Effects of Agonist-Antagonist Paired-set and Superset Resistance Training Protocols on Training Volume, Efficiency, Metabolic and Electromyographic Responses

コーチング科学研究領域
５０１７Ａ０４２－２　趙　寒曄　　研究指導教員：岡田　純一　教授

I. Introduction

Resistance training is effective in developing muscular strength and power. However, time limitations are challenges for both athletes and normal populations that are unable to commit such prolonged periods of resistance training period because of the requirements of other training or daily work. Therefore, resistance-training protocols that enhance training efficiency might be an effective method for providing a sufficient stimulus to muscular, metabolic and endocrine systems within a short period. One of these efficient protocols is Superset(SS), which combines two kinds of resistance exercises that work on agonist and antagonist muscles consecutively, with no rest intervals between the exercises. Another efficient protocol, which is based on complex training and under designation of SS, is the paired-set(PS), which combines two kinds of agonist and antagonist muscular exercises with short rest intervals between the exercises.

The purpose of this study was to compare PS and SS through total volume(TV), set volume (SV) of exercises, training efficiency, ratings of perceived exertion(RPE), electromyographic(EMG), and blood lactate concentration(LAC).

II. Methods

Eleven males aged 20–25 years with at least two years of experience in resistance training volunteered to participate in the study. The order of PS and SS resistance training was selected according to a randomized design. Each training order contained the same two resistance exercises, which were grouped into either a PS or a SS configuration. The subjects were asked to participate the strength measurement of one-repetition-maximum(1RM) of bench press(BP) and bent-over row(BOR) prior to the resistance exercise session. The prescribed training load across the two resistance training orders was 70% of BP and BOR's 1RM. In performing the PS exercise order, a single bout of BOR was followed by a short rest interval of 60 seconds. The BP was then performed after the first rest interval followed by a short rest interval of 60 seconds. When the SS exercise order was performed, a single bout of BOR was followed by a single bout of BP. These two exercises were performed consecutively followed by a rest interval of 120 seconds. The exercise configurations were repeated until the required number of sets was completed.

LAC and RPE were assessed at previously decided time points before, during, and after exercise sessions. TV, SV and training efficiency were calculated after exercise sessions. EMG including mean power frequency(MNF), root mean square(RMS) and the rate of increase were recorded used in the analysis.

III. Results

There was no significant difference in TV between PS (4263.95±524.60 kg) and SS (4180.11±538.30 kg). No significant difference was observed in training efficiency between PS (268.36±36.86 kg/min) and SS (269.76±39.85 kg/min). As for the result of each resistance exercise's SV, there was significant difference in BP in SET5 as compared PS (295.59±60.13 kg) with SS (289.23±80.48 kg). The result showed PS is significantly higher than SS ($p<0.01$). The result of RPE showed that PS (7.27±0.63) was significantly lower than SS (8.19±1.05) after resistance exercise sessions.

The results of EMG indicated that the Pectoralis Major(PM)'s RMS increased significantly in each set in both PS and SS, whereas Latissimus Dorsi(LD) didn't increase in some sets. Increase rate form the first to last repetition indicated that no significant difference in rate of muscular

activation change as compared PS with SS. The MNF results indicated that no significant difference was observed across PS and SS. As for the differences of determined muscular, PM's MNF decreased in some sets, whereas no significant decrease was observed as the exercise advanced.

The results of LAC indicated that the LAC was immediately increased significantly after the beginning of the exercise, and it reached a peak point as the exercise advanced, but no difference was observed as compared PS with SS.

IV. Discussion

The first finding of this research concerned the EMG. Although Significant effects on RMS across PS and SS of maximum values or selected repetitions were not found, there were differences from the first repetition to the last repetition in all sets in the concentric and eccentric contraction phases in PM during both PS and SS. A significant increase was not found in LD during the same contraction phase in some sets. The results of RMS might indicate that the different proportions of muscular fiber composition in LD and PM might have caused differing muscular activation by the same exercise load. In this study, the results of MNF also indicated the proportions of muscular fiber composition in LD and PM might play an important part in muscular activation.

The most important findings of this study were in SV and RPE. In performing SS, the BP of SET5 was significantly lower than in performing PS. Although the difference between PS and SS was not enormous (SS: 289.23±80.48 kg; PS: 295.59±60.13 kg), it should be noted that greater differences might could be observed when the target number of sets was more than five. Further research is required to determine the effects of this difference on longer exercise duration and on muscular hypertrophy during long periods.

Regarding the RPE, the results of this study showed that in performing PS, the perceived intensity was significantly lower than that of SS. In the performance of PS and SS, it seems that the neuromuscular system recovery speed was affected by the different rest interval configurations when the total necessary time was consistent. In contrast, the neuromuscular system was unable to recover when the resistance exercises were performed in a consecutive manner, even if they worked on a different muscular group. Because of this phenomenon, SS induced greater pressure on the neuromuscular system. This result partly demonstrated the higher SV of BP in SET5 during PS. However, because of the absence of neuromuscular performance assessments, further research is required on the differences in RPE.

The LAC result indicated that the resistance training structure, in which rest intervals between exercises are reduced or eliminated, could increase the anabolic requirements that affect metabolic perturbation and fatigue. However, there were no significant differences between PS and SS at any test point. The reason might be considered the same as for the results of training efficiency, the TV, and the target muscular groups.

V. Conclusion

When the target of resistance training was to perform the training content with short rest intervals, both PS and SS reached the training target in a time-efficient manner because of the similar results in TV, training efficiency, and metabolic responses. However, when resistance training was performed in PS, the recovery of neuromuscular function was improved compared with SS during the exercise session, sustaining a higher number of succeed repetitions with lower perceived intensity, and could possibly result in a higher TV in longer exercise duration. According to this theory, PS may also result in higher training performance in both single training sessions and long-term training programs, which could lead to further gains in strength, power, and muscular hypertrophy in the long term. According to this result, PS is more appropriate than SS when the training time is limited.