

Descriptive analysis of retirement of Thoroughbred racehorses due to tendon injuries at the Hong Kong Jockey Club (1992–2004)

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Summary

Reasons for performing study: This study was part of a programme to optimise the longevity and maximise the health and welfare of the Thoroughbred racehorses in Hong Kong. Injuries to the superficial digital flexor (SDF) tendon are the most common veterinary reason for premature retirement in this population.

Objective: To describe the frequency and pattern of retirements associated with SDF tendon injuries in Thoroughbred racehorses and to compare the characteristics of these horses with those that retired for other reasons.

Methods: A retrospective analysis of retirement records documented in the Hong Kong Jockey Club clinical database between 1992 and 2004 was conducted. As this is complete census data, no statistical inference to the population is necessary.

Results: The mean annual cumulative incidence of retirements due to tendon injury was 3.2% accounting for 14% of all retirements. The risk of tendon injury increased over the 12 year period from 2.3–4.2%. The racing career, number of starts and earnings of horses retired with tendon injuries were reduced by 25.6, 41.2 and 53.3%, respectively. Thirteen percent of these horses never raced in Hong Kong. A greater proportion of 3- and 4-year-olds and entire males were retired because of tendon injuries. Ninety-seven percent of injuries affected the forelimb, the right more frequently than the left. Only 19.7% of retired horses that had received ultrasound examination for SDF tendon injury retired for this reason.

Conclusions: This study provides population based data on the frequency, career and economic losses associated with tendon injury induced retirement.

Potential relevance: This descriptive study has provided a useful resource for further case-control studies to investigate risk factors for retirement from racing due to tendon injury. This is the first step toward the development of management tools to reduce the incidence of tendon injury related retirement in Hong Kong.

Introduction

Tendon injury was the single most important veterinary reason for retirement of Thoroughbreds recorded in clinical records at the Hong Kong Jockey Club 1992–2004 (Lam *et al.* 2007). Injuries to the superficial digital flexor (SDF) tendon are acknowledged to be common in Thoroughbred racehorses but there are few precise data on their frequency in training and racing owing to the lack of population based descriptive studies.

Published reports use different denominators, horse populations and case definitions. The prevalence of tendon injuries during racing on US racetracks was estimated as less than 2 per 1000 race starts (Peloso *et al.* 1994). In the UK, Williams *et al.* (2001), reported 0.78 tendon or suspensory ligament injuries per 1000 starts. In an early study on 'wastage' of racehorses during training in the UK by Rosedale *et al.* (1985), the prevalence of diagnosed tendon injuries was reported to be 3.4% (20/581). In a retrospective study in Japan, the overall prevalence of SDF tendon injuries sustained by flat racing Thoroughbreds, in both training and racing, was 11.1% (1130/10,262 horses) (Kasashima *et al.* 2004).

A number of risk factors for tendon injuries have been identified. These include horse-related factors, such as age, sex, weight, previous steeplechase experience and tendon abnormalities detected at pre-race inspection; and course-related factors such as racecourse, surface and distance (Mohammed *et al.* 1991, 1992; Cohen *et al.* 1997; Takahashi *et al.* 2004; Perkins *et al.* 2005).

Treatment for SDF injury is often prolonged with a high prevalence of re-injury (Palmer *et al.* 1994; Gibson *et al.* 1997; Dyson 2004), therefore, prevention through rational intervention strategies is particularly important to improve horse welfare and longevity of racing career. This is the aim of a study currently being carried out at the Hong Kong Jockey Club (HKJC). Here we describe the early retirement of Thoroughbred racehorses associated with SDF tendon injuries; and compare their characteristics with the remaining population of horses retired for other reasons.

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Materials and methods

Study population

All Thoroughbred racehorses stabled at the HKJC, between 1 July 1992 and 30 June 2004, were included in this study. There are no stud facilities in Hong Kong, therefore all racehorses are imported, the majority (approximately 70%) from Australia and New Zealand. Most (approximately 70%) are imported as unraced 2- and 3-year-olds and race until age, performance or health-related retirement. During the period of study the median number of horses imported per annum was 336 (range 232–458).

Horse racing in Hong Kong consists entirely of flat racing. The season year runs from 1st July to 30th June the following year, with races taking place from late August or early September through to the end of June. There is continual importation and retirement of racehorses throughout the season. The majority of the races (approximately 87%) are held on the sand based turf tracks at the Happy Valley Racecourse in the heart of Hong Kong city, and at the Sha Tin Racecourse in the New Territories. Sha Tin also has an all-weather 'dirt' track on which approximately 13% of races, and most of the training, occur. All racing and training on the main all-weather track and turf tracks is in a clockwise direction. A smaller all-weather track is available for trotting and canter work on which training in an anti-clockwise direction is available one day a week.

All racehorses are stabled at Sha Tin Racecourse. A maximum of 1200 horses can be accommodated at any one time. All clinical care is provided by a team of veterinary surgeons employed by the HKJC. Details of the training facilities and procedures of veterinary inspections to manage the suitability of horses to race have been described previously (Osborne *et al.* 2000; Stewart and Watkins 2004).

Horses can potentially remain in training and racing until compulsory age-related retirement at age 10 years. This age limit was 11 years prior to the 1996 season. Premature compulsory retirement may also occur. Current regulations require compulsory retirement following 2 officially recorded episodes of epistaxis (external exercise induced pulmonary haemorrhage, EIPH) or 2 episodes of heart irregularity during the racing career. Horses can be retired voluntarily at any time during the racing career due to injuries with a poor prognosis or for other reasons. Retired racehorses are assessed by a compulsory veterinary inspection for suitability for local riding schools, for export or

when an application is made for a replacement horse. All import and export of racehorses is licensed by the Jockey Club. This policy maintains a controlled racing population in Hong Kong.

Design and HKJC database

A retrospective study was conducted using data from computerised records held by the HKJC.

The HKJC began computerised data collection in 1972. In 1992, an official Racing Information System (RIS) was established, followed, in 1996, by a separate Veterinary System within the RIS, to store all veterinary clinical records and prescriptions. The database currently consists of over 3700 fields in over 400 Access (Microsoft) database tables. Data on date and reasons for retirement and other related variables e.g. racing history, horse and owner details were available for the 12 years, 1992–2004.

Data analysis

Reasons for retirement were recorded in the database as free text. These entries were classified using content analysis software (WordStat version 4)¹. This has been reported in detail elsewhere (Lam *et al.* 2007). Descriptive analyses were performed with Epi-info, Version 3.3.2, Centers for Disease Control and Prevention (CDC), USA, (Dean *et al.* 2005) to produce population estimates of parameters associated with retirement from racing due to tendon injury in Hong Kong, between 1992 and 2004.

Results

The number of horses in the racing population in each race season, including all new imports and retired horses increased over the study period from 1045 to 1432, median 1286 horses (Table 1). A total of 3727 records of retired racehorses were available for analysis and fourteen percent (510/3727) of these were due to SDF tendon injury. The mean annual cumulative incidence of retirements due to tendon injury was 3.2%.

The cumulative incidence of all retirements increased from 18.5% (193/1045) to 28.8% (412/1432) and the tendon injury-related retirements from 2.3% (24/1045) to 4.2% (60/1432) (Table 1). The temporal pattern revealed an increase in the annual cumulative incidence of all retirements with the major increase in the risk of retirement occurring between 1994 and 1998 (Fig 1). In

TABLE 1: Summary of the number of horses in training and number of retirements in each season between 1992–93 and 2003–04

Racing season	Horses (n)	Horses retired (cumulative incidence)	Horses retired from tendon injuries (n)	Percentage retirement attributed to tendon injuries	Annual cumulative incidence of retirement due to tendon injury
1992	1045	193 (18.5)	24	12.4 (24/193)	2.3 (24/1045)
1993	1098	217 (19.8)	31	14.3 (31/217)	2.8 (31/1098)
1994	1110	200 (18.0)	34	17.0 (34/200)	3.1 (34/1110)
1995	1195	242 (20.3)	41	16.9 (41/242)	3.4 (41/1195)
1996	1298	312 (24.0)	43	13.8 (43/312)	3.3 (43/1298)
1997	1299	319 (24.6)	39	12.2 (39/319)	3.0 (39/1299)
1998	1274	348 (27.3)	55	15.8 (55/348)	4.3 (55/1274)
1999	1271	338 (26.6)	40	11.8 (40/338)	3.1 (40/1271)
2000	1331	353 (26.5)	48	13.6 (48/353)	3.6 (48/1331)
2001	1437	394 (27.4)	42	10.7 (42/394)	2.9 (42/1437)
2002	1421	399 (28.1)	53	13.3 (53/399)	3.7 (53/1421)
2003	1432	412 (28.8)	60	14.6 (60/412)	4.2 (60/1432)

TABLE 2: Prevalence of retirement stratified by age, gender, race history before and after importation to Hong Kong for the 510 horses that retired due to tendon injuries and the 3217 horses that retired for other reasons

Category		Retired with tendon injuries (Total 510)	Retired with other reasons (Total 3217)	Prevalence of tendon injuries in the retired population (%) (Mean 13.68%; 510/3727)
Age (years)	2	2	34	5.56
	3	78	318	19.70
	4	119	575	17.15
	≥5	311	2290	11.96
Gender	Gelding	471	3034	13.44
	Entire male	36	159	18.46
	Female	3	24	11.11
Race career before import to Hong Kong	Never raced before import	335	2185	13.29
	Raced before import	175	1032	14.50
Race career in Hong Kong	Never raced	68	177	27.76
	Raced at least once	442	3040	12.69

contrast, the proportion of all retirements due to tendon injury fluctuated within a narrow range over the whole study period (10.7% in 2001–17% in 1994) and increased from 12.4% in 1992 to 14.6% in 2003 (Figure 1).

Age and gender distribution

There were a higher proportion of horses retiring due to tendon injuries at ages 3 and 4 years (19.7% and 17.2% respectively) than at 2 (5.6%) or >5 (12.0%) years (Table 2). A higher proportion of entire males retired with tendon injuries (18.5%) compared with geldings (13.4%) and females (11.1%), as shown in Table 2.

Training period from import to retirement in Hong Kong

Horses that were retired because of tendon injuries were younger and in training in Hong Kong for a shorter time compared with the remaining retired population. The median age at retirement from tendon injuries was 5 years (range 2–11) compared with 6 years (range 2–11) for the remaining retired population. The median time period in training was 29 months (range 2–104) for the horses that retired due to tendon injury.

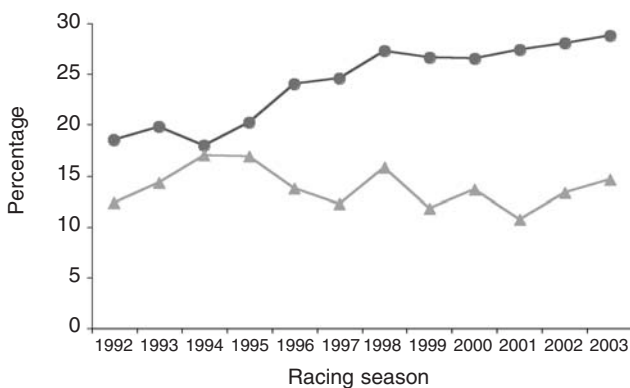


Fig 1: Annual cumulative incidence of all retirements from racing at the HKJC and the percentage of retired horses attributed to tendon injuries, in each racing season (1992–2003). ● = Annual cumulative incidence of all retirements. ▲ = Percentage of retired horses attributed to tendon injuries.

This was over 25% less than the median time in training of 39 months (range 0–106) in the population that was retired for other reasons.

Career earnings in Hong Kong

Career earnings in the group retired because of tendon injuries (median = Hong Kong Dollars (HK\$) 0.35 million: range HK\$ 0–8 million) were less than half of those in the remaining retired population (HK\$ 0.75 million: range HK\$ 0–35 million). Almost one-third of the horses that retired from tendon injuries (28.4%; 145/510 horses) had no earnings in their career. This was greater than the remainder of the retired population, where 18.5% (596/3217) had no career earnings.

Race history and career starts in Hong Kong

Horses that retired from tendon injuries had fewer race starts than the remaining retired population. The median number of starts was 10 (range 0–68 starts) and 17 (range 0–107 starts), respectively. In both populations the percentage of horses that had not raced before importation was similar, being 65.7%; (335/ 510) in horses that retired from tendon injuries and 67.9% (2185/3217) in the remaining retired population (Table 2). Overall 245 retired horses (6.6%) never raced in HK. The percentage of horses retiring with tendon injuries that did not race in HK (13.3%; 68/510) were over twice that recorded in the population that retired for other reasons (5.5%; 177/3217).

TABLE 3: Distribution of affected leg(s) in the 510 horses that retired due to tendon injury

Affected leg	Number of horses (column %)			
	All horses	Geldings	Entire males	Females
Left-fore	164 (32.2)	148 (31.4)	14 (38.8)	2 (66.7)
Right-fore	287 (56.3)	266 (56.5)	20 (55.6)	1 (33.3)
Both forelegs	44 (8.6)	42 (8.9)	2 (5.6)	0
Left hind	6 (1.1)	6 (1.3)	0	0
Right hind	9 (1.8)	9 (1.9)	0	0
TOTAL	510	471	36	3

Distribution of limbs affected

Over 97% of the tendon injury induced retirements were associated with the forelimbs. Right-fore SDF tendon injuries were more common than left-fore SDF tendon injuries and 8.6% (44/510) of horses had injured tendons in both forelimbs (Table 3). There were only 9 cases (1.8%) reported in the right hind tendon and 6 cases (1.1%) in the left hind tendon.

Ultrasound examination of the superficial digital flexor tendon

There was a 4-fold increase in the number of ultrasound examinations of tendons performed over the 12-year period of study, from 43 in the 1992 to 172 in 2004. A total of 824 horses underwent tendon ultrasonographic examination, of any limb prior to the date of retirement, of which 162 (19.7%) retired due to tendon injury. Thirty-two percent (162/510) of horses retiring from tendon injuries had an ultrasonographic examination of the SDF tendons, during their career in Hong Kong, of which 98% (158/162) underwent examination of the tendon recorded as injured at the date of retirement. Twenty-one percent (662/3217) of horses that retired for other reasons also had a history of ultrasonographic examination of SDF tendons.

Discussion

A number of studies have highlighted the importance of tendon injuries to Thoroughbred horses but few have provided population based data on the quantitative contribution of this injury to racehorse longevity and performance. The structure of racehorse management in Hong Kong offers the opportunity to do this and to identify important risk factors for tendon injury. Although the primary purpose of this study was to improve the health of the racehorse population in Hong Kong it could also be of relevance to the Thoroughbred population worldwide. Over a 12-year period tendon injury was the single most common veterinary related reason for retirement, with a median of 13.7% of all retirements being due to tendon injury.

The temporal trend was interesting as there was a relatively small variation in the annual percentage of retirements that were attributed to tendon injury, despite an increase of approximately 2-fold in the annual cumulative incidence of horses that retired from tendon injuries. This may be explained by an increase in the cumulative incidence of all retirements from 18.5% to 28.8% and by changes in HKJC's policies. From 1995 new criteria for the replacement of racehorses were introduced which made it easier to retire a horse for nonveterinary reasons. This might be expected to increase the total proportion of retirements and the number of these attributed to nonveterinary reasons. Intuitively, this should result in a decrease in the proportion of retirements attributed to tendon injury but this was not evident because of the independent increase in the cumulative incidence of 'tendon injury retirements'.

The data used for this study were taken from historical retirement records. Veterinary examination is compulsory at retirement and the reason for retirement must be listed. Previous analysis of these data indicated good compliance with less than 2.5% of retirements being unclassified (Lam *et al.* 2007). The annual cumulative incidence of tendon injury retirements ranged 2.3–4.3%. This is lower than the prevalence of SDF tendon injury reported from Japan in 1999 of 11% (Kasashima *et al.* 2004). There may be differences in training regimens, training surfaces and

population demographics that contribute to differences between racing populations. However, our data suggest the most likely explanation is the difference in case definition: In this study only those tendon injuries that resulted in retirement are included, whereas the Japan study focussed on the first incidence of ultrasound diagnosed tendon injuries occurring during training and racing (Kasashima *et al.* 2004). The overall frequency of ultrasonographic examination for suspected tendon injury in our retiring population was 22% (824/3727), but only 19.7% (162/824) of these retired because of SDF injury. This suggests that the majority of horses with acute tendon injuries may recover and continue an active athletic life eventually retiring for other reasons.

The age distribution of horses retired because of a tendon injury was different to that reported by Kasashima *et al.* (2004). In the current study, it was highest in the 3-year-old group and appeared to decrease with age. The higher prevalence rates of retirement from tendon injuries in the 3- and 4-year-old groups could reflect extrinsic risk factors, such as increasing exercise or racing intensity or intrinsic risk factors such as genetic susceptibility. It is also possible that horses age >5 years might have been better managed to have a longer racing career despite tendon injury at an early age. The reduced rate of retirement in 2-year-old horses is probably because they have not accumulated sufficient exercise related microdamage to result in tendon injury (Birch *et al.* 1999; Smith *et al.* 1999). It may, however, also be the case that the apparent reduction in the proportion of horses retiring due to tendon injury in both young and old horses is due to an increase in the number of retirements for other reasons. For example, fractures are particularly common in horses in their first year of training (Parkin *et al.* 2004) and retirement due to poor performance is likely to be more common in older horses, as well as young horses showing little racing potential early in their career.

The horse population at the HKJC consists predominantly of castrated males and this is reflected in the retirement data where 94% (3505/3727) were geldings. The proportion of retirement attributed to tendon injuries appeared to be slightly higher in the entire males (18%; 36/195) than in geldings (13.4%; 471/3505). The reason and significance of this is unclear. However, Kasashima *et al.* (2004) also demonstrated an increased likelihood of SDF tendon injury in entire males and Perkins *et al.* (2005) reported that male horses were more likely to sustain tendon injuries during training and racing. The effect of male sex hormones associated with the often difficult temperament of entire horses may increase the likelihood of tendon injury. Alternatively, differences in body composition, including greater forequarter size, have been reported in entire males of other species compared to geldings (Watson 1969; Wood *et al.* 1986). Similar differences in entire horses may increase the likelihood of SDF tendon injury.

Premature retirement is important to the HKJC. It affects the ability of race-goers to follow the form of individual horses, investment from the horse owners and the HKJC, and, more importantly, animal welfare. This study provides quantitative data on the effect of early retirement because of tendon injury compared with all other reasons for retirement; and demonstrates the economic and welfare impact of tendon injury retirements in the population of racehorses at the HKJC. Their racing career was reduced by a median time period of 1 year, the median period in training decreased by 25.6%; starts were reduced by 41.2% and earnings by 53.3%. There were also a significant proportion of horses that retired due to tendon injury (13.3%: 68/510) that had never raced in Hong Kong. This did not appear to reflect events

occurring prior to their importation into Hong Kong, as there was little difference in the tendon retirement rate for those horses imported as unraced, compared with those that had raced prior to importation. It is possible that this reflects events occurring during the preparation for racing while in Hong Kong. Perkins *et al.* (2005) also found that injuries to the SDF tendons were common in Thoroughbreds in preparations without a race start. The consistency of these findings suggests that the early phases of training are high-risk periods for development of SDF tendon injury. Modifications to early training regimens could, therefore, significantly reduce the number of horses retiring due to tendon injury.

SDF tendon injuries, which resulted in retirement, were more common in forelimbs than hindlimbs. This finding was consistent with other studies (Peloso *et al.* 1994; Cohen *et al.* 1997; Kasashima *et al.* 2004; Takahashi *et al.* 2004; Perkins *et al.* 2005). In the current study the risk of retirement from tendon injuries in the right-fore leg appeared to be 1.75 times higher than the left-fore leg. The predominant direction of racing and training in Hong Kong is clockwise. Tendon injuries in horses that raced and trained in the anticlockwise direction are more common in the left (47/63) compared with the right-fore leg (17/63) (Rooney and Genovese 1981). This suggests that tendons of the inside forelimb are at greater risk on oval tracks. The inside limb is most commonly used as the lead leg (the forelimb that reaches out the furthest and is the only limb in contact with the surface immediately before the suspension phase) on these tracks (Parkin *et al.* 2006). This increased risk may reflect more than simple loading, as ground reaction force is greater in the nonlead limb at the canter and has been predicted to be similar at higher speeds (McGuigan and Wilson 2003; Witte *et al.* 2004).

Clinical diagnosis of tendon injuries at the time of retirement was confirmed by a combination of clinical examination, ultrasonographic examination or *post mortem* examination. The low percentage of records of ultrasonographic examination in the retired group from SDF tendon injuries (32%; 162/510) reflects, in part, the development and increased use of this technique during the study period. It is also possible that some horses were not presented for ultrasonographic examination by their trainers. This may be partially attributed to the HKJC regulations, which require an official veterinary examination following diagnosis of injuries. Horses that have undergone an ultrasound examination for diagnosis of tendon injuries must pass an official veterinary examination before and after a gallop, before they are allowed to enter to race. A list of such horses is published and horse owners are notified. It is also possible that trainers use their own expertise to rehabilitate mild tendon injuries and see no great advantage in ultrasonography. If this is the case, there may be some value in collecting and formalising these skills and the knowledge behind them. These horses were probably treated conservatively and kept in training until retirement. It is unlikely that the majority of tendon injuries were due to single overstrain events that would not have been presented for ultrasound examination prior to the injury that resulted in retirement (Dowling and Dart 2005). From the results of this part of the study, a new policy has been introduced to encourage the presentation of suspected mild tendon injury cases for diagnostic ultrasonographic examination at an early stage.

In conclusion, this study has demonstrated that the annual percentage of horses retiring from racing at the HKJC increased from 18.5% (193/1045) in 1992-93 to 28.8% (412/1432) in 2003-

04. The most important single reason recorded for retirement was tendon injury and the percentage of horses retiring due to tendon injury has risen from 2.3% (24/1045) to 4.2% (60/1432), over the same period. The overall aim of epidemiological research being conducted at the HKJC is to reduce the number of horses that are replaced each season. This will have major economic benefits for the racing industry in Hong Kong and further case control studies will identify risk factors for the major reasons for retirement, thus also improving equine welfare.

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