Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.
FLEXURAL LIMB DEFORMITIES IN THOROUGHBRED FOALS IN NEW ZEALAND

A thesis presented in partial fulfilment of the requirements for the degree
Master of AgriScience (Equine)
at Massey University, Manawatu, New Zealand.

AMANDA KYLIE SHOTTON
2014
(Submitted 17 April, 2014)
Abstract
The aims of this thesis were to describe the descriptive epidemiology of congenital flexural limb deformities (FLD) in foals on commercial Thoroughbred stud farms, and to describe the management and treatment of these foals. Data were collected on five commercial Thoroughbred stud farms in the Auckland and Waikato regions. Data were collected primarily by stud farm personnel, and assisted by study personnel when on farm. Data were collected on a selective population of 203 foals during the 2013/2014 season.

Pre-selection by stud farm personnel towards foals with FLD prevented the calculation of prevalence and resulted in 67% (135/203) of the foals with records having one or more FLD recorded. Laxity was observed to affect 87/135 foals, contracture of at least one joint region 57/135 foals and 6/135 foals were back at the knee; nine foals suffered from multiple forms of deformity. The median score for laxity was 2 (IQR 2-3) on a four point scale. The median score for contracture affecting hoof-ground contact was 2 (IQR 2-3) on a three point scale, while the median score for contracture affecting the fetlock and carpal regions was 2 (IQR 2-2). Multiple scorings over time were provided for 69/135 foals, 64 of these foals showed improvement in the severity of deformities by the final scoring.

Inter-observer agreement (between study personnel) was strong when scoring flexural laxity (κ=0.95), contracture affecting hoof-ground contact (κ=1.00) and contracture in the joint regions (κ=0.85). In contrast, inter-observer agreement between study personnel and stud farm personnel was lower when scoring flexural laxity (κ=0.69) and when scoring contracture in the fetlock and carpal regions (κ=0.14).

Treatment data were provided for 40/135 foals. Confinement was the most common form of treatment provided for mild and moderate cases of flexural contracture and flexural laxity; severe cases of flexural contracture required more invasive forms of treatment in combination with confinement. Improvement in the severity of deformities was observed following treatment in 28/42 (67%) cases of contracture observed to effect hoof-ground contact, 33/43 (77%) cases of contracture affecting the fetlock and carpal regions and 36/56 (64%) cases of laxity.

This thesis provides insight into the effect of FLD on Thoroughbred foals in New Zealand. The results indicate that foals tend to be mildly or moderately affected by FLD at birth and that treatment by stud farms is pragmatic.
Acknowledgements

I would like to offer my sincere gratitude to the many people who have made this project possible.

Firstly, to my supervisors Dr Chris Rogers, Dr Erica Gee and Dr Charlotte Bolwell, thank you for your continuous support and encouragement throughout the duration of this project. Thank you also for always finding the time to chat – whether the problems were big or small.

Special thanks to the New Zealand Equine Trust for providing the funding for this project and enabling us to get it this far.

Without the support of the stud farms involved, this project would not have been possible – thank you for being so willing to be involved and for allowing us on farm on such a regular basis. Thank you particularly to Mal, Calvin, Jess, Keith and Donna for collecting the data on foals for us to use and for catching up with us when you could find some time!

Thank you to Maxim for helping collect data on some of the other farms. Thank you to Dave, Saifon and Jonathan for having me to stay on my many trips to the Waikato – it was much appreciated and your kindness won’t be forgotten. Thank you also to my fellow equine post grads Jaz, Karlette and Lana – the coffee breaks and company will be missed!

Lastly, to the rest of my friends and family, thank you for your continual support and encouragement as I have completed this project and spent yet another year studying!
# Table of Contents

Abstract........................................................................................................................................... i

Acknowledgements................................................................................................................................ii

List of Abbreviations ........................................................................................................................ vi

List of Figures .................................................................................................................................... vii

List of Tables ..................................................................................................................................... x

Introduction ...................................................................................................................................... 1

Chapter 1  Literature Review ........................................................................................................ 4
  1.1  Commercial Horse Production ...................................................................................... 4
    1.1.1  Industry ................................................................................................................ . 4
    1.1.2  Sales & Export ....................................................................................................... 6
    1.1.3  Management ......................................................................................................... 7
  1.2  Career ............................................................................................................................ ........ 9
  1.3  Wastage ........................................................................................................................... ... 10
  1.4  Foals ..................................................................................................................................... 12
    1.4.1  Bone & Cartilage Development .......................................................................... 12
    1.4.2  Prematurity & Dysmaturity ................................................................................. 13
    1.4.3  Developmental Orthopaedic Disease (DOD) ...................................................... 14
    1.4.4  Angular Limb Deformity ...................................................................................... 16
    1.4.5  Flexural Limb Deformities ................................................................................... 18
    1.4.6  Flexural Laxity ..................................................................................................... 25
    1.4.7  Number of foals affected by flexural contracture and laxity .............................. 28
  1.5  Aim and Objectives of Thesis ...................................................................................... 29

Chapter 2  Descriptive epidemiology of flexural limb deformities in Thoroughbred foals in New Zealand. .............................................................................................................................. 30
  2.1  Abstract ...................................................................................................................... ..... 30
  2.2  Introduction .............................................................................................................. .. 30
  2.3  Materials and Methods ............................................................................................... 32
    2.3.1  Recruitment of Studs/Foals ................................................................................ 32
    2.3.2  Scoring System .................................................................................................... 32
    2.3.3  Data Collection .................................................................................................... 34
    2.3.4  Statistical Analysis ............................................................................................... 35
  2.4  Results ................................................................................................................... ...... 36
    2.4.1  Descriptive Data .................................................................................................. 36
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALD</td>
<td>Angular limb deformity (deformities)</td>
</tr>
<tr>
<td>DIP</td>
<td>Distal interphalangeal joint</td>
</tr>
<tr>
<td>DOD</td>
<td>Developmental orthopaedic disease</td>
</tr>
<tr>
<td>FLD</td>
<td>Flexural limb deformity (deformities)</td>
</tr>
<tr>
<td>HRNZ</td>
<td>Harness Racing New Zealand</td>
</tr>
<tr>
<td>IQR</td>
<td>Interquartile range</td>
</tr>
<tr>
<td>LF</td>
<td>Left fore</td>
</tr>
<tr>
<td>LH</td>
<td>Left hind</td>
</tr>
<tr>
<td>MCP</td>
<td>Metacarpo-phalangeal joint</td>
</tr>
<tr>
<td>MTP</td>
<td>Metatarso-phalangeal joint</td>
</tr>
<tr>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>NZB</td>
<td>New Zealand Bloodstock</td>
</tr>
<tr>
<td>NZTBA</td>
<td>New Zealand Thoroughbred Breeders Association</td>
</tr>
<tr>
<td>RF</td>
<td>Right fore</td>
</tr>
<tr>
<td>RH</td>
<td>Right hind</td>
</tr>
<tr>
<td>SB</td>
<td>Standardbred</td>
</tr>
<tr>
<td>TB</td>
<td>Thoroughbred</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1-1 The number of Thoroughbred mares served annually and the annual Thoroughbred foal crop (NZTBA, 2014). .......................................................... 5

Figure 1-2: The number of Standardbred mares served annually and the annual Standardbred foal crop (HRNZ Inc, 2013). ........................................................................................................... 5

Figure 1-3: Data reporting the number and value of Thoroughbred exports for the period 1999/00 to 2012/13 (NZTBA, 2014). ........................................................................................................... 7

Figure 1-4: Foal presenting with carpal valgus in the left and right forelimbs. .................. 16

Figure 1-5: Foal presenting with a minor carpal valgus deformity in the left forelimb and a marked carpal valgus deformity in the right forelimb. Both limbs were treated with periosteal stripping, after showing no improvement in the right forelimb, a staple was inserted............ 18

Figure 1-6: Foal presenting with bilateral contracture of the carpal regions............................ 19

Figure 1-7: Foal presenting with contracture in the fetlock region of the left forelimb; a cast was provided as treatment. .......................................................... 22

Figure 1-8: Foal presenting with bilateral contracture in the fetlock and hoof regions at birth. Following an unsuccessful treatment regime, the foal underwent surgery for bilateral check ligament desmotomy in both forelimbs. .................................................................................... 23

Figure 1-9: Foal presenting with bilateral laxity in the hindlimbs. ............................................. 25

Figure 1-10: Foal presenting with moderate to severe bilateral laxity in the hindlimbs and was bandaged to minimise injury. .......................................................... 27

Figure 2-1: Diagrams of the four scores used to score the severity of flexural laxity in foals. Score 1 (A) - normal. Score 2 (B) - foal stands on caudal aspect of hoof and is observed to ‘rock’ back and forwards between toe and heel. Score 3 (C) - heel contact only, toe is off ground completely as is most of hoof sole. Score 4 (D) – hoof completely off ground, foal stands on caudal aspect of fetlock. ............................................................................................................. 33

Figure 2-2: Diagrams of the three scores used to score the degree of hoof-ground contact observed in foals with flexural contracture. Score 1 (A) - hoof-ground contact is normal. Score 2 (B) – some sole contact with ground, heel is entirely off ground; foal is up on toes and may have some difficulty in standing unassisted (moderate contraction). Score 3 (C) - entire sole of hoof off ground, foal is essentially standing on tips of toes; unlikely to be able to stand unassisted (severe contraction).......................................................................................... 34

Figure 2-3: The total number of foals scored in this study was observed to vary by month. .... 36
Figure 2-4: The effect of feeding assistance on the median (IQR) time (minutes) taken for foals to feed, when accounting for the presence of deformity. Data is presented as a box and whisker plot. Medians are represented by horizontal lines with the 75th percentiles at the top and the 25th percentiles at the bottom of the box. Range is represented by the whiskers, while outliers are represented by the circles. ................................................................. 37

Figure 2-5: The proportion of foals scored by farm (A-E). Two pie charts are shown for each farm; the first pie chart represents the total number of foals that were scored on farm, of all the foals that were born on farm. The second pie chart represents the number of foals that were scored with FLD out of all the foals scored on that farm. ................................................. 40

Figure 2-6: The observed proportions of foals scored with a flexural limb deformity (FLD) by month of birth................................................................. 40

Figure 2-7: The distribution of flexural laxity severity scores in foals from birth - 2 days of age. ........................................................................................................... 42

Figure 2-8: Examples of scores given to foals with apparent flexural laxity. Foal A - score 1, Foal B (left hind) – score 2, Foal C (left hind) - score 3 and Foal D (right hind) – score 4. ................. 43

Figure 2-9: The distribution of severity scores for contracture affecting hoof-ground contact in foals from birth - 2 days of age. ................................................................. 43

Figure 2-10: The distribution of score severity identifying the severity of contracture observed in the carpal and fetlock regions of foals from birth - 2 days of age... 44

Figure 2-11: Examples of scores given to foals with apparent carpal contracture. Foal A - score 1, Foal B – score 2 and Foal C - score 3................................................................. 44

Figure 2-12: Examples of scores given to foals with apparent contracture of the fetlock region. Foal A - score 1 and Foal B (left hind) - score 2................................................................. 45

Figure 2-13: Changes in the scores observed for flexural laxity severity in foals on follow up visits. ........................................................................................................... 46

Figure 2-14: This foal was bilaterally lax in the hind limbs at birth and was initially given scores of 3 at birth by the farm. Scoring by study personnel the following day gave the foals scores of 4 (A). Two weeks later (B), the foal was much improved and the hind hooves now scored 1. . 46

Figure 2-15: The changes observed in the severity of contracture score observed in the fetlock and carpal regions for foals on follow up visits. ................................................................. 47

Figure 2-16: This foal was observed with apparent bilateral contraction at the carpus and given severity scores of 2 (A), with no improvement shown the foal underwent bilateral check ligament desmotomy. Post-surgery (B) the foal struggled to stand by itself, the contracture worsening the longer it stood still (given severity scores of 3). Two weeks post-surgery (C), the
foal was standing better however was still given severity scores of 3 – again deformity was observed to worsen the longer the foal stood still. Reports from the farm indicate that this foal recovered and severity scores of 1 would be appropriate.

Figure 2-17: An example of the *pro forma* recording sheet provided to farms for scoring flexural and angular deformities.
List of Tables

Table 1-1: International Thoroughbred foal crops for the 2007 and 2012 breeding season (Anonymous, 2013; Fennessy, 2010). ................................................................. 6

Table 2-1: Scoring system used to describe the severity of flexural contraction observed in the fetlock and carpal regions of the limb. ......................................................... 34

Table 2-2: The number of cases of contracture in the carpal and fetlock regions scored 2 or 3 (out of a 3 point scale) observed in foals between birth and 2 days of age. The number of foals affected bilaterally is shown in brackets. ..................................................... 41

Table 2-3: Variations of hoof-ground contact was seen alongside apparent contracture of the fetlock and carpal regions in nine foals. ................................................................. 45

Table 3-1: Agreement between study personnel (observer A and M) was strong when scoring the severity of laxity................................................................. 60

Table 3-2: Agreement between study personnel (observer A and observer M) was strong when scoring contracture affecting hoof-ground contact. ........................................... 61

Table 3-3: Agreement between study personnel (observer A and observer M) was strong when scoring contracture in the fetlock or carpal regions. ........................................... 61

Table 4-1: Severity of laxity deformities (scores 1-4) at birth and the number of these deformities observed by treatment type. The number of deformities which were recorded to improve following treatment is also shown. ........................................... 69

Table 4-2: Severity of flexural contracture on the degree of hoof-ground contact (scores 1-3) at birth and the number of these deformities observed by treatment type. The number of deformities which were recorded to improve following treatment is also shown. ................. 69

Table 4-3: Severity of apparent flexural contracture on the fetlock and carpal regions (scores 1-3) at birth and the number of these deformities observed by treatment type. The number of deformities which were recorded to improve following treatment is also shown. ................. 70