Endocrine and cardiac parameters in parturient mares - Prediction of foaling -

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• Physiological induction of parturition in horses different from ruminants and pigs

• No progesterone in late pregnant mares but pregnancy is maintained by 5α-pregnanes

• Precursors for placental progestin production originate from fetal adrenal glands

➢ Fetus essential for maintenance of pregnancy
Endocrinology during late gestation

Maturation of enzyme pathways

Pregnenolone → CORTISOL

Placenta: Maintenance of pregnancy

Induction of foaling

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Prediction of parturition
• Parturition in horses
  – Short and active expulsive phase
  – Is suggested to be a strenuous and painful process

• Stress response
  – Activation of the sympathetic nervous system and the hypothalamo-pituitary-adrenal axis

• Stress response
  Stress during parturition \(\rightarrow\) inhibition of labor via activation of uterine \(\beta_2\)-receptors

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Parturition and stress responses

• Stress response is indicated by
  - Cortisol concentration ↑
  - Heart rate ↑
  - Heart rate variability ↓
Stress responses

- Hypothalamus
- Anterior pituitary
- Adrenal gland

Brain

CRF → ACTH → Glucocorticoids

Autonomic nervous system

Hypothalamic-pituitary adrenocortical response

Cortisol (Saliva = non-invasive sampling)

Sympathetic-adrenomedullary response

Adrenaline

Heart rate

Heart rate variability

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Stress responses

Autonomous nervous system (ANS)

**Sympathetic part of ANS**
- increased activity in response to stressful situations and external challenges ("fight or flight")

**Parasympathetic part of ANS**
- increased activity during times of rest ("rest and digest")
Heart rate variability

- HRV $\downarrow$ = Sympathetic dominance
- HRV $\uparrow$ = Parasympathetic dominance

- RMSSD = Root mean square of successive RR differences
  Specific for parasympathetic activity

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Hypothesis

• Parturition in mares induces a stress response and thus parturition can be predicted by changes in stress parameters
  - Heart rate
  - Heart rate variability
  - Cortisol concentration

**Cut-off point:** Increase of more than 2 times the standard deviation of respective parameter from mean values of days 5, 4 and 3 before foaling

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Material and methods

Group 1: Warmblood brood mares (n=24)
- Starting 15 days before calculated day of parturition
- ECG recordings once daily for one hour
- Salivary cortisol 4 x daily (6:00, 12:00, 18:00, 24:00)

Group 2: Warmblood brood mares (n=17)
- From 2 hours before to 2 hours after parturition
- Continuous ECG recordings
- Salivary cortisol at 0, 15, 30, 60, 120 min after foaling
Electrocardiogram
Salivary cortisol

- Non-invasive technique
- Only biological active part of total cortisol concentration
- Need of laboratory equipment

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Results
Salivary cortisol concentration in mares from 15 to 1 day before parturition at 6:00, 12:00, 18:00 and 24:00

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Salivary cortisol concentrations from 1 day before to 1 day after parturition
80% of mares show an increase in cortisol during the last 24h before parturition (> 2 x SD of basal values)
Heart rate

Heart rate from 15 days before to 1 day before parturition

Heart rate from 120 min before to 120 min after parturition

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Heart rate variability

HRV variable RMSSD from 15 days before to 1 day before parturition

HRV variable RMSSD from 120 min before to 120 min after parturition

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Heart rate

- Increases during the last month of gestation but no further changes towards foaling.
- False positive results with regard to prediction of foaling.

HRV

- High individual variations.
- Increase in less than 70% of mares during the last 2 h before parturition.

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Atrioventricular blocks

• Horses have a powerful cardiovascular system and at rest occasionally “skip” one heart beat due to second degree atrioventricular blocks (AV blocks)
• Sign of high parasympathetic tone
• Disappear during exercise, due to increased demands on the cardiovascular system

• AV blocks in parturient mares?
  ➔ If parturition is a stressor, no AV blocks are expected

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Number of AV blocks per mare during 15 min intervals from 120 min before to 120 min after parturition (n=11)

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Number of AV blocks per mare and number of mares with AV blocks during 15 min intervals from 120 min before to 120 min after parturition (n=11)

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- No AV blocks in any mare days before parturition
- 9/11 mares showed AV block during 15 min interval before parturition
- Only one mare showed no AV blocks at all
Summary and conclusion
Summary and conclusion

• HR increases during equine gestation because of adaptation of the cardiovascular system to increasing demands of the growing fetus

• Before and during foaling heart rate remains at the same level

• High incidence of AV blocks and high HRV during and after parturition

⇒ In horses parturition and the immediate post partum period are dominated by parasympathetic activity
⇒ Physiological parturition is no major stressor in horses

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• Salivary cortisol increases 1-2 days before parturition
  - Coincides with increase in fetal plasma cortisol
    (Silver and Fowden 1995)
  - Cortisol in the maternal circulation could in part be of fetal origin

• Maximum cortisol concentration at 30 min after parturition
  - Not directly associated with labor
  ➔ High level of cortisol during high parasympathetic activity

➔ Rise in cortisol concentration is unlikely a stress response but part of the endocrine pathways initiating parturition
Prediction of parturition

- Heart rate and HRV no reliable parameters
- Detection of AV blocks during normal parturition?
- Cortisol concentration increases >2 ng/ml in up to 80% of mares during the last 24 hours before parturition
Most systems are not advisable for prediction of parturition. Prediction of parturition is still challenging.
Thank you for your attention