COACHING & SPORT SCIENCE REVIEW

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COACHING & SPORT SCIENCE REVIEW

The Official Coaching and Sport Science Publication of the International Tennis Federation

EDITORIAL

Welcome to issue 73 of the ITF Coaching and Sport Science Review, the final issue of 2017. The articles in this issue cover a wide selection of tennis specific topics; the current nature of tennis at the elite level from recent data trends, nutrition strategies in tennis, the effects of varied practice and key considerations for players and coaches when working with the media.

This issue follows the conclusion of the landmark 20th ITF Worldwide Coaches Conference by BNP Paribas in Sofia, Bulgaria in October. ITF President David Haggerty and the Bulgarian Tennis Federation hailed this year's event a resounding success. The President opened the conference addressing the delegates and highlighting that "development of the game is one of the key strands of ITF 2024, the long-term plan for sustainable growth, and coaches play a big part in that. There are so many different aspects within development," he explained. "We're talking about developing, growing and promoting the game and coaches do each of those".

'The journey of the player' was the theme of the week in Bulgaria, with the week's presentations beginning with high-energy grassroots level sessions for young players aged 4-12 years old delivered by; Ruben Neyens (BEL), Sam Richardson (GBR) and Anne Pankhurst (GBR) and progressing to the elite side of the game with insights and personal journeys from renowned former professional players and tour coaches including; Mary Pierce (FRA), Magdalena Maleeva (BUL), Elena Likhovtseva (RUS) and Louis Cayer (CAN). The afternoon workshop presentations also gave diverse and significant knowledge applicable to all levels of coaches and were well received. Presentations were also delivered on the importance and role of coaches to the ITF's Anti-Doping programme, the Tennis Integrity Unit and the efforts being made to educate coaches against corruption and betting related offences and the ITF Transition Tour 2019.

The ITF/Olympic Solidarity courses and scholarships programme has proven to be world leading in a report published by the IOC for the years 2013-16. The objective of this programme is to provide training to active, officially recognised coaches through courses led in the country by an expert approved by the relevant International Federation. Between the 2013-16 period, National Olympic Committees organised almost 1,000 technical courses across more than 30 summer Olympic sports. The ITF was delighted to see that tennis ranked among the top 3 sports for organising these courses for coaches around the world cementing the ITF Coach Education programme as world leading in its ongoing efforts to produce more and better coaches.

Updated content on Tennis iCoach sees new presentations from the 2017 LTA National Coaches' Conference and the 20th ITF Worldwide Coaches Conference. The new resources cover; doubles tactics for U14 girls, current game-styles observed in professional women's tennis and what coaches should be working on to develop female players for the future, dynamic balance training for U14 players and the latest biomechanics applications in tennis.

The official research study evaluating 'the impact of the ITF Tennis Play and Stay campaign on the tennis industry, since its inception in 2007' will be completed soon. The research, which is being administered by the Institute of Sport, Exercise and Active Living (ISEAL) at Victoria University, Australia, will seek to acquire a broader understanding of the actual adoption and the impact of the campaign by consulting with the National Tennis Associations; the tennis equipment suppliers and manufacturers; teachers and coaches who deliver programmes relate to the campaign; and the players impacted. To provide you feedback on the ITF Tennis Play and Stay campaign, please click here to complete a short online survey.

We thank you for your continued support in 2017 and hope that you find the 73rd edition of the ITF Coaching and Sport Science Review insightful and that it will keep allowing coaches across the world to develop their coaching knowledge using the latest scientific research. As always, you can continue to make use of all the ITF´s comprehensive coaching resources and news by visiting the ITF coaching website here.

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Tennis at the elite level – An ITF technical centre review

Jamie Capel-Davies (GBR)

ITF Coaching and Sport Science Review 2017; 73 (25): 3 - 5

ABSTRACT

In order to fulfil its mission, the Technical Centre strives to quantify the parameters that describe the current nature of tennis at the elite level, and thus constitute 'the state of the game'. The Technical Centre's annual review of the state of the game consists of player analysis, including match statistics, and monitoring the equipment used by players.

Key words: player analysis, equipment analysis, match statistics

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PLAYER ANALYSIS

Physiology

Figure 1 shows that the average height of the top 50 women has increased by 1 cm since 2002, compared to an increase of 4 cm for the top 50 men. This increase in the average height of the men was due to the number of players over 200 cm tall that are currently active – in 2002 there were none – and a general increase in height across all 50 players (figure 2). Taller players typically have a greater arm span, which results in a higher racket head speed (for a constant swing speed), and hence faster serve. In addition, taller players are able to serve with a steeper trajectory and with a greater margin for error. In 2002, women in the top 50 were 12 cm shorter, on average, than their male counterparts. This difference has now increased to 15 cm. The tallest woman in the current top 50 is 4 cm shorter than the average height of the top 50 men (189 cm).

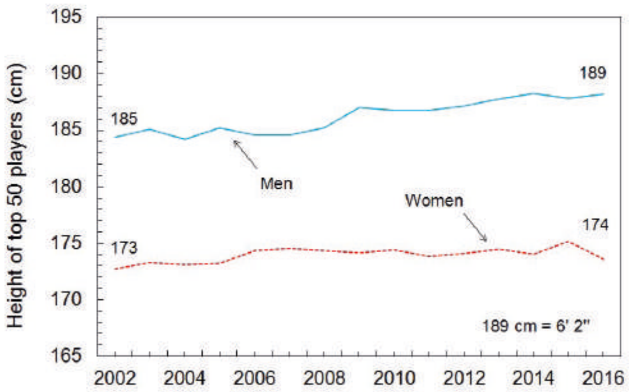

Figure 1. Average height of top 50 men (blue) and women (red).

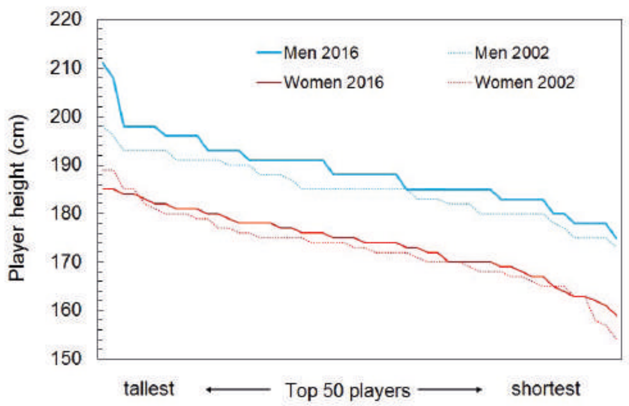

Figure 2. Individual heights of the top 50 men (blue) and women (red) in 2002 and 2016.

Figure 3 shows that since 2002 the average age of the top 50 women has increased by 2 years, while the average age of the top 50 men rose by 3 years. In 2002, few players in the men's or women's top 50 were over 30 years old. Currently, nearly half of the top 50 men are in their thirties (figure 4). This suggests that the careers of the top players are being extended and fewer younger players breaking into the top 50 than did previously.

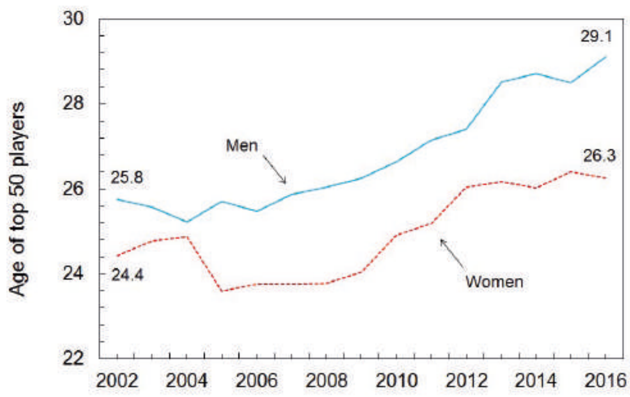

Figure 3. Average age of top 50 men (blue) and women (red).

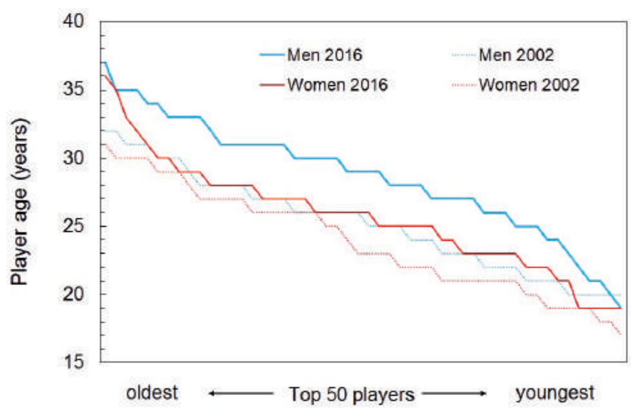

Figure 4. Individual ages of the top 50 men (blue) and women (red) in 2002 and 2016.

Serve speed and success

In both the men's and women's game, serve speed increased between 2002 and 2005, before reaching a plateau in most of the Grand Slams (figure 5). Since 2012, serve speed at the Australian Open has been increasing (for both men and women). Over the past decade, the top 20 fastest serving men served, on average, at 220 km.h-1 and the women at 185 km.h-1. The only major deviation from these values during this period was in the women's 2010 competition at Roland Garros, which appears to have been an anomaly (at 195 km.h 1).

Figure 6 shows that the incidence of aces in the women's game has been reasonably stable since 2002. In the men's game the frequency of aces at Wimbledon has increased, and was roughly double that of Roland Garros for much of the period. Throughout the period, men served aces at twice the rate of women, which can be attributed to the 35 km.h-1 average difference in serve speed between the genders. Figures 5 and 6 suggest that the increase in stature in the men's game has not greatly impacted the speed of serve, but may have influenced the numbers of aces (as the additional height could have been used to improve the placement of the serve).

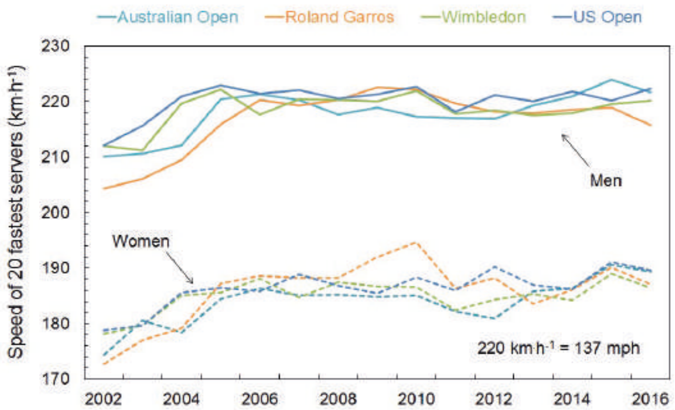

Figure 5. Average serve speed for the fastest 20 servers in Grand Slam singles.

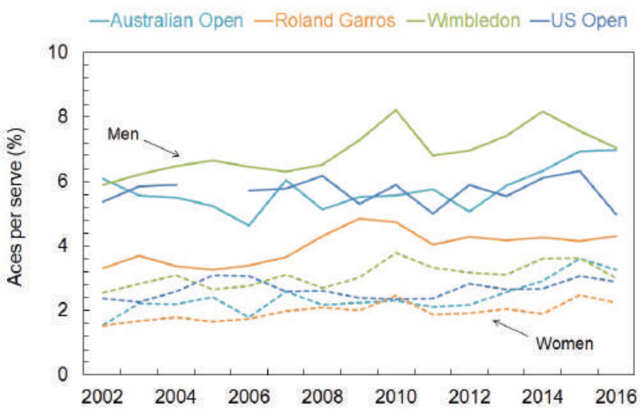

Figure 6. Percentage of aces per serve in Grand Slam singles.

The serve has been most potent at Wimbledon, which is testament to the influence of the speed of the court (figure 7). The recent increase in serve speed at the Australian Open correlates with an increase in ace rate and serve points won. Surprisingly, the 10 km.h-1, or so, increase in serve speed between 2002 and 2005 had little impact on serve points won (or aces). It is also remarkable that although the aces served were less frequent at Roland Garros serve points won were comparable to those at both the Australian Open and US Open between 2006 and 2013.

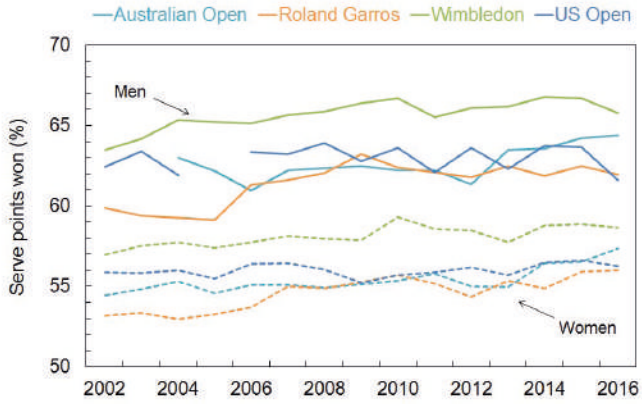

Figure 7. Percentage of points won on serve in Grand Slam singles.

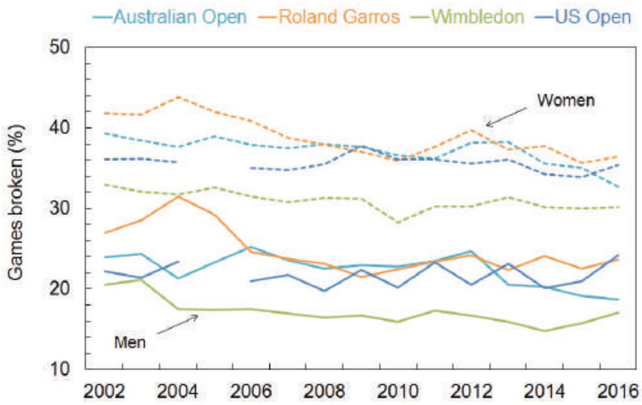

Figure 8. Percentage of games broken in Grand Slam singles.

Figure 8 shows the impact of serve points won on games broken. The serve has been less dominant in the women's game than it has been in the men's. In the past 10 years, the average percentage of games broken in men's matches has been less than 25% at all of the Grand Slams and below 20% at Wimbledon.

EQUIPMENT ANALYSIS

Rackets

Figure 9 shows the variation in strung mass of the rackets used by the top 50 men and women in 2016 . The most common racket mass for both men and women was 322 g, although the men's average racket mass was 6 g heavier (325 g compared to 319 g).

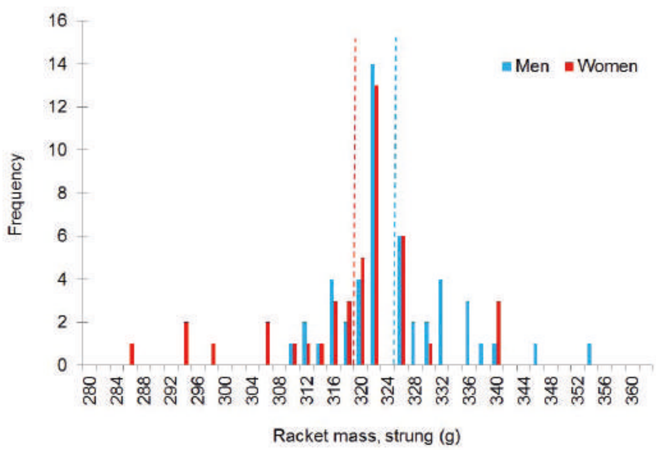

Figure 9. Distribution of strung mass for rackets used by the top 50 men (blue) and women (red) in 2016 (data from Tennis Warehouse University). Dashed vertical lines indicate the mean values for each gender.

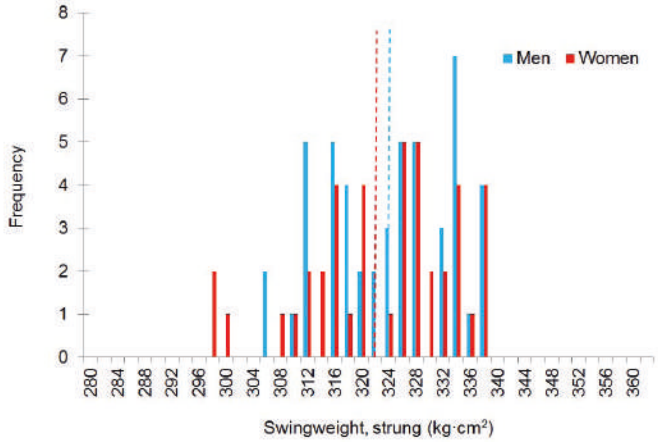

Figure 10. Distribution of strung swing weight for rackets used by the top 50 men (blue) and women (red) in 2016 (data from Tennis Warehouse University). Dashed vertical lines indicate the mean values for each gender.

There was little difference in the variation in swingweight (distribution of mass within the frame) of rackets used by the top 50 men and women in 2016 (figure 12). The average swingweight for men was 324 kg·cm2, compared to an average of 322 kg·cm2 for women. Greater racket mass and swingweight generate faster serve speeds (for a given swing speed).

Balls

Figure 11 shows a general trend of increasing bounce height for balls obtained from tournaments up to 2013, which would increase serve speed (all other factors being equal). However, in each of the last three years the average bounce height of tournament balls has decreased. The average bounce height of tournament balls is now the same as that for balls submitted for approval (which has typically remained close the midpoint of the specifications since 2002).

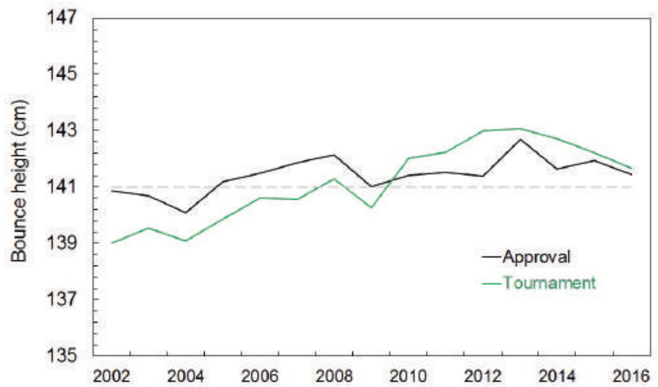

Figure 11. Average bounce height of pressurised balls for tournaments and approval. Dashed horizontal line indicates the midpoint of the specification.

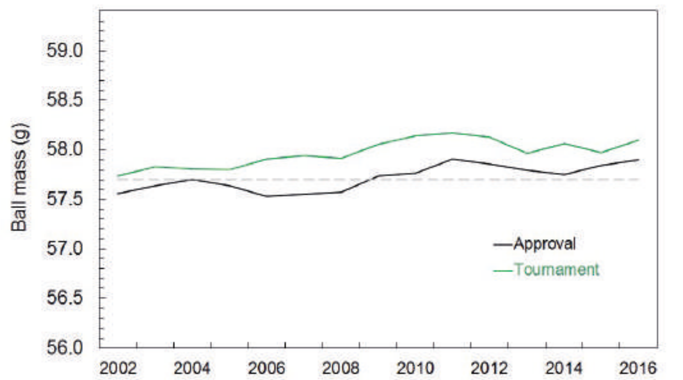

Figure 12. Average mass of pressurised balls for tournaments and approval. Dashed horizontal line indicates the midpoint of the specification.

Figure 12 indicates that the mass of tournament balls has increased slightly over time, which has negligible impact on the speed of the serve (at the point it reaches the receiver), and has been continually greater than that for balls submitted for approval by manufacturers. The average values for tournament and approval balls have remained within 0.5 g of the midpoint of the specifications (57.7 g).

CONCLUSION

The average height of the top 50 has increased since 2002: by 1 cm, to 174 cm, for women; and by 4 cm, to 189 cm, for men. These increases in stature have not had a noticeable impact on serve speeds of the top 20 fastest servers at the Grand Slams. The men served, on average, 35 km.h-1 faster than the women, resulting in double the frequency of aces. The effectiveness of the serve has increased at Roland Garros, and more recently at the Australian Open, but continues to be most potent at Wimbledon. The serve is a key shot in the game and constituted over a quarter of all shots in the Davis Cup and Fed Cup.

The top 50 men tended to use only marginally heavier rackets than their female counterparts in 2016, and was little difference in the swing weight of the rackets between the genders. Therefore, the choice of racket is unlikely to be responsible for the difference in men's and women's serve speed. The average bounce height of balls used in tournaments has decreased over the last three years, to the point where it is close to the midpoint of the specification (and the value for balls submitted for approval). The average mass of balls used in tournaments has increased slightly, but remains close to the midpoint of the specifications.

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Make the media your ally

Janet Young (AUS) and Kerryn Pratt (AUS)

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ABSTRACT

This paper provides an overview of key considerations for working with the media. While enormous potential exists to reach and build relationships with players and other stakeholders, coaches should be mindful of the risks associated with inaccurate and disparaging communications.

Key words: media, communication, information

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INTRODUCTION

The media is part of everyday life. While it can mean different things to individuals, the media has been recently defined as "*a range of communication modalities including traditional ones like print, television and radio, but also internet-based communications such as online magazines, podcasts and blog*" (Matthews, 2015). Unquestionably the media landscape has changed dramatically in recent times, so much so that we are said to be living in an "*era of instantaneous information transmission*" (Shoemaker & Ashburn, 2000). Never has this been more evident than in the explosion of digital and social media leading to new ways of communicating with, and engaging an audience. We need look no further than the billions of people around the world who have Facebook, Instagram and Twitter accounts!

Any user of electronic devices can create and post content, bypassing the "*old media*" gatekeepers such as journalists, editors or producers. This revolutionising of content production provides amazing opportunities, but there can be pitfalls.

It is understandable that some coaches have been hesitant to engage and work with the media; others will have embraced the media as spokespeople, presenters, writers and consumers (e.g., receiving news via online or social media). Looking forward, coaches will need to work with the media as it becomes more and more our 'modus operandi'. We all need to be communicators, and effective communicators at that! In this article, we highlight some key considerations to facilitate effective engagement with the media and offer some practical strategies to ensure that a coach's communication is clear, accurate and ethical.

Examples of media activities

Many media opportunities exist for coaches including:

- Providing content for a tennis magazine, local paper, radio or newsletter
- Writing an editorial or a letter to a publisher/editor
- Providing opinion about tennis and/or delivering messages across a variety of mediums
- Influencing policy and direction of tennis by rousing public opinion with information and messages through social media that are then picked up by traditional media outlets
- Preparing releases/flyers/brochures/website etc. about tennis programmes, camps and other tennis activities
- Using Twitter, Facebook, Instagram and blogs etc. to connect with players, parents and other stakeholders
- Commentating on matches for radio, television, podcasts etc.
- Developing video clips for training purposes

Potential benefits

The explosion in media options, and particularly the increasing use of social media, has far-reaching potential benefits for coaches including:

- Direct dissemination of information broadly and quickly
- The ability to control the message, particularly via digital media
- Raise awareness of/promote coaching business and activities
- Build and strengthen professional and business relationships
- Facilitate active interactions with players, other coaches, etc.
- Engage players and teams in actively producing content
- Establish and build coaching/personal profile
- Promote and grow the sport

Choice of media option(s)

Coaches need to consider many factors when deciding which media options to engage with. Relevant factors include:

- How best to reach the target audience – which medium works best and what style within that medium?
- Your personal style, prior experience and level of confidence – for example, are you more comfortable in writing material than presenting before a television crew
- The opportunities to present verbal or written materials
- Most effective use of social media, for instance whether to produce a written or audio-visual blog, and the style, for example, first person or observational
- The cost and time involved in preparing, presenting and distributing material
- Identifying a journalist/publication that is most likely to be interested and positive about your message

Have a story to tell

Before engaging with the media coaches should ensure they have a story to tell. This means:

- Know what you want to say and achieve
- Carefully choose words (verbal and/or written) to best appeal to your target demographic. When communicating with laypeople, avoid jargon/technical terms but use them for specific target groups
- Avoid using disparaging or negative language
- Ensure your story contains, and is limited to, 1-3 key messages
- Consider including photos, diagrams, videos, effects, fun facts or even humour to enhance interest

- Be clear about your audience and tailor communication accordingly (e.g., use digital/social media to engage with youngsters and more traditional communication such as emails or newsletters to parents)

Preparation

Effectively telling a story entails thorough preparation so it is vital for coaches to:

- Ensure you have sufficient detail about the audience, topic to be addressed, length/time of presentation, any deadlines etc
- Take time to update your knowledge and research a topic/issue – what is the latest information to inform your communication?
- If using traditional media, such as local newspaper or radio station, invest time in developing a relationship of trust with the relevant personnel - journalists/producers/hosts - to give your message the best chance of being delivered accurately and positively
- Prepare a draft of written material, to be checked by someone else or yourself some time later, before releasing
- Practise presentations such as talks, lectures or interviews prior to the event – this can be done in front of colleagues/friends or in front of a mirror if more convenient
- Practise bringing an interview back to your message
- Think before you hit the send button - digital communications are instant and largely irretrievable
- Ensure you are conversant with all aspects of your subject and potential follow up questions/relevant issues

Ethical considerations

Coaches should be mindful of their duty of care and professional responsibilities. This means:

- Stick with what you know; keep to the facts and ensure your information is accurate and timely
- Understand your professional boundaries and communicate only on matters/topics/issues where you have the relevant expertise and experience. Refer to others if outside your area of expertise
- Before disclosing information about your players get their permission to do. Likewise, before disclosing sensitive information or presenting the work of others, get relevant consents
- Provide comment about others in an objective, respectful and accurate way. It is best to avoid hearsay and keep comment to your own direct experiences
- Ensure your opinions (the currency of social media!) are informed, well expressed and respectful
- Evaluate the potential impact or consequences of your communication BEFORE actioning it
- Show passion about a matter/topic/issue but avoid emotive comments that could be construed as offensive, bigoted, 'out-of-touch' or defamatory

Risks

The ability for coaches to disseminate information quickly and widely to many people carries potential risks including:

- Substantial damage resulting from inaccurate or ill-advised communications
- Threats to confidentiality and safeguarding player/client confidences

On-going development

Given the rapidly changing media environment coaches can be vigilant and attend to their on-going professional development. To this end you may wish to:

- Attend coaching conferences
- Access relevant materials on the ITF coach website, http://en.coaching.itftennis.com/home.aspx
- Keep coaching qualifications current by fulfilling professional development requirements
- Undertake media training with special attention to the use of digital and social media
- Access the multitude of media/communications material on the web for guidance
- Keep up with new media trends to further your business, relationships and profile
- Discuss with colleagues to identify best practice
- Evaluate what peers are doing in media to help guide your own media strategy

CONCLUSIONS

It is understandable that some coaches may be reluctant to work with the media, but the growth of digital media has undoubtedly given coaches greater control over direct communications. Still, all comments need to be carefully considered. The safeguard might be imagining your opinion, quote or message on the front page of the newspaper or being announced to a room full of your colleagues/peers. Only go ahead if you are comfortable with this scenario.

Clear communication and setting boundaries with journalists regarding what is 'off the record' and what exactly you will be quoted about can save much angst and damage.

In the first author's case, comments she made to a journalist several years ago were taken out of context reflecting poorly on one of her players. While a formal apology was given by the journalist, it was an experience that left a mark and trepidation to again discuss tennis matters with any journalist. Other coaches may have had similar experiences however the fact remains that we, as coaches, can gain much if we embrace the media to help promote our professional profile, businesses, players and the sport. Further, todays offerings of media options provide tremendous potential for us to engage with, and build relationships, with players and other key stakeholders (Wang & Zhou, 2015). With the touch of a computer key coaches can disseminate information 'in real time' and reach literally millions of people. But this ability to rapidly and widely disseminate information has a downside. There is potential for damage resulting from inaccurate or disparaging communication; especially in light of our inability to retract in many instances once the communication is released.

For information to be shared effectively, coaches should be mindful of a number of important factors including adherence to professional boundaries and respect for player confidentiality. It is critical that coaches exercise careful judgement and sound common sense in what they say/write, and how, and where they say/write it. Always pause to think twice about the potential impact of what you have to say or write (Shoemaker & Ashburn, 2000).

It is hoped that this paper provides guidance to facilitate clear, accurate and ethical communications. Much can be achieved when coaches embrace the media after completing due diligence to understand, not only its potential, but also its risks. Nothing is more important to a coach than player-coach relationship(s) and his/her reputation. With considered use of the various media available, relationships and reputations need not be jeopardised. Indeed, with awareness and preparation, they can be powerfully enhanced by using the media effectively. Making the media an ally seems a beneficial, sensible and wise approach to take.

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ITF/GSDF boys' teams - 30 years of history

Ivan Molina (COL)

ITF Coaching and Sport Science Review 2017; 73 (25): 9 - 10

ABSTRACT

After thirty years of traveling with the ITF team I want to do a review of some of the tours, players, results on the junior and pro circuit, and the countries involved across all of these years with the different boys' teams that I was taking part of it.

Key words: ITF, GSDF, juniors, teams

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INTRODUCTION

European Tour

1987 was the year the ITF, headed by Development Director Doug MacCurdy and with the support of the Grand Slam Tournaments, decided to create a program for the benefit of junior players to help those less developed nations to bring players to international exposure by competing in the best junior tournament around the world.

The first ITF/GSDF team competing in Europe had the participation of 20 players, 10 boys and 10 girls, with one boy and one girl each representing the ten South American countries. We were two coaches and one tour manager for the whole team.

Up until 1994, the team consisted only of South American players and one Mexican player. In 1995, the new Development Director Dave Miley decided to have an International team including all continents to give players from all over the world the opportunity to be part of this program. Also, he added new teams. The program continues as such to this day.

During the past 30 years, a total of 221 players participated from 62 different countries participated in this program.

Other teams

- Florida Tour: This tour was created in 1999 until 2002 to compete in tournaments such as the Eddie Herr and the Orange Bowl. After a break, in 2010 it was played for the last time. A total of 14 players from 13 different countries had the opportunity to compete in this tour.
- USA/Canada Tour: This tour was created in 1999 and is still on the calendar: 81 players had the opportunity to participate in this tour when I was with them as a coach, representing a total of 42 countries. Then from 2013 to 2015, I was absent and some other coaches were there with a group of players. In 2016 I was again part of the team. A total of 7 new countries not involved in other teams were here.
- Mexico/Florida Tour: This tour began in 2012 and continues to this day. 12 boys have competed in this tour from 12 different countries.

BEST BOYS' PERFORMANCES STATISTICS

Grand Slam Singles Titles or Runner Up in Boys:

1993 Wimbledon runner up - Jimy Zsymansky (VEN)

1999 US Open winner - Jarkko Nieminen (FIN)

2001 Australian Open winner - Janko Tipsarevic (former Yugoslavia)

2003 Wimbledon winner - Florin Mergea (ROU)

2003 Australia winner - Marcos Baghdatis (CYP)

2005 US Open winner - Ryan Sweeting (representing Bahamas)

2007 Roland Garros winner - Vladimir Ignatik (BEL) also runner up at Wimbledon

2007 US Open winner - Ricardas Berankis - LTU

BOYS' GRAND SLAM DOUBLES TITLES

1994 US Open - Nicolas Lapentti (ECU)

1994 Roland Garros - Gustavo Kuerten (BRA)/ Nicolas Lapentti (ECU)

1997 Roland Garros - Jose De Armas (VEN)/ Luis Horna (PER)

1997 Wimbledon - Luis Horna (PER)/ Nicolas Massu (CHI)

1997 US Open - Nicolas Massu (CHI)

1998 Roland Garros - Jose de Armas (VEN)

2002 and 2003 Wimbledon Florin Mergea (ROU) / Horia Tecau (ROU)

2005 Australia - Kim Sun-Yung (KOR)

2008 Roland Garros - Henri Kontinen (FIN)/ Cristopher Rungkat (IDN)

2008 Australian Open and Wimbledon - Hsieh Chen Peng (TPE)

2009 Australian Open - Francis Alcantara (PHI)/Hsieh Chen Peng (TPE)

2009 US Open - Hsieh Chen Peng (TPE)

2010 Roland Garros and US Open doubles - Duilio Beretta (PER)/ Roberto Quiroz (ECU)

2017 Australia - Yu Hsiou Hsu (TPE)

2017 Wimbledon and US Open - Yu Hsiou Hsu (TPE)

Other Titles in Grades A/1

During the different years the boys competed in tournaments of the European tour, which usually began in Santa Croce and ended at Wimbledon, there was always a champion in singles in each of them.

Total number of boys players in different teams

326 boys' players have competed in all of the programs in which I was involved, some of them have been selected to participate in the different tours in the same year and also some have played for two or more years as well.

The total number of countries that have received the opportunity to bring their players to the different tours is 65.

BEST PERFORMANCES OF FORMER ITF/GSDF JUNIOR PLAYERS ON THE PROFESSIONAL CIRCUITS

- Top 10 Pro Singles Ranking Players: Gustavo Kuerten (BRA), Mariano Puerta (ARG), Paradon Srichapan (THA), Marcos Baghdatis (CYP), Nicolas Massu (CHL), Nicolas Lappenti (ECU), Janko Tipsarevic (SRB)
- Top 20: Hernan Gummy (ARG), Victor Troicki (SRB), Jarkko Nieminen (FIN)
- Top 50: Fernando Meligeni (BRA), Luis Horna (PER), Thomas Belucci (BRA), Ricardas Berankis (LTU), Yen Hsun Lu (TWN), Hyeon Chung (KOR), Damir Dzumhur (BIH)
- Top 100: Mauricio Hadad (COL), Jimy Zsymansky (VEN), Luis Herrera (MEX), Ramon Delgado (PRY), Alejandro Hernandez (MEX), Yeu Tzoo Wang (TPE), Ryan Sweeting (USA), Gastao Elias (POR), Alejandro Gonzalez (COL), Radu Albot (MDA), Ricardo Mello (BRA)

GRAND SLAM TITLES

Singles as professionals

Gustavo Kuerten won the French Open title three times in singles: 1997, 2000 and 2001. He achieved a highest ATP ranking of # 1 in 2000.

Mariano Puerta from Argentina was runner up at the French Open in 2005. His highest ATP ranking was # 9 that same year.

Grand Slam Doubles Titles or Runner Up as Professionals

Wimbledon

2010, 2011 and 2012 - Horia Tecau (ROU), runner up
2013 - Marcelo Melo (BRA), runner up
2015 - Jean Julian Roger (NED)/ Horia Tecau (ROU), winners
2017 - Marcelo Melo (BRA), winner

Australian Open

2014 - Raven Klaasen (RSA), runner up
2016 - Bruno Soares (BRA), winner
2017 - Henri Kontinen (FIN), winner

French Open

2008 - Luis Horna (PER), winner
2015 - Marcelo Melo (BRA), winner

US Open

2010 - Aisham Ul-Haq Quereshi (PAK), runner up
2013 - Bruno Soares (BRA), runner up
2016 - Bruno Soares (BRA), winner
2017 - Jean Julian Roger (NED)/ Horia Tecau (ROU), winners

2017 GRAND SLAMS COMPETITIONS – PROFESSIONALS COMPETING

- Australian Open: A number of nine players who did the ITF juniors in the past were competing in the 2017 singles main draw. In doubles, fourteen players played main draw in this event
- Roland Garros: A total of nine players in singles who in the past were part of the ITF junior teams were competing this year in the main draw of the Roland Garros tournament, all of them in the top 100 of the ATP ranking. In doubles, fifteen players were part of the ITF team
- Wimbledon: Nine players in the singles draw with a top 100 pro ranking competed in this Grand Slam tournament. All of them were part of the ITF/GSDF team. In doubles fourteen players were competing
- US Open: A total of nine singles players competed in the main draw of this US Open and fourteen players did take part in the doubles tournament. All singles and doubles players were part of the ITF/GSDF teams

TOP PROFESSIONAL DOUBLES RANKED PLAYERS

All the players mentioned here were part of the ITF team and right now they are on the top professional doubles ranking: Melo, Kontinen, Soares, Tecau, Mergea, Aisham Quereshi, Jean Julian Roger, Klaasen, Julio Peralta, Hans Podlipnik. Bruno Soares was recognized as the 2016 ITF world doubles champion.

COLLEGE OPPORTUNITIES

Among the benefits to be part of the ITF/GSDF teams is the opportunity the players have to finish their education and graduate for free or after finishing college to try to play professional tennis, as has happened in many cases. Many past members of the teams achieved playing college level tennis and gaining a university degree.

CONCLUSION

I want to thank Doug MacCurdy who was the Development Director at that time, for having the vision to create this team and for confiding in me to be part of this. I would like to thank the ITF for the opportunity and confidence they gave me to be part of this team and I wish all the best in the future for the next teams. Thanks to I the GSDF for their support for this program and for giving the opportunities to many players to achieve their dreams. And last but not least, I want to thank all of the coaches who shared this great adventure of being part of the ITF/ GSDF team with me. I hope that my contributions have helped all the players who were part of those wonderful teams to achieve their best potential in their tennis and everyday life.

The "Great Combat C"

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ABSTRACT

Modern technology presents lots of useful statistics about a tennis match. It helps us to dig deeper into its "fabric", to understand tactical patterns, to detect underlying currents and simply follow the match flow being a better equipped spectator. We know where Nadal likes to go with his forehand, we know what serve Federer prefers to use on grass, we can foresee shot selection of Serena Williams from the mid-court and we can detect the preferable height of the ball for Kristina Mladenovic. Match statistics cover practically every bit of technical and tactical mastery of the contenders. Much could be understood about their current physical form. However, the psychological bit remains elusive. This article offers a new look at the tennis match through the introduction of a psychological measurement - the "Combat C" or "Combat Coefficient" - an easy and straightforward measure of contenders' competitive effort.

Key words: match analysis, deciding points, competitive effort

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INTRODUCTION

While tennis enjoys a comfortable and well-established position among the world's most prestigious sports, there's always room for improvement in terms of view value. For the last couple of decades, tennis researchers have been analysing the progress of the game in comparison with other professional sports – and tireless efforts are being made to fill the stands and raise the TV ratings. Lots of valuable data is collected. And, being as diverse a game as tennis is, there can never be too much of it for a tennis nut. What we also want are tennis statistics that can be easily understood and followed by an outsider, someone who might never be able to tell a forehand from a smash, but who nevertheless can enjoy a gripping duel.

An uncompromising contest of two well-matched contenders is after all, the game's major attraction. Tennis popularity peaked during the decade of the Borg-Connors-McEnroe rivalry. These were well-matched warriors with an insatiable desire to conquer all – never happy with second best. Their rivalries personified the essence of competitive sport – the contest of wills. Can this be measured? And secondly: could it be put to good use?

METHODS AND RESULTS

To evaluate the intensity of the match we usually rely on statistics such as: score line and length of the match.

For example, 7:6, 6:7, 7:6 looks more like a fierce contest of equal players than 6:0 6:0. In reality though, a score line with tie-breaks on the ATP tour could hide easy games on serve and a Russian roulette in the tie-break. View value? – Not much higher than a "bagel set". On the other hand, 6:0 can be equally deceptive, as every game could be fiercely contested and decided only after several "deuces".

Noting the length of a match implies the assumption that the longer battle goes, the tougher the resistance, a.k.a. the intensity. In reality, long points are no guarantee of battle ferocity. Just think of a contest of two clay court specialists, who often produce long matches even when the level of the players is quite different: the ball might always go over the net 20-odd times, but the rallies are won by one and the same player.

Match time doesn't filter time-dragging (up to 37sec between points), medicals -- which happen more and more often -- or toilet breaks. All these real or fake necessities can prolong a match by as much as half-an-hour. And that represents on average one third of a best-of-three sets match.

The author suggests that the closest to real substance of the match is not the length of the match and not the score line, but the amount of "deciding" or "advantage points" in it. We know that to win a game one needs to win at least 4 points and to get to "deuce" each player needs to win at least three.

By dividing the total amount of points played in the match on the total amount of games played in the match, we get the measure of competitive effort or the "Combat coefficient" of that match. Here, any amount over 6 will indicate a tough battle, whereas anything lower than 6 suggests a pretty one-sided affair.

Some examples from Roland Garros 2017:

Male draw:

1. Wawrinka - Murray 7:6 3:6 7:5 6:7 1:6. CC=6,28 (339:54)
2. Raonic – Carreño Busta 6:4 6:7 7:6 4:6 6:8. CC= 6,37 (382:60)
3. Edmund – Anderson 7:6 6:7 7:5 1:6 6:4. CC= 6,0 (328:55)
4. Pouille – Ramos Vinolas 2:6 6:3 7:5 2:6 1:6. CC = 7,0 (307:44)
5. Ferrer - Lopez 5:7 6:3 5:7 6:4 4:6. CC = 6,5 (345:53) Most fiercely contested set is the set with the lowest scoreline 6:3. CC=7,55 (68:9).

Female draw:

1. Ostapenko – Bacsinszky 7:6 3:6 6:3. CC = 6,8 (211:31)

2. Halep - Pliskova 6:4 3:6 6:3. CC = 6,93 (194:28)

3. Svitolina - Martic 4:6 6:3 7:5. CC= 5.77 (179:31) The score line indicates a gripping match, while the CC tells a more sober story. It was in fact a mediocre match plagued by 75 unforced errors.

4. Bacsinszky – Mladenovic 6:4 6:4. CC= 7.25 (145:20) 1h45min

5. Kuznetsova - McHale 7:5 6:4. CC= 7.5 (165:22). In the second set 82 points were played, thus CC reached a staggering 8,2! But the first set took longer time.

DISCUSSION

The "Combat Coefficient" is a rating which is not affected by format (best of three- or best of five-setter) or by sex, as it eliminates the advantage of physical strength.

Examples from Roland Garros 2017 might give the impression that females produce a better battle. It should be noted that comparing both sexes was not the goal of this research, and more data is needed to confirm or reject this assumption. However Deaner (2016) in his article "Sex differences in sports interest and motivation: An evolutionary perspective" mentions one study which, in contrast to all others, revealed a greater competitiveness of females in comparison with their male counterparts. It was a study of professional tennis players.

At the same time, the lower CC in male matches could simply indicate the greater role of the serve.

A consistently low CC in lost matches can indicate flaws in a player's tournament planning, as one should seek events more suitable to his level.

While the "Combat coefficient" could serve as a match evaluation tool, it could also lead to the introduction of a player's personal CC, which might serve as an indicator of his or her current form and effort: CC for winning matches and CC for losing matches.

This could be done as follows: After a match, both players are awarded the same CC, but for a winner it goes to the "winning" column and for the loser to the "losing" column. An average in the "winning column" would be a player's personal winning CC and an average in the "losing column" would be a player's losing CC.

Consistently low personal losing CC could help to encourage a player to exert better effort, or to adjust to a tournament schedule and seek events more suitable to his/her level.

To eliminate the tie-break's influence on CC, (where one needs to win at least 7 points and not 4 as in an ordinary game), a suggestion could be to discount tie-breaks completely, removing them from both the game and the point tally in calculations.

CONCLUSIONS

The introduced "Combat coefficient" can serve as a simple and adequate tool in match analysis, which is easy to understand and follow. It tells us a bit more about the competitive level of the game, player's profile and might help coaches indicate the necessity to improve mental toughness of their pupils.

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Nutritional and water needs

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ABSTRACT

Tennis is a sport with high liquid and nutrition requirements. A correct nutritional - dietetic approach assures health as well as an optimal performance for the tennis player. All approaches must be based on the determination of those factors that reduce sport performance, in order to set a number of targets based on those factors, and then set the most appropriate strategies to achieve the targets proposed.

Key words: nutrition, hydration, performance, tennis

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INTRODUCTION

An athlete's health and performance are closely related to appropriate nutrition (Kondric, Sekulic, Uljevic, Gabrilo, & Zvan, 2013), also very relevant for injury prevention and recovery (Moran et al., 2012).

A tennis player has to combine high levels of strength and muscular power, speed, agility, coordination and decision making, in fatigue and mental stress conditions, over long periods of time (Lacoboni, 2001), since a tennis match may last 90 minutes, or even 4-5 hours (Kondric et al., 2013). Besides, a tennis point lasts an average of 7-10 seconds, with recovery periods between 10 - 90 seconds, depending on whether there is a change over or not (O'Donoghue & Ingram, 2001).

It is of utmost importance to provide the right nutrition, to control those factors that limit performance, facilitating a good recovery after matches and training sessions, to create better physiological adaptations for the best performance of the tennis player.

LIMITING FACTORS IN TENNIS PERFORMANCE

It is key to identify those tennis performance limiting factors and to set nutrition targets that take these limiting factors into account (Maughan, 2003).

The decline in performance due to the lack of strength or a sustained motor control, as a result of fatigue, and tennis physiological demands, has some limiting factors which are shown in Figure 1.

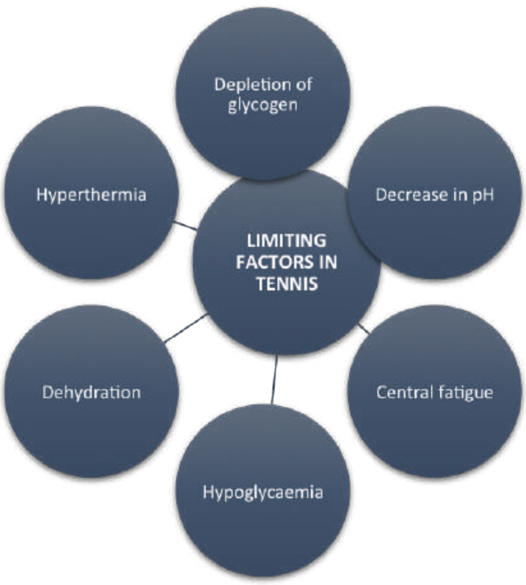

Figure 1. Limiting factors in tennis performance.

Muscular and liver glycogen stores may deplete in high demand matches, or great volume training sessions (Ferrauti, Pluim, Busch, & Weber, 2003), impacting on performance due to energy disability (Hornery, Farrow, Mujika, & Young, 2007). There can also exist a decrease in blood glucose, which decreases physical and mental performance, together with catabolic processes (Kovacs, 2008). Besides, a decrease in pH during exercise can bring about a decrease in energy through the phosphagen system and muscle contraction (Wallimann, Tokarska-Schlattner, & Schlattner, 2011), and an increase in the subjective perception of effort. (Price & Moss, 2007). This can lead to the use of branched chain amino acids as energetic substrate in what is called central fatigue (Blomstrand, 2006).

The loss of body liquid is another limiting factor in tennis. This decreases the thermoregulatory capacity of the organism (Binkley, Beckett, Casa, Kleiner, & Plummer, 2002), the cardiac output (González-Alonso, Mora-Rodríguez, & Coyle, 2000), and increases the anaerobic glycolysis (Ranchordas, Rogersion, Ruddock, Killer, & Winter, 2013) and the appearance of cramps (Sawka et al., 2007). Hyperthermia correlates with the duration of matches (Morante & Brotherhood, 2008) and with the degree of dehydration (González-Alonso et al., 2000), which can have vital consequences.

ENERGY NEEDS

To maintain a certain body weight all along the season is one of the challenges in tennis, considering the great variability in energy demands, depending on the training phase the player is in, or on the different rounds in a competition (Ranchordas et al., 2013).

The diet, apart from meeting the daily needs in vitamin and mineral requirements, must meet the tennis player demands in macronutrients and time of intake, so as to reinforce health and sport performance (Tavío & Domínguez Herrera, 2014).

Hydrocarbons (HC)

Replenishing glycogen stores is the main target in HC intake, it is also important to avoid over-training, and for the right functioning of the immune system. The decrease in resistance is intimately linked to the reduction of glycogen reserves (Domínguez, 2012), and produces an increase of cytokines and cortisol (Nieman, Zwetsloot, Lomiwes, Meaney, & Hurst, 2016). In order to palliate this, and depending on the recovery times between effort and their intensity and duration, a tennis player needs 6-10 g/kg/day (Ranchordas et al., 2013). This HC intake must take place before, during and after, in relation to what was stated above (figure 2).

The low glycemic index HC is key for the previous intake, assuring a glycemic stability, and is recommended at least 2 hours before (Fernández, Miranda, & Jiménez, 2008), since a decrease in performance has been recorded when taking high glycemic index food during the previous 45 minutes. (Sousa et al., 2010).

The oxidation of glycogen, the stability of glycemia and the economy in the glycogen stores will be favoured when ingesting HC during exercise (Ostojic & Mazic, 2002). The subjective perception of the effort and response of cortisol were lower in a tennis match in which there was an intake of 0.5 g / kg / hour of HC, in addition to maintaining stable glycemia(Gomes et al., 2013). It has recently been pointed out that the intake of HC during physical exertion can rise to 90 g / h, provided that the glucose-fructose ratio of 2: 1 is respected (Jeukendrup, 2013), which is above the classical of 60gr/h (Sawka et al., 2007).

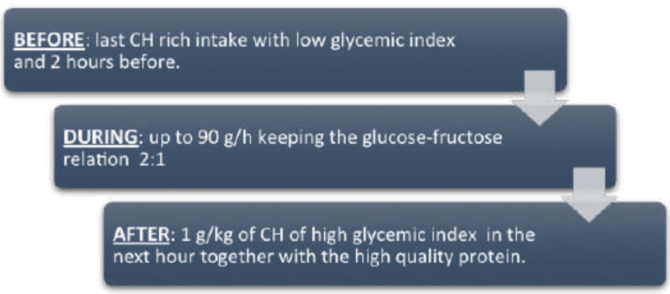

Figure 2. Tennis CH Recommendations.

The glycogen synthesis capacity is greater in the 30-60 minutes after the effort (Domínguez, 2012), it is recommended a 1 g/kg. high glycemic index HC intake over the next hour. Some authors suggest adding proteins, so as to enhance this effect, and add that the protein that accompanies HC should be a high value protein (Moore et al., 2008).

Proteins (PRO)

Although the PRO will only be used for energy purposes when there is a decrease in glycogen and an increase in cortisol, these are fundamental for the proper functioning of the organism (Aparicio, Nebot, Heredia, & Aranda, 2010). Since tennis players have a high percentage of lean mass, and because of their possible contribution to energy metabolism, needs are set between 1.6 g / kg / day (Ranchordas et al., 2013) and 1,8 g/kg/day (Phillips & Van Loon, 2011). Besides, it is necessary to consider the time of the intake and the quality of the proteic sources (Ranchordas et al., 2013; Suárez López, Kizlansky, & López, 2006). Simultaneous ingestion of CH & PRO after exercise is fundamental for recovery, and to keep the lean mass (Stark, Lukaszuk, Prawitz, & Salacinski, 2012), 6 g of essential amino acids are recommended, which equal 20 g of high biologic value PROs (Borsheim et al., 2004), or 0,3 g/kg of high biologic value PRO, since higher values will not be used for the synthesis of new PROs (Moore et al., 2008).

Lipids (LIP)

Although there is no specific requirement for the ingestion of LIP in tennis, these are of great importance, since it is difficult to reach the minimum requirements of fat-soluble vitamins and essential fatty acids if they are not consumed (Robertson, Benardot, & Mountjoy, 2014). In addition, intramuscular triglycerides are an important source of energy in long-term exercises, playing an important role in tennis recovery periods (Horvath, Eagen, Ryer-Calvin, & Pendergast, 2000). Taking into account the daily energy expenditure and the demands in HC and PRO, daily calories in the form of fatty acids should represent between 20% -35% of the total, prioritizing the intake of polyunsaturated fatty acids versus saturated (Mozaffarian, Micha, & Wallace, 2010) and setting a 2 g/kg/day LIP limit in tennis (Ranchordas et al., 2013).

HYDRIC NEEDS

Dehydration is one of the most important limiting factors in tennis. The reduction of body mass due to dehydration during sports practice should not exceed 1.5-2% (Sawka et al., 2007), thus, a good hydration plan is important, both in training and competition (figure 3). Tennis players with high sweating rates may lose around 2,3-2,7% kg/h (Bergeron, 2003); in order to avoids this, Kovacs (2008) suggests that a tennis player should drink 250 ml/h during practice.

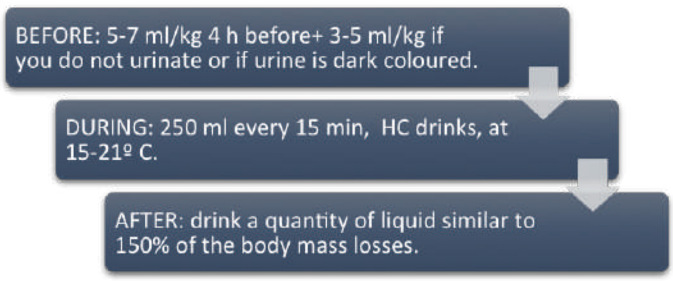

Figure 3. Water needs in tennis.

In addition, to ensure a correct state of hydration, the tennis player should ingest 5-7 ml / kg in the previous 4 hours, which will complement, if during this period the player does not urinate or the urine is dark, with 3 -5 ml / kg more (Sawka et al., 2007). The intake of liquids after exercise will be 150% of the loss produced, considering the drinks between 150 and 210 C with HC will stimulate thirst (Sawka et al., 2007).

CONCLUSION

Nutrition can have an important impact in tennis, it plays a key role in tennis players´ health and it positively impacts on their performance. Adopting the right nutrition strategies can help to improve the tolerance to exercise and to a better recovery after training and competition.

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Using technology in modern tennis: an insight into the practice of the world's top tennis player

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ABSTRACT

Investigating physical activity profiles of individual-sport practice and competition provides coaches with an understanding of the aspects of physical fitness that may influence match performance. In the present study, we tracked (1) the activity profiles in approximately a 30-minute period of practice of a top tennis player, and (2) the intensity of activity during predefined periods of practice match-play of the player. The player wore the GPS device (OptimEye S5, Catapult, Australia) during their on-court practice. It can be concluded that using technology in modern tennis could be of great help for coaches in order to avoid overtraining but also enables coaches to greatly improve the quality of feedback to their athletes.

Key words: technology, analysis, GPS

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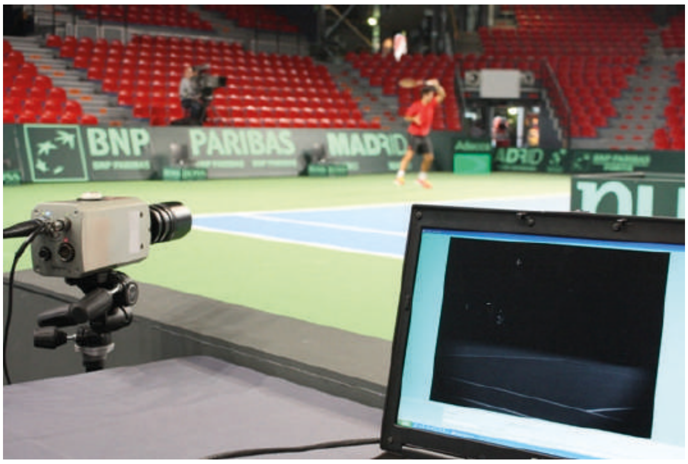
INTRODUCTION

On-court tennis training and match play involve prolonged, physically demanding activity profiles, resulting in substantial elevation of physiological and perceptual strain and reduced contractile function. Tennis players are expected to be in optimal condition during a large number of tournaments during the year, and there is no time for the "long" preparation period (Duffield et al., 2014). For this reason all the measurements that provide a quick feedback of performance are very beneficial. Early identification of high training load is critical for avoiding overtraining (Hagger & Chatzisarantis, 2005). There are many monitoring devices in elite sport, with many coaches using them to enhance performance and mitigate injury risk. In general, using technology in sport could be very useful in analysis of sport performance and enabling coaches to greatly improve the quality of feedback to players/athletes, but also increase accuracy in time measurements of sport performance. However, fewer studies to date have focused on quantifying activity profiles during the practice of top tennis players. In the present study, the experiments investigated (1) activity profiles in approximately a 30-minute period of practice of a top tennis player, and (2) the intensity of activity during predefined periods of practice match-play of the player.

METHODS AND PROCEDURES

The subject in this study was an elite male player who was top 10 in the world while this study was conducted (The Association of Tennis Professionals ranking list, December, 2016). He gave consent in accordance with the requirements of the Declaration of Helsinki. The study was performed during the winter off-season (November and December, 2016). The preparation period was marked by a fairly large amount of conditioning trainings (i.e., jogging, endurance, tennis, strength and power training).



Movement was recorded using a GPS unit (OptimEye S5, Catapult Innovations, Melbourne, Australia). The GPS unit included a tri-axial accelerometer and gyroscope sampling at 100 Hz, which provided information on player load and volume of explosive efforts. The unit was worn in a small vest, on the upper back of the player.

RESULTS

The summary of time-motion analyses is presented in Table 1. In general, the figures seem to be very constant during the observed period. A total player load of 133 units during the period of 30-minutes with an average player load per minute of 4.75 units (Picture 1) can be observed. It is interesting to note that the player performed a high number (302) of low explosive efforts (locomotive movements) comparing with medium (rallying groundstrokes) and high explosive efforts (drives) (Picture 2). Interestingly, there are very few jumps, especially low jumps during the practice match-play (Picture 3).

	Total player load	Player load per minute	Total explosive efforts / min	High explosive efforts	Medium explosive efforts
Game 1	36	4.33	12.75	12	21
Game 2	23	4.94	18.13	13	19
Game 3	29	5.21	17.73	15	22
Game 4	45	4.54	17.11	22	32
Total	133	19.02	65.73	62	94

	Low explosive efforts	Total jumps	Medium jumps (20-40cm)	High jumps (>40cm)
Game 1	72	1	0	0
Game 2	52	2	1	0
Game 3	62	2	0	0
Game 4	116	5	2	0
Total	302	10	3	0

Table 1. Summary of time-motion analyses.

DISCUSSION

The preparation period of the top tennis player provided a unique opportunity to evaluate activity profiles that occur during prolonged high intensity activities. The objective of this study was to investigate the (1) activity profiles in approximately a 30-minute period of practice of a top tennis player, and (2) the intensity of activity during predefined periods of practice match-play of the player. The results of some previous studies demonstrate that compared with more successful players, less successful players covers greater total distance, perform more high-intensity running, and are involved in a greater number of repeated high-intensity effort bouts (Austin, Gabbett, Jenkins, 2011; Gabbett, 2012). Therefore, some findings suggest that greater amounts of high-intensity activity and total distance are not related to success in elite sport (Gabbett, Jenkins, Abernethy, 2012; Hulin et al. 2015). Hulin et al. (2015) suggest that a greater number of collisions are linked with a greater rate of success in elite rugby league teams. As a result, our findings are of importance to coaches and sport scientists when interpreting time-motion analyses, as our results may indicate that overall technical and tactical effectiveness of the player rather than greater running workloads may indeed be a greater determinant of success.

Recognition of physiological and psychological factors contributing to the development of performance, therefore, would be of particular value for those administering training routines (Terry, 2000). This type of practice activity tracking using the GPS technology could be very beneficial for fitness and tennis coaches for avoiding symptoms of decreased performance or overtraining. Also, using technology could be useful in analysis of sport performance and enabling coaches to greatly improve the quality of feedback to athletes, but also increase accuracy in time measurements of sport performance. It is, however, also worth pointing out that the sample size in this case study is too small to produce a clear picture, however, it is still considered important and beneficial to measure these changes during the preparation period.

CONCLUSION

Tennis today requires the tennis player to have a very high level of readiness. At the same time, one must be aware that the stress of overtraining may lead to the development of “staleness” (Ryan, 1983; Morgan et al., 1987). The GPS technology could be very beneficial tool to track activity profiles of tennis players especially during high intensity sessions. Additional studies are needed to identify interventions that can increase performance with the ultimate goal of achieving healthier athletes.

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Towards polarized training in tennis? Usefulness of combining technical and physiological assessments during a new incremental field test

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ABSTRACT

Although tennis performance analysis underlines the relationship between physical and technical parameters, scientific or coaching approaches often neglect to develop these two aspects in the same training session. The effectiveness of combining physical and technical factors is reinforced by new results made available through the optimization of new technologies. Here, we discuss how the use of radar and ball machine may offer practical information to improve players' preparation concerning production of optimal ball velocity, ball accuracy and ball frequency.

Key words: Incremental test, ball accuracy, ball velocity, polarized training

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INTRODUCTION

For the past 30 years, tennis has evolved from a sport in which players' skill proficiency (technique) was the main determinant of performance into a game where physical attributes likely play a more predominant role. Nowadays, tennis is characterized by intense physical demands (Kovacs, 2007; Mendez-Villanueva, Fernandez-Fernandez, Bishop, Fernandez-Garcia, & Terrados, 2007) coupled with rapid perceptual-motor processing (Triolet et al., 2013). Tennis is an explosive sport based on power, strength, and speed, in which serves faster than 200 km.h-1 are common (Kovacs, 2007).

In addition to producing elevated ball velocity (BV, km.h-1), maintaining ball accuracy (BA, i.e., number of errors, %) during intense periods towards a set or match end is also a key component for winning the faster-paced modern game (Kovacs, 2007). Although the sport-specific technical skills and tactical choices are predominant factors, even in the modern game, players require well-developed physical conditioning in order to execute advanced shots and maintain stroke efficiency as fatigue develops (Girard, Lattier, Maffiuletti, Micallef, & Millet, 2008).

Evaluation of aerobic fitness is commonly used to characterize training effects, evaluate physical fitness, and identify target training areas (Brechbuhl et al., 2016a). Recently, Baiget et al. highlighted the usefulness of using the Maximal Aerobic Frequency of ball hitting as a new training load parameter in tennis (Baiget et al, 2017), while we introduced analysis of technical alterations with incremental fatigue during a Test to Exhaustion Specific to Tennis (TEST) (Brechbuhl et al., 2017). Considering these two recent articles, we aim to report how they can lead to the integration of combined technical and physical prescription for specific on-court training. Moreover it is possible to assess the implementation of the "polarized training" approach (Seiler & Kjerland, 2006) in tennis by classifying types of sessions. Seiler and Kjerland (2006) refer to this training distribution as a polarized model, where approximately 75% of sessions are performed below the first ventilatory threshold, with 15% above the second ventilatory threshold and ‹ 10% performed between the first and second ventilatory thresholds.

EQUIPMENT AND METHOD

Players

Twenty high-level competitive male tennis players (mean ± SD; age = 18.0 ± 3.2 year, stature = 182.8 ± 7.3 cm, body mass = 72.7 ± 7.2 kg) volunteered to participate in the study. They were all members of the national teams of the French Tennis Federation (International Tennis Number 1 [elite]). Players were either members of the Association of Tennis Professionals (ATP) (two in top 100, two in top 200, two in top 500, and nine in top 1000) or of the International Tennis Federation (ITF) Juniors ranking (Participating in Grand Slams) at the time of the experiments (2013–2015). Two players have now reached the top 30 ATP.

All players performed the TEST protocol, previously described (Brechbuhl et al., 2016a; Brechbuhl et al., 2016b; Brechbuhl et al., 2017). Both the accuracy and the reliability of this new tennis ball machine appear satisfying enough for field testing and training purposes (Brechbuhl et al. 2016).

Evaluation of ground stroke performance

During TEST, groundstroke production was assessed by the mean of two "primary" variables: BV and BA. BV (km.h-1) was measured with a Solstice 2 radar (Hightof®, Echouboulains, France) positioned 50 cm behind the baseline. All shots that were hit out, into the net, and to the wrong spot on the tennis court were excluded. Spots where each ball landed (i.e., hits–errors) were instantaneously recorded by an experienced coach on a dedicated recording sheet. BA (%) was defined as the percentage of correct hits in the defined zones (Baiget et al., 2014). For each stage, BV and BA data have been averaged and expressed for forehands (BVf and BAf) and backhands (BVb and BAb), respectively. Finally, because BV and BA in combination better reflect the overall tennis performance, a TP index was calculated for forehands and backhands separately (TPf and TPb) as the product of these two variables.

Physiological measurements

Expired air was analyzed continuously (breath-by-breath measurements) for oxygen consumption (VO2) using a portable gas analyzer (Metamax II CPX system, Cortex®, Leipzig, Germany). Gas and volume calibration of the measurement device were performed before each test according to manufacturer's instructions. HR was recorded continuously (Suunto Ambit2®, Vantaa, Finland). Furthermore, 25 μL KL capillary blood samples were collected from the fingertip and analyzed for blood lactate concentrations (LT-1710; Arkray®, Kyoto, Japan) at the baseline, during TEST (i.e., during the 30-s recovery periods after every stage until a value of 4 mmol.L-1 was obtained and thereafter every 2 stages), and 15 s after exhaustion.

RESULTS

The players reached on average stage 10.9 ± 1.5 (~26 ± 1 balls.min-1). At exhaustion, maximal oxygen uptake (VO2max), maximal heart rate (HRmax), and blood lactate concentration values were 61 ± 5 mL.min-1.kg-1, 195.8 ± 1.4 bpm, and 10.5 ± 1.9 mmol.L-1, respectively. At the second ventilatory threshold (VT2), VO2 and HR were 53.8 ± 4.5 mL.min-1.kg-1 (87.7 ± 0.1% VO2max) and 183.7 ± 4.2 bpm (93.8 ± 1.6% HRmax), respectively, corresponding to stage 7.3 ± 2.8 (~22 ± 3 balls.min-1).

Ground stroke performance

BV, BA, and TP (both backhand and forehand) did not differ between 60% and 80% of VO2max (Fig. 1).

We found significant reductions above this later intensity with BV, BA, and TP decreasing from 80% to 100% of VO2max (Table 1) for both strokes.

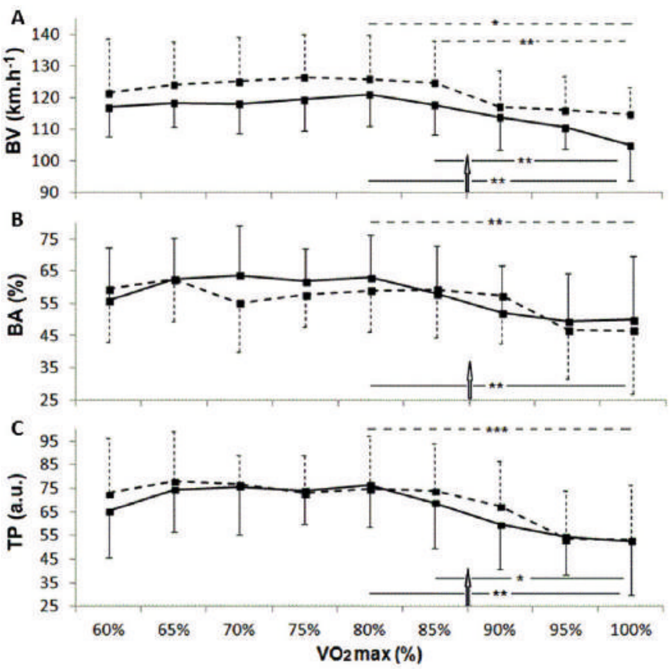

Figure 1: Changes in (A) ball velocity (BV), (B) ball accuracy (BA) and (C) tennis performance (TP) as a function of exercise intensity (% of VO2max) for forehands (white dots) and backhands (black dots). Vertical arrows indicate the second ventilatory threshold. BVf was 5.2% higher than BVb (121.7 ± 4.9 vs 115. 7 ± 8.6 km.h-1).

		Forehand	% change	Backhand	% change
BV	80%	126±13.8	-9.0% *	121±9.9	-13.3 % **
	100%	114.7±8.6		104.9±14.9	
BA	80%	57.7±10.4	-19.4 %***	61.9±10.1	-18.4%***
	100%	46.5±17.1		50.5±19.7	
TP	80%	73.0±16.0	-27.4 %***	74.1±21.8	-29.1 %***
	100%	53.0±14.4		52.5±22.6	

*Table 1: Differences in relative (%) and absolute values of Ball Velocity (BV, in km.h-1), Ball Accuracy (BA, expressed as % in zone) and Tennis Performance (TP), calculated as BA x BV and expressed as arbitrary units) for both forehands and backhands between 80% and 100% of VO2max. Values are presented as mean ± SD. * P < 0.05, ** P < 0.01, *** P < 0.001 significantly different from 80% of VO2max.*

Correlation

Not surprisingly, there were correlations between the players' ranking level and BA in both forehand (r = 0.45 to - 0.47, P < 0.05) and backhands (r = - 0.49, P < 0.05) and with TP (r = - 0.44 to - 0.46, P < 0.05) for forehand only between 80% and 100% of VO2max.

Associations of TP with BV (r = 0.51 and r = 0.49; both P < 0.001) and BA (r = 0.91 and r = 0.96; both P < 0.001) for forehands and backhands were significant. We observed an inverse correlation (r = - 0.51; P = 0.008) between blood lactate concentration and TP.

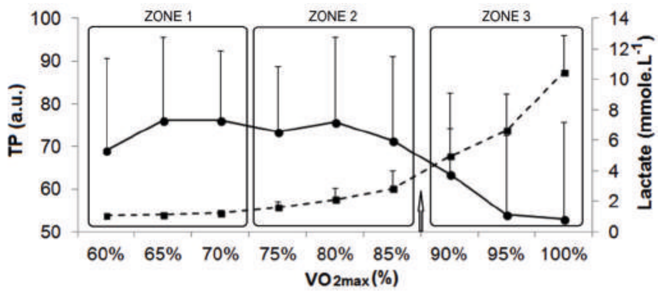

Figure 2: Intensity zones of change in tennis performance (TP) (plain line) and blood lactate concentration (dotted line) as a function of exercise intensity (% of VO2max). Zone 1 below 70% of VO2max, zone 2 between 75% to 87% of VO2max and zone 3 above 87% of VO2max. Vertical arrows indicate the second ventilatory threshold.

DISCUSSION

Elite players were able to maintain technical effectiveness until an intensity of 80% VO2max, which was slightly below VT2 (87% VO2max, and 94% HRmax). Information obtained during TEST can be used to illustrate changes in stroke quality of tested players at different exercise intensities in a context appropriate to the game.

We highlight some practical implications of our findings. First, by using TEST data we propose that technically- or physically-oriented training sessions can easily be developed, as previously detailed for one elite player (Brechbuhl et al., 2016b). Second, of interest is that the correlation between TP and BA (r = 0.91 and r = 0.96, for forehand and backhand strokes, respectively) is stronger than that with BV (r = 0.51 and r = 0.49), highlighting the prominence of the technical skills in elite tennis. It means that high technical skills but not neither power nor speed are necessary to be classified as a "technically good" player. Baiget et al. (2014) also identified a significant and moderate correlation (r = 0.61, P = 0.001) between the competitive level and the accuracy. This highlights that to reach the highest level, players need not only to hit fast strokes but also need to maintain accuracy as fatigue develops. BA has been identified as a key predictor for tennis competitions (Smekal et al., 2000).We showed that TP is affected by the arduousness of the activity (Brechbuhl et al., 2017), so that coaches can carefully adjust training intensity in order to target specific development objectives within the same session (table 2).

For instance, when targeting improvement in technical skills, we recommend to train at low intensities, in zone 1 (VO2 at or below VT1) (Esteve-Lanao et al., 2005), corresponding to BA of ~70% and BV of ~120 km.h-1 in our cohort of players. Even if it represents a small playing time (3% ± 5%) (Baiget et al., 2015), time in zone 1 brings physiological benefits and will indirectly lead to improved capacity to cope with the higher intensity of competitive tennis (zone 3: VO2 at or above VT2) corresponding to the "money time" of the game.

	Zone 1	Zone 2	Zone 3
	Stage 16-22 balls.min-1 ≤ 70% VO2max. BA ~70% BV ~ 120 km.h-1 ‹ 80% HRmax. [la-] ‹ 2 mmol.L-1	Stage 22-24 balls.min-1 Between 75%-87% VO2max. BA ‹ 60% ; BV ‹ 120 km.h-1 80%-90% HRmax. 2 mmol.L-1 ‹ [la-] ‹ 4 mmol.L-1	Stage 25-29 balls.min-1 VO2 ≥ 87% VO2max. BA ‹ 60% BV ‹ 120 km.h-1 › 90%HRmax [la-] › 4 mmol.L-1
Technical	Balance, energy transfer, skill of the hand, short footwork	Big footwork, balance, energy transfer, coordination between upper and lower body	Velocity of footwork, balance, coordination between upper and lower body, braking and restarting of the course
Physical	Vascularisation of muscles, number and size of mitochondria, amount of aerobic enzymes and beta-oxydation enzymes (Laursen, 2010)	Use of shuttle systems of transport of hydrogen ions (Nicotinamide Adenine dinucleotide) (White & Schenk, 2012), carbohydrate and fat use (Holloszy, Kohrt, & Hansen, 1998))	Maximal Aerobic Frequency of ball hitting, cardiopulmonary capacity, transport of oxygen, glycolytic enzymes (Phosphofructokinase and Lactate deshydrogenase), muscle buffering capacity, muscle glycogen stores (Laursen & Jenkins, 2002)

Table 2. Sample for specific on-court training protocols for optimizing aerobic fitness and technical effectiveness in elite tennis players. Maximal oxygen uptake (VO2max.), ball accuracy (BA), ball velocity (BV), maximal heart rate (HRmax),

As shown in Figure 1, we can also estimate VT2 from the decline of the technical parameters, and more particularly the decrease in BA. Our proposed model with 3 intensity zones for training the tennis player can also be based on the HR response associated to reproducible metabolic demarcation points (i.e., lactate or ventilatory thresholds), thus allowing to examine the physiological strain during various types of exercise. It has consistently been used in endurance (Esteve-Lanao et al., 2005) and team sports (Akubat et al., 2012). The HR-based model was previously used in tennis and defines three HR zones (Baiget et al., 2015), while we suggest here the following distribution: zone 1 (low intensity, ≤ 80% HRmax), zone 2 (moderate intensity, 80% to 90% HRmax), and zone 3 (high intensity, ≥ 90% HRmax). Second, TEST enables us to easily assess BA, which is a key predictor of tennis performance (Smekal et al., 2000), also supported by significant correlations between stroke production and success in match play (Vergauwen et al., 1998).

CONCLUSION

A model (3 intensities) is proposed starting from the realization of an incremental test in which physiological and technical data are measured simultaneously, and then their kinetics of change are compared.

Through TEST and its applications, our aim was to suggest a global approach designed to avoid redundant physiological demands.

Without underestimating the diversity of practices, the combination of physical and technical contents may contribute to more efficient planning and better management of fatigue. Since the present data only concerns elite male players, further investigation on female players is required.

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The relationship between distance of overhand ball throw and maximal ball speed of serve in elite junior tennis players

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ABSTRACT

The aim of this research was to test the hypothesis that there is a positive correlation between the distance of the overhand ball throw and maximal ball speed of serve of elite junior tennis players for a wide-scale representative sample comprising both sexes (80 boys and 80 girls). A significant, positive correlation was found in both sexes (girls r=0.72; boys=0.78), which is why the application of overhand ball throw training and its use as a performance diagnostic method is suggested in the general preparation of elite junior tennis players.

Key words: ball speed, correlation, plyometric movements

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INTRODUCTION

In the modern tennis game, the key role of the serve is unquestionable. The serve is the only technical element that is executed by the player independent of the opponent's ball. This independent execution ensures the highest possible level of movement control (Bhamonde & Knudson, 2003). In addition, the ability of the players to generate high-speed balls has become one of the basic fundamentals of successful competition performance (Cross & Pollard, 2009). The serve hit with a higher speed allows a shorter preparation time for the receiver. At a 117 km/hour average second serve speed, the preparation time is 1,200 milliseconds, which decreases to 900 milliseconds in the case of a 160 km/hour first serve. The time spent on preparation further decreases on hard court to about 200 milliseconds (Kleinöder, 2005). At the professional level, it is not rare that served balls travel at a speed of 200 km/hour for men and at 190 km/hour for women. This results in a further decrease in preparation time, which is why it is thought that the use of training equipment developing motor skills (e.g. overhand ball throw) in preparation phase (especially in the case of junior tennis players) is of key importance, helping the player in forming the proper service movements and in speeding up the racket.

Reid, Giblin & Whiteside (2015) and Wagner et al. (2014) investigated the relationship between the kinematic specialities of the overhand throw and of the serve. The results showed that the overhand throw and the speed of serve showed a slight positive correlation. Besides the mechanical similarities of the two movements, there are several mechanical differences as well which show the difference between the two types of movements. But the researchers agreed that the movement pattern of the overhand throw ensures a proper basis for the development of the serve.

The mentioned tests were carried out on only a small sample (n=28; n=10). In addition, the relationship which exists between the distance of the overhand ball throw and the maximal speed of the serve could also be interesting as suggestions from the professions and other scientific researchers have already proven the relationship between the speed of stroke and the distance of different throws (Genevois, Pollet & Rogowski, 2014; Ikeda et al., 2007). Therefore, the aim of this research on a wide representative sample comprising both sexes (80 boys and 80 girls) was to test the hypothesis that the distance of the overhand ball throw of elite junior tennis players and the speed of serve shows a close positive correlation in both sexes.

METHODS AND PROCEDURES

The sample consisted of elite junior tennis players (under 12, 14, 16 and 18). The subjects were selected with the stratified random sampling method, so in each age-category 20 boys and 20 girls, altogether 160 people, were tested. From the point of view of the research, one boy and one girl age group was formed (Table 1). The selected sample represents the best girl and boy populations of Hungarian junior tennis players.

To examine the relationship between maximal ball speed of serve and distance of overhand ball throw, two field tests (Figure 1.) were used (Nádori et al., 2005; Ulbricht, Fernandez-Fernandez & Ferrauti, 2013). The players had to execute the field tests in a given order (overhand ball throw and serve velocity) after a 15-minute standard warm up. The players had three trials in the overhand ball throw and eight for the serve velocity tests. The best results were used for later analysis. The weight of the small ball was 100 grams (diameter 6.5cm). To measure the speed of serve, the "Stalker ATS II" serve speed measurer (within 1 km/h accuracy) was used.

Pearson correlation coefficient was calculated to determine the relationship between the maximal ball speed of the serve and distance achieved in the overhand ball throw. The level of significance was determined at p ‹0.05. The statistical analysis of the data was carried out with SPSS 13.0 software.

Sex	Age	Distance of the overhand ball throw (m)		Maximal ball speed of the serve (km/h)	
	Mean (SD)	Mean (SD)	Range	Mean (SD)	Range
Girls	14.37(2.24)	28.84 (6.07)	16.57-44.30	140.61 (19.12)	87.00 - 176.00
Boys	14.30±2.22	41.83 (9.41)	25.75-66.18	157.56 (22.97)	110.00 - 211.00

Table 1. Basic statistics in elite junior tennis players.

Figure 1. Serve and overhand ball throw tests.

RESULTS

In both sexes, a significant strong positive correlation was found between the distance of the overhand ball throw and the maximal ball speed of serve (Figure 2. 3.).

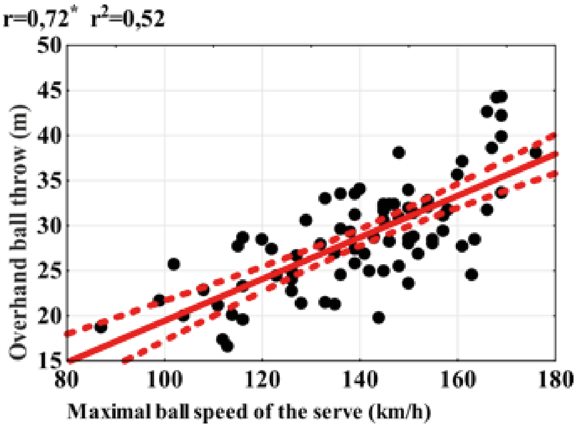

Figure 2. Correlation coefficients between the distance of the overhand ball throw and the maximal ball speed of the serve in elite girl junior tennis players p ‹0.05.*

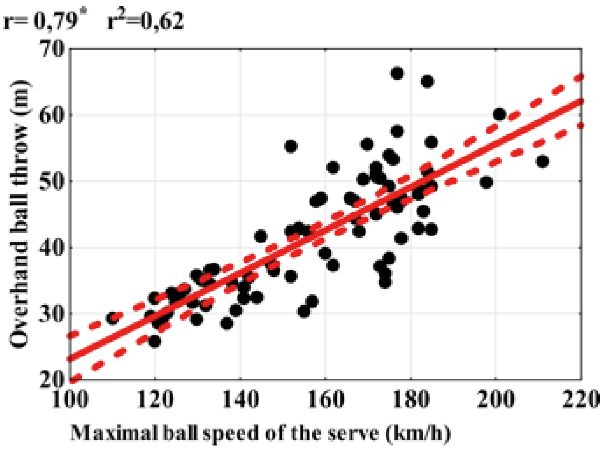

Figure 3. Correlation coefficients between the distance of the overhand ball throw and the maximal ball speed of the serve in elite boy junior tennis players p ‹0.05.*

DISCUSSION

The explosive strength of the dominant upper arm of elite junior tennis players showed a strong positive correlation to the maximal ball speed of serve. The results well-demonstrate the statement that the so-called "plyometric" movement form (the stretch-shorten cycle) is the most frequent muscle contraction type in tennis, as the coordination pattern of most of, the strokes comprises this contraction type. Thus, those tennis players who can make use of their strength most effectively are able to hit the ball hardest, and will have the strongest serves (Chu, 2003). Furthermore, the mechanical similarities of these two movements (Reid, Giblin & Whiteside, 2015; Wagner et al., 2014) aid the player in building up a successful serve. Therefore, in our opinion the explosive strength manifested in the overhand ball throw can be well transferred to the movement pattern of the serve.

Accordingly, this is why the use of the overhand ball throw as a plyometric throwing practice is indispensable in creating a proper serve speed. In addition, the determinant coefficients also show (girls, r2=0.52; boys, r2=0.62) that the two movement forms are similar to each other, but are not the same. The results reinforce the suggestions of the previous research results (Reid, Giblin & Whiteside, 2015; Wagner et al., 2014).

CONCLUSIONS

The research was carried out on a representative sample comprising all official age-groups, in which the distance of the overhand ball throw and the maximal ball speed of serve showed a strong and significant correlation in both sexes. Therefore, it is suggested that the overhand ball throw be a part of junior tennis players' general preparation and be used as a means of performance diagnostics.

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RECOMMENDED ITF TENNIS ICOACH CONTENT (CLICK BELOW)

TennisiCoach

Ball velocity and spin at the impact of tennis serves: Reliability of a ball motion measurement instrument (TRACKMAN)

Bumpei Sato, Ryo Wakatsuki, Yu Kashiwagi and Kazuo Funato (JAP)

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ABSTRACT

To verify the reliability of the precision of TRACKMAN measurements, we analyzed 3 types of serves (flat, slice, kick) and compared the results to values obtained with the 3D motion capture system (VICON). Positive linear strong correlations were observed in velocity calculated with TRACKMAN(x) and VICON(y) ; (r = 0.996, p<0.01), as well as number of ball spin; (r = 0.978, p<0.01). This suggests that ball velocity and the number of ball spin values calculated with TRACKMAN, can provide immediate feedback and is provides sufficient reliability and would be useful in training situations.

Key words: TRACKMAN,VICON,velocity,spin

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INRTODUCTION

Takahashi(2007) and Cross and Pollard(2009) pointed out that serve velocity gradually increased for a decade from 1999 to 2009, and that a high-speed serve is an important advantage for controlling games and can thus underpin winning or losing a match. However, their research focused on serve velocity and the number of points won without serve characteristics analyses.

In 2011 to 2017, the author returned practice serves from Roger Federer, one of the top-ranked players in the world. This demonstrated to the author that in addition to higher ball velocity, Federer's serve has particular characteristics regarding to higher spins, which include the trajectory of the ball from impact until its entry into the service area and its specific motion after the bounce.

Kreighbaum and Hunt (1978) suggested 5 variables that influence pitched baseball trajectory: initial ball velocity, the direction of the ball's axis of rotation, the number of spins, the angle of delivery, and air density. Tennis serves can be categorized into 3 types: flat, slice and kick which include different combinations of ball speed, spin and trajectory. In addition to velocity, the ball's trajectory and rotation, both factors that can change how a ball behaves after the bounce, can confuse an opponent's predictions and have a negative impact on the ability of the opponent to receive and respond to the serve. Consequently, these are considered factors that can induce errors and mistakes. Previous research has shown that among the top players in the world, the number of spins differs between the 1st and 2nd serves (Muramatsu et al.,2010, 2015). However, this analysis was performed based on image analysis of high-speed cameras; thus it was impossible to obtain immediate feedback on this data.

The recent development of TARCKMAN which provides immediate feedback on ball motion data, has made it easy to accurately measure the motion and velocity of balls widely in golf and baseball. TRACKMAN is an instrument that applies the Doppler effect, a military-use, radar-based projectile tracking system, to perform specific measurements. For tennis, the development of "TRACKMAN TENNIS RADAR" in 2003 enabled the immediate calculation of trajectory data, such as initial ball velocity, the number of spins, and ball path, as well as positional data, such as the impact point.

In a previous research study the precision of TRACKMAN was verified by using high speed cameras and speed guns, resulting in high levels of correlation in ball velocity and number of spins (Murakami et al.,2016). However, the data analysis in this experiment was performed visually using images obtained from one high speed camera. Consequently, more detailed studies of 3-dimensional (3D) analysis of ball motion, using multiple cameras, are now required to further verify the reliability of TRACKMAN .

In the present study, we simultaneously measured ball velocity, and the number of ball spins from flat, slice, and kick serves using VICON and TRACKMAN. 3-D motion analysis of balls were conducted to verify the reliability of TRACKMAN data.

METHOD

Subjects involved in this study included 1 champion of the All Japan Tennis Championships (a professional player) and 19 male students belonging to sections 1 and 3 of the Kanto Inter-Collegiate Tennis Federation (mean age: 23.8±4.8 years; mean height: 171.8±3.3 cm; mean weight: 68.9±4.0 kg; mean competitive experience: 11.5±3 years). All the participants were right-handed. Experimental procedures and safety guidelines were explained and informed consent were approved for all subjects by the ethical committee of NSSU.

Experimental task

Before the measurements were taken, all participants warmed up by hitting each type of the 3 types of serve. The racquets used in the experiment were those that the participants used regularly; type Dunlop Fort balls were used in all experiments. A local coordinate system was constructed by placing 5 reflective markers on the upper hemisphere of the balls.

The experimental task consisted of hitting each of the 3 serves (flat, slice, kick) at full power until data was obtained on 5 balls for each type of serve. For flat and kick, the serves were hit to the center (T-zone), while for slice, the serves were hit wide. A successful task was defined as when the ball bounced on the court with the markers attached and hit the target area. In our experiment, which used the experimental procedure developed measurements of service velocity and the number of spin, made by TRACKMAN and VICON were compared(Sakurai et al.,2012).

Experimental equipment

Ball velocity and the number of spins were measured using a 3-D motion capture system (VICON MXV5) with 12 cameras, and TRACKMAN. VICON used a personal computer to control the cameras and perform the measurements, VICON MXV5 cameras, a 16-bit 64-channel AD conversion box, and a VICON MXV5 wand to construct the 3D coordinates. VICON Nexus version 1.3 was used as the measurement software. Two MXV5 cameras were attached to the ceiling and 5 cameras were placed on both the left and right sides of the server to surround the subject. Ball velocity and the number of spins for each serve were calculated based on the coordinates of the reflective markers. The TRACKMAN instruction manual was followed and the device was placed so that its center was on a line that extended from the center mark.

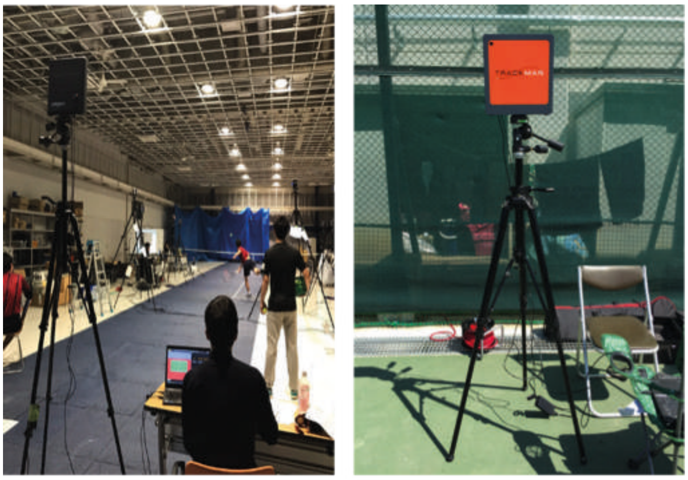

Figure 1. Experiment environment and TRACKMAN.

Statistical processing [coordinate system definition]

For the global coordinate system, the X axis was the direction of movement, the Z axis was in the vertical direction, and the Y axis was perpendicular to the X axis. Correlations with maximum ball velocity and the number of spins calculated with TRACKMAN were determined by calculating Pearson product-moment correlation coefficients. Statistical analysis software (IB) was used for all statistical processing. Data for the 3 serve tasks and figures calculated from the measurement instruments were subjected to 2-way analysis of variance (ANOVA). Multiple comparisons with the Bonferroni method were performed when significant main effects were observed. A risk ratio of 5% or less was considered to be statistically significant.

RESULTS AND DISCUSSION

Correlation of service velocities measured by TRACKMAN and VICON

Figure 2 shows the correlations between service velocities measured using TRACKMAN(x) and VICON(y). A high correlation coefficient was observed for the 3 serves; $r = 0.996$; $p<0.01$). High correlation coefficients were also obtained for the respective serve conditions (flat: [$r = 0.996$]; slice: [$r = 0.992$] ; kick: [$r = 0.996$] , $p<0.01$). In this study, the velocities of 3 serves performed by top Japanese players were measured using TRACKMAN and a speed gun. Although a high correlation coefficient ($r = 0.997$) was obtained, TRACKMAN generally tended to show higher velocity (5.5 km/h) than a high speed camera (Murakami et al., 2016). This shows that velocity cannot be measured accurately if the speed gun lens surface (an optical axis) does not line up with the direction that the object being measured is travelling and that the larger the angle between the electrical wave and the object's trajectory, the larger the measurement error becomes(Morimoto et al., 2007). Consequently, it is possible that the values were affected by the angle between the speed gun and the ball's trajectory (Murakami et al., 2016). In contrast, the ball velocity values obtained from TRACKMAN and VICON in the present study were almost an exact match. We believe that this is because the entire singles court could be exposed to radar with TRACKMAN, which enabled more accurate velocity measurements over a larger area than is possible with a speed gun.

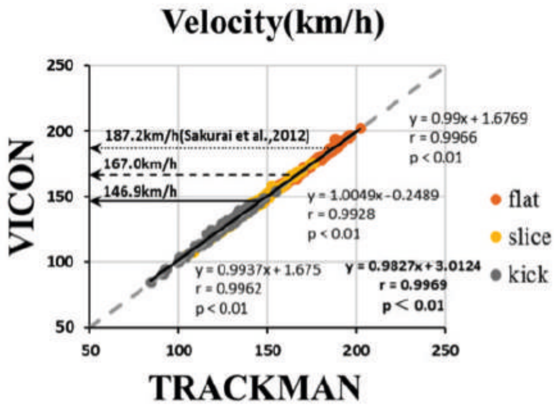

Figure 2. Ball velocity measured by TRACKMAN and VICON.

Number of ball spin measured by TRACKMAN and VICON

Figure 3 shows the correlation of the number of ball spins (rpm) from the three serves as measured using TRACKMAN(x) and VICON(y). A high correlation coefficient was observed for all 3 types of serve (flat, slice, kick ; $r = 0.978$, $p<0.01$). High correlation coefficients were also obtained for the serves individually (F: $r = 0.949$]; S:[$r = 0.906$,]; K:[$r = 0.885$] $p<0.01$). The r values for the number of spin for the 3 serves increased successively as the serve type changed from kick to slice to flat. The number of ball spins was obtained with TRACKMAN by exposing the entire singles court to radar and based on the information obtained 300 ms after ball impact. In the present study, the kick values exhibited a higher correlation than flat or slice when compared to the VICON values, although the error was very slight. This is thought to have occurred because this type of serve had the largest number of spins. In any case, the number of spins calculated with TRACKMAN exhibited a high level of reliability, suggesting that this instrument could be useful in training situations.

For ball velocity, the 2-way ANOVA results between the TRACKMAN and VICON instruments showed no interaction and no statistically significant difference. Significant main effects were observed between the three types of serves (flat, slice, kick), but there was no significant difference between the measurement instruments.

With regard to the number of ball spins, 2-way ANOVA results between the TRACKMAN and VICON instruments showed no interaction and no significant difference. However, while significant main effects were observed between the 3 types of serves, there was no significant difference between the instruments.

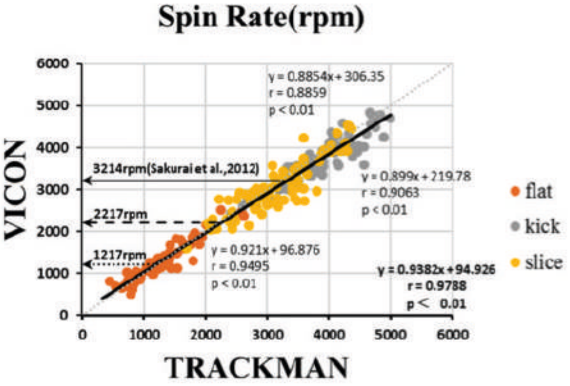

Figure 3. Ball apin rate measured by TRACKMAN and VICON.

CONCLUSION

To verify the reliability of the precision of TRACKMAN measurements, we analyzed 3 types of serve and compared the results to values obtained with VICON. Data showed that the correlation coefficient of ball velocities calculated with TRACKMAN and VICON conformed to ($r = 0.996$, $p<0.01$) and both measuring equipment had no significant effect. Furthermore, there was a high correlation coefficient for the number of ball spins: ($r = 0.978$, $p<0.01$) and both measuring equipment had no significant effect. This suggests that ball velocity and the number of ball revolution values calculated with TRACKMAN which provides immediate feedback, are highly reliable and would be useful in training situations. When the player knows the information of ball flight immediately, the skill can be adjusted immediately on court with this feedback.

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Creativity on court I: Felt visualization

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ABSTRACT

This article provides two examples of imagined practice, laying emphasis on the feelings that accompany visualization (quality of the image, sounds or feelings) as a way of enhancing the efficiency of this tool. Some practical tips are provided about their application.

Key words: Imagined practice, visualization, sensations, exercises

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INTRODUCTION

"Imagination is more important than knowledge" (Albert Einstein).

"I believe in the power of the mind and visualization, which is a big part of my everyday life." (Novak Djokovic)

Imagined practice, more commonly known as visualization, refers to the use of senses to recreate or create an experience in the mind (Vealey & Greenleaf, 2001). This resource, which has been recognized in the sport context for a long time (Cox, 2009), has not been systematically used in proportion to this recognition.

The power of imagined practice is huge due to its capacity to reproduce, at brain level, the neurologic routes we would go along if we performed the situation in reality (Fisher, 1986). Among its benefits, it is suggested that imagined practice can improve confidence, the learning process, reduce the number of errors, reduce anxiety or facilitate injury rehab (Crespo, Reid & Quinn, 2006), and facilitate technical improvement (Guillot, Desliens, Rouyer, & Rogowski, 2013).

This article intends to provide the image with all senses, laying special emphasis on physical sensations, sound quality, and above all...emotions, in short, to make a sensed visualization, connecting with the emotion, just as it will be felt when the proposed target is achieved. Experiencing the emotion will provide more credibility to our brain, and its materialization in the real level will be more intensely encouraged by means of the virtual experience.

PRACTICAL CONSIDERATIONS

Can any player visualize?

Those who have competed know what it is like to spend the whole night imagining possible scenarios, related to the match the next day, to the tournament... Have you ever imagined your opponent hitting extremely accurate strokes, with an incredible power and a supernatural elegance? This is the best proof that we all visualize, the key is to make it voluntarily, consciously and driven to our targets, and to avoid making it unconsciously, reactively, and as a result of tension.

One of the most important aspects to consider, to increase its effectiveness, are the preferred perception channels, that is, the increased ease to "see", "hear" or "feel". Anyway, and apart from this perception channel, all can be achieved with proper training.

How to start

Since we tend to remember more easily those situations which are similar to those of our emotional state (Fernández-Abascal, Jiménez Sánchez, Martín Díaz, & Domínguez Sánchez, 2010), it is convenient to make sure that our player is in an optimal mood, as

regards confidence and satisfaction. We are, thus, facilitating the connection with other moments of confidence and achievement in which he made similar changes.

Basic guidelines

Related to content: If you expect to incorporate a new technical movement, one possibility is to connect directly with the feelings and the projection of the image. If we expect to elicit a state, it is recommended to make a visual warming-up (breathing), a principal (technique) and a final part.

In relation to speed and duration: It will depend on the target and the environment. If we are doing an on-court exercise, it will be good to make a direct and fast imagined practice, imagining the technical movement, eliciting the desired state according to the objective, and characteristics of our player. If, on the contrary, we are at the initial stage of the change/ learning, it is convenient to take enough time for the brain to integrate the new modifications, recreating in the movement, and especially, in the feelings.

In movement? With or without a racket? The follow-through with the racket is particularly recommended in intermediate players, with some technical knowledge, but it is not so in higher level players (Mizuguchi, Takahiro, Nakata, & Kanosue, 2015). Our suggestion is to try and give the player the possibility to determine the most effective way.

EXERCISES:

The following are examples of imagined practice, so that as a coach, you use them according to the player´s needs and general situation. It is key to try them ourselves, before we try them with others, so as to be familiar with the feelings, the times, the tone of voice... In short, your will have a better capacity to connect with your emotions, as well as those of your player.

I. Capture the feeling of the stroke

1. Make a series of 15 strokes on court. Just observe and be aware of your sensations.

2. Then, just close your eyes for a moment and concentrate your attention on your body feelings.

3. For a moment, let the stroke provide the information that is necessary (point of impact, timing, touch, body weight, body attitude, intensity, sound, position of the free hand, contraction of the trunk...). Let the stroke tell you what is necessary. You can ask yourself: in order to be more fluid, direct, natural, firm, what is necessary? Take a minute to capture this.

4. Now, observe internally and feel the stroke, just as it should be: first the sensation, then its firmness, how it flows, being aware of the bodyweight, first on one foot, then on the other one... And even observe how the ball leaves your racket, its direction....

5. Last, without thinking or verbalizing, finish the exercise, being aware of how your body integrates now, and later, the most convenient modifications.

Suggestions
- Duration and place: 3-5 minutes, on court.
- The key is not to judge the gesture as "right/wrong", it is just on the observation of what happens.
- With practice and perseverance, the observation will become something natural and will help modifications and the learning processes.
- Exercise inspired on Gallwey (1997)

Table 1. Suggestions for exercise 1.

II. Intensify a state: Determination

"I doubt, I do not think I am sure of myself... But my head lets me play with determination in important moments, moments of pressure..." (Rafael Nadal)

1. Bring to your memory a situation in which you experienced great courage while playing... courage and conviction, accurately.

2. Observe yourself: your shoulders, your head up, look ahead, safe steps... feel your movements, the intensity of your legs and your heart, quick, strong. Be also conscious of your intense and centred breathing, that provides energy each time you inhale, and unloads the unnecessary, when you exhale... Let this inspiration create the right stroke each time (...)

3. Zoom in your mental image, as if you had a zoom, and as if you could change it at will. Zoom in a little bit more,...that is right... very good... now make it a bit bigger. Observe when the image gets more intense and gives you better sensations (...) then, fix it. Do the same with the clarity of the image: at times, increase (or decrease) its colour, its brightness, its accuracy ...choosing an image you are totally at ease with, determined.

4. Now, the sounds: listen to the perfect impact of the ball on your racket, be also aware of the sound you make when you hit the ball, the sound the player you are playing with makes, ...the sounds outside ...Increase (or reduce) the volume of what you want, maybe you want it louder, deeper, determined... Make the adjustments, this way... Your way... Until they are perfect for you.

5. Now feel which is the gesture that you make which connects you with the courage and determination you are feeling at this time (in case you have none, it is the right moment to start) Correct... Be aware of what you tell yourself, a word or phrase that captures the sensation....?

6. Remain like this for a moment (1- 2 min).

7. When you are ready, come again to this court and open your eyes.

Suggestions
- Duration and place: 5 -7 minutes, on court.
- When the player is familiar, the time tends to be shorter.
- Once the anchorage is set (gesture, words...) repeat it constantly at each training session. The more it is repeated, the more effective and the faster the player will connect with the sensation induced. Within several weeks, it will be enough to activate the anchorage (make the gesture, repeat the word or phrase) to connect with the sensations.

Table 2. Suggestions for exercise.

THE OTHER SIDE OF IMAGINED PRACTICE

At times, imagined practice may be counterproductive. The loss of confidence makes the player suffer different consequences that impact on the effectiveness of the strategies to improve. When a player finds themself in a limiting situation they will often find it difficult to connect with the desired situation or state, they will find it tough to imagine or re-live, resulting in a feeling of frustration, totally opposed to the objective expected. In these situations, it is recommended to guide the player to modify the emotions (by means of a talk, relaxation, remembering a memory, etc.) and then, to make the practice, or else, disregard the exercise temporarily.

CONCLUSION

The only way to make sure of the reach of the benefits of imagined practice is just by means of its application. We suggest you should practise in a conscious way targeting the objectives, and improvements will start in no time, you will also improve complementary aspects which are key for performance, such as concentration, emotional regulation, or control of your thoughts. Table 3 provides a summary of the main aspects in this article, as well as an exercise you can immediately start using with your players.

Remember Einstein's words: "if you want different results, do not do the same all the time". Enlarge your resources toolbox, as a coach by means of simple, realistic and efficient visualization that will make players, and you as a coach, notice the difference.

3 Keys

- More practice, more effectiveness

- Practice, first, with yourself.

- Individualize practice, design custom made outfits for your players..

1 Exercise

- Get used to visualizing at the beginning, what the sensations will be like, once the training is over.

Table 3. Practical application keys.

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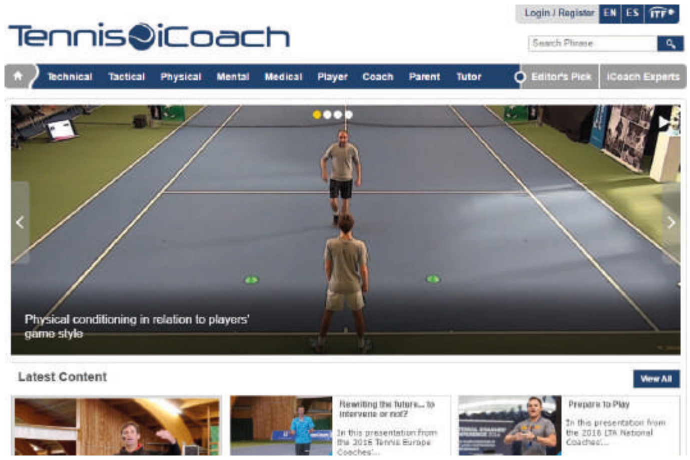

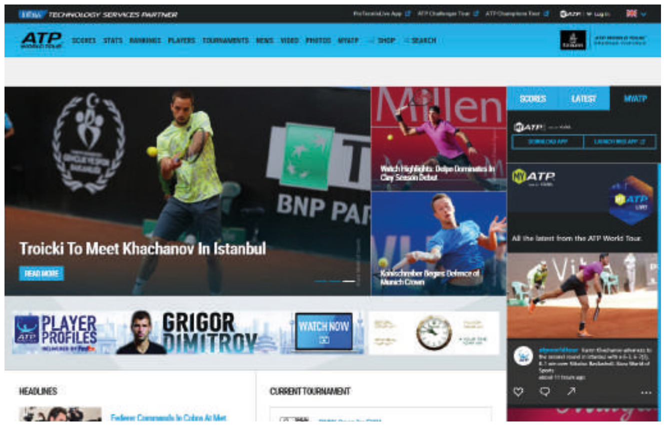

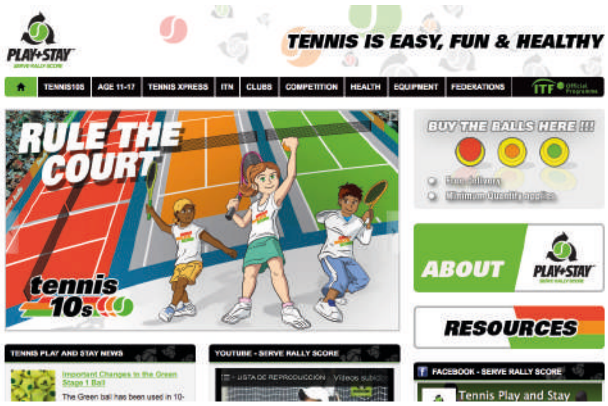

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