

The 33rd International Conference on Biomechanics in Sports

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Presentations at this annual meeting of the International Society for Biomechanics in Sports are available on-line and are reviewed here. [The ISBS Experience](#): biomechanics in the heat of summer in Poitiers, France. [The Knee Joint](#) studied with advanced techniques. [Monitoring Bilateral Asymmetry](#) during recovery from injury. [Studies of Injury Prevention](#) in rugby union and Australian football. [Noteworthy Presentations](#) focusing on performance are summarized under the following sport headings... [Cycling](#): Stages, Vector and I-Crankset ergometers. [Field Athletics](#): compression shorts; hurdles. [Figure-skating](#): toe loops and salchows. [Football](#): throw-in; goal kicking and goal saving. [Golf](#): anchored putting. [Gymnastics](#): longswing; elite case studies. [Kayaking](#): individual technique. [Martial Arts](#): roundhouse and Taekwondo kicks. [Rowing](#): drive phase; instrumented oar and pin. [Running](#): barefoot; starting blocks; sprint acceleration. [Skiing](#): freestyle take-off; accelerometry. [Surfing](#): instrumented board. [Swimming](#): turns; starts. [Tennis](#): style and tactics; elite case studies; kinesio taping. [Trampolining](#): forward somersault. KEYWORDS: athlete, digitizing, injury, kinematics, kinetics, performance, video.

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This report on the annual conference of the International Society for Biomechanics in Sports consists of a first-hand account of selected presentations (by Scott Brown) and a summary of presentations relevant to athletic performance (by Will Hopkins, who did not attend the conference). Visit the [conference website](#) where you will find a [program page](#) that has links to all the presentations in each session. Most of the presentations are full conference papers of 3-5 pages, in some cases with color figures. The full PDF of proceedings was 123 MB in size and is not available as a download, nor is there a search form at the site. For anyone who can't access the full PDF from someone who attended the meeting, we have exported the presentations reviewed below into a more manageable 17-MB file, [available here](#). Use the advanced search form (Ctrl-Shift-F) in the Adobe PDF reader to find the presentation using the name of the first presenter shown in brackets [...].

[The ISBS Experience](#)

[Scott Brown](#)

Visiting France in summer is a typical bucket-list item for most individuals. For many of us

in the sports science community, this dream became a reality with the 33rd International Conference on Biomechanics in Sports. Held in the small but very lovely town of Poitiers, France, the conference ran between 29th June and 3rd July 2015. While only ~500 attendees were present (some of whom were coming directly from ECSS in Malmö, Sweden), we were more than able to make our presence known, as the Université de Poitiers had just released students for the summer, reducing the town's population by nearly 25,000.

Accompanying the mass of cheerful and enthusiastic students, researchers and practitioners was a not-so-friendly hot spell bringing a dry and stagnant heat (35-37 °C) to last the duration of the conference. It didn't help that I was coming from the dead of winter in New Zealand, where several all-time low temperatures had been reached. So while heat acclimation was not a topic of discussion in this conference, every delegate was a participant in a study of the effects of heat on concentration, comfort and irritability at a sport-science conference.

The conference consisted of three and a half days of keynotes and presentations (oral and

poster) and several entertaining social events. An opening ceremony with a sport-focused interpretive dance, a wine and cheese night with product from all over France, a day trip to explore the local attractions (Cognac, La Rochelle, Marais Poitevin, Chateaux de la Loire and Futuroscope) and a wonderful closing gala at the beautiful Salle des Pas Perdus which featured dancers, comedy acts and more. As a whole, ISBS offered the perfect blend of academic and social experience.

As at similar conferences with parallel sessions, I could not attend every presentation. Of those I attended, I have highlighted a few that I felt were deserving of special mention.

The Knee Joint

The full title of this keynote was *Image-based measurement and biomechanical analysis of the knee joint during functional activities*. Soft tissue artefacts are a common problem in current motion-capture techniques, leading to substantial error in estimation of some kinematic and kinetic measures. The team at National Taiwan University have focused their attention on more accurate estimation of the forces in the knee in sport movements. Through the combined use of 3-D motion capture, computerized tomography and magnetic resonance scans, the group uses participant-specific finite element modelling to recreate the bones of the leg and to produce real-time 3-D analyses of the underlying stresses and strains placed on its soft tissue structures. [Tung-Wu Lu]

Thirteen participants were scanned for individual modeling while they performed cycling movements on a cycle ergometer. As expected, the marker-based measurements were over- or under-reported during cycling compared to the 3-D fluoroscopy technique. The more detailed modeling showed that the posterior cruciate ligament experienced greater loads than the anterior cruciate ligament during cycling; which is in disagreement with the current rehabilitation recommendations. Although these techniques require high levels of expertise and financial commitment beyond many labs, they are absolutely the way of the future.

Monitoring Bilateral Asymmetry

In this presentation, which won the Hans Gros award, the author [Kimitake Sato] argued for bilateral assessments in return-to-play decisions following injury. Competitive and recreational level athletes (unknown sample size)

from a collaborative database were examined with a battery of testing (static and counter-movement jumps, isometric mid-thigh pull, etc.). All tests were performed on dual force plates to allow for bilateral comparisons and to relay information back in a coach-friendly method. A symmetry index was produced to best describe the differences between the legs. The index had a moderate-large negative correlation ($r = -0.52$) with static jump height, and the index appeared to track performance well. Symmetry indexes could therefore provide useful information about an athlete's recovery. Strength and conditioning personnel should target any lingering asymmetries with specific exercises.

Studies of Injury Prevention

Higher isometric neck strength was related to lower head accelerations during the rugby tackle in 10 professional **rugby union** players. Increasing neck strength may therefore reduce concussion risk in contact sports like rugby. [Alasdair R Dempsey]

Greater neck muscle activation was found in real versus machine scrummaging and higher pre-activations were found in the crouch-bind-set versus crouch-touch-set procedure in **rugby union**. Real scrummaging may therefore better prepare a rugby athlete for a match scenario by increasing the pre-activation strategies of the neck muscles to better protect against injury. [Dario Cazzola]

In a 4-week training intervention, 13 community-level players of **Australian football** showed improved knee mechanics during a sidestepping task as a result of "zero-impact perceptual training" (six watched videos; seven watched videos with added cue markers) compared with three control players. Such training may reduce ACL injuries without increasing workload. [Stephen Tidman]

Noteworthy Presentations

Will Hopkins

I have limited my review to presentations that had reasonable relevance to competitive performance. Most of these fall into the category of "athletes I have digitized", which provide only suggestive evidence of avenues to performance enhancement. Here's my pick of presentations with more of a wow factor: testing the [I-Crankset ergometer](#), which performs better than SRMs; enhancement in jump performance with [compression shorts](#); a case study of enhancing

[kicked-ball speed](#); enhanced warm-ups for [martial-arts kicking](#); and optimizing [the turn in swimming](#).

I found no prospective cohort studies or controlled trials with injury incidence as the outcome and with risk factors based on biomechanical insights. Scott Brown has reviewed selected presentations where the biomechanical analyses had *potential* implications for injury prevention. There were many such presentations in ballet, climbing, dance, football, golf, gymnastics, rowing; rugby, skiing, tennis, and volleyball. Searching the full book of abstracts using the sport as the keyword is a suggested strategy for finding these presentations. Unfortunately you will get dozens of hits for some of these sports, and the advanced PDF search form does not allow restriction to "all of the words" (e.g., injury, rowing) to narrow down the number of hits.

Cycling

The I-Crankset sensor is a new mobile cycling **ergometer** that measures the forces and torques produced at the right and left pedals together with the pedals' orientation to calculate the resultant torque and power output. In this study it outperformed the SRM ergometer, which did not measure instantaneous pedaling velocity adequately. [Julien Bernard]

There appears to be way too much random error introduced by the Stages and the Garmin Vector **ergometers** compared with the criterion SRM, although the authors were not so critical. [Anthony Bouillod]

Field Athletics

Compression shorts enabled 10 men to improve their long-jump performance by 5.8% [Russell Peters]. Apparently there was a similar finding by Bill Kraemer's group in 2003, so how come more research hasn't been done since then, especially in competitive athletes?

The emphasis on biomechanical outcomes of this crossover study of five male hurdlers makes it difficult to determine if there is something useful here in changing the configuration of the **hurdles** to improve performance. [Kazuhito Shibayama]

Figure-skating

"Non-traditional entries had significantly more jump height and ankle plantar flexion at landing in the **toe loop**, and significantly more horizontal displacement in the **salchow**" in this analysis of 10 skilled ice figure skaters. [Bry-

anna L. Nevius]

Football

An intervention aimed at extension of the support leg during the **kicking** stride increased ball speed by 8.6% in a training study of a single soccer player. [Simon Augustus]

"Our result indicates that players should not change their **shoes** before taking a penalty kick. [Nicholas P. Linthorne]

Analysis of a **goalkeeper's** motion to save a goal kick provides "findings that might be useful to improve the goalkeeper's saving motion." [Naoki Numazu]

Analysis of differences in the **throw-in** of 12 players differing in proficiency "could contribute to develop specific muscular training to increase the accuracy and distance of the throw-in skill during a soccer game." [Luis Carlos Hernandez Barraza]

Golf

Anchored putters tended to reduce accuracy of putting in this study of 72 golfers, so the intention to ban the practice seems misplaced. [Ian Kenny]

Gymnastics

In artistic gymnastics, "effective coaching practices require mechanical knowledge and understanding of the desired skills in order to develop technique and keep in line with this rapidly developing sport." The focus of this study of contestants in two elite competitions was effective technique selection for the female **longswing**. The inclusion of forward dynamic models helped develop understanding of optimal technique. [Michelle Manning]

Case-study analyses of elite gymnasts might be useful. [female, Lu Zhong; male, Xiuling Bian, Melanie Golding, Wei Xie]

Kayaking

On-water **kinetic and kinematic analysis** of 12 international-level kayakers provided "technique-related factors that presented opportunities to improve performance... Each athlete used an individual style to create velocity, which suggests that standardized technique interventions used by coaches may not be equally effective in improving performance in different individuals." [Barney Wainwright]

Martial Arts

In a crossover study of 16 trained martial arts practitioners, warming up by kicking against elastic resistance increased **roundhouse kick**

speed by 3.3%, presumably via post-activation potentiation [Håkon Strand Aandahl]. Faster hopping in the warm-up was also more effective for a **Taekwondo kick** in junior athletes [Young-Kwan Kim].

In a study the speed of the **roundhouse kick** of 13 male Japanese Taekwondo athletes, "our data suggest that coaches should pay greater attention to the support leg when adapting the technique for kicking distance as well as the motions of the pelvis and hip joint of the kicking leg when adapting the technique to increase kicking speed." [Madoka Kinoshita]

Rowing

Analysis of the **drive phase** in rowing on the Rowperfect ergometer and on water revealed an unexpected flexion phase at the knee joint. "This pattern is clearly different to the pattern observed in the dead lift, a common strength training activity for rowers. A more specific activity for rowers' lower-limb muscles should be introduced into the strength training program." Furthermore, "The on-water observation that 30% of the power of power delivered to the boat was during the recovery phase has focused attention on movement technique during the recovery phase...to optimize the 'run of the boat'." [Richard Smith]

Richard Smith and his colleagues have developed an **instrumented oar** that seems to work well in providing real-time measurement of oar angles and force. [Timothy Turner]

Analysis of force and angle from an **instrumented pin** in on-water rowing revealed differences between individuals and competition levels that "provide a strong evidence base for discussions with coaches and athletes about how to increase performance in on-water rowing." [John Warmenhoven]

Running

Conclusion from a comparison of **shod and barefoot** running in 10 healthy males: "if the function of footwear is to facilitate movement that mimics barefoot gait while providing comfort and protection for the foot, then the prevailing paradigm for footwear needs to change [Richard Smith]. Presumably minimalist shoes do represent the paradigm shift.

Instrumented starting blocks might help sprinters optimize their starts, but "a more lightweight, easier to use version of instrumented starting blocks needs to be developed." [Steffen Willwacher]

Data from a radar device or timing lights can be transformed into force, velocity, power output and effectiveness of force application onto the ground during a **sprint running acceleration**. "Its validity and ease of use make it an interesting tool for sprint training and performance optimization." [Jean-Benoit Morin]

Skiing

Modeling of the factors affecting **take-off speed in freestyle skiing** might be useful for planning specific aerial maneuvers. [Hou Boyi; Wang Xin; Zhao Le]

Studding an alpine skier with **accelerometers** won't allow accurate 3-D reconstruction of some aspects of movement. [Benedikt Fasel]

Surfing

An **instrumented surfboard** appears to work. [K. Lestrade]

Swimming

Kinetics and kinematics of **turns** of nine to 14 elite Australian swimmers in each gender category and each of the four stroke categories were included in this analysis to identify parameters that correlated with turn performance, which will "ascertain where a swimmer should concentrate their efforts to improve performance" [Bruce R. Mason]. You'll need the Wetplate or similar system to make use of these findings.

Although swimmers had faster **starts** when using their preferred track start [Sergio Carradori], for half of 17 elite swimmers at least one stance alternative provided a better swim start time than the preferred stance [Armin Kibele]. So you have to find each swimmer's best starting stance.

The same goes for the **underwater phase** of the start, where seven of the fourteen swimmers performed faster using a non-preferred technique (deeper or shallower). [Elaine Tor]

A **backstroke start** device introduced in 2014 (apparently the Omega starting platform: see [this critique](#)) shaved 0.07 s on average off the start time of 14 high-level swimmers [Suzanne Sinistaj]. That's approximately equal to the smallest important effect for a 50-m race.

Tennis

Differences between top-ranked and lower ranked tennis players in hawk-eye data revealed obvious skill differences, but the better players also "played more groundstrokes from behind the baseline, delivered the ball deeper into their opponent's court, and covered a greater dis-

tance during matches", findings that may help coaches to develop **playing style** and **match tactics**. [David Whiteside]

Analysis of Sharapova's **forehand stroke** technique in tennis "offers theoretical instructions to coaches and athletes for proper understanding and mastery of such a technique during training" [Zuqing Li]. There might also be something useful in the analysis of the **erves** of Serena Williams and Simona Halep [Jun Guo].

Forearm **kinesio taping** in 14 male tennis players "would have a significant positive effect on muscle fatigue resistance" [Weijie Fu].

Trampolining

By developing a model of the **forward somersault** in trampolining, the authors provided information that can "inform coaching practice through a better understanding of the use of the arms in forward somersaults." [Dave Burke]

Reviewer's Comment

Gareth Irwin

ISBS was much less descriptive this year, and there was more research driven by theory and aimed at explaining underlying mechanisms. This was particularly evident in the presentations by new investigators. The keynotes were innovative and added novelty and a wider scope to this conference than others I have attended.

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