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TESTING VERT™ ACCELEROMETER TO IDENTIFY VALIDITY AND RELIABILITY WHEN COMPARED TO SWITCH MAT

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Testing Vert™ Accelerometer to Identify Validity and Reliability When Compared to Switch Mat

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By

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ABSTRACT

This present study was intended to identify the reliability and validity of the Vert™ device when compared to a Switch mat. Vert is a wireless device intended to measure jump count and jump height through an application on a smartphone or tablet and the Switch mat provides jump height using wireless sensors. Jump height is an important factor in many sports such as volleyball and basketball and it is important to have devices that coaches and trainers can use for testing that they can rely on. If this device is found to be valid and reliable, coaches and trainers could potentially use it in more practical settings such as practice and games due to the portability and small size. This study consisted of 6 subjects who volunteered. The switch mat was connected to the device to display the jump height immediately after the jump. The Vert sensor was clipped onto the subject's hip near the center of mass and the jump count and height were then displayed on an app. The subjects completed a series of warm-ups followed by 3 sets of 5 repetition countermovement jumps while using both devices to collect the data. The total 15 jump heights from these 3 sets of 5 were then analyzed using Pearson correlation analysis as well as a paired sample T-test. The jump height recorded from the Vert was consistently about 10 cm off from the jump height of the switch mat, which for a volleyball player, could be the difference between blocking and missing the ball. The results of this study showed that the Vert device is reliable but not practically valid. If technical improvements were made to the device to correct the height components the device could potentially be used in place of a force plate or switch mat when conducting athlete testing but the device is not currently valid for practical use.

Introduction

Jump analysis is important to test in most sports, specifically if that sport involves jumping. Whether it is volleyball, basketball, gymnastics, cheerleading, etc., jumping is an integral part of how the athletes perform during competition. Jump height has been used to classify populations of different training status, as well as to track training-induced changes (Castagna et al., 2013). Using volleyball as an example, since jumping ability is a key element for success, coaches need to pay special attention to testing and developing vertical jumping abilities to allow the players to compete at more advanced levels (Sattler, Sekulic, Hadzic, Uljevic, & Dervisevic, 2012). Coaches and trainers seek effective and efficient methods of improving jump performance, making jump analysis an important tool in evaluating training tactics.

There are many different types of devices that can be used for analyzing jump performance. Jump analysis can be conducted using a variety of tools that range from advanced instruments such as force platforms (which are considered the gold standard), switch mats, and photocells, as well as popular field-testing procedures such as the Sargent jump test or the Abalakov test (Sattler, Sekulic, Hadzic, Uljevic, & Dervisevic, 2012). In recent years, there have also been multiple different versions of wireless accelerometers developted to analyze jump performance. The Myotest, The Vertec, Just Jump System and the Optojump system are among some of the other systems involving switch mats and wireless sensors used to determine jump height. (Castagna et al., 2013; Nuzzo, Anning, & Shargenberg, 2011).

Recently, coaches and practitioners have explored the efficacy of wireless sensors in favor of relying on force plates or switch mats for jump analysis. The force plates and

switch mats are a reliable way to analyze jump performance but have practical limitations. Wearable accelerometers are portable and affordable, and may provide instantaneous measurements reasonably close to the center of mass during a jump (Picerno, Camomilla, & Capranica, 2011). With more devices being made portable and wireless, jump analysis is becoming something that can be done more often, as well as in different settings than previously allowed.

The wireless device being tested in this study is called Vert™. The Vert device aims to measure jump count and jump height, which would be useful in a few different sports. If it is found to be valid and reliable, this could be used during matches and practices in a multitude of different sports to help both the coaches and the players. If a player could wear the Vert during a practice, game, or match then the coaches or trainers could view the data and determine how much work needs to be done on the player's end or how much progress they have made.

Purpose

The purpose of this study is to validate the Vert, by using the height when compared to the switch mat and provide an alternative to the switch mat. By comparing this device to the switch mat we can tell whether or not the Vert can be reliable and valid when used for testing these two variables. The Vert is more portable than the switch mat as well and can collect the data from an app on a tablet or a phone giving more reason to switch to using these over the switch mat. Due to coaches already using tablets and phones for other applications within their training, having jump analysis accessible on the same device would be advantageous. If it is found to be valid and reliable, coaches and trainers could

potentially replace the switch mat so that testing could be done during games and practices instead of in a laboratory setting where coaches are restricted to what they can do.

Literature Review

Vertical jumping is a major aspect to many sports such as basketball, volleyball, track, and gymnastics, as well as general strength and conditioning. The vertical jump is one of the most popular methods for the indirect assessment of lower-limb maximal power in populations of different age, gender, and training status (Castagna et al., 2013). Due to the prevalence of vertical jumps in sport, it becomes an emphasis within the training programs of those specific sports and can be used as a monitoring tool to determine progress. Volleyball being one of the most popular team sports in the world, characterized by short explosive movement patters, quick, agile positioning, jumps and blocks with a net whose top height is 2.43 m for men and 2.24 m for women is a prime example of why vertical jump performance testing is valuable (Sattler, Sekulic, Hadzic, Uljevic, & Dervisevic, 2012). Two specific types of jumps used in volleyball include a block jump, where the player jumps up to block the ball at the net, sending it back to the opponents side, and an attack or spike jump also making vertical jump testing a valuable tool (Sattler, Sekulic, Hadzic, Uljevic, & Dervisevic, 2012). Vertical jump performance is the difference between the center of body mass when standing and its position at the peak of the jump (Choukou, Laffaye, & Taiar, 2014). Sports scientists can use these measurements to calculate lower body power and to discriminate between levels of sport playing as well as assessing non-athletic populations lower-limb function (Nuzzo, Anning, & Schargenberg, 2011). This type of research is beneficial not only to athletes but to the general public. In laboratory and practical settings the assessment of vertical jumps can provide leg muscle power data

about the individual being observed (Castagna et al., 2013). A device to measure these aspects would benefit both the general public and athletes. Currently these types of devices are only available to strength and conditioning coaches as they have the abilities to test the accuracy and reliability (Nuzzo, Anning, & Shargenberg, 2011).

There have been many validation studies conducted to test the reliability and accuracy of different devices to measure jump height. Vertical jump performance can be tested using a variety of different procedures, tools, or systems. Some of these include force platforms, video analysis systems, switch mats, photoelectric cells with different jump modalities such as squat jumps, countermovement jumps, drop jump, and repeated jumps (Casartelli, Muller, & Maffiuletti, 2010). A few of the most commonly tested devices and measurement tools are the Vertec, Myotest (Nuzzo, Anning, & Shargenberg, 2011), Optojump (Castagna et al., 2013), and the Kinejump (Magnusdottir, Porgilsson, & Karlsson, 2014), along with switch mats as well as the gold standard for vertical jump height, the force plate (Castagna et al., 2013).

With there being so many products and options available, reliability and validity are fundamental evaluations of any technology before implementation. One study, used vertical jump height to validate a product called Myotest, consisting of a transportable accelerometric system (Choukou et al., 2014). The accelerometer is contained in a small device that is attached to the hip level during the execution of the jump so it can record the vertical acceleration of the jumper's body (Casartelli, Muller, & Maffiuletti, 2010). This accelerometer was being tested to evaluate three different variables used in jumping: jump height, vertical force and power, and leg stiffness and reactive strength index. The validation study was conducted using twenty males who trained once or twice a week in

non-jump based activities and were all given the same instructions before their sessions. Using three types of vertical jump tests, hopping in place, countermovement jumps, and squat jumps they attempted to validate this product against the force platform. Each participant came in two separate times, separated by 2-3 days keeping each trial as accurate as possible. After assessment and statistical analysis it was found to be highly reliable and valid for assessing hopping in place height, force during squat and countermovement jumps, and leg stiffness and reactive strength index. There were no significant differences between the test and retest data ($p>0.05$) showing that there was a high level of reliability. The intraclass correlation coefficients (ICCs) for these variables were all moderate to high in the range of 0.74 to 0.96 giving it the validity. It was found to be invalid when evaluating jump height as well as velocity and power in squat and countermovement jumps with those ICCs being from 0.29 to 0.79 (Choukou, Laffaye, & Taiar, 2014).

Another study tested the reliability and accuracy of three different devices on vertical jump height. The three devices were The Vertec, Just Jump System and Myotest (Nuzzo, Anning, & Shargenberg, 2011). Vertec is a device that measures the difference between the fully extended standing-reach-height and the maximum vertical jump-and-reach height (Magnusdottir, Porgilsson, & Karlsson, 2014). The just jump system determines jump height by measuring flight time, which is detected by sensitive micro switches located within the mat (Nuzzo, Anning, & Shargenberg, 2011). Finding out which device is the most reliable is important to strength and conditioning professionals so they know which one would be best to use. The procedure is similar to the previous in that there was two different sessions as well as identical procedures for all participants, trying

to keep the data as accurate as possible. The results from this study show that jump height measurement is most reliable when using the Myotest (Nuzzo, Anning, & Schargenberg, 2011). This device had not yet been validated when the study was done but it is now known to be valid when measuring certain variables of jumping. Based on the information found in this study, the Myotest would be a better device to use when measuring jump height.

A third study tested the reliability of two portable jump accelerometers against the force platform, which is considered to be the gold standard for vertical jump height (Castagna et al., 2013). One such device is an optical timing system, or (i.e. Optojump) used to determine vertical jump height just as switch mats do when testing in the lab by using the flight time of the jump. This type of device would greatly benefit sports and conditioning coaches that are looking for something more portable and accessible outside of a lab setting. The other device being tested was once again, the Myotest. As with the other two studies, this study required the participants to come in two times. This is important so there is enough data to analyze and compare to get the necessary results. When this study was conducted the Myotest had not yet been proved to be accurate, while there had been previous research with the Optojump system, so researchers were attempting to test the accuracy in comparison to other jump measuring devices. The results showed a significant difference of the two devices compared to the force platform, with the Optojump being the closest to the force platform (Castagna et al., 2013).

While there have been studies that confirmed the validity of accelerometer-based techniques to measure and jump height (Magnusdottir, Porgilsson, & Karlsson, 2014), there are still many new other devices coming out that could change the way these variables are

tested. These devices that are coming to be are beneficial to the strength and conditioning coach because they are relatively inexpensive, require minimal training for operation, do not require extensive data analysis, and provide immediate results (Nuzzo, Anning, & Shargenberg, 2011). It is important to test these devices against ones that are gold standard or known to be accurate and reliable so coaches and trainers can pick a device that they know will give them the results they need to help improve performance.

Methods

Subjects

All subjects are healthy, young adult who volunteered for the study (N = 6). The eligible criteria including; free of injuries, at least or over 18 years of age, and people who can do repetitive jumps up to five repetitions continuously. Study information was provided to all potential, eligible individuals verbally. Institutional review board approved all protocols.

Instruments

In this study, two instruments were used. One as a standard measure for jump repetitions and the other is a comparable wireless device to measure the same variables.

- Switch mat (Probiotics, Inc., Huntsville, AL): this instrument provides jump height at each repetition. The jump height at each repetition was recorded manually.
- Vert™ (Vert, Ft. Lauderdale, FL): this device wirelessly measures jump count and jump height through app of smartphone or tablet.

Procedures for validity and reliability tests

Subjects performed a self-selected general warm-up before completing sub-maximal jumps. Since the purpose of the study was to validate the sensors, no maximal

effort from subject is necessary. Wireless sensors were tested with a switch mat, which is often used in a practical setting to measure jump height. The sensor (Vert™) was placed on the hip near the center of mass of subject with a clip-on.

Countermovement Jump. After the participants completed the warm-up, they perform a repetitive jump on the switch mat 72.0 x 72.0 cm switch mat (Probiotics, Inc., Huntsville, AL). Each subject performs 3 sets of 5 repetition countermovement jumps (CMJ). All jumps were counted to ensure the 15 jumps total. Both devices provide jump height from their respective software (switch mat = from the connected box, Vert™ = application of smartphone).

Statistical Analysis

For validation analysis, each jump trial height (total 15 jumps) was used to compare devices. Jump heights from each device were compared using Pearson correlation analysis. A paired sample T-test was done to identify the difference between the two outcomes of data at an alpha value of 0.05.

Results

The results of this study show that the Vert is reliable but not practically valid. The average jump height for the switch mat was 25.89 cm with a standard deviation (SD) of 6.27 cm and the average for the Vert was 35.88 cm with a SD of 7.38 cm. The coefficient of variation for the switch mat and Vert was found to be 24.21% and 20.58%, respectively, indicating that measuring variation is relatively similar. The correlation between the two devices was found to be r=0.88, indicating that both devices' data are highly correlated. The data for the Vert was reliable based on above analysis as well as consistency of the measure, but the measurements tended to be different from the switch mat by

approximately 10 cm as shown below in Figure 1, each time producing differing outputs compared to the switch mat. When the paired T-test was conducted the value was found to be t=0.72 and p=0.06 making it non-significant but very close to achieving statistical difference.

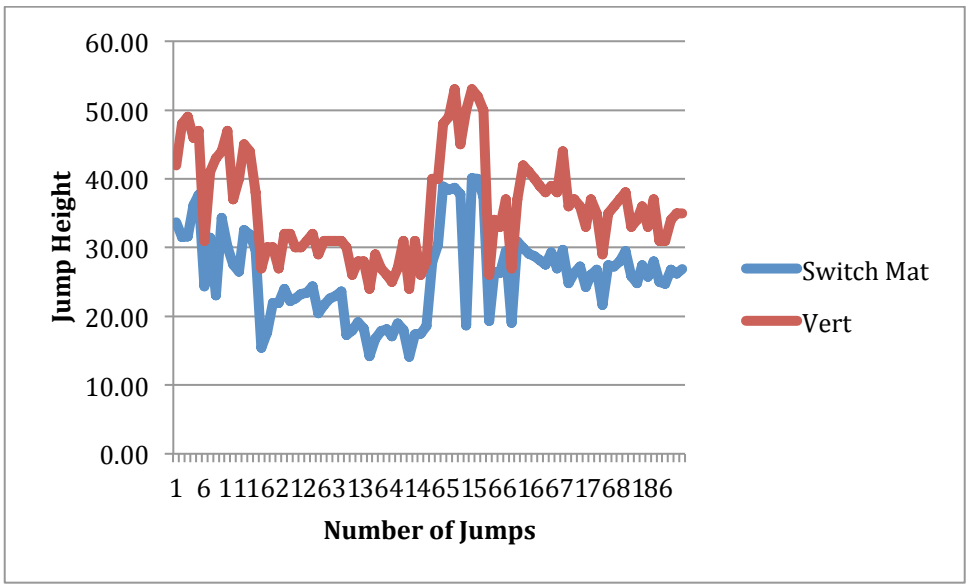

Figure 1: Comparison of jump height between Vert™ and Switch mat

Discussion:

This study was done to test the Vert against a switch mat to see whether or not coaches and trainers could use this device as an alternative to the switch mat. In a practical setting, Vert could be used in volleyball practices and matches, basketball practices, as well as just about any sport that involves jumping. Since the device is wireless it would be easier to collect data from athletes in other settings besides the lab. Coaches and trainers could observe the quality and quantity of jumps in real time whether it is while the athlete is training or playing. Data obtained from both devices measure nearly different based on statistical analysis but practically speaking, nearly 10 cm difference is very significant. It was found during this study that no matter how high or low the subjects jumped there was

a consistency of difference in the jump height when comparing the Vert and switch mat. However, since the Vert showed to be reliable but not valid in this study due to consistently different jump height measures between devices, technical improvements on the product need to be made before anyone could use it for valid data collection in a practical setting.

Since the Vert was consistently 10 cm off from the switch mat, it may not be ideal for use in a practical setting. If a volleyball coach wanted to make sure their athletes could jump high enough to block and spike the ball over the net, this device could not accurately tell them if the jump was high enough. Being 10 cm off is about the length from the tip of your fingers to about mid palm, so that would be the difference of a player either blocking or missing the ball. If the coach trusted this device and accepted the overestimated jump height to be accurate and didn't have the player working more to improve the height of the jump, that player would miss the ball in practice or a match because the device is not valid in a practical setting.

A previous study done, testing the reliability and validity of a portable switch mat called the Newtest Powertimer 300 series® in comparison to a force platform had similar results to this study. The results showed that the Newtest Powertimer system was proven to be a reliable testing instrument just as the Vert was found to be, but they could not call the device valid due to jump height measurements that ranged from -2.4 cm below to 8 cm above those of the force platform. However, the study did state that the device could be used as a means to measure jump height only if there was no other gold standard available. It also pointed out that if used for testing, the device should be used for the follow up testing as well, to ensure consistent measurements of improvements made (Enoksen, Tønnessen, & Shalfawi, 2009). With that being said, the Vert could potentially be used by

coaches and trainers as a means to track improvements in jump height but those measurements would not be valid, only a way to see if improvements were made. If improvements were made to the Vert it would then have to be tested against switch mats and/or force plates again to determine if those improvements helped make the device more valid and make sure it was still reliable. After improvements were made and testing was done, coaches and trainers could then eventually replace other devices with this one. Force plates and the equipment used to record data are restricted to the lab and switch mats can be taken out of the lab to other settings such as practices and training, but neither of these devices can be used in practical settings such as on the field or court as they are stationary tests. The Vert, if improvements were made and was found to a be valid and reliable device, could replace these devices and give coaches better feedback while the athlete is actually playing the sport versus jumps in a lab setting that might not be as accurate to how the athlete actually performs.

References

Casartelli, N., Muller, R., & Maffiuletti, N. A. (2010). Validity and Reliability of the Myotest Accelerometric System For the Assessment of Vertical Jump Height. *Journal of Strength and Conditioning Research, 24.*

Castagna, C., Ganzetti, M., Ditrioilo, M., Giovannelli, M., Rocchetti, A., & Manzi, V. (2013). Countercurrent Validity of Vertical Jump Performace Assessment Systems. *Journal of Strength and Conditioning Resarch, 27*.

Choukou, M. A., Laffaye, G., & Taiar, R. (2014). Reliability and validity of an accele-rometric system for assessing vertical jumping performance. *Biol Sport, 31*(1), 55-62.

Enoksen, E., Tønnessen, E., & Shalfawi, S. (2009). Validity and reliability of the Newtest Powertimer 300-series® testing system, *Journal of Sports Science*s, 27:1, 77-84.

Magnusdottir, A., Porgilsson, B., & Karlsson, B. (2014). Comparing Three Devices for Jump Height Measurement in a Heterogeneous Group of Subjects. *Journal of Strength and Conditioning Resarch, 28.*

Nuzzo, J. L., Anning, J. H., & Schargenberg, J. M. (2011). The Reliability of Three Devices Used For Measuring Vertical Jump Height. *Journal of Strength and Conditioning Resarch, 25*.

Picerno, P., Camomilla, V., & Capranica, L. (2011). Countermovement jump performance assessment using a wearable 3D inertial measurement unit. *Journal of Sports Sciences, 29*(2), 139-146.

Sattler, T., Sekulic, D., Hadzic, V., Uljevic, O., & Dervisevic, E. (2012). Vertical Jumping Tests in Volleyball: Reliability, Validity, And Playing-Position Specifics. *Journal of Strength and Conditioning Research, 26*.