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Effect of Proprioceptive Neuromuscular Facilitation Program on Muscle Endurance, Strength, Pain, and Functional Performance in Women with Post-Partum Lumbo-Pelvic Pain

A.Tanvi[1], G.Shalini[2], R.Parul[3], S.Gaurav[4]
[1]*MPT (Musculoskeletal), Assistant professor, Santosh Medical College*
[2]*MPT (Musculoskeletal), Assistant professor, Manav Rachna international university.*
[3]*MPT (Cardiopulmonary), Assistant professor, Santosh Medical College.*
[4]*MPT (Sports), Consultant Physiotherapist, Institute of brain and spine, Sun-flag Hospital.*

Abstract: ***Purpose****-The purpose of pre and post experimental study was to know the effect of Proprioceptive Neuromuscular Facilitation techniques on muscle endurance, functional performance on post-partum lumbo-pelvic pain and to compare it with lumbo-pelvic stabilization exercises.*
Background- Pregnancy and child birth elicit psychosocial and physical changes with pain in pelvic or lower back. There is focus on importance of activation of muscles for motor control and stability of lumbo-pelvic region. Specific stabilizing exercises programs in women with post partum pelvic pain improves functional status and reduced pain.
Method-*A total of 28 females were taken on the basis of inclusion (7SI joint test) and exclusion criteria and divided into two groups via convenient sampling. Group A (n=14) received set of lumbo-pelvic stabilization exercises after IRR and Group B (n=13) received proprioceptive neuromuscular facilitation techniques (rthymic stabilization and combination of isotonics) after IRR for four weeks. All the outcome variables i.e. trunk flexors and extensors static and dynamic endurance, pain and quality of life were measured at 0 (pre-test), 2nd and 4th week.*
Results- *Paired t-test indicated that Group A (Lumbo-pelvic stabilization group) demonstrated significant improvements in static and dynamic muscle endurance, pain and Quebec back pain disability scale, measurements. However Group B (proprioceptive neuromuscular facilitation group) also shows improvement on the measure of functional ability and pain from baseline. With in group analysis was done found to be significantly different.*
Conclusion- *The results of the study suggest that both the groups show improvement but lumbo-pelvic stabilization exercises are beneficial for improving trunk muscle endurance, pain and functional ability in women with post partum lumbo-pelvic pain.*
Keywords: *lumbo-pelvic pain, postpartum, muscle endurance, proprioceptive neuromuscular facilitation, stabilization exercises.*

I. Introduction

The transition to motherhood is a period of social, psychological, behavioral, and biological change in women's lives. [1] Pregnancy and childbirth elicit both psychosocial and physical changes, with pain in the pelvic or low back region as a possible complication. [2]

According to ICD-10 CM official loading guidelines- 'The postpartum period begins immediately after delivery and continues for six months and above after delivery' [3]. Pregnancy related low back pain (LBP) and pelvic girdle pain (PGP) are common in many countries. More than 50% of women complain of some degree of low back pain during pregnancy and many describe pubic, pelvic, hip, knee and various other joint discomforts. [4] This is reflected by the inability to perform daily activities and by reduced health related quality of life.

While the etiology of low back pain during pregnancy remains theoretical, four mechanisms are described; Biomechanical, Hormonal, Musculoskeletal, Vascular [5-6]. Low back pain in pregnancy is generally described to the many changes in load and body mechanics that occur during the carrying of a child. Rodacki et al showed that the spines of pregnant women with low back pain compress more after activity than pregnant women without back pain and those who are not pregnant, 4.57, 4.23, and 3.99 mm respectively. It has been suggested that the hormone relaxin increases 10-fold in concentration during pregnancy [7,8,19] .Physiological adaptation includes a profound increase in body mass, retention of fluid and laxity in supporting structures.

Recent research has focused on the importance of activation of muscles for motor control and stability of the lumbo-pelvic region, and a theoretic model of pelvic function has been developed on the basis of anatomic and biomechanical studies. This model introduces the self-locking mechanism of the sacroiliac joints

with the principles of form and force closure.[9]. In this dynamic process, muscle slings are in connection with ligamentous and fascial structures described to contribute to stability.

Laxity in the supporting tissues either pre-existing is the source of muscle strain during the actual birth. The lower back muscles are used, along with the pelvic muscles and abdominals during a vaginal birth as well as caesarean.[10] Low endurance of back and hip muscles has been reported postpartum in women with longstanding PGP and lumbar pain.[11] Back extensors, abdominals and hip extensors are important muscles of force closure and stabilizing exercises improves muscle function, pain and functioning in women with PGP[9].

Specific stabilizing exercises programs in women with post-partum pelvic pain improved functional status and reduced pain (Stuge et. al 2004). Strengthening of core stability muscles (Multifidus, Erector Spinae) is must for treatment and prevention of low back pain in post-partum period. Therefore initial stabilization exercises are directed toward these muscles, which can control individual segmental mobility[10]. This will facilitate neuromuscular coordination, enhance endurance, strength and also emphasize the smaller postural stabilizer (Weinstein et al., 1998).These muscles are not only involved in moving the spine, but are also responsible for transferring load directly between the thoracic cage and the pelvis[10] .

Proprioceptive neuromuscular facilitation (PNF) is the therapeutic intervention used in rehabilitation which was originally developed to facilitate performance in patients with movement deficits. Proprioceptive neuromuscular facilitation (PNF) exercises are designed to enhance the response of neuromuscular mechanisms by stimulating proprioceptors[13] .

There are different forms of PNF exercises. Two commonly used forms are rhythmic stabilization training (RST) and combination of isotonic exercises (COI) [14]. The RST technique uses isometric contraction of antagonistic patterns and results in co-contraction of the antagonists if the isometric contraction is not broken by the physical therapist. The COI technique is another form of PNF exercise used to evaluate and develop the ability to perform controlled purposeful movements. It involves the performance of alternating concentric, eccentric, and isometric contractions and is used to treat deficiencies in strength and range of motion. [15]

PNF patterns have been found useful on rehabilitation of several neurological disorders but their effect on muscle performance has not been exclusively studied in lumbo-pelvic pain after pregnancy. To date, information on the effectiveness of dynamic and combined static contraction exercises of trunk muscle stabilization and strength is lacking. The purpose of this study is to examine the effects of modified PNF techniques, RST and COI on dynamic and static trunk muscle endurance in post-partum women and also compare PNF techniques to conventional treatment i.e. with stabilization exercises for local muscles. Also the purpose of the study was to compare the set of lumbo-pelvic stabilization exercises and the proprioceptive neuromuscular facilitation program in women with postpartum lumbo-pelvic pain.

II. Method

2.1 **Subject's Criteria**

This study was carried out on 30 female patients, out of which 27 continued the study and other drop out in between the study and the patient was collected from MMG women district hospital,Ghaziabad. Their ages ranged from 20-35 years old, the number of parity not more than three times i.e. Multiparous or primiparous, positive pelvic mobility test/pain provocation test/ positive active SLR test, gansalens test positive, back pain since last 6 months of delivery and persists in postpartum period were included and was excluded if history of trauma to low back e.g. fractures, surgery of lumbar spine and hip, radiculopathy, spondylolisthesis, any systemic diseases of locomotor system, and rotational torsion or forward/backward torsion of SI joint.

Patients were informed that results drawn out of study will facilitate them to measure their performance and help in further enhancing the variable that improve their performance. A written consent form was taken from the patients who volunteered for the study and fulfilled the inclusion and exclusion criteria of the study.

2.2 Inclusion Testing

7 test for the selection of the patient were done namely [16-19]

1. ACTIVE SLR
2. POSTERIOR PELVIC PAIN PROVOCATION test
3. GAPPING test
4. PATRICK test
5. SACRAL test
6. Pain at isometric adduction of hip
7. Pain at isometric abduction of hip

Out of these atleast 3-4 test should be positive and then patient is included in the study.

Subjects were randomly selected for the study and by convenient sampling assigned to 2 different intervention groups: Group A received lumbo-pelvic stabilization exercises, Group B received PNF training for the back pain.

2.3 Outcome Measures

Demographic variables of all subjects, such as age, height, and weight were recorded. All subjects underwent a detailed orthopaedic assessment. A baseline measurement of dependent variables was taken on *curl-up test, Sorenson test, Quebec back pain disability score and Numeric pain rating score*

Trunk flexor strength [14,15]: The endurance of the abdominal muscles was measured with the curl-up test. In particular, the subjects were asked to lay supine with the knees at an angle of 90 degrees and with arms straight at the sides of the body and pointing toward their knees. The subjects were instructed to curl up with straight arms pointing toward their knees until their iliac crests were raised from the table and to hold this posture for a maximum of 240 seconds. During the test, maintenance of performance was inspected visually. The test was terminated when the subject could not maintain the same position. The recorded time for the test was used for further analysis.

Trunk flexor endurance : To measure the trunk extensor endurance, Sorenson test position was maintained and from this position repetitions are done as many as possible at a rate of 25 per minute to a maximum of 25.

Trunk extensor strength [15]**:** Trunk extension endurance will be measured by use of a modification of the **Sorensen back extension test**. The participants will lie face down along the platform. Velcro straps will be used to stabilize the buttocks and the mid-thigh of the subjects, and their calves will be held by the physical therapist. Patient iliac crests will be positioned at the edge of the platform In particular, for static endurance assessment, the participants maintained a horizontal position for as long as possible for a maximum of 240 seconds with no rotation or lateral shifting. The test will be terminated when the upper torso dropped below the horizontal.

Trunk extensor endurance: To measure the trunk extensor endurance, Sorenson test position was maintained and from this position repetitions are done as many as possible at a rate of 25 per minute to a maximum of 25.

Pain: Pain assessed by Numeric Pain Rating Scale (NPRS). NPRS is a scale that allows continuous data analysis and uses a 10cm line.

Functional Performance: Patient will be asked to fill Quebec back pain disability score according to the restriction of daily activities.

2.4 Treatment

Both the groups were given Infrared radiations as hot fermentation for 15 minutes for muscle relaxation.

GROUP –A was given lumbo-pelvic stabilization exercises.

After receiving IRR for 15 minutes, each patient performed the following exercise program every day for 1 month except on Sunday (24 sessions), repetition of each exercise between 10-15 times(10 times in first 12 sessions after that 15 times at other 12 sessions).Lumbopelvic stabilizing exercises training program consisted of abdominal hollowing ,quadruped abdominal hollowing, ,unilateral abduction ,unilateral knee raise, bilateral knee raise ,unilateral heel slide and bilateral heel slide.

GROUP –B was given PNF techniques

After application of IRR following 2 techniques were applied with total of 15 reps in 1 set total of 3 sets. Patient is given 10 minutes rest in between the two techniques. RST program consisted of alternating (trunk flexion-extension) isometric contractions against resistance for 10 seconds, with no motion intended. COI exercises include concentric, isometric and eccentric contraction of agonists without relaxation. Exercises were performed with the subject in a seated position. Resistance was provided by placement of the hands on the scapula-shoulder-region.

Data was collected prior to start of treatment program, at 2^{nd} week and after the end of treatment session i.e. after 4^{th} week.

III. Data Analysis

The mean and standard deviation of all the variables were analysed. Data analysis was done with the help of SPSS for windows version 16.0 in order to verify the investigations of the study. Independent t-test was used to compare between group difference and repeated ANOVA measures was used to analyze within group difference for all the dependent variables. The significance level set for this study was 95% ($p<0.05$).

IV. Result

Descriptive variables: Demographic details of all the two groups are reported in Table 1. There was no significant difference between the groups on demographic information and the groups were found to be comparable.

Outcome measures of trunk muscle endurance: Table 2 shows the pre intervention readings for the trunk flexor and extensor muscle endurance and strength, numeric pain rating scale and functional performance. Between-group analysis reveals that there is significant difference in trunk flexors and extensors static strength both the groups after 4 weeks of intervention (trunk flexion, t=11.67, p=0.000; trunk extension, t= 10.03, p= 0.00)Fig 5.1 and Fig 5.2 but no significant difference was found between trunk flexor and extensor endurance i.e. dynamic strength (trunk flexion, t=0.32, p=0.07; trunk extension, t=-1.96, p=0.06) as shown in Table 3 and . And with-in group analysis reveals that there is a significant improvement in lumbo-pelvic stabilization group (Group A) and in proprioceptive neuromuscular facilitation group in both static and dynamic trunk extensor and flexor endurance. There is improvement in NPRS and functional performance as shown by mean difference and percentage improvement, Fig 5.3 and fig 5.4.

V. Figures And Tables

Table 1. Demographic characteristics of the subjects of Group A (Lumbopelvic stabilization group) and Group B (Proprioceptive Neuromuscular Facilitation group) at baseline

MEASURES	LPS group (GROUP A) MEAN ± SD	PNF group (GROUP B) MEAN ± SD
AGE(years)	28.28 ± 3.79	27.23 ± 4.81
HEIGHT(meters)	1.56 ± 0.04	1.58 ± 0.121
WEIGHT(kg)	59.78 ± 6.47	64.19 ± 7.06
BMI(kg/m^2)	24.37 ± 2.39	25.64 ± 4.80

LPS Grp: lumbopelvic stabilization group
PNF Grp: proprioceptive neuromuscular facilitation group
SD: standard deviation
BMI: body mass index

Table2.Outcome characteristics of the subjects at baseline of Group A (Lumbo-pelvic stabilization group) and Group B (Proprioceptive Neuromuscular Facilitation group)

VARIABLES	LPS Grp (Group A) MEAN ±SD	PNF Grp (Group B) MEAN ±SD	t-value	p-value
FLEXOR STRENGTH (seconds)	26.99±1.49	27.09±1.70	-0.15	0.87
FLEXOR ENDURANCE (reps)	8.28 ± 2.92	9.15 ± 2.03	-0.88	0.38
EXTENSOR STRENGTH(seconds)	9.84 ± 3.68	9.82 ± 5.38	0.01	0.99
EXTENSOR ENDURANCE(reps)	7.64 ± 2.30	6.84 ± 3.15	0.75	0.45
NPRS	7.39 ± 1.43	7.00 ± 1.13	0.78	0.43

LPS Grp: lumbopelvic stabilization group
PNF Grp: proprioceptive neuromuscular facilitation group
SD: standard deviation
NPRS: numeric pain rating scale

Table3. Comparison of Post-Intervention (after 4th week) scores of outcome variables among Group A (Lumbopelvis stabilization) and Group B (Proprioceptive neuromuscular facilitation).

VARIABLES	LPS Grp	PNF grp		
	Mean ±SD	**Mean ±SD**	**t-value**	**p-value**
FLEXOR STRENGTH (seconds)	84.34 ± 7.89	47.14 ± 8.65	11.67	0.000**
FLEXOR ENDURANCE(reps)	21.42 ± 1.65	19.61 ± 3.20	0.32	0.07
EXTENSOR STRENGTH (seconds)	83.31 ± 6.48	56.37 ± 7.46	10.03	0.000**
EXTENSOR ENDURANCE (reps)	16.00 ± 2.80	18.53 ± 3.86	-1.96	0.06
NPRS	4.14 ± 1.74	4.53 ± 1.76	-0.58	0.56
FUNCTIONAL PERFORMANCE	12.57 ± 7.07	24.46 ± 7.99	-4.09	0.000**

** significant at p≤0.05

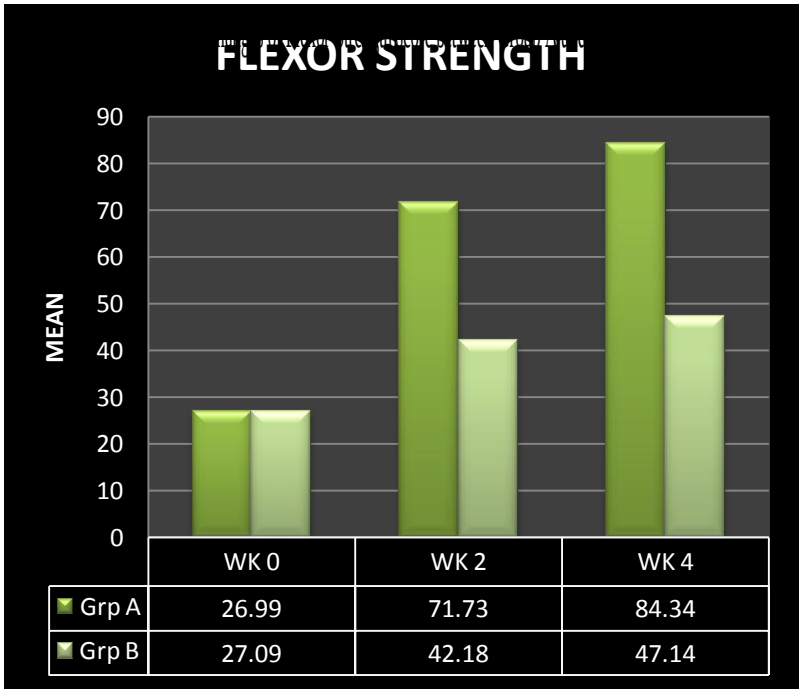

Fig 5.1 Changes of Flexor Strength score between Group A and Group B

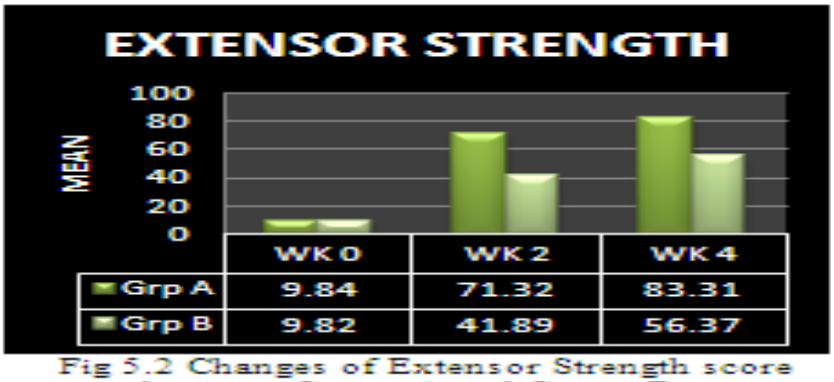

Fig 5.2 Changes of Extensor Strength score between Group A and Group B

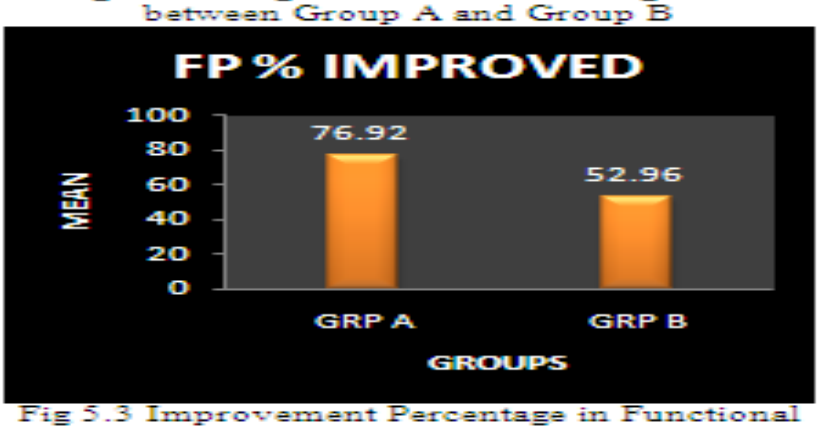

Fig 5.3 Improvement Percentage in Functional Performance Score

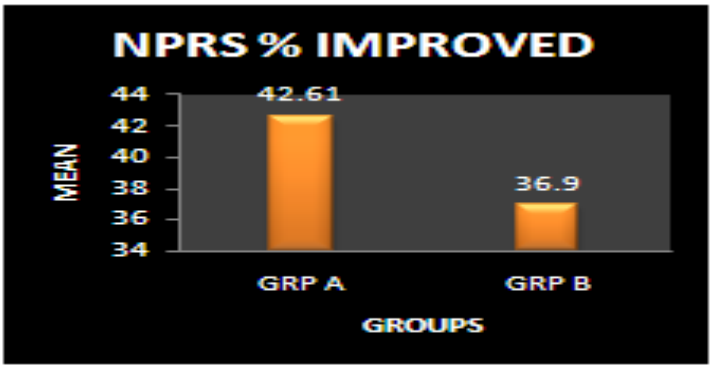

Fig 5.4 Improvement Percentage in NPRS Score

VI. Discussion

The purpose of the present study was to determine the effect of Proprioceptive Neuromuscular Facilitation on muscle endurance, pain, flexibility and functional performance on post-partum low back pain. The findings of the present study suggest that both the lumbo-pelvic stabilization group(group A) and the PNF group(group B) reduces the NPRS(numeric pain rating scale) score and Quebec back pain disability scale and improves the flexor and extensor strength, endurance over the period of 4 weeks.

Comparison of trunk muscle endurance (static and dynamic)

Between group analysis revealed significant differences between lumbo-pelvic stabilization group (group A) and proprioceptive neuromuscular facilitation group (group B) in static muscle endurance i.e. strength of flexors and extensors but no significant difference was found in dynamic muscle endurance of flexors and extensors. The results are in agreement with different studies which conclude that different phases of core stability improves endurance.

Strength increases on the other hand have been more readily observed in several exercise studies (Mannion et al; 2001, Risch et al; 1993) that have used a range of sub-maximal to maximal training to intensity program on lower back. The endurance of back extensors, trunk musculature strength increased during 3 month exercise regimen mostly due to neural drive adaptations[21]. More prominent at the beginning of any training

regimen (related to training specificity and skill acquisition) and have a positive effect on strength performance (Sale,1998). Moffroid et al in 1997 described a series of exercises that increases static mechanical endurance of trunk extensors in sound women over 6 weeks but did not significantly alter the median frequency measure of lumbar muscles, either because physiologic changes did not occur [22] .In the present study trunk flexor and extensor endurance was found to be non- significant as the study was 4 week intervention. This might be due to the less time period of intervention as seen in literature that other studies conducted were of more duration as compared with the present study and might be due to overtraining.

In PNF (proprioceptive neuromuscular facilitation) group (group B), there is significant difference within group in increasing muscle strength and endurance which could be attributed to the dynamic nature of both combination of isotonic exercise, which uses all muscle action types (eccentric, concentric and isometric) through a progressively increased range of motion, and can be related to the static nature of rthymic stabilization technique. Nick et al (2006) showed that 4 weeks of intensive proprioceptive neuromuscular facilitation training for chronic low back pain patients was very effective in improving trunk muscle endurance and strength [14].
PNF training alters fibre type distribution and mean area and that these changes occur in the type II fibre subgroup and follow a unidirectional pattern of transformation (fast to slow). Other studies have also suggested that strength training induces a histochemical fibre type change from type IIB to type IIA [24] In present study, the inclusion of some exercises may contribute the similar findings. the exercises were subject specific i.e. the exercise intensity was a progressively increased and adjusted to each subjects performance; therefore, significant muscle system adaptations were observed at the end of exercise program.

Comparison of pain score

In between group analysis, the findings show that the improvements was marginally better in lumbo-pelvic stabilization group (group A) by 42.61% in 4 week period as compared to proprioceptive neuromuscular facilitation group (group B) 36.90%. According to Koumantakis [25]et al 2001, the decrement in pain perception may be related to the increase in strength performance and the psychological improvements, the patients during the programme, as such improvement have been related to a positive strength performance before. In the study conducted by Stuge et al in 2004[4] ,specific stabilization exercises to women after pregnancy to improve pelvic girdle pain for 8 weeks showed effective in reducing pain, improving functional status and health related quality of life.Hala and Fayiz (2011) [10] conducted a study on women diagnosed with postpartum backache delivered normally, received stabilizing exercises for lumbo-pelvic muscles for 8 weeks and concluded that lumbo-pelvic stabilizing exercises appears to be effective in the management of post- partum backache. According to Kofotollis and Kellis (2006), apart from physical factors, pain symptoms in people with chronic low back pain may be affected by psychological or social factors, which may not be affected easily by a 4 week exercise program [22] .In our study, pain relief was also found at the end 4 weeks in proprioceptive neuromuscular facilitation (group B) was due to the addition of proprioceptive neuromuscular facilitation exercises. This can be linked to increased trunk muscle endurance.

Comparison of the scores of Quebec back pain disability scale

In between group analysis depicts significant differences among the groups when the scores measured before and after the intervention. Increasing the functional performance of patients with low back pain is a desirable and tangible outcome to researchers but most importantly to patients. this agree with Richardson and Jull(1995)[26] who reported that the specific sub-maximal training of lumbar stability muscles of lumbar spine and integration of this training into functional disability in patients suffering from low back pain.
Also functional disability improved was in association with the study of Stuge and Laraeum (2004) [4] who also uses the Oswestry disability questionnaire and found that specific stabilizing exercises was considerably more effective in improving functional status and improving health related quality of life as compared with an intervention without specific stabilization exercises. In the present study, Quebec back pain disability scale was used instead of Oswestry disability questionnaire. The Quebec back pain disability scale was used by Leonie et al (2001)[28] to measure the disability during pregnancy. In within group analysis the functional ability measurement showed statistical significant improvements in both the training groups; in this study lumbo-pelvic stabilization group (group A) demonstrated better improvement in mean percentage in functional ability by 76.62% as compared to proprioceptive neuromuscular facilitation (group B) 52.96%.

Relevance to clinical practice

In constructing programs for conditioning and rehabilitation particularly endurance regime for postpartum back pain. One should incorporate exercises that improve joint position sense, enhance dynamic stability and improve reactive neuromuscular control. This could be achieved by interventions provided in the study. The further studies can be done only for caesarean section deliveries or only for normal deliveries and both the techniques can be applied on two consecutive days rather on the same day and for longer duration with

appropriate follow up. Correlation between pain and strength and functional test can be done as another relevant study.

VII. Conclusion

Lumbo-pelvic stabilization exercises proved to be better in improving muscle endurance (both static and dynamic) and quality of life, in decreasing pain significantly than the two dynamic and static techniques of PNF in post- partum lumbo-pelvic pain. Thus, the alternate hypothesis was partially accepted.

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