Physiotherapy and Occupational Therapy Journal
Volume 3 Number 3, July - Sept 2010

Comparison of Acute Hemodynamic Effects of Straight Partial Sit Ups Versus Oblique Partial Sit Ups on Healthy Subjects

Tabia Gayas*
Jamal Ali Moiz**
Altaf Hussain***

ABSTRACT

Objective: To compare the magnitudes of change in heart rate(HR), systolic blood pressure(SBP), diastolic blood pressure(DBP), arterial oxygen saturation(SpO_2),rate pressure product(RPP) and rate of perceived exertion(RPE) during straight partial sit-ups and oblique partial sit-ups **Design:** Randomized controlled parallel design. **Participants:** Thirty male volunteers with mean age 23.7±1.9 years, height 5.5± 0.2 meters, weight 59.2+5.7 kg and BMI of 21.4 ± 2.1were included in the study. **Methods:** 30 male healthy volunteers were randomly assigned to two groups and they performed 30 repetitions of SPU and OPSU depending upon the group they were allocated to. After recording there baseline HR, BP, SpO_2 for one minute same were recorded during and post exercise for 10 minutes with the help of monitors attached with a BP cuff and pulse oxymeter. **Result:** Data was analysed using SPSS 14.0 for window version. t-test was used to compare the pre-exercise, during-exercise and post-exercise effects on hemodynamic variables between SPSU and OPSU. Within group comparison was done using ANOVA. The level of significance was set at $p< 0.05$. Mean difference of pre and post exercise hemodynamic variables were compared and no significant difference was found between the two exercises at during exercise and post exercise levels However, within group analysis, a significant difference at pre exercise, during exercise and post exercise levels in each hemodynamic variables in both the abdominal exercises were found. **Conclusion:** The results suggest that there was no significant difference in rise in hemodynamic variables during the two exercises. However there was a significant difference between pre exercise and during exercise magnitude of hemodynamic variables of each exercise. This suggests that acute hemodynamic changes of these two abdominal exercises are clinically relevant, however both oblique partial sit-ups and straight partial sit-ups warrant same amount of concern.

Keywords: Hemodynamics, abdominal exercises, rehabilitation, blood pressure, rate pressure product

INTRODUCTION

Abdominal exercises are prescribed for variety of reasons but mainly for low back injury and as a component of fitness programs of person with cardiovascular disease.[1,2]

Low back pain is a health problem with a major societal impact and is most commonly treated in primary health care setting. Of those seeking medical attention, many are prescribed abdominal strengthening exercises as a part of treatment program.[3] Strong abdominal muscles help stabilize the trunk and unload lumbar spine stress. Abdominal muscles commonly are activated by active flexion of the trunk through a concentric muscle contraction. [4] although numerous abdominal exercises exist, researchers have reported that the strait partial sit-ups (SPSU) and oblique partial sit ups (OPSU) produce high muscle elecromyographic activity while maintaining low lumbar compressive and shear forces.[1] Consequently these two abdominal exercises are often included in therapeutic spine stabilization and general fitness program. Abdominal exercises are also recommended by American Heart

Author's Affiliation: *Post Graduate Student, Department of Rehabilitation Sciences, Hamdard University; **Assistant Professor, Centre for Physiotherapy and Rehabilitation Sciences, New Delhi, Jamia Millia Islamia, ***Physiotherapist Trauma Centre AIIMS, New Delhi.

Reprint's request: Jamal Ali Moiz (PT), Assistant Professor, Centre for Physiotherapy and Rehabilitation Sciences, Jamia Millia Islamia, New Delhi 110025., Email : jmoiz@jmi.ac.in.

(Received on 22.09.2010, accepted on 24.10.2010)

Association in endurance and resistance training of person with cardiovascular diseases.[5]

It is generally agreed that the cardiac response to the exercise is complex and involves the interaction of number of variables such as heart rate, stroke volume, ventricular end diastolic volume and hearts neurohumoral mechanisms. To date exercise research has focused primarily on the elecromyographic and biomechanical aspects of exercise. The hemodynamic effect of abdominal exercise as used in rehabilitation low back injury and fitness training programs of cardiovascular disease are largely unknown.

It is clinical importance to determine the hemodynamic responses to common abdominal exercise during the actual exercises. With such information, clinician may make more informed decisions regarding the appropriateness of abdominal exercise prescription not only on a biomechanical basis, but also on a hemodynamic basis. This would be particular importance in population who have pre-existing cardiac or cerebrovascular disease, many of which may present in the office setting with low back ache.[3,6]

It is therefore, this study was designed to compare the hemodynamic variants of two abdominal exercises oblique partial sit ups versus strait partial sit ups.

METHODS

A total of 30 healthy male volunteers were selected for the study with mean ±SD age of 23.7±1.96 years, height of 5.5±0. 26 m, weight of 59.2 ± 5.7 Kg and BMI of 21.4 ± 2.1 after they met the following criteria:

Healthy, young males with a normal BMI in range of 18.5-24.9, Age: 18 to 30 years, abdominal muscle power grade-'Fair' and willingness to participate

Subjects with any history of acute or chronic illness, backache from last 6 months or any participation in any abdominal exercise earlier were excluded.

Hemodynamic parameters and instrumentation

The hemodynamic parameters monitored during this study included heart rate(HR),Diastolic blood pressure(DBP),systolic blood pressure(SBP),arterial oxygen saturation(SpO_2),Rate of perceived exertion on Borg's scale(RPE) and rate pressure product(RPP).

These parameters were monitored with the help of Phillips MP20 bedside monitor attached with BP cuff and pulse oxymeter. RPP was calculated by the formula (HR X SBP/100).

PROCEDURE

The purpose and the nature of the study was explained to the prospective participant and subjects were screened by filling up of the PAR-questionnaire and their height and weight was measured to ensure if they fulfilled the normal BMI criteria. Each subject's abdominal muscle strength was assessed by Kendall's manual muscle testing.[7] The procedure for the study was formulated on the basis of a pilot study conducted on two subjects to identify the possible difficulties that may be encountered during the process of data acquisition.

Each subject was randomly assigned to either group A or group B. Subjects assigned to group A were demonstrated and made to practice state partial sit up and subjects in group B were demonstrated and made to practice oblique partial sit up a day before the test day. Subjects were instructed to exhale during the concentric phase and inhale during the eccentric phase of contraction of exercise. Explanations about the exercise, post exercise rest period, Borg's CR-10 RPE scale and method of recording hemodynamic variables were given.

EXERCISE PROTOCOL

On the test day, one subject at a time was taken to the ICU and asked to lie supine with knees flexed after removing his shirt. Five ECG electrodes were fixed on their body. BP cuff and pulse oxymeter was attached to the subject's right arm and index finger respectively. When subject, allocated randomly to Group A was completely relaxed, each subject's HR, SBP, BDP, SpO_2 were monitored for 1 min before exercise. At the end of 1 min the subject was instructed to perform straight partial sit ups, knees flexed to 90, hip flexed to 45 and the feet flat on the table. The subject was instructed to cross his arms across the chest and raise the upper back of the table. The rise was high enough to just clear the inferior angles of the scapulae.

This position was held for three seconds (timed by investigator with the help stop watch), and then the upper back lowered to the table. This was counted as one repetition. Each repetition took six seconds to complete, and a total of thirty continuous repetitions were performed. After completion of thirty repetitions the subject was asked to relax, his hemodynamic variables being monitored for ten minutes. All these data being saved on the monitor.

Subjects allocated to group B performed oblique partial sit ups in the same position as described above. With the arms across the chest, the subject raised the upper back off the table in an oblique direction high enough to just clear the inferior angles of bilateral scapulae. This was counted as one repetition. Each repetition took six seconds to complete, and thirty continuous repetitions were performed to alternating sides. The first repetition was performed to the subjects right side and then to the left and thirty repetition were completed in the same way. Subjects were instructed to exhale during the concentric phase of the abdominal muscle contraction and to inhale during eccentric phase of contraction.

RESULTS

The difference in effect of SPSU and OPSU on HR, BP, SpO_2, RPP and PRE was analysed by paired t-test using SPSS.14.0 for windows software. Within group analysis for all the variables was done using ANOVA. The level of significance for a two tailed experimental hypothesis was set at <0.05. the between group results are summarised in table 1 and graphically represented by figures bellow.

Table 1: Comparison of pre exercise, during exercise and post exercise effects on hemodynamic variables between SPSU and OPSU

Variables	SPSU Mean + SD (n=15)	OPSU Mean + SD (n=15)	t-test	
			t	p
HR_{Pre}	77 ± 9.3	73±6.2	1.4	0.15
HR_{d}	83±8.7	81±8.3	0.61	0.54
HR_{post}	78±8.8	75±4.8	0.94	0.35
SBP_{pre}	109.4±6.3	106±9.8	1.0	0.2
SBP_{d}	117±7.3	113.6±7.8	1.4	0.1
SBP_{post}	111.2±5.9	108.5±9.1	0.9	0.3
DBP_{Pre}	65.4±7.3	64±5.8	0.577	0.569
DBP_{d}	73.2±3.2	72.9±4.6	0.182	0.857
DBP_{post}	68.8±6.5	65.9±5.3	1.3	0.20
$SpO2_{Pre}$	99.3±0.8	99.4±0.5	0.2	0.06
$SpO2_{d}$	98.8±0.6	99.0±0.2	1.1	0.2
$SpO2_{post}$	99.2±0.8	98.8±0.6	1.4	0.1
RPP_{Pre}	84.2±9.6	77.4±11.03	1.8	0.08
RPP_{d}	97.8±15.4	92.2±13.6	1.0	0.3
RPP_{post}	86.2±11.3	81.6±10	1.1	0.2
RPE_{post}	3.6±2.1	4.6±1.8	1.3	0.18

The mean difference HR for group A and B, during exercise was statistically non significant with (p=0.15) and (p=0.54).

Figure 1: Comparison of HR between SPSU and OPSU

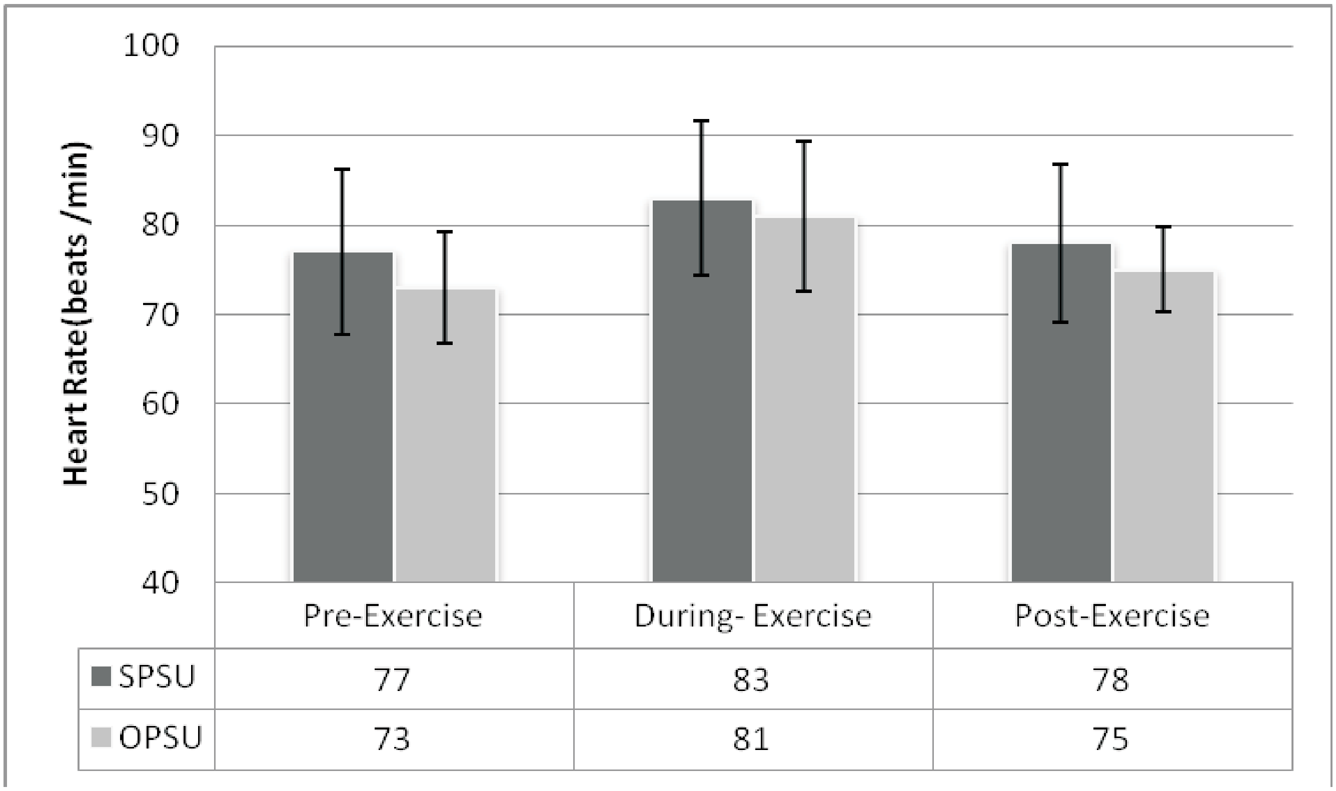


Figure 2: Comparison of SBP between SPSU and OPSU

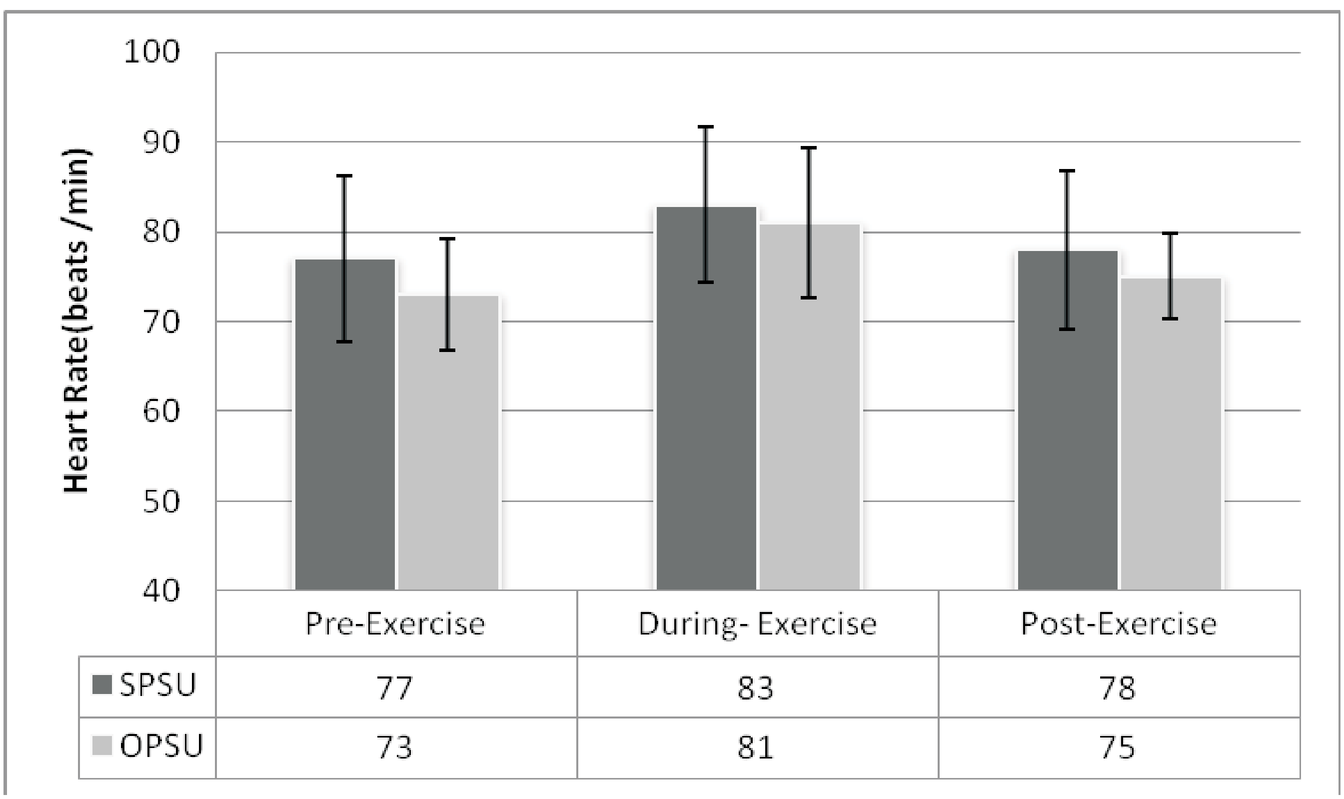


Figure 3: Comparison of DBP between SPSU and OPSU

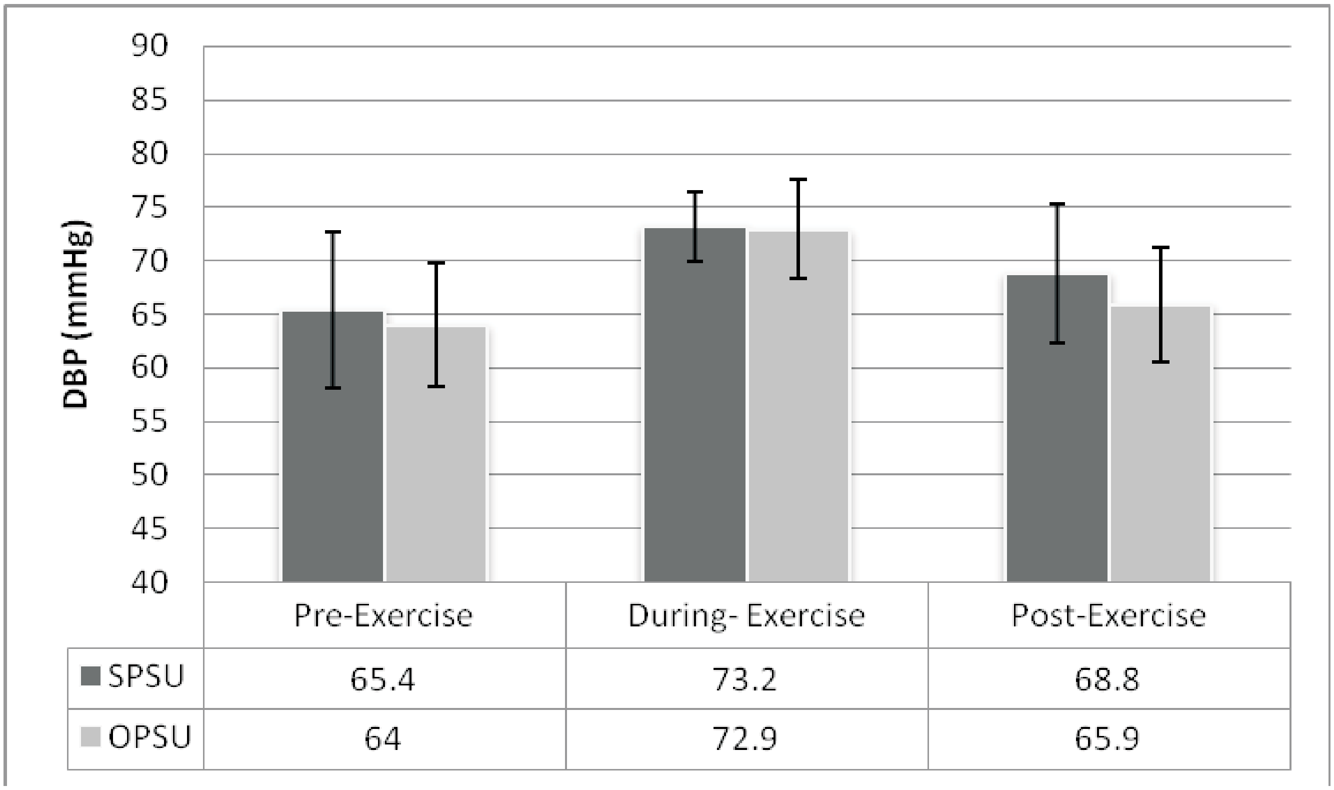


Figure 4: Comparison of SPO2 between SPSU and OPSU

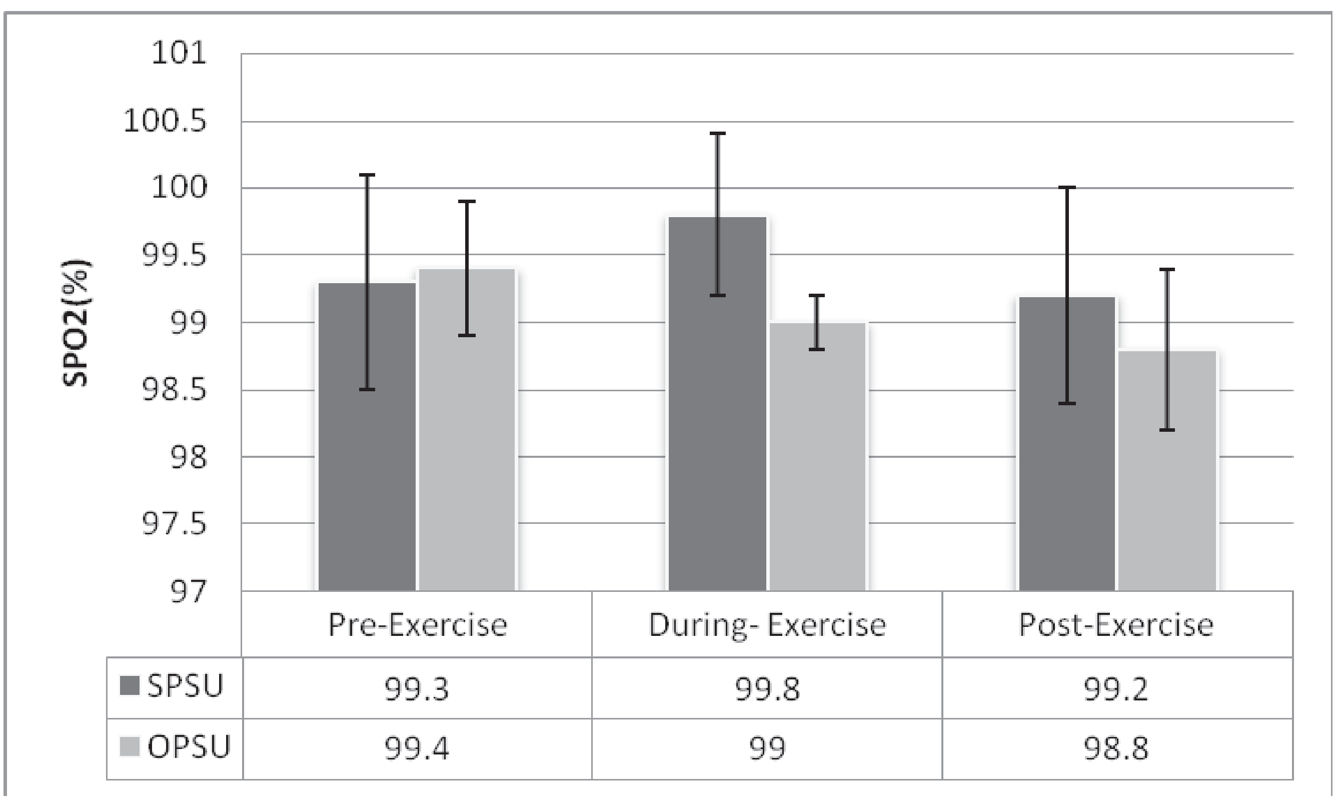


Figure 5: Comparison of RPP between SPSU and OPSU

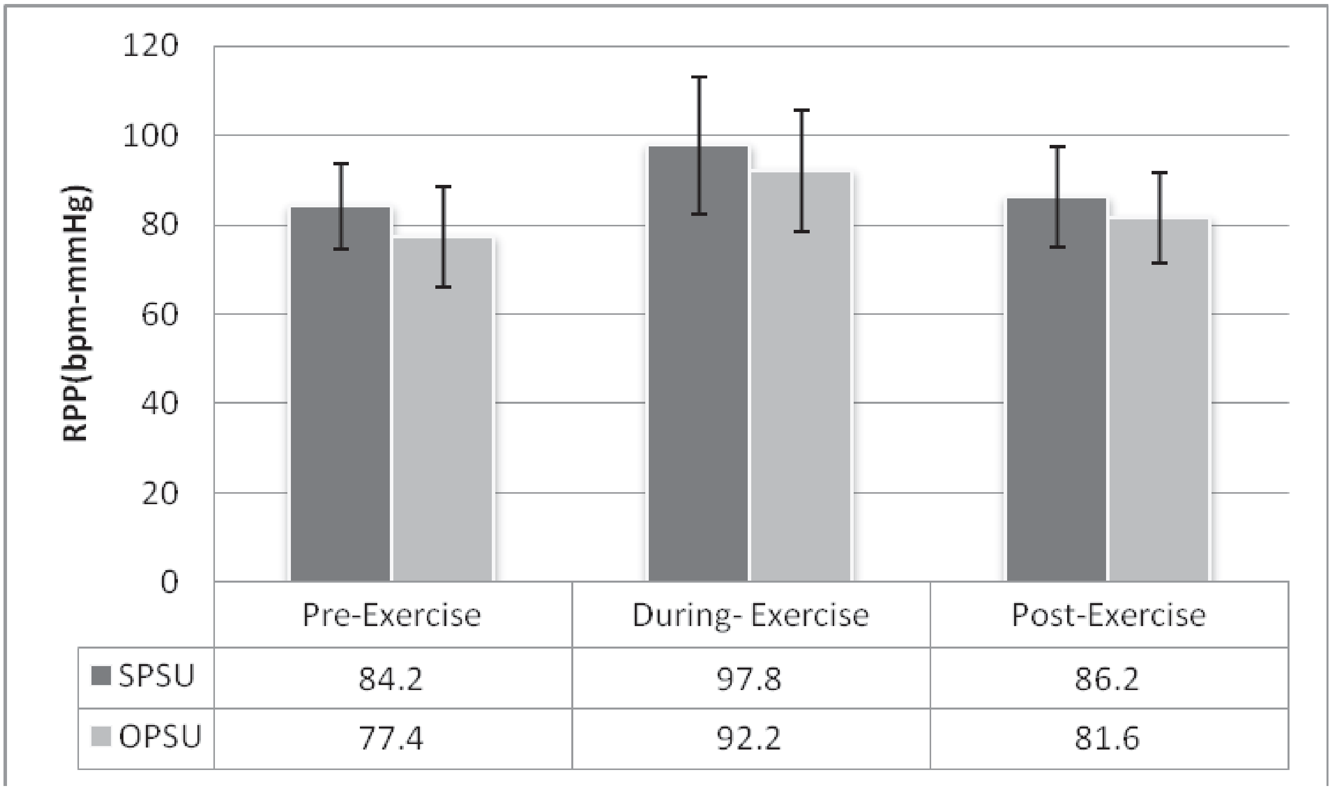
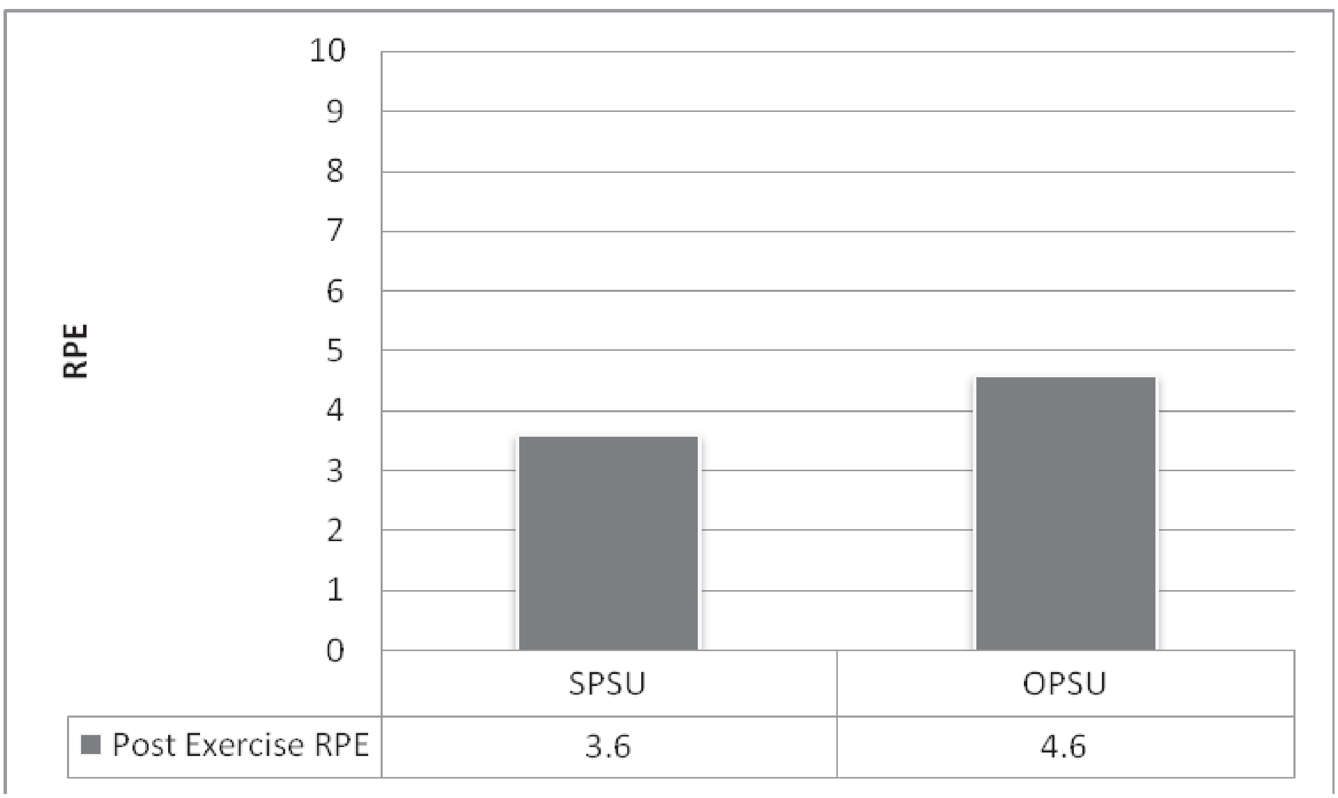


Figure 6: Comparison of post exercise RPE between SPSU and OPSU



Similar were the results for SBP and DBP, the mean difference of SBP and DBP for group A and B, during exercise, were statistically non significant with (p=0.1), (p=0.86) respectively.

The results SpO_2 were again insignificant with (p=0.06) . the mean difference of RPP for group A and B during exercise was statistically non significant with (p=0.3).

The RPE was also insignificant with (p=0.18) for post exercise in both the groups.

DISCUSSION

Abdominal exercises are prescribed for a variety of reasons but mainly for rehabilitation of low back injury and a component of fitness training programs of persons with cardiovascular diseases.[1,2]

Abdominal exercises are most appropriate for persons with back pain related to excessive lumbar lordosis and significantly increased sacrohorizontal angle and are best tolerated by persons with facet joint syndrome, spondylolisthesis, and vertebral or intervertebral foramen stenosis.[4] the study by Halpern and Bleck has shown that bent knee sit ups, in which subjects with their knee supported flex the trunk and hips simultaneously until the elbows are even with the knees , generate greater lumbar interdiscal pressure and compression largely because of increased lumbar flexion and muscle activity from the rectus femoris and psoas muscles than in SPSU and OPSU in which the rise from the bed is high enough only to clear the bilateral scapulae off the bed.[8] these findings suggest that the SPSU and OPSU may be safer exercises to perform and so based on their favourable biomechanical and electromyographic profiles were chosen for this study.[4]

To date, abdominal exercise research has focused primarily on the electromyographic research focused primarily on the electromyographic and biomechanical aspects of exercise. The hemodynamic effect of abdominal exercise as used in rehabilitation of low back injury and as a component of fitness training programs of persons with cardiovascular disease are largely unknown. It was believed in this study that obtaining these data would be of clinical importance , given the large blood pressure elevations previously reported during traditional weight training exercises. There has been only one published study that examined the hemodynamic parameters during OPS and SPSU and AbSculptor at a lower intensity in a within subject randomised crossover design and the authors reported that there were greater hemodynamic changes during OPSU as compared to other two.[4] as the hemodynamic variations at higher intensity were unknown and also ten repetitions of OPSU were compared to five repetitions of SPSU and AbSculptor in the previous study, this necessitated the need of this study and it was against this back ground, the current study was planned to compare HR,BP,RPP,SpO_2 and RPE while performing the SPSU and OPSU. This concern was validated by the finding of this study.

This investigation represents the first quantification of the acute hemodynamic changes that occur during OPSU and SPSU at a higher intensity comprising of thirty continuous repetitions in randomized parallel sample design, in males, to eliminate the carryover and gender difference effects. The results of the only study that monitored hemodynamic variables during SPSU and OPSU by Finoff et al (2003) formed the basis for comparison.

Hemodynamic monitoring during abdominal exercises at higher intensity had not been previously performed, therefore a homogenous, healthy group of subjects rather than a more heterogeneous clinical population were chosen . as the aim of the study was to compare hemodynamic variables of the two different abdominal exercises i.e. SPSU and OPSU, this kind of sampling and a randomized parallel design seemed appropriate. It also helped to get the subject's opinion on Borg's scale of RPE after they had performed the exercises.

It was found in this study there was no significant difference in increase of hemodynamic variables between the SPSU and OPSU in contrast to the findings of Finoff et al. The mean heart rate was 83±8.7 during SPSU and 81 + 8.3 during OPSU in this study. The difference heart rate between the two exercises was not statistically significant (with p=0.5). the difference in SBP and DBP between the two exercises was not statistically significant with (p=0.1) for SBP and (p=0.8) for DBP between the two exercises. This means there was a similar increase in heart rate and blood pressure in both SPSU and OPSU. Similar were the findings of Finoff el al. For HR, SBP and DBP of SPSU and OPSU.

In this study, the mean RPP was found to be 97.8±15.4 during SPSU and 92.2±13.6 during OPSU. The difference between the two exercises were in significant with (p=0.3) in contrast to the finding of Finoff et al. in which the difference between RPP was significant with (p=0.05). this discrepancy may be explained in terms of the fact that Finoff et al. in his study compared five repetition of SPSU with ten repetitions of OPSU to alternating sides resulting in a total of ten continuous repetitions of OPSU. In comparison, this study compared same number of repetitions of SPSU to the same number of repetitions of OPSU. Another factor that may be responsible for this discrepancy was that each subject in the study by Finoff et al performed sis sets of exercises comprising five repetitions of SPSU, five recitations of AbSculptor and ten repetitions of OPSU, each set exercise being performed with and without breath holding. It was reported by the authors that some hemodynamic parameters did not reach the base line when subjects started a new set of exercises. This may have resulted in carryover effect to the next exercise and so the increase in hemodynamic parameters during that particular exercise could not be attributed to that particular exercise. In comparison, in this study, subjects were instructed to perform only one set of exercise of 30 repetitions at a time and the increase in hemodynamic variables was only because of that particular exercise beyond no doubt. It was because of this reason that subjects in this study showed lesser increase in all variables as compared to the previous study although subjects performed more repetitions. At the same time, valsalva manoeuvre was avoided by instructing patient to exhale during the concentric phase and inhale during eccentric phase of contraction of exercise.

The similar increase in hemodymic parameters in both SPSU and OPSU may be explained by the electromyographic findings of Rafael F et al (2006) and Cresswell et al (1994).[4,9] according to them transversus abdominis and internal oblique muscle is mainly responsible for increasing intra-abdominal pressure and both these muscles exhibited similar activation pattern and amplitude in both SPSU and OPSU. In their study on electromyographic analysis of abdominal exercises, Rafael F et al found that the EMG activity of internal oblique and transverses abdominis, in SPSU and OPSU, was similar.[4] According to Cresswell et al the common use of straight partial sit-ups as the training stimulus to increase IAP is questionable, as this form of abdominal exercise is known to predominantly activate and train the rectus abdominis muscle whose fibers primarily generate trunk flexor torque.[9] studies using intramuscular electromyographic recordings have substantiated this rationale.[10] it was found by Cresswell et al that the main muscles responsible for increasing IAP (i.e trasversus abdominis and internal oblique muscle) were active while performing loaded rotations in both sitting and standing position[10,11] the exercises, examined in this study, activate trasversus abdominis and internal oblique muscles by small and similar amplitude as per the study by Rafael et al, leading to a similar rise in hemodynamic variables in both the exercises, thus proving the null hypothesis

CONCLUSION

The results suggest that there was no significant difference in rise in hemodynamic variables during the two exercises. However there was a significant difference between pre exercise and during exercise magnitude of hemodynamic variables of each exercise. This suggests that acute hemodynamic changes of these two abdominal exercises are clinically relevant, however both oblique partial sit-ups and straight partial sit-ups warrant same amount of concern.

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