Effect of Structured Abdominal Exercise Programme On Diastasis of Rectus Abdominis Muscle in Postpartum Women- An Experimental Study

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Abstract: *Background &**Objective:** Diastasis of rectus abdominis is a conventional term used to define the split between the two-rectus abdominis muscle.It has an important function in abdominal wall support, maintenance of posture, trunk stability, respiration & trunk flexion, rotation and side bending. Any pathology in this muscle may lead to lower back pain, poor posture, shallow breathing, weakness of pelvic floor and core muscles, difficulty in heavy weight lifting & uterine prolapse. Literature suggests that, Careful re-education of abdominal musculature by exercises is helpful to restore and improve strength & function of linea-alba. Thus, the study aimed to determine the effect of a structured abdominal exercise programmed on diastasis of rectus abdominis muscle in postpartum women.*

Methods: *A total sample of 30 postpartum women was enrolled during the study period. Of which 15 women were allocated in the experimental group (Group B) and 15 women were allocated in the control group (Group A) using envelope method. Control group intervention included conventional therapy and an experimental group included a corset along with conventional therapy.*

Outcome measures: Dial caliper and digital palpation method were used for assessing inter recti distance. Abdominal strength was evaluated by manual muscle testing using Oxford Scaling and abdominal girth was measured by measuring tape in cm.

Results: *Mean, standard deviation, % of change, paired t-test and Chi-square were used to analyse the data. There was a statistically significant change in both groups with p value <0.05. However, the experimental Group B participants (Experimental Group).showed better reduction in Diastasis of Rectus Abdominis Muscle as compared to Group A participants (Control Group)*

Conclusion: *The study concluded that structured abdominal exercises with abdominal corset are more effective in reduction of diastasis recti in postpartum women.*

Key words:*Diastasis Recti, Structured Abdominal Exercises, Postpartum Women, Dial caliper, Abdominal girth, Abdominal Strength*

I. Introduction

The abdominal muscles consists of four layers, which span from the breastbone and ribs to the pelvis. The abdominal muscles are known as primary "Core Muscle". The abdominal wall consists of rectus muscles, transverse abdominis, internal and external oblique. The lateral and anterior abdominal wall is formed by five pairs of muscles with fibres oriented vertically, horizontally and obliquely. These muscles have skeletal attachments on their thoracic cage, pelvis and on the spinal column through thoracolumbar fascia.

The lateral muscles of abdomen are arranged in three layers with their muscle fibres running in different direction: in deep layer the fibres run transversely (transverses); in the intermediate layer, fibres run obliquely, superiorly and medially (internal oblique); in the superficial layer they are obliquely inferiorly and medially (external oblique)[1]

Important function of these muscles includes abdominal wall support, maintenance of posture, trunk stability, respiration, trunk flexion, rotation, side bending and these muscles also stabilize the lower back during all movements. The main function of the rectus abdominis is flexion of the trunk on fixed pelvis or flexion of pelvis on fixed trunk.[2]

This separation of inter rectus distance is referred to as diastasis rectus abdominis. This condition has no association with morbidity and mortality. Diastasis recti may appear as a ridge which runs down in the middle of the abdomen from xiphoid process to umbilicus. It becomes prominent while straining and disappears when abdominal muscles are relaxed[3]

Diastasis of rectus abdominis is a conventional term used to define the split between the two-rectus abdominis muscle. As the two recti muscles are attached to the middle line by the lineaalba, widening actually occurs as a result of stretching & thinning in linea alba. Therefore, it should be considered as a inter recti distance rather than a separation. Divertation of the muscle is most commonly visible during strong recruitment of anterior abdominal pressure. Activities like coughing, sneezing, lifting heavy objects, sitting forward against gravity puts pressure on abdomen and during these activities,divertation is seen easily. A domed protrusion of abdominal wall is seen which is described as "Doming". Separation can occur anytime in the pregnancy but most commonly occurs in the third trimester[.4]

Diastasis recti occurs commonly in pregnancy, the incidence rate is more than 67%, in multipara compared to primipara. Diastasis recti starts initially in second trimester and its incidence peaked in third trimester. It remained high in the women with immediate postpartum and decline but did not disappear in later postpartum women.[5]

During pregnancy, female body undergoes many hormonal and anatomical changes that affect musculoskeletal system to maximum extent. These changes cause various musculoskeletal complaints predisposing to injury or they cause alteration pre exacting alignments. Abdominal muscles suffers commonly during pregnancy due to over stretching of muscle fibres around the growing uterus. As a foetus grows, the rectus abdominis elongates and abdominal wall expands. The lineaalba softens and two recti muscle separates, most of the separation occurs at the level of umbilicus because of this reason the abdomen is usually felt flabby and very weak immediately after delivery. Furthermore, as the pregnancy progresses and abdominal muscle stretches, the force vector decreases in strength of abdominal muscle. During pregnancy amount of relaxin and oestrogen hormones increases which is another cause that leads to softening of linea alba.[6]

Number of factors can contribute to the divertation of rectus abdominis muscle like close pregnancies, carrying a large baby or twin pregnancy, successive pregnancies without adequate recovery of abdominal tone, and obesity. Other causes include poor breathing techniques, constipation which leads to increase intra-abdominal pressure.[7]

Before beginning of an exercise program after pregnancy, the integrity of abdominal wall should be assessed. Often the rectus abdominis separates vertically along with the lineaalba. Diastasis of rectus abdominis classified as present or absent according to Nobel's criteria: Any separation above, below or at the level of umbilicus of two-finger width or less is considered as normal, greater than two finger width is considered as diastasis of rectus abdominis muscle. This criterion is based on normal anatomical arrangement of rectus muscle.[8-9]

However, the studies included only one exercise with a reliable measuring tool or other has used abdominal exercise for 2 weeks without a measuring tool. The present study aimed to find the effect of a structured exercise programme including core and abdominal exercise for 4 weeks duration in postpartum women, with a reliable measurement tool to assess the outcome measure.

II. Methodology

- Source of data: The data was collected from Tertiary Care Centre, Belagavi, Karnataka.
- Study design: An Experimental study
- Study type: A Randomized controlled trial
- Target population: Postpartum women (After 1-3 year of delivery) working in KLE hospital & its constituent Units
- Duration of study: Study duration was from March 2016 to February 2017. (12 months)
- Sampling design & technique: Non-probability sampling/ Convenience sampling

Inclusion criteria:1) Postpartum females after pregnancy a period of 1-3 year, 2) Age: 25-40years, 3) Primiparous and multiparous pregnancy, 4) Diastasis of rectus abdominis muscle with mild (two fingers), moderate (two - three fingers) and severe (more than three fingers) condition at the level of umbilicus.
Exclusion criteria:1) Surgical correction of diastasis recti, 2) Cardio-respiratory conditions,3) Medically unfit for exercise, 4)Abdominal Hernia,5)Musculoskeletal complications (Disc Prolapse, Disc Bulge, etc.), 6) Any Spinal Surgeries 7) Subjects who exercise regularly
ProcedureApproval for the study was obtained from Institutional Ethical Committee. Subjects were recruited based on the inclusion and exclusion criteria. A written informed consent were obtained from the study subject. A total sample of 30 post-partum women were enrolled during the study period and random allocation was done. Of which 15 subjects were in with GroupA(Control Group) and 15 subjects were in Group B (Experimental Group). The demographic data was collected which included age, gravida, parity. All subjects were tested for diastasis of rectus abdominis muscle with the help of using dial caliper and digital palpatory method. After testing for diastasis recti a group of abdominal exercises were given to all subjects. Pre-post intervention outcome measures were recorded at every week.

GROUP A: EXERCISE
GROUP B: EXERCISE+ CORSET

Intervention:1) Static abdominal exercise:
Subject was in supine lying position and ask her to draw her abdomen inward and hold it for 10secs.
2) Head lifting in crook lying:
Subject was in crook lying position with her arm crossed over the diastasis for support and slowly lift the head and hold it for 10secs.
3) Bridging:
Subject was in crook lying position and ask her to raise hips off the floor so that a body forms a straight line from shoulder to knee and hold it for 10secs.
4) Straight leg rising with posterior pelvic tilt:
Subject was in supine lying position with bent her one knee and another leg should raise straight followed by posterior pelvic tilt and hold it for 10secs.
5) Superman exercise in quadruped:
Subject was in quadruped position in which she has to lift her opposite leg and opposite hand and hold it for 10secs.

Therapy Dosage: According to American College of Sports medicine all this exercises should be done by 4- 5 session per week with repetition of 2-3sets of 8-12repetations.[10]
• Frequency: 4-5sets of 8-12repetations
• Intensity: Mild to Moderate
• Duration: 4-5 session/weeks

Outcome measure:
1) Inter recti distance:
A) By using digital palpatory method:
Subject assumed a supine crook-lying position on an examination table. The subjects were asked to lift her head and shoulders off the table with arms extended, reaching toward the knees until the spine of the scapula clear the couch. In this position, the examiner measured for diastasis recti abdominis by placing fingers horizontally across the linea-alba determining how many fingers fit into the space between the borders of the two rectus abdominis muscles. Two types of measurements were taken for each subject: resting (rectus abdominis at rest) and active (rectus abdominis contracted during a curl-up).Measurements were taken from 2.5 cm above, 2.5cm below, and at the umbilicus.

B) By using dial caliper method:
Dial caliper of 0-150mm was used to measure Inter Recti Distance. A standardized measuring procedure using dial caliper was followed. The medial edge of the recti muscle borders were palpated and place the dial caliper perpendicular to the recti borders. Measurements were taken with the dial facing away from the investigator. Readings were taken and recorded. Measurement were done during each testing session. Two types of measurements were taken for each subject: resting (rectus abdominis at rest) and active (rectus abdominis contracted during a curl-up).Subjects were positioned in crook lying on a floor mat with a pillow under their head and their knees flexed to 90 degrees. The measurements were taken at three levels in the following order: at the superior border of the umbilicus; 2.5cm above the umbilicus; and 2.5cm below the umbilicus.

2) Abdominal Strength:
• Position:
Subject was in supine position ask subject to lift her head, shoulders, and arms off the table and subject was asked to hold position for 10-15 seconds.
• Grading:
Grade 5(Normal): Subject completes range of motion until inferior angle of scapula clear the mat with hands clasped behind head.
Grade 4(Good): Subject completes range of motion and raises the trunk until scapula clear the mat resistance of arm will be reduced in the cross-chest position.
Grade 3(Fair): Subject completes range of motion and flexes trunk until inferior angles of
Scapula off the mat.
Grade 2(Poor): Subject will able to raise head only.
Grade 1(Trace): Subject will need assistance to lean forward.

Grade 0(Zero): Only abdominal contraction will be felt.[11]
3)   Abdominal girth:
Subjects were in crock lying position measuring tape was passed under the lower back and abdominal girth was measured at the level of umbilicus in cm.

Statistical analysis: Statistical analysis for the present study was done manually as well as using statistical package of social sciences (SPSS) version 20 so as to verify the results obtained .For this purpose data was entered into the Microsoft Excel Sheet, tabulated and subjected to statistical analysis. Mean, standard deviation and test of significance that is paired t-test were used. Nominal data from patient's demographic data i.e. age, sex, BMI, height, weight distribution were analysed. Chi-square test was used for type of parity and gravida and type of delivery. Comparison of the pre intervention and post intervention outcome measures such as inter-recti distance, abdominal girth, and abdominal strength was done byusing Paired t-test.

III. Results
Demographic profile:
The mean age of participants of group B was 26.67 ± 2.41 and group A was 30.73 ± 2.59. The difference of mean age of females was not statically significant among two groups which suggests that all the study participants were equally distributed in terms of age.The mean Body Mass Index of participants of group B was 24.40 ± 2.87. In group A it was 25.59 ± 2.03. The difference in mean BMI of females was not statistically significant which means that all study participants were equally distributed in terms of Body Mass Index.(Table:1)

Parity:
The participants in this study were both primiparous as well as multiparous. The differences in chi-square values of females by type of parity in four groups werenot statistically significant. (Chi square=0.6792, p=0.7141) which suggests that all study participants were well distributed in terms of parity. (Table: 2)

Gravida:
The differences in chi-square values of females in both groups were not statistically significant. [Chi-square = 0.09174, P = 0.63] which suggests that all study participants were equally distributed in terms of gravida. (Table: 3)

Mode of delivery:
Mode of delivery in group B 13.33 % (n=3) were with FTVD and 86.67% (n=13) were with LSCS. In group A 40% (n=6) were with FTVD and 60% (n=9) were with LSCS. Total number of females with FTVD were 8 (26.67%) and with LSCS were 22 (73.33%) in this study. (Table: 4)

Year of delivery:
The participants in this study were of more than 1 year of post-delivery. In group B after 1 year of delivery 4 subjects were there, after 2 years of delivery 8 subjects were there and after 3 years of delivery 3 subjects were there. In group A after1 year of delivery 5 subjects were there, after 2 years of delivery 7 patients were there and after 3 years 3 patients were there. (Table: 5)

Outcome measurements:
If we compare inter recti distance by digital n dial caliper before and after intervention both groups shows statistically significance(p<0.05). After 4 weeks of intervention there was increase in abdominal strength in both groups. Abdominal girth has a positive correlation with abdominal strength. So, in present study abdominal girth also shows significance in both groups (p<0.05). (Table: 6, 7, 8)

IV. Discussion
In present study effect of structured abdominal exercise programme on diastasis of rectus abdominis muscle in postpartum women was investigated. The control group participants were given conventional exercises and experimental group participants were given conventional exercises with corset for consecutive 4 weeks.Result of present study proved that abdominal strengthening programme is beneficial in recovery of diastasis recti. According to American Collage of Sport Medicine exercises were given for 4 weeks.
In this study the mean age of participants in group A was 26.7 ± 2.41 and in group B was 30.73 ± 2.59. Rankin et al found a significant negative correlation between age and muscle thickness in the analysis of 123 subjects without a history of lumbopelvic pain, between 20 and 72 years of age. The present study is in consensus with study who Teyhen et al, found no age-related differences in the change in thickness of the TrA

and OI muscles measured with USI. Study also proved that there is no such correlation found between age and incidence of diastasis recti.[13-14]In this study the mean BMI of participants in group Bwas 24.40 ± 2.87 and for group A it was 25.59 ± 2.03.BMI.

Gravida and parity also has a positive correlation with diastasis recti. In multigravida chances of diastasis recti was more and location wise also in multigravida location of diastasis is more common below the level of umbilicus while in primigravida more common in above the level of umbilicus. In multigravida depth and also chances of diastasis recti are more. In present study, number of multiparous was more compare to primiparous.

Diastasis recti also has a correlation with mode of delivery, compare to vaginal delivery there are more chances in c- section. After surgery of abdomen the strength of abdominal muscle reduces and leads to weakness of abdominal muscles these weakness leads to dome shape of abdomen and loosening of skin around abdominal area.[14]Because of this reason in present study participants were more with caesarean section compare to vaginal delivery.

A belt which can provides support to part of abdomen is called as an abdominal corset. Generally, corset classified as cosmetic corsets and medical or therapeutic corsets. A cosmetic corset is designed simply to enhance the appearance of the wearer. A medical corset, is designed to provide a therapeutic or corrective body support for persons afflicted with certain types of body weaknesses or other abnormalities in their body structure. Medical corset are usually uniquely constructed and arranged to provide optimum body support and accommodate application of the corset to a various body sizes and shapes.This corset offers mainly three unique and beneficial advantages. First, the corset is adjustable and uniquely constructed in such a way to accommodate application of the corset to various body shapes and sizes. Secondly, the corset is designed to provide support for the back and abdominal regions of the wearer's body. Third, the corset is extremely simple in construction, relatively simple to manufacture, and can be produced at least cost.This belts mainly provides abdominal and back support and provide static contraction of the abdominal muscles.[15-22]In present study experimental group shows better result mainly due to, corset provides continues state of static contraction in abdominal muscles and with this continues contraction exercises are more effective in diastasis recti.

In present study dial caliper and finger palpation methods were used to measure inter-recti distance. Aerospace dial caliper (Range: 0-150mm, Resolution: 0.02mm) was used as an outcome measure. Results of the present study found that dial caliper is more valid and reliable method compare to finger palpation method to measure diastasis recti. The measurements with dial caliper are more accurate and it also gives true value of the distance between two recti muscles. After intervention also the values provided by dial caliper gives true scenario of the intervention and it is also easy to compare pre-test and post-test values. A study done on thirty women who ranged from 1.5 to 22 weeks postpartum with the age between 26-36years, among which 17 were Primiparous and 13 were multiparous, Parity ranged from one to three births. In this study nylon dial caliper (0-15Omm) was used and this study concluded that dial caliper can used by a single clinician to measured Rectus abdominis diastasis during the postpartum period with a high degree of reliability. Dial calipers have proven to be an uncomplicated, accurate and practical measuring instrument for use with DRA testing during the postpartum period.[23]

Weakness of abdominal muscles may leads to major complications including abnormal posture, lumbo-pelvic pain and cosmetic defects. The abdominal muscles have function synergy with the pelvic floor muscles, such that each muscle group enhances the effectiveness of the other during contraction. Because of the synergistic relationship between the pelvic floor and abdominal muscles, a decrease in abdominal muscle function associated with DRA could affect the performance of the pelvic floor musculature. Loss of the support-related function of the pelvic floor muscles implicated in the diagnoses of stress urinary incontinence (SUI), faecal incontinence (FI) and pelvic organ prolapse (POP). Thus, DRA plays an important role in the development, persistence and recurrence of conditions related to impairments of the pelvic floor region, in particular, impairments affecting the support-related function of the pelvic floor muscles. So, strengthening of abdominal muscles plays important role in women's health.[24,.25]

In present study, static abdominal exercise, head lifting in crock lying position, bridging, straight leg raisingwith posterior pelvic tilt and superman exercise in quadruped were given in intervention. These all structured exercises are beneficial in recover of diastasis recti. In experimental group the effect of exercises can be seen for inter recti distance from week 1, in week 3 it was reached at its maximum level and it stabilized by week 4 while in control group the effects of exercises are also seen from week 1 but changes were minimal it also reached at peak by week 3 and stabilized by week 4. So, study proved that for abdominal strengthening minimum 3 weeks of intervention is required. Present study also shows positive correlation between abdominal strength and abdominal girth. In results, it is found that if abdominal strength increases girth of the abdomen decreases. There is a positive correlation between abdominal strength and abdominal girth. In experimental group difference is seen mainly due to abdominal corset, so corset is required for better result in term of diastasis recti strengthening programme.

Limitations of the study are 1) present study was single centric study 2) Progression of exercises were not given. Strength of the study is 1) Dial caliper was used which is reliable tool for assessment.

V. Conclusion

The study concluded that structured abdominal exercises with abdominal corset are more effective in reduction of diastasis recti in postpartum women.

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TABLES:

Table 1: Distribution of mean Age and BMI in both groups (A, B)

Variable	Group	Mean	SD
Age in years	Group A	29.67	2.41
	Group B	32.73	4.35
BMI	Group A	24.40	2.87
	Group B	25.59	2.03

Table 2: Distribution of participants in both groups (A, B) by type of parity

Factors	Group A	%	Group B	%	Total	%
Parity 1	6	40.00	5	33.33	11	36.67
Parity 2	7	46.67	9	60.00	16	53.33
Parity 3	2	13.33	1	6.67	3	10.00
Chi-square=0.6742 P = 0.7141						

Table 3: Distribution of participants in both groups (A, B) by Postpartum year

Years after delivery	Group A	Group B
After 1 year	4	5
After 2 years	8	7
After 3 years	3	3

Table 4: Comparison of experiment and control groups with respect to inter recti distance in Digital Method (fingers) at different time points by t test

Time points	Experiment group		Control group		p-value
	Mean	SD	Mean	SD	
Baseline	2.71	0.25	2.80	0.25	0.3322
Week 1	2.69	0.27	2.80	0.25	0.2448
Week 2	2.58	0.23	2.76	0.23	0.0472*
Week 3	2.24	0.23	2.49	0.28	0.0146*
Week 4	2.29	0.25	2.58	0.27	0.0046*
Baseline -Week 1	0.02	0.20	0.00	0.00	0.6669
Baseline -Week 2	0.13	0.25	0.04	0.12	0.2163
Baseline -Week 3	0.47	0.25	0.31	0.20	0.0664
Baseline -Week 4	0.42	0.20	0.22	0.24	0.0193*

*$p<0.05$

Table 5: Comparison of experiment and control groups with respect to inter recti distance in Caliper (mm) method at different time points by t test

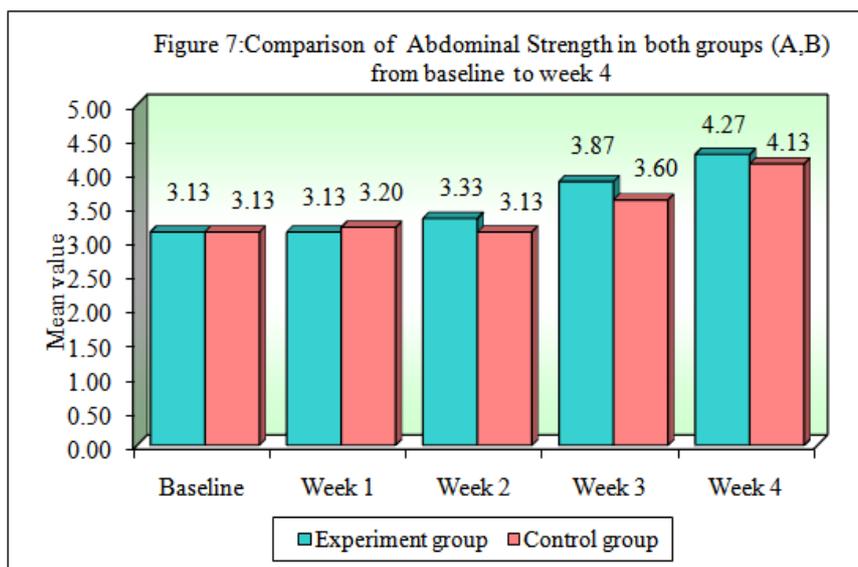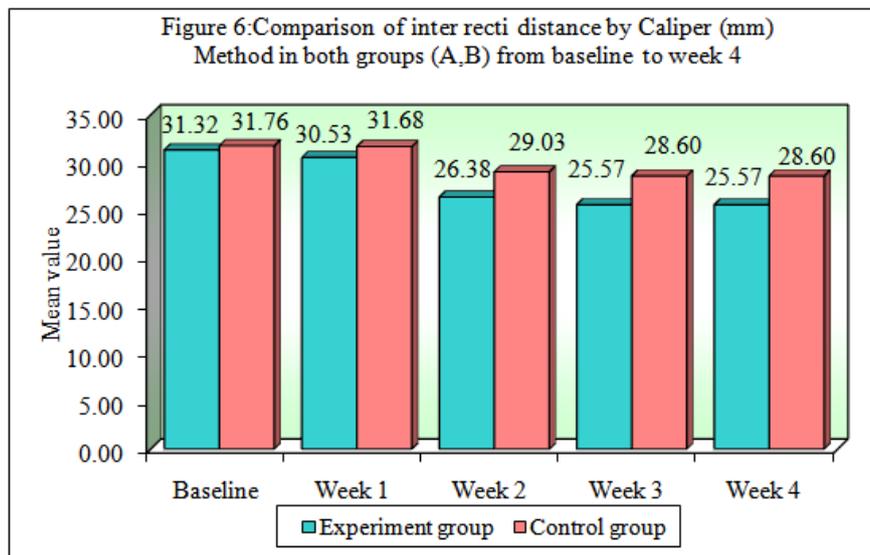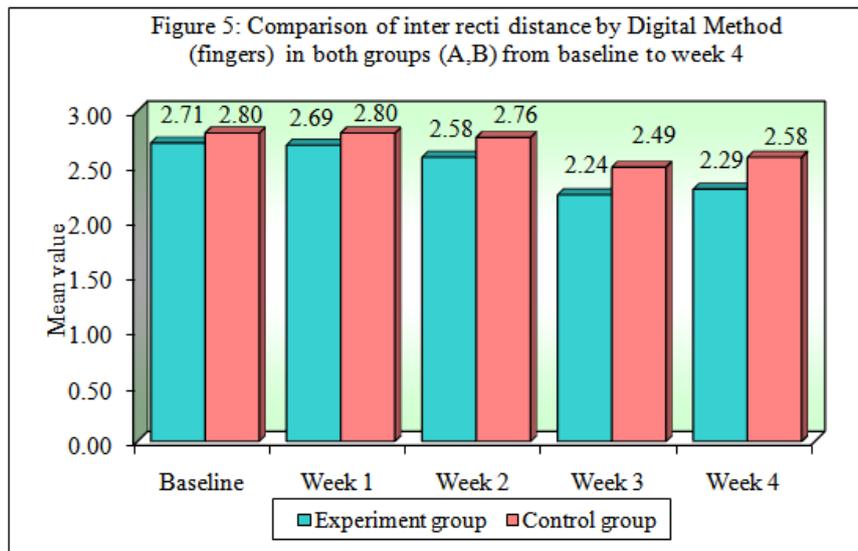| Time points	Experiment group		Control group		p-value
	Mean	SD	Mean	SD	
Baseline	31.32	2.76	31.76	2.44	0.6473
Week 1	30.53	3.38	31.68	2.65	0.3091
Week 2	26.38	4.71	29.03	3.92	0.1053
Week 3	25.57	4.68	28.60	3.90	0.0644
Week 4	25.57	4.68	28.60	3.90	0.0644
Baseline -Week 1	0.79	0.83	0.09	0.80	0.0245*
Baseline -Week 2	4.95	2.72	2.74	2.29	0.0228*
Baseline -Week 3	5.75	2.74	3.16	2.24	0.0084*
Baseline -Week 4	5.75	2.74	3.16	2.24	0.0084*

*$p<0.05$

Table 6: Comparison of experiment and control groups with respect to ABDOMINAL STRENGTH at different time points by t test

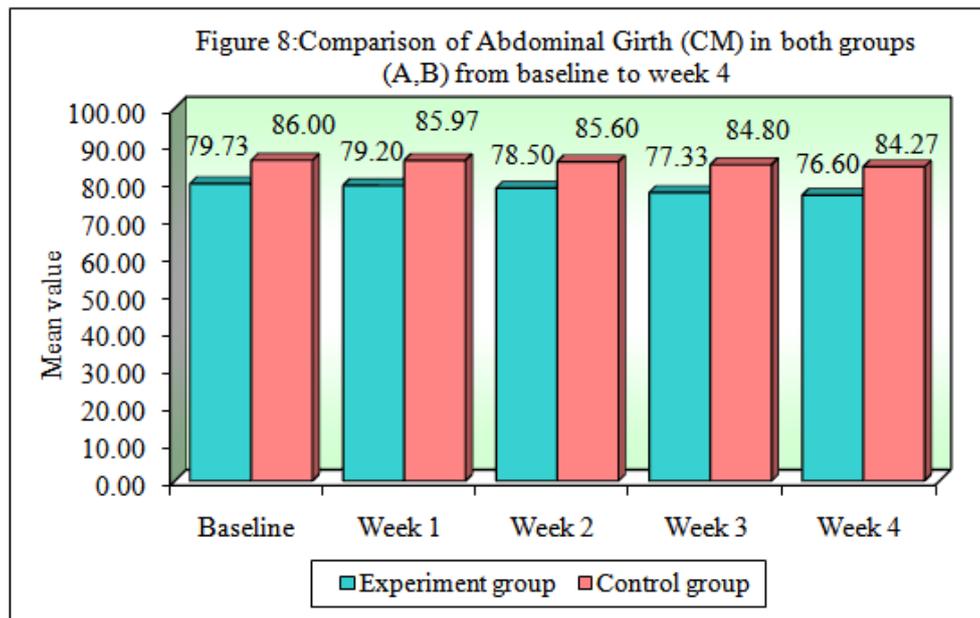| Time points	Experiment group		Control group		t-value	p-value
	Mean	SD	Mean	SD		
Baseline	3.13	0.35	3.13	0.35	0.0000	1.0000
Week 1	3.13	0.35	3.20	0.41	-0.4752	0.6383
Week 2	3.33	0.49	3.13	0.35	1.2876	0.2084
Week 3	3.87	0.64	3.60	0.51	1.2649	0.2163
Week 4	4.27	0.46	4.13	0.35	0.8944	0.3787
Baseline -Week 1	0.00	0.00	0.07	0.26	-1.0000	0.3259
Baseline -Week 2	0.20	0.41	0.00	0.38	1.3817	0.1780
Baseline -Week 3	0.73	0.46	0.47	0.64	1.3127	0.2000
Baseline -Week 4	1.13	0.35	1.00	0.00	1.4676	0.1534

Table 7: Comparison of experiment and control groups with respect to ABDOMINAL GIRTH (CM) at different time points by t test

Time points	Experiment group		Control group		t-value	p-value
	Mean	SD	Mean	SD		
Baseline	79.73	7.86	86.00	4.21	-2.7234	0.0110*
Week 1	79.20	8.26	85.97	4.20	-2.8276	0.0086*
Week 2	78.50	8.45	85.60	4.31	-2.8990	0.0072*
Week 3	77.33	8.27	84.80	4.51	-3.0700	0.0047*
Week 4	76.60	8.05	84.27	4.29	-3.2557	0.0030*
Baseline -Week 1	0.53	1.27	0.03	0.13	1.5119	0.1418
Baseline -Week 2	1.23	1.36	0.40	0.34	2.3014	0.0290*
Baseline -Week 3	2.40	1.23	1.20	0.59	3.4104	0.0020*
Baseline -Week 4	3.13	1.33	1.73	0.65	3.6636	0.0010*

*$p<0.05$

Figure 5: Comparison of inter recti distance by Digital Method (fingers) in both groups (A,B) from baseline to week 4

Figure 6:Comparison of inter recti distance by Caliper (mm) Method in both groups (A,B) from baseline to week 4

Figure 7:Comparison of Abdominal Strength in both groups (A,B) from baseline to week 4

Figure 8:Comparison of Abdominal Girth (CM) in both groups (A,B) from baseline to week 4

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