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Subscriptions and Membership:
Todd S. Ellenbecker
Physiotherapy Associates
Scottsdale Sports Clinic
Scottsdale, AZ 85258, USA
E-mail: membership@stms.nl

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E-mail: webmaster@stms.nl

Website:
http://www.stms.nl

Message from the President

The Society of Tennis Medicine and Science continues to serve its mission with worldwide support from a multifaceted approach. This month's journal continues the fine tradition of disseminating information to all interested parties about advances in tennis medicine and science. Javier Maquirriain continues his stewardship in the same tradition as his predecessor, Babette Pluim. Neeru Jayanthi continues to advance the newsletter for more helpful information of importance to our membership.

The 2009 annual meeting in Valencia, Spain, the 11th World Congress of the Society for Tennis Medicine and Science, held in conjunction with the 100th Anniversary Celebration of the Spanish Tennis Federation was a smashing success – to which Dr. Angel Ruiz-Cotorro has received many accolades. May 2010 saw another fantastic Tennis Medicine Meeting. Anchored by the annual ITF Sports Science committee meeting prior, and the Swedish Sports Medicine Society Meeting after, Per Renstrom held a Tennis Medicine meeting in Båstad, Sweden that was an absolutely first rate. With many of our members who are active in sports science, combined with invited speakers for the other meetings, made Professor Renstrom's meeting as the high level as there has ever been. With concurrent sessions for physicians and coaches, we could draw on our many strengths and disseminate and share information important to both groups.

Next year will see two STMS meetings. In the winter we will have the first STMS meeting in the US in quite a while. In the fall, Bernard Montalvan will host another meeting in France. Both meetings promise to have a very high level of science and knowledge combined with excellent professional tennis. Further, in 2012, Michael Turner has promised to host the STMS World Congress during Wimbledon. Thus, there are a lot of exciting opportunities forthcoming for our society.

I hope you stay tuned for the dates and information regarding our upcoming meetings. E-mails will be forthcoming shortly. I hope you will attend these meetings and consider bringing your family to these upcoming STMS meetings.

Sincerely,

Marc R. Safran, MD
President, STMS

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Contents

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Where are the Risks?

Welcome to the June edition of the JMST.

This issue includes an epidemiological study *("The evaluation of the injury risk and recovery in junior competitive tennis players")* by Dr. Neeru Jayanthi (Loyola University, Chicago IL, USA) which is part of a group of investigations performed by the United States Tennis Association. In the present study, the authors approached the relationship of injury risk to on- and off-court training volume and ranking position. In previous articles, this research group studied the injury risks within a tennis tournament; the cumulative risks throughout a year; and the risks related to practicing hours, annual rest periods and early sport specialization.[1]

Athlete's injuries risks have been a topic of concern since long time in Sports Medicine. Lesions can counter the beneficial effects of sports participation at a young age if a child or adolescent is unable to continue to participate because of residual effects of injury.[2] Dropping-out from youth sport due to injury is primarily related to physeal lesions, and ACL ruptures. Fortunately, both types of injuries are rarely observed in young tennis players.

Several authors have pointed out the relevance of a previous injury as a predisposing factor to suffer further lesions in the athletic population. Jayanthi et al founded a clear increase in injury and medical withdrawal risks with *"playing with prior injury"*. In other words, this concept means that after a sport injury, even if the player has reached a satisfactory clinical outcome, he/she will carry an *"epidemiological backpack"* which may predispose he/she to a new injury during his/her tennis career. Therefore, the health-team and coaches should encourage the implementation of proper training programs, injury prevention strategies and early treatment of injuries in tennis players.

Finally, the authors have collected data using a novel electronic instrument which may become a useful tool for future epidemiological studies.

We also celebrate the inclusion of a Review article on ´Eating Disorders´ by the WTA Tour Health Care Team. This comprehensive overview of anorexia, bulimia, and other problems also provides practical information on early detection, athletic consequences, and current approach to management.

The present issue also includes a brief description of a novel initiative from the World Anti-doping Agency, the *´Athlete Biological Passport´*. This concept was developed since 2002, and it is based on the monitoring of selected biological variables, which indirectly reveal the effects of doping, as opposed to the traditional direct detection of doping. Although there is no evidence of systematic doping in tennis, and the incidence of blood doping was 0% in the last seven years [3], the biological monitoring throughout an athlete's sporting career should make any prohibited preparation far harder to implement.

Javier Maquirriain MD, PhD.
JMST, Editor-in-Chief

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Kathy Martin, Page Love

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"Managing Athletes with Eating Issues: the WTA Tour Approach"

Introduction

Eating disorders (anorexia nervosa, bulimia nervosa, binge eating disorders and eating disorders not otherwise specified or EDNOS) and disordered eating are known to affect athletes competing in many levels in sport, including the elite level.[1] Tennis, although categorized as a non-thinness demand sport in the ball games specialty category, appears to have lower risk than other lean sports such as gymnastics, figure skating, and track and cross country.[2] Characteristics that are desirable in elite athletes, sometimes termed "good athlete traits," also occur in people susceptible to developing disordered eating, such as being goal oriented and achievement driven; persistent; tolerance of pain and discomfort; independence and perfectionism.[1, 3, 4]

Eating issues are a continuum of behaviors with poor nutritional habits (disordered eating) at one end and anorexia, bulimia, binge eating disorder and EDNOS at the other. The latter four are classifiable psychiatric disorders.[5] Diagnosis is not made purely on meeting the clinical parameters as described in the Diagnostic and Statistical Manual IV, (see Table One). Especially in the athletic population, clinical parameters alone may be insensitive diagnostic tools for athletes. For example, an athlete's Body Mass Index (BMI = kg/m^2) may appear normal due to an increased lean (muscle) body mass.[1] A BMI of 17 or less is considered criteria for underweight/malnutrition status.[6] To make the sport safer for competition, Olympic ski-jumping has recommended a minimum BMI of 18.5 for sport participation in normal format.[2]

Diagnosis may be compounded by the hidden nature of the problem, the difficulty of getting the athlete to agree to a medical or specialist consultation, the denial that surrounds the condition which may extend to parents and others in the athlete's inner circle, and the masking of the problem by the intense physical and mental stress associated with elite level competition.[1,7]

Definitions

Anorexia nervosa, bulimia nervosa, binge-eating disorder and EDNOS are serious conditions, which negatively affect an athlete's performance, health and life. They are associated with restricted food intakes or bingeing and purging behaviors, such as laxative abuse, extreme emotional distress and obsessive worry about body image, shape and weight. Frequently, sufferers have poor self-esteem and a conflicted relationship with food involving guilt and/or control issues.[1] There also may be co-morbid psychological conditions, such as depression, anxiety disorders, and obsessive compulsive disorders [3, 4, 5] (Table 1). Anorexia nervosa is the third most common chronic illness among teenage girls, after obesity and asthma, and has the highest fatality rate of any psychiatric disorder.[8] There is little research on the prevalence of eating disorders among athletes, very little incidence reported in tennis, and the true prevalence of eating disorders is very difficult to gauge due to the secretive nature of the illness. Using strict criteria for anorexia and bulimia, prevalence rates among athletes are about 3% and 20% respectively. When all "disordered eating" behaviors are included, the prevalence rates increase to 15 - 60% depending on the study and the sport.[9] "Disordered eating" is where the athlete exhibits abnormal eating behaviors and deliberately tries to lose weight or body fat by engaging in restrictive dietary practices, reducing overall calorie intake, fasting and eliminating certain food groups.[8, 10] Sports that are associated with higher rates of eating disorders are classed into three groups: appearance sports (such as gymnastics and ballet), low body fat sports (such as distance running and body building) and weight category sports (such as jockeys, boat crews, and wrestling).[1]

Very little research has been conducted in the tennis playing population. The available research has focused on populations of junior players, so it may not be representative of what is occurring at the professional athlete level. However, results from these studies indicate

that there is evidence of "disordered eating" and of misconceptions regarding healthy body composition and dietary intake within this population.[11, 12, 13] The distorted eating "thinking" of junior players identified the following results:

- 33% reported optimum body fat as 12%
- 33% reported they were currently dieting
- 33% reported they check their body weight once a week or more.[12]

A report examining junior players, their parents and coaches attitudes found that players, mothers, and coaches all wished to be thinner than they were. Coaches considered weight-related issues important but were not highly knowledgeable about them. Additionally, both players and coaches viewed ideal body shapes as smaller than healthy; weight was ranked as very important to players; most female players felt they needed to lose weight; and 38% of coaches reported having tried fasting while 33% had tried crash diets. Coaches additionally revealed negative feelings about larger sized players. There is a clear need for more preventative education about body image and healthy dieting in the junior tennis community.[13]

Anorexia Nervosa	Bulimia Nervosa	Binge Eating Disorder	EDNOS
• Weight 15% below normal for age and height • Obsessive fear of fatness and preoccupation with food • Abnormal, distorted body image • Loss of menstrual periods for 3 months or more • Noticeable weight loss	• Feel loss of control about food and self disgust • Recurrent binge eating = large amounts of food eaten at one time • Regular purging behaviors e.g. self-induced vomiting, laxative use, excess exercise, strict fasting • Minimum 2 binge/purge episodes/week over 3 month period • Often average or slightly above average weight	• Recurrent episodes of binge eating (eating large amounts of food without feeling hunger) without compensatory methods • Eating until uncomfortably full • Eating more rapidly without feeling in "control" • Hiding eating from others • Feelings of disgust, despair, and guilt after consuming a large amount of food	• Those who do not meet the specific criteria for the other eating disorders, but have many of the presenting symptoms. • For example, all symptoms of anorexia except has regular periods •Could be disordered eating

Table 1. Eating Disorder Categories [5]

Athletes at Risk

Eating disorders are complex and are caused by many factors as described below:

Individual factors

- Gender – Females ten times more likely than males to develop eating disorders.
- Genetics - there is a genetic predisposition to developing an eating disorder.
- Personality traits - characteristics such as high levels of sensitivity to others, perfectionism, low self esteem, body dissatisfaction and food obsessions are very common in sufferers.
- Co-morbidity of depression and/or anxiety disorders.
- History of dieting - the most common feature of sufferers is that they have all been on a diet at some stage. People with a history of vegetarian eating are also at higher risk.[14]

- Traumatic life events (physical, sexual or emotional abuse, bullying at school, major life changes stress such as separation or divorce, death or illness of family members).

- Parental alcohol or substance abuse and parent history of eating disorder.[1, 3, 4, 7, 8, 10, 15]

Sociocultural and Sport-specific Factors:

- Media influences and portrayal of unrealistically slender/lean "ideal" body types.

- Pressure to improve athletic performance associated with (false) assumption that leaner athletes perform better - pressure may come from the athlete, coaches, parents and others in the athlete's inner circle.

- Participation in sports which require adherence to a strict diet may be a risk factor.

- Sports that require revealing clothing or thinness demand and appearance sports.

- Using weight control as a method to increase control in the athlete's life when the athlete lacks power and autonomy over decisions.[1, 10, 16, 17, 18]

Medical and Athletic Consequences

Disordered eating and eating disorders will reduce athletic performance and adversely affect the athlete's health.[1] Inadequate macronutrient/energy intake and the decrease in micronutrients (calcium, iron, zinc, magnesium, potassium, vitamins) and electrolyte imbalances that occur in eating disorders, can cause problems with tissue repair and building; hemoglobin synthesis; bone density and structure; cardiovascular health; pancreas, kidney and immune system function.[3] Eating disorders in female athletes are associated with amenorrhea and osteoporosis. This "Female Athlete Triad" has an associated increased risk of stress fractures, which can significantly interrupt an athlete's career.[10] The reduced muscle protein, low glycogen and fluid stores associated with inadequate nutrients and fluids also negatively affect muscle activity, power production and performance. All of these side effects of poor nutrition will negatively impact upon athlete's health, well-being and performance.[7, 10, 18] (See Table 2 for a complete list of negative health consequences).

All Eating Disorders Dehydration	Anorexia Nervosa	Bulimia Nervosa
Edema	Amenorrhea	Esophagitis
Anemia	Hypothermia	Poor oral health
Slowed metabolism	Lanugo	Pancreatitis
Reduced digestive motility	Bradycardia	Enlarged salivary glands
Poor skin and hair	Decreased gastric emptying	Ipecac poisoning
Irregular menses/infertility	Hypotension	Laxative dependence
Electrolyte abnormalities	Elevated hepatic & heart enzymes	Kidney disease
Irregular heart rate	Constipation	Impaired colon function
Osteoporosis	Muscle atrophy	Excessive training/exercise
Sleep disturbances		with corresponding increased
Loss of appetite		musculoskeletal injuries

Table 2. Common physiological symptoms that negatively impact athletic performance [6]

The impact of eating disorders, both physically and emotionally, can be long lasting and devastating to the individual, their families and their performance. Many of the above mentioned medical complications are reversible with restored nutritional intake; however, psychological counseling is imperative for recovery back to emotional

and physical health.[1] A treatment team approach that includes a registered dietitian, psychotherapist, and doctor is recommended. The registered dietitian's role is to provide a detailed nutrition assessment that accurately depicts the athlete's health and nutrition status and to provide direction in the process of education and normalization of food intake. Medical monitoring and psychotherapy treatment are essential to identify and treat all factors involved in the development of the disorder and decrease the risk of relapse. For recovery, long-term goals are to re-establish normalized eating, meet nutritional needs for weight gain and/or weight maintenance, obtain a healthy body weight, alleviate medical and nutritional deficiency states, restore psychological health and healthy attitude toward food, improve social eating skills, and improve a body image state.

The WTA Tour Approach

The WTA Tour approach follows the four principles recommended by the International Olympic Committee (IOC),[10] to reduce the risk for eating disorders as outlined below.

Education

The WTA Tour takes a pro-active approach to health education, which includes eating disorder education. As evidenced by the research from the junior tennis population, players and their support teams need accurate information and education about healthy eating, healthy body image, and the consequences of disordered eating behavior.[11, 12, 13] The Physically Speaking and Athlete Assistance topics have addressed this issue directly (examples: Food Fight, Love Your Shape and Winning Weighs) and on associated subjects (examples: Feel Good, Play Great on self-esteem and R.E.S.P.E.C.T. on abuse prevention). These topics are available, in a number of languages, for the players through the Sport Sciences and Medicine and Athlete Assistance staff; via the private player intranet, called the PlayerZone©; and they are posted in the private player locker rooms at WTA Tour events.

The Tour also has contracted a health information service provider, which provides health and preventative information via a website, Achieve Solutions (https://www.achievesolutions.net/tennis), which has extensive eating disorder information and links to reputable eating disorder organizations. The Sport Sciences and Medicine and Athlete Assistance staff are also available at WTA Tour tournaments to educate athletes and to guide them to helpful resources.

In addition, the Sport Sciences and Medicine team conducts outreach to others in the tennis community, such as coaches, fitness trainers and parents, to provide education on health topics relevant to tennis. For example, information regarding the myths about body composition measurements is disseminated via the Physically Speaking topics and through the Game, Set, Health® section of the public WTA Tour website, http://www.sonyericssonwtatour.com/page/HealthSection.

It is important that players and their support team members understand that there is no real value in taking body composition measurements of tennis players, which is a sport that does not favor any specific body type. Composition measurements can be unreliable as assessment tools of an athlete's health status if the athlete is adhering to an appropriate training program and a nutritionally balanced and adequate diet. These measurements also do not provide useful information about the parameters which affect a player's performance, such as core stability, strength and endurance. Body composition percentages are purely a set of numbers, similar to weight and ranking, by which the athlete may judge herself. If misinterpreted, these percentages may be implicated in the development of eating disorders.[19]

The PRO U™ educational resources, such as the on-line rookie education system for young players entering the Tour environment, is proven to be effective in ameliorating the stressors associated with professional tennis participation.[20] The on-line tools include health information, safety and abuse prevention information and information about how players can access help.

Early Recognition Strategies

The WTA Tour Sport Sciences and Medicine and Athlete Assistance staff are trained to recognize the early warning signs of eating disorders and to promptly refer the at-risk player for medical, nutritional and psychological assistance. Early warning signs include:

- Players who exhibit rapid weight loss or weight loss below a healthy competition weight.
- Players who frequently exhibit signs of distorted body image, (such as refer to herself fat when the reverse is true), or are obsessed with food, calories or comparisons with other's eating habits or size and shape.
- Extreme training regimes, including high training loads that are maintained during the off season and above what is considered normal for tennis.
- Secretive eating isolated eating, excuses for not eating, or disappearing after meals to the toilet or shower.

- Weakness, fatigue, dizziness, headaches or fainting, with no obvious organic cause.
- Denial that anything is wrong.

A valuable early detection tool on the WTA Tour is the Tennis Specific Physical Examination, conducted by the WTA Tour's team of medical advisors, which includes a registered dietitian, cardiovascular, women's health, orthopedic, and internal medicine specialists. This examination includes screening questions designed to identify issues with body image, weight and eating; a thorough nutritional assessment; a psychological screen for potential contributing life stressors and personality traits; and a medical screen including measurement of height and weight, cardiovascular health and blood tests as applicable.

Healthy Culture

In recognition of the socio-environmental factors that influence the development of eating disorders in athletes, the Tour has implemented some innovative resources to promote a healthy environment, which encompass the IOC recommendations to promote safe training, healthy eating and healthy body image practices.[10] The ScheduleZone©, is an interactive, online tool available for all players and their support teams to assist them to plan a healthy calendar with appropriate rest, recovery and training and competition loads. Healthy training and competition schedules can improve athletic performance and minimize the risk of career interrupting injuries and illnesses, including eating disorders.

The WTA Tour's revised and healthier circuit structure, entitled Roadmap, has created a longer off-season (8 weeks) and a potential mid-season break of 3 weeks to allow players to properly periodize their competition year and maximize their performance. The ScheduleZone© and Roadmap are valuable initiatives which aim to facilitate smart, healthy decisions by player's and their teams regarding training and competitive loads and recovery. It is anticipated both will enhance overall player health.

The WTA Tour also provides media training to help young players in particular understand how mass media messages are constructed, empower them with this knowledge, and provide them with skills to express and manage messages aligned with their personalities and goals. The goal of the training is to instill confidence in the players and to help them develop a healthy body image, despite the intense attention. This is important as negative media images are a possible contributing factor to eating disorder development.[15, 16, 17] A media-educated young person is less likely to be negatively affected by the unrealistically thin body images portrayed in mass media.[21]

Multidisciplinary Approach to Treatment

The WTA Tour team includes medical advisors in the disciplines of sports dietetics, internal medicine, women's health, cardiovascular health, orthopedic surgery, sports psychology and the WTA Tour's own Athlete Assistance (counseling) and Sport Science and Medicine Departments. Should a player be diagnosed with an eating disorder, or be flagged with disordered eating behaviors, this team will actively work with the player's own medical advisors to promote recovery. The WTA Tour advisors are available for players to consult in person at various events throughout the year, which assists in the monitoring and management of athletes at risk for developing clinical eating disorders.

Confidential telephone counseling is also available to athletes in need via the Athlete Assistance services. Successful treatment is not based simply on weight gain but includes nutritional improvement or nutritional counseling and psychological or psychiatric therapy to resolve the complex web of irrational thinking, fears and distortions that are part of these conditions. The most successful treatment outcomes include a blend of medical, nutritional and psychiatric/psychological care and include the family and athlete in the process. Due to the severity and recalcitrant nature of these disorders, some athletes may require in-patient or hospital care. The research shows poor outcomes for complete recovery from clinical eating disorders. About 40% of sufferers make a good five-year recovery, 40% retain symptoms but function to some extent, and 20% remain chronically affected.[1] All effective treatment regimes should include relapse management and risk reduction strategies.

Summary

Eating disorders adversely affect sporting performance and can have a long-lasting and devastating impact on the lives of sufferers. It is known from research in other sports that athletes are at risk of eating disorders, and although it is not suspected that women's tennis has as high a risk as other thinness demand sports, the WTA Tour is taking a pro-active approach to the prevention and treatment of eating disorders which involves general and targeted education initiatives; an emphasis on early recognition and intervention, which is correlated to improved recovery rate and decrease in relapse rate in athletes; and a strong multi-disciplinary approach to treatment. Eating disorders are serious and potentially life-threatening conditions with long lasting implications for its sufferers. The sooner an athlete at risk is identified, the sooner she can commence her recovery. The WTA Tour approach is helping its athletes have healthy and productive lives and tennis careers.

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About the Authors.

Kathy Martin, M.Couns., B.A., B.App.Sci(Physio), G.D.Adol. Hlth. & Welf.

Counselor and Sports

Physiotherapist

Director Athlete Assistance, WTA Tour

Player Welfare Officer, ITF

Page Love, MS, RD, CSSD, LD

Registered and Licensed Dietitian

Certified Specialist in Sport Dietetics

Nutrifit Sport Therapy, Inc.

Consultant Dietitian, WTA Tour

Neeru A. Jayanthi, T. Calloway Robertson, Lara Dugas, Amy Luke

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"The Evaluation of Injury Risk and Recovery in Junior Competitive Tennis Players"

Abstract

Background: Despite available data regarding potential injury risks of training in junior competitive tennis players, there is little information to date elucidating the potential longitudinal risks of training, competition, and recovery.

Objective: To prospectively evaluate the relationship between training volume, ranking/performance, recovery, and off-court conditioning and risk of injury utilizing serial monitoring during a summer tournament season.

Methods: A prospective longitudinal study using a novel weekly electronic survey during 2009 USTA (United States Tennis Association) summer tournament season in 16 competitive junior tennis players.

Results: Players who participated in more training sessions/week (3.69 versus 2.31) were less likely to develop injury ($p<0.04$), while participating in more off-court conditioning may be protective of injury ($p<0.067$). Players with better rankings had better recovery scores than those with worse rankings ($p<0.05$) while there was a linear improvement in recovery scores related to increasing age ($p<0.001$).

Conclusion: Although higher weekly training volumes did not result in increased risk of injury, this effect may be masked by higher amounts of off-court conditioning, and also the level of the player. Older and better players also seem to report better recovery then younger and lower ranked counterparts.

Keywords: Tennis, injury, junior, competitive, recovery

Introduction

Competitive junior tennis players have large training volumes and a rigorous and competitive schedule. We had previously done a prospective analysis of 519 junior tennis players showed that the average starting age was 6.3, average age at which they began competing was 9.1, and the median practice hours per week was 11-15. [1] The median number of tournaments was 11-15/year and nearly 70% of players specialized in only tennis by the age of approximately 10 years old. Maintaining such a high level of performance and meeting the demands of training can lead to injuries. [11] Injury incidence and prevalence at boys' USTA nationals for ages 16 and 18 were 21.5/1000 athletic exposures and 21.1 injuries/100 athletes. [2] The most common injuries were to the lower extremity. A four-year study was conducted by prospectively following girls' and boys' 14's and 16's USTA National Hardcourt Championships. [3] There was no difference in injury rate between boys and girls; however, boys sustained more new injuries. [3] In a recent study, we found that in retrospectively evaluating over 28,000 match exposures in USTA national junior tennis tournaments, there is a highly significant increase in risk of medical withdrawal related to higher age division matches, singles matches, male matches, and back-draw matches. [4] There is a significant increase in medical withdrawal rates beyond the fourth match in the tournament. [4] The ability to assess the recovery from an injury, details of the types of tennis injuries, and the severity of the injuries were not assessed. The study was limited due to its retrospective nature and the lack of any baseline assessment of the athletes. The influence of training on consequent injuries was also not evaluated in these epidemiologic studies. A prospective longitudinal study will be performed with statistical analysis to determine potential associations with factors of interest such as volume of training, tournament matches, and recovery during training of a summer tournament season. We would also like to determine differences between high ranking and lower ranking junior tennis players as well as effects of off-court conditioning. We have developed a novel weekly electronic survey tool to assess training, injury, severity, and recovery.

Material and Methods

Design: Prospective longitudinal study (Pilot Study).
Ethical Considerations: Human Subjects approval was obtained from Loyola University Stritch School of Medicine Institutional Review Board (IRB). Informed consent from parent/guardian as well as child's assent to participate was obtained prior to inclusion in the study by all subjects.
Subjects: USTA Midwest Competitive Junior Tennis Players aged 10-18 years old.
Methods: Players completed a baseline survey, prior to the start of their 2009 summer tournament season. Training, USTA Midwest ranking, injuries, injury severity, and recovery were monitored through a weekly electronic survey through www.surveymonkey.com over a 10-week exposure period.

The inclusion criteria included all male and female USTA junior competitive tennis players (age 10-18 years old) at several tennis training centers who are able to have a baseline survey completed and have access to email/internet to complete a weekly electronic survey. We only excluded athletes if they were unable to complete the baseline survey and were not available to have serial monitoring of their summer tournament season. Subjects were included even if they reported an injury or were unable to continue to participate the remainder of the summer tournament season related to an injury. The match exposure and playing exposures would reflect this lack of participation.
Throughout the 10-week period of monitoring the players, training and match volume, player reports of injuries, the severity of the injuries, recovery, and other factors of interest were captured through a weekly electronic survey. We included an abbreviated Rest Q (survey tool) to evaluate components of recovery based on the most sensitive predictors of recovery. [5] We also collected data regarding tournament match results (wins/losses) and medical withdrawals on publicly available site www.usta.com. Participants were assigned an ID number that they used to fill out the electronic survey to maintain relative anonymity.

Statistical analysis:
The statistical package STATA v.11 (College Station, TX) was used in the analysis. A two-way ANOVA was used to examine main effects for injured versus non-injured players and high versus low ranked players. We used multiple linear regression analysis to examine the relationship between recovery scores and player age. Statistical significance was accepted at a level of $p<0.05$. Data are presented as mean ± standard deviation.

Results

There were 28 players who consented to participate and of those, 16 (13 female, 3 male), mean age 15.9 (SD 2.1, range 11-18) completed baseline survey and weekly surveys sufficient for analysis. The baseline survey suggested that there was a lower risk of injury for those players who reported tennis playing 14-15 hours/week versus 11-12 hours/week ($p<0.0223$). Additionally, those that reported <5 hours/week of off court conditioning were more likely to have reported an injury ($p<0.067$). These relationships were further evaluated on prospective weekly surveys.
There were 103/160 weekly electronic surveys completed (64.4%). A total of 208 tournament match exposures were recorded. Over a 10-week period the injury incidence was 5/1000 athletic exposures and the injury prevalence was 50 injuries/100 players with a mean of 3.93 days missed per injury.

Training volumes:
Mean on court tennis training sessions/week: 3.46.
Mean on court sessions in the injured group was 2.31/week while it was 3.69/week in uninjured group, ($p<0.04$) again suggesting that higher weekly volumes do not increase chance of injury in this study (Figure 1).
Mean matches/week: 2.37/week,
Mean matches/week in the injured group 2.25 and 2.40 in the uninjured group, with no statistical differences between weekly matches and injury. ($p=0.75$)
Mean off court conditioning was 1.15 sessions/week. Participating in 2 sessions versus 1 session weekly of off court conditioning resulted in a trend towards less risk of injury ($p<0.067$).

Ranking/Performance:
Mean ranking was 81.9 (SD 93.55, Range: 2-410) (Midwest USTA sectional ranking).
Injured players mean rank 111.1, mean rank uninjured players 75.2. There was no statistical difference, but this relationship between ranking and injury risk may need to be elucidated with larger sample size. (Figure 2) We also found that higher ranked players Rest-Q (Recovery) scores were better than lower ranked players ($p<0.05$).

Recovery:
Mean Rest Q score (recovery score) was 34.8 (SD 7.25, range 16-48).
There was no difference in Rest-Q scores between cohorts of injured and uninjured junior tennis players. However, there appears to be a linear relationship between recovery scores and increasing age ($p<0.001$), (Figure 3).

Discussion

This study tested a novel weekly electronic survey to elucidate details of training, injuries, and also recovery that has not been studied in this fashion before. We feel that during a tournament season, a majority of weekly surveys was completed and therefore the use of this survey tool may be utilized in other settings. There were differences noted in training based on baseline survey and actual weekly monitoring. In addition to reducing recall bias the specific reporting of training, reporting of injuries, severity, and off-court condition can be better captured with serial monitoring.

Training Volume:

Previous studies have suggested increased risk of injury related to cumulative match volume within a tournament as well as annually. [4] We have also seen that injury risk is generally more likely during matches than practice. [6] However, there is some suggestion that elevated weekly practice volumes alone can be an independent risk factor for injury certainly for older, recreational populations where playing >2 hours daily versus less than 2 hours daily significantly increases the risk for tennis elbow. [7] This risk has also been seen for all injuries when playing as little as 5 hours weekly. [6] We found in a recreational adult competitive sample no rates of injury differences between 2-4 hours weekly, 4-6 hours weekly or greater than 6 hours weekly of tennis. [8] Some preliminary findings suggest that weekly practice volumes of 16 hours or greater weekly may potentially increase future risk of medical withdrawals in junior tennis players, although this needs to be further validated. [1] Monitoring and validating self-reported practice volumes may be generally less reliable then match volume since match results are generally publicly available. Furthermore, there is little evidence regarding specific weekly risks of early, intensive training in junior tennis players.

We were able to design a novel weekly electronic survey that would allow us to capture specific weekly on-court tennis practice sessions, on-court match sessions, and off-court conditioning sessions. Although these were self-reported, weekly monitoring may limit recall bias significantly, and may provide clearer causative links to training volume and injury. However, it appears that players reporting lower volumes of practice and matches were more likely to be injured. At the same time, though, players who had less weekly off-court conditioning were also significantly more likely to be injured. In this pilot study, we feel that the effect of training volume risks may be potentially masked by off-court conditioning that is geared towards injury prevention. Future evaluation of weekly training volumes should be adjusted for level of player and amount of off-court conditioning to elucidate independent risks. There could not be controlled for in this smaller sample size of junior tennis players.

Ranking/Performance

The influence of the level of player cannot be ignored. We previously studied differences in risk of injury in recreational adult league players and found that there were no statistical differences in reporting of injuries with a general trend for better players to report injury. [8] There have not been many studies that evaluate these risks in junior elite tennis players. We had previously randomly selected various levels of nationally ranked junior competitive USTA boys to determine relationships of annual match volume and risk of medical withdrawal. There were no specific differences related to national ranking, while playing > 40 singles matches annually correlated with significantly increased risk of medical withdrawal. [9] However, other studies of elite players found that performance success was directly related to injury rate. [10] In this study, we found that better players (lower ranking) might have an early trend towards fewer injuries, but specifically have better recovery scores. We may make a calculated assumption that it is in fact better players who have greater weekly training volumes, more weekly off-court conditioning, and then in fact may ultimately have an overall lower risk for injury. It is possible that due to these reasons, recovery scores for this type of population were also better.

Recovery:

There are few studies evaluating not only characteristics of recovery in competitive junior tennis players, but also overall enjoyment with the sport. We previously found that players 14 years old or greater have lower enjoyment and satisfaction with tennis than those <14 years old. [1] This was also accompanied by significantly greater percentage of children specializing in only tennis in junior players >14 years old. The Rest Q is a survey tool previously validated as a 70-question survey to assess overall feelings of recovery. [5] There were 8 specific questions that seemed to be the most accurate predictors of recovery when applied to a cohort of rowers. We used these validated questions as part of our weekly assessment tool.

Again, it seems that recovery scores seemed to correlate well with age as older players were more likely to report better recovery (higher Rest Q scores). Additionally, these scores were better in lower numerically ranked (better) players. In our population, there may have been a little bias in that

our better players were typically older, and more likely to participate in off-court conditioning and play more tennis weekly as they may be nearing the end of high school and pursuing competitive college/university scholarships. However, although we felt that injured players would be more likely to report lower recovery (Rest Q) scores, there was no such difference. We may not have been able to elucidate this relationship in our study population and the relationship between recovery and risk of injury in junior tennis players during training or tournaments should be further evaluated.

Limitation/Future Research:
It would be difficult to adjust for ranking and off-court conditioning when evaluating the relationship of weekly on court tennis volume as statistical power would be lost with stratification of a small cohort of players. However, we do feel that the natural assumption that the best players typically play more tennis weekly and are also more likely to participate in off-court conditioning programs. Although we did serial weekly monitoring, it was difficult to maintain near 100% compliance without any other additional incentives. Additionally, even weekly self-reporting may not only have recall bias, but also potential inaccuracies in reporting of training and injuries. Future prospective evaluation with serial monitoring may be more effective in a captive audience such as national training center or university team. Prospective evaluation of weekly training volumes, match volumes, and off-court conditioning while controlling for level and age of the tennis player should be performed in other captive tennis audiences. Additionally, more specific evaluation of the independent factor of recovery during training but also tournament play utilizing the Rest Q tool, may elucidate further relationships.

Conclusions

The electronic survey proved to be a useful tool to track players through their tournament season. Junior USTA players who play more tennis weekly may be less likely to develop injury than those who play less tennis. Having more weekly off court training and injury prevention in junior USTA competitive tennis players may be protective of injury. Higher ranked players and older players report better recovery than lower ranked players. There is no apparent relationship between performance and recovery and there is no relationship between injuries and recovery in this study sample. The usefulness of tracking training and recovery needs to be elucidated in a larger sample and also in other competitive tennis populations.

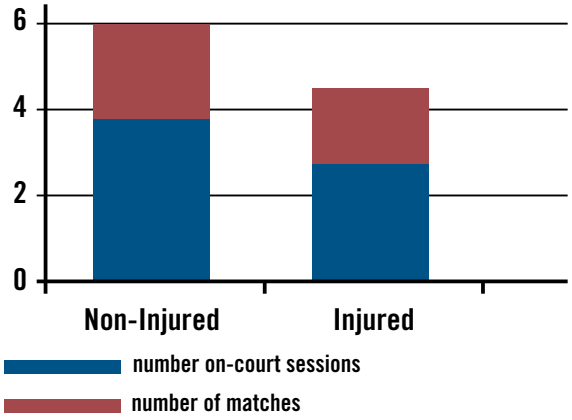

Figure 1. Total average time playing tennis each week in injured versus uninjured players. Injured players report more weekly tennis time (tennis training + matches), (p=0.0983), with specifically more weekly tennis training then uninjured players (p<0.04).

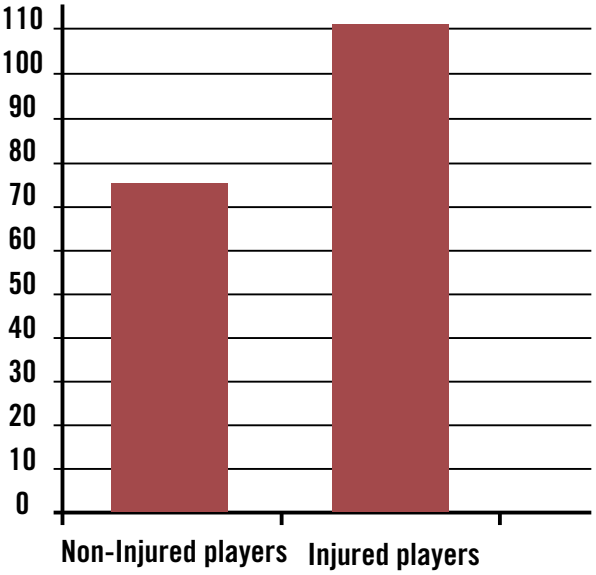

Figure 2. Mean rank for injured vs. non-injured players from tennis injuries. There is no statistically significant difference between ranking in injured players and uninjured players. (p=0.178)

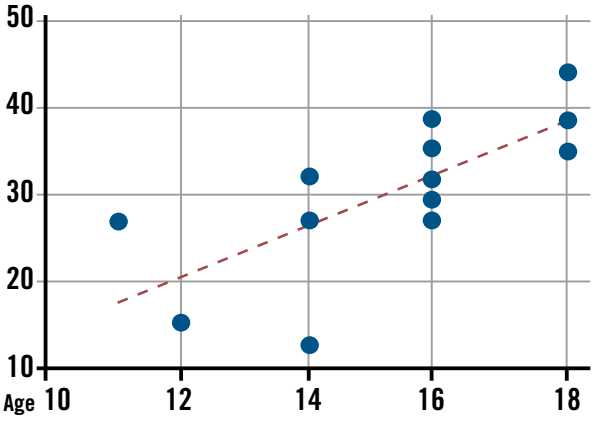

Figure 3 Age and relationship to recovery. For every 1 year increase in age, a player's Rest-Q (Recovery) increases by 3 points (p=0.001).

About the authors

Neeru Jayanthi, M.D.

Neeru Jayanthi, M.D. is the Medical Director of Primary Care Sports Medicine at Loyola University Medical Center outside of Chicago, IL, USA. He is an Associate Professor of the Departments of Family Medicine and Orthopaedic Surgery & Rehabilitation at the Loyola Stritch School of Medicine. He serves as the Chair of Education for STMS, and is a Volunteer ATP Physician. He also is a USPTA-certified teaching professional who supervises the injury prevention and conditioning programs at local junior tennis training academies. njayant@lumc.edu

T. Calloway Robertson

Medical Student, Loyola Univeristy Chicago Stritch School of Medicine, M.D. expected in 2012.

Dr. Amy Luke

Is Associate Professor of Preventive Medicine and Epidemiology (and Family Medicine) at Loyola Stritch School of Medicine.

Dr. Lara Dugas

Is a Research Assistant Professor in the Department of Preventive Medicine & Epidemiology at Loyola University Chicago. She is by training an exercise physiologist and her research focuses on the effects physical activity, fitness, and obesity have on morbidity and mortality in populations as well sports medicine epidemiology.

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Stefan Koehn

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"Variations in Flow State during Junior Tennis Competition"

Abstract

Flow is a positive experience in sport that is closely intertwined with performance. Theoretical models of flow [1,2] and performance [3] have indicated a positive relationship between positive experiences and performances. Previous research on flow state and performance provided evidence for a positive relationship between the two variables. [4,5] A general limitation of flow studies has been the measurement of a single flow state for a specific performance, not considering possible variations in the intensity of flow state during performance. The aim of the current study was to examine changes in flow state in three-set competition matches. Ten participants, who were listed in the Australian junior rankings, completed the Flow State Scale-2 for each of the three tennis sets following a competition match. The results supported the theoretical hypothesis showing that flow state was higher in conjunction with a successful performance (i.e., winning the set), whereas flow decreased when participants lost the set. The conclusion can be drawn that the patterns between flow and performance were signified by a positive relationship. Future studies need to clarify if the link between flow state and performance is causal in either one direction or reciprocal. Implications for future interventions would be to aim to enhance flow state and performance to increase competition outcome.

Keywords: flow state, performance, competition, junior tennis.

Introduction

Flow is a state of positive experience characterised by intrinsic motivation, total immersion in the activity and a high levels of enjoyment that increases athletes' effort and perseverance in their sport. [6] Therefore, flow state can play an important role in competition as the experience helps athletes to get the most out of themselves and perform above average, which could make a difference between winning and losing. On the other hand, flow is an ephemeral, hard-to-control state that is difficult to attain and easily disrupted. [7,8] A precondition to experience flow is a balance between personal skills and situational challenges. [1,6] Athletes' skills that match competition challenges are likely to experience a state of flow, whereas an imbalance between challenges and skills can result in anxiety, boredom, or apathy. Flow state consists of nine antecedents contributing to the positive experience, including challenge-skills balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, time transformation, and autotelic experience. [6]

Flow theory mainly focused on the effect of personal and situational factors of the experience of flow, [1,2] but has not produced a model that delineated the link between flow and performance in sport. Previous research, though, indicated a positive link between flow state and performance. [4,5] Besides distinct qualities, flow and performance were proposed to share several similar characteristics, such as enjoyment, involvement and absorption in the task. [9] Privette and Bundrick [10] further developed this approach presenting an experience model that aimed to describe the link between athletes' experiences and performance. The model consists of two orthogonal dimensions that incorporate seven different feeling and performance states with neutrality as centre point. Feeling states gradually increase from negative (misery, worry, boredom) to positive (enjoyment, joy, ecstasy) experiences. Similarly, performance levels were differentiated between unsuccessful (total failure,

inadequacy, inefficiency) and successful (effectiveness, high performance, personal best) performances. According to the experience model, feelings of worry and boredom are counterproductive to superior performances, as both experiences are related to performances that are below average. Enjoyment, on the other hand, which is also a key aspect of flow, would signify performances that are above standard. Testing the experience model, results showed that feeling states differed distinctly at the various performance levels. [10] Even though the results supported the hypothesised positive link between feeling and performance, the model has rarely been used in the following years, and research on the nexus between feelings and performance has mainly emerged as a concomitant of flow research.

The aim of this study was to examine the relationship between flow state and performance outcome in competitive junior tennis players. Based on theoretical propositions, [10] it was hypothesised that flow state would be higher in conjunction with a successful performance, such as winning a competition set, whereas flow state would be lower when athletes lose a competition set.

Methods

Participants

The sample consisted of ten junior players (5 male; 5 female) from Melbourne, Australia, ranging between 13 and 15 years of age, with an average of 5.50 years of tennis experience and 3.10 years of competition experience. Participants frequently competed in tennis tournaments (11 to 20 tournaments per year) and were listed in the Australian Junior Rankings (AJR) between position 137 and 463. This group of participants was part of a bigger sample, but this sub-sample was chosen to examine the variation of flow state and performance as participants were more likely to experience fluctuations in flow state through the course of a three-set match then during a clean two-set win or loss.

Measures

Flow State Scale-2 (FSS-2). [11] The FSS–2 assesses the intensity of flow state on one occasion (e.g., one tennis match). The 36-item scale consists of nine subscales, which represent the nine dimensions of flow as described in the introduction. The internal consistency alpha coefficients for the nine subscales were between .81 and .90. [11] The response format was a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) with 3 indicating *neither agree nor disagree*. The flow state score has a possible range between 36 and 180. For this study, the FSS-2 was modified by including two additional response scales that allowed participants to report on their flow experience in Set 1, Set 2, and Set 3. The modified FSS-2 provides more information on the development and variation of flow intensity over the course of a competition match, which could not be detected by a single measurement. The modification was not expected to compromise the validity of the FSS-2 given there were no response format or item modifications.

Performance.

Participants reported on the match outcome following the completion of the FSS-2. The score was then cross-checked with the tournament organizers for verification. Participants performed in official tennis tournaments that provided players with points for the Australian junior ranking list. Competition play was conducted in the best-of-three modus, six games were required to win the set, or a tie-breaker was played at 6 games all.

Procedures

Following the University's standard Ethics procedures, access was obtained to several junior tournaments in Australia. Tournament directors were informed about the purpose of the study and an information statement outlining the objectives and procedures of the study and a consent form were made available at the tournament box. Employing convenience sampling, participants who were interested in joining the study provided the consent form signed by parents and players. Following the competition, the researcher informed participants on how to fill out the modified FSS-2, which was completed within half an hour after the end of the match. The data analysis was based on visual assessment evaluating changes in athletes' flow state between successful (set won) and unsuccessful (set lost) performance.

Results

As shown in Table 1, seven participants won and three participants lost their competition match in three sets. Based on the set scores, some matches were comparatively close (e.g., Participant 3 winning 6:4, 6:7, 7:5), whereas other competitions appeared to be rather one-sided (e.g., Participant 9 lost 3:6, 6:1, 1:6). The flow state score for the thirty sets ranged between a minimum of 93 and a maximum of 154 (Mean = 127.77; Standard Deviation = 16.71). A mean score of 108 would not provide conclusive evidence about the occurrence or absence of flow state, as, on average, participants neither agreed nor disagreed with the statements provided.

Table 1

Descriptive statistics on flow state and performance during the three-set competitions

No.	Gender	AJR	Outcome	Match Score			Flow State Score		
				Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
1	Female	277	Won	4:6	6:4	6:1	98	111	128
2	Male	155	Won	6:3	1:6	6:3	126	102	125
3	Female	137	Won	6:4	6:7	7:5	134	134	138
4	Female	463	Won	4:6	6:4	7:6	135	140	132
5	Male	203	Won	7:6	1:6	6:4	140	93	128
6	Male	214	Won	4:6	6:2	6:3	141	154	153
7	Male	346	Won	6:1	3:6	7:6	141	115	147
8	Female	181	Lost	7:5	3:6	3:6	150	113	110
9	Male	241	Lost	3:6	6:1	1:6	114	133	107
10	Male	196	Lost	3:6	6:3	4:6	115	149	127

Note. AJR is abbreviated for Australian Junior Rankings.

The raw data presented in Table 1 was than transformed into graphs as shown in Figures 1 and 2. Spreading the data over two figures were deemed necessary as an accumulation of ten graphs would have made it difficult to visually detect flow patterns across the three sets. Presenting the graphs for winning and losing performances separately would show changes of flow state more clearly.

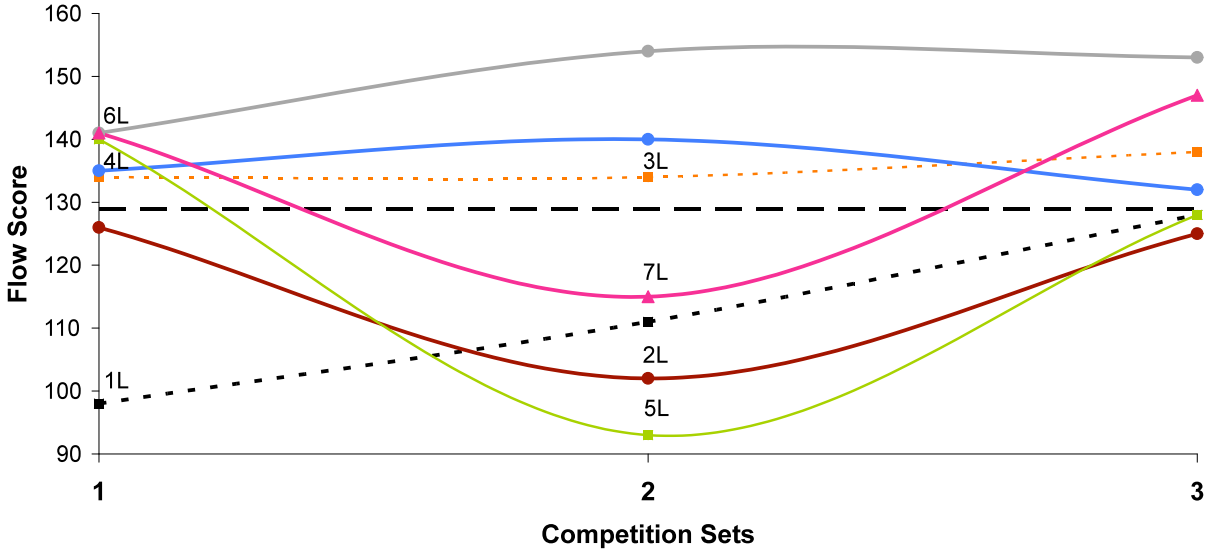

Figure 1. Flow state scores for each set by participants who won the competition.

Figure 1 showed seven graphs of participants who won their competition match. Each graph has an L, signifying that this set was lost, and a number that corresponds with the participant number in Table 1. The mean flow score for all matches won was 129.29, represented by the dashed black line. Flow state scores across the three sets showed either almost linear relationships (Participants 1, 3, 4, and 6) or curve-linear relationships (Participants 2, 5, and 7) with performance. After losing the first set, Participant 1 reported gradually increasing flow experiences in the following two sets. Participant 3 indicated that his experience varied marginally throughout the three sets. The performance scores signified a close competition and high performance, as flow state scores remained above average for each set. Participant 6 won the second and third set, which was also reflected by a higher flow state. Interestingly, Participant 4 was the only contestant who reported higher flow scores for losing a set and lower flow scores after winning a set. Distinctive flow-performance patterns were found for Participants 2, 5, and 7. All three contestants lost their second set, which was accompanied by a substantial decrease in flow state.

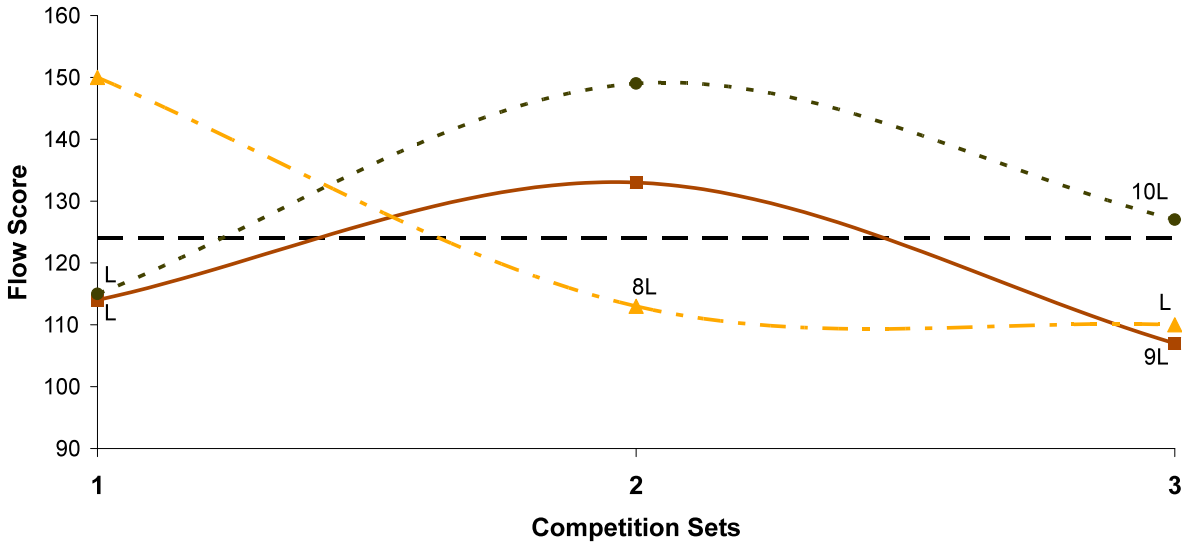

Figure 2. Flow state scores for each set by participants who lost the competition.

An inverted U-shape pattern was found for participants who won their second set competition match but lost Sets 1 and 3. Participants 9 and 10 reported a peak in flow state for the second set, whereas flow was experienced substantially lower in the first and last set. Finally, Participant 8 won the first set and then displayed a strong decrease of flow for the following two sets. The mean flow score for matches lost was 124.22. Overall, there were different patterns of linear and curve-linear relationships between flow state and performance. The results generally provided support for flow state being higher in the light of a successful performance and lower in conjunction with an unsuccessful performance.

Discussion

The aim of this study was the investigation of the variation of flow state in conjunction with successful and unsuccessful performance in tennis competition. The results indicated that flow is a volatile state that varied substantially for most participants during the three-set matches. Competition sets won generally showed a higher flow state than competition sets lost, supporting the research hypothesis that was derived from the experience-performance model [10] and previous research on flow and performance. [4,5]

Despite the general support for a positive relationship between flow and performance, some results did not fit this pattern. For instance, flow states for Participants 3, 4, and 6 varied marginally between successful and unsuccessful performance. In a study with elite tennis players, Young [8] concluded that flow was related to optimal performance, but that this optimal performance was not necessarily associated with a winning performance. This would mean that athletes in some instances evaluate their experience in relation to the quality of their performance, but not to the performance outcome. This might partly explain why flow states do not change substantially between the three sets. Especially for Participants 3 and 4 who played one of the closest matches, suggesting a close balance between personal skills and situational challenges may have led to evaluations based on performance quality rather than performance outcome. Future studies should employ post-match interviews and qualitative analyses, that is, asking the competitors about their perceptions in match deciding situations, to further examine variations in flow state that cannot be accounted for by quantitative studies.

Interventions provided evidence in successfully enhancing flow state and performance in a training task. [12,13] These results were only partly confirmed in a competition setting, as several flow state and performance measurements in the post-intervention phase revealed substantial overlap with baseline measurements. [14] This indicates the difficulties researchers can encounter when aiming to enhance flow and performance in a setting with higher ecological validity. Nonetheless, athletes' experience and performance are of particularly high importance in a competition setting, future interventions need to develop sport and athlete specific interventions.

Theoretical guidance for the development of interventions would be important to increase the efficacy of such interventions. First and foremost, the relationship between flow state and performance need to be investigated as to whether there is causal one-directional link, flow state impacting on performance or performance affecting flow state, or if a reciprocal relationship characterises interactions between flow and performance in tennis competition. To have a closer look at this relationship more detailed information on flow state during competition is necessary. The recently developed short form of the FSS-2 [15] takes less than a minute to complete and studies on flow in tennis competition could employ the new scale by having athletes report on their flow state during competition when changing ends. This approach would provide crucial information and shed more light on the relationship between flow and performance in competition. It might advisable for athletes to initially use the FSS-2 short form during training matches to get used to modifications in their match routine, which will also indicate to researchers if the on-court completion of the scale disrupts flow state

Conclusion

This study provided new and potentially useful insight into the relationship between flow and performance in junior tennis. The variation of flow state during the course of a three-set tennis match indicated a positive relationship with performance. The results corroborated theoretical propositions [3] that a stronger flow state was perceived during successful performances, whereas lower flow states were associated with unsuccessful performances. The rather small sample size may have limited the scope of the findings. Future studies providing a better theoretical insight into the flow-performance relationship need to examine if flow positively impacts on performance or whether performance outcomes increase flow state. Intervention studies should aim to increase both, flow state and performance, as experience and performance seemed to be closely intertwined, and enhancing one variable might positively affect the other.

Competing interests: none declared

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About the author

Stefan Koehn

PhD: School for Health, University of Bath, Claverton Down, Bath, BA2 7AY. United Kingdom.

Email: s.koehn@bath.ac.uk

Anthony Bedford, Tristan Barnett, Graham Pollard, Geoff Pollard

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"How the Interpretation of Match Statistics Affects Player Performance"

Introduction

Commentators often refer to match statistics during a live match to make an assessment as to how the players are performing. For example, one player may have converted 80% of break point opportunities compared to 10% for the other player, and this is reflected in the scoreboard. At the completion of the match, the coaches and players are likely to use the match statistics to assess performance. Therefore, it is important to interpret match statistics correctly as misinterpretation could affect future performance. Andre Agassi lost to Marat Safin at the 2004 Australian Open semi-finals, even though Agassi won more points overall (171 for Agassi compared to 170 for Safin). This could be interpreted after the match as Agassi being "unlucky" in the sense that Agassi really performed better on the day by winning more points overall and lost as a result of two close tiebreaker sets that went in favor of Safin. The logic in the previous sentence is flawed. It is often the case that the weaker player serves more often and therefore has more opportunity to win more points. Therefore, a comparison of the percentage of points won on serve by each player should be used to interpret whether a player was "unlucky" to lose the match. As it turned out, Safin won a higher percentage of points on serve with 67.7% compared to 66.1% for Agassi. This article begins with a summary of the statistics collected at the Australian Tennis Open. Section 3 provides calculations and analysis of statistics that can be obtained from broadcasted match statistics. Section 4 provides further statistics based on match statistics, where the information is calculated for players over many matches. Lastly, section 5 discusses how the match statistics can be used in mathematical models to optimize performance. The statistical information obtained from data collection at tennis events, broadcasted match statistics, commercial tennis software providers and mathematical models could be used by players and coaches to possibly improve performance.

Collection of Statistics

Clarke et al [1] discuss methods used to collect statistical data at the Australian Tennis Open. As quoted: *"The recorded statistics at the Australian Open are reported back to players and coaches in the form of a two page summary forwarded after the match. This summary is much more detailed than the broadcasted television match statistics. In singles, the statistician does not enter the winner of the point, but the last player to make a play on the ball. Thus, an entry of Nadal/forehand/forced error would result in the computer crediting the point to Nadal's opponent and advancing the score appropriately. The person serving the first game of the match has to be entered, and the computer tracks the server for the remainder of the match. For singles, each serve is entered as one of in play/fault/winner/ace (lets are not recorded), the point conclusion is entered as the player to make the last play, one of forehand/backhand/overhead/volley, and one of unforced error/forced error/winner. In addition, if either or both players are at the net when the point is concluded, this is entered."*

Match Statistics from an Australian Open 2004 Semi-Final Match

Table 1 represents the match statistics for the 2004 Australian Open men's semi-final between Marat Safin and Andre Agassi. The Winning % on Serve for each player is not given directly, but can be calculated from the Receiving Points Won or using the 1st Serve %, Winning % on 1st Serve and Winning % on 2nd Serve. Calculations for the Winning % on Serve are given in Table 2 using the Receiving Points Won. There are other statistics given in Table 2 that can be obtained from calculations of the match statistics given from Table 1 and are as follows. The Winning % on 1st Serve is given in Table 1 as being conditional on the 1st Serve going in whereas the Winning % on the 2nd Serve is given in Table 1 as being unconditional on the 2nd Serve going in. The inconsistency between the 1st Serve being conditional and the 2nd Serve being unconditional should be identified when interpreting these two statistics. Calculations for the Winning % on the 1st Serve (unconditional on the 1st serve going in) are given in Table 2. Calculations for the Winning % on the 2nd Serve (conditional on the 2nd serve going in) requires calculating the 2nd Serve %, and both these statistics are given in Table 2. Calculations for the conditional and unconditional percentages for the Receiving Points Won on the 1st and 2nd Serve are given in Table 2. The outcome of a point is recorded as being an ace, double fault, winner, unforced error or forced error. It may be helpful for players and coaches to understand the subjectivity involved in how these statistics are recorded as detailed in by Clarke et al. [1] The percentage of these different outcomes as a proportion

of the total number of points played are given in Table 2. The percentage of aces and double faults as a proportion of the total number of points served for each player can be obtained from the match statistics in Table 1. These values can then be used to obtain the percentage of errors and winners combined as a proportion of the total number of points served for each player and are given in Table 2. The percentage of net approaches and baseline play are given in Table 2 as well as the percentage of break point opportunities.

Table 1

Match statistics for the 2004 Australian Open men's semi-final between Marat Safin and Andre Agassi.

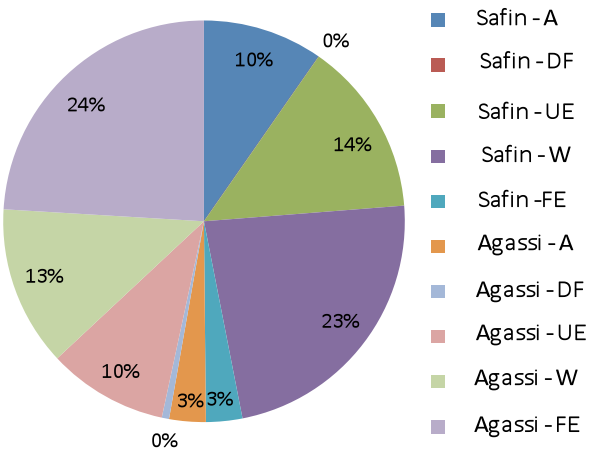
Match Statistic	Marat Safin	Andre Agassi
1st Serve %	88 of 161 = 54%	107 of 180 = 59%
Aces	33	10
Double Faults	0	2
Unforced Errors	48	33
Winning % on 1st Serve	68 of 88 = 77%	81 of 107 = 75%
Winning % on 2nd Serve	41 of 73 = 56%	38 of 73 = 52%
Winners (including Service)	79	44
Break Point Conversions	2 of 7 = 28%	4 of 8 = 50%
Receiving Points Won	61 of 180 = 33%	52 of 161 = 32%
Net Approaches	13 of 24 = 54%	18 of 22 = 81%
Total Points Won	170	171
Fastest Serve	211 KPH	198 KPH
Average 1st Serve Speed	195 KPH	176 KPH
Average 2nd Serve Speed	148 KPH	148 KPH

Table 2

Statistics calculated from the match statistics given in Table 1.

Match Statistic	Marat Safin	Andre Agassi
Winning % on Serve	1-52/161 = 67.7%	1-61/180 = 66.1%
Winning % on 1st Serve (uncond.)	(88/161)*(68/88) = 42.2%	(107/180)*(81/107) = 45.0%
2nd Serve %	1-0/161 = 100%	1-2/180 = 98.9%
Winning % on 2nd Serve (cond.)	(41/73) / (1-0/161) = 56.2%	(38/73) / (1-2/180) = 52.6%
Receiving Points Won on 1st Serve (cond.)	1-81/107= 24.3%	1-68/88= 22.7%
Receiving Points Won on 1st Serve (uncond.)	1-((107/180)*(81/107))= 55.0%	1-((88/161)*(68/88)) = 57.8%
Receiving Points Won on 2nd Serve (cond.)	1-((38/73) / (1-2/180))= 47.4%	1-((41/73) / (1-0/161))= 43.8%
Receiving Points Won on 2nd Serve (uncond.)	1-(38/73)= 47.9%	1-(41/73)= 43.8%
Percentage of aces of total points played	33/(170+171)= 9.7%	10/(170+171)= 2.9%
Percentage of double faults of total points played	0/(170+171)=0%	2/(170+171)=0.6%
Percent. of unforced errors of total points played	48/(170+171)=14.1%	33/(170+171)=9.7%
Percentage of winners of total points played	79/(170+171)=23.2%	44/(170+171)=12.9%
Percentage of forced errors of total points played	(170-(33+48+79))/(170+171)=2.9%	(171-(10+2+33+44))/(170+171)=24.0%
Percentage of aces of points served	33/175=18.9%	10/180= 5.6%
Percentage of double faults of points served	0/175=0%	2/180= 1.1%
Percentage of errors and winners of points served	1-((33+0)/175)= 81.1%	1-((10+2)/180)= 93.3%
Percentage of net approaches of total points played	24/(170+171) = 7.0%	22/(170+171) =6.5%
Percentage of baseline play of total points played	1-(24/(170+171))= 93.0%	1-(22/(170+171))=93.5 %
Percentage of break point opportunities	7/(170+171)=2.1%	8/(170+171)=2.3%

OUTCOME OF POINTS



The percentage of aces (A), double faults (DF), unforced errors (UE), winners (W) and forced errors (FE) of the total points played sum to 100%. These statistics are represented graphically in Figure 1 in the form of a pie chart. Similar graphical representations could be developed for the outcome of points as a percentage of points served by each player, and the percentage of net approaches and baseline play by each player.

Figure 1
A graphical representation of the outcome of points from Marat Safin vs. Andre Agassi match at the 2004 Australian Open

Agassi lost to Safin even though Agassi won more points overall (171 for Agassi compared to 170 for Safin). If the better performance on the day is determined by the player with the higher percentage of points won on serve, then Safin had the better performance with 109/161=67.7% compared to 119/180=66.1% for Agassi. The reason Agassi still won more points overall is because he served more points (as is often the case for the weaker player). Agassi served 19 more points than Safin, and therefore had a greater opportunity to win more points. This needs to be taken into account when comparing two players. Safin's overall performance is 109/161 (his serve) plus 61/180 (Agassi's serve) equaling 101.6%. Agassi's overall performance is 119/180 (his serve) plus 52/161 (Safin's serve) equaling 98.4 per cent. It is now clear Safin was the better player overall. This paradox is more commonly referred to as Simpson's Paradox and can arise in statistical data when analyzing proportions. One entity can have a higher proportion or average of some desirable attribute in each of several categories but lower when the categories are combined. It might be argued that Safin was able to win the match as he won a higher percentage of the more "important" points. [2] This is reflected by Safin winning the two tiebreaker sets, where a tiebreaker game has a high level of "importance".

Many questions can presently be answered using the data that is collected, but are not presented in the final statistics. Just a few examples are:

1. Safin made more unforced errors than Agassi, but were they on his service or Agassi's? Were they on break point opportunities?
2. Safin made more winners than Agassi, but were they on his service or Agassi's? Were they on break point opportunities?
3. Did faults on first serve for Agassi occur when his service was faster than his average speed?
4. Did net approach conversions for Agassi result more often from Safin's unforced errors than from Agassi's winners?

Given the large number of comparative and absolute statistics that can be relevant for an in-depth analysis of a match between two players (and for comparing that match with a 'general or average' match), it would be possible to program a computer to automatically output the 'relevant statistics' for any particular match. Such 'in-depth' output relevant to that particular match could be very useful to players, coaches and commentators.

Comparison of Career Match Statistics

The OnCourt database (www.oncourt.info) provides some match statistics since the 2003 French Open. Not all the match statistics for the ATP and WTA events are given. However, the number of matches and tournaments included in the database has increased in recent years. The surfaces are categorized by grass, carpet, indoor hard, hard, acrylic and clay. Calculations of averaged match statistics over many matches can be conditioned by categories. For the Player category, calculations could be obtained for a particular player across all opponents or a particular player against a particular opponent. For the Surface/Tournament category, calculations could be obtained for a particular surface, a particular grand slam event, all grand slam events or all surfaces. For the Year category, calculations could be obtained for a particular year, particular years or across all years. The serving and receiving statistics averaged across all matches on the surfaces of grass, carpet, hard and clay are obtained for men (Table 3) and for women (Table 4), taken from the

6th Aug 2007. The results indicate that women serve a higher percentage of first serves in play compared to men for all four surfaces. However, the results indicate that men win a higher percentage of points on the first and second serve compared to the women on all four surfaces. Overall, the results indicate that men win a higher percentage of points on serve compared to the women on all four surfaces. This agrees with the results of Barnett et al. [3] There is evidence to suggest that players on average win the highest percentage of points on the first serve when on grass, followed by carpet, hard and clay. There is evidence to suggest that players on average win the highest percentage of points on serve when on grass, followed by carpet, hard and clay. This agrees with the results of Barnett et al [3] where there is a natural ordering of points won on serve from the fastest surface of grass to the slowest surface of clay.

Table 3
Match statistics for men separated by court surface

Statistic	Grass	Carpet	Hard	Clay
Percentage of first serves in play	61.9%	61.3%	60.0%	61.5%
Percentage of points won on first serve (cond.)	74.1%	73.0%	71.0%	67.1%
Percentage of points won on second serve (uncond.)	51.8%	51.3%	50.9%	49.2%
Percentage of points won on serve	65.5%	64.6%	62.5%	60.2%
Percentage of points won on return on first serve (cond.)	25.9%	27.0%	29.0%	32.9%
Percentage of points won on return on second serve (uncond.)	48.2%	48.7%	49.1%	50.8%
Percentage of points won on return of serve	34.5%	35.4%	37.5%	39.8%
Number of matches	928	304	4319	3331

Table 4
Match statistics for women separated by court surface

Statistic	Grass	Carpet	Hard	Clay
Percentage of first serves in play	63.1%	63.4%	62.1%	63.4%
Percentage of points won on first serve (cond.)	65.4%	63.1%	62.0%	59.6%
Percentage of points won on second serve (uncond.)	46.1%	46.4%	45.3%	43.6%
Percentage of points won on serve	58.1%	57.0%	55.5%	53.5%
Percentage of points won on return on first serve (cond.)	34.6%	36.9%	38.0%	40.4%
Percentage of points won on return on second serve (uncond.)	53.9%	53.6%	54.7%	56.4%
Percentage of points won on return of serve	41.9%	43.0%	44.5%	46.5%
Number of matches	881	199	3432	2293

Figure 2 presents a comparison of the average percentage of points won on the first serve (conditional on the first serve going in) between Roddick, Nadal and overall player averages across the surfaces of grass, hard and clay. It shows that both players are winning a higher percentage on the first serve on all surfaces compared with overall averages, and that Roddick is winning a higher percentage of points on the first serve compared to Nadal on all four surfaces. However, the difference between these two players is only marginal on a clay surface compared to the surfaces of grass and hard.

Figure 3 represents a comparison of the average percentage of points won on the return of the first serve (conditional on the first serve going in) between Roddick, Nadal and overall player averages across the surfaces of grass, hard and clay. It shows that Nadal is winning a higher percentage on the return of the first serve compared to Roddick on the surfaces of hard and clay and about the same on grass. However, Roddick is winning a higher percentage of points on the return of the first serve compared to overall player averages on grass, about the same on hard and less on clay.

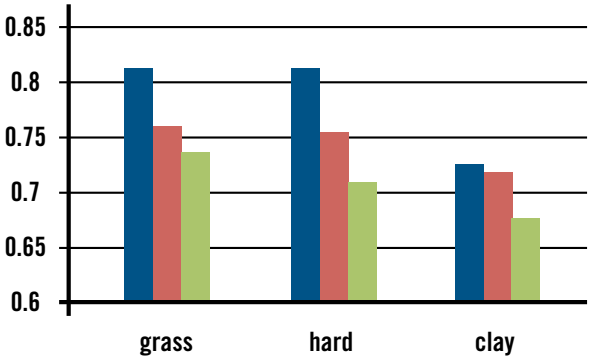


Figure 2: A graphical representation of the average percentage of points won on the first serve between Roddick, Nadal and overall player averages across the surfaces of grass, hard and clay.

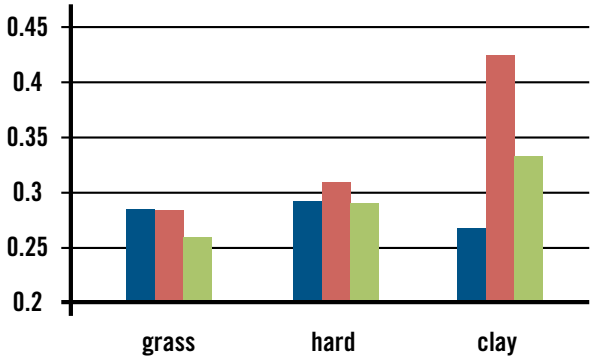


Figure 3: A graphical representation of the average percentage of points won on the return of the first serve between Roddick, Nadal and overall player averages across the surfaces of grass, hard and clay.

Mathematical Modeling Using Match Statistics

Match statistics have been applied to serving strategies to determine how much risk players should take on their serve to optimize performance. [4,5] Similar models could be developed to determine how often a player should serve-and-volley to optimize performance. This would require data on how often serve-and-volley was used and the relevant success rate. This data is currently not recorded in the official recorded statistics as detailed below.

In addition to the player's statistics given in section 4, further statistics averaged over many matches for players could include whether the outcome of a point was a forehand, backhand, volley or overhead, and the outcome of a first or second serve being an ace or a winner. These statistics could be made available on a tennis statistics software package such as OnCourt, and presented in a form that could be used by players and coaches to improve performance.

There are some statistics of interest that are not collected [1] such as the number of strokes in a rally, the side (forehand or backhand) of any volleying winners or errors, the side of the opponents court to which winning shots are hit and whether a player approached the net directly after a serve (serve-and-volley) or during the rally. The latter statistic would be particularly useful for determining strategies as to how often players should serve-and-volley to optimize performance.

Conclusions

Using a match from the 2004 Australian Open, this article has shown how the interpretation of player match statistics can affect player performance. By analyzing match statistics from commercial software providers, further statistics such as a player's average percentage of points won on serve (across many matches) can be obtained. Furthermore, these statistics could be conditioned by many factors such as the court surface. An example was given in a graphical format where a player's percentage wins on the return of the first serve across different court surfaces could be compared to another player and the average player. These types of comparisons in a numerical or graphical display could be useful to players and coaches for tactical and coaching regimes.

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Javier Maquirriain

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"Athlete Biological Passport"

As the international independent organization responsible for coordinating and monitoring the global fight against doping in sport, WADA (World Anti-Doping Agency) has taken the lead in the development of the Athlete Passport concept. The fundamental principle of the Athlete Biological Passport is based on the monitoring of an athlete's biological variables over time to facilitate indirect detection of doping on a longitudinal basis, rather than on the traditional direct detection of doping.

Introduction

WADA's Athlete Biological Passport Operating Guidelines were approved by WADA's Executive Committee on December 1, 2009, and took effect immediately.

This document provides an overview of the scientific principles behind the blood module of the ´Athlete Biological Passport´ and provides practical advice to anti-doping organizations on the implementation of such a program.

In addition, it includes mandatory requirements for collection, transportation, analysis of blood samples, and results management, that anti-doping organizations wishing to adopt WADA's model will have to follow in order to ensure consistency of application and to comply with the World Anti-Doping Code and the related International Standards. These mandatory technical documents will be incorporated into WADA's International Standard for Testing and International Standard for Laboratories.

What is the ´Athlete Biological Passport´?

The fundamental principle of the ´Athlete Biological Passport´ is based on the monitoring of selected biological variables which indirectly reveal the effects of doping, as opposed to the traditional direct detection of doping. Biological monitoring throughout an athlete's sporting career should make any prohibited preparation far harder to implement.

The ´Athlete Biological Passport´ will be used to meet the two-fold objective of pursuing possible anti-doping rule violations under Article 2.2 of the World Anti-Doping Code (Code) – Use or Attempted Use by an Athlete of a Prohibited Substance or a Prohibited Method – and supporting more intelligent targeting of athletes for conventional doping control.

How was this concept developed?

The concept of an ´Athlete Passport´ has been discussed by WADA since 2002. It gained further momentum as a result of questions raised by WADA during the 2006 Olympic Winter Games surrounding "no start" suspensions of athletes by their federations following health checks that reported high haemoglobin levels. Some concerns were expressed at the time regarding the results and their potential relation to doping.

Cognizant of the varying approaches to monitoring blood profiles among different sports, WADA convened a meeting to foster exchange of information and to develop a consensus on the topic. The participants (representatives of International Sports Federations including FIS, IBU, ISU, UCI, and IAAF) agreed that the analysis of blood variables should be considered as part of the anti-doping process itself as it can help to identify abnormal profiles, and that WADA should take the lead in convening further meetings of relevant experts in the field of haematology.

The group, through a series of meetings, came to the consensus that the longitudinal analysis of athlete blood variables should be registered in a database, and should be used in target testing and sanctioning when abnormal values are observed.

When did WADA approve the widespread implementation of the ´Athlete Biological Passport´?

WADA's Executive Committee approved WADA's ´Athlete Biological Passport Operating Guidelines´ on December 1, 2009. These guidelines took effect immediately, and any anti-doping organization (ADO) can now adopt WADA's model to implement a biological monitoring program.

Although the concept is simple, in that different models have already been validated for widespread use in other scientific fields, such as epidemiology, legal medicine or even veterinary monitoring, several key considerations had to be taken prior to its widespread use in the field of anti-doping.

In order to respond to the complexity of this situation, WADA developed a multi-level strategy that included the examination of legal issues and the nature of possible disciplinary decisions, as well as a feasibility study and implementation of strategies that took into account the features and specificities of different sports.

What is WADA currently doing to further develop the ´Athlete Biological Passport´?

As the international independent organization responsible for coordinating and monitoring the global fight against doping in sport, WADA's role and mandate are not to intervene on the operational level in specific sports, but to provide harmonized protocols.

Following extensive expert and stakeholder consultation, WADA drafted and fine-tuned operating guidelines, as well as harmonized protocols for collection, transportation and analysis of blood samples, and results management.

The resulting document – WADA's Athlete Biological Passport Operating Guidelines – was approved by WADA's Executive Committee on December 1, 2009, and took effect immediately. This document provides an overview of the scientific principles behind the blood module of the Athlete Biological Passport and provides practical advice on the implementation of such a program. In addition, it includes mandatory requirements for collection, transportation, analysis of blood samples, and results management, those ADOs wishing to adopt WADA's model will have to follow in order to ensure consistency of application and to comply with the World Anti-Doping Code and the related International Standards.

The ´Athlete Biological Passport Operating Guidelines´ have been established to harmonize the results of monitored variables within the ´Athlete Biological Passport´ to ensure both legal and scientific fortitude. However WADA's Athlete Biological Passport concept does not undermine the validity or efficacy of any existing longitudinal profiling program that an ADO may currently operate. Rather, WADA's Athlete Passport model is intended to equip ADOs with a robust and harmonized framework in which to pursue anti-doping rule violations in accordance with Article 2.2. of the World Anti-Doping Code (Use or Attempted Use by an Athlete of a Prohibited Substance or a Prohibited Method) and support intelligent, targeted testing.In addition, WADA continues to further develop the Passport by working on an endocrine module that includes steroid profiling.

Will the ´Athlete Biological Passport´ replace traditional anti-doping testing?

If the urine and blood tests, which are essentially toxicology tests, are to be maintained and improved through increasingly sophisticated analytical methods, these will inevitably have to be rapidly combined with effective tools such as biological monitoring. In view of the challenges posed by current and future biotechnological methods, an increasingly global and biological approach, similar to that used in forensic science, is necessary in order to respond with the expected efficiency.

The fight against doping relies on several strategies, including the direct testing of athletes as well as evidence gathered in the context of non-analytical doping violations. By combining these strategies, and seeking new ones to address emerging threats, the global fight against doping is more effective.

Resource:

www.wada-ama.org

Hugo Gravil, Paul Ness, Michal Novotny, Clay Sniteman, Chirs Sweir, Todd S. Ellenbecker

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"Techniques to Protect the Forefoot in Elite Tennis Players"

Introduction

Injuries to the foot and ankle in elite tennis players are commonplace and make up a large part of the treatments provided by physiotherapists on the ATP tour. Lynch et al [1] have reported on common injuries to the foot and ankle in tennis players including retrocalcaneal bursitis, Achilles tendonitis, plantar fasciitis, Morton's neuroma, hallux valgus and ridgidus, and hammer toe. While these injuries are commonly encountered and treated with a variety of interventions in elite players, preventative measure including taping to manage the extreme friction and overuse the tennis players' foot endures during high performance play is a very common practice.

Characteristics of On-Court Movement in Tennis.

The high levels of friction and stress the elite tennis players' foot encounters are the result of the multidirectional movement demands inherent in tennis play. It has been estimated that during heel to toe running on tennis surfaces at 3.83 meters per second that peak impact forces between the ground and tennis shoe approximate 2 to 2.3 times bodyweight are experienced. [2] During these repetitive impacts during tennis play, extrinsic loads are also experienced due to the need for tennis players to pivot and push-off to change direction to facilitate lateral movements and changes in direction. [3] Kovacs [4] has summarized typical on-court movements during tennis play reporting an average of 4 directional changes per point with ranges between as little as a single movement to as many as 15 directional changes in a very long point. Up to 1000 directional changes have been reported in a match. Over et al [5] studied the characteristic movements associated with 1,540 tennis strokes performed on clay at Roland Garros. They found that 80% of all strokes were characterized with movements requiring less than 2.5 meters. These repeated maximal intensity movements covering short distances, with many repeated directional changes create excessive stresses to the plantar surface of the skin, which can result in blistering and skin breakdown limiting performance. Physiotherapists' on the ATP tour routinely treat and provide preventative care for the toes and plantar surface of the foot to assist players with existing insults to the skin and prevent skin breakdown by attempting to both protect and mitigate these stresses during competition and practice. The purpose of this article is to provide the reader with a practical, yet comprehensive step by step summary of both, the materials needed and techniques most commonly used to protect the toe and plantar surface of the foot in elite players.

Techniques to Protect the Forefoot in Elite Tennis Players.

Two techniques will be profiled in this article. The first is for protection of the metatarsal phalangeal (MTP) region

Figure 1. Materials needed for protection of the MTP region of the foot

Figure 2.

Padding applied to the plantar surface of the foot.

of the foot and the second is for protection of individual toes of the foot. The materials needed for protection of the MTP region of the foot are shown in figure 1 and include Tuff Skin Spray™ (Cramer), Friar´s Basalm + Q Tips™ (Unilever), Hypafix™ (BSN Medical) 10 cm wide roll, Leukoplast™ (BSN Medical) band and adhesive foam 3- or 4-mm thick.

The technique is profiled in the photos contained in this article. This text follows the figures and helps to describe what techniques are being used and what materials are being applied to the players' foot. The Tuff Skin™ and Friar Basalm™ will prepare the skin and make it sticky enhancing the ability of the preparation to adhere to the players foot. The padding will be made with the Adhesive foam and the Hypafix™ and Leukoplast™ band will be used to fix the padding and maintain its location and support on the foot. Figure 2 shows the shape of the padding (almost like an "L" form).

It must be fairly wide across the foot to provide protection but yet not too wide to bother the player or impede motion or movement of the foot. Above all else, it has to be comfortable, because in some cases the player will have to wear it for 4 hours or more continuously. With a Q Tip™, the Friar's Basalm™ is spread on all the forefoot from the base of the toes to the middle of the foot (Figure 3).

Spread the plantar surface of the foot during application without forgetting the sides and dorsal surfaces of the foot as the Hypafix™ and Leukoplast™ will be fixed on the foot and it needs to hold perfectly. Once it's dry (and only when it's dry), spray the Tuff Skin™ over the same areas and let it

Figure 3.

Preparation of the skin prior to pad application.

Figure 4.

Pad Application on the foot.

dry as well. This preparation of the skin is very important and is the key to avoiding movement or sliding of the padding on the foot.

Remove the protection from the foam and place the padding on the foot at the bottom (proximal to) of the toes as demonstrated. It's very important to avoid any wrinkles so as not create blisters (Figure 4).

Precut the Hypafix™ in the shape of an "H" Figure 5. The length is approximately 10 cm longer than the width of the plantar surface of the foot. Remove the protection or backing on the tape to apply the central part of the "H" beginning with the base of the toes to cover the padding. Then complete the application of the padding by applying the "legs "of the "H" on the sides of the foot, finishing on the dorsal surface of the foot as pictured. It is also important to try not making wrinkles to avoid blisters. Additionally, it is important to take care not compressing the big toe and the 5th toe by applying too much compression on the forefoot during the final application of the Hypafix™ to the foot.

Finally, once the Hypafix™ is in place, the Leukoplast™ band is used to cover the complete tape and padding. It is again important to point out that during the application of the Leuokoplast™ band, great care should be taken to not compress the big toe and the 5th toe (forefoot) Figure 6. Do not use too much tension on the band and finish again with theses strips on the dorsal surface of the foot. In many cases, the physiotherapist can now apply baby powder over the tape to allow the "tape" to slide in the socks.

The second technique demonstrated is to protect the great

Figure 5. - Wrapping of pad with Hypafix™.

Figure 6. - Final covering of pad and Hypafix™ with Leukoplast™.

Figure 7. - Supplies needed for protection of the toe.

toe. This technique can be applied to other toes as well using modifications to the size of the materials cut with similar principles. The supplies needed for this tape job are displayed in figure 7 and include Tuff Skin Spray™, Friar Basalm™ + Q Tips™, Hypafix™ 3x10 cm (10 or 15 strips), Hypafix™ 3x8 cm (2 "special shaped" strips), and vaseline or skin lube.

Figure 8 shows a close up of the 3 cm wide Hypafix™ strips (cut in a 10 cm wide roll), 2 strips cut in a special shape (center of the photo). To make these special shaped strips, fold the strip in the middle, and with a scissors, cut the angles to produce the shape of the tape in central part of the photo.

Figure 8. - Close up of Hypafix™ strips used for technique.

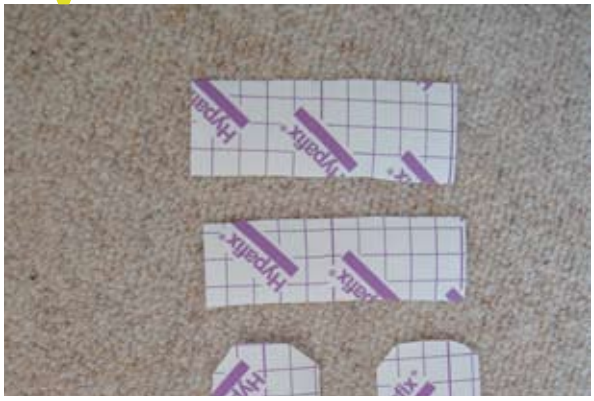

Figure 9.

Skin preparation prior to tape application.

Figure 10.

Application of first strip of Hypafix™.

Figure 11. Application of second strip of Hypafix™.

Figure 12. Finishing steps of taping technique.

The preparation of the skin is similar to the one described above for padding the foot with Friar Basalm™ used first, then Tuff Skin™ (Figure 9).
Spread and spray all around the toe from the bottom to the top being sure to hit all areas to enhance the adhesion of the tape to the toe. Once everything is completely dry (and not before), remove the protection and apply the first special shaped Hypafix™ strip on the top of the toe (Figure 10).

Then, stick one end on the dorsal surface and the other one on the plantar surface. After that, apply the second special shaped strip of Hypafix™ perpendicular to the previous one and stick it on the inside and outside surfaces of the toe. Finally, apply the normally shaped strips (standard rectangular strips) one after the other all around the toe (Figure 11).
These repeated strips will create circles around the toe from the bottom to the top enhancing the adhesion of the initial strips of Hypafix™ to the toe. The number of stripes used will depend on the feeling of the player, but around 10 or 15 strips typically works very well. Once all the strips are applied, spread Vaseline or skin l ıbe between the toe that is taped and the one beside it t ɔ avoid friction and minimize the chance of blisters.

Summary:

These techniques can be applied repeatedly to the player's foot to provide added protection against the stresses and loads that are encountered during high-level tennis play. In addition to these taping and protection techniques, evaluation of the player's foot mechanics and ensuring that proper footwear and sock wear are adhered to forms the basis for the complete care and prevention of the foot for elite tennis players.

Competing interest: none declared

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About the authors

Hugo Gravil

Physiotherapist, ATP World Tour

Metz, France

Paul Ness

Physiotherapist, ATP World Tour

Melbourne Australia

Michal Novotny

Physiotherapist, ATP World Tour

Tenerife, Spain

Clay Sniteman, PT ATC

Physiotherapist, ATP World Tour

Ogden, Utah, USA

Chris Swier

Physiotherapist ATP World Tour

Utrecht, Netherlands

Todd S. Ellenbecker, PT

Director of Sports Medicine,

ATP World Tour

Clinic Director Physiotherapy Associates Scottsdale Sports Clinic

Scottsdale Sports Clinic

National Director of Clinical Research, Physiotherapy Associates

Scottsdale Arizona, USA

Maarten Moen

J Med Sci Tennis 2010;15(2):36-38

Tennis Medicine Update

This section of the JMST discusses three of the most recent tennis medicine-related articles. The most interesting and revolutionary papers are then selected for analysis. For each article a brief overview is given of the hypotheses, methodology, results and conclusions. The information presented is intended to be concise but informative, giving the reader quick access to knowledge.

Management of tennis elbow with sodium hyaluronate periarticular injections

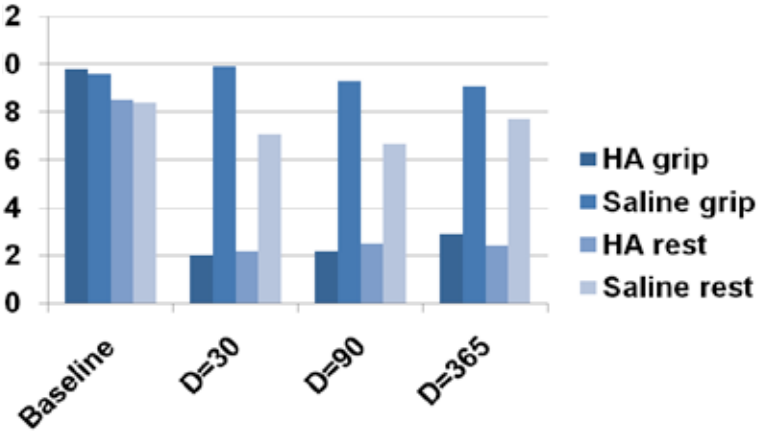
Petrella RJ, Cogliano A, Decaria J, et al. *Sports Med Arthrosc Rehabil Ther Technol* 2010; 2: 4-11

Background:
No consensus exists on the treatment of the tennis elbow. A recent study on ankle sprains showed promising effects of the injection of hyaluronic acid (HA).

Research question/s:
Does injection of HA improve clinical pain and function outcomes in a long term follow-up compared to a control injection in patients with tennis elbow?

Methodology:
Subjects: 331 racquet sport athletes with complaints of clinically diagnosed tennis elbow for more than three months
Experimental procedure: After randomization, the athletes were injected with blinded syringes filled with HA (1%, 1.2 cc) or saline (1.2 cc). Two injections were given, one at baseline and one 7 days after baseline.
Measure of outcome: The VAS pain score at rest and VAS pain score after maximal grip strength were primary outcome measures. Also various satisfaction parameters were noted on a 0-5 scale.

Main finding/s:
The global functioning assessed by patients and physicians was significantly better in the HA group at D=30, D=90 and D=365



Graph: VAS pain scores at rest and after maximal grip strength test over time

Conclusion/s:
Patients receiving HA for tennis elbow had significantly more improvement in VAS pain score at rest and after maximal grip strength test that persisted to 356 days follow-up.

Injury profile in junior tennis players: a prospective two year study

Hjelm N, Werner S, Renstrom *P. Knee Surg* Sports *Traumatol Arthrosc* 2010 Mar Epub

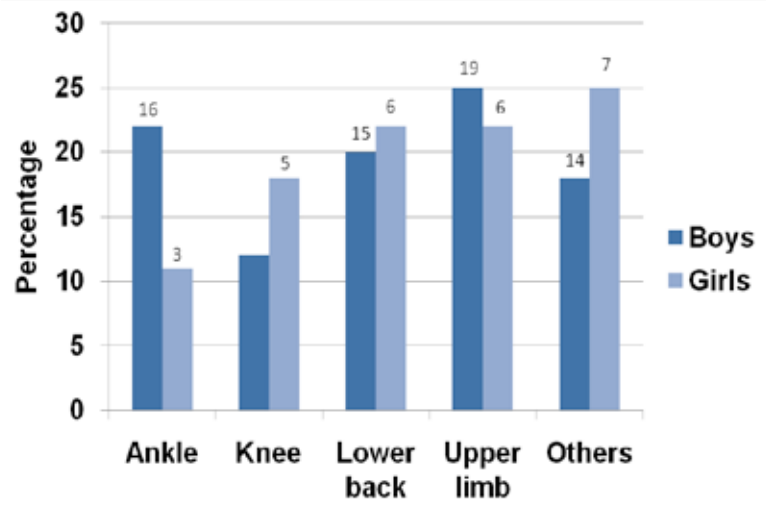
Background:
In epidemiological studies on tennis injuries junior players are the least well studied.

Research question/s:
Which injuries are sustained by junior club tennis players of all levels with respect to gender, anatomical location, type and cause of injuries and degree of severity?

Methodology:
Subjects: 55 tennis players between 12 and 18 years of age who played at least twice a week at a large tennis club in Stockholm, Sweden.

Experimental procedure: After baseline characteristics were taken, tennis players recorded tennis related injuries and hours playing tennis. When an injury was present the investigator examined the player. The investigator contacted the players every third month as well.
Measure of outcome: Location of the injury, type of injury and diagnosis were noted, based on the Orchard Sports Injury Classification System (OSICS).

Main finding/s:
Injury incidence for boys was 1,7 / 1000 hours play and for girls 0,6 / 1000 hours play. 54% of the injuries were due to overuse and 46% were traumatic. The most common causes of injury were hitting a ball, training intensity and unclear genesis.



Graph: Injury distribution according to anatomic region in boys and girls

Conclusion/s:
The injury incidence in junior tennis players is relatively low although 40% of the injuries were considered to be severe and 30% were classified moderate.

Lateral elbow tendinopathy: correlation of ultrasound findings with pain and functional disability

Clarke AW, Ahmad M, Curtis M, et al. *Am J Sports Med* 2010 Mar 24, EPub ahead of print

Background:
Several recent studies presented different findings regarding an association between findings on ultrasound in tendinopathy and clinical outcome.

Research question/s:
Which, if any, ultrasound findings have a significant relationship with clinical outcome in tennis elbow?

Methodology:
Subjects: 62 patients (52% male) with clinical diagnosis of tennis elbow (mean age 43 years). Mean number of days with complaints: 47 days.
Experimental procedure: At baseline an ultrasound was made of all patients which were assessed: for 1) echotexture 2) intrasubstance tears 3) presence of lateral collateral ligament (LCL) rupture 4) tendon thickness 5) neovascularity
Measure of outcome: Ultrasound findings were compared with the clinical outcome after 6 months of eccentric training. The validated Patient-Rated Tennis Elbow Evaluation (PRTEE) was used to assess the elbows.

Main finding/s:
58 of 62 patients had an intrasubstance tear. In patients with a good outcome the mean size was 4 mm and in patients with a poor outcome (change in PRTEE of less than 25 points in 6 months) the mean size was 8 mm.

	p-values
Presence of LCL tear	0,0001
Size of intrasubstance tear	0,0001
Amount of hypoechogenicity	0,001
Age	0,9521
Gender	0,3671
Duration of symptoms	0,3330
Tendon thickness	0,7014
Amount of neovascularity	0,8262

Table: Association of ultrasound finding and clinical outcome

Conclusion/s:
In patients with a tennis elbow, ultrasound can predict a poorer outcome when an accompanying LCL tear or a larger intrasubstance tear is present.

About the author

Working in the Netherlands as a final year registrar in Sports Medicine, Maarten Moen provides medical support for the Siemens Open Challenger tournament. His main interests in medicine and tennis medicine are in bone overload and muscle injury. He is currently working on randomised controlled trials in these fields.

Maarten is a tennis player and coach. In 2004 he gained experience working at the IMG Bollettieri Tennis Academy . He is now based in his home town of Amsterdam.

Conference Calendar

San Diego Shoulder Institute 27th Annual Course: Arthroscopy, Arthroplasty, and Fractures
Hyatt Regency at Aventine, San Diego , USA . June 23 - 26, 2010
www.shoulder.com

10th Amsterdam Foot and Ankle Course
University Hospital AMC. Amsterdam , NETHERLANDS.
June 24 - 25, 2010 - www.ankleplatform.com

Shoulder and Elbow Meeting
Corfu Imperial - Grecotel Exclusive Resort. Corfu,
GREECE. June 27 - 30, 2010
http://guest.cvent.com/EVENTS/Info/Summary.aspx?e=b6e56836-8b96-48a4-9b1b-15acf1fe9304

Advanced Instructional Course on Arthroscopy of the Shoulder, Elbow and Knee
University Medical Centre. Utrecht , NETHERLANDS. July 5 - 8, 2010
www.shoulder-elbow-knee.nl

The Ligament Reconstruction Seminar & Live Surgery in Sapporo
Faculty House "Enreisou". Sapporo , JAPAN
July 29 - 30, 2010. Fax: 81-11-707-782

The 2nd Biennial Asia Arthroscopy Congress
China National Convention Center. Beijing , CHINA
September 10 - 12, 2010 - www.aac2010beijing.org

45th Knee Severance Arthroscopy Fresh Cadever Workshops
Surgical Anatomy Education Center; Yonsei University Anatomy Department. Seoul , SOUTH KOREA. September 18, 2010
www.severanscopy.com

Indian Arthroscopy Society Annual Conference 2010
GRT Bay Hotel.Chennai , INDIA
September 24 - 27, 2010 - www.IAS.com

2010 Korea Arthroscopy Society Annual Meeting With Arthroscopy Master of ASIA in October 1-2, 2010
Konkuk University Hospital Auditorium. Seoul , KOREA
October 1, 2010 - www.korarthro.com

46th Shoulder Severance Arthroscopy Fresh Cadaver Workshops
Surgical Anatomy Education Center; Yonsei University Anatomy Department. Seoul , SOUTH KOREA
October 2, 2010 - www.severanscopy.com

4nd Advanced Course on Knee Arthroplasty - 14èmes Journées Lyonnaises de Chirurgie du Genou
Centre de Congrès. Lyon , FRANCE
October 7 - 9, 2010 - http://www.lyon-genou.com

Ukrainian Congress of Arthroscopy, Knee Surgery and Sport Trauma
Hospital "Feofania" - Kiev , UKRAINE
October 7 - 8, 2010 - www.uastka.org

10th Turkish Sports Traumatology, Arthroscopy and Knee Surgery Congress
Gloria Hotels and Resorts. Antalya , TURKEY
October 12 - 16, 2010 - www.tusyad2010.org/eng

Orthopedic Surgery Controversies 2010
Silverado Resort. Napa , USA - October 14 - 16, 2010
www.orthopedicsurgerycontroversies.com

4th International Hip Arthroscopy Meeting
Alte Kongresshalle. Munich , GERMANY
November 19 - 20, 2010
www.ocm-muenchen.de; www.intercongress.de

6th Meeting of the European Federation of National Associations of Orthopaedic Sports
Dolce La Hulpe. Brussels , BELGIUM
November 25 - 27, 2010 - www.efost2010.com

SFA Annual Congress
Grand Theatre de Provence. Aix en Provence , FRANCE
December 1 - 4, 2010 - www.sofarthro.org

Basic & Advanced Knee Arthroscopy
Learning Resource Centre,Cairo University. Cairo , EGYPT
December 2 - 3, 2010 - www.lrc.edu.eg

Basic Shoulder Arthroscopy
Learning Resource Centre, Cairo University. Cairo , EGYPT
December 4, 2010 - www.lrc.edu.eg

BILBAO SHOULDER 2010
June 10 - 11, 2011
Bilbao Exhibition Centre. Bilbao, Biscay Spain
www.bilbaoshoulder.com

ACSM- Advanced Team Physician Course
12/9/2010
Grand Hyatt Washington. Washington, District of Columbia
United States

ACSM Conference on Integrative Physiology of Exercise
September 22-25, 2010
Eden Roc. A Renaissance Beach Resort & Spa
Miami Beach, Florida.

Maarten Moen, Babette Pluim

J Med Sci Tennis 2010;15(2):40-41

"Hot Topics in Tennis Medicine Hosted by Båstad"

In May 2010, the Swedish Tennis Association and the Swedish Society of Sports Medicine organized a tennis medicine conference in the southwest of beautiful Sweden. The town of Båstad was the location for another outstanding congress on hot topics in tennis medicine. A few months earlier things were not so hot in the south of Sweden, with one of the fiercest winters since years. But now, the scenery was perfect with Båstad being located on the shoreline, with a pretty harbor, lots of green trees, picturesque wooden houses and some great clay courts on top. Who did not want to immigrate on arrival?

Apart from the perfect picture, the conference started of perfect as well, with introductions from Per Renström, Tönu Saartok and Henrik Ekersund. After this, on Tuesday morning, different international speakers presented on a wide range of topics. In addition to orthopedic surgeons, sports physicians, and physical therapists, lots of tennis coaches were present as well. In the afternoon, Professor Bruce Elliott kicked off with an excellent presentation on power development in tennis, which led to multiple questions from the audience. Later on, the conference went on with a symposium on elbow and wrist injuries. It became apparent that the whole kinetic chain, starting in the feet, should be examined to find an explanation for the complaints more distally. Due to the fact that one speaker thought he had to present a day later, Bruce Elliott and Ben Kibler took the stage and free styled about the kinetic chain and its effect on groundstrokes. After this, theory was transformed into practice on the lush Båstad clay courts. The Båstad tennis academy and Anders Jarryd, a resident of Båstad, provided a great and sweaty tennis clinic. After freshening up, in the evening, dinner was served at the Båstad tennis museum, with a wide array of tennis history (the Båstad tennis tournament in July of the year is on the tennis schedule for decades already).

Wednesday morning started-off with a talk by Stuart Miller on equipment in tennis while at the same

time the free presentations started (on the effects of glenohumeral internal rotation deficit "GIRD" and the use of platelet rich plasma in sports medicine). After this, the audience was totally ready for the shoulder symposium by Bruce Elliott, Ben Kibler, Giovanni Di Giacomo, Marc Safran and Anne Cools. Many interesting facts and theories were presented and the audience learned the favorite body parts of some speakers. Ann Cools was "addicted" to the lower trapezius muscle, while Ben Kibler had a "love affair" with the scapula. The afternoon continued with imaging in tennis medicine and a new symposium; this time on the hip and groin. Different surgeons and orthopedic surgeons guided the audience through the difficulties in establishing a diagnosis and provided insight in the state of the art treatment of injuries in this area. The rest of the afternoon focused on rehabilitation (mainly on shoulders) and recovery, both physically and mentally.
After a little break, everybody gathered for the outstanding diner in the main hotel (where most of the conference participants stayed). All people enjoyed themselves and laughed especially loud when Per Renström announced that in his younger years, he ones slept on the beach (which could easily be seen from the hotel) due to a lack of money…
On Thursday, more conference attendees arrived, since on this day the Swedish Sports Medicine conference also started. They listened to presentations about health benefits of tennis by Babette Pluim and Professor Karl Weber, who was in favor of cardio tennis. He provided the evidence of its effectiveness on health. The morning session was pimped up by energetic moderators like Michael Turner and Anna Frohm, although the program was a bit postponed due to the long laughing sessions after Michael Turners comments on the presenters.
Most participants left Sweden shortly after these last presentations, but some could not resist hitting a few more strokes on the scenic clay courts of the academy. With that, a great and outstanding conference was finished. Thank you Båstad !



Erratum

Carl Petersen. Learning to land: Basis of ACL protection for tennis.

J Med Sci Tennis February 2010;15(1):23-28.

In this paper, it should be noted that the first paragraph following the subheading "The Female Athlete" do not correspond to this article. That paragraph should be disregarded. The publisher would like to apologize for this error.

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