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ORIGINAL ARTICLE

Epidemiology of tennis injuries: An eight-year review of Davis Cup retirements

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Abstract

Tennis practice, especially at elite levels, may place players at risk for debilitating musculoskeletal injuries. The aim of this study was to analyse the epidemiological pattern of retirements due to medical conditions sustained by tennis players during Davis Cup matches in the 2006–2013 period. All uncompleted matches due to a medical condition (injuries and illnesses) occurred in the above-mentioned competition were collected from the official source, registered and analysed according to published guidelines. The overall incidence of match retirements was 1.66% (12/719). The injury rate was 6.05/1000 playing hours; and 6.64/1000 match exposures. Musculotendinous lesions were the most common type of injury (66.66%). The incidence of lower-limb injuries was higher than upper-limb and trunk lesions. The incidence of retired matches due to medical conditions was higher in hard courts than in clay courts (2.97% and 0.90%, respectively; $p = 0.04$), while the median value of inactivity of injuries was 32.0 days (range 3–297). In conclusion, the incidence of retirements due to medical conditions in Davis Cup matches was low supporting the assumption that elite tennis is a low-risk sport activity. Findings provided scientific evidences of injury patterns among male professional tennis players and may contribute to conduct better injury prevention strategies.

Keywords: *Competition, injury and prevention, quantitative study*

Introduction

Tennis practice, especially at elite levels, may place players at risk for debilitating musculoskeletal injuries (Abrams, Renström, & Safran, 2012). An appropriate injury surveillance system is considered as the cornerstone of effective injury management. Several articles have studied the incidence and prevalence of medical conditions in tennis, but most authors have agreed on that there are surprisingly few studies on professional tennis players (Abrams et al., 2012; Sell, Hainline, Yorio, & Kovacs, 2012).

The Davis Cup is the premier international team event in men's tennis. It is run by the International Tennis Federation (ITF) and is contested annually between 16 teams from competing countries in a knock-out format. The competition began in 1900 as a challenge between Great Britain and the USA, and, by 2013, 130 national teams entered into the tournament. The format of each Davis Cup tie

consists of five matches to the best of five sets, which are played in three days: on the first day, the first two rubbers are singles; on the second day, the doubles rubber is played; while on the final day, two reverse singles matches are disputed. Players usually consider Davis Cup as a highly demanding competition, both physically and mentally (Maquirriain & Segal, 2005); however, injury rates and trends at the Davis Cup over multiple years are unknown.

The Davis Cup celebrated its 100th final in 2012, which also marked the start of the ITF's Centenary Year; however, to the best of our knowledge, an injury surveillance study of this high-level professional competition has never been officially conducted.

The aim of this study was to analyse the epidemiological pattern of retirements due to medical conditions sustained by tennis players during Davis Cup matches in the 2006–2013 period.

Materials and methods

All procedures used in the study met the international ethical standards and were formally approved by the ethical committee of the Nixus Research Foundation (ethics approval # E04-2013).

A series of Davis Cup between two countries comprises five matches: four singles matches and one doubles match. All retirements due to injury or illness sustained by tennis players during Davis Cup World Group matches in the 2006–2013 period were collected from the official webpage (Davis Cup webpage, 2013), registered and analysed according to recently published guidelines (Pluim et al., 2009). Analytical data including match duration from previous Davis Cup matches were not available. Subjects were de-identified for analysis.

Retirement matches in professional tennis are closely related to injuries (Breznik & Batagelj, 2012). According to the official rules, a tennis match is recorded as “retired” when a losing player retired due to illness or injury after a match began (International Tennis Federation webpage, 2013). Moreover, according to Davis Cup rules, an independent doctor is always present during matches. He has to verify all medical conditions sustained by players and sign an official form in case of retirements. Several previous scientific epidemiological studies have used “retired matches” as injury definition as they represent an indication of a serious injury (Breznik & Batagelj, 2012; Cross, 2006). The impact of an illness on the competitive athlete’s health can be just as significant as that of an injury (Engebretsen et al., 2013). Therefore, the term “medical condition” was adopted in this study rather than injury, in order to reflect the desire to collect information on both injuries and illnesses (Pluim et al., 2009).

The rate of medical conditions was reported as retirements per 1000 playing hours and also as match withdrawals per 1000 match exposures (MEs). “ME” is defined as play (including on-court warm-up) between competitive players (Pluim et al., 2009). Two MEs were computed for each singles match (two players per match), and four exposures for each doubles match (four players per match).

Medical conditions were analysed using terminology derived from a consensus statement developed specifically for tennis (Pluim et al., 2009). The location of medical conditions (injuries and illnesses) which lead to match retirement was categorized within one of the four general body regions: head/neck, upper limbs, trunk and lower limbs. The type of injury was classified as: bone, joint (non-bone) and ligament, muscle and tendon, skin, central/peripheral nervous system or other. Illnesses were classified according to the affected system (gastrointestinal, respiratory, cardiovascular,

renal/urogenital/gynaecological, metabolic/endocrinological, haematological, dermatological, neurological, psychiatric, ophthalmic/otorhinolaryngological, dental, rheumatological, allergic, infectious, environmental and others).

Injury severity was defined as the number of days that have elapsed from the date of retirement from the Davis Cup match to the date of the player’s return to full participation in a professional tournament and data were obtained through the Association of Tennis Professionals webpage (Association of Tennis Professionals webpage, 2013; Cross, 2006). The severity of injuries was reported as both the mean and median number of days lost. According to the time lost, they were grouped in: slight (0 days), minimal (1–3 days), mild (4–7 days), moderate (8–28 days), severe (29 days–6 months) and long term (>6 months).

Data were analysed using descriptive statistics and non-parametric cross-tabulation procedures (chi-square) using a statistical package (*Statistica for Windows, StatsoftTM, Tulsa, Oklahoma, USA*). *P*-value <0.05 was considered significant.

Results

During eight editions of Davis Cup (2006–2013), 906 matches were played and 24 retirements due to medical conditions were recorded. However, we found a significant difference between the incidence of retirements on “effective matches” versus the incidence of “residual” matches (defined as those games after the result of the series was already set). The incidence of retirements in “effective” matches was 1.66% (12/719), while the rate in “residual” matches was 6.41% (12/187; *p* = 0.0003, chi-square test). The reason may be the lack of motivation of players to compete after the completion of the tie, which usually leads them to simulate an injury and retire from the match. Therefore, for the purpose of this study, only retirements during “effective” matches were considered for statistical analysis, comprising a total sample of 719 Davis Cup matches (535 singles and 184 doubles matches).

The results showed an incidence of one retirement by 59.91 matches (719/12); one injury by 15.33 series (184/12) or 6.52% in each individual series. Furthermore, there was a 1.50% chance of retirement due to a medical condition per year in Davis Cup competition.

The mean duration of matches was 165.51 ± 52.37 min (*n* = 699; range 33–421; CI 95%: 161.62–169.40). Therefore, the injury rate was 6.05/1000 hours of playing, while the mean playing time until retirement due to injury was 113.33 ± 68.88 minutes (*n* = 12; range 33–246; CI 95%: 69.56–157.10).

ME accounted of 1806. The overall incidence of match retirements was 6.64/1000 MEs (9.34/1000 singles MEs and 2.71/1000 doubles MEs).

Seventy-five per cent of medical conditions occurred in matches played on hard courts (9/12) and 25% of total retirements occurred on clay courts matches (3/12). No injuries were reported in grass or carpet courts. Relative incidence showed that medical conditions were significantly higher in hard courts 2.97% (9/303 matches) than in clay 0.90% (3/331; $p = 0.04$, chi-square test). No medical conditions were reported in grass (0/17) and carpet surfaces (0/68).

The incidence of retirements due to medical conditions in outdoor courts and indoor courts was 1.99% (5/251) and 1.49% (7/468), respectively ($p = 0.62$, chi-square test).

The type of medical condition was: muscle and tendon 66.66% (8/12); joint (non-bone and ligament) 16.66% (2/12); illnesses 16.66% (2/12); skin 0%; bone 0%; nervous system (0%). The location distribution was: head and neck 0%; upper limbs 25% (3/12); trunk 16.66% (2/12); lower limbs 41.66% (5/12); and other (illnesses) 16.66% (2/12).

The inactivity time of medical conditions averaged 73.41 ± 92.48 days (range 3–297; median 32.00; CI 95%: 14.65/132.17). Fifty per cent of medical conditions were severe, 25% were moderate,

8.33% were minimal and 16.66% were long term. One of the latter group was an ACL-MCL knee injury which needed surgical treatment, and the player returned to competition approximately at 10 months.

No differences were found in the incidence of medical retirements of visitor players (58.33%; 7/12) and local players (41.66%; 5/12; $p = 0.41$).

No differences were found in the incidence of medical withdrawals during the first part of the season (first round and quarter-finals; 5.20%; 5/96 series) and the second part of the year (semi-finals, final and play-off matches; 7.95%; 7/88 series; $p = 0.45$). The potential cumulative fatigue and overuse during annual tennis competition does not seem to influence the injury rate in Davis Cup matches.

Retirements occurred mostly during the second set (41.66%) and the third set (33.33%). Only two retirements occurred in the fifth set (16.66%); one in the first (8.33%), and none retirements were reported in the fourth set (0%).

When a medical retirement occurred, the team lost the series in 83.33% of cases and won in 16.66%.

The incidence of match retirement was higher in second-day singles matches (2.39%; 4/167) than in the first-day singles matches (1.63%; 6/368);

Table I. Descriptive results of retired matches in Davis Cup (2006–2013)

	Year	Match	Previous match	Round	Home	Court	Set	Team	Diagnosis	Match time (min)	Injury inactivity (days)
1	2013	S1	No	R1	V	Clay outdoor	5°	l	Thigh muscle strain	246	33
2	2012	S1	No	PO	V	Clay outdoor	3°	l	Shoulder tendinopathy	74	211
3	2011	S2	No	SF	L	Hard indoor	2°	l	Lumbar muscle strain	152	45
4	2011	S1	No	QF	L	Hard indoor	2°	l	Knee sprain ACL-MCL	44	297
5	2011	S1	No	PO	L	Hard outdoor	2°	l	Wrist tendinopathy	51	17
6	2011	S1	No	PO	L	Hard outdoor	3°	l	Thigh muscle strain	88	136
7	2011	S2	Yes (1)	PO	V	Hard outdoor	2°	l	Illness (gastrointestinal)	86	17
8	2009	D	No	PO	V	Hard indoor	3°	w	Groin muscle strain	79	23
9	2009	S1	No	PO	L	Hard indoor	2°	w	Ankle sprain	124	31
10	2008	S2	Yes (1)	QF	V	Clay indoor	5°	l	Shoulder tendinopathy	219	30
11	2008	S2	No	R1	V	Hard indoor	3°	l	Illness (respiratory)	164	3
12	2006	D	Yes (1)	R1	V	Hard outdoor	1°	l	Rib muscle strain	33	38

S1, first-day singles match; S2, second-day singles match; D, doubles match; SF, semifinal; QF, quarter-final; R1, round one; PO, play-off; L, local team; V, visitor team; l, loser team; w, winner team.

Table II. Summary of statistics of medical conditions in Davis Cup matches

Incidence of retirements in effective matches = 1.66%

One retirement every 59.91 matches
One injury every 15.33 series
Mean duration of matches = 165 ± 51 min
Injury rate 6.05/1000 playing hours
Retirement incidence: 6.64/1000 MEs
Median value of inactivity time of injury = 32.0 days (range 3–297)
Significant higher incidence of retirements in hard courts matches

$p = 0.54$, chi-square test) and doubles matches (1.09%; 2/182; $p = 0.35$, chi-square test).

In 75% of cases (9/12), the player retired from his first match of the series; in 25% of cases (3/12), the player had previously played one match in the same series.

The incidence of retirements was 1.86% in singles matches (10/535) and in doubles matches 1.08% (2/184; $p = 0.47$; chi-square test).

Results are summarized in [Tables I and II](#).

Discussion

The main finding of the present epidemiological study was the low incidence (1.66%) of medical conditions leading to retirement during Davis Cup matches. The incidence of retired matches was slightly lower than data reported by Breznik and Batagelj (2012) and Cross (2006) who studied Grand Slam men matches (also played to the *best-of-five* sets) for a long period and found an incidence of uncompleted matches of 2.42% and 2.18%, respectively.

The previously reported incidence of tennis injuries ranged from 0.04 to 3 injuries/1000 player hours (Pluim, Staal, Windler, & Jayanthi, 2006) and the authors considered that the main reason for the differences was more likely to be due to the variation in injury definitions and protocols employed in the studies. Engebretsen et al. (2013) studied all injuries and illnesses during the London Olympic Games 2012. Tennis accounted of 5.9% of all sport injuries and was considered as a low-risk sport. Results of the present study represent strong evidence that tennis is a low-risk injury sport, even at elite level such as “best-of-five” Davis Cup matches. Moreover, the incidence of medical conditions in Davis Cup matches is not higher than in other similar male competitions like Grand Slams.

Injury due to tennis participation may occur in any location of the musculoskeletal system. In the present study, the lower extremity has shown higher incidence of lesions than the upper limb and trunk. Similar results have been reported in the literature

with an interval incidence of 31–67% for the lower extremity, 20–49% for the upper limb and 3–21% for the trunk (Abrams et al., 2012). Even the small number of injuries, the present study also showed the trend that the acute injuries commonly occur in the lower extremity while chronic injuries most often manifest themselves in the upper extremity and the trunk. Musculotendinous lesions were the more prevalent (66.66%) including thigh and groin muscle strains, and shoulder and wrist tendinopathies, among other soft tissue injuries. The more severe lesion sustained by a player during Davis Cup matches was a combined knee ligament rupture (ACL-MCL) due to a rotational valgus mechanism. This is considered an uncommon injury in tennis even at professional level playing on hard courts. Surprisingly, there were not retired matches due to muscular cramps or other heat-related conditions.

It is widely assumed that the court surface influences the match activity in elite tennis and several studies have examined the relationship between court surface and injury in tennis players. Mean duration of rallies and effective playing time is significantly longer on clay courts than in hard surfaces (Martin et al., 2011). The gritty nature of clay courts creates a high frictional coefficient with the ball and the lowest frictional resistance with the player (Dragoo & Braun, 2010). In general, a hard surface is believed to be the most high-risk surface for injury incidence (Breznik & Batagelj, 2012). A study examining injury rates in professional male tennis players for three years on different surfaces revealed that injury treatment during match play was required more often on hard court than on clay (Bastholt, 2000). Results of the analysis of retired matches in Davis Cup matches added additional scientific evidence to consider hard courts as the most dangerous surface for tennis players.

In conclusion, this article analysed and discussed the risk of injuries and illnesses among tennis players competing in Davis Cup matches. The main findings of the present epidemiological study were the low incidence of retired matches (1.66%), and the low rate of medical conditions leading to retirement during Davis Cup matches (6.05/1000 playing hours). Furthermore, results showed a higher incidence of medical conditions in matches played on hard surfaces than in other type of courts, representing strong evidence that playing tennis on hard court increases injury incidence in the male circuit. A better understanding of medical conditions and the identification of areas of susceptibility to injury should improve the medical care of athletes and could inform about future preventive strategies. Systematic surveillance of medical conditions constitutes the foundation for developing preventive measures in sports. Tennis stakeholders should

continue to protect the players to ensure that tennis is practised without danger for their health.

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