PASIG MONTHLY CITATION BLAST: No.33   **August 2008**

Dear PASIG members:

Many of us have been watching the Olympics this week (how about that Phelps?). The first week culminated with an exciting individual women's gymnastics competition. Despite the home advantage (see Balmer and Nevill, 2003 in the annotated bibliography), Americans Nastia Liukin and Shawn Johnson took Gold and Silver respectively (63.325 and 62.725), with Chinese Yilin Yang winning Bronze (62.650) in the in the all-around competition. How wonderful to see former Russian gymnast father-coach, Valeri Liukin, embrace his daughter Nastia and a Chinese born coach, Liang Chow, with Shawn. We are truly a nation of immigrants!

For the annotated bibliography this month, I've selected a sampling of recent *gymnastics* references. This month's citations will be added to EndNote libraries available on the PASIG webpage for our members to access and download. (Information about EndNote referencing software can be found at http://www.endnote. com, including a 30-day free trial). If you'd like to suggest a topic or create one, please let me know. As always, your comments and entry contributions to these Citation Blasts are always welcome.

As always, please drop me an e-mail anytime.

Regards,
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Al-Kashmiri A, Delaney JS (2007). Case report: Fatigue fracture of the proximal fibula with secondary common peroneal nerve injury. Clin Orthop Relat Res **463**: 225-8.

Stress fractures of the proximal fibula are uncommon and usually result from axial loading, which is mostly described in runners. We report an unusual mechanism of such a fracture in a circus performer resulting from repetitive direct horizontal loading from a trapeze bar. In addition, the bony injury resulted in a secondary injury to the common peroneal nerve with corresponding weakness. Both injuries responded well to nonoperative treatment and the athlete had an excellent recovery with no residual symptoms. He was able to resume his training with the use of protective padding applied to the proximal legs. Fracture of the proximal fibula caused by direct repetitive stress to the bone with a secondary compression injury to the common peroneal nerve is a previously undescribed injury. We report a patient who presented with this injury, the possible mechanisms of such injury, its management, and outcome.

Aydog ST, Tetik O, et al. (2005). Differences in sole arch indices in various sports. Br J Sports Med **39**(2): e5.
BACKGROUND: There are controversial data about the relation between foot morphology and athletic injuries of the lower extremity. Studies in soldiers have shown some relationship, whereas those involving athletes have not shown any significant relationship. The reason for these differences is not clear. OBJECTIVE: To determine the effect of various sports on sole arch indices (AIs). METHOD: A total of 116 elite male athletes (24 soccer players, 23 wrestlers, 19 weightlifters, 30 handball players, and 20 gymnasts) and 30 non-athletic men were included in this cross sectional study. Images of both soles were taken in a podoscope and transferred to a computer using a digital still camera. AIs were calculated from the stored images. RESULTS: The AI of the right sole of the gymnasts was significantly lower than that of the soccer players, wrestlers, and non-athletic controls (p<0.01). The AI of the right sole of the wrestlers was significantly higher than that of the soccer players, handball players, weightlifters, gymnasts, and non-athletic controls (p<0.03). The AI of the left sole of the gymnasts was significantly lower than that of the wrestlers and non-athletic controls (p<0.001). The AI of the left sole of the wrestlers was significantly higher than that of the soccer players, handball players, and gymnasts (p<0.007). The AI of both soles in handball players was significantly lower than those of the non-athletic subjects (p = 0.049). The correlation between the AI of the left and right foot was poor in the soccer players, handball players, and wrestlers (r = 0.31, 0.69, and 0.56 respectively), but was high in the gymnasts, weightlifters, and non-athletic controls (r = 0.96, 0.88, and 0.80 respectively). CONCLUSION: The AIs of the gymnasts and wrestlers were significantly different from those of other sportsmen studied, and those of the gymnasts and handball players were significantly different from those of non-athletic controls.

Balmer NJ, Nevill AM, et al. (2003). Modelling home advantage in the Summer Olympic Games. J Sports Sci **21**(6): 469-78.
Home advantage in team games is well proven and the influence of the crowd upon officials' decisions has been identified as a plausible cause. The aim of this study was to assess the significance of home advantage for five event groups selected from the Summer Olympic Games between 1896 and 1996, and put home advantage in team games in context with other sports. The five event groups were athletics and weightlifting (predominantly objectively judged), boxing and gymnastics (predominantly subjectively judged) and team games (involving subjective decisions). The proportion of points won was analysed as a binomial response variable using generalized linear interactive modelling. Preliminary exploration of the data highlighted the need to control for the proportion of competitors entered and to split the analysis pre- and post-war. Highly significant home

advantage was found in event groups that were either subjectively judged or rely on subjective decisions. In contrast, little or no home advantage (and even away advantage) was observed for the two objectively judged groups. Officiating system was vital to both the existence and extent of home advantage. Our findings suggest that crowd noise has a greater influence upon officials' decisions than players' performances, as events with greater officiating input enjoyed significantly greater home advantage.

Baudry L, Leroy D, et al. (2006). Auditory concurrent feedback benefits on the circle performed in gymnastics. J Sports Sci **24**(2): 149-56.

In this study, we examined the effectiveness of auditory concurrent feedback on body segmental alignment during the circle movement performed on a pommel horse. Eighteen gymnasts were assigned to one of two groups: a concurrent auditory feedback group (experimental) or a control group that received no concurrent feedback. After 2 weeks of training (300 circles), the body segmental alignment (BSA) of the experimental group had improved by 2.3% between the pre test (85.7 +/- 4.8% BSA(max)) and the post test (87.7 +/- 4.0% BSA(max)). Furthermore, the results of a retention test administered 2 weeks after the post test revealed no decline in performance for the experimental group. No gains in body segmental alignment were found for the control group. It was concluded that augmented auditory feedback made available in real time can be used to correct complex movements, such as the circle movement on a pommel horse, and does not appear to lead to information-dependence despite the frequent administration of feedback. The auditory signal available in real time could help gymnasts to become more objective about their own intrinsic information necessary for the refinement of the circle movement.

Bradshaw EJ, Le Rossignol P (2004). Anthropometric and biomechanical field measures of floor and vault ability in 8 to 14 year old talent-selected gymnasts. Sports Biomech **3**(2): 249-62.

The aim of this study was to identify the anthropometric and physical prerequisites for high difficulty floor tumbling and vaulting. Twenty 8-14 year old female talent-selected gymnasts performed handstand push-offs, and single and multiple jumps on a portable Kistler force plate. The force curves were analysed using Kistler and Excel software to obtain peak displacement, peak take-off force, and power The gymnasts were also assessed for sprinting, with and without vaulting, and standing broad jump performances. Video footage from the vault take-off was analysed using Video Expert II software to obtain the horizontal and vertical take-off velocities. Each gymnast's best vault starting score, three best floor tumbling skills, and anthropometric characteristics were recorded. Statistical analysis included one-way analysis of variance (ANOVA) to examine the effect of age (8-10 years, 11-12 years, 13-14 years) on the performance measures and linear regression analysis with performance start score for vault or best floor tumbling score as the outcome variable. The best regression model for indicating vaulting talent had, as predictor variables, resultant velocity at take-off from the board, squat jump power, and average power during the last five jumps in the continuous bent-leg jump series. The best regression model for indicating floor tumbling ability had, as predictor variables, age, vault running velocity, and reduced ground contact time in a handstand push-off.

Calmels C, Holmes P, et al. (2006). Chronometric comparison of actual and imaged complex movement patterns." J Mot Behav **38**(5): 339-48.

The authors' aim in this study was to consider the functional equivalence of internal imagery, external imagery, and action execution. Sixteen elite gymnasts imaged and performed a complex gymnastic vault. Ten performers imaged from an internal perspective,

and 6 used an external perspective. Although the results revealed that the time to image the entire motor task did not significantly differ from the time required to physically perform it, irrespective of the imagery perspective used, the temporal organization of the action was different within the imagery conditions than it was in the physical condition. The results do not provide support for the principle of temporal functional equivalence. The authors discuss the results in light of recent findings from the cognitive neuroscience and psychology literatures.

Cuk I, Korencic T, et al. (2007). Differencies in morphologic characteristics between top level gymnasts of year 1933 and 2000. Coll Antropol **31**(2): 613-9.
> In 1933, at the 5th Regional Sokol Meeting in Ljubljana which was at the time a place in the Yugoslav Kingdom, Skerlj carried out the first measurements of 189 gymnasts, active competitors; in 2000, at the World Cup Meeting in Ljubljana, Cuk and associates carried out measurements of 40 top gymnasts. Our analysis of identical variables has shown that there is no difference in body height and weight of the gymnasts in 1933 and those in 2000, while there is a significant difference in the width of their shoulders and pelvis, the contemporary athletes being wider in their shoulders and narrower in their pelvis. The differences can be assigned to the new requirements in contemporary gymnastics as exercises are becoming more difficult, including more rotation around the vertical and horizontal axis.

Grant-Ford M, Sitler MR, et al. (2003). Effect of a prophylactic brace on wrist and ulnocarpal joint biomechanics in a cadaveric model. Am J Sports Med **31**(5): 736-43.
> BACKGROUND: Wrist pain from repetitive dorsiflexion and compression during pommel horse exercises is common among male gymnasts. PURPOSE: To determine the biomechanical effects of a prophylactic wrist brace on the wrist and ulnocarpal joints during mechanical loading in a cadaveric model. HYPOTHESIS: The lateral wedge of the palmar pad of the brace will compensate for positive ulnar variance, distributing contact forces more evenly across the radioulnar carpal joint. STUDY DESIGN: Controlled laboratory study. METHODS: Six male and six female fixed cadaveric forearm-wrist specimens were subjected to a 32.13-kg compressive load applied through the long axis of the pronated forearm with a dorsiflexed wrist in contact with a support surface. Wrist joint dorsiflexion angle and ulnocarpal joint intraarticular peak pressure were assessed under three brace conditions: Ezy ProBrace with and without palmar pad and a nonbraced control. RESULTS: Wrist joint dorsiflexion angle was significantly reduced by the Ezy ProBrace with and without the palmar pad. However, ulnocarpal joint intraarticular peak pressure was reduced only by the brace with pad. CONCLUSION: Prevention of pathologic wrist changes requires intervention in pressure attenuation, which was achieved with the Ezy ProBrace with palmar pad. Clinical Relevance: This brace may decrease the cumulative effects of repetitive stress of pommel horse exercise training.

Grassi G, Turci M, et al. (2005). Body movements on the men's competition mushroom: a three dimensional analysis of circular swings. Br J Sports Med **39**(8): 489-92.
> OBJECTIVES: To develop a method for the three dimensional analysis of body movements and body positions during the performance of circular swings on the competition mushroom, an apparatus used by young gymnasts for pommel horse training. METHODS: Five experienced male gymnasts, all of national level, performed three series of 10 circular swings on the competition mushroom. An optoelectronic instrument was used for the detection of the three dimensional movement of 13 body landmarks. From landmark

trajectories, several technical measurements were obtained: diameters of ideal circles of ankles, hips, shoulders; deviation of the ankle diameters from circularity and from the horizontal plane; angle between the shoulder, hip, and ankle. The values were used for a quantitative assessment of performance of the five gymnasts. RESULTS: During the exercise, each ankle should follow a nearly horizontal circular path (deviation from circularity ranged from 3.6% to 6%, deviation from horizontality was 9.4-19.7%), there should be an angle of about 180 degrees at the hips (actual values 146-153 degrees), and the shoulders should move as little as possible, and only in the lateral plane, without major anteroposterior movements (shoulder movement was 27-31% of ankle movement, hip movement was 16-20%). CONCLUSIONS: The method could help coaches and gymnasts to determine which parts of the body are not repeating a selected movement with sufficient accuracy and to quantify improvements made after a specific training programme.

Grassi GP, Santini T, et al. (2005). Spatiotemporal consistency of trajectories in gymnastics: a three-dimensional analysis of flic-flac. Int J Sports Med **26**(2): 134-8.
Sport performance during the execution of closed skills combines specific body and limb movements into codified patterns where stability and consistency may be more important than variability. Repeated sport movements can be investigated to assess the consistency of body trajectories. More consistent trajectories will result in more repeatable movements. The present study quantified the short-term consistency of body trajectories during the performance of the backward flic-flac, a technique of floor gymnastics. Nine experienced gymnasts (six men, three women), all of national level, performed 10 repetitions of backward flic-flac. An optoelectronic instrument was used for the detection of the three-dimensional movement of 13 body landmarks. The spatiotemporal consistency of repeated landmark trajectories was measured by the standard deviation between standardized trajectories. The results showed smaller standard deviation (larger consistency between landmark trajectories) in female than in male gymnasts. The analysis of the consistency of landmark trajectories could help gymnasts indicating which parts of the body do not repeat a selected movement with sufficient accuracy.

Harringe ML, Nordgren JS, et al. (2007). Low back pain in young female gymnasts and the effect of specific segmental muscle control exercises of the lumbar spine: a prospective controlled intervention study. Knee Surg Sports Traumatol Arthrosc **15**(10): 1264-71.
Prospective controlled intervention study. To evaluate a specific segmental muscle training program of the lumbar spine in order to prevent and reduce low back pain in young female teamgym gymnasts. Teamgym is a team sport comprising three events: trampette, tumbling and floor programme. In a recent study, it was found that teamgym gymnasts practice and compete despite suffering from back pain. Specific muscle control exercises of the lumbar spine have shown good results in reducing pain intensity and functional disability levels in patients with low back pain. To our knowledge, this type of training has not been studied in an adolescent athletic population before. Fifty-one gymnasts, with and without LBP, 11-16 years old, from three top-level gymnastics team participated in the study comprising 12 weeks. Every day the gymnasts answered a questionnaire regarding low back pain. After baseline (4 weeks) the intervention group performed a specific segmental muscle training program. Twenty-four gymnasts (47%) reported low back pain during baseline. Nine gymnasts failed to answer the questionnaire every day and the following results are based on 42 gymnasts (intervention group, n = 30, and control group, n = 12). Gymnasts in the intervention group reported significantly less number of days with low back pain at completion compared to baseline (P = 0.02). Gymnasts in the control group showed no difference in terms of days with low back pain or intensity of low back

pain between baseline and completion. Eight gymnasts (out of 15) with LBP in the intervention group became pain free. Specific segmental muscle control exercises of the lumbar spine may be of value in preventing and reducing low back pain in young teamgym gymnasts.

Hiley MJ, Yeadon MR (2007). Optimization of backward giant circle technique on the asymmetric bars. J Appl Biomech **23**(4): 300-8.

The release window for a given dismount from the asymmetric bars is the period of time within which release results in a successful dismount. Larger release windows are likely to be associated with more consistent performance because they allow a greater margin for error in timing the release. A computer simulation model was used to investigate optimum technique for maximizing release windows in asymmetric bars dismounts. The model comprised four rigid segments with the elastic properties of the gymnast and bar modeled using damped linear springs. Model parameters were optimized to obtain a close match between simulated and actual performances of three gymnasts in terms of rotation angle (1.5 degrees), bar displacement (0.014 m), and release velocities (<1%). Three optimizations to maximize the release window were carried out for each gymnast involving no perturbations, 10-ms perturbations, and 20-ms perturbations in the timing of the shoulder and hip joint movements preceding release. It was found that the optimizations robust to 20-ms perturbations produced release windows similar to those of the actual performances whereas the windows for the unperturbed optimizations were up to twice as large. It is concluded that robustness considerations must be included in optimization studies in order to obtain realistic results and that elite performances are likely to be robust to timing perturbations of the order of 20 ms.

Hiley MJ, Yeadon MR (2008). Optimisation of high bar circling technique for consistent performance of a triple piked somersault dismount. J Biomech **41**(8): 1730-5.

The dismount from the high bar is one of the most spectacular skills performed in Men's Artistic Gymnastics. Hiley and Yeadon [2005. Maximal dismounts from high bar. Journal of Biomechanics 38, 2221-2227] optimised the technique in the backward giant circle prior to release using a computer simulation model to show that a gymnast could generate sufficient linear and angular momentum to perform a triple piked backward somersault dismount with a sufficiently large release window (the period of time during which the gymnast could release the bar and successfully complete the dismount). In the present study, it was found that when the timing of the actions at the hip and shoulder joints from the optimum simulation were perturbed by 30ms the resulting simulation could no longer meet the criteria for sufficient aerial rotation and release window. Since it is to be expected that a gymnast's technique can cope with small errors in timing for consistent performance, a requirement of robustness to timing perturbations should be included within the optimisation process. When the technique in the backward giant circle was optimised to be robust to 30ms perturbations, it was found that sufficient linear and angular momentum for a triple piked dismount could be achieved with a realistic release window.

Hiley MJ, Yeadon MR, et al. (2007). Consistency of performances in the Tkatchev release and re-grasp on high bar. Sports Biomech **6**(2): 121-30.

The Tkatchev on the high bar is a release and re-grasp skill in which the gymnast rotates in a direction during flight opposite to that of the preceding swing. Since the release window is defined as the time during which the gymnast has appropriate linear and angular momentum to ensure the bar can be re-grasped, it was speculated that the release

windows for this skill would be smaller than for dismounts that are less constrained. One senior male gymnast competing at national standard performed 60 Tkatchev trials. A four-segment planar simulation model of the gymnast and high bar was used to determine the release windows in 10 successful and 10 unsuccessful performances of the Tkatchev recorded using a Vicon motion analysis system. Model parameters were optimized to obtain a close match between simulations and recorded performances in terms of rotation angle (1 degree), bar displacements (0.01 m), and release velocities (1%). Each matched simulation was used to determine the time window around the actual point of release for which the model had appropriate release parameters to complete the Tkatchev successfully. The release windows for the successful trials were small compared with those of dismounts. The unsuccessful trials were associated with later release and later timing of the actions at the shoulders and hips.

Irwin G, Kerwin DG (2005). Biomechanical similarities of progressions for the longswing on high bar. Sports Biomech **4**(2): 163-78.
Based on specificity of training and biomechanical analysis, the aim of this study was to develop a method to rank selected progressions for learning the longswing on high bar. Four members of the Men's National Gymnastics Squad were recorded (50 Hz) performing three series of five longswings and eight progressions. Real world co-ordinates from the digitized data were determined using two-dimensional direct linear transformation. Biomechanical similarity between the functional phases of the longswing and the corresponding phases of the progressions were calculated. The functional phases were described as a hyperextension to flexion of the hip and hyperflexion to extension of the shoulder joints as the gymnast passed underneath the bar. Using a combined score of 'Difference' and movement 'Variability' a 'Specificity score' was calculated for hip and shoulder angular displacements and velocities. An overall score based on the average of the four scores provided a ranked list of progressions based on their similarity to the target skill. The progression that showed the greatest similarity to the biomechanics of the longswing, and was therefore ranked first, was the chalked bar pendulum swing. The least similar progression, and, therefore, eighth ranked, was the chalked bar bent knee longswing. The hip kinematics were found to contribute most to the overall differences because the performance requirements of these progressions emphasize an increase in hip flexion during the ascending phase. The method described provides a means to quantify and rank progressions based on their kinematic similarity to the longswing.

Irwin G, Kerwin DG (2007). Inter-segmental coordination in progressions for the longswing on high bar. Sports Biomech **6**(2): 131-44.
This study focused on identifying the most effective skill progression for developing the longswing on high bar in men's artistic gymnastics. Building on previous work by Irwin and Kerwin, in which a method to rank progressions based on their angular kinematics was developed, this study aimed to use the method to quantify similarities in inter-segmental coordination between selected progressions and the longswing on high bar. Video images of four members of the UK men's national gymnastics squad performing three series of five longswings and eight progressions were recorded at 50Hz. Two-dimensional direct linear transformation techniques were used to determine the real-world coordinates from the digitized data. Inter-segmental coordination of the hip and shoulder joints during the functional phases of the longswing was assessed using continuous relative phase. Similarity between the longswing and each progression was represented by a "specificity score", which was also used to rank the progressions. Each progression's specificity score was calculated by combining a "difference score" (root mean squared difference between

the continuous relative phase profiles of the longswing and the progression) and a "variability score" (standard deviation of the continuous relative phase profiles for each progression). The progressions that were most similar to the longswing included the looped bar longswing and layaway swing down (ranked 1st and 2nd), with specificity scores of 9% and 10% respectively. In contrast, the least similar progressions were the looped bar "no action" longswing (51%) and pendulum swing (63%) (ranked 7th and 8th). Establishing effective skill learning pathways is recognized as a key component of the coaching process and ranking progressions based on their specificity score provided a mechanism to identify progressions with similar inter-segmental coordination profiles to the key skill on the high bar, the longswing.

Irwin G, Kerwin DG (2007). Musculoskeletal demands of progressions for the longswing on high bar. <u>Sports Biomech</u> **6**(3): 361-74.

> Kinetic analyses of the chalked bar longswing on high bar and its associated progressions were used to explain musculoskeletal contributions during the performance of these skills. Data on four international male gymnasts performing three series of chalked bar longswings and eight progressions were recorded. Customized body segment inertia parameters, two-dimensional kinematics (50 Hz), and bar forces (1000 Hz) were used as input to inverse dynamic modelling. The analysis focused on the relative contributions of the knees, hips, and shoulders with root mean squared differences between the chalked bar longswing and the progressions being used to rank the progressions. Seventy per cent of the total work occurred between 200 degrees and 240 degrees of angular rotation in the longswing, 67% of which was contributed by the shoulders. The shoulders were also dominant in all progressions, with the largest such contribution occurring in the looped bar longswing with "no action". The least similar progression was the looped bar pendulum swing, while the most similar was the chalked bar bent knee longswing. This study provides a useful means for ranking progressions based on their kinetic similarity to the chalked bar longswing and builds on earlier research in identifying that progressions can be classified into those similar in physical demand (kinetics) and those similar in geometry (kinematics).

Prassas S, Kwon YH, et al. (2006). Biomechanical research in artistic gymnastics: a review. <u>Sports Biomech</u> **5**(2): 261-91.

> Biomechanical research into artistic gymnastics has grown substantially over the years. However, most research is still skill oriented with few tries at generalization. Consequently, our understanding of the principles and bases of the sport, although improved, is still marginal with gaps in knowledge about technique attributes throughout the sport. For that reason, this review begins with an attempt to identify important variables contributing to successful performance. The review is presented in clusters of work in similar apparatuses culminating in Tables offering an 'at a glance' summary of knowledge in each cluster. The last section of the review tries to give some direction to future biomechanical research in gymnastics in issues relating to data collection--two-dimensional or three-dimensional, image size, frame rate--and analysis, such as descriptive or explanatory, simulation and optimization, and statistical issues.

Takei Y, Dunn JH, et al. (2007). Somersaulting techniques used in high-scoring and low-scoring Roche vaults performed by male Olympic gymnasts. <u>J Sports Sci</u> **25**(6): 673-85.

> The aim of this study was to compare the somersaulting techniques used in the 16 highest-scoring and 16 lowest-scoring Roche vaults. Our hypothesis was that the gymnasts performing the highest-scoring Roche vaults would demonstrate a better technique than

those performing the lowest-scoring Roche vaults while on the horse (pushing off the horse more effectively), somersaulting (executing most of the required somersaults higher in flight), and landing (showing a greater control). A 16-mm motion picture camera, operating at 100 Hz, recorded the vaults during the official competition. The two-dimensional direct linear transformation was used for spatial reconstruction. The results of t-tests ($P < 0.05$) indicated that, compared with the low-scoring gymnasts, the high-scoring gymnasts had: (1) greater height of body centre of mass and a more fully extended body position at the horse take-off; (2) greater height of body centre of mass at the peak of post-flight, knee release, and touchdown on the mat; (3) greater horizontal and vertical displacements of body centre of mass, greater somersaulting rotation, and longer time from the knee release to mat touchdown; and (d) markedly smaller landing point deductions. In conclusion, a successful Roche vault is likely when the focus is on: (a) leaving the horse with a large vertical velocity in an extended body position to achieve a high trajectory of centre of mass by first extending the legs, then immediately pushing off the horse vigorously, using the muscles of the upper extremity; (b) grasping the knees immediately after the take-off from the horse, achieving the tightly tucked body position early during the ascent to the peak, and completing two-thirds of the required somersaults at a great height; (c) releasing the knees and extending the body above the top level of the horse; and (d) contacting the mat with a high body centre of mass position.