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Prognosis Following of Carpal Arthroscopy in Thoroughbred Racehorses

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Abstract

The published evidence related to the success of carpal arthroscopy is of lower levels, and sometimes conflicting. To determine the prognosis and investigate which surgical variables significantly affect clinical outcomes and race day performance., a retrospective cohort study was carried out on 251 carpal arthroscopies at the Singapore Turf Club between October 2008 and May 2011, a unique environment with detailed accurate unbiased records and without loss of cases to follow up. Exposure variables studied were limb, joint, intra articular medication, degree of pre-existing osteoarthritis, size of fragment, and grade of cartilage damage. Outcome variables measured were race day performance and clinical outcome. Veterinary histories were obtained from management software, the pre-surgery x-rays read from stored images by a single blind observer, and the race records obtained from the club website. Horses race performance post-surgery was as per previous studies (77% return to race), but complications such as ongoing lameness (60%) severe osteoarthritis (27%), and repeat of the bone chips requiring a 2nd surgery (20%) were more common. Radiocarpal lesions had a much better prognosis than intercarpal lesions ($p<0.01$). Grades 1 and 2 cartilage lesions also had a better prognosis than 3 and 4 lesions. Radiological findings of the size of fragment and degree of pre-existing arthritis were not related to outcomes. Horses undergoing a repeat surgery had a slightly reduced but overall acceptable prognosis. Post-surgical administration of intra articular cortisone appears to be contra-indicated, and more attention should be given to post surgery rehabilitation.

INTRODUCTION

Carpal arthroscopy is a common surgical procedure in the Thoroughbred (TB) racehorse with an annual incidence of 1.5% [1]. Arthroscopic removal of osteochondral chip fractures has been described as the treatment of choice, with good success rates and returning horses to work earlier [2,3]. It is difficult for a veterinarian to give an accurate prognosis for carpal arthroscopy to remove chip fractures for a number of reasons. First, most studies are type 3 or 4 quality based on an evidence based medicine classification system of veterinary orthopaedic research [4], being retrospective and often lacking controls [2]. Second, the prognosis for return to race varies significantly (63% to 89%) depending on the study [3,5-8]. Third, there are variables that can significantly affect prognosis that need consideration, although studies of these variables are often conflicting. Most studies measure success in terms of return to racing, and racing performance [3,5-9]. McIlwraith [10], described other outcomes such as post-surgical lameness, development of arthritis, formation of a second osteochondral fragment requiring a repeat surgery, and retirement from racing due to persistent carpal pain that for welfare reasons and owner satisfaction that also should be considered when describing the prognosis. McIlwraith [10], classified the grade of articular lesion in racing TB and Quarter Horses from 1-4, and found that the return rates to equal or better performance was 71 %, 75%, 53% and 54% for the four grades, respectively. In contrast, a study of the intercarpal joints in Standardbreds did not find any association between severity of cartilage lesions and post-surgical outcomes [5]. A more recent study found a poorer prognosis with grade 4 lesions only [11]. McIlwraith [10], found no difference in return to race records in TB when comparing radiocarpal joints (65%) with intercarpal joints (66%), a finding confirmed in later publications on Japanese thoroughbreds [1] and in the USA [11]. However, when including other breeds in the data, McIlwraith [3], found the proximal locations (distal radius, proximal intermediate carpal and radial carpal bones) had better prognosis than distal radial carpal and proximal 3rd carpal bones. Further conflicting evidence is found with two studies on intercarpal joints giving a better prognosis with 3rd carpal bone lesions compared to distal radio carpal bone lesions [5,6]. The study of English TB had an 88% return to race figures for proximal third carpal bone lesions compared to 79% for distal radial carpal bone lesions [6]. Case selection is important and such factors as repeated joint injection, racing record, previous carpal surgery, and degenerative change on radiographs, all have important implications for prognosis and should be considered before the decision is made [12]. It has also been stated that removal of larger fragments has a worse prognosis than a removal of smaller fragments in a similar location, although this was anecdotal evidence and not proven experimentally [6]. At present, the evidence on how the size and position of the chip fragment, and the degree of concurrent

pathological change in the joint, affects the prognosis is not at a high level [2]. The evidence for use of post-operative intra articular sodium hyaluronate and polysulphated glycosaminoglycan, and intramuscular polysulphated glycosaminoglycan is confusing, with variable results provided and without clear criteria on what to base treatment choices [3,7,8]. Kannegieter et al. [13], found post-surgery intra articular medication of cortisone plus hyaluronic acid superior to cortisone without hyaluronic acid or no medication. A controlled study [14], with an induced arthroscopic chip model found improvements with lameness scores and cartilage lesions with post-surgical intra articular medication with triamcinolone (cortisone), leading this to be a popular post-surgical treatment by veterinarians. A perceived advantage to arthroscopy over arthrotomy was a shorter convalescence time and an earlier return to work [3,8]. The recommendations for rest vary greatly, from as little as 2 weeks up to as long as 7 months [3,5-9]. A recent study found an improved prognosis with longer rest times [13], with the odds of racing were 22% higher for every month of spell after surgery, with 9-11 months' time from surgery to first start being optimum. Recent developments in the understanding of repetitive stress syndrome and sub chondral bone disease being significant in the pathogenesis of osetochondral fragment formation in the carpus [15], are altering veterinarian advice in terms of postoperative rest and rehabilitation. The aim of this retrospective cohort study is to determine the prognosis of carpal arthroscopy in terms of clinical outcome and race performance, while also assessing the effect of exposure variables on these outcomes. The results should provide the information to make more accurate prognosis predictions once a carpal osteochondral fragment is diagnosed, allowing the owner/trainer to make an informed decision regarding the choice for arthroscopic surgery as a treatment. The results should also give some indication regarding post-operative management to maximize the outcome.

MATERIALS AND METHODS

This was a retrospective cohort study of flat racing thoroughbreds at the Singapore Turf Club (STC). Records of all carpal arthroscopies between Oct 2008 and May 2013 at the STC were examined from the Veterinary management software (Rx works). Exposure variables studied were surgeon, limb, joint (radiocarpal or intercarpal), intra articular medication (cortisone plus hyaluronic acid) history in 3 months preceding and 6 months following surgery, history of previous surgery, degree of pre-existing osteoarthritis, size of fragment, and grade of cartilage damage. Outcome variables measured were race day performance, and clinical outcome of the horse post-surgery. Race performance data was obtained from the STC racing website. History of previous surgery, limb, joint, surgeon, and intra articular medication pre and post-surgery were obtained from the software records. All cases of intra articular medication involved both cortisone and hyaluronic acid so no differentiation was made. Grade of cartilage damage was recorded by the three individual surgeons at the time of surgery and recorded in the program. The grading system was based on that previously published [10]. Radiographs taken preceding the surgery were reviewed from a stored PACS system (Impax) at the STC by a single reader blinded to the case details who was experienced in equine Thoroughbred race practice and radiology. The degree of pre-existing arthritis was graded 1-4 based on a human grading system for osteoarthritis in knees [16]. The size of the most prominent osteochondral fragment was also graded 1-4 on a subjective judgment system from "small" to "large", and its location recorded. The clinical outcome was divided into three categories 1) Retired due to reason other than carpal arthritis in operated joint; 2) Retired due to pathology in operated joint; and 3) underwent a 2nd surgery in the joint. The clinical outcome group was determined from veterinary records on management software. These outcomes variables were chosen as trainers and owners strongly perceive outcomes 2 and 3 to be 'failures', but accept outcome 1 as 'success'. Each individual surgery was counted as a separate case, hence some horses appeared twice and one horse three times in the study. Cases were excluded from the study if the primary indication for surgery was sepsis. Data was collated on an excel spreadsheet and transferred to Minitab 17 for statistical analysis. Statistical analysis was performed using the chi squared test for categorical date. An Anderson-Darling test for normality revealed a non-normal distribution so a Kruskal-Wallis test was used for quantitative data.

RESULTS

Review of the STC records revealed 251 carpal arthroscopies performed on 207 horses between October 2008 and May 2011. This would equate to an annual incidence of 5% based on population and turnover of horses at the STC. The horses were all Thoroughbred racehorses aged from 2-7 years of age, mostly (95%) castrated males. The limb distribution of chip fractures was 39% right limb, 35% left limb and 25% bilateral. The joint distribution was 42 % single IC joint, 25% single RC joint, and 33% both joints. The fragment location distribution was distal radius 24%, proximal radio carpal bone 6%, proximal intermediate carpal bone 5%, distal radio carpal bone 38%, distal intermediate carpal bone 3%, and proximal 3rd carpal bone 23%. The pre-surgical radiological variables were as follows; Size of osteochondral fragment distribution was grade one 23%, grade two 28%, grade three 36% and grade four 13%. Grade of pre-existing radiological osteoarthritis distribution was grade zero 19%, grade one 34%, grade two 18%, grade three 21% and grade four 9%. Cartilage lesions noted in surgery were grade one 20%, grade two 36%, grade three 36% and grade four 8%. All intra articular medications were a combination of both cortisone and hyaluronic acid and the percentage of horses receiving medications are shown in [Table 1].

Table 1: IA medications post-surgery and clinical outcome.

IAs in the 6 months post sx	No medication	One medication	Two medications	Three or more medications
Retired for any other reason	62%	46%	50%	30%
Retired with OA in joint or 2nd surgery	38%	54%	50%	70%

Sx surgery; OA osteoarthritis; IA intra-articular injection.

Race record post-surgery

Seventy seven percent of the cases returned to race at least one race following surgery. Forty four percent of the horses returned to run at least one placing, and twenty eight percent returned to win at least one race. The horses ran on average 7.2 races each post-surgery (median 4 races, standard deviation 8.9, range of 0 to 68).

Clinical outcome following surgery

Of the original study cohort, 53% of the horses retired for a reason other than osteoarthritis in the affected carpal joint(s), Twenty seven percent of the horses were retired directly due to osteoarthritis in the carpal joint(s) post-surgery and twenty percent of the horses underwent a repeat surgery on the carpal joint. The most common complication that was recorded post-surgery was ongoing lameness attributable to the carpal joint (60%), normally when the horses returned to work and racing. Other complications were bandage reactions (6%), joint sepsis (1.6%), hygroma (0.7%) and no recorded complications (28%).

Table 2: Surgical variables and race performance. Performance displayed as percentage of horses returning to race, and number of races (median) for each variable. (Significant in bold)

Variable		% return to race	P value (chi squared)	Median number races post surgery	P value (Kruskal Wallis)
Leg:	Left	75		4	
	Right	78	-	5	-
	Bilateral	80		4	
Joint:	IC	69	P<0.001	3	P<0.001
	RC	94		7	
Site:	Distal Radial	90		7	
	Proximal IC	85		4.5	
	Proximal RC	86	P=0.025	6	P=0.012
	Distal IC	57		3	
	Distal RC	76		4	
	Proximal 3rd	64		2	
Degree of OA	0	82		4	
	1	77		6	
	2	80		4	
	3	71		3	
	4	81		6	
Size of fragment	1	73		4	
	2	78		5	
	3	81		5	
	4	72		3	
Cartilage damage	1	84		4	
	2	87	P=0.02	7	P<0.001
	3	65		2	
	4	68		2	
Pre-surgery IAs	0	82		5	
	1	71		4	
	2	81		4	
	3+	60		2	
Post-surgery IAs	0	73		4	
	1	77		4	
	2	70		4	
	3+	88		5	
Previous surgery	no	81	P=0.001	4	P=0.015
	yes	60		3	

IC intermediate carpal; RC radial carpal; Proximal 3rd proximal third carpal bone; OA: Osteoarthritis; IAs: Intra-articular injection

Surgical variables and race performance

The results of the variables as the outcome of race performance are displayed in Table 2. The null hypothesis was able to be rejected with the following variables indicating that there is a significant effect on prognosis when consideration is given to post-surgical race performance; joint (intercarpal or radiocarpal), location of fragment, grade of cartilage damage and a history of previous surgery. Other variables that had p values indicating the null hypothesis could not be rejected (unable to prove a significant effect on race performance prognosis) were limb (left or right), degree of pre-existing osteoarthritis, size of osteochondral fragment.

Surgical variables and clinical outcome

These results are displayed in Table 3. The surgical variables that appeared significant were location of chip fragment and post-surgical intra articular medication. The variables that had no significant effect demonstrated on clinical outcomes were limb (left or right), joint (radiocarpal or intercarpal), degree of pre-existing osteoarthritis, size of fragment, degree of cartilage damage, pre-surgery medications and history of previous surgery.

Table 3: Surgical variables and clinical outcome (Significant in bold)

Variable		% retired for other reason	% retired with OA in joint or 2nd surgery	P value chi squared
Leg	Left	44	56	
	Right	60	40	
	bilateral	50	50	
Joint	IC	52	58	
	RC	56	54	
Site	Distal. Rad	58	42	
	Proximal IC	50	50	
	Proximal RC	46	54	P<0.001
	Distal IC	43	57	
	Distal RC	53	47	
	Proximal 3rd	45	55	
Degree of OA	0	55	45	
	1	51	49	
	2	50	50	
	3	47	53	
	4	68	32	
Size of fragment	1	55	45	
	2	55	45	
	3	50	50	
	4	47	53	
Cartilage damage	1	58	42	
	2	50	50	
	3	53	47	
	4	42	58	
Pre-surgery IAs	0	57	43	
	1	50	50	
	2	41	59	
	3+	41	59	
Post-surgery IAs	0	62	38	
	1	46	54	P<0.001
	2	50	50	
	3+	30	70	
Previous surgery	no	50	50	
	yes	56	44	

IC intermediate carpal; RC radial carpal; Proximal 3rd proximal third carpal bone; OA: Osteoarthritis; IAs: Intra-articular injection

DISCUSSION

Singapore Turf Club is a unique environment with factors to be kept in mind when interpreting data being on the equator, there are no seasons and horses race all year round. There are no paddocks and limited space, so owners are under pressure financially to minimize time out of competition and keep horses racing. There is also a combined official single regulatory and clinical veterinary department, closely examining all horses on a regular basis. Veterinary fees are heavily subsidized so regular and frequent diagnostic tests such as radiography are readily carried out, and all records kept on a central system. These factors mean little or no loss to follow up, and accurate records both in terms of performance and medically are readily available [17]. The annual incidence of 5% carpal surgical arthroscopies of the STC population is higher than the 1.5% previously reported [1]. This could be due to the unique factors of the STC environment (see above). With repetitive stress syndrome and chronic sub chondral bone inflammation being important in the pathogenesis of carpal chip fractures, lack of spelling time or environment could account for the higher incidence at the STC. The unique veterinary system would also lead to a much lower chance of carpal chip going undiagnosed at the STC. The most common lesion in the Japanese study was osteochondral fragmentation off the distal radius, whereas in the Singapore population the distribution of lesions was in alignment with other studies [8,14] that found most lesions off the distal radio carpal bone followed by proximal 3rd and distal radius in equal numbers.

Return to racing and performance

The overall return to racing of 77% equates with the range reported in the literature of 60-88.6 %, depending on breed and location of chip fragment [3,5-9]. A recent study [11] quoted a much higher return to win figure of 66 % compared to the STC figure of 28%. However, this was a different jurisdiction and study design, with the STC study for example having no loss to follow up. Recent studies [17], at STC put the return to win figures of control (normal) horses at 45% [Table 4]. In this study there was a high correlation between return to race and return to win figures, confirming the return to race statistic is a valuable yardstick that is commonly used to measure prognosis [18]. The results are "skewed" with a non-normal distribution, with many horses racing a few times and a few horses racing many times, a finding that repeats other work studying post carpal arthroscopy racing performance [8,13].

Clinical Outcomes

This study reported that 60 %, of the horses continued to suffer from some degree of ongoing lameness, normally at the resumption of training and racing, and this is higher than the 11% that was previously reported [10]. The current study also found that 47% of the horses either retired due to pathology in the carpal joint or went to a second surgery in that joint. And this was also much higher than the 9 % reported in the McIlrwaith study. The current study was unique in that phone follow up as a method of gathering data was not used, and there was no loss to follow up, which may account for some difference. However, these results reinforce that removal of the chip is not a permanent cure, and that the subchondral bone pathology and bone remodelling associated with the original fragment formation may cause articular pain to re occur when the horses are returned to work post-surgery [15].

Table 4: Race day performance following arthroscopy STC

	Return to Race	Return to Win	Mean Starts
All Carpal Arthroscopy	77%	28%	4
RC joint only	94%	41%	7
IC joint only	69%	26%	3
Control*	95%	45%	10

*control group performance from STC 2019 study on epiglottic entrapment
IC intercarpal; RC radiocarpal;

EXPOSURE VARIABLES

Joint and location of lesion

This study found a better racing performance post-surgery with radiocarpal joints pathology (94% return to race) compared to intercarpal joints pathology (69% return to race). These findings are in agreement [3] with some studies and contrast [1,10,11], with others. The location of the fragment was also significantly associated with prognosis for return to racing and clinical outcome, with the more dorsal fragments having more favourable race performance and clinical outcomes. These findings are in agreement [3] and [1] contrast with previously published work. At the STC chip fractures of distal radius have the best prognosis, followed by proximal intermediate and radio carpal bones. Horses with fragments off the distal radio carpal bone had a reduced prognosis, followed by the proximal 3rd carpal bone lesions. Distal intermediate carpal bone fragments were few in number but had the worst prognosis for both race performance and clinical outcomes.

Cartilage lesions

The better prognosis for grade 1 and 2 cartilage lesions versus 3 and 4 is in agreement with one previous study [10], and adds evidence that this surgical information can give valuable prognostic information hence giving another supporting reason to perform the carpal arthroscopy. Another study found no difference with grades of damage, however, this was in a different breed and studied carpal chip fractures in one location only off the 3rd carpal bone, so is not necessarily comparable with the current data [5].

Size of osteochondral fragment and pre-existing osteoarthritis

The size of osteochondral fragment and pre-existing osteoarthritis are thought to be important in terms of case selection for arthroscopy although this appears to be based on expert opinion and experience rather than any higher degree of evidence. A study based on the feasibility of screw repair of carpal chip fractures claimed that removal of large chip fractures from carpal bones have been associated with a worse prognosis

than removal of small fragments in a similar location [6]. It would appear that this was based on the earlier study of the prognosis for cartilage repair [10], and made the assumption that the size of cartilage defects was always associated with the size of the fragment. This current study found no significant difference in the prognosis of performance or clinical outcomes based on the size of fragment which was surprising based on previous literature. In this population there were often marked differences between the size of fragment on the pre-surgical radiograph and the grade of cartilage damage at surgery. Similarly, no significant association was recorded between the degree of pre-existing radiological osteoarthritis with racing and clinical outcome. While it is very tempting for the veterinarian in practice to study carpal radiographs and give an opinion on prognosis following surgery based on osteochondral size and degree of pre-existing arthritis [11], this study provides evidence that these factors may not have been important as previously thought.

Intra articular medication pre and post-surgery

This study would suggest overall pre surgery medication did not have a significant effect on racing prognosis, however, there was a significant worsening of clinical outcomes associated with intra articular medication post-surgery, which was more marked with increasing number of medications in the 6 months following surgery [Table 1]. This was in contrast with an Australian study [13], which found an increase in earnings with post-surgery intra articular medications. As another previous study [14], had found favourable effects with post-surgery intra articular triamcinolone, the current finding will come as a major surprise to veterinarians and trainers. With cohort studies assumption of a causal relationship is not advised, and the apparent detrimental effects of post-surgery intra articular cortisone could be explained that the horses requiring more intra articular medication post-surgery were the horses returning to work earlier post-surgery, and having a worse outcome because of a lack of rest to resolve subchondral bone damage [13-15]. There is a wide range of rest periods quoted in the literature, and while an early return to work has always been touted as an advantage of arthroscopic surgery [3,8]. The findings in this study add credence to another study that found a benefit of a longer period of rest of up to 9 months before a return to racing [13]. A recent carpal arthroscopy study in the USA found an average time from surgery to first race of 9 months [11] while in STC at the time of the study most trainers would be returning to work after 6 weeks, expecting to race 4-5 months post-surgery. The unique environment at the STC may lead to more remodelling bone stress, and the masking of pain with intra articular medication is associated with a higher injury rate [19]. Rather than masking pain, trainers may be better advised to monitor post-surgical lameness more closely and investigate strategies such as longer post-surgical spells and altered low impact training regimes for a better clinical outcome, especially in radio carpal joint cases.

Previous surgery

A history of a previous surgery in the same joint had a mixed effect on race performance. Horses having undergoing a 2nd surgery had a 60 % chance of return to racing, compared with 81% for a horse undergoing its first surgery. However, it is worth noting that that the return to win figures of horses having 2nd surgeries was similar to horses having first surgeries. This possibly reflects that owners of horses of superior ability may be more willing to approve the financial costs of repeat surgery. There was no effect on clinical outcome comparing horses undergoing repeat surgery with horses undergoing their first. While previous reports give a poor prognosis for repeat surgeries [12], the current study suggests these should not be ruled out.

CONCLUSIONS

Arthroscopy does not represent a permanent cure for carpal joint pathology and related lameness. Horses can race successfully after surgery, however, and important prognostic factors include location of chip and degree of cartilage damage. In contrast to previous publications size of chip fragment and degree of pre-surgical radiological osteoarthritis did not appear to be important prognostic indicators in this racing population and country. There is significant detrimental post-surgery medication effect on outcome that appears to be related probably to post-surgical rest and rehabilitation protocols, and this is a field that needs more research. While repeat surgeries have decreased return to race performance, they have similar return to win performance and clinical outcomes to first surgeries and should not be ruled out. Based on these findings, veterinarians may consider improving prognosis by avoidance of post-surgical intra articular pain masking medications for 6 months following surgery, and delaying return to racing up to 9 months post-surgery. These strategies should be considered with especially in cases involving the radio carpal joint, grade 3 or 4 cartilage lesions noted in surgery and with repeat surgeries [Figure 1], due to the significance of the location of the chip, and the non-

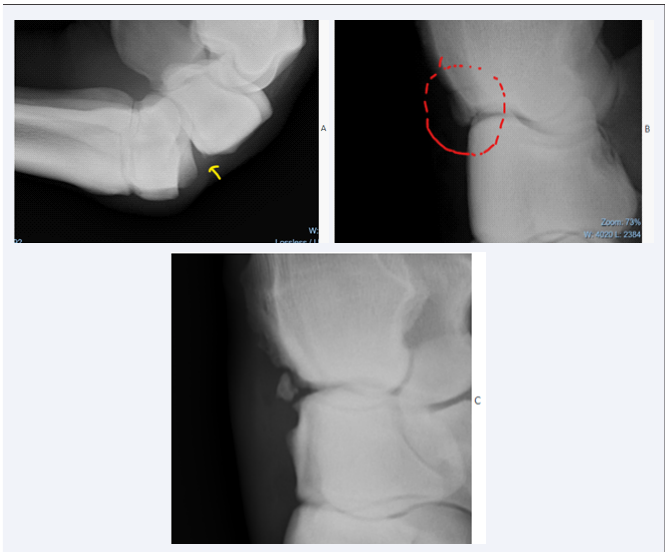

Figure 1 Due to the significance of the location of the chip, and the non-significance of both size of fragment and degree of radiological osteoarthritis, it would surprise many that there would be no difference in prognosis for Horse A and Horse B, but Horse C would have significantly worse prognosis than both A and B, based on these findings.

significance of both size of fragment and degree of radiological osteoarthritis, it would surprise many that Horse A would have a much worse prognosis than horse B, but no difference between B and C, based on these findings.

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AUTHORSHIP

Study design and data collection by D.S. All authors contributed to study execution, data analysis and manuscript preparation.

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