The effect of high intensity power training during a competitive international track and field season

Riggberger[1], K., Eriksrud[2], O.

[1] *Malmø Idrottsakademi, Malmø, Sweden*

[2] *1080 Motion, Stockholm, Sweden*

BACKGROUND

Many elite athletes have difficulty maintaining the ability to generate power during a long competitive season. Competitions or games are frequent and therefore it is difficult to schedule the necessary training sessions to maintain the power generation capacity in the lower extremities. The purpose of this case study is to investigate if it is possible to maintain and even enhance the power generation capacity of the lower extremities during a competition season.

METHODS

One subject participated in six training sessions over 9 weeks. The equipment used in the training was a 1080 Quantum Syncro (1080 Motion AB, Stockholm, Sweden), which includes two 1080 Quantum and a smith rack. The robotic technology embedded in 1080 Quantum allows for different resistance settings, and the ability set load and speed independent in the concentric and eccentric phase of an exercise or movement. The exercise used was a single leg squat. In the concentric phase an isokinetic (speed limit) setting was used. One can also call this variable resistance, since the load of the system is matched by what the athlete is able to generate. In the eccentric phase a constant load was used. Performance was measured by different jump tests, bilateral and unilateral squat jumps and countermovement jumps, which was performed both before and after the training intervention.

RESULTS

There was on average a 2,5% improvement in jumping performance for the different bilateral and unilateral jumps. In addition there were some improvements in force, speed and power. Left leg power increased 24,3% and 32,1% in the concentric and eccentric phase respectively.

DISCUSSION

The training load (sessions, sets and repetitions) was very low in this study as compared to what is usual in strength and power training. Considering the load used and the short time the subject trained, one might want to consider high intensity training during a competition period. Each training session consisted of approximately 15 seconds of active work, with the total time for the whole training period of 1 minute and 26 seconds. During this short time the subject had moved 15600 kilograms per lower extremity. Based on training load and frequency the results of the case shows great promise and warrants further studies not only to establish if this is found in group of subjects, but also to determine how this training would impact athletic performance.

1. BACKGROUND

During a competitive season it can be difficult the schedule strength and power training. The ability to improve lower extremity power and sport specific performance have been found in the water polo (Veliz et al., 2015) and track and field (Chelly, Hermassi, & Shephard, 2015), which has led to recommendation of changes in training regimen in the specific sports. The purpose of this case study is to see if lower extremity power and performance can be improved as a result of short and intense power training during an international track and field season.

2. METHODS

Training was conducted using 1080 Quantum Syncro (1080 Motion AB, Stockholm, Sweden). The robotic technology that this system is based upon allows for independent control of load and speed in the concentric and eccentric phase of a given movement or exercise. Furthermore, the system offers accurate measures of distance, time, speed, force and power (http://www.1080motion.com). This allows for highly accurate documentation of training load, time and linear distance for a given exercise.

1080 Quantum Syncro was used for half-squats for both left and right lower extremity. The load in the concentric phase was set to 119 kg with a maximum speed of 4 m/s, while the load in the eccentric phase was set to 139 kg with a speed of 4 m/s. There were 2 sets of 5 repetitions performed with 10 minutes rest between sets. There were a total of 6 training sessions completed over 9 weeks. The total training time was 8 and 6 seconds concentric and eccentrically respectively for each session. This gives a total training time of 1 minute and 24 seconds for the six training session (48 seconds concentrically and 36 eccentrically).

Force, power and velocity were measured using Muscle Lab (Ergotest Innovation, Porsgrunn, Norway) in 1080 Quantum both before and after the training intervention. This was done for both left and right single leg squat with only the bar as resistance, and the speed at 4m/s in both the concentric and eccentric phase. During these tests Muscle Lab was used to obtain the following measures:

- AP = average power concentrically (Watt)
- APn = average power eccentrically (Watt)
- AV = average velocity concentrically (m/s)
- AVn = average velocity eccentrically (m/s)
- pV = peak velocity concentrically (m/s)
- tpV = time to peak velocity (s)

Jumping performance was also measured before and after the training intervention (Muscle Lab). Both squat jump (SJ) and countermovement jump (CMJ) were performed bilaterally and on the left and right lower extremity. In addition bilateral countermovement jump with armswing (CMJas) was performed

The training sessions were scheduled accordingly based upon competition schedule:

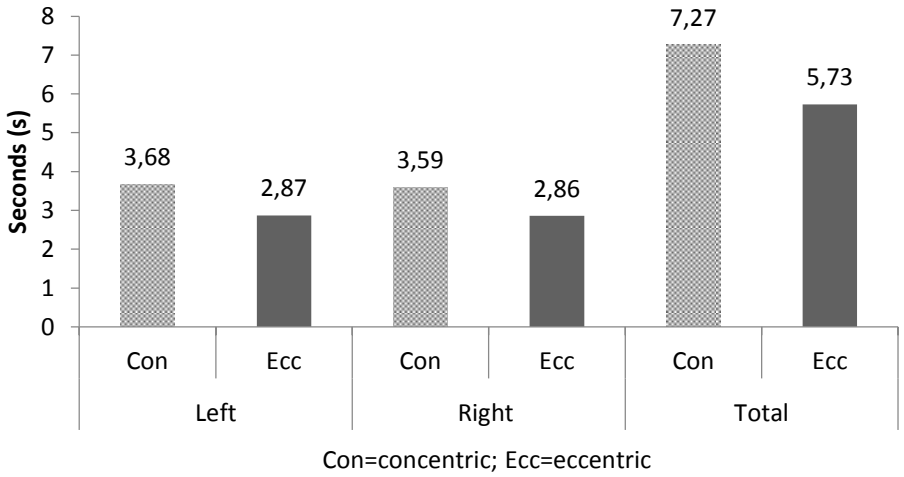
- Session 0: May 13th jump tests
- Session 1: June 3rd
- Session 2: June 13th
- Session 3: June 25th

- Session 4: July 2nd
- Session 5: July 19th
- Session 6: August 4th

RESULTS

Figure 1 shows training time for one session (sixth session) for the left and right lower extremity and combined. The training time is shorter in the eccentric phase with the total training time for this particular session being 13 seconds.

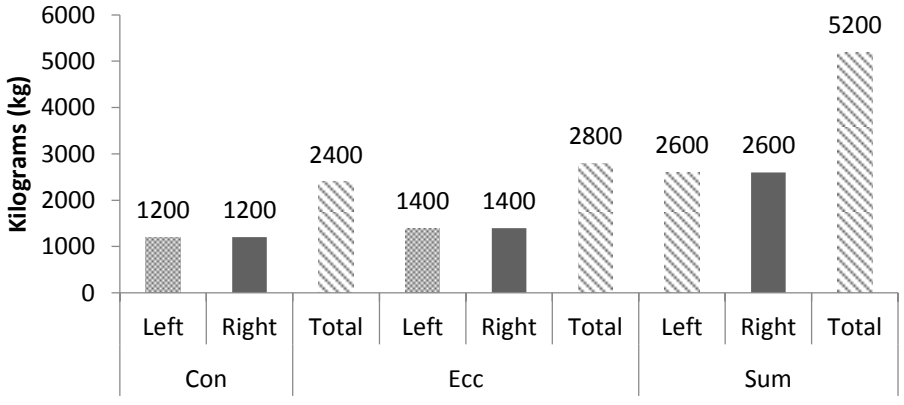
Figure 1. Training time



Con=concentric; Ecc=eccentric

For each training session the load was a total of 5200 kg lifted. Distribution left and right leg and concentric and eccentric phase is presented in Table 2 below.

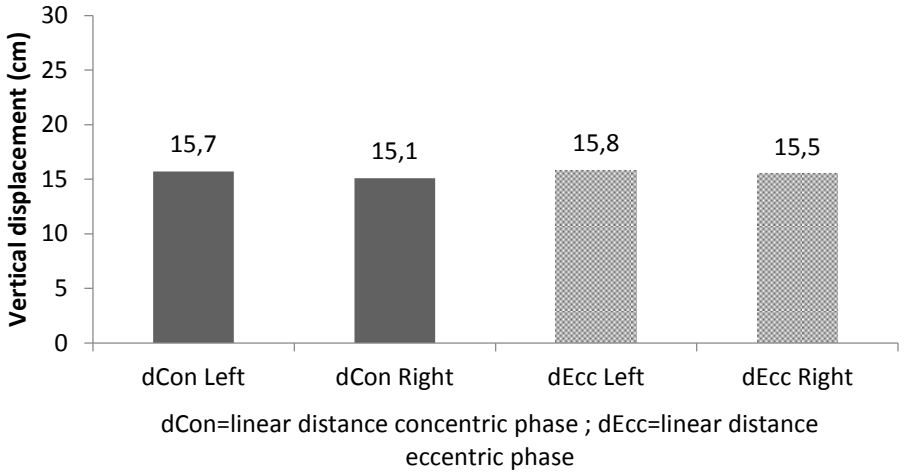
Figure 2. Training load



Con=concentric; Ecc=eccentric; Sum=load concentric; eccentric and total load

Figure 3 below shows the linear distance left and right lower extremity during the concentric and eccentric phase of the single leg squat.

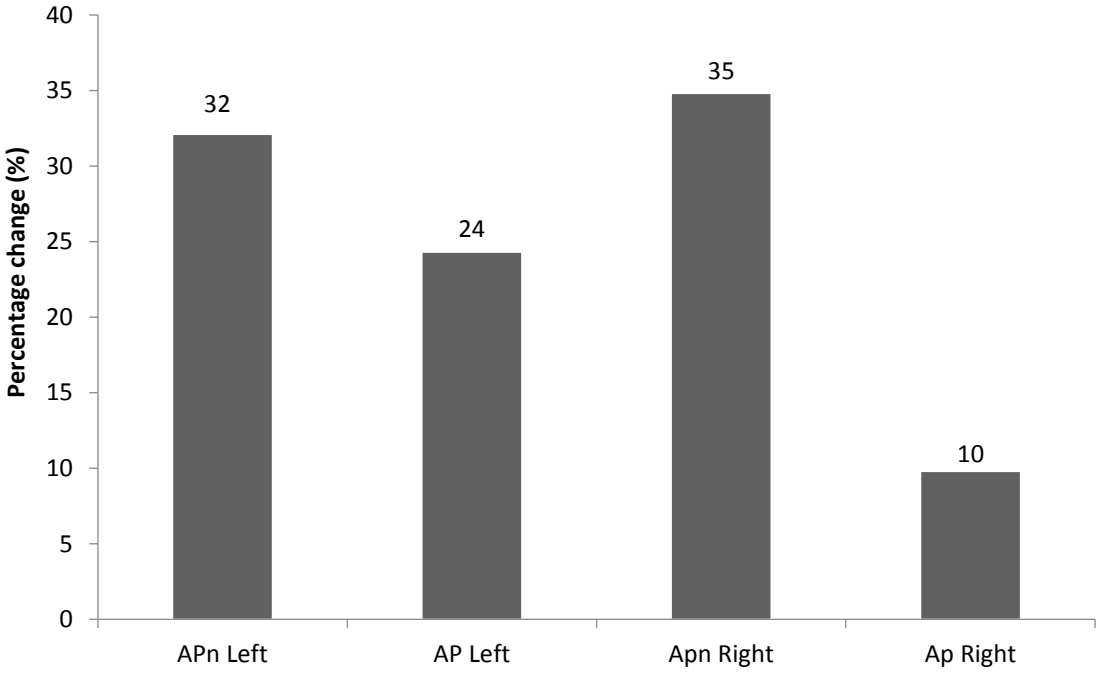
Figure 3. Linear displacement single leg squat



dCon=linear distance concentric phase ; dEcc=linear distance eccentric phase

Figure 4 below shows the percentage change of both concentric and eccentric power from session 1 to session 6 showing a 32% and 35% change in eccentric power left and right respectively, and a 24% and 10% concentric power change left and right respectively.

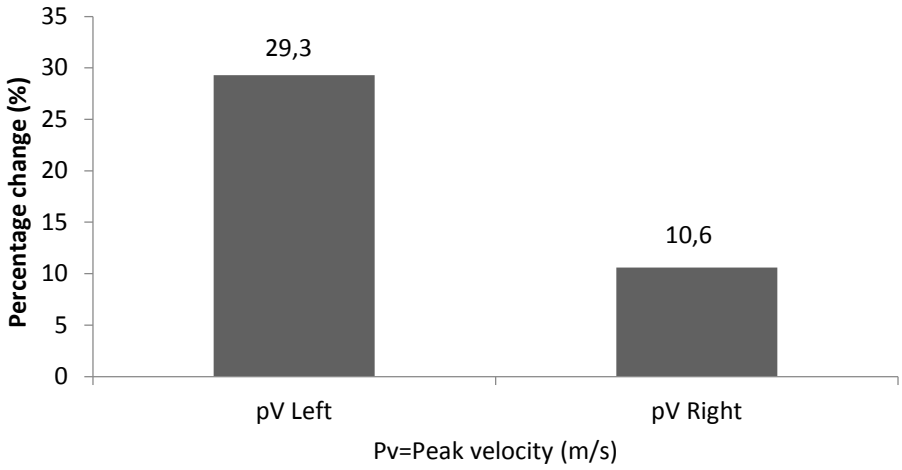
Figure 4. Percentage change concentric and eccentric power



APn=Eccentric power ; AP=concentric power (Watt)

The maximum velocity also changed 29% and 11% left and right leg respectively (Figure 5).

Figure 5. Percentage chage peak velocity



Peak velocity occurs at some point in the movement. Figure 6 shows that the peak velocity was reached 12,5% and 19,2% percent sooner in the left and right lower extremity respectively.

Figure 6. Percentage change in time to peak velocity

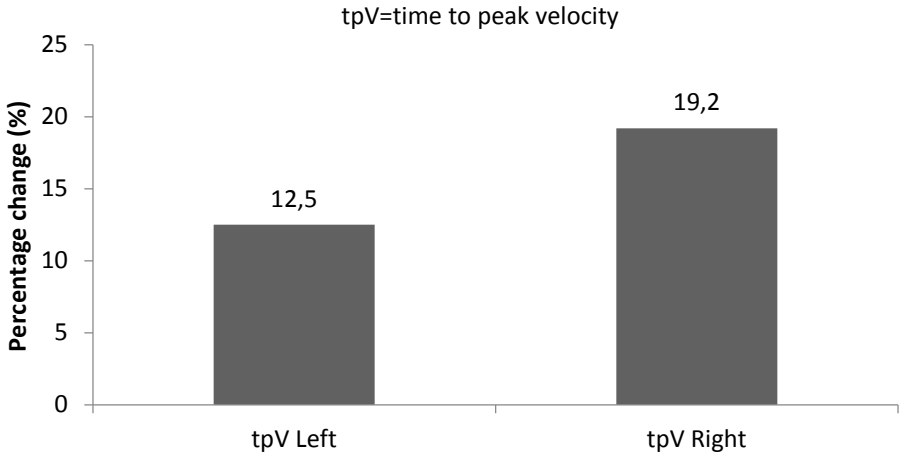
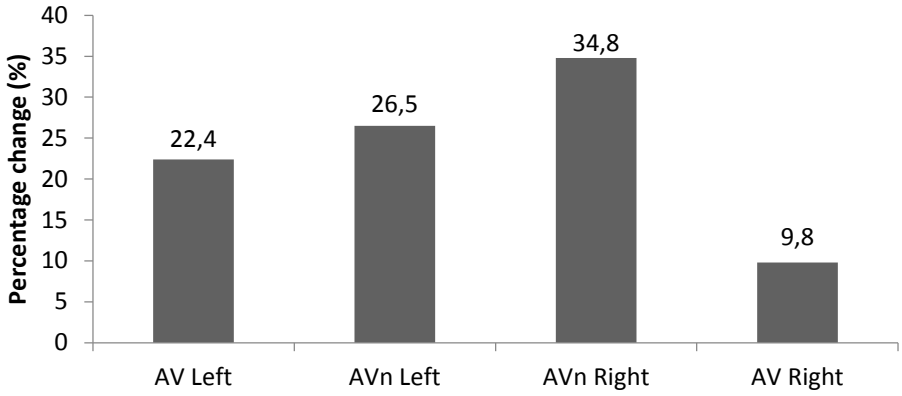


Figure 7 below shows the changes in both average concentric and eccentric velocity

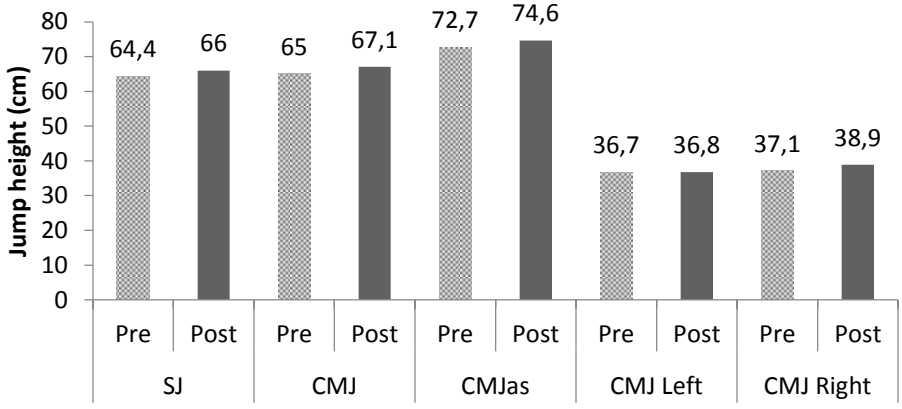
Figure 7. Percentage change average velocity



AV=Average velocity concentrically; AVn=Average velocity eccentically

The results of the different jump tests are presented in Figure 8 below. There is an improvement for all tests.

Figure 8. Jump tests



SJ=Squat Jump; CMJ=Countermovement Jump;
CMJ as=Countermovement Jump arms assisted

DISCUSSION

The greatest improvement in power was found in the eccentric phase, 32% and 35% left and right lower extremity respectively. The difference in improvement between the left and right lower extremity is insignificant. This improvement can be due to that the athlete is assisted at 4m/s in the eccentric phase, which means that the athlete must learn how to follow the bar in the eccentric phase with a high load (140 kg). This high load then has to be transformed into the concentric phase.

However, there was a large difference in improvement of power in the concentric phase, 24% and 10% left and right respectively. This difference can be explained by that the left lower

extremity has improved more in max and velocity than the right lower extremity. However, the right lower extremity is showing greater improvement in time to max velocity than the left side, which means an improved acceleration in the right lower extremity. Furthermore, the left lower extremity is also showing a better improvement of average velocity as compared to the left.

The differences in improvement in concentric power and speed for the left and right lower extremity can not be explained by training load and time, since that is almost identical. Furthermore, the depth of the single leg squats was similar in both the concentric and eccentric phase for the left and right lower extremity. Consequently, load, time and linear distance (excursion) cannot explain the observed side difference change in power and speed.

During the training period no jump training was done. Considering this, the improvements, consistent for all jumps, are impressive considering that the athlete starts out at a high level. Countermovement jump with arms assisted (CMJas) is a good example, which improved from 72,7cm to 74,6 cm.

CONCLUSION

This study shows that power can be maintained and even enhanced with high intensity training during a competitive track and field season at the international level.

REFERENCES

Chelly, M. S., Hermassi, S., & Shephard, R. J. (2015). Effects of in-season short-term plyometric training program on sprint and jump performance of young male track athletes. *Journal of strength and conditioning research / National Strength & Conditioning Association*. doi: 10.1519/JSC.0000000000000860

Veliz, R. R., Suarez-Arrones, L., Requena, B., Haff, G. G., Feito, J., & Saez de Villarreal, E. (2015). Effects of in-competitive season power-oriented and heavy resistance lower-body training on performance of elite female water polo players. *Journal of strength and conditioning research / National Strength & Conditioning Association, 29*(2), 458-465. doi: 10.1519/JSC.0000000000000643