Approche histologique et neurophysiologie de la douleur liée à la coupe de queue chez les porcelets

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Leading the way in Agriculture and Rural Research, Education and Consulting

Presentation overview

Approaches for assessing nociception and pain in pigs – tail docking/biting (FareWellDock Project)

- Tail histopathology (characterization, traumatic neuromas)
- Neurophysiology (peripheral nerve, dorsal root ganglia, spinal cord)
  - gene expression (pain neuropeptides)
- Behaviour (mechanical threshold testing)

Pig research at SRUC

- Heath & Welfare
  - Sow (dry, farrowing), piglets
  - Grower & finisher

FareWellDock project

- 3 year EC funded research programme (ANIWHA Era-Net initiative)
- 10 project collaborators from 8 different EU countries (plus 1 from USA)
- Address major welfare issues of tail docking and tail biting in commercial pig production in EU.

Aims: supply necessary information for quantitative risk assessment of tail docking and biting and develop towards a non-docking policy in the EU.

Tail biting/docking in pigs

Tail biting is a major welfare and health issue

- **up to 30% losses (NADIS, 2013)**
- **complicated multifactorial background**

Tail docking is carried out as a measure against tail biting, but is a welfare issue in itself.

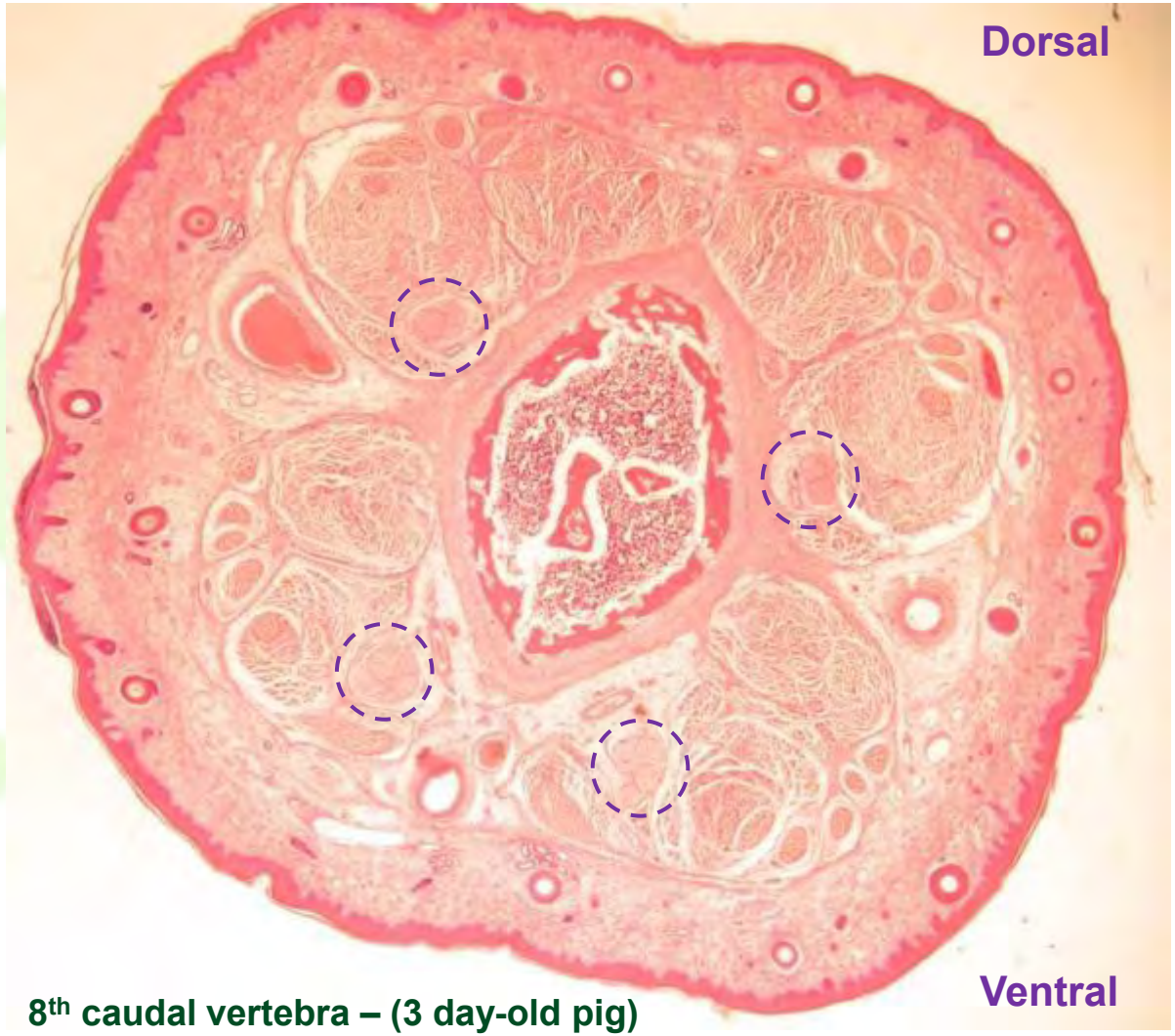
Objectives

Adverse effects: Hazard characterisation

- Assess the short (acute inflammation), medium (post-trauma repair) and long term (traumatic neuroma formation) pain associated with tail docking piglets
- Characterize the time course of traumatic neuroma development caused by tail docking in piglets
- To assess the effects of tail resection in older pigs on neuroma formation and stump pain sensitivity. Provides a basis for assessing the pain associated with being tail bitten

Pig tail - anatomy

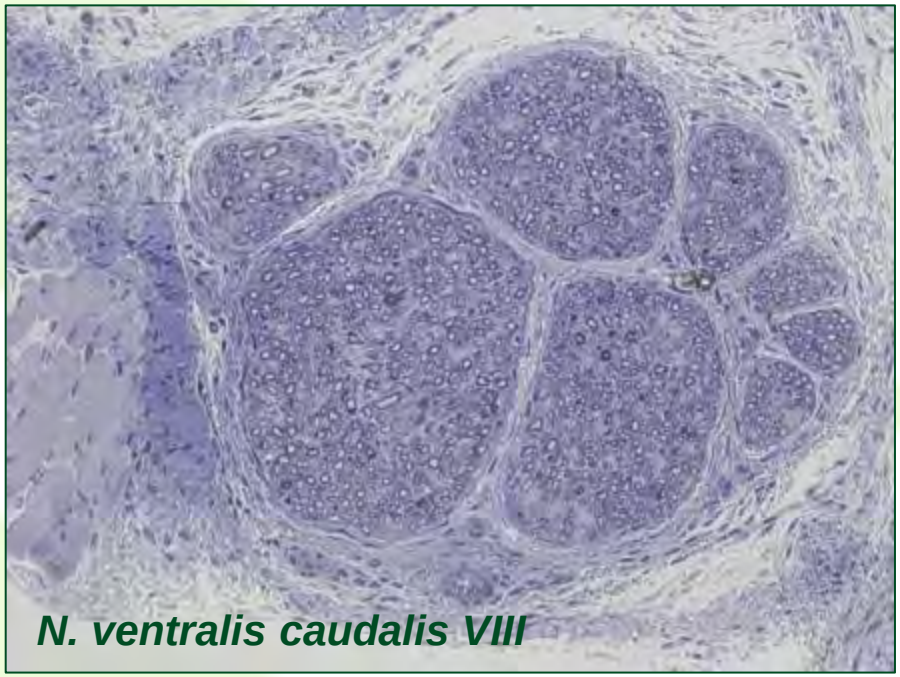
Pig tail - cross section



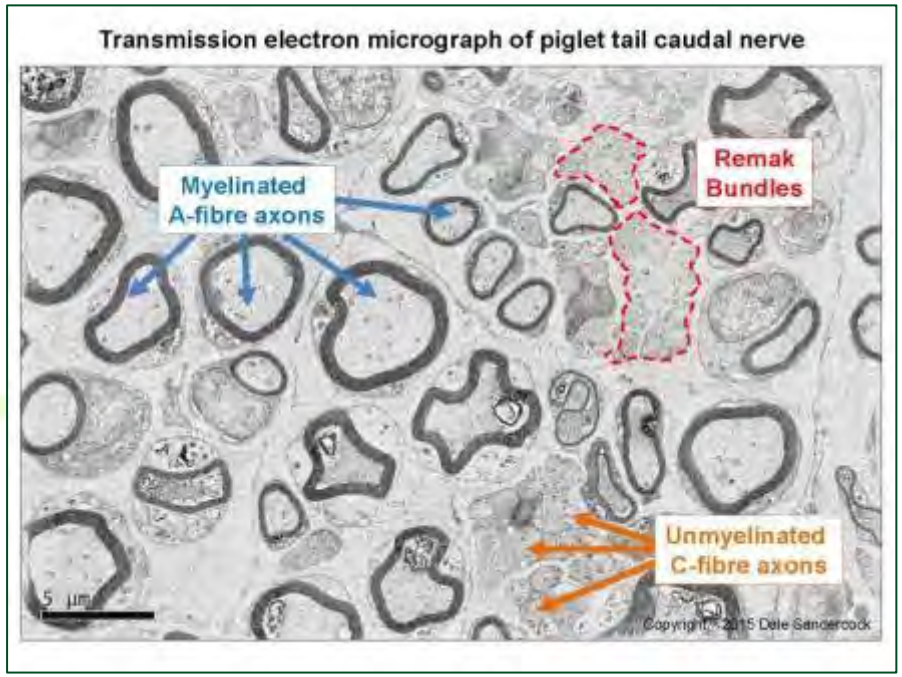
8th caudal vertebra – (3 day-old pig)

Pig tail - caudal nerves

Nerve cross section (Ca. 8th/9th caudal vertebrae)

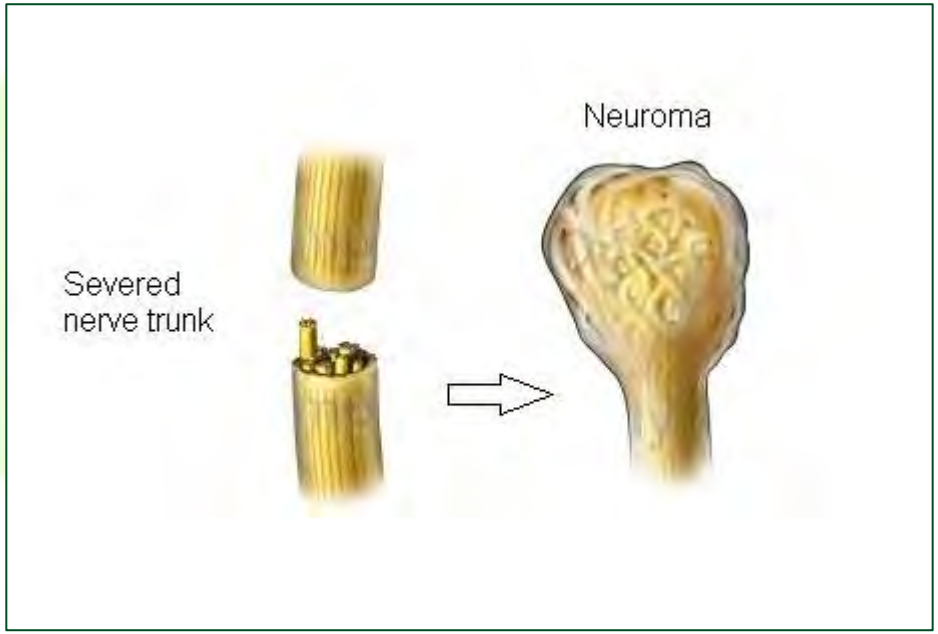


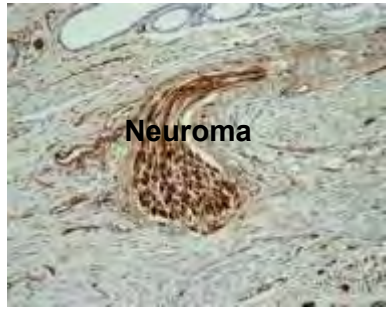
N. ventralis caudalis VIII



Traumatic neuroma

Tail docking leads to neuroma formation in peripheral nerves





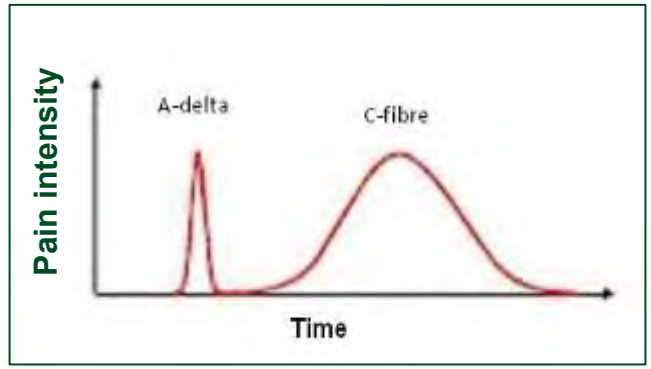
Can be associated with persistent pain or increased sensitivity to mechanical stimulation in tail stump

Sensory neurons - nociceptors

Physiological pain is the immediate response to noxious stimuli mediated through high-threshold receptors located on nociceptive sensory neurons

Fast pain – small diameter, myelinated A-δ fibres

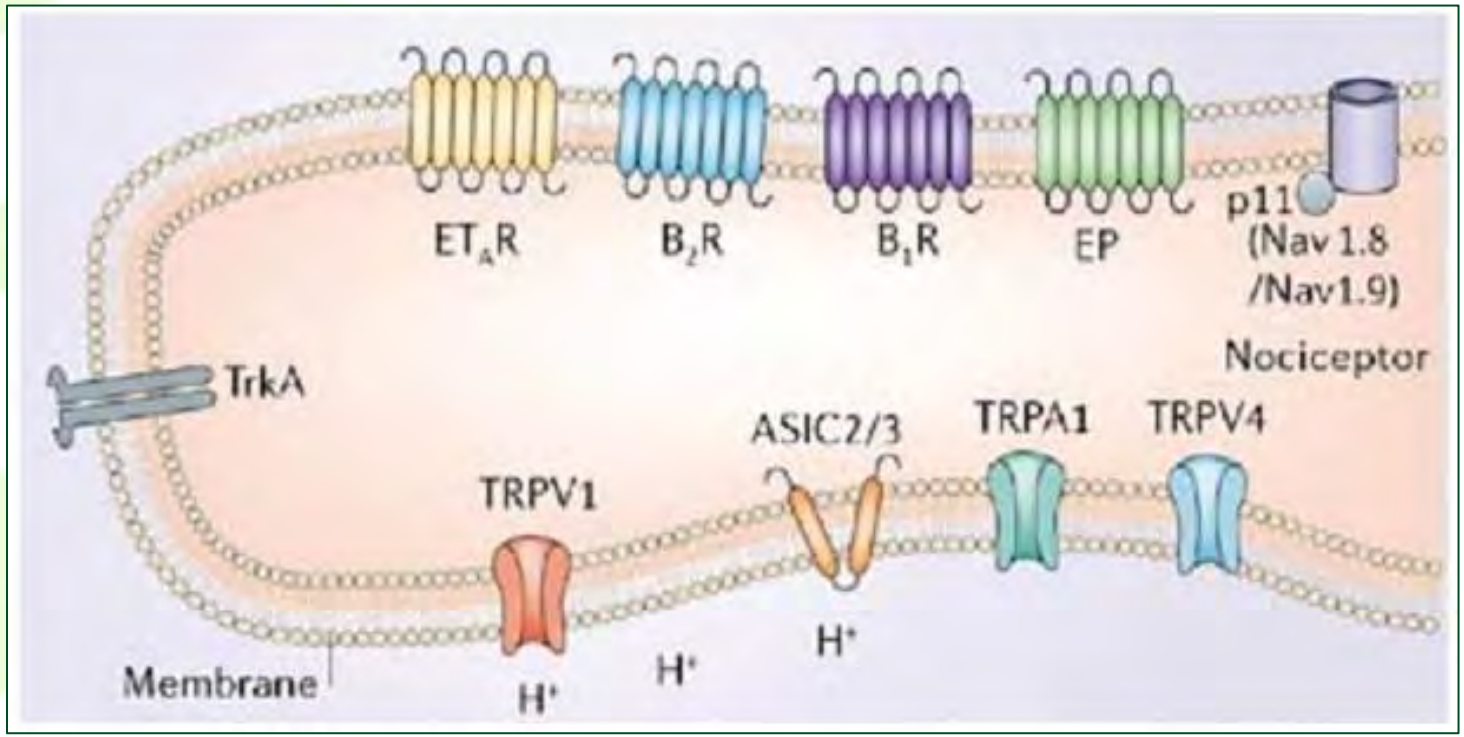
Slow pain – small diameter, unmyelinated C-fibres



Sensory receptors

Transduce painful stimuli into action potentials which is transmitted along primary sensory nerves to dorsal horn of spinal cord

Nociceptive nerve ending

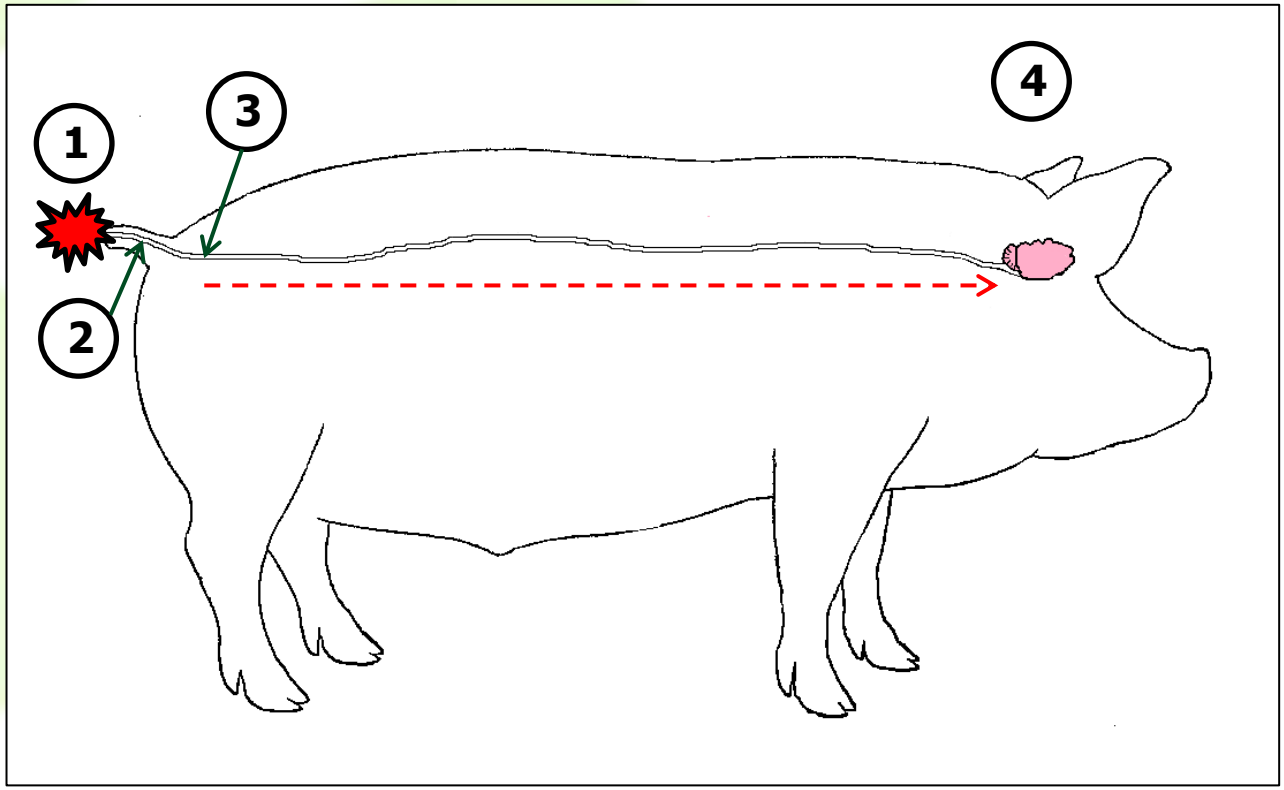


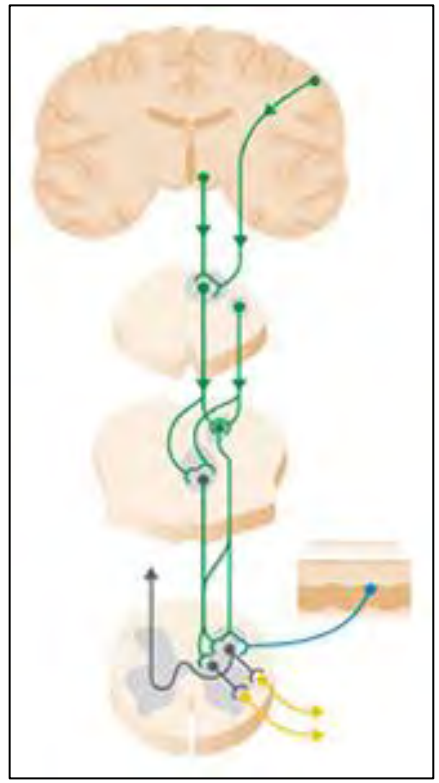
Pain pathway

4 stages:

1 *Transduction* 2 *Transmission* 3 *Modulation* 4 *Perception*

Nociception **Pain**

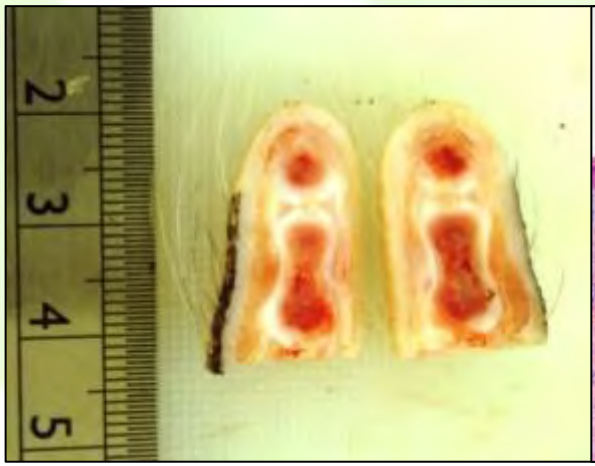


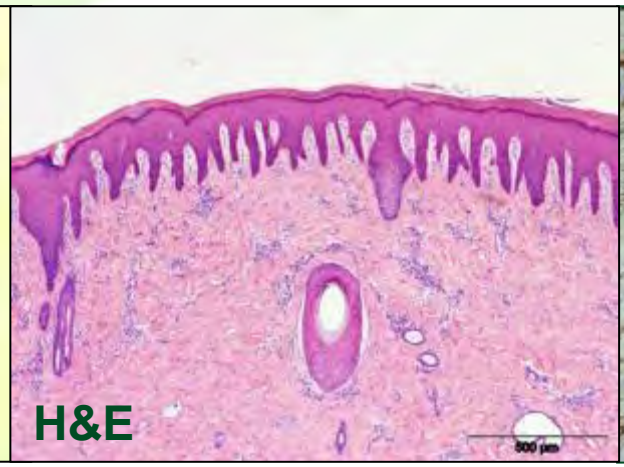


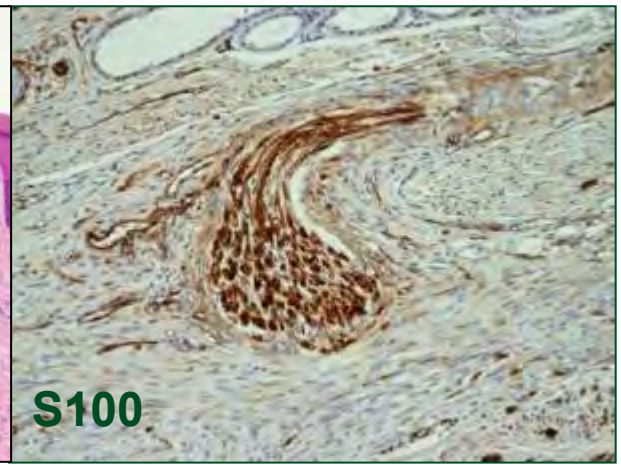
Tail histopathology

Characterize tail injury and peripheral nerve repair (pre, peri and post-neuroma development)

- Commercial docked pigs (3d)
- Assessment **1, 4, 8** and **16** weeks after tail docking (n=16)
- 200 sections (every 10, 20, 30 ……max 150)
- H&E and S100 immuno-localization of peripheral nerves

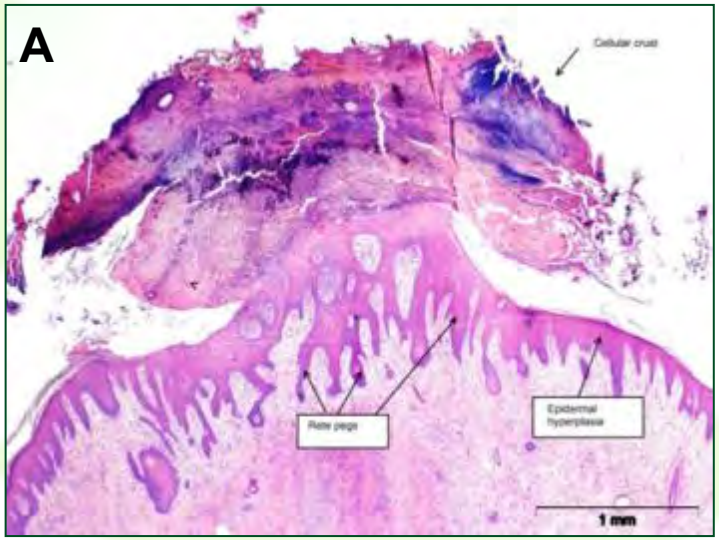


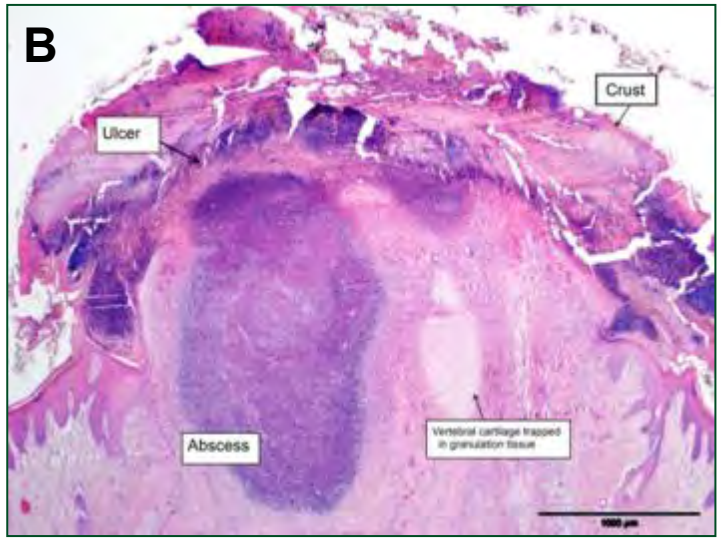


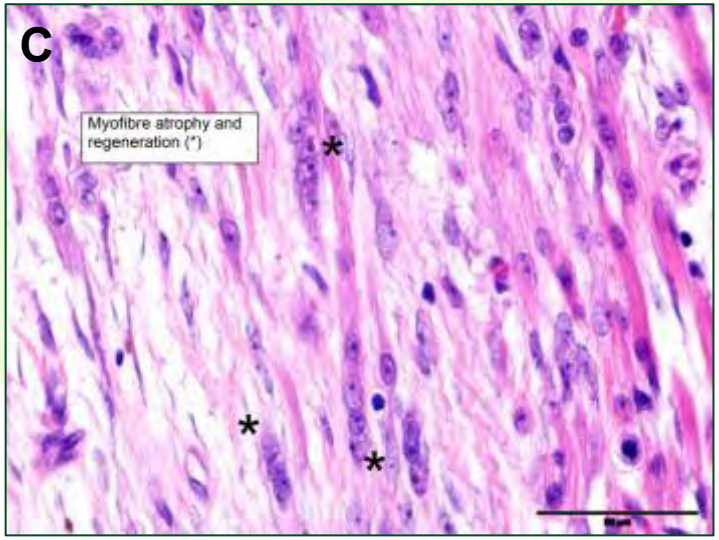


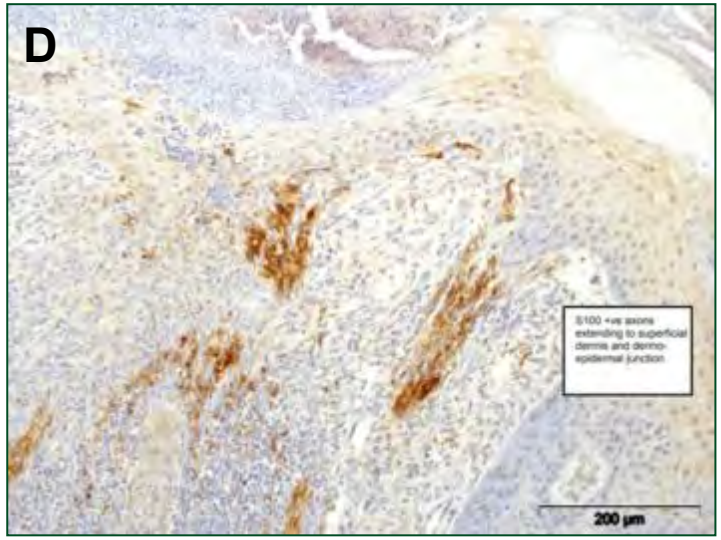
Tail histopathology

1 week after tail docking



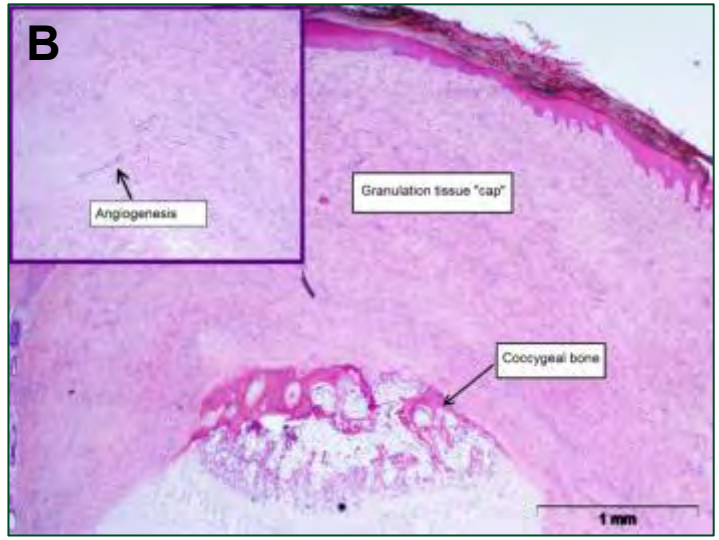


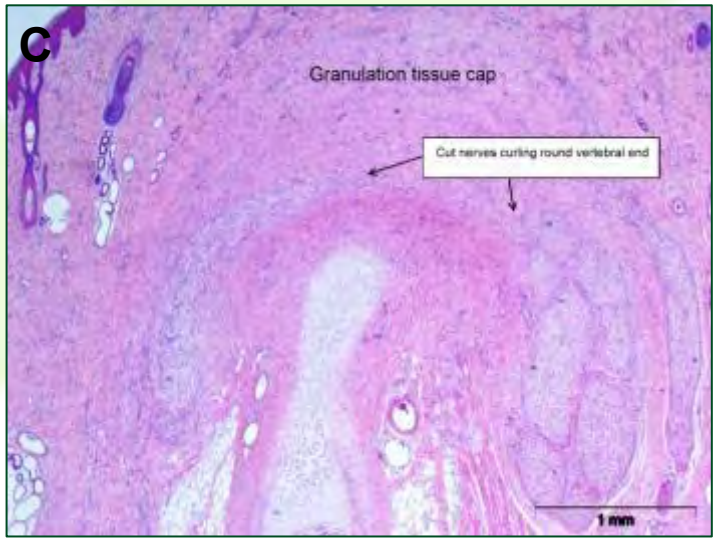


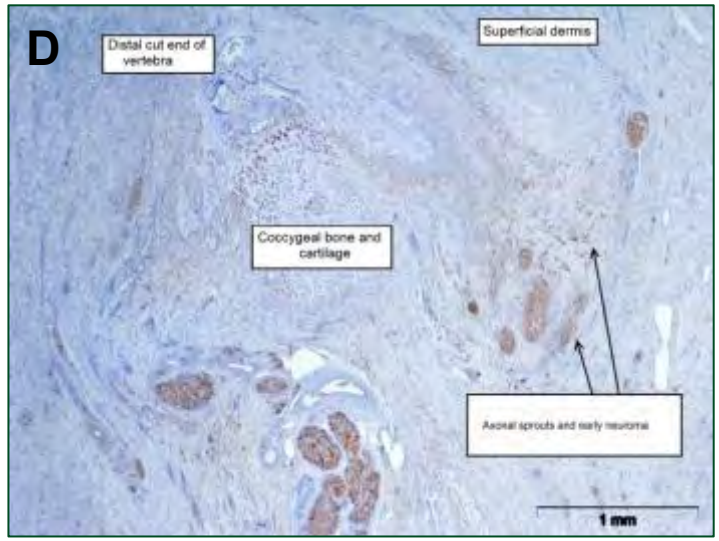


Tail histopathology

4 weeks after tail docking

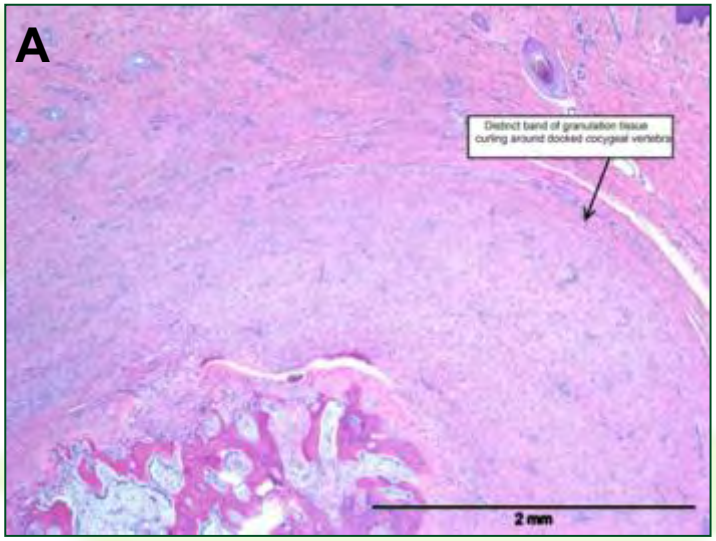


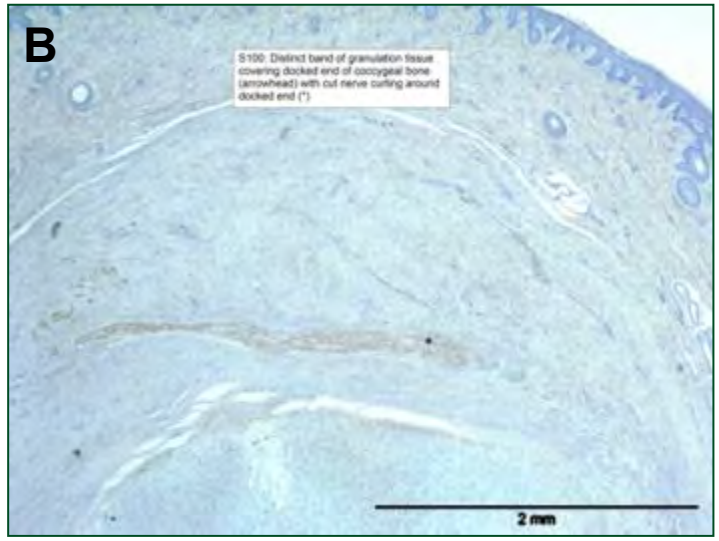


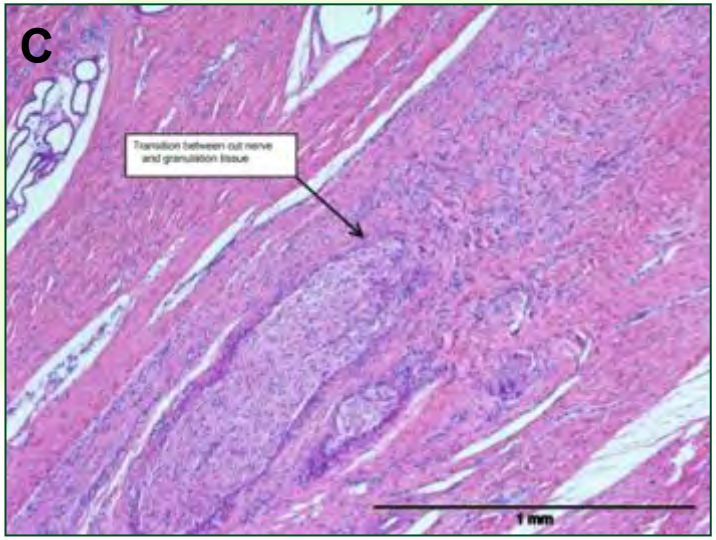


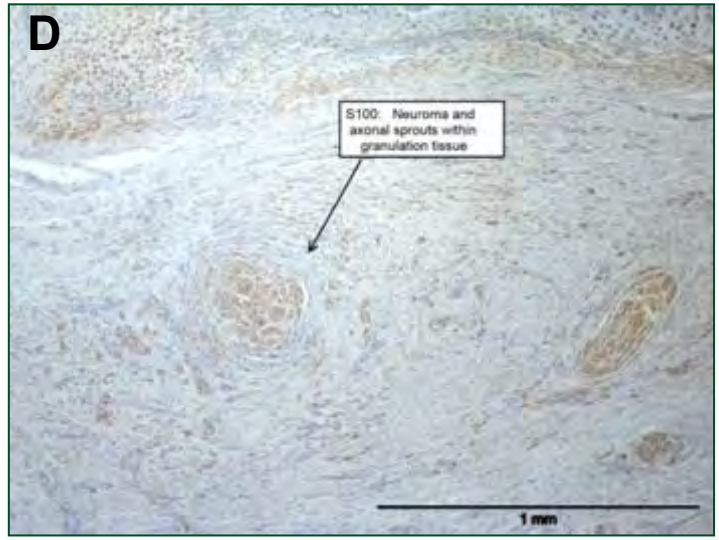
Tail histopathology

8 weeks after tail docking



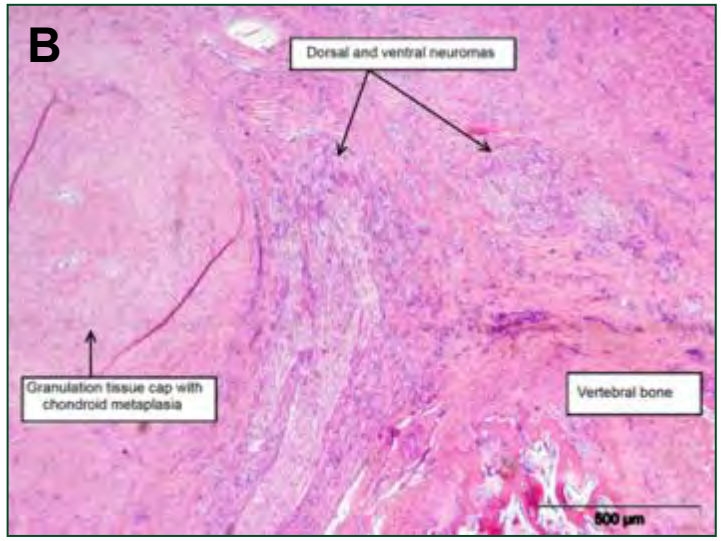


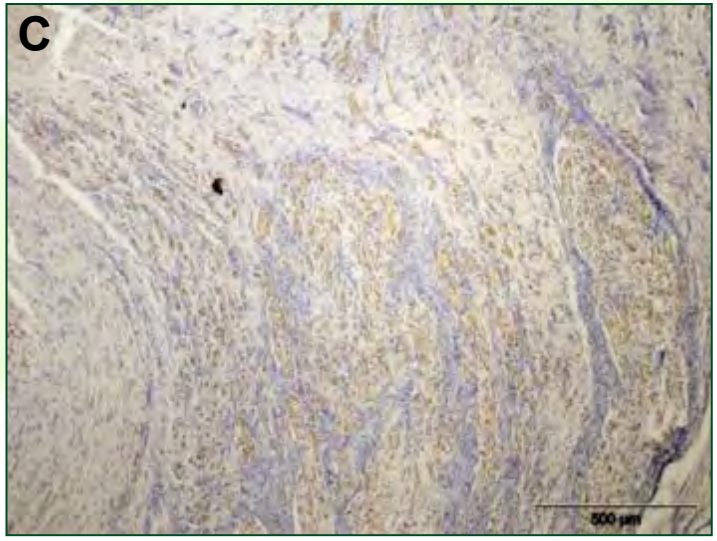


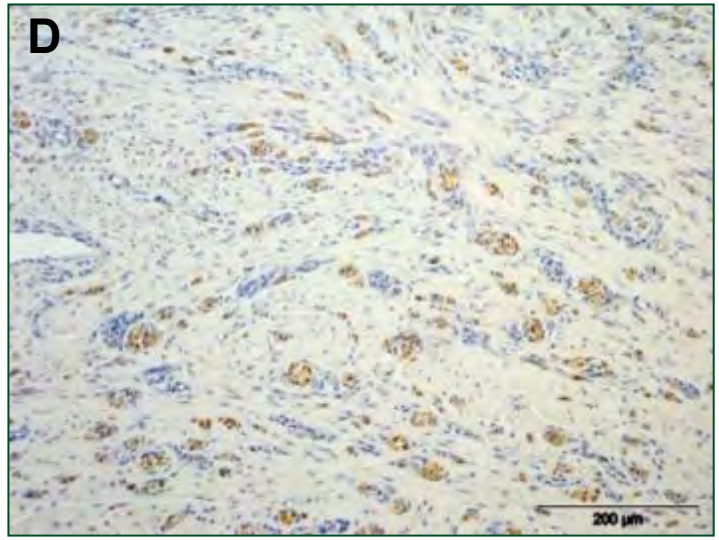


Tail histopathology

16 weeks after tail docking







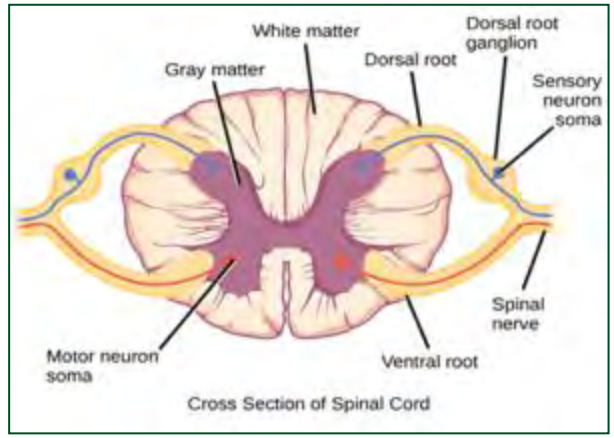
Tail histopathology

- Tail docking causes significant tail injury
- Histopathological lesions that occur shortly after docking (one week & beyond) are not likely to induce or maintain pain
- Caudal nerve traumatic neuroma development is a consistent feature of this type of injury
- Neuromata axonal proliferation and dispersion is still on-going 4 months after tail docking
- Not possible to confirm based only on histopathological assessment if this affects tail sensitivity

Gene expression studies –qRT PCR

Caudal DRG and spinal cord

- Collected **1, 4, 8** and **16** weeks after tail/sham docking (n=32)



Activating transcription factor 3 (ATF-3)

- a mediator of peripheral nerve axonal regeneration following injury (DRG)

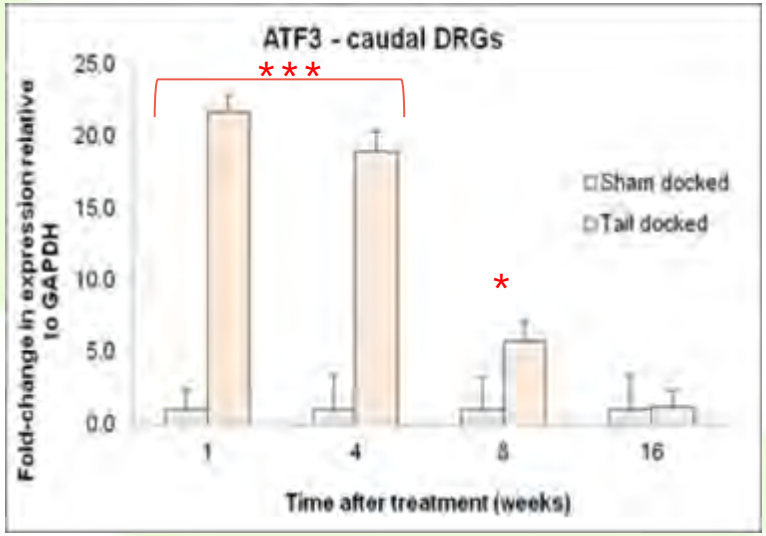
Calcitonin gene related peptide (CGRP)

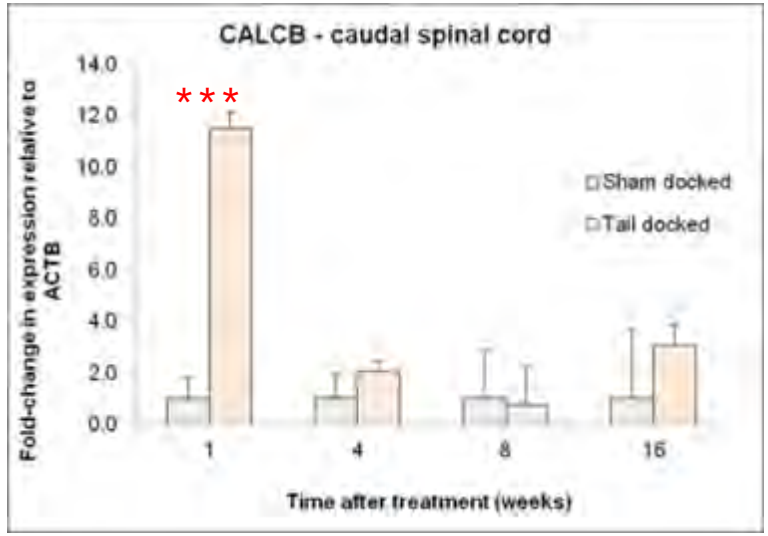
- a peptidergic sensory fibre marker specific to dorsal horn neurons involved in inflammatory pain processing

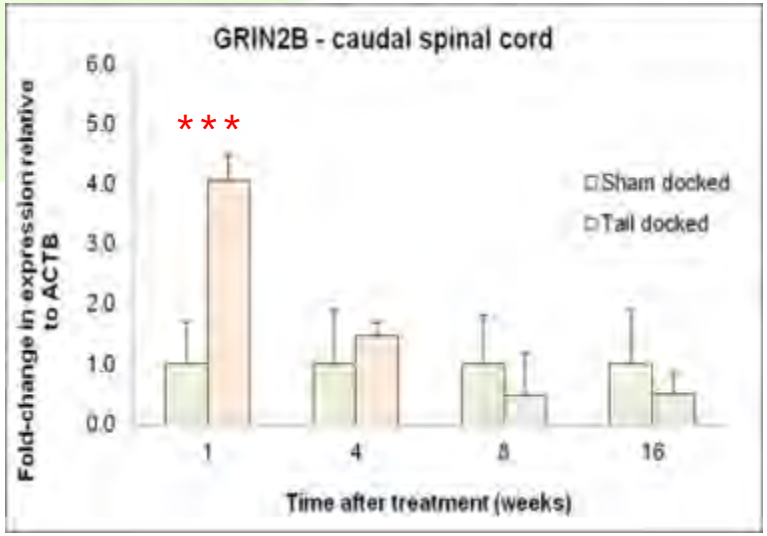
NMDA glutamate receptor 2B (GRIN2B)

- participates in the maintenance of chronic pain in the spinal dorsal horn

Gene expression studies







Gene expression studies

- **Significant ATF3 upregulation in the caudal DRGs observed up to 8 weeks after tail injury, but not different from sham-docked 16 weeks after tail docking**
- **Spinal changes in CGRP expression mediating the induction and maintenance of inflammatory pain are relatively short lasting (TD+1 week), and are not different from sham-docked thereafter.**
- **Significant elevation spinal GRIN2B expression is only observed 1 week after tail docking**

The effects of tail docking on injured peripheral nerve axonal activity are relatively short-lasting (consistent with histopathological data)

The possible painful consequences of tail docking linked to peripheral and spinal neuronal nociceptive processing appear to be resolved 4 weeks after tail injury

Behavioural Assessment

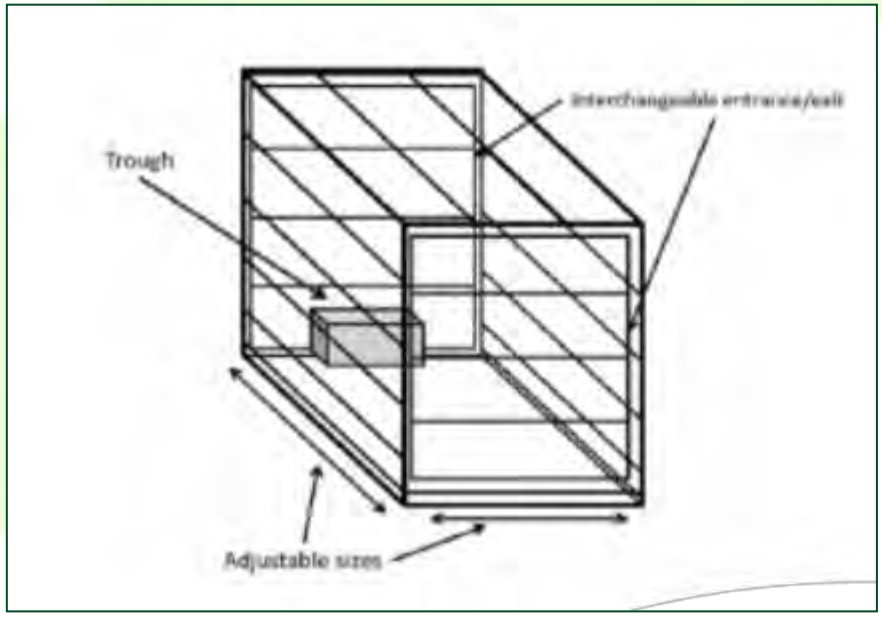
Approaches

- Spontaneous behaviours (pain-related, abnormal, desynchronized)
- Validate pain-related facial expressions in pigs (piglet grimace scale)
- Nociceptive mechanical threshold testing on tail (Pressure Application Measurement [PAM] device)

Nociceptive testing

Experimental set-up

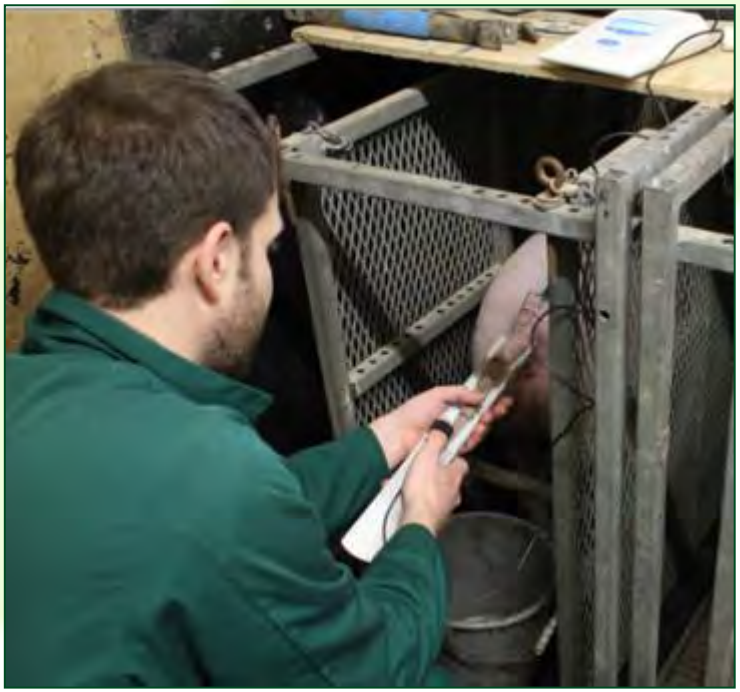
- Adjustable test crates
- Habituation
  - Pairs of pigs – (1 session per day over 4 days, test day 5)
  - 5% sucrose solution
  - Testing bout duration (15 minutes)

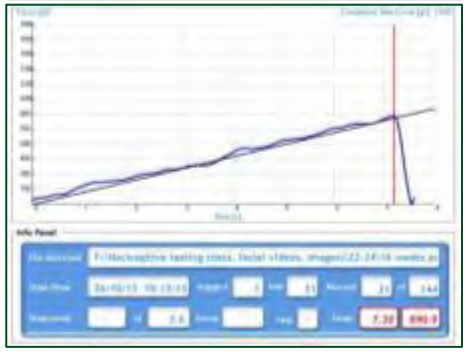


Nociceptive testing

Pressure Application Measurement (PAM) device

- Force application and measurement system (Ugo Basile)
- Probe/force transducer linked to laptop
- Purpose built software
- Response measure – Tail flick

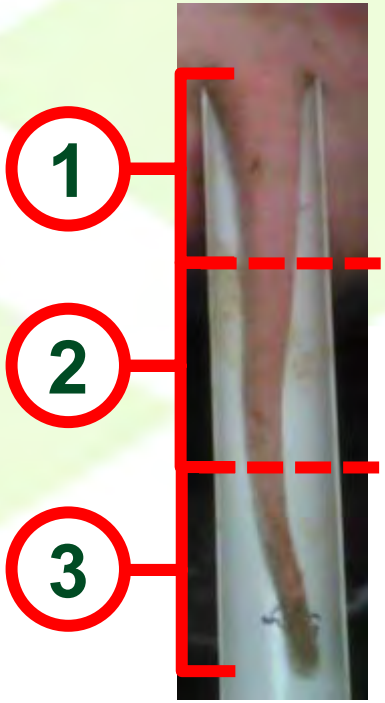


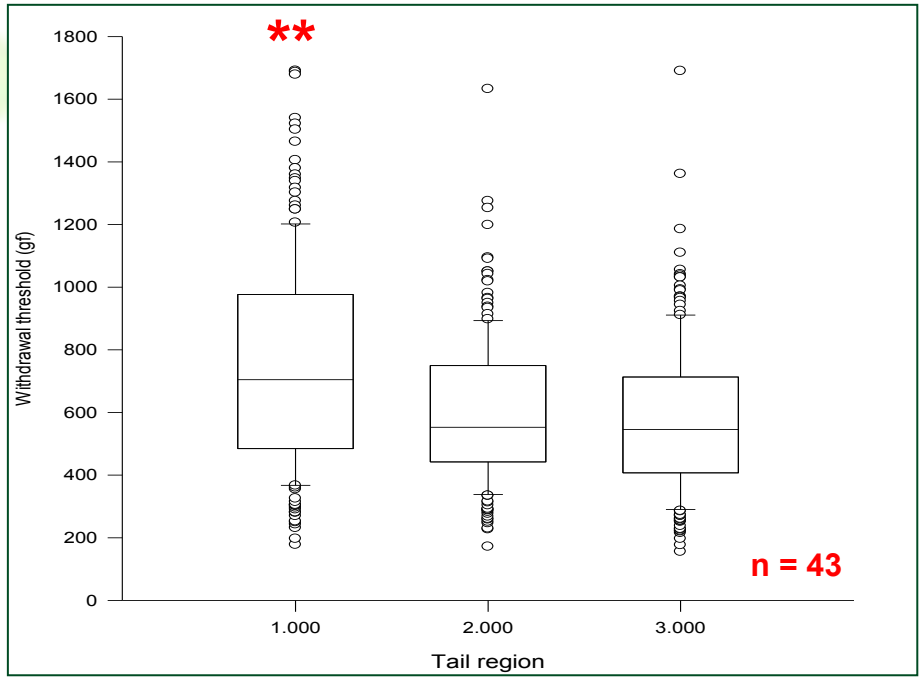


Nociceptive testing

Baseline thresholds in intact pigs (17 week-old)

- Three tail regions (dorsal tail), 3 stimuli applied (peak force at response - averaged)
- Significant difference (*P<0.01*) in thresholds of intact tail sensitivity across different regions.
- **Region 1** - higher thresholds compared to regions 2 and 3

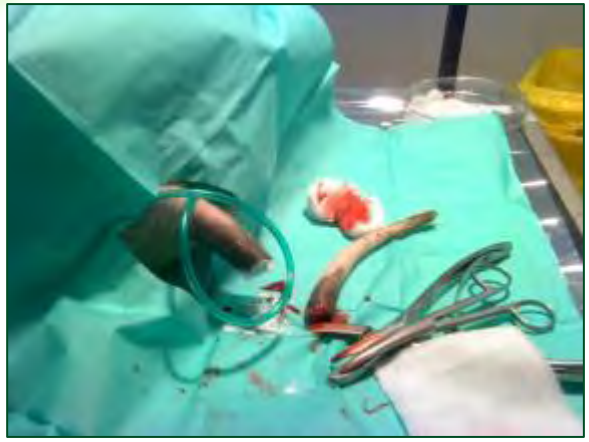




Tail resection

Simulation of effect of tail biting

- 3 treatment groups (16 gilts/group)
  - sham (intact)
  - 1/3rd tail removed
  - 2/3rd tail removed
- Surgical amputation at 16 weeks of age
- Assess short and long term consequences on tail sensitivity

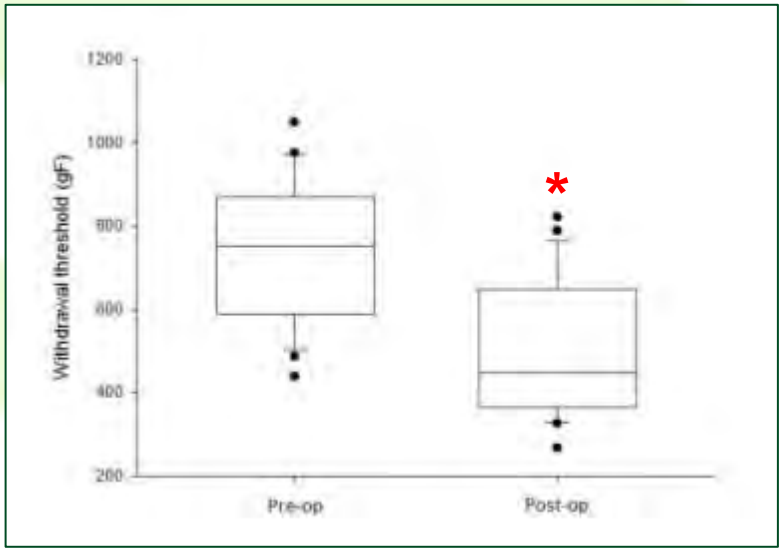


Tail resection

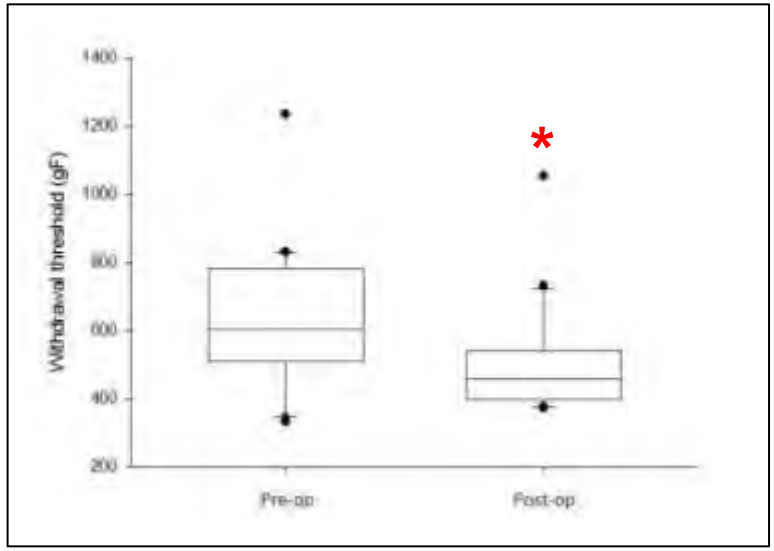
Post operative mechanical thresholds

- Testing: pre operative (-1 day), post -operative (1 week)
- Significant decrease (*P<0.05*) in threshold sensitivities compared to pre-op in both 2/3rd (short) and 1/3rd (long) one week after tail resection

2/3rds tail resection (short)



1/3rd tail resection (long)



Summary (1)

- **Tail docking piglets produces a significant tail lesion**
- **Minimal evidence of histological features likely to induce or maintenance of pain (beyond 1 week after TD).**
- **Gene expression studies support histopathological observations**
  - **peripheral nerve axonal activity, proliferation and peripheral and spinal nociceptive processing after tail docking are short lasting (resolved 1 month after tail injury)**

Summary (2)

- Clear withdrawal responses to mechanical stimulation (PAM) were observed and allowed characterisation of thresholds of sensitivity in the pig tail before and after tail amputation.
- Tail resection (simulating tail biting in older pigs) induced increases in regional tail sensitivity to mechanical stimulation one-week post surgery, reflecting physiological events associated with the acute phase of injury.
- Further data on the thresholds of mechanical sensitivity **several weeks post-surgery** will provide information on the **temporal nature of the change in mechanical sensitivity** associated with tail amputation injury.
- Gene expression analysis is currently being undertaken in tail resected pigs

SRUC Pig Facilities

- Two farms (Easter Howgate, Oatridge)
- Located South and West of Edinburgh City Centre

Oatridge:
100 sow farrow-to-finish
Conventional indoor unit
Focus on **education**

Easter Howgate:
100 sow farrow-to-finish
High welfare unit, conventional and research buildings
Focus on **research**

SRUC Pig health & welfare research

- **Dry sow**
  - Hunger in sows
- **Farrowing sow**
  - Social aggression and prenatal stress
  - Analgesia to reduce pain at farrowing
  - Developing free farrowing environments
- **Piglet**
  - Tail docking
  - Play
- **Grower & Finisher**
  - Social mixing aggression
  - Tail biting
  - Gastric ulcers

Hunger in sows

Rick D'Eath

SRUC

- Ration feeding of dry sows resulting in hunger
- EU requirement to provide fibre
  - What do farmers provide?
  - Do sows eat straw bedding?
  - Which fibre types really help satiety?

Prenatal stress

Kenny Rutherford

SRUC

- Stress **during pregnancy** affects progeny ability to cope with postnatal challenges
- Social stress caused by mixing gilts and sows
- **Piglets from mixed sows have:**
  - greater pain and stress responses
  - altered growth after weaning
- **Mixed gilts have:**
  - impaired social and maternal behaviour
  - altered immune and reproductive function

Pain at farrowing

Sarah Ison, Kenny Rutherford

SRUC

- Farrowing may be painful for some sows
- PhD project:
  - survey of UK vets and farmers to understand attitudes and practices in relation to pain relief for sows
  - identify possible behavioural indicators of pain during and after farrowing
  - investigated use of analgesia (Ketoprofen) after farrowing

BBSRC bioscience for the future

Pfizer

PigSAFE

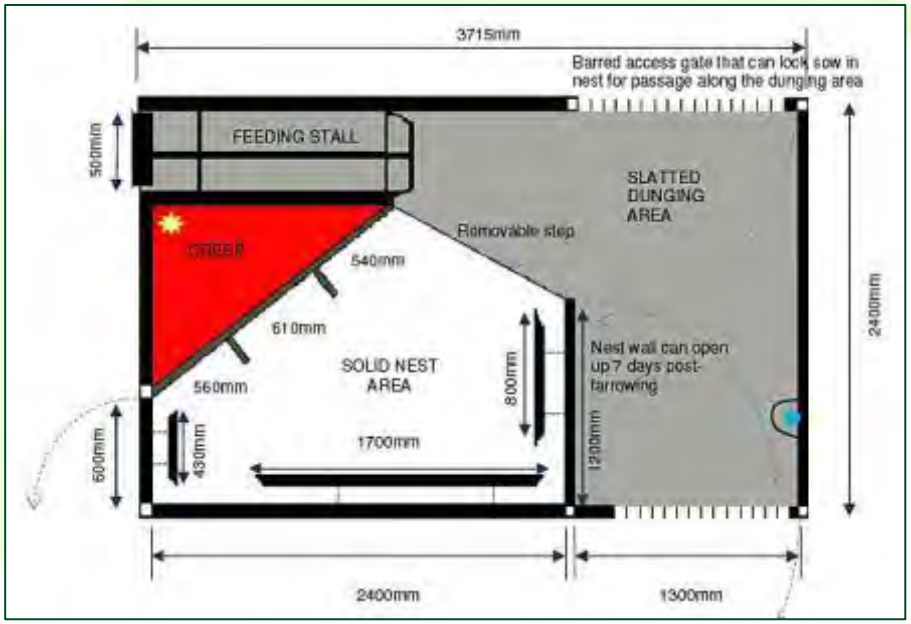
Emma Baxter

Newcastle University

SRUC

defra
Department for Environment Food and Rural Affairs

- Free farrowing system
- Promoting better maternal behaviour
- Improved piglet survivability and productivity

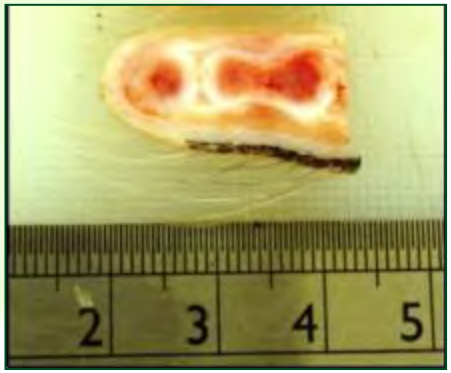


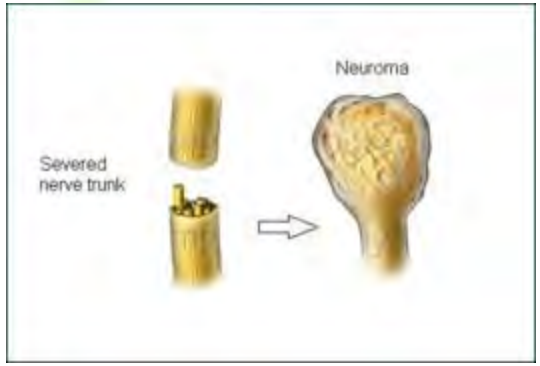
Neurobiology of tail docking and biting

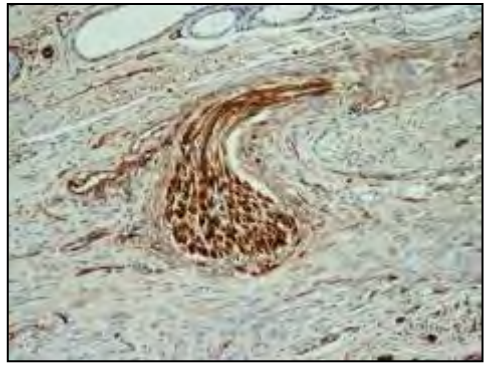
Dale Sandercock

SRUC

- "FareWellDock" ANIWHA Era-Net Project
- Addresses major welfare issues of tail docking and tail biting in commercial pig production in EU
  - Does docking cause long term pain in the tail
  - Does chronic sensitivity and/or pain result from traumatic neuromas?
  - How does tail injury later in life (tail biting) affect sensitivity/pain?







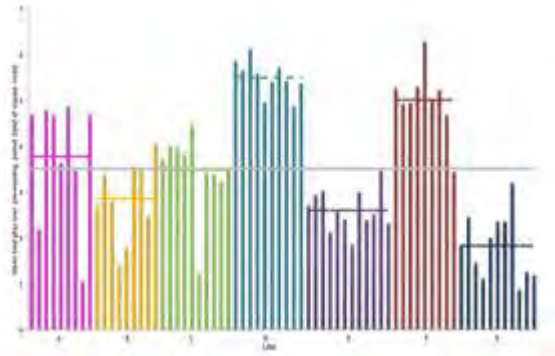
FareWellDock

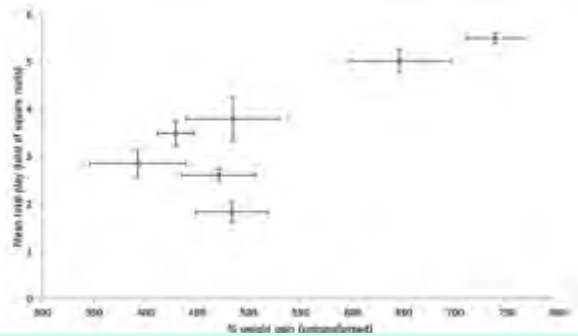
anihwa

Piglet play

Alistair Lawrence. Sarah Brown

- Growing emphasis on ‘positive’ welfare states
- Play is widely thought to be a positive welfare indicator
- Situations and environments which promote play in livestock are poorly understood
  - Litters differ in the amount of play
  - Fast growing litters play more





Brown et al., 2015 Applied Animal Behaviour Science, 172: 17-25.

Breeding to reduce pig aggression

Simon Turner

SRUC

- **Routine mixing results in social aggression:**
  - ⬆ injury, disease, activity (= poorer FCE), pre-natal stress
  - ⬇ welfare, food intake, growth rate, reproductive success
- **Mixing aggression is heritable (h^2=0.3 – 0.4)**
  - breed against it using skin lesion scores
  - molecular markers might be even easier?
- **Aggression in stable groups?**
  - How does it relate to mixing aggression?
  - How can we breed to reduce mixing and stable group aggression?

Assessment strategies during aggression

Irene Camerlink

SRUC

- Gaining a better understanding of why pigs fight (or not), who they fight and why they give up (or not)
- Game theory models studied through dyadic contests between pigs matched or unmatched for:
  - Body weight
  - Aggressiveness as personality trait
- Effect of experience/socialization on aggression
- Stakeholders' perception of pig aggression

BBSRC
bioscience for the future

Tail biting

Rick D'Eath

- Review of causes of tail damage
- Economic assessment of systems
- Can behaviour be used for early detection of tail biting?
  - Tail posture, activity, tail investigation
  - How can we use this to stop an outbreak?
  - PhD Helle Lahrmann (University of Copenhagen, Denmark)

- Developing practical enrichment methods to occupy pigs in fully slatted systems
  - Materials, presentation
  - PhD Jen-Yun Chou (Teagasc, Ireland)

Gastric ulcers

Kenny Rutherford

Danish pig research centre

SRUC

- Highly prevalent in many countries
- Main risk factor is feed structure and content
- Welfare relevance of different lesion severities is uncertain

- Current work is investigating whether ulcers are painful for finisher pigs
  - behavioural analysis
  - response to analgesia

The “FareWellDockers”

Newcastle University – Sandra Edwards, Matt Leach, Pierpaolo Di Giminiani, Mark Brett, Emma Malcolm
RDSVS Vet Pathology Unit – Neil McIntyre, Sionagh Smith, Dawn Drummond
Edinburgh Genomics/Roslin – Richard Talbot, Alison Downing, Stephen Meek
SRUC AVS – Jenny Coe, Sarah Hall

FareWellDock website: http://farewelldock.eu/