Original article

Analysis of selected acute hemodynamic changes by abdominal exercises, with and without breath hold in males

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Abstract:

Abdominal exercises is an important part of treatment plans for post operative orthopedically surgeries, cardio-thoracic, general surgeries and gynecological conditions as planed by physiotherapists. These exercises aimed at physical fitness for the population after post operative surgical conditions. Anterior abdominal muscles along with the posterior trunk muscles are important in supporting the body weight. One of the previous study found that weakness of these muscles predisposes to low back pain in middle aged population. Therefore, often he advised that abdominal muscle strengthening exercises is mandatory for above said age group people. Its has been observed by that approximately 80% of adults will experience low back pain (LBP) at some time in their lives. Thus those who seeking medical attention, many of them are prescribed ABDOMINAL STRENGTHENING EXERCISES (ASE) as part of a comprehensive treatment program **.** Although numerous abdominal exercises exist, in the fitness world but researchers have reported that the straight partial sit-up (SPSU) and oblique partial sit-up (OPSU) produced high abdominal muscle electromyography activity while maintaining low lumbar compressive and shear forces **.**

Introduction

Abdominal exercises is an important part of treatment plans for post operative orthopedically surgeries, cardio-thoracic, general surgeries and gynecological conditions as planed by physiotherapists. These exercises aimed at physical fitness for the population after post operative surgical conditions. Anterior abdominal muscles along with the posterior trunk muscles are important in supporting the body weight. One of the previous study **[Rao.S et al. 1993]** found that weakness of these muscles predisposes to low back pain in middle aged population. Therefore, often he advised that abdominal muscle strengthening exercises is mandatory for above said age group people. Its has been observed by **Biering-Sorensen F, [1983]** that approximately 80% of adults will experience low back pain (LBP) at some time in their lives. Thus those who seeking medical attention, many of them are prescribed ABDOMINAL STRENGTHENING EXERCISES (ASE) as part of a comprehensive treatment program **[Saal J, 1989]**. Although numerous abdominal exercises exist, in the fitness world but researchers have reported that the straight partial sit-up (SPSU) and oblique partial sit-up (OPSU) produced high abdominal muscle electromyography activity while maintaining low lumbar compressive and shear forces **[Axler C.et al.,**

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1997; Andersson E et al, 1997; Negrao Filho R de F et al, 1997; Shields R, 1997].

Contrasting to the above facts, a research article presented in **critical care medicine, [1997]** explained that there is a positive relationship between increased intra abdominal ,intra thoracic and intra cranial pressure. He states that increased abdominal pressure causes increased intra cranial pressure and decreased in cerebral pressure, that causes idiopathic intracranial hypertension. Even W.F.HAMILTOM et al**.[1943]** also concluded from their study that increased abdominal and intra thoracic pressure causes increased arterial , cerebral and venous pressure in men. It is known that heart rate and blood pressure change will occur during abdominal exercise because large muscle co-contractions and dynamic trunk movement are involved, but during abdominal crunch exercises some of them hold their breath during training programe, which may increase intra-abdominal pressure (IAP),and leads to a true Valsalva maneuver during the exercises.

The above said articles and such related studies, persuade us to know the selected hemodynamic changes during abdominal exercises with and without voluntary breath holding. In the light of the above mention facts, the researched planed to compare the magnitude of change in heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure/mean arterial pressure (MBP / MAP) during abdominal exercises, with effect of - with and without breath holding. Bases on previous research scholar hypothesized that **t**he breath holding during abdominal exercise, would increase all selected hemodynamic parameters except for heart rate, which would decrease based on a Valsalva-like response.

Methodology

In order to clear the ethical issue, the scholar randomly selected 40 healthy voluntaries, from Swatantra College of Physiotherapy and Rehabilitation.

The age of all volunteers ranges between 19- 45 years, with no resent history of any kind of medical or surgical interventions. The present were carried out in the Dept. of Cardiology, GSL Hospital. To conduct the study, a time limit of 30 minutes per volunteer have been allotted. The overall 6 days have been spend to complete the entire workout. The fixed time has been given to each participants to avoid the thread to internal validity. The volunteer are instructed to wear a loose dress and maintain a gap of 24 hrs for taking any kind of drugs/stimulants and 3 Hrs in taking heavy meal before initiating the experiment. Before the test procedure starts they were signed on voluntary concern form and thereafter the procedure are explained. They are free to stop the testing procedure, if they feel uncomfortable at any time during the test protocol. For the test SCHILLER MONITOR (multi-parameter hemodynamic monitor) and ABFLEXOR® (Abdominal exerciser) were used to get high reliable data. To find out the hemodynamic fluctuation with respect to exercises, we opted for abdominal exercises, because previous study concluded that increased abdominal and intra thorasic pressure causes increased arterial , cerebral and venouspressure in men.**[W.F.HAMILTOM etal.1943]**

Procedure : The Abflexor machine has a frame that supports the neck and arms during abdominal exercise, similar to the Abshaper and Abscluptor machines**.[Warden S, 1999; Beim G, 1997].** The Abflexor **[Fig-1]**exercise began with the specific position, as he has to lie on supine with his neck and

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head supported by a pad in the middle of the frame. His elbows are rested on foam ring and hands grasping the cross bar. The potential advantage of thAbflexor is, to relax the appendicular musculature by providing supporting structures, and therefore "isolate" abdominal musculature for exercise, thus hand placement should remain constant, to minimize artifactual readings caused by changes in hand position during exercise. He has to keep his knees flexed to 90°, hips flexed to 45°, and the feet flat on the table. The subject has to raised the upper back off of the table. The rise was high enough to just clear the inferior angles of the scapulae. This position was held for 3 seconds (timed by the investigator), and then the upper back was lowered to the table. This counted as 1 repetition. Each repetition took approximately 4 to 5 seconds to complete, and a total of 5 continuous repetitions were performed. The supervising investigator ensured correct technique during each repetition.

For exercises **[Fig-3]**requiring breath holding, subjects were asked to close their mouths and hold their breath during the exercise, and to breathe through the nose between each repetition For exercises performed without breath holding, subjects were instructed to exhale during the concentric phase of the abdominal muscle contraction, and to inhale during the eccentric phase of the abdominal muscle contraction. Proper breathing technique was ensured through clinical observation.

Test Protocol :Each subject received verbal instructions followed by demonstration of the abdominal exercises by the investigator. The subject then practiced each exercise 2 to 3 times to ensure proper technique, and then was given a 2-minute rest period before initiating the exercise protocol. Prior to the exercise the base-line parameter were recorded **[Fig-3]** and then instructed to start the exercises without any breath hold. After 5 repetition, immediately after the post test data were recorded, and allowed them to rest until the selected hemodynamic parameter comes to normal. As the data come to normal, the subjects were instructed to do same pattern of exercise but this time with breath-hold. As the exercise repetition completed, the post-breath hold data were collected.

Result

To find out the result SPSS-16 has been used. The outcome of the research has been describes as descriptive statistical as well analytical statistical analysis.

Heart Rate:

DISCRIPTIVE STASTICS FOR HEART RATE							
Table. No- 1	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
BASELINE	40	18.00	67.00	85.00	75.0250	.77002	4.87004
POST WITH BREATH HOLD	40	21.00	72.00	93.00	87.2000	.70456	4.45605
POST WITHOUT BREATH HOLD	40	17.00	78.00	95.00	86.9500	.57840	3.65815

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From the table No-1, the discriptional analysis on heart rate had many interesting outcome. The heart rate at resting state(Baseline) of 40 subjects ranges from 67 – 85 beats/min with range gap of 18 beats/min, and average heart rate range was 75.03±4.87 beats/min with a range gap of 21 beats/min. With an negligible error of 0.77 beats/min. The post with-breath hold data shows surprisingly high. The heart rate ranges from 72 beats/min to 93 beats/min. with an average 87.20±4.46 beats/min with negligible error of 0.64 beats/min. When same group of subjects are performed abdominal exercise with breath hold it shows that the range from 78-95 beats/min with an average of 86.95±3.66 beats/min with an range gap of 17 beats/min.

Systolic blood pressure

DISCRIPTIVE STASTICS FOR SYSTOLIC BLOOD PRESSURE							
Table-2	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
BASELINE	40	69.00	111.00	180.00	1.2068E2	1.62606	10.28414
POST WITH BREATH HOLD	40	19.00	119.00	138.00	1.2762E2	.57811	3.65631
POST WITHOUT BREATH HOLD	40	18.00	116.00	134.00	1.2525E2	.59566	3.76727

From the table no-2: when we observed the systolic blood pressure of 40 subjects, it is found that the baseline / resting blood pressure ranges from 111 to 180 mm of Hg with a range gap of 69 mm of Hg. The mean value was 120.68±10.28 mm of Hg with an negligible error of 1.62 mm of Hg. When these subjects were tested after exercise with breath hold we found range of systolic blood was ranged from 119 to 138 mm of Hg with a range gap of 19 mm of Hg, but the mean value shoots up to 127.62±3.66 mm of Hg, with negligible error of 0.42 mm of Hg. When same sample done same abdominal exercise, but without holding their breath, we found that systolic blood pressure is ranged from 116 to 134 mm of Hg with range gap of 18 mm of Hg. The mean value was 125.25±3.77 mm of Hg, with negligible error of 0.60mm of Hg.

Diastolic blood pressure:

DISCRIPTIVE STASTICS FOR DIALSTOLIC BLOOD PRESSURE							
Table No-3	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
BASELINE	40	12.00	73.00	85.00	79.8000	.47122	2.98028
POST WITH BREATHHOLD	40	13.00	83.00	96.00	89.4250	.42349	2.67838
POST WITHOUT BREATH HOLD	40	12.00	80.00	92.00	86.4500	.42358	2.67898

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From Table No-3: when we evaluate the diastolic blood pressure we found that baseline / resting Diastolic blood pressure was ranging from 73 to 85 mm of Hg with range gap of 12 mm of Hg, on further observation the mean value was 79.8±2.98 mm of Hg and have an minimum error of 0.47mm of Hg. When they done their abdominal exercise by holding their breath, the diastolic pressure shoots up by range of 83 to 96 mm of Hg with range gap of 13 mm of Hg. The mean value was 89.43±2.68 mm of Hg, and the error was 0.43 mm of Hg. When they done same exercise but without holding their breath, the diastolic pressure ranges from 80 to 92 mm of Hg with range gap of 12 mm of Hg. The mean value was 86.45±2.68 with negligible error of 0.43 mm of Hg.

Mean Blood Pressure:

DISCRIPTIVE SATASTICAL ANALYSIS FOR MEAN BLOOD PRESSURE							
Table -4	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
BASELINE	40	13.00	83.00	96.00	89.6000	.50358	3.18490
POST WITH BREATH HOLD	40	9.00	89.00	98.00	93.5000	.43264	2.73627
POST WITHOUT BREATH HOLD	40	9.00	88.00	97.00	92.1000	.42787	2.70612

On analyzing the mean blood pressure **(from table no 4)** the base line ranges from 83 to 96 mm of Hg, with a range gap of 13 mm of Hg. The mean value was 89.6±3.19 mm of Hg with an negligible error of 0.50 mm of Hg. When they conducted abdominal exercises with breath hold the mean blood pressure shoots up with an range of 89 to 98 mm of Hg with an range gap of 9 mm of Hg, and the mean value of 93.5±2.73 mm of Hg with an error of 0.43 mm of Hg. The mean blood pressure without breath hold was 88 to 97 mm of Hg and range gap was 9 mm of Hg. The mean value was 92.1±2.7 mm of Hg, with an error of 0.42 mm of Hg.

Analytic Statical result:

Table-5	Range	Minimum	Maximum	mean	Std. Deviation	
DIFFERENCE(post breath hold - base line)	16.00	4.00	20.00	12.5000	4.06360	**Heart Rate**
DIFERENCE(post without breath hold - baseline)	14.00	4.00	18.00	11.95	3.55145	
DIFFERENCE(post breath hold - baseline)	13.00	3.00	16.00	8.4250	2.67838	**Systolic blood pressure**
DIFERENCE(post without breath hold -	11.00	1.00	12.00	5.9500	2.66939	

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baseline)						
DIFFERENCE(post breath hold - baseline)	8.00	6	14	9.6750	2.26894	**Diastolic blood pressure**
DIFERENCE(post without breath hold - baseline)	11.00	3.00	14.00	6.9000	2.28484	
DIFFERENCE(post breath hold – baseline)	9.00	1.00	10.00	4.0000	2.25320	**Mean blood pressure**
DIFERENCE(post without breath hold – baseline)	8.00	.00	8.00	2.6500	2.17857	

Table -5 & 6 tried to visualize the comparing the rate of change on selected hemodynamic parameters, as a result we got few interesting outcome. On analyzing the heart rate, the exercise with breath hold changes ranges from 4 to 20 beats / min with an average of 12.5±4.06 where as exercise without breath hold the rate of change in heart beat ranges from 4 to 18 beats / min with an average 11.95±3.55. On further when analyzing, we found that heart rate fluctuated 31.9% from base line when the subjects done their exercises with breath hold, but when we do same exercise without breath hold the heart rate fluctuation was only 30.6%. Similarly, when we tried to analyze the second parameter i.e- systolic blood pressure we found that rate of change of systolic blood pressure was ranges from 3 to 16 mm of Hg with an average value of 8.43±2.67 mm of Hg, when exercises was performed with breath hold, whereas without breath hold it was it was fluctuated only 5.95 ±2.66 mmof Hg eith ranges between 1 to 12 mm of Hg. The further analysis shows that exercise with breath hold the systolic blood pressure fluctuates only 32.5 %, whereas same exercise without breath hold fluctuation was 43.9%.

The third parameter was diastolic blood pressure. We discovered from the present sample the rate of change of diastolic blood pressure ranges from 6 to 14 mm of Hg with an mean value of 9.68±2.268 mm of Hg after the exercise done with breath hold but whereas same exercise by same sample group done the rate of change of diastolic blood pressure ranges from 3 to 14 mm of Hg with an mean value of 6.9±2.248 mm of Hg. but when we analyse the percentage of change in diastolic blood pressure we found that fluctuation without breath hold was 32.7% whereas with breath hold it was only 24.9%. On the last parameter i.e mean blood pressure, we found that changes in mean blood pressure with breath hold abdominal exercise was ranges between 1 to 10 mm of Hg, with mean value of 4±2.25 mm of Hg, where as same exercise performed the changes was ranges from 0 to 8 mm of Hg with a mean value of 2.65±2.17 mm of Hg. On analyzing the percentage of change we found that on breath hold it was only 75.6% whereas without breath hold it was 109.4%.

Discussion

The benefits of exercises are known fact, but the same exercises can be utilized in rehabilitation for postoperative patients. Even previous researchers coated in their articles about the merits and demerits of exercises depend on breathing pattern. Based on previous article, our aim of the research is to know

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that rate of change of hemodynamic pattern with and without breath hold wile doing abdominal exercises. The importance of the research is for Physical rehabilitation professionals such as physiotherapist, nurses, physicians who are dealing with clinical work to avoid the complication during treatment and get their result soon as possible. To conduct this study we selected 40 volunteers from SIPR students and staffs members who are physically fit and to avoid the complication which can be generated by patients.

Ethel M et al .2002 suggested that measurement of HR and BP provides the physical therapist with information about the patient's present physiological status and response to activity that can help the physical therapist to decide whether there is any abnormal HR response towards activity, which can be a predictor of ischemic heart disease and related disorders. Information obtained from HR and BP, the physical rehabilitation professionals can choose the most appropriate interventions for the patient's activities. Monitoring HR and BP also provides information about the patient's response during a physical therapy intervention and the possible need to modify during the intervention. Thus, we have selected hemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure and mean blood pressure for our study.

WITH BREATH HOLD					WITHOUT BREATH HOLD			
	Heart rate	Systolic blood pressure	Diastolic blood pressure	Mean blood pressure	Heart rate	Systolic blood pressure	Diastolic blood pressure	Mean blood pressure
Minimum	4	3	6	1	4	1	3	0
Maximum	20	16	14	10	18	12	14	8
Mean	12.5	8.4250	9.6750	4	11.95	5.95	6.9	2.65
% of change(difference/final value)	31.9	32.5	24.9	75.6	30.6	43.9	32.7	109.4

The first variable is based on suggestions reported by **SCOTT O. ROBERTS [2002]** that during exercise, the quantity of blood pumped by the heart increases to match the increased skeletal muscle demand. Heart rate (HR) monitoring is a method commonly used to determine and assess exercise intensity levels. Exercise intensity is a key component of the training response. Therefore, it is important to understand the factors that can influence HR during exercise, so modifications can be made when establishing training heart rate (THR). He concluded that monitoring heart rate is a common method of tracking exercise intensity and performance.

Our selected volunteers resting hemodynamic parameters are heart rate ranges from 67 to 85 beats/ min, with a mean value of 75.025±4.87 beats /min, the systolic blood pressure ranges from 111 to 180 mm of Hg, with mean value of 120.68±10.28, which is slightly higher than standardized value that is 100 to 140 mm of Hg sited in literature by **Edwards**

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Lifesciences-LLC,2009). The diastolic blood pressure ranges from 73 to 85 mm of Hg, with a mean value of 79.8±2.98 mm of Hg, which is quite normal to standardized value i.e.- 60 to 90 mm of Hg. as quoted by **Edwards Lifesciences-LLC,2009).** The mean blood pressure value was ranges from 83 to 96 mm of Hg with a mean value of 89.6±3.148 mm of Hg. The standardized mean arterial pressure is 70 to 105 mm of Hg, **(Edwards Lifesciences-LLC,2009)** which is quite normal to standardized international value. The cause of systolic blood pressure can be high salt intake, lack of exercises.*

Our subjects conducted abdominal exercise with abflexore machine, first time with breath hold and second time without breath hold. The changes in selected hemodynamic parameters were noted and discussed further. When our volunteers done abdominal exercises with breath hold we found that change in heart rate was ranged 4 to 20 beats/min with a mean value of 12.5 beats/min. where as same group of volunteer done same exercises but without holding their breath it was less fluctuated ranged from 4 to 18 beats/min, with a mean value of 11.95 beats/min. The rate of change of heart rate is much higher in breath hold i.e.- 31.9 % rather than without breath hold, i.e.- 30.6%. the similar result was suggest by **Butler.P.J. & Woakes A.J., (1987)**, when they concluded and found that first 10 to 15 seconds their was no change in heart rate but later on the apnea leads to higher change, when human do physical activity with holding their breath, as compare to exercise with normal breathing.

The second parameter used is blood pressure, in which we analysed three components, ie- systolic blood pressure (i.e.- pressure in the arteries when the heart muscles contracts), diastolic blood pressure(i.e.- when the heart muscles is resting between beats and refilling the blood in the heart)**[American heart association]** and mean arterial pressure (consider to be the perfusion pressure seen by organ in the body **[Wikipedia]**.

Our study shows that when our volunteers done their exercises with breath hold we found that rate of change in systolic blood pressure(SBP) difference from 3 to 16 mm of Hg with mean value of 8.42 mm of Hg, where as diastolic blood pressure(DBP) differences was ranges from 6 to 14 mm of Hg, with an mean value of 9.68 mm of Hg and change in mean blood pressure (MBP) value ranges from 1 to 10 mm of Hg.** The similar result also found when Massimi Ferrigno et al (1997) tried to analysis the cardiovascular changes during deep breath hold dives in a pressure chamber. He found that arterial blood pressure was shot up upto 280/200 to 290/150 mm of Hg. when they drive about 40 to 55 mts depth. The cause for hypertension was due to periphery vasoconstriction, which is led by anaerobic metabolism. Whereas same group of volunteers done same exercises but this time without holding their breath, the hemodynamic parameters are changed. The change in systolic blood pressure was ranges from 1 to 12 mm of Hg with mean value of 5.95 mm of Hg. Similarly in diastolic blood pressure the change was ranges from 3 to 14 mm of Hg, with mean value of 6.9 mm of Hg and the mean arterial pressure was ranges from 0 to 8 mm of Hg with mean value of 2.65 mm of Hg. E Grossman et al.(2001) discovered from his study that exercise with breathing for 10 minutes can reduce the blood pressure as an effective non-pharmacological modality.

Even same result was matches with our study when S.Rao et al, [1993] found the cardiovascular responses of abdominal exercises in female age

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between 35 and 45 years. Study /results of the abdominal exercises showed a significant raise in SBP, DBP and Pulse Rate, but it was unclear that the exercises were with breath hold or without breath hold.

Finally we tried to study the rate of change of selected hemodynamic variables and its values, it was found that when exercise was performed with breath hold their was very minimal change in for SBP, DBP & MBP that is 32.5%, 24.9% & 75.6% respectively, where as when same exercise was done without breath hold the observed rate of change was 43.9%, 32.7 % & 109.4 % respectively in same variables, whereas heart rate a change doesn't show much differences i.e. 31.9% & 30.6 % changes are seen in with and without breath hold. However we are unable to find any supporting or opposing results related to our findings. From our study we like to conclude, that exercises to postoperative patients can be given by keeping complication on account, however patients with vascular complication, vacuities or any kind of metastasis related clinical conditions should be avoided from the exercises. Even in earlier study explained relationship between increased intra abdominal ,intra thoracic and intra cranial pressure. Increased abdominal pressure causes increased intra cranial pressure and decreased in cerebral pressure, that causes idiopathic intracranial hypertension [Critical care medicine1997]

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FIG-1 Subject position for abdominal exercises with ABFLEXOR

FIG-2SHILLER: MULTIPARAMETER PATIENT MONITOR

FIG-3 Instruction for breath holding maneuver

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