FETAL ULTRASONOGRAPHY OF THE DISTAL LIMB – a new tool to assess equine fetal age and bone development

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UCDAVIS VETERINARY MEDICINE

INTRODUCTION

- Fetal age/growth evaluation
  - US measurements of fetal parts: cranium, eye, femur, aorta
  - Age prediction in QH (Renaudin AAEP 2020):

    - Within 2 weeks: <200d (FL, BPD, EyV)

    - Within 3 weeks: > 200d (EyV)

    => Need for a **better biometric parameter > 200d**

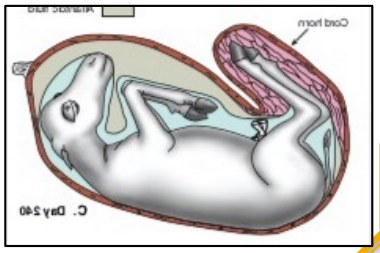
- Fetal bone maturation
  - Can only be assessed with X-rays in vivo

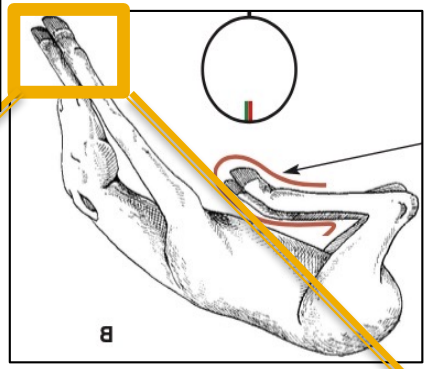
    => Need for **a non-invasive practical method in vivo**

OBJECTIVES

- How to image the distal limb (TR US)
  - Distal MC_3
  - Prox sesamoid
  - P_1
  - P_2
  - Distal sesamoid (navicular bone)
- How to measure the length of P_1 and P_2
- How to determine age of gestation based on P_1L and the number and size of the epiphyses
- How to determine bone maturation in late gestation

TR US IMAGING OF DISTAL LIMB





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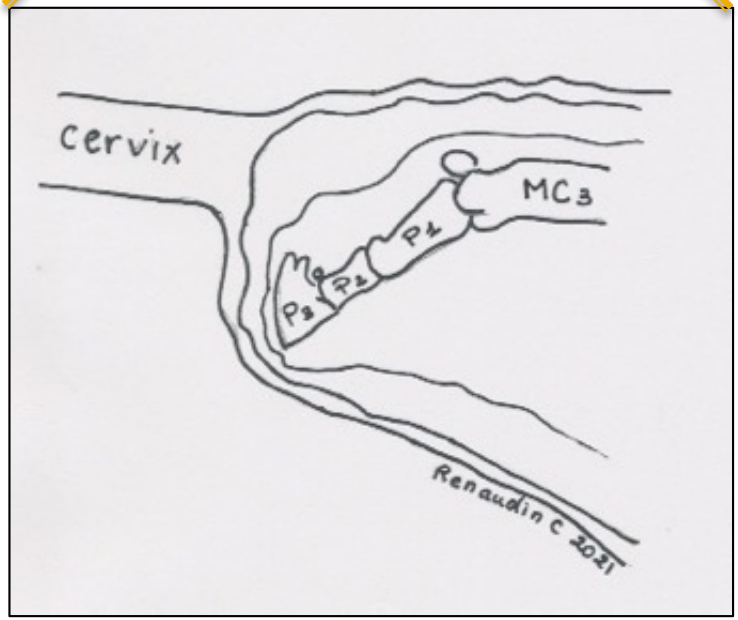
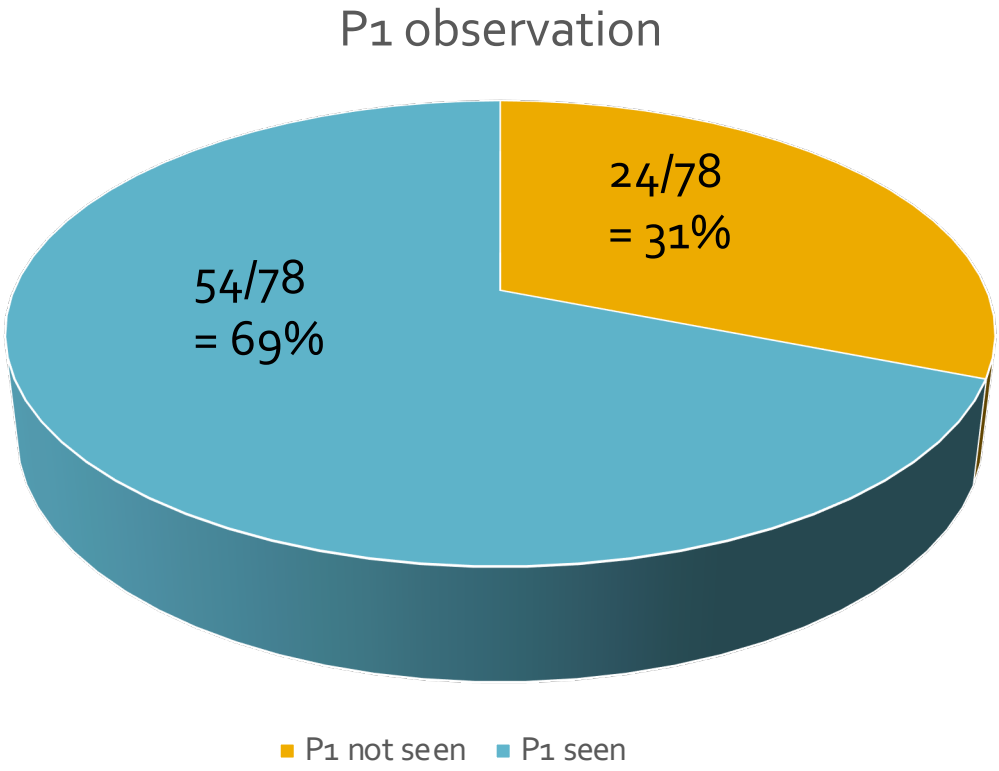
AAEP 1998



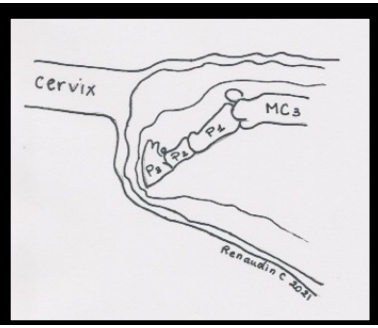
How often can we see the distal limb on TR US?

10 normal QH, TR US q15d; 240d -parturition

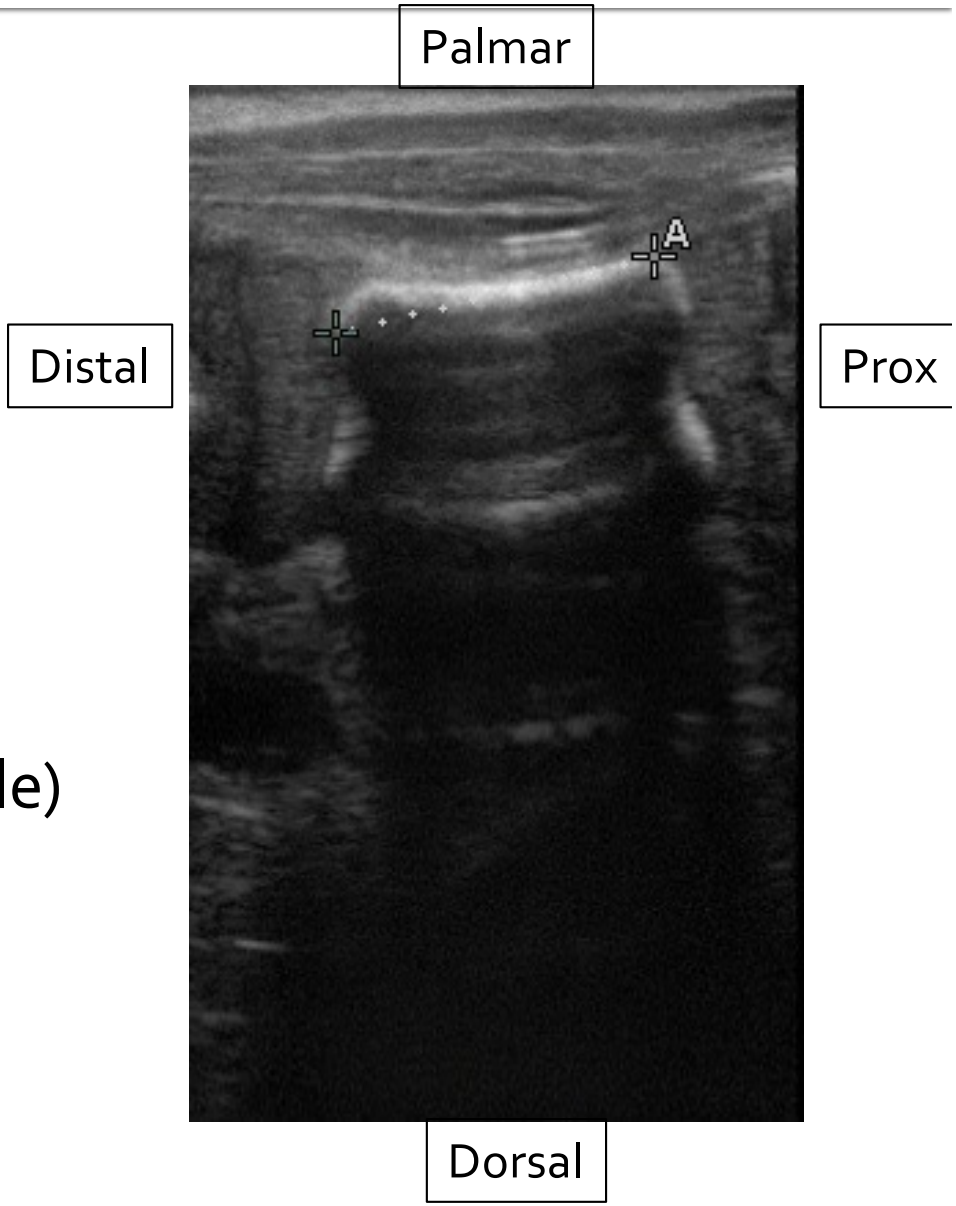
- Observed = 69% (54/78)
- Non observed= 31% (24/78)
  - Carpi or fetlock flexed
  - Post presentation



P1 length



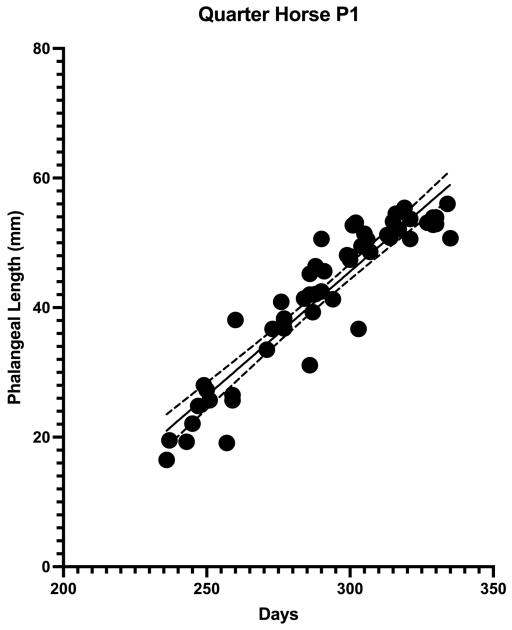
- Image:
  - P1 long view
- Measurement:
  - 1 cursor: prox. extremity
  - 1 cursor: dist. extremity (condyle)
  - Maximum L of P1 diaphysis



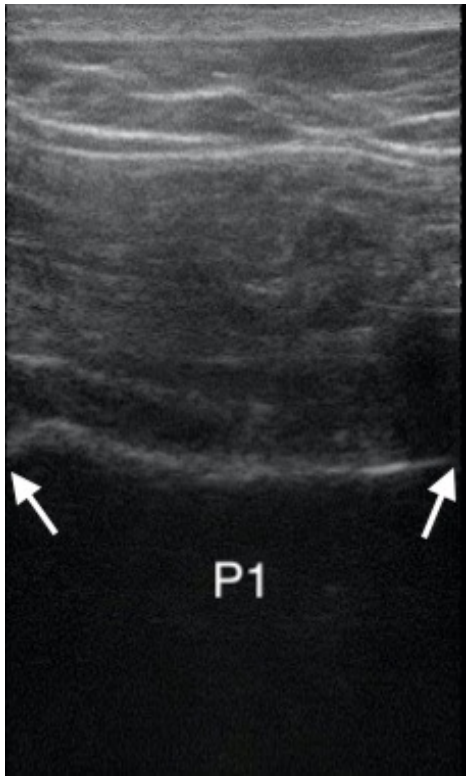
P1 length

- Strong linear relationship with days of gestation

  y = 0.3872x-69.81
  x = days of gestation
  y = predicted P1 value
  r^2 = *0.91*



- P1L = width US image (52 mm)
  => mares (9/10) > 300d



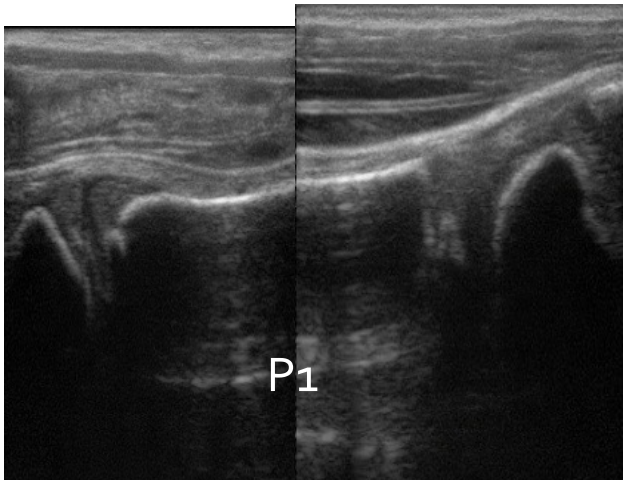
306 d

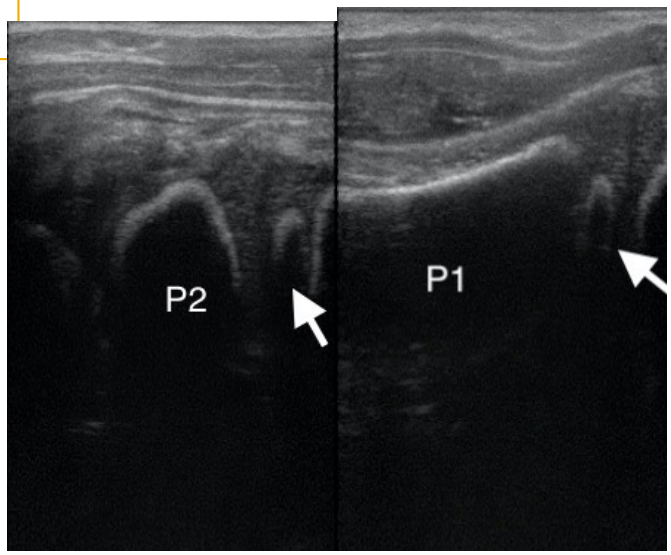
P1 shape changes overtime

Diaphysis only: < 277d

- Rectangular shape
- Condyle formation

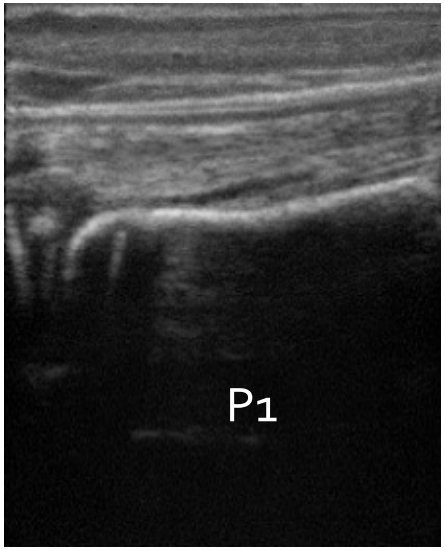
Diaphysis + epiphyses: 288d (277-294d)



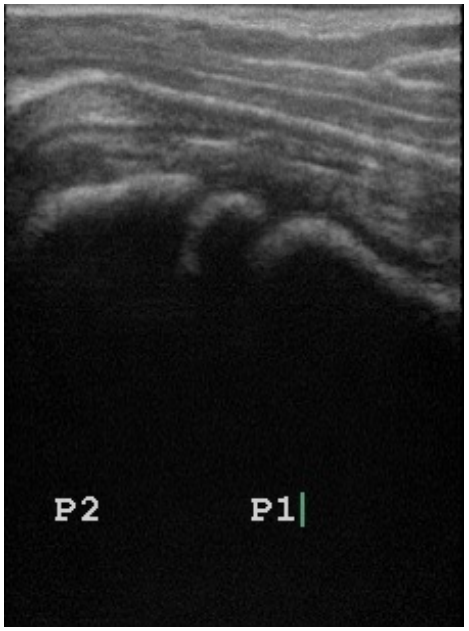


P1 shape changes overtime

Closure of **distal** epiphysis

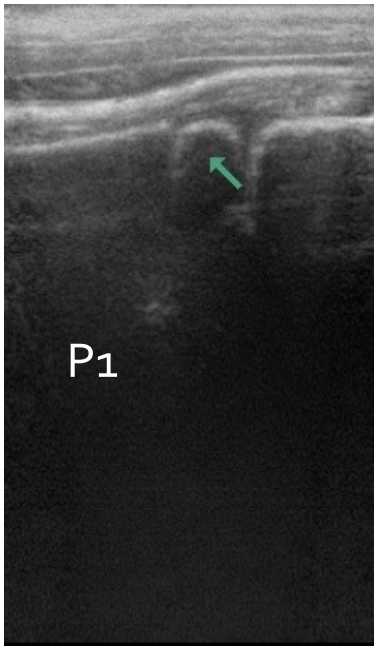


P1 distal closing



P1 distal closed 320d (306-333d)

P1 **proximal** epiphysis does not close



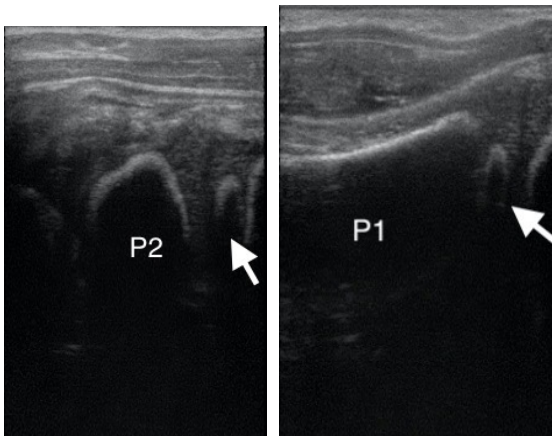
P1 prox. not closed + reaches palmar aspect P1

In PRACTICE: fetal age prediction based on P1 appearance

MARE < 300 D

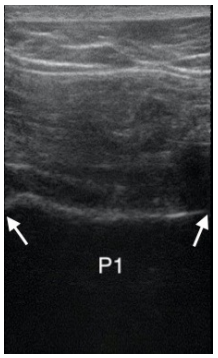
- **No epiphysis** present

- **Both epiphyses** present: about 10 months



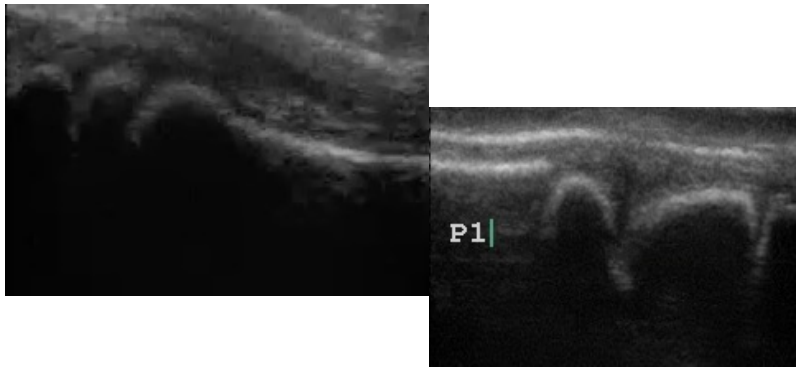
MARE > 300 D

- P1 **L = or > width US image**



(52 mm)

- P1 **prox. epiphysis** present and distal closed: about 11 months

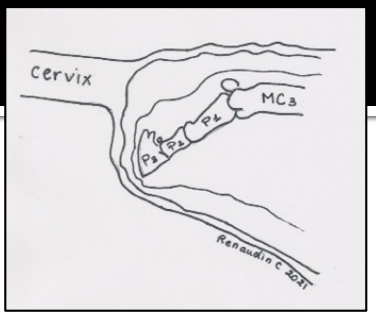


Fetal age prediction based on P1 appearance

Fetal age prediction based on P1 appearance

Fetal age prediction based on P1 appearance

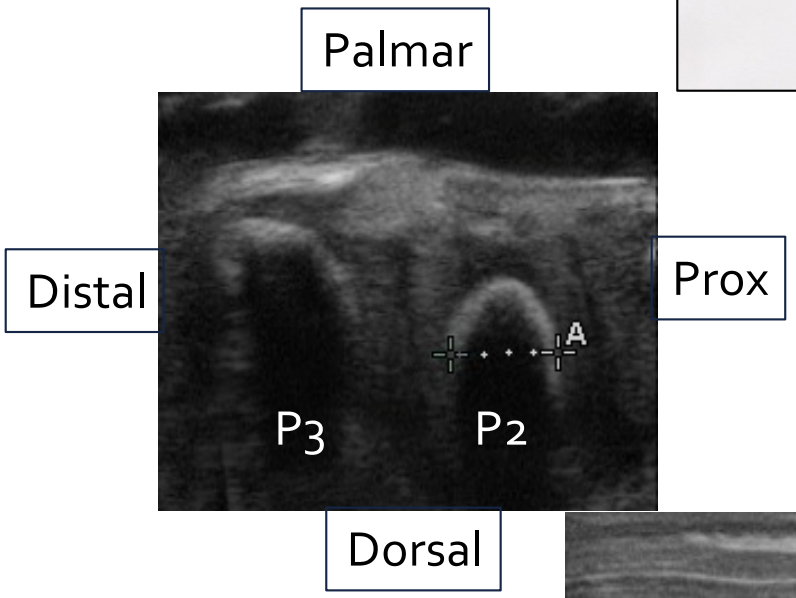
P2 length and bone development



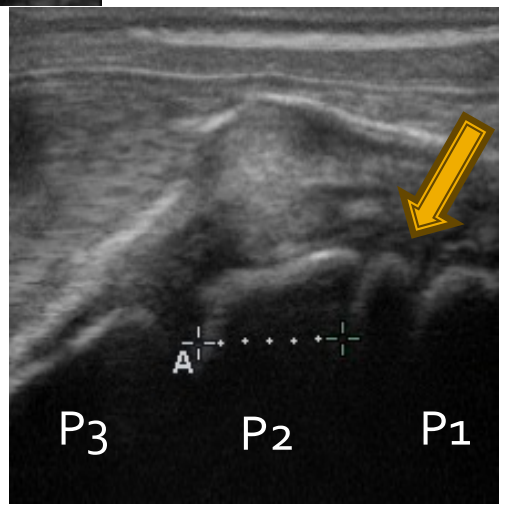
- Image
  - Long view
- P2L measurement
  - Maximum L of P2 diaphysis

(Lowest ossified borders)

- P2 epiphyses
  - Absence: < 285d
  - Proximal epiphysis appearance: 294d(285-306d)
  - Distal epiphysis: not seen on US
  - No closure before foaling



250d



315d

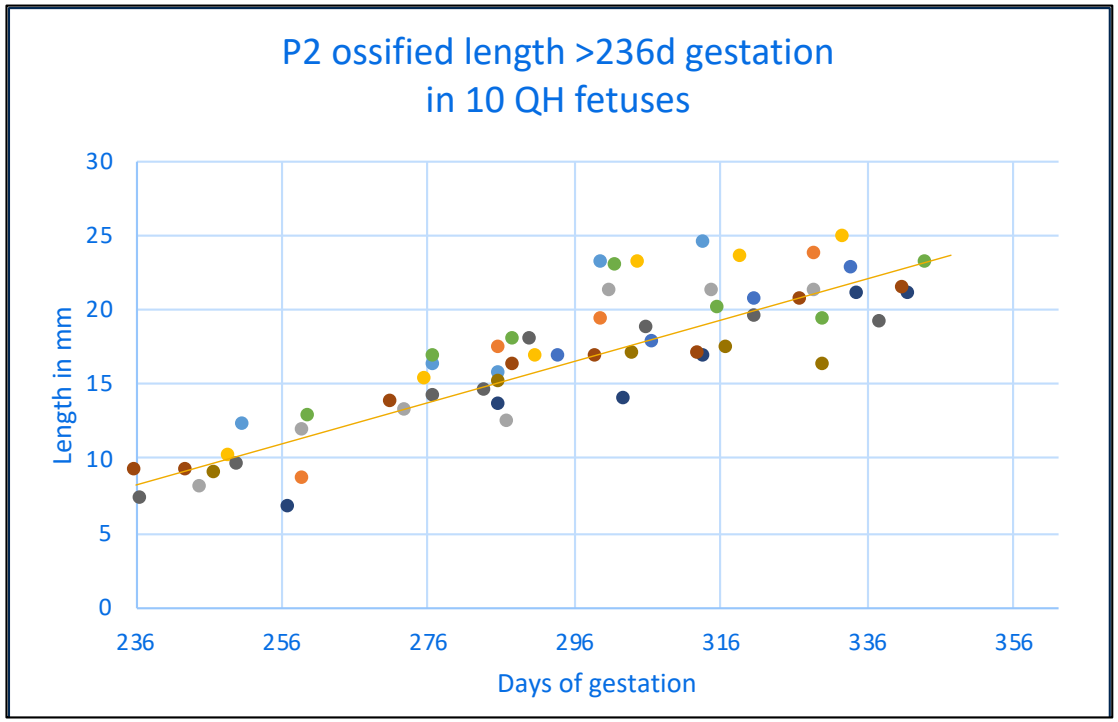
P2 length

- Strong linear relationship with days of gestation ($r^2 = 0.75$)

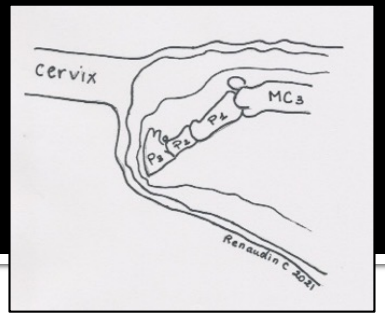
y = 0.1413x-24.89

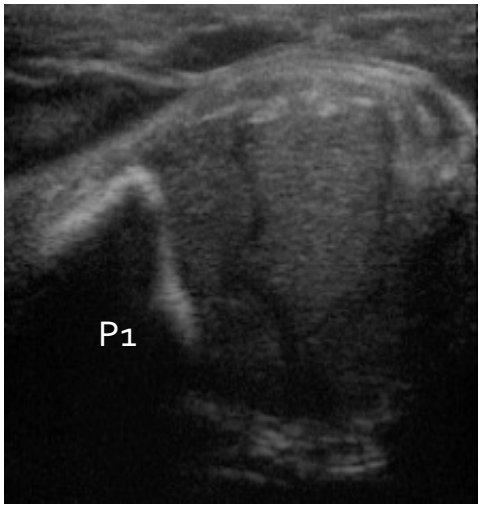
x = days of gestation

y = predicted P2 value

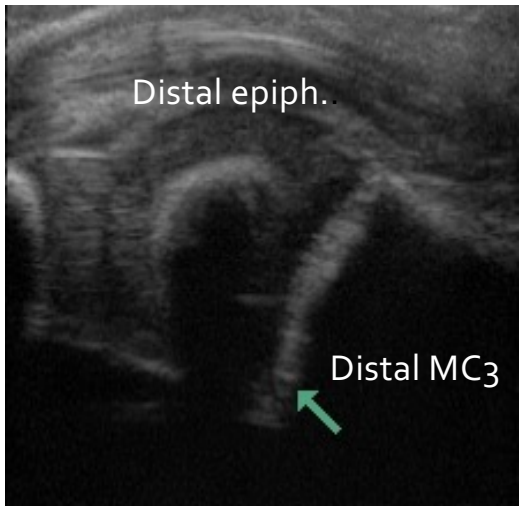


Distal MC3 epiphysis

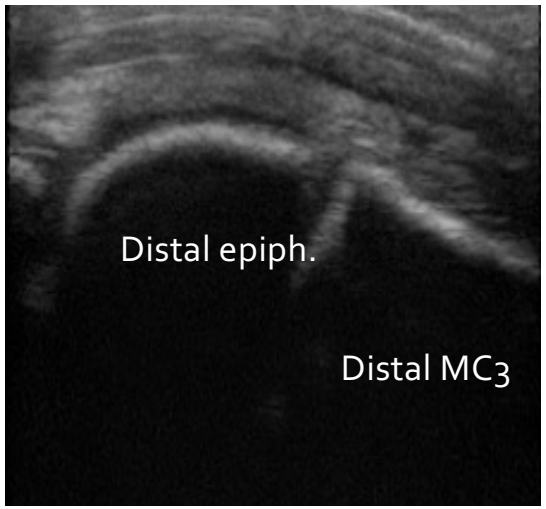




259d



273d



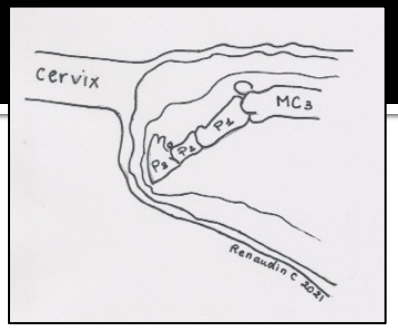
301d

Absence < 260d

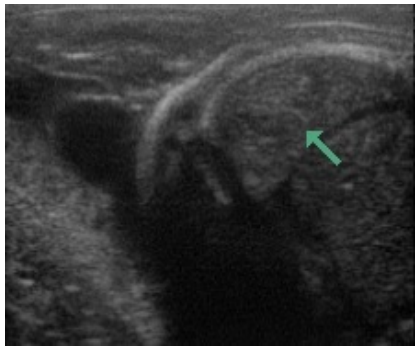
Presence: 268d (260-294d)

No closure

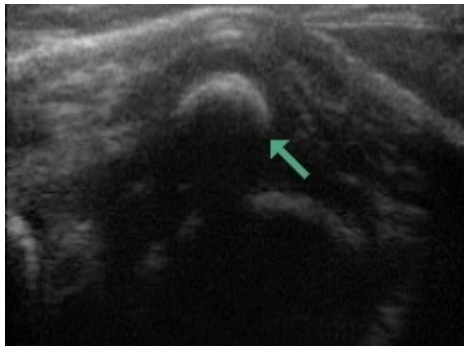
Prox. sesamoid and navicular bones development



- Prox. sesamoid bones



268d

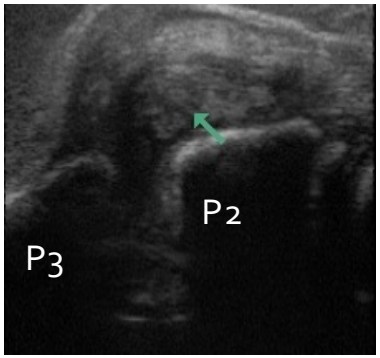


298d

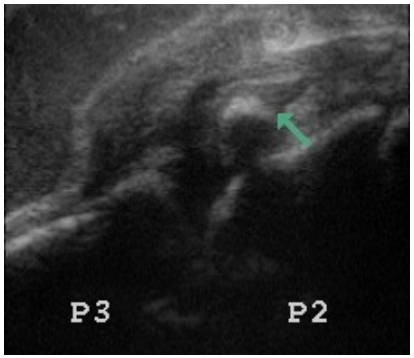
Absence: < 286d

Presence: 294d (285-306d)

- Navicular bone



307d

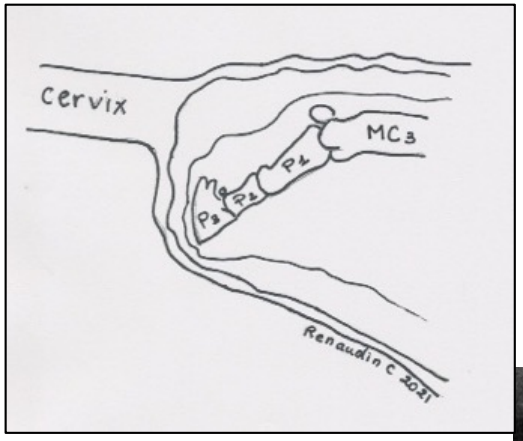


319d

Absence: < 300d

Presence: 317d (300-329d)

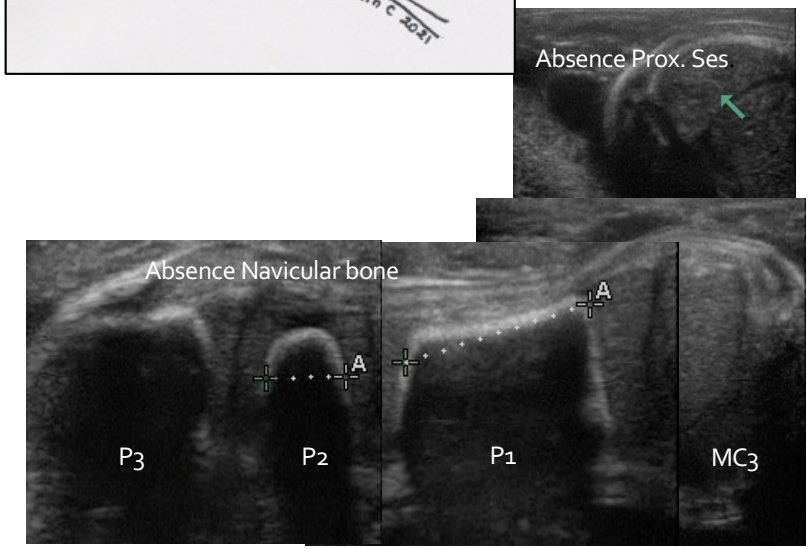
Incomplete vs complete ossification

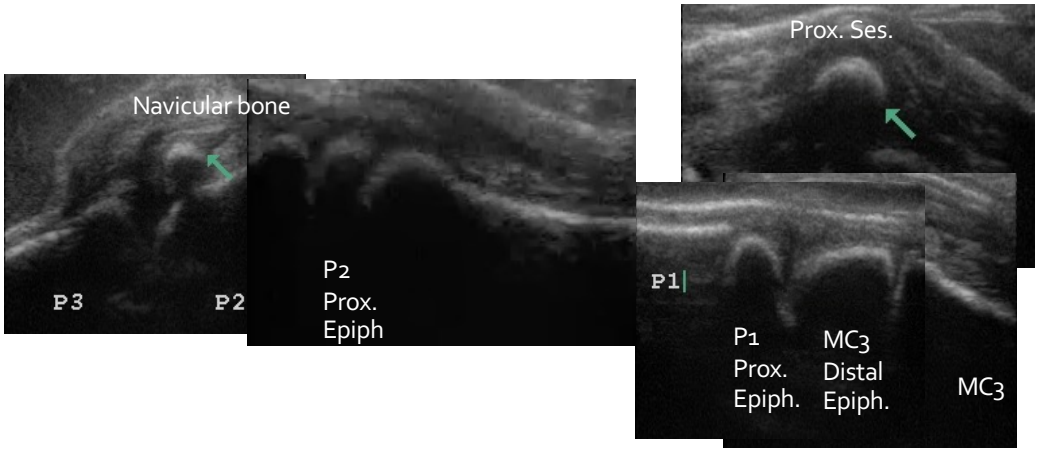


Time bone appearance (mean (range) in days)

1. Distal MC3: 268 (260-294d)
2. P1 prox. and distal epiph.: 288 (277-294d)
3. P2 prox. epiph.: 294 (285-306d)
4. Prox. Ses. bone: 295 (286-306d)
5. Navicular bone: 317 (300-329d)

*P1 distal epiph. closure: 320 (306-333d)





<260 days old fetus: incomplete ossification

315 days old fetus: complete ossification

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Incomplete ossification

Complete ossification

CONCLUSION

- **New parameters to assess fetal growth/age late in gestation:**
  - P1L , (P2L)
  - Time of appearance of
    - epiphyses of MC3, P1 and P2
    - sesamoid bones' diaphysis
  - ➢ Better assessment of fetal age/growth > 250 days

- **New markers of bone maturation/development**
  - Presence or absence of
    - distal MC3's and P1's and P2's epiphyses
    - sesamoid bones' diaphysis
  - ➢ Knowledge of normal distal limb ossification process *in utero*
  - ➢ May be useful:
    - in the decision-making process of not inducing parturition if the navicular bone is not present
    - in predicting readiness for birth

QUESTIONS