Validation SPEED4LIFTS vs T-Force

AUTHOR: BORJA ALBALÁ GÓMEZ

DATE: 11/09/2017

UNIVERSITY OF LEÓN

INTRODUCTION

If you have arrived to this point, it is because you know perfectly the importance of the quantification of the training to be able to reach the proposed objectives. However, there is something worse than not quantifying, quantifying with a device that measures poorly and does not provide consistent data.

A lot of devices are appearing in the market, but it is very important to know if their measurements are really accurate, and most importantly, consistent. That is, the values that the device throws are as close as possible to reality, and always measure equal, not random values. Having a device that meets these two requirements, we ensure that the data we are registering in a training session will serve us to plan our training correctly.

In this document we will summarize the validation study of Speed4lifts that was carried out at the University of Leon by Borja. In this link you can access the actual document: https://buleria.unileon.es/bitstream/handle/10612/6966/201617%20%28SEP%29%20ALBALAGOMEZBORJA.pdf?Sequence=1

You can also see a short summary that the BCPERFORMANCE guys did on their website https://www.bcpentrenamientopersonal.es/speed4lifts-a-examen/

In this study, SPEED4LIFTS has been compared with T-FORCE. T-FORCE is the GOLD STANDARD and it is the device that has been used in the most relevant studies on velocity based training, and precisely because of that, it has been taken as a reference device to assess whether SPEED4LIFTS is accurate enough.

It is very important to add that, being a summary of a validation study, all the information that is going to be presented is going to be taken from that study practically literally and with the same objectivity that has been applied in the study. The study has been done by third parties, Speed4lifts has nothing to do with it.

STUDY SUMMARY

METHODOLOGY

Sixteen young, healthy and active men, with high experience in strength training and bench press exercise, were selected to be part of this study (average age = 26 ± 6 years, 1RM in bench press = 110 ± 32 kg).

Instrumentation

Smith Machine

During the experimental phase, a Smith machine (Gervasport) was used to perform the bench press exercise. This machine has a bar, on which the load is added (inserting weight disks at its ends) and which the subject must move, joined to two lanes on which it slides, limiting the movement to a single piano (vertical piano). A Smith machine was used with the aim that the movement was produced in a single piano, which ensured great stability in the technique and in the measurement of the different repetitions.

T-FORCE System

T-FORCE System (TF), developed in 2007. It is a high precision linear speed transducer, considered as Gold Standard for the measurement of the speed of execution and other variables of training and used in many scientific studies related to sports science.

The TF has a sampling frequency of 1000 Hz, an error in the displacement calculation of ± 1 mm and an error in the calculation of the velocity 0.25%. The validation of this device is made by comparing its measurements with those obtained by a high precision digital caliber calibrated by the National Institute of Aerospace Technology (INTA) (4).

This device allows us to obtain a multitude of variables, among which we can highlight the route, the time, the MV, the VMax, the VMP, the force and power average and maximum, the contribution of the propulsive phase to the total of the concentric part of the movement and information about the eccentric phase of the movement. It also selects the best repetition of the series and calculates the percentage loss of speed in the series, being able to emit a sound feedback when the lost speed is reached that we have programmed. In addition, it estimates the relative intensity that the mobilized load has assumed, based on the VMP obtained, and makes an estimate of the 1RM.

Despite its high quality, the TF, remains a relatively expensive and impractical device for use in the field of training and sports performance, since it requires the use of a laptop and some wiring.

Speed4lifts

The S4L is a linear position transducer with a variable sampling frequency as a function of speed, with a maximum frequency of 15 KHz (50 samples per centimeter) and a resolution of 2 mm.

The S4L provides the VM, VMax, the range of travel (ROM) and the maximum power of each repetition, both in the concentric phase and in the eccentric phase of the movement. In addition, it allows us to program a loss of speed and emits a sound feedback when the programmed loss is reached.

You also have the option of creating a load-speed curve, by performing an incremental test, or by entering a known equation. Once the equation is obtained, it will inform us of the relative intensity that an absolute load supposes, in function of the speed achieved with this load, and it will make an estimation of the 1RM.

NOTE FROM SPEED4LIFTS: Finally it has been decided to work with a fixed frequency of 100HZ thus achieving greater precision of the device at high speeds while maintaining the same accuracy at low. The measurement of the average propulsive velocity was also added.

Experimental protocol

After a specific warm-up, the participants performed an incremental test up to 1RM in the bench press exercise on the Smith machine. During the incremental test the variables VM, VMax and ROM were measured simultaneously with the TF and the S4L in each of the repetitions made

For the data collection, the two linear transducers (TF and S4L) were placed on the same side of the Smith machine, with both cables hooked at the end of the bar, next to the displacement rail, and totally perpendicular to the ground, making them coincide with the bar movement piano.

The TF data was transferred in real time to its specific software, installed on a laptop computer with the Windows 10 operating system, while the S4L data was sent to its smartphone application, installed on a BQ Aquaris.

Heating

The warm-up prior to the incremental test consisted in the realization of joint mobility exercises, dynamic stretching and neuromuscular activation exercises for the upper limbs.

The heating protocol is shown in Table 3. Subsequently, a series of heating was performed with the weight of the bar, in the bench press exercise on the Smith machine, in order to finish warm-up and familiarize with the machine and the performance protocol, before starting the incremental test.

EXERCISES	SERIES	REPS
Dynamic stretch of the chest	1	12
Shoulder dislocation	1	10
Dynamic stretch of the chest	1	12
Wrist circles	1	10
Dynamic stretch of the chest	1	12
Flexo elbow extensions	1	10
Band pull apart	3	15
Triceps extensions with band	3	15
Plyometrics push-ups	3	5

Incremental test

For the incremental test, a protocol similar to that described by Sanchez Medina et al. (16) Charges were used between 14% and 100% of the 1RM. The initial percentage oscillated between 14% and 25% of the 1RM, depending on the subjects, since they all started the test with an absolute load of 20 kg. Load increases of 10 kg were made when the VMP of the previous series, measured with the TF, was greater than 0.5 m - s-1 and increases of between 1 kg and 5 kg when the VMP was less than 0.5 more -1.

For loads mobilized to more than 1 maas-1 of VMP, three repetitions were performed and rested for two minutes. When the speed oscillated between 1 m - s-1 and 0.65 m - s-1, two repetitions were performed, with three-minute breaks. And, for speeds lower than 0.65 m - s-1, a single repetition was performed, with five-minute breaks

VMP	Increment of the load	
≥ 0,5 m/s	10 kg	
< 0,5 m/s	Between 1 and 5kg	
VMP	Reps	Rest
≥ 1 m/s	3	2'
< 1 m/s; ≥ 0,65 m/s	2	3'
< 0,65 m/s	1	5'

Each repetition, which started at the beginning voice of one of the evaluators, was performed with a second pause between the eccentric phase and the concentric phase (bar supported on the chest), to avoid variability between repetitions. At the voice of "press" the bar was lifted by the subject at the maximum possible speed.

We analyzed a total of 231 repetitions, which were divided, depending on the relative intensity, in light (<55% 1RM), medium (55% - 85% 1RM) and high (> 85% 1RM), for later analysis.

Statistic analysis

The results are expressed as mean ± standard deviation. Assumption of normality was verified using the Shapiro-Wilk test. An analysis of variance (ANOVA) was used to compare the variables analyzed.

The Bonferroni test was used to establish the differences between means. The relationship between the variables was calculated by means of the Pearson correlation coefficient (r). The relative reliability of intraseries measurements was evaluated using the intraclass correlation coefficient (ICC). P values

RESULTS

The average MV values for light, medium and high loads are shown in Figure 7. Significant differences are observed between the three devices for loads below 55% of the 1RM. For loads between 55% and 100% of the 1RM, no significant differences are observed between the two linear transducers.

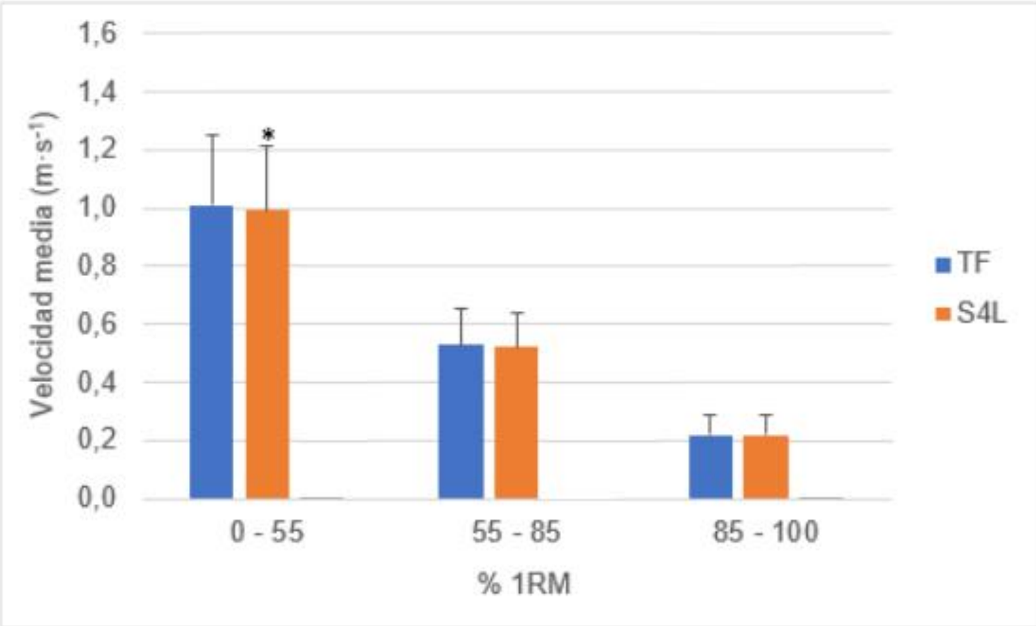

Figure 7. Mean velocity values of the two devices for light (0-55%), medium (55-85%) and high (85-100%) _ significant differences with TF (p <0.01) , significant differences with the SFL (p <0.01)

Very high correlations were observed in the VM between the TF and the S4L (r = 0.996). This correlation is shown in Figure 8.

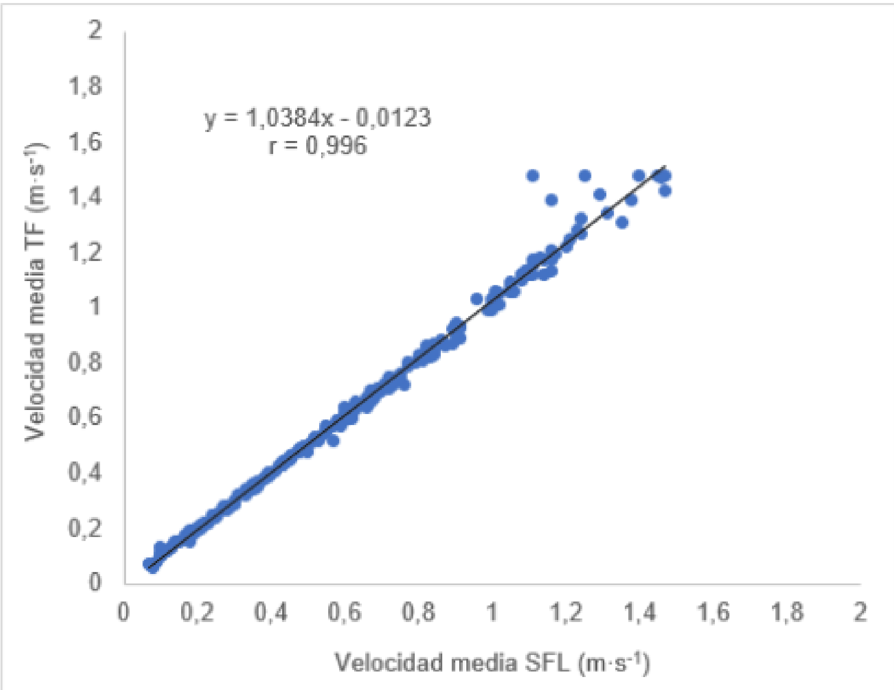

Figure 8. Correlation between the median speeds obtained with the T-FORCE (TF) and the median speeds obtained with Speed4lifts (S4L).

Figure 10 shows the average values of VMax of the two devices, for the three levels of relative intensity. Significant differences are observed between S4L and TF for loads less than 55% of the 1RM. In contrast, for loads greater than 55% of 1RM, no differences were observed between TF and S4L.

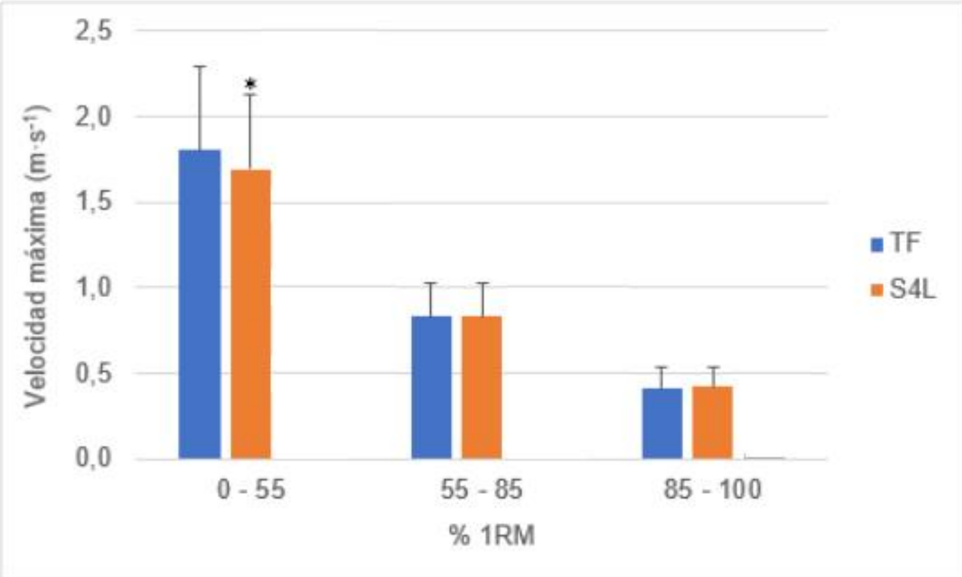

Figure 10. Maximum speed medical values of the two devices for light loads {0-55%), medium (55-55%) and high (55-100%). , significant differences with the TF (p <C1,01). t. significant differences with the SFL (p <0.01).

For the ROM, the values obtained are the following:

		Carga (% 1RM)		
		0 - 55	55 - 85	85 - 100
ROM	TF	40,78 ± 4,87	37,77 ± 5,28	33,87 ± 7,00
	S4L	39,90 ± 5,47*	37,89 ± 5,33*	34,32 ± 5,26

DISCUSSION

The main objective of the present study was to analyze the validity and reliability of the S4L device. Previously, other linear position transducers have been studied, such as the Tendo Weightlifting Analyzer System (20), demonstrating its high validity for the measurement of the speed and its high reliability in the measurements, reason why they seem recommendable devices for this assignment. However, the study cited above uses a single relative load (85% of the 1RM) for data collection. These results agree with those obtained in this study, since we have not found significant differences in MV and VMax, for relative intensities greater than 55% of the 1RM, between S4L and TF. In addition, as in the present study, they found high correlations when compared to the TF and high ICC when the reliability of the device was studied, although the CVs were considerably higher than those obtained in our study with the S4L device.

All these findings show a high validity for the measurement of the speed of execution through the use of linear position transducers, at least for loads greater than 55% of the 1RM, in addition to its high reliability.

This agrees with the results obtained by Garcia-Ramos et al. (21), when studying the reliability of VM and VMax measurements obtained with a linear transducer in the Smith machine bench press exercise. They obtained a high reliability in the measurement of both variables, however, and contrary to what was observed in our study, they found higher CV in the VM than in the VMax, reason why they concluded that the use of this last variable could be a good option for the control of strength training. In our study, the S4L device has considerably higher CV in the VMax, in comparison with the VM, for all the intensities. In the case of TF, if CVs are slightly higher for MV at low intensities (<55% of 1RM), but are equal to relative intensities greater than 55%

It should be noted the practical value of the linear S4L transducer versus the TF. The fact that it does not require wiring, coupled with its great autonomy, its small size and weight, its compatibility with mobile devices, avoiding having to transport a laptop to the training site and, above all, its reduced cost, makes it a great choice for the field of sports training.

CONCLUSIONS AND PRACTICAL APPLICATIONS

In light of the results obtained, we can conclude the validity of the S4L device for the measurement of the execution speed at relative intensities greater than 55% of the 1RM. In addition, given the high correlation between the measurements obtained with this device and those obtained with the TF (Gold Standard), and after observing its high reliability, it can be said that it is a very valid device for speed control.

All the above, together with its low cost, its small size and limited equipment, and the ease of use, makes it a great tool for its practical use in the field of training and sports performance, for the dosing and control of strength training.

PERSONAL ASSESSMENT AND CRITICAL REFLECTION

Today the new paradigm of strength training based on the speed of execution is in vogue of all. This type of methodology can bring great benefits in the area of sports performance, providing physical trainers with a great tool for the correct dosage and control of training.

This new trend is making new tools appear for its application, many of them along with strong marketing campaigns, especially in the case of accelerometers. However, care should be taken when choosing a device that can provide information that is at the same time practical for use in field work and with an acceptable quality-price relationship.

The new generation of linear transducers, cheaper and simpler than their predecessors, seem to meet all these requirements. They turn out to be practical tools, they bring Alicia information and they have a more affordable price.

In contrast, accelerometers, despite their great appeal and great potential, do not seem to be, today, a good option for the evaluation and control of strength training. The adoption of this type of device for use in the field of sports performance involves the improvement of its sensitivity, sampling frequency and detection of repetitions.

In addition, it should be taken into account that the use of tools to measure the speed of execution and the application of training based on speed, do not guarantee the quality of the training. These are very good tools for the improvement of the strength training methodology and can suppose a quality leap in their dosing and control, but they require a familiarization and a good knowledge of the variables used and the components of the load for its correct implementation.

BIBLIOGRAPHIC REFERENCES

1. Tous J. Entrenamiento de la fuerza en los deportes colectivos. Máster profesional en alto rendimiento en deportes de equipo. Ed. Mastercede. Barcelona. 2007.

2. 2. Badillo JJ, Gorostiaga E. Fundamentos del entrenamiento de la fuerza. Aplicación al alto rendimiento deportivo. Ed. Inde. Madrid. 2002.

3. Zouita S, Zouita AB, Kebsi W, Dupont G, Abderrahman AB, Salah FZB, Zouhal H. Strength training reduces injury rate in elite young soccer players during one season. The Journal of Strength & Conditioning Research 2016; 30(5): 1295-1307.

4. González-Badillo JJ, Sánchez-Medina L, Pareja Blanco F, Rodríguez Rosell D. La velocidad de ejecución como referencia para la programación, control y evaluación del entrenamiento de la fuerza. 2017

5. González-Badillo JJ, Sánchez-Medina L. Movement velocity as a measure of loading intensity in resistance training. International journal of sports medicine 2010; 31(05): 347- 352.

6. González-Badillo J. Bases teóricas y experimentales para la aplicación del entrenamiento de fuerza al entrenamiento deportivo. Infocoes 2000; 5(2): 3-14.

7. Sánchez-Medina L, González-Badillo JJ, Pérez CE, Pallarés JG. Velocity-and powerload relationships of the bench pull vs. Bench press exercises. International journal of sports medicine 2014; 35(03): 209-216.

8. Sánchez-Medina L, Pallarés JG, Pérez CE, Morán-Navarro R, González-Badillo JJ. (2017). Estimation of relative load from bar velocity in the full back squat exercise. Sports Medicine International Open 2017; 1(02): E80-E88

9. Allen DG, Lamb GD, Westerblad H. Skeletal muscle fatigue: cellular mechanisms. Physiological reviews 2008; 88(1): 287-332.

10. González-Badillo JJ, Yañez-García JM, Mora-Custodio R, Rodríguez-Rosell D. Velocity Loss as a Variable for Monitoring Resistance Exercise. International journal of sports medicine 2017; 38(03): 217-225.

11. Sánchez-Medina L, González-Badillo JJ. (2011). Velocity loss as an indicator of neuromuscular fatigue during resistance training. Medicine & Science in Sports & Exercise 2011; 43(9): 1725-1734.

12. Rhea MR, Alvar BA, Ball SD, Burkett LN. Three sets of weight training superior to 1 set with equal intensity for eliciting strength. The Journal of Strength & Conditioning Research 2002; 16(4): 525-529.

13. Rhea MR, Alvar BA, Burkett LN. Single versus multiple sets for strength: a metaanalysis to address the controversy. Research quarterly for exercise and sport 2002; 73(4): 485-488.

14. González-Badillo JJ, Rodríguez-Rosell D, Sánchez-Medina L, Gorostiaga EM, Pareja-Blanco F. Maximal intended velocity training induces greater gains in bench press performance than deliberately slower half-velocity training. European journal of sport science 2014; 14(8): 772-781.

15. Pareja-Blanco F, Rodríguez-Rosell D, Sánchez-Medina L, Gorostiaga EM, GonzálezBadillo JJ. Effect of movement velocity during resistance training on neuromuscular performance. International journal of sports medicine 2014; 35(11): 916-924.

16. Sánchez-Medina L, Pérez CE, González-Badillo JJ. Importance of the propulsive phase in strength assessment. International journal of sports medicine 2010; 31(02): 123- 129.

17. Bosco C, Belli A, Astrua M, Tihanyi J, Pozzo R, Kellis S, Tranquilli C. A dynamometer for evaluation of dynamic muscle work. European journal of applied physiology and occupational physiology 1995; 70(5): 379-386.

18. Balsalobre-Fernández C, Kuzdub M, Poveda-Ortiz P, del Campo-Vecino J. Validity and reliability of the push wearable device to measure movement velocity during the back squat exercise. The Journal of Strength & Conditioning Research 2016; 30(7): 1968-1974.

19. Balsalobre-Fernández C, Marchante D, Baz-Valle E, Alonso-Molero I, Jiménez SL, Muñoz-López M. Analysis of Wearable and Smartphone-Based Technologies for the Measurement of Barbell Velocity in Different Resistance Training Exercises. Frontiers in Physiology 2017; 8: 649

20. Garnacho-Castaño MV, López-Lastra S, Maté-Muñoz JL. Reliability and validity assessment of a linear position transducer. Journal of sports science & medicine 2015; 14(1): 128

21. García-Ramos A, Haff GG, Padial P, Feriche B. Reliability of power and velocity variables collected during the traditional and ballistic bench press exercise. Sports Biomechanics 2017; 1-14.

22. Gómez-Piriz PT, Sánchez ET, Manrique DC, González EP. Reliability and comparability of the accelerometer and the linear position measuring device in resistance training. The Journal of Strength & Conditioning Research 2013; 27(6): 1664-1670.