THE INTERDEPENDENCE OF FUNCTIONAL AND DYNAMIC STABILITY OF THE 16-18 YEARS OLD BASKETBALL PLAYERS – A PILOT STUDY

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We aimed to determine the interdependence between functional and dynamic stability of young basketball players. Nineteen, young basketball players took part in the experiment. They were tested with Y Balance Test™ for functional stability and with "Drift protocol" of the Optojump Next System for dynamic stability. The correlation analysis showed interdependencies between functional balance testing and dynamic performance. The Composite Reach Score is highly associated with individual leg jump power. Also there are significant dependencies between jumping stability in AP and ML planes and reach distances in specified directions. Other significant correlations indicate the need for conducting functional testing in parallel with dynamic trials in order to achieve wider picture of the athletes performance.

KEY WORDS: functional and dynamic balance, sport performance, injury

INTRODUCTION: There is much confusion about what is understood by static and dynamic balance in the literature. Many researchers refer to dynamic balance when subjects are fixed to the ground, standing on one or both legs and perform some functional tests. These tests include reaching or leaning with one extremity or whole body in specified directions (Clark and Rose, 2001; Bressel et al., 2007; Bouillon and Baker, 2011; Butler et al., 2013). All these tests are more functional than dynamic since the base of support does not change during the testing procedure. We advocate for the truly dynamic task when addressing the dynamic balance. There are many studies that investigate dynamic balance during gait in different populations (Madehkhaksar and Egges, 2016; Malone et al., 2016) and not so many which deal with the problem of dynamic stabilization during dynamic performance (i.e. jumping) (Wikstrom et al., 2004, 2006; Ross et al., 2005; Liu and Heise, 2013). This distinction seems to be quite important and we propose to differentiate between functional and dynamic testing. Unilateral balance and dynamic neuromuscular control are required for sport. Dysfunctional unilateral stance has been prospectively identified as a risk for injury in sport (McGuine et al., 2000; Plisky et al., 2006; Trojian and McKeag, 2006). The recent discussion in the literature has occurred regarding the importance of assessing functional and dynamic neuromuscular control for injury prediction using body relative movement testing. Standard static balance measures are usually not sensitive enough to detect the subtle changes in proper functioning of postural control. Therefore it is our goal to find adequate functional and dynamic testing procedures that complementarily will detect any signs of possible injury in sports. We hypothesize that there is close connection between functional and dynamic balance which are based on the similar or the same neuromuscular processes. We look for the effective and more effortless methods of screening the athletes. We propose dynamic balance testing in the form of jumping as this is a very common movement in almost every sport. It is also reported that many non-contact injuries are sustained by the improper neuromuscular control during jump performance. The main objective of the study was to show the distinct correlates of the functional and dynamic stability. Both require precise neuromuscular control and are crucial in sports performance.

METHODS: 19 healthy basketball players voluntarily took part in the experiment. Their average age, height and weight were respectively: 16.5±0.7 years, 186.8 ±7.0 cm, 73.8±8.7

kg (mean±SD). All the subjects or their legal guardians have signed an informed consent form approved by the Institutional Review Board. All subjects reported to be right-footed. To assess the functional and dynamic balance of the athletes Lower Quarter Y Balance Test™ (FunctionalMovement.com, Danville, VA) and Optojump Next (Microgate, Italy) were used respectively. The Lower Quarter Y Balance Test (YBT-LQ) is an instrumented version of components of the Star Excursion Balance Test (SEBT) developed to improve the repeatability of measurement and standardize performance of the test. The device utilizes the anterior, posteromedial, and posterolateral components of the SEBT (Plisky et al., 2009). The Optojump Next photocell system demonstrated strong concurrent validity and excellent test-retest reliability for the estimation of vertical jump height (Glatthorn et al., 2011). The system offers different options of jump testing, among which "Drift Protocol test" is designed to assess dynamic stability. The test protocol consists of five, consecutive, unilateral, vertical jumps for both legs. The series of jumps are repeated two times (foot parallel and orthogonal to the Optojump bars) in order to achieve the two dimensional picture of the dynamic stability of the jumping performance. To standardize the test execution each subject had to elevate their foot at the knee height of the contralateral leg and try to keep it at this level during the jumps. Subjects' hands were in the akimbo position to eliminate the influence of arm swing on the jumping performance. They were instructed to jump 5 times as fast and as high as they could on one leg. At the beginning of testing session subjects performed 10 minute warm-up with jump rope and stretching. First, they were examined with the use of standardized procedures of the YBT-LQ followed by "Drift protocol" testing of the Optojump Next System. The following variables of YBT-LQ were further analyzed: Right_Anterior Reach [cm], Left_Anterior Reach [cm], Right_PostMedial Reach [cm], Left_PostMedial Reach [cm], Right_PostLateral Reach [cm], Left_PostLateral Reach [cm], Composite Reach Score [%], deltaAnterior [%], deltaPostMedial [%], deltaPostLateral [%]. The Drift protocol offers the following variables that were further analyzed: jump height (H) [cm], power (Power) [W/Kg], contact time (CT) [s], flight time (FT) [s], average drift in the mediolateral direction (DR_ML) [cm], average drift in the anterioposterior direction (DR_AP) [cm], standard deviation of the average drift in ML (Sd_DR_ML) [cm], standard deviation of the average drift in AP (Sd_DR_AP) [cm], occupied area during jump (Area) [cm^2]. All parameters were established for both legs denominated by R (right) and L (left) in variable names. Additionally the deltas (d) for the same variables were calculated as the difference between right and left leg performance. The interdependence between these variables was estimated by the means of the correlation analysis. The significance level was set at $p<0.05$.

RESULTS: Preliminary results show statistically significant correlations of the Y Balance Test outcomes, as a functional measure of balance, and parameters of the dynamic balance test in the form of Drift Protocol of the Optojump Next System. Considering the reach distances in different directions we have observed high positive correlations between Left_PostMedial Reach (r=.53, p<.024), Right_PostLateral Reach (r=.54, p<.019), Left_PostLateral Reach (r=.511, p<.03) and right leg power (Power_R). Interestingly, no such correlations were observed for the left leg. There were high negative correlations between PostLateral Reach of the right leg (Right_PostMedial Reach) and delta average drift in ML (r=-.53, p<.022). The same was observed for the left leg (Left_PostMedial Reach) and (dSd_DR_ML) (r=-.53, p<.024). Additionally the difference in the occupied area between right and left leg (dArea) was highly, negatively correlated with PostMedial Reach distance for the right leg (r=-.53, p<.025). Composite Reach Score was positively correlated with power, both right (r=.52, pp<.027) and left leg (r=.49, p<.04). The difference between anterior reach score between legs (deltaAnterior) was negatively correlated with the delta of standard deviation of drift in ML (dSd_DR_ML) (r=-.47, p<.046). The difference in PostLateral Reach between right and left leg (deltaPostLateral) was positively correlated with drift in AP for the right leg ($r=.50$, $p<.035$) as well as for the standard deviation of the drift in AP for right leg ($r=.59$, $p<.01$).

DISCUSSION: The results of the study showed that there are distinct dependencies between functional and dynamic balance. Although, the functional and dynamic task is different in nature, one should consider these dependencies an important factor in the assessment of the motor performance in sports. The functional tests have proven to be good predictors of injury in competitive sports (McGuine et al., 2000; Plisky et al., 2006). It is possible that dynamic tests being closer in nature to the sport competition have an even higher probability of finding the individuals with possible risk of injury. It has been found that the important factor for overall functional stability based on the Composite Reach Score of the YBT-LQ is associated with individual leg power performance. Our results are in accordance with the study by Garrison et al. (2015), who also reported association of the jumping performance (single hop distance and triple hop distance) and isometric knee extension strength with the anterior reach symmetry indices. Although the authors presented data on sportsmen returning to sport after ACL reconstruction, the idea seems to be similar. The concept of this study was to show the dependence of the functional stability with dynamic stability in the group of sportsmen (basketball players). I would be useful to compare these results with a control group to verify whether they are specific for this group of subject or can be generalized, however this is a pilot study and we plan to do this in future. The dynamic stability in the Drift protocol of the Optojump Next System is expressed as displacement of the jumping point during execution of 5 consecutive vertical jumps. It demands proper motor control and efficient core stability. These are, in our opinion, important factors influencing the execution and determine a good score in this test. The rationale for this assumption might be the data presented by Sharma et al. (2012) where they reported improvements in different types of jumps of volleyball players after a nine-week core strengthening exercise program. The satisfying result is considered when the subject is able to control high power jumps and limit the AP-ML displacements of the body to minimum (ie. jumping point stays in one place). Of course, there is a high probability that the athletes would limit the jump height in order to limit the drift along the testing area, however the ratio between vertical jump height and average drift will be adverse. Similarly, in functional balance testing, core stability and muscle strength as well as neuromuscular control will be crucial (Cook, 2010).

CONCLUSIONS: At this point we did not incorporate EMG measurements, however this might help to answer the question, what neuromuscular mechanisms are similar in functional and dynamic balance strategies. This was partly done by Norris and Trudelle-Jackson (2011) who investigated the hip and thigh muscle activation during SEBT. The question remains: how is it different or similar to dynamic performance? Our goal in the future would be to identify the key contributions to proper execution of functional and dynamic test in order to address them in the sport training/physiotherapeutic interventions and achieve the best transfer into the sport field. In addition the Optojump Next system offers quick, effortless and reliable screening possibilities of the athletes. It may be more costly, however, when it comes to reliable identification of possible injuries during the high season, the time or its lack is sometimes the biggest problem. Therefore using this procedure instead of two or more would be for some coaches the best solution.

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