



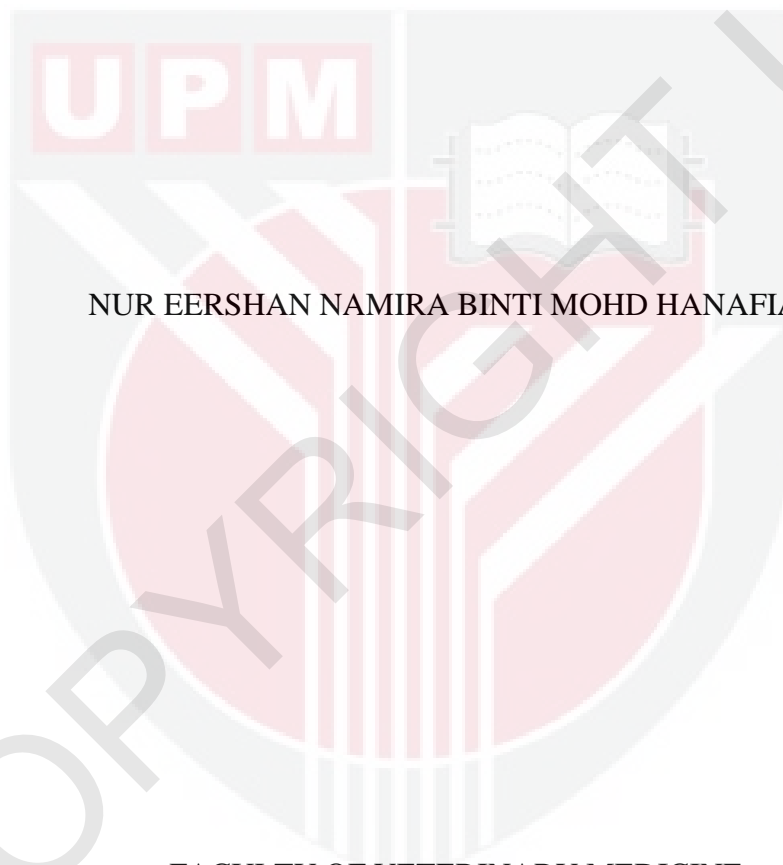
**UNIVERSITI PUTRA MALAYSIA**

***FRACTURE INJURIES IN RACEHORSES ON HORSE TRACK IN  
MALAYSIA***

**NUR EERSHAN NAMIRA BINTI MOHD HANAFIAH**

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FPV 2015 17**

FRACTURE INJURIES IN RACEHORSES ON HORSE TRACK IN MALAYSIA



NUR EERSHAN NAMIRA BINTI MOHD HANAFIAH

FACULTY OF VETERINARY MEDICINE

UNIVERSITI PUTRA MALAYSIA

SERDANG, SELANGOR

2015

**FRACTURE INJURIES IN RACEHORSES ON HORSE TRACK IN  
MALAYSIA**

**NUR EERSHAN NAMIRA BINTI MOHD HANAFIAH**

A project paper submitted to the

Faculty of Veterinary Medicine, Universiti Putra Malaysia

In partial fulfilment for the requirement of the

**DEGREE OF DOCTOR OF VETERINARY MEDICINE**

Universiti Putra Malaysia

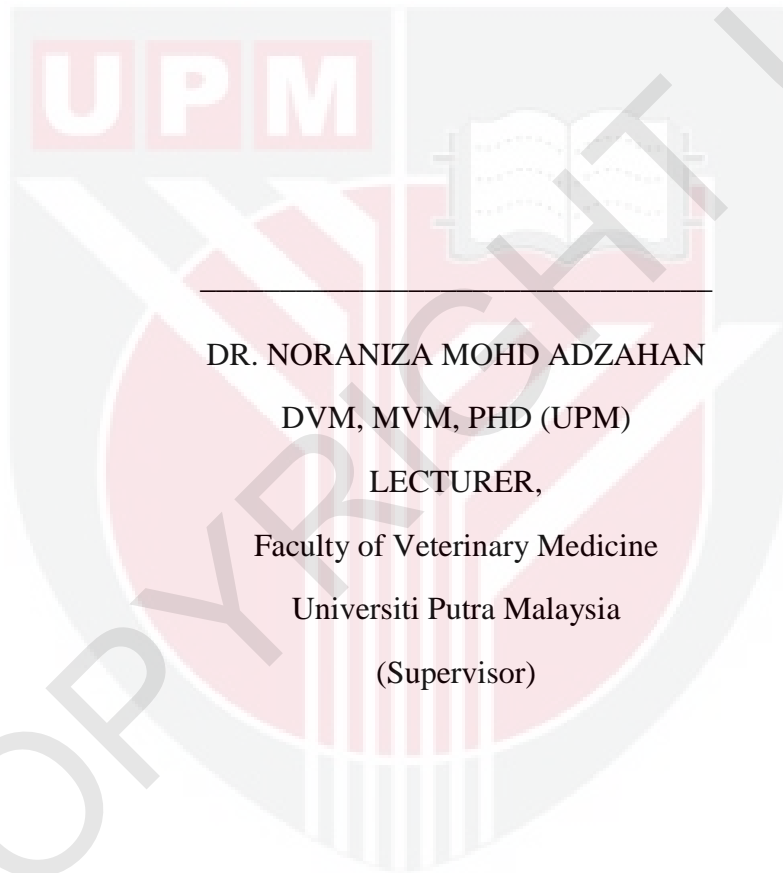
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Malaysia

**MARCH 2015**

## **CERTIFICATION**

It is hereby certified that we have read this project paper entitled “Fracture Injuries in Racehorses on Horse Track in Malaysia” by Nur Eershan Namira Bt Mohd Hanafiah and in our opinion it is satisfactory in terms of scope, quality, presentation as partial fulfilment of the requirement for the course VPD 4901 Project.



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“The hooves of horses!  
Oh! Witching and sweet  
Is the music earth steals from the iron-shod feet;  
No whisper of lover, no trilling of bird,  
Can stir me as much as hooves of horses  
Have stirred.”

~ Will H. Ogilvi

*To my beloved husband,  
Mohd Nazri bin Mohd Nayan.*

*To my lovely parents,  
Hjh. Noor Hamidah Bt Ali*

*and*

*Hj. Mohd Hanafiah Bin Hassan,*

*Family,*

*for all the love and prayers.*

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Dr. Noraniza Mohd Adzahan,

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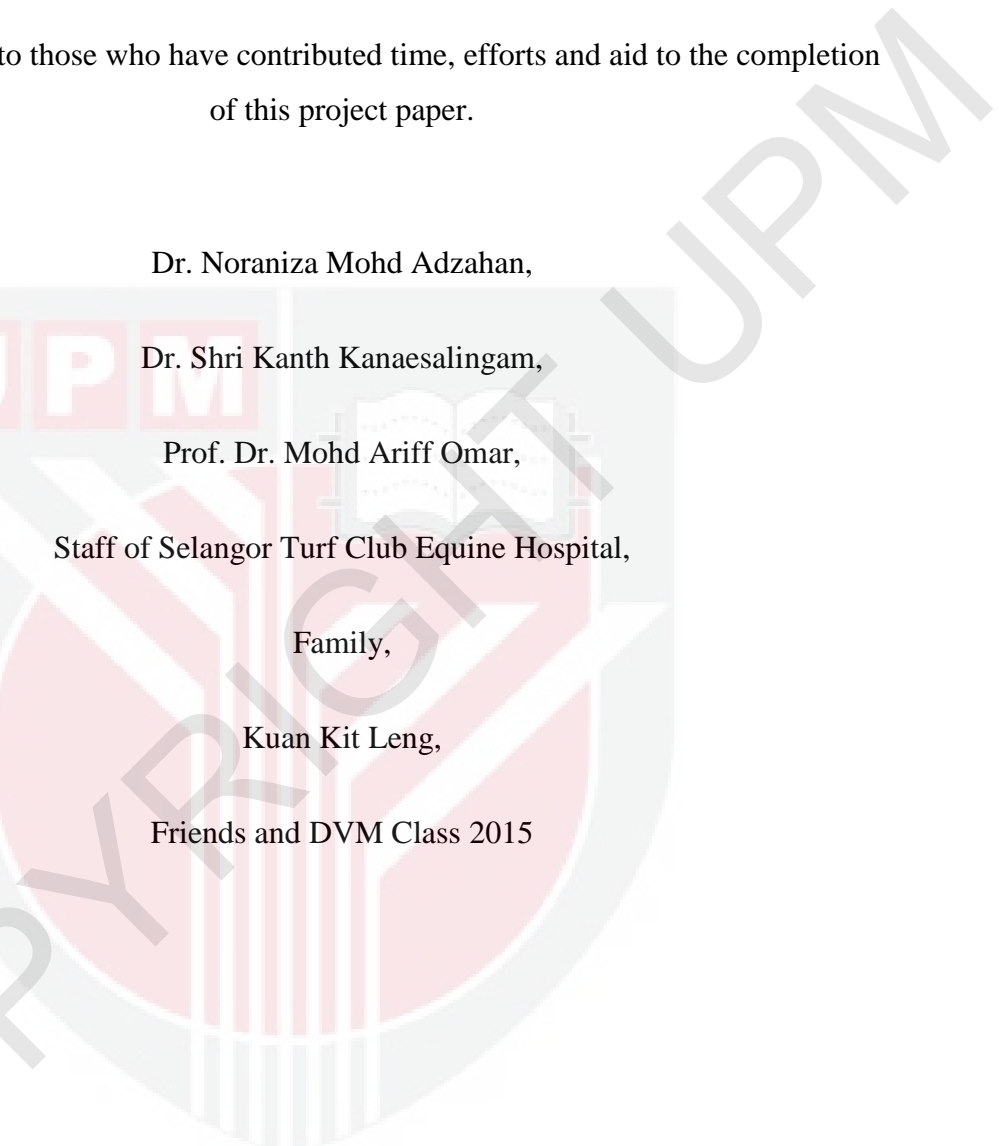
Staff of Selangor Turf Club Equine Hospital,

Family,

Kuan Kit Leng,

Friends and DVM Class 2015

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**LIST OF ABBREVIATIONS**

CMI<sub>s</sub> Catastrophic Musculoskeletal Injuries

Fig Figure

ms Millisecond

N Number

STC Selangor Turf Club

Std Standard



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**ABSTRAK**

Abstrak kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar dalam memenuhi sebahagian daripada kursus VPD 4999 – Projek Tahun Akhir.

**KECEDERAAN KERETAKAN TULANG DALAM KUDA LUMBA DI ATAS  
TREK PERLUMBAAN KUDA DI MALAYSIA**

Oleh:

**NUR EERSHAN NAMIRA MOHD HANAFIAH**

**2015**

**Penyelia: Dr. Noraniza Mohd Adzahan**

**Penyelia bersama: Dr. Shri Kanth Kanaesalingam**

Kecederaan muskuloskeletal merupakan antara punca utama kerugian ketika latihan dan perlumbaan kuda Torugbred. Banyak kajian telah dilakukan berkaitan kecederaan maut namun kajian berkaitan kecederaan bukan maut masih belum dikaji secara meluas. Kajian ini dilaksanakan bagi menentukan kekerapan keretakan tulang

dalam kuda Torugbred semasa latihan dan perlumbaan di Malaysia berserta kaitan yang berkemungkinan. Rekod radiografi serta kecederaan maut bagi kuda yang dihantar ke Hospital Ekuin Kelab Lumba Kuda Selangor diakses untuk memperolehi kejadian keretakan tulang. Sejumlah 107 kes telah dinilai dalam kajian ini di mana keretakan pada tulang karpus (31.8 %) merupakan nilai tertinggi dengan kebanyakannya keretakan berlaku pada tulang radial karpal (15 %). Terdapat perbezaan yang signifikan antara kumpulan umur, jantina, lokasi keretakan serta kaki yang terlibat. Kumpulan umur 5 hingga 8 tahun, kuda jantan yang dikasi, karpus serta kaki kiri hadapan merupakan bahagian yang paling banyak menghadapi keretakan. Walaubagaimanapun, faktor-faktor ini tidak berkaitan secara langsung dengan kes kecederaan maut. Semua kes keretakan termasuklah kes kecederaan maut kebanyakannya berlaku pada kaki hadapan. Terdapat corak keretakan yang signifikan terhadap kejadian keretakan tulang dalam kuda lumba Torugbred semasa latihan dan perlumbaan.

Kata kunci: *Muskuloskeletal, tulang retak, kuda lumba, umur, jantina.*

**ABSTRACT**

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfilment of the course VPD 4999 – Final Year project.

**TITLE: FRACTURE INJURIES IN RACEHORSES ON HORSE TRACK IN  
MALAYSIA**

**By:**

**NUR EERSHAN NAMIRA MOHD HANAFIAH**

**2015**

**Supervisor: Dr. Noraniza Mohd Adzahan**

**Co-supervisor: Dr. Shri Kanth Kanaesalingam**

Musculoskeletal injuries are among the most common cause of loss during training and racing in Thoroughbred racehorses. There were many studies on catastrophic musculoskeletal injuries (CMIs) however non-catastrophic injuries were not well described. The present study was performed to determine the frequencies of fractures

injuries in Thoroughbred racehorses during training and flat race racing in Malaysia with the possible associations. Radiographic and CMIs records for horses presented at Selangor Turf Club (STC) Equine Hospital were assessed for the occurrence of fracture injuries. A total of 107 cases were included in this study; fractures of carpus (31.8 %) were the most common with highest fractured bone of radial carpal (15 %). There were significant differences among age group, gender, location of fracture and fractured limb. Age group 5 to 8 years old, gelding, carpus and the left forelimb were the most to obtain fractures. However these factors were not significantly associated with CMIs. Non-catastrophic and CMIs were both commonly occurred at the forelimb. There were significant pattern of fracture injuries in Thoroughbred racehorses during training and racing.

Key words: *Musculoskeletal, fracture, racehorse, age, gender*

## 1.0 INTRODUCTION

The history of horse racing in Malaysia started in the 1800s which was brought by the British traders (Malayan-racing.com, 2015). Even though the sport was introduced as a foreign sport, it was well supported by horse racing enthusiasts and made it into a very popular events. Here in Malaysia, the type of racing is flat racing. It is a form of horse racing that run on a level track at a predetermined distance. As the sport is developing very well, the welfare of the racing horses become as well as important as the generated profit.

Earlier, the equine veterinary community begins to describe racehorse injuries and fatality at a population level. It started in the late of 1960s and 1970s and the researches still continues. The case definitions evolved from a general and population level such as lameness and breakdown, into a specific type injuries such as proximal sesamoid bone fracture. There was also many studies regarding the risk and the racehorse injuries and majority of them focused on Thoroughbred horses (Parkin, 2008).

Generally, racehorse injuries does not only involved on musculoskeletal and soft tissues injuries but they are also at risk of cardiovascular and respiratory failure (Cruz *et al.*, 2007). As injuries continues to happen, it create alertness and interest regarding cause and subsequent preventive measures. It became critical if the injuries requires euthanasia decision. Therefore many researchers performed studies on factors that may contribute to the occurrences of these injuries so that the welfare of the horses are not compromised during the racing.

Fracture is one from the three case definitions discussed in reporting racetrack injury. Other cases are tendon injury and sudden death. It was agreed that chips less than 5 mm in size is excluded from fracture cases. Stress fractures are included as one type of fracture, regardless of the details and outcome; complete/incomplete, displaced/non-displaced, surgery/euthanasia. The term catastrophic is preferred rather than fatal in differentiating catastrophic and noncatastrophic. They provide useful information when investigating fractures at multiple sites (Parkin, 2007).

In the early 1980s, they have identified that musculoskeletal disorders were a major reason for horses not training or racing (Jeffcott *et al.*, 1982). Even though there were variety of injuries location described in literatures, this study focussed at distal limb that encounter fracture cases. They include structures distal to radius and tibia. It has been reported that limb fractures were the most common cause for euthanasia on the racecourse (McKee, 1995). Among the various racing injuries structures, 86% of the representative descriptive studies were structures at or distal to the carpus (Peloso *et al.*, 1994).

Most of racehorse injuries affects the forelimb. At rest, 60 to 65 % of horse weight is supported by the forelimb (Sellnow, 2008; Higgins, 2012). Therefore, it is expected that more weight is stressed on the forelimb especially when saddle and rider is on the horseback. Pressure and stress to bones, joints and soft tissues will be increased as the horse is at force and speed during training and racing. In Kentucky, 90.2 % of racing injuries involved the forelimb (Peloso *et al.*, 1994). In Poland, 70.2 % of the Thoroughbred racehorses injured their forelimb (Pieszka *et al.*, 2011).

Since majority of the racehorse injuries involved the forelimb, studies was performed to find the possible factor that may contribute to the occurrences of the injuries. Most of the time, the fact is that racehorses were trained and raced in a counter-clock wise. Including in the Selangor Turf Club where this study was conducted. During working in a counter-clock wise, the horses are on the left lead of their gait when in turns (Nunamaker, 2001).

Records pertaining racetrack injuries are valuable in monitoring racing and training injuries. Many literatures are available especially regarding CMIs because fatalities are recorded in all racing jurisdictions, however the recording systems vary in recording other types of injuries. Most major racing jurisdictions record information from horses injured while racing and returning lame from racing, but few have systems in place to document training injuries.

There is still limited study on horse racing industry in Malaysia and no literature available on racehorse injuries in Malaysia. This study will be the first report on horse track injuries and provide preliminary information on occurrence of racehorse fractures during training and racing presented at Selangor Turf Club (STC) Equine Hospital. The objectives of this study are to:

1. Determine the most common location of fractures and affected limb in racehorses during training and racing.
2. Determine the frequencies and proportions on fractures location in racehorses during training and racing.
3. Retrospectively evaluate the associations between age group and gender on fracture cases and CMIs.

## 2.0 LITERATURE REVIEW

### 2.1 Racetrack Injuries

Racehorses are at risk of high speed injuries. There were many reports on types and sites of injuries have been documented. A study from National Hunt racehorses in United Kingdom described the epidemiology of fracture, tendon and suspensory ligament injuries for two racing seasons. Fracture sites were categorized into vertebra, humerus/scapula, pelvis, radius/ulna, tibia, carpal bones, third metacarpal, third metatarsus, sesamoids and proximal/distal phalanx. The highest fracture sites were contributed by pelvic and third metacarpal fractures with 17.1 %. It is followed by tibia fractures 16.2 % and the least is contributed by sesamoids fractures 1.8 % (Ely *et al.*, 2010). A study from Newmarket, United Kingdom reported on musculoskeletal injuries in thoroughbred racehorses from three training yards for the 2005 to 2007. The injuries were categorized into tibia, proximal phalanx, carpus, pelvis, SDFT, third metacarpus and metatarsus condylar and cannon, suspensory branch, hock, sesamoid and other. The highest rates of injuries were contributed by tibial stress fracture which was 20.7 %. It was followed with fractures of proximal phalanx 14.5 % and carpal fractures 11.2 %. The least fractures were contributed by sesamoid fractures which was 0.83 %. In this study, most of the injuries were identified on the forelimb, 76.2 % from suspensory branch lesions, 68.6 % contributed by proximal phalanx fractures and 56.0 % from condylar fracture. Some injuries showed predilection to the right forelimb, 81.5 % from carpal fractures, 69.2 % from SDFT lesions and 68.6 % from proximal phalanx fractures. A study from Japan reported that fracture sites can be categorized into thoracic limb:

scapula, humerus, radius and ulna, metacarpus, proximal sesamoid and phalanx; pelvic limb: pelvis, femur, tibia, tarsus, metatarsus and proximal sesamoid; and non-limb fractures. Sites of fractures were obtained from flat racing at 10 racetracks from year 1987 to 2000. Forelimb fractures were 86.26 % at risk of the fracture sites. The pelvic limb was 13.58 % and the non-limb fractures were only 0.15 %. The highest incidence risk for forelimb fractures was contributed by the radius and ulna fracture with 20.77 % followed by metacarpus 17.61 %, and the least was scapula 0.11 %. The highest incidence risk for pelvic fractures was contributed by metatarsus fractures with 5.19 % followed by tarsus 2.44 %, and the least was femur 0.06 %. The non-limb fracture was only 0.15% at incidence risk (Oikawa & Kusunose, 2005).

## **2.2 Distal Limb Fractures and Catastrophic Musculoskeletal Injuries (CMIs) In Thoroughbred Racehorses**

Catastrophic distal limb fractures can be defined as one or more horses who suffered a fracture of any bone that is distal to the radius or tibia which required euthanasia (Parkin *et al.*, 2004). In United Kingdom racecourses, distal limb fractures are the most common cause of fatality (Parkin *et al.*, 2004). A study on epidemiologic characteristics of catastrophic musculoskeletal injuries in thoroughbred racehorses conducted in Ontario, Canada for the year 2004 and 2005 reported that 67.2 % of causes of death euthanized at racing or training were due to CMIs (Cruz *et al.*, 2007). Out of 76 horses with CMIs, the post mortem examinations performed by the senior veterinary pathologist revealed that 29 % or

the most affected are the metacarpal/metatarsal regions. It is followed by carpus 19.7 % and proximal sesamoids bones 18.4 %. The least reported case was from distal interphalangeal joint with only 1.3%. During the study period, the mean incidence rate of racing-related CMIs reported was 1.05/1000 starts (95 % CI, 0.75 to 1.43 CMIs/1000 starts). The incidence of training-related CMIs was 0.39/1000 workouts (95% CI, 0.23 to 0.63 CMIs/1000 workouts). The most common locations of CMIs were metacarpal/metatarsal regions and carpus (Cruz *et al.*, 2007; Estberg *et al.*, 1998). The most common noncatastrophic injuries are carpal injuries (Stover, 2003). An evaluation of CMIs in thoroughbreds and quarter horses at three Midwestern racetracks from 2000 to 2006 revealed that the most common injuries were reported to be contributed by proximal sesamoids fractures with 38.7 % (Beisser *et al.*, 2011). It is followed by carpal bone fractures with 21.8 % and metacarpal bone fractures with 20.2 %. The metacarpophalangeal joint disruption with proximal sesamoid bone and third metacarpal bone fracture contributed in 8.1 % of the thoroughbred horses. The left forelimb contributed to the most site for the CMIs (55.6 %). It is followed by right forelimb (29.8 %), both forelimbs (9.7 %), right hind limb (3.2 %), left hind limb (0.8 %); and both hind limbs (0.8 %).

### 2.3 Reported Factors Associated With Musculoskeletal Injuries

Generally, horses age 4 years or older are at greater risk to obtain moderate to severe injuries as compared to younger horses (Estberg *et al.*, 1996). In United Kingdom, the highest fractures incidence was contributed by horses age 12 to 14 with 1.39 [0-3.31 (2/100 fractures)], followed by horses age 6 to 8 with 1.19 [0.86-1.51 (51/100 fractures)] and the least was from horses age 2 to 5 with 0.93 [0.63-1.23 (37/100 fractures)] (Ely *et al.*, 2010). However, the most CMIs occurred was during at 3 years of age (41.1 %) and only 6.5 % CMIs occurred at 2 years old (Beisser *et al.*, 2011). Geldings may be more likely to have a longer racing career while valued stallions and broodmare are more likely to be retired from racing and served in breeding farms (Stover, 2003). In United Kingdom, the highest fractures incidence was contributed by male with 1.09 [0.87-1.32 (90/100 fractures)] and followed by female with 0.82 [0.31-1.33 (10/100 fractures)] (Ely *et al.*, 2010). The SDFT lesions and condylar fractures occur mostly in males which contributed 92.3% and 72.0% each (Ramzan & Palmer, 2011). In Florida, geldings were at greater risk for CMIs (Hernandez *et al.*, 2001). In Canada, age groups and sexes were not significantly associated with the incidence of racing-related CMIs. It is concluded that age groups were not significantly associated with incidence of training-related CMIs but the sexes did show significant difference. The result was colts and stallions had higher incidence of training-related CMIs compared to females (Cruz *et al.*, 2007). There was no significant difference between thoroughbreds and quarter horses for which the gelding had the greatest number of CMIs (56.7 %), as compared to females (30 %) and sexually intact males (13.3 %) (Beisser *et al.*, 2011). The risk

decline as the horses enters their 2-5 years of racing but increased again after the fifth year of racing (Parkin *et al.*, 2004). At horse-level, it was reported that the fracture risk was at greatest when the horses did no gallop work. At the race- and course-level risk, the number of runners and race distance were significantly associated with the potential of fracture during racing (Parkin *et al.*, 2004). An additional runner and furlong raced it results in 1.1 times increased risk of fracture each (Parkin *et al.*, 2004). Racing track surface have potential risk for musculoskeletal injury by affecting the limb loading (Stover, 2003). A study in United Kingdom stated that any races going any harder that soft on the previous day of racing at the course will increase the risk of fracture (Parkin *et al.*, 2004). In comparison between turf and dirt tracks in Florida, higher incidence of CMIs was reported on turf than dirt (Hernandez *et al.*, 2001). However, horses with different ages may arrived at different racetracks at different seasons thus these differences creates susceptibility for musculoskeletal injuries until adaptation to new loading circumstances is complete (Stover, 2003).

### **3.0 MATERIALS AND METHODS**

#### **3.1 Data Retrieval**

A retrospective study on radiographic images of horses admitted to Selangor Turf Club (STC) Equine Hospital during the period from 1<sup>st</sup> January 2013 to 31<sup>st</sup> December 2014 was reviewed and cross checked with STC veterinary officers. Radiographic records were accessed through computerised database FUJIFILM FCR XG-1 and radiographs was taken using MIKASA HF8015+DLP. Horses that were euthanized during the period from 1<sup>st</sup> January 2013 to 31<sup>st</sup> December 2014 due to CMIs were retrieved from euthanasia request and deletion forms.

The age was further grouped into 3 categories; 0 to 4 years old, 5 to 8 years old and 9 to 12 years old. Horses' gender was grouped into gelding, mare and undefined due to the unable of accessing the patient's record. Data were collated onto the following distal limb locations: phalanx, sesamoid, fetlock (any fracture that occurred at metacarpophalangeal/ metatarsophalangeal joints), metacarpus, carpus metatarsus, and tarsus. The fractures were then grouped into 4 categories according to the fractured limb; left fore, right fore, left hind and right hind.

To be included as a case, any fractures diagnosed that can be visible through the radiographic imaging including the displaced or non-displaced, complete or incomplete fractures. Horses presented to the STC Equine Hospital during both training and racing were included for the study. Multiple injuries in the same horse at different times during the period of study were included. Recurrent injuries at the same location were not included as separate events when considering occurrence of

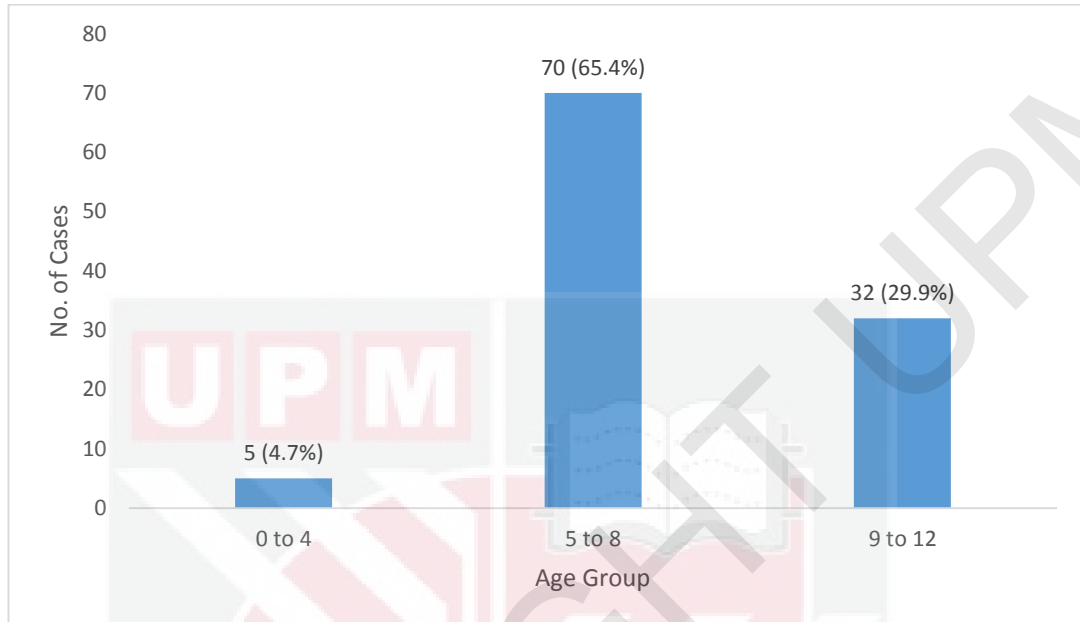
injury types. Data obtained were number of cases, location of fractures, fractured limb, horses' age and gender.

### **3.2 Statistical Analysis**

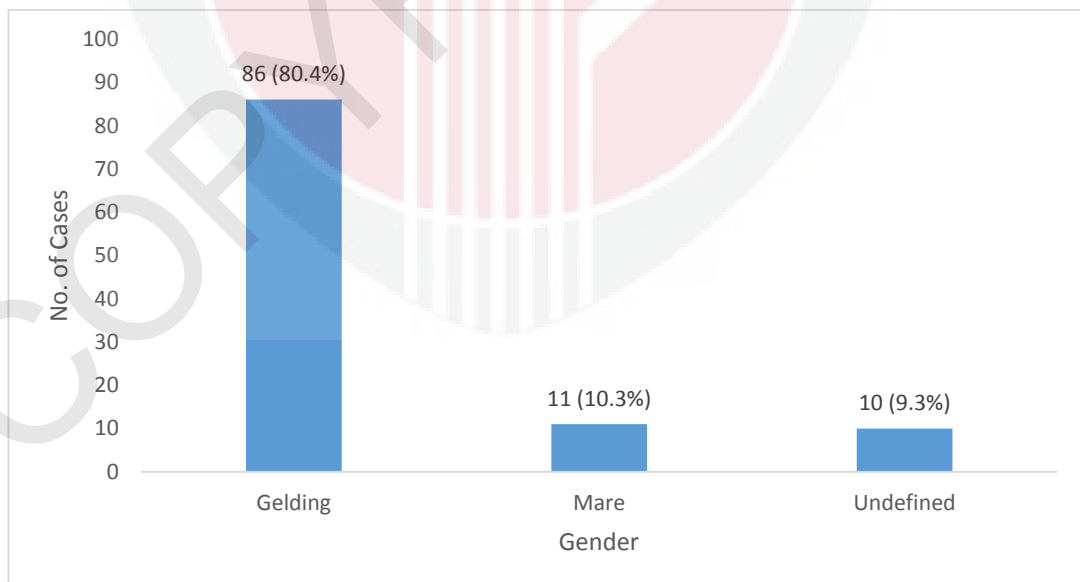
The data regarding the number of cases, location of fractures, fractured limb, horses' age and gender were presented in tables and bar charts. The differences among age group and gender with location of fracture, fractured limb and CMIs were determined at 95% confidence and significant at  $p < 0.05$  using Chi Square Test. All the statistical analyses were performed using SPSS software version 20 (SPSS, IBM Inc, USA).

In total, there were 107 fracture cases included for the period of study from 1<sup>st</sup> January 2013 to 31<sup>st</sup> December 2014. All scale values were analysed using parametric test and was normally distributed. The collected were from fractured horses with age range from 4 years old until 12 years old. The data was normally distributed with age mean was  $7.52 \pm 0.189$  (Table 5). Other categorical values were analysed using non-parametric test.

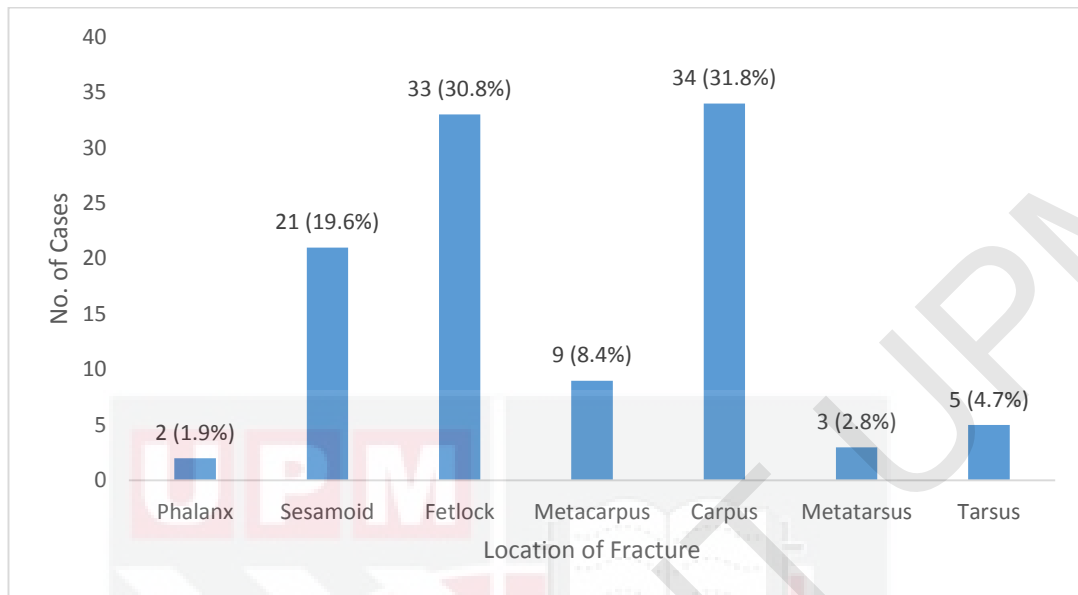
#### 4.0 RESULTS AND DISCUSSION



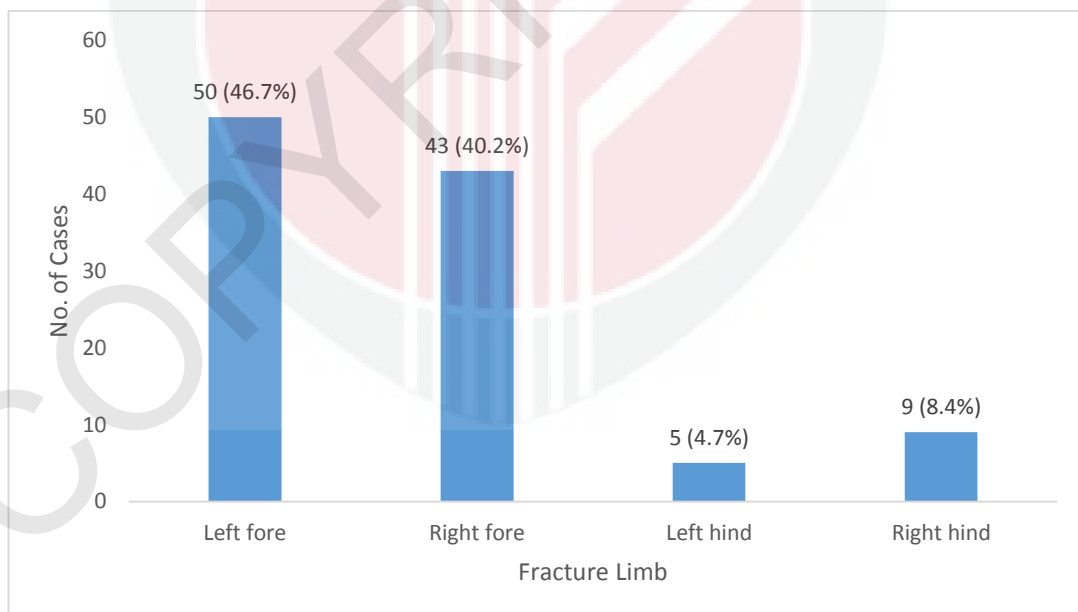
**Fig. 1** No. of cases by age group for 2 years of study period



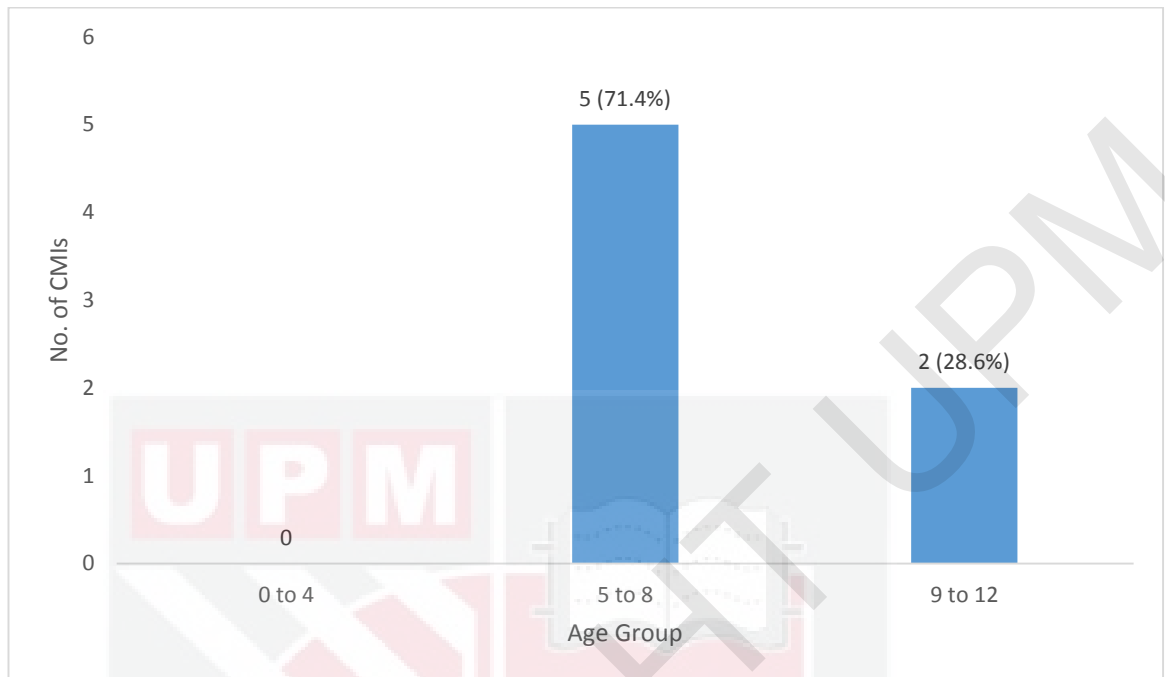
**Fig. 2** No. of cases by gender for 2 years of study period



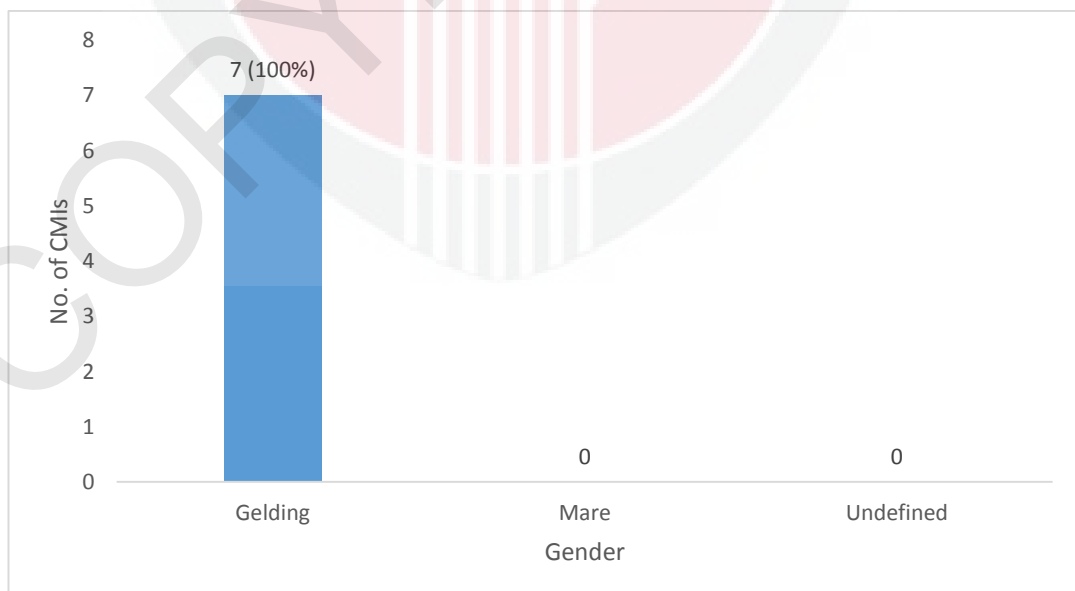
**Fig. 3** No. of cases by location of fracture for 2 years of study period



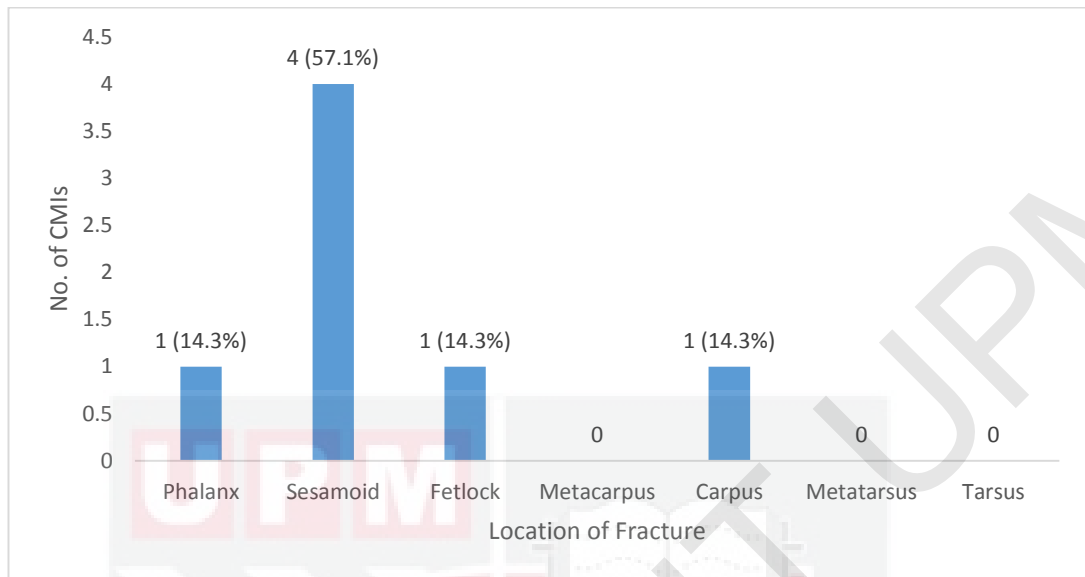
**Fig. 4** No. of cases by fractured limb for 2 years of study period



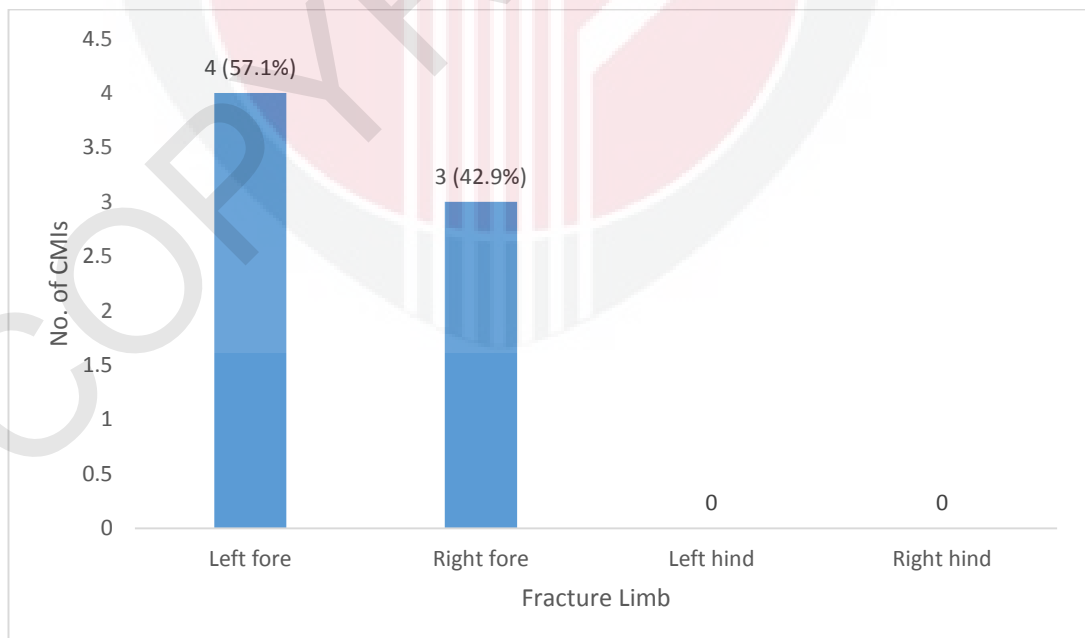
**Fig. 5** No. of CMI cases by age group for 2 years of study period



**Fig. 6** No. of CMI cases by gender for 2 years of study period



**Fig. 7** No. of CMI cases by location of fracture for 2 years of study period



**Fig. 8** No. of CMI cases by fractured limb for 2 years of study period

Out of 107 cases, the highest cases was contributed from horses age 5 to 8 years old with 70/107 (65.4 %) cases. There was significant differences among age group towards fracture cases  $\chi^2$  (df=2, N=107) = 59.79,  $p < 0.01$ . This result was consistent with a study that shows that horses 4 years or older are at greater risk to obtain moderate to severe injuries (Estberg *et al.*, 1996). A study have concluded that horses older than five years were 1.7 times more likely to sustain an injury than those four years or less (Bailey *et al.*, 2006). It was followed by horses age 9 to 12 years old with 32/107 (29.9 %) cases and the least was from horses age 0 to 4 years old with 5/107 (4.7 %) cases (Figure 1). In this study, there was no significant association between age group and location of fractures ( $p = 0.07$ ). However, there was 29/70 (41.4 %) of fractures contributed by age group 5 to 8 years old occurred at the left forelimb. There was significant association between age group and fractured limb ( $p = 0.04$ ) (Table 4). Increasing age has been proven to be associated with increased risk of musculoskeletal injury in USA flat racing (Cohen *et al.*, 2000). Generally as the horse getting older, the chance to acquire injuries also increased. It can be due to the cumulative effect pertained from more racing exposures (Mundy, 1997).

There was significant differences among gender towards the fracture cases,  $\chi^2$  (df=2, N=107) = 106.56,  $p < 0.01$ . The majority fracture cases was contributed by gelding with 86/107 (80.4 %) cases. A case control study also determined that males face twice the risk of female in obtaining injuries (Estberg *et al.*, 1996). It was followed by mare with 11/107 (10.3 %) cases and undefined group with 10/107 (9.3 %) cases (Figure 2). Gelding shows 29/86 (33.7 %) fractures occur at the fetlock

meanwhile mare shows 6/11 (54.5 %) fractures occur at carpus. There was significant association between gender and location of fractures ( $p=0.04$ ) (Table 3). No literature available regarding gender with predilection location of fractures. Additional studies of other risk factors and their inter-actions with sex are necessary to evaluate associations (Cruz *et al.*, 2007 ; Boden *et al.*, 2007). However, there was no significant association between gender and fractured limb ( $p=0.25$ ).

From the total of fracture cases, it was found that the majority of fracture was located at carpus with 34/107 (31.8 %) cases. There was significant differences among location of fractures  $\chi^2$  ( $df=6$ ,  $N=107$ ) = 76.51,  $p<0.01$ . It was followed by fetlock with 33/107 (30.8 %), sesamoid with 21/107 (19.6 %), metacarpus with 9/107 (8.4 %), tarsus with 5/107 (4.7 %), metatarsus with 3/107 (2.8 %) and phalanx with 2/107 (1.9 %) (Figure 3).

This study reveals that the highest fracture cases were located at carpus with 34/107 (31.8 %) cases. This was supported by a study whereby carpal injuries were the most common location happened in non-catastrophic injuries (Stover, 2003). The most common type of carpal bone involved during fractures were the radial carpal fractures 16/34 (47.1 %). Since the knee have a high injury possibility, this study shall assist the especially during examination procedure prior purchasing a yearling as it is important to review the health records in ensuring the horse is sound for a successful racing career (Larson *et al.*, 2010).

Most of the fractures occurred at the forelimb with total of 93/107 (86.9 %) cases. It is consistent with a finding in Kentucky where majority (90.2 %) of racing injuries involved the forelimb (Peloso *et al.*, 1994). This result also was supported

whereby non-catastrophic and CMI's were found most commonly occurred at the distal half and forelimb (Cohen *et al.*, 1997). Hindlimb fractures only contributed 14/107 (13.1 %). There was also significant differences among fractured limbs  $\chi^2$  (df=3, N=107) = 59.54,  $p < 0.01$ . It was found that most of the fractures has a predilection to occur at the left forelimb with 50/107 (46.7 %) cases, followed by right forelimb with 43/107 (40.2 %) cases, right hindlimb with 9/107 (8.4 %) cases and left hindlimb 5/107 (4.7 %) cases (Figure 4).

The forelimb of horses carries 60-65 % of its body weight. Therefore more stress is applied onto the forelimb compared to the hindlimb. When a horse is running at speed, there will be a split second in every stride where all of the animal's weight, plus the additional impact involved when running all out, lands on one front leg (Sellnow, 2006). It is the energy of the first fore that produces a force which takes weight off the lead fore, but that energy is not as powerful as the second rear. Hence the lead fore makes ground contact with a higher vertical load compacting the surface more rapidly and stopping the lead fore more abruptly (Pratt, 1997).

Since forelimb were at greater risk in obtaining injuries, studies have been performed to find the mechanism that may cause the injuries. A study done at Massachusetts proposed that the greatest threat comes from bending stresses generated in the first 10-20 ms after ground contact when the hoof slides into the surface and stops. There were three factors that affects the level of stress on a contacting foreleg; the torque about the centre of mass of the horse which is produced by the driving force of the leg about to complete its stance at the entry of

the fore, the force required to shear the racing surface and the type of shoe (Pratt, 1997).

Among the 107 fracture cases, fracture affecting the phalanx were 2/107 (1.9 %) with both were incomplete oblique fracture of proximal phalanx. Total sesamoid fracture were 19.6 % with the highest fracture was abaxial sesamoid fracture (7.5 %), followed by apical sesamoid fracture (3.7 %), comminuted sesamoid fracture (2.8 %), mid-body sesamoid fracture (2.8 %), basal sesamoid fracture (1.9 %), and undefined fracture (0.9 %). Total fetlock fracture were 33/107 (30.8 %) with the highest fracture was osteochondral chip fracture of distal third metacarpus (11.2 %), this was a common type of fracture occurred in fetlock (Declercq *et al.*, 2011), followed by chip fracture of proximodorsal of proximal phalanx (9.3 %), osteochondral chip fracture of distal third metacarpus together with fracture of proximodorsal of proximal phalanx (5.6 %), chip fracture of proximopalmar of proximal phalanx (1.9 %), articular fracture of proximal phalanx (0.9 %), condylar fracture of proximal phalanx (0.9 %) and undefined fracture of fetlock (0.9 %). Total of metacarpus fracture were 9/107 (8.4 %) with the highest fracture was splint bone fracture (4.7 %), followed by incomplete oblique fracture of third metacarpus (1.9 %) and saucer fracture of third metacarpus (1.9 %). Among the fracture types occurred at carpus and tarsus were slab, sagittal and chip fractures. Total of carpus fracture were 34/107 (31.8 %) with the highest fracture was radial carpal fracture (15 %), this result is consistent with a study done at United Kingdom whereby 10.1 % of the carpal fracture was the radial carpal bone (Verheyen and Wood, 2004). It is then followed by third carpal fracture (7.5 %), intermediate together with radial

carpal fracture (2.8 %), third together with radial carpal fracture (2.8 %), intermediate carpal fracture (1.9 %), intermediate together with radial and central carpal fracture (0.9 %) and undefined fracture (0.9 %). Total of metatarsus fracture were 3/107 (2.8 %) with incomplete oblique fracture (1.9 %) and saucer fracture of third metatarsus (0.9 %). Total of tarsus fracture were 5/107 (4.7 %) with third tarsus fracture (2.8 %) and central tarsus fracture (1.9 %) (Table 1).

In the study of relationship among age group, gender, location of fracture and fractured limb with CMIs cases, all of them revealed no significant associations ( $p>0.05$ ); between age group and CMIs ( $p=0.82$ ), between gender and CMIs ( $p=0.40$ ), between location of fracture and CMIs ( $p=0.28$ ) and between fractured limb and CMIs ( $p=0.76$ ).

Out of 107 of total cases, the CMIs cases were 7/107 (6.5 %) and was euthanized either directly after racing and performed post mortem or after being diagnosed with radiographs. The most occurrence location of CMIs fracture was sesamoid fracture with 57.1 %, followed by phalanx 14.3 %, fetlock with 14.3 % and carpus with 14.3 % (Figure 7). Out of 4 total sesamoid fractures, there were abaxial sesamoid fracture, mid-body sesamoid fracture, comminuted sesamoid fracture and undefined sesamoid fracture each. The CMIs involving phalanx fracture was due to chip fracture of proximodorsal of proximal phalanx. The CMIs at carpus and fetlock fracture was undefined on which bone involved (Table 2).

**Table 1** Location of fracture by fractured bone

| <b>Fracture Location</b> | <b>Fractured Bone</b>   | <b>N</b>  | <b>%</b>    |
|--------------------------|---|-----------|-------------|
| Phalanx                  |   | <b>2</b>  | <b>1.9</b>  |
|                          | Incomplete oblique fracture   | 2         | 1.9         |
| Sesamoid                 |   | <b>21</b> | <b>19.6</b> |
|                          | Abaxial fracture  | 8         | 7.5         |
|                          | Apical fracture   | 4         | 3.7         |
|                          | Basal fracture  | 2         | 1.9         |
|                          | Comminuted fracture   | 3         | 2.8         |
|                          | Mid-body fracture   | 3         | 2.8         |
|                          | Undefined fracture  | 1         | 0.9         |
| Fetlock                  |   | <b>33</b> | <b>30.8</b> |
|                          | Articular fracture proximal phalanx   | 1         | 0.9         |
|                          | Chip fracture proximodorsal proximal phalanx  | 10        | 9.3         |
|                          | Chip fracture proximopalmar proximal phalanx  | 2         | 1.9         |
|                          | Condylar fracture   | 1         | 0.9         |
|                          | Osteochondralchip fracture third metacarpal   | 12        | 11.2        |
|                          | Osteochondralchip fracture third metacarpal and dorsoproximal fracture proximal phalanx | 6         | 5.6         |
|                          | Undefined   | 1         | 0.9         |
| Metacarpus               |   | <b>9</b>  | <b>8.4</b>  |
|                          | Incomplete oblique fracture third metacarpal  | 2         | 1.9         |
|                          | Saucer fracture third metacarpal  | 2         | 1.9         |
|                          | Splint bone fracture  | 5         | 4.7         |
| Carpus                   |   | <b>34</b> | <b>31.8</b> |
|                          | Intermediate carpal   | 2         | 1.9         |
|                          | Intermediate and radial carpal  | 3         | 2.8         |
|                          | Intermediate, radial and central carpal   | 1         | 0.9         |
|                          | Radial carpal   | 16        | 15.0        |
|                          | Third carpal  | 8         | 7.5         |
|                          | Third and radial carpal   | 3         | 2.8         |
|                          | Undefined   | 1         | 0.9         |

|                                     |            |              |
|-------------------------------------|------------|--------------|
| Metatarsus                          | <b>3</b>   | <b>2.8</b>   |
| Third metatarsus                    | 2          | 1.9          |
| Saucer fracture of third metatarsus | 1          | 0.9          |
| Tarsus                              | <b>5</b>   | <b>4.7</b>   |
| Central tarsal                      | 2          | 1.9          |
| Third tarsal                        | 3          | 2.8          |
| <b>Total</b>                        | <b>107</b> | <b>100.0</b> |

**Table 2** Location of CMIs fracture by fractured bone

| <b>Fracture Location</b> | <b>Fractured Bone</b>                        | <b>N</b> | <b>%</b>     |
|--------------------------|--|----------|--------------|
| Phalanx                  |  | <b>1</b> | <b>14.3</b>  |
|                          | Chip fracture proximodorsal proximal phalanx | 1        | 14.3         |
| Sesamoid                 |  | <b>4</b> | <b>57.1</b>  |
|                          | Abaxial sesamoid fracture                    | 1        | 14.3         |
|                          | Mid-body sesamoid fracture                   | 1        | 14.3         |
|                          | Comminuted sesamoid fracture                 | 1        | 14.3         |
|                          | Undefined                                    | 1        | 14.3         |
| Fetlock                  |  | <b>1</b> | <b>14.3</b>  |
|                          | Undefined                                    | 1        | 14.3         |
| Carpus                   |  | <b>1</b> | <b>14.3</b>  |
|                          | Undefined                                    | 1        | 14.3         |
| <b>Total</b>             |  | <b>7</b> | <b>100.0</b> |

**Table 3** Age group and fractured limb frequencies

|           |         | Fractured Limb |             |           |            |              |
|-----------|---------|----------------|-------------|-----------|------------|--------------|
|           |         | Left fore      | Right fore  | Left hind | Right hind | Total        |
| Age Group | 0 to 4  | 2 (40.0 %)     | 1 (20.0 %)  | 0 (0.0 %) | 2 (40.0 %) | 5 (100.0 %)  |
|           | 5 to 8  | 29 (41.4 %)    | 29 (41.4 %) | 5 (7.1 %) | 7 (10.0 %) | 70 (100.0 %) |
|           | 9 to 12 | 19 (59.4 %)    | 13 (40.6 %) | 0 (0.0 %) | 0 (0.0 %)  | 32 (100.0 %) |

p=0.04

**Table 4** Gender by location of fracture frequencies

|        |           | Location     |                |                |               |                |               |              | Total           |
|--------|-----------|--------------|----------------|----------------|---------------|----------------|---------------|--------------|-----------------|
|        |           | Phalanx      | Sesamoid       | Fetlock        | Metacarpus    | Carpus         | Metatarsus    | Tarsus       |                 |
| Gender | Gelding   | 2<br>(2.3 %) | 18<br>(20.9 %) | 29<br>(33.7 %) | 6<br>(7.0 %)  | 26<br>(30.2 %) | 1<br>(1.2 %)  | 4<br>(4.7 %) | 86<br>(100.0 %) |
|        | Mare      | 0<br>(0.0 %) | 0<br>(0.0 %)   | 0<br>(0.0 %)   | 2<br>(18.2 %) | 6<br>(54.5 %)  | 2<br>(18.2 %) | 1<br>(9.1 %) | 11<br>(100.0 %) |
|        | Undefined | 0<br>(0.0 %) | 3<br>(30.0 %)  | 4<br>(40.0 %)  | 1<br>(10.0 %) | 2<br>(20.0 %)  | 0<br>(0.0 %)  | 0<br>(0.0 %) | 10<br>(100.0 %) |

p=0.04

The majority location of fracture in CMIIs was sesamoid fracture with 57.1 %. Sesamoid bone fracture were the top 3 CMIIs fractures in Canada racehorses (Cruz *et al.*, 2007). Similar finding was found that majority 45 % of horses had sesamoid injuries during racing (Cohen *et al.*, 1997). The CMIIs cases was then followed by fracture of phalanx (14.3 %) and fetlock (14.3 %) whereby Clegg (2011) has reviewed that proximal phalanx fractures were the most common diagnosis in fatal fractures in flat turf racing.

In this study, all the CMIIs cases were contributed by horses age more than 4 years old. Seventy one point four percent were from age group 5 to 8 years old and 28.6 % were from age group 9 to 12 years old (Figure 5). The CMIIs cases were all gelding (100 %) (Figure 6). This result is consistent with a study performed in Florida where geldings were at greater risk for CMIIs (Hernandez *et al.*, 2001).

The CMIIs cases were also contributed by all forelimb. Fifty seven point one percent of the CMIIs cases were from left forelimb meanwhile the right forelimb contributed 42.9 % (Figure 8). The result was also consistent with CMIIs fractured limb that occurred mostly at left forelimb (Peloso *et al.*, 1994). Since the turf club is racing in counter-clock wise, the lead limb which is the left fore might be at higher risk (Nunamaker, 2001).

In the study of relationship between age group and gender with CMIIs cases, all of them revealed no significant associations with ( $p=0.82$ ) and ( $p=0.40$ ) each. This result is supported by a study in Canada whereby age groups and gender were not significantly associated with the incidence of racing-related CMIIs (Cruz *et al.*,

2007). A study also confirm that injury rates vary among trainers whereby the more successful trainers the lower injury rates obtained by the horse (Wilson *et al.*, 1997).

## 5.0 CONCLUSION

Fractures are generally common in racehorses during working on racetrack. The most common location of fracture was the carpus (31.8 %) with highest fractured bone of radial carpal (15 %). Forelimb (86.9 %) were the majority to involve in fracture with predilection showed by left forelimb (46.7 %) for all fracture and CMIs cases. There were significant differences among age group, gender, location of fracture and fractured limb. Age group 5 to 8 years old, gelding, carpus and the left forelimb were the most to obtain fractures. There were significant association between age group and fractured limb and between gender and location of fractures. However these factors were not significantly associated with CMIs. The majority location of fracture in CMIs was sesamoid fracture (57.1 %). There were significant pattern of fracture injuries in Thoroughbred racehorses during training and racing. This preliminary information should lead to an increased emphasis on the inspection and implementation of the examination.

## 6.0 RECOMMENDATIONS

It is recommended that future studies should be conducted on specific type of fractures obtained during training of racehorse on horse track since there are few studies available. It is also recommended that risk factors such as age at first racing, total age spent for racing, race distance and type of track surface on occurrence of fracture injuries in Malaysia are studied since preliminary information on age and gender factor has been discussed.



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## APPENDICES

**Table 5** Age normality

|            | <b>N</b>  | <b>Minimum</b> | <b>Maximum</b> | <b>Sum</b> | <b>Mean</b> | <b>Std. Deviation</b> | <b>Skewness</b> |            | <b>Kurtosis</b> |            |       |
|------------|-----------|----------------|----------------|------------|-------------|-----------------------|-----------------|------------|-----------------|------------|-------|
|            | Statistic | Statistic      | Statistic      | Statistic  | Statistic   | Std. Error            | Statistic       | Std. Error | Statistic       | Std. Error |       |
| <b>Age</b> | 107       | 4              | 12             | 805        | 7.52        | 0.189                 | 1.954           | 0.177      | 0.234           | -0.587     | 0.463 |