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Letter to the Editor

Letter to the Editor Concerning: "An Interval Throwing Program for Baseball Pitchers Based upon Workload Data"

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Dear Editor:

This letter is written in response to the article "An Interval Throwing Program for Baseball Pitchers Based upon Workload Data" by Reinold et al.[1] The authors should be applauded for their attempt to design an interval throwing program (ITP) with the goal of providing a gradual workload buildup. The researchers had good intentions of designing a program to allow healing of the ulnar collateral ligament after elbow reconstruction without experiencing setbacks. However, we would like to raise our own concerns of the study's methodology that have led to false conclusions, which are: the newly created ITP was able to achieve a gradual buildup in chronic workload, returns pitchers back to competition safely and efficiently with potentially less risk of setbacks or reinjury, and is the new modern throwing program after Tommy John surgery.[1]

We agree when progressing an athlete performing an ITP coming back from an upper extremity injury, the program should progressively apply load to the healing tissue in which the clinician carefully monitors the thrower's mechanics, throwing intensity, distances, and volume.[1-4]

However, Reinold et al.[1] utilized in their methodology an unvalidated inertial measurement unit (IMU) device, the motusBaseball (Motus Global now Driveline Pulse; Driveline Baseball, Kent, WA), to propose an ITP based on a workload formula that factors in elbow varus torque and number of throws at a particular distance in a given day. The workload formula was modeled after the work of co-author Dowling et al.[5] that insinuated the IMU was able to produce precise and reproducible data. Both studies reference an index paper[6] that was not originally designed to validate the IMU. In fact, one of the co-authors Fleisig et al.[7] publicly acknowledged the index study[6] was not designed to be a validation study. Fleisig et al.[7] agreed with Driggers et al.[8] that several rigorous studies are required to validate this particular IMU device. Furthermore, there are multiple scientific publications that have clearly demonstrated that this particular IMU device is not valid for accurately measuring elbow arm stress in the absence of the gold standard motion capture system.[8-10] When looking at Figure 1. showing 2nd order polynomial regression model to classify relationship between throwing distance (ft) and peak elbow varus torque (Nm), Reinold et al.[1] report peak elbow torque means of 45-48 Nm between 175 ft and 300 ft in their throw analysis. The values are not consistent with the literature of reported values of 90 Nm at 120 ft and 95 Nm at 180 ft as reported using motion capture.[11] One explanation for the difference is explained by Driggers et al. that the accuracy of the IMU decreases as torques increase in their Bland-Altman plot for elbow torques indicating a bias in the torques estimated.[8]

We agree with Reinold et al.[1] that throws being carried out during an interval throwing program should be thrown with a slight arc through the majority of the program to the intended target using distance as the guide. Similar to our clinical experience, athlete's should be instructed to initially "throw to the target and not through the target" with a slight arc and not on a line during the majority of the program to properly apply controlled stresses to the reconstructed elbow ligament.[2-4] Given that this is an important concept, there is no way of knowing what throwing technique (arc vs on-line throws) were captured and data mined retrospectively in the throwing data analyzed by Reinold et al.[1] Daily workload was calculated by taking the accumulation of elbow torque from every throw in a given day in their study.[1] Without knowing the throwing technique for each distance is not sound methodology. The authors acknowledge in their limitations section that the relationship between elbow torque and workload will vary for pitchers and their throwing technique![1]

Reliability is not the same as validity. For example, possessing a ruler that states one foot equals fourteen inches can reliably measure fourteen inches repeatedly between multiple points very predictably. However, it is not valid because one foot is equal to twelve inches. Camp et al.[10] demonstrated that the IMU reliably produces untrustworthy numbers within the same subject. In our extensive experience using the IMU, we have found that the IMU indiscriminately records all sudden movement as pitches thus making it difficult to review retrospectively, the sleeve that contains the IMU tended to slip down the throwing arm

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thus skewing measurements over time, and required another person to stand behind the thrower in close proximity while using the phone app to accurately tag the distance that is thrown to match up with the IMU elbow torque data. Driggers et al.[8] brought to light the flaw in the manufacturer claiming accuracy of data collected as long as a 2-inch radius of movement from the correct placement of the IMU device was allowed by conducting a pilot study examining a sleeve outfitted with 3 IMUs in succession 3.5 cm medial or lateral to the recommended placement. Testing results showed low agreement with the reference IMU, displacing the notion the sensor movement of less than a 2-inch radius would provide meaningful data. Other researchers have described a protocol to conduct live charting of thrower's distance with each throw and to recheck sleeve IMU placement every 3-4 throws to minimize device error.[12] None of these standards were incorporated in the methods when they data mined retrospectively 111,196 throws.[1] This is an additional source of measurement error, making the study lacking reliability. Despite all this, Reinold et al.[1] proceeded to use this methodology and submit for publication believing their overall findings were accurate.

Reinold et al.[1] referenced papers reporting acute:chronic workload concepts as related to injury risk in pitchers.[13,14] A closer inspection of these referenced papers show they erroneously used the same unvalidated IMU in their methods to create injury statistics. This is a huge problem when studies are building off the work of other researchers who are using an unvalidated device to create erroneous statements and conclusions.[5,6,13-22] For example, in their discussion, Reinold et al.[1] stated they do not suggest using radar guns to monitor intensity during ITP because it doesn't match actual elbow load. Unfortunately, this is a completely inaccurate statement because they referenced a study that utilized the IMU to draw those conclusions.[20] Careful inspection of their other cited reference[23] to substantiate their additional claim that velocity does not correlate with elbow varus torque is inaccurate because they failed to acknowledge that the researchers demonstrated that within an individual pitcher, higher ball velocity was strongly associated with higher elbow varus torque. It has been shown in the literature that velocity is directly correlated to the rate of elbow injuries and ulnar collateral ligament reconstructions in Major League baseball pitchers.[24-27] Biomechanical studies demonstrate that higher velocity pitches, such as the fastball and slider, are highly correlated with increased shoulder and elbow torques during the pitching motion.[28,29] Using this evidence from the literature, we carefully monitor the throwing intensity of the rehabbing athlete by utilizing a radar gun to measure the velocity at each of the distances of the throwing program to help control and monitor intensity to ensure that appropriate and gradual loads to the elbow are applied throughout the program. This method of monitoring throwing intensity has proven to be highly successful in our clinical practice.

In summary, Reinold et al.[1] utilized an unvalidated device in their study methodology to calculate elbow torque, did not control for technique of throws (arc vs on-line throws), had no accountability of appropriately tagging throwing distance with elbow torque data, and no control of whether the IMU sleeve was worn correctly in their retrospective analysis to calculate workload. This presents with issues of both validity and reliability in the methods of their study. Therefore, the notion of being able to calculate elbow workload and claim to have devised a more modern and safer interval throwing program is very much flawed and inaccurate. We advise the medical community to be wary of conclusions and statements from studies[1,5,6,13-22] that continue using this unvalidated IMU device before making changes to existing interval throwing programs.

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