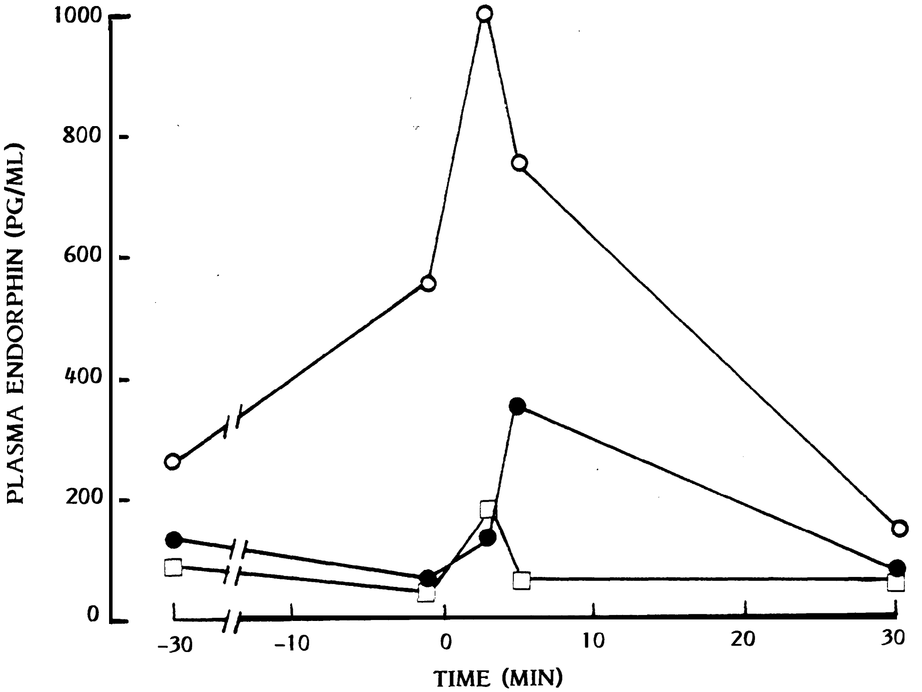

Fig. 2. Changes in plasma immunoreactive β-endorphin concentrations in 3 Hereford steers in response to pre-slaughter handling stress. Steer 1 ❑ O Steer 2 = ● Steer 3 = ☐. Time in area where stunning would normally have taken place, indicated from Time 0 (min).

DISCUSSION

There is good evidence that certain surgical procedures, including mulesing in lambs, can be the triggers for the release of β-endorphin, a potent analgesic (Smith et al. 1985; Shutt et al. 1987a). The findings of a post-operative release of β-endorphin lasting for up to 60 min after mulesing in wethers, agrees with behavioural observations indicating the onset of soreness occurred between l-2 h a'fter mulesing. Comparing the present data with our previously published results (Shutt et al. 1987a), total immunoreactive endorphin concentrations were up to three-fold higher in the plasma of 3-5 weeks old lambs than in the present 6-7 months old wethers. However, as determined using ultrafiltration, the immunoreactive β-endorphin measured in the plasma of the lambs contained about 60% of a non-analgesic precursor hormone, β-lipotrophin, compared with less than 30% in the wethers. In contrast to these observations of possible endorphin-induced analgesia, the intense distress immediately following the application of rubber rings for castration and tail docking of 3-6 weeks old lambs may be due to a lack of β-endorphin release, compared with that following surgical castration and tail docking (Shutt et al. 1987b).

A significant stimulus to the release of endorphins can be observed during some handling procedures of livestock. As the present results showed in three Hereford steers, pre-slaughter handling restraint can cause a marked "non-pain" release of β-endorphin. We have also found a similar emotional response to restraint in rams. For example, when untrained rams were restrained in a race for blood sampling, β-endorphin levels rose to 480-500 pg/ml in three out of four rams with blood levels remaining at about 150 pg/ml in the fourth ram (Shutt and Fell, unpublished). Wolfle and Liebeskind (1983) consider that situations perceived by the animal to be intensely stressful could interfere with effective coping responses, and therefore the activation of an intrinsic analgesic system under these conditions would prove adaptive. The above examples also confirm that handling restraint can be a considerable stress to livestock.

ACKNOWLEDGEMENTS

We wish to thank Mr. Alan Bell, Department of Agriculture, Tamworth, N.S.W. for his expert assistance and advice with the mulesing experiments, and thank Ruth Connell for endorphin radioimmunoassays.

REFERENCES

FELL, L.R., SHUTT, D.A. and BENTLEY, C.J. (1985). Aust. Vet. J. 62: 403.

FELL, L.R. and SHUTT, D.A. (1986). Proc. Aust. Soc. Anim. Prod. 16: 203.

GUILLEMIN, R., VARGO, T., ROSSIER, J., MINICK, S., LING, N., RIVIER, C., VALE W. and BLOOM, F. (1977). Science 197: 1367.

SHUTT, D.A., FELL, L.R., CONNELL, R., BELL, A.K., WALLACE, C.A. and SMITH, A.I. (1987a). Aust. J. Biol. Sci. 40: 97.

SHUTT, D.A., FELL, L.R., CONNELL, R. and BELL, A.K. (1987b). Aust. Vet. J. 64: (in press).

SMITH, R., BESSER, G.M. and REES, L.H. (1985) Neurosci. Lett. 55: 17.

TSENG, L.F., LOH, H.H. and LI, C.H. (1976). Nature 263: 239.

WOLFLE, T.L. and LIEBESKIND, J.C. (1983). In "Animal Pain: Perception and Alleviation", p.107, editors R.L. Kitchell and H.H. Erickson. (American Physiological Society: Bethesda, Maryland).