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Comparison of Hip Extensor Strength and Lumbopelvic Stability in persons with Non Specific low back pain vs normal healthy persons: An Observational Study

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Abstract
Background: Persons with LBP (LBP) avoid painful trunk movements. Also hip spine interaction gets disturbed in LBP. Conventional treatment has emphasized on transversus abdominis and multifidus. But hip extensors have received very little attention.
Objective: To assess lumbopelvic stability and hip extensor strength in persons with non-specific LBP & normal healthy individuals.
Study Design: Cross-Sectional Observational Study
Study Setting: Pain Clinics
Participants: 50 healthy individuals and 50 with Non-Specific LBP
Interventions: It was an Observational Study. Ethical Committee approval was taken. 110 persons were divided into 2 groups: Group A (control group) and Group B (LBP Group). Training of Abdominal Draw-In Maneuver was given using pressure biofeedback for 3 days and assessed using Sahrmann's Test. Isometric hip extensor strength was assessed using Isokinetic dynamometer. Data was analysed using Wilcoxian Signed-Rank Test and Mann-Whitney U Test**.**
Outcome Measures: Sahrmann's Lumbopelvic Stability Test and Hip Extensor Peak Torque
Results: Lumbopelvic stability of LBP group was significantly lesser than control group. Between group comparison of dominant as well as non-dominant limb torque did not show any significant difference.
Conclusion: Lumbopelvic stability was significantly lesser in persons with non-specific LBP group. In across group comparison, hip extensors strength did not show significant difference in dominant as well as non-dominant limb.

Keywords: Hip extensors, Lumopelvic stability, Non-Specific LBP Abbreviations: LBP: LBPM

Introduction
Stability and movement are critically dependent on co-ordination of muscles of lumbar spine. Although recent research has advocated few muscles (in particular transverus abdominis and multidus all core muscles are necessary for optimal stabilization and performance [1].

Lumbar stabilization also referred as internal stabilization is achieved by isometric contraction of abdominal and lumbar muscles to maintain stability. Two deep muscles, the transversus abdominis and lumbar multifidus, are important for this spinal segment stabilization. It was also suggested that co-contraction of these deep muscles must be performed without involvement of the rectus abdominis or external oblique muscles, which are overactive in patients with LBP [2].

Nonspecific LBP presents a major clinical problem because of likelihood of high cost, limited activity levels, and recurrence. Recent literature supports that recurrent, nonspecific LBP is result of inefficient neuromuscular control of the transverse abdominus muscle [3]. According to Reiman *et al*. (2009) [4]; LBP is a multifactorial dysfunction with one of the potential contributors being the hip joint. The biomechanical-specific link between hip joint and lumbar spine has been described as hip spine syndrome (HSS). HSS specifically depicts the influence of pathological hip joint on the alignment of the spine and subsequent muscle length and joint forces.

Patients who suffer from LBP often avoid painful movements and subsequently have reduced activity of gluteus maximus and decreased muscle endurance through disuse [5]. LBP has been associated with changes in hip extensor recruitment pattern and disturbed lumbo-pelvic rhythm [10]. Delayed recruitment or weak activation of the gluteus maximus induces compensatory overload stresses on lumbar spine and simultaneous overactivity of thoracolumbar erector spinae [6]. Also kinesiological studies have proven that recruiting hip extensors without abdominal draw in maneuver recruits erector spinae 3 times more than with abdominal draw in [6].

Studies by Nadler and colleagues [7] (2000, 2001) confirmed the association of hip extensor weakness and LBP in female athletes; interestingly, however, the researchers did not find such an association in male athletes. Also studies by Nadler (2000) have determined relationship of previous lower extremity (LE) injury and/or LBP (LBP) on hip abduction and extension strength. But the non-athletic population has not been addressed.

Gluteus maximus has also been found to fatigue faster in participants with LBP (Kankaanpää *et al*., 1998) [8] with avoidance of aggravating movements of lumbar spine leading to subsequent deconditioning of back and hip extensor muscles. The finding of increased fatigue levels in gluteus maximus highlights the need to incorporate this muscle in LBP rehabilitation.

AIM: To compare hip extensor strength and lumbopelvic stability in persons with non-specific LBP and normal healthy persons.

Objective: To investigate core strength and hip extensor strength in persons with and without non- specific LBP & hence compare them. Second objective being to assess the effect of leg dominance on hip extensor strength in persons with non-specific LBP and normal healthy persons.

Methodology

This observational study was conducted after approval was obtained from Institutional Ethics Committee. Anonymity and confidentiality were assured and all procedures were performed in compliance with relevant laws and institutional guidelines.

Participants

A total of 110 participants were included in the study. The participants were screened as per inclusion & exclusion criteria. The criteria for inclusion being: age of 20-40 years, normal BMI i.e 18-24.9kg/m^2, subacute non-specific LBP with VAS $\leq$3 &Centralized pain. Any past/present neurological; musculoskeletal or cardiopulmonary disease, hip flexion contracture, scoliosis, previous back surgery, persons with gait deviations, back pain due to sacroiliac and hip joint pathology, positive slump test & red flag signs were excluded.

Participants were selected according to selection criteria by convenience sampling method and selected participants were explained about detailed procedure of the study and after which written, informed consent was taken from them in the language best known to them. Demographic data was collected and LBP assessment was done. The core assessment was then done using pressure biofeedback unit and hip extensor torque was calculated using Biodex dyanamometer.

Outcome measures

Abdominal bracing maneuver [9]

Fig 1: Method of core activation using pressure biofeedback unit

With the participant in hook lying position, an air filled pressure sensor of pressure biofeedback unit was placed beneath participant's lumbosacral spine. Pressure biofeedback unit cuff was inflated upto 40 mm Hg and dial was held in participant's hand to observe the pointer. Participant was instructed to brace his/her abdomen such that to prepare himself or herself to protect from punch in his /her gut. While doing so they were asked to raise pointer from 40 mmHg to 50 mmHg. The participant was asked to contract his/her abdominal muscles by pulling the navel toward spine and then perform the limb motion as per Sahrmann's grading. Participant had to maintain contraction of abdominal muscles and avoid distension of abdomen by keeping the back flat and was instructed to breathe normally during exercise. Participants were asked to maintain this rise in pressure for 10 counts and repeat the same procedure for 10 times by placing the fingertips on each side of ASIS, to monitor the contraction of transversus abdominis. Participants underwent training for core recruitment by abdominal bracing technique with pressure biofeedback for 3 days. Pressure biofeedback unit is valid & reliable for its clinical use [10]. Assesment of Lumbopelvic Stability was done after training & graded using Sahrmann's Test. On third day, participants were assessed using Sahrmann's Test for Lumbopelvic Stability [11] using pressure biofeedback unit. Once the patient could correctly perform 10 repetitions at easiest level, he/she would be progressed to next level.

For the ease of statistical analysis the levels of Sahrmann's Lumboplevic stability were assigned numbers and then statistical tests were used. The numbers assigned to each level were as follows:

Sahrmanns Level Grading	Number assigned
0.3(E1)	1
0.4(E2)	2
0.5	3
1A	4
1B	5
2	6
3	7
4	8
5	9

Isometric Testing of Hip Extensors

Fig 2: Assessment of isometric hip extensor strength using Isokinetic Dyanamometer Biodex-4Pro

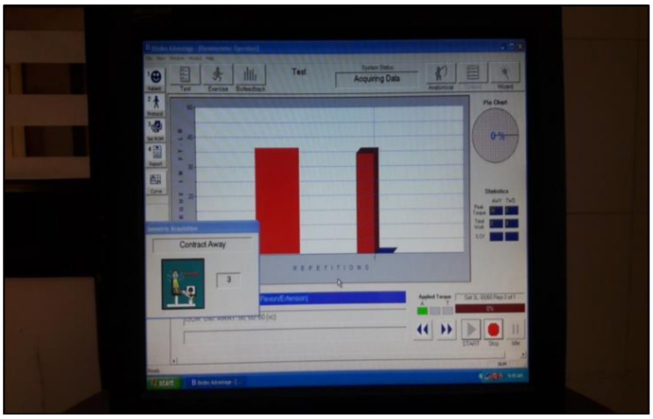

Fig 3: Computer screen displaying the peak torque during testing of isometric hip extensor strength

* The figure 1 & 2 demonstrates the methodology of the outcome measures, for which the participant had provided consent for publication. The individual in this manuscript has given written informed consent to publish these case methodology details. Before testing isometric muscle work of hip extensors; submaximal warm up (cycling and stretching) was given to the participant. Isometric hip extensor peak torque was recorded using Isokinetic System-Biodex 4 Pro. Participant was positioned in supine lying with pressure biofeedback inflatable cushion kept under lumbar spine and hip to be tested was at 60 degrees of flexion. The use of loose comfortable clothing was ensured. The thigh was strapped up and rested at hip attachment accessory of the dynamometer. The participant was asked to maintain the abdominal draw in keeping the mercury level constant at 40mmHg. The participant was given a brief, accurate, simple and well-timed command and was instructed to "press and hold" the hip attachment for 5 seconds while maintaining the abdominal draw in; thereby preferentially recruiting the hip extensors isometrically. Following the trial, 3 test repetitions was done and the highest peak torque was recorded. The maximum torque i.e. peak torque during isokinetic movements is a measure of muscular force applied in dynamic conditions [12]. For data normalization, peak torque was divided by body weight as literature has stated that muscle force is directly proportional to cross sectional area of muscle [13].

Determination of Leg Dominance: As per literature, dominance has a role in relationship with the muscle strength. The determination of leg dominance is yet debatable. Previous studies has assessed the leg dominance by method of leg preferred to kick the ball [14] Thus leg dominance was assessed by leg that was preferred to kick the ball and dominant side was recorded.

Data Analysis

The data was analysed using SPSS Software with significance at $p<0.05$, 95% confidence interval. Normality distribution was tested using Shapiro-Wilk test. Since sample data did not pass the normality test, non- parametric tests- Mann whitney U Test & Wilcoxian Signed Rank test was used. The comparison between groups of baseline characteristics such as age, BMI were analysed using Unapired t- test.

Results

Table 1 shows patients' enrolment and allocation with no patient drop-out. Statistical analysis of the demographic data, including gender, age & BMI found no significant differences between the groups, which showed they were comparable (*Table 1*). Also leg dominance was found to be right for most individuals in control as well as LBP group.

Table 1: Demographic Data (Age & Bmi): Mean+Sd

Characteristic	Control Group(n=55)	Intervention Group(n=55)	t value	p value	Statistical Difference
Age (years)	Mean±SD: 30.27±6.11	Mean±SD: 30.09±6.07	0.1566	0.8759	Non- Significant *
	Range: 20-40	Range: 20-40			
BMI (kg/m^2)	Mean±SD: 22.03± 2.26	Mean±SD: 22.64±1.97	0.1323	1.5167	Non- Significant *
	Range: 18.5-24.9	Range: 18.5-24.9			

*The above table represents the demographics of Age & BMI showing non-significant changes, thus indicating similar baseline parameters.

Table 2: Comparison of outcome measures (scores of within-group & between-group comparison)

	Group A (Median)^A	Group B (Median)^A	p- value	Significance
Core strength (sahrmann's grade)	4 (1A)	2 (0.4-E2)	0.0091	Highly significant *
Hip extensor strength (dominant leg) group a vs group b	35	35	0.4104	Not significant †
Hip extensor strength (non-dominant leg) group a vs group b	39	41	0.7043	Not significant †
Hip extensor strength Control group- a	**Dominant leg (median)^b**	**Non-dominant leg (median)^b**	**P- value**	**Significance**
	35	39	0.0071	Highly significant ‡
Hip extensor strength LBP group- b	35	41	0.0001	Exremely Significant ‡

^{a}Analysed by Mann Whitney U Test

^{b} Analysed by Wilcoxain Signed Rank Test

* Core strength of Non-Specific LBP group was significantly less than the control group.
† Hip Extensor comparison between Group A & Group B revealed no significant difference.
‡ Hip Extensors when compared within groups revealed that strength of non-dominant leg was more than dominant leg in both the groups.

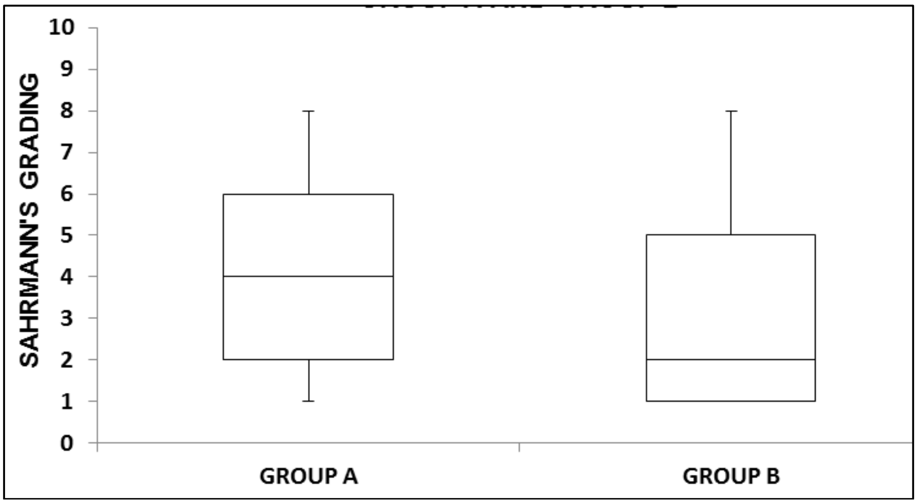

Fig 1: Between Group Comparison of Core Strength In Group A And Group B

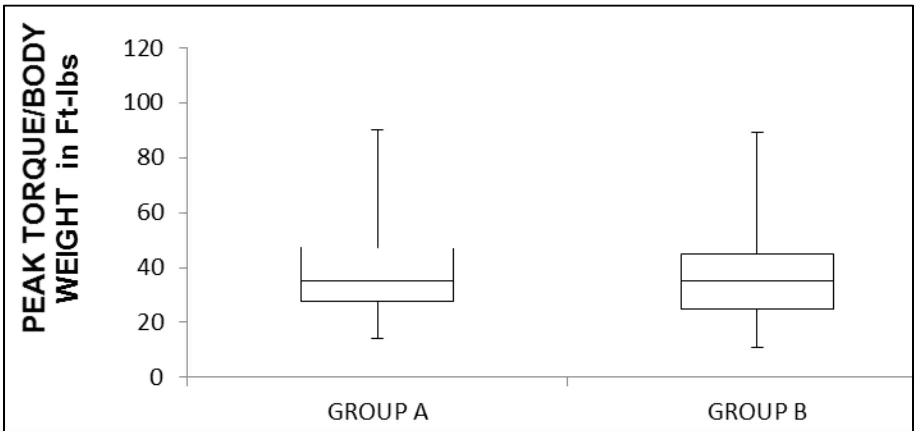

Fig 2: Between Group Comparison of dominant leg torque in group A Vs group B

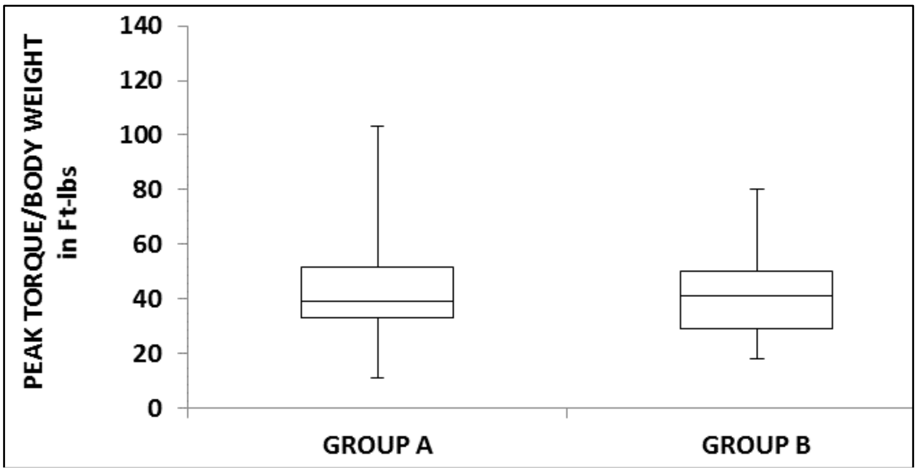

Fig 3: Between Group Comparıson of hıp extensor strength of non-domınant leg ın group a vs group b

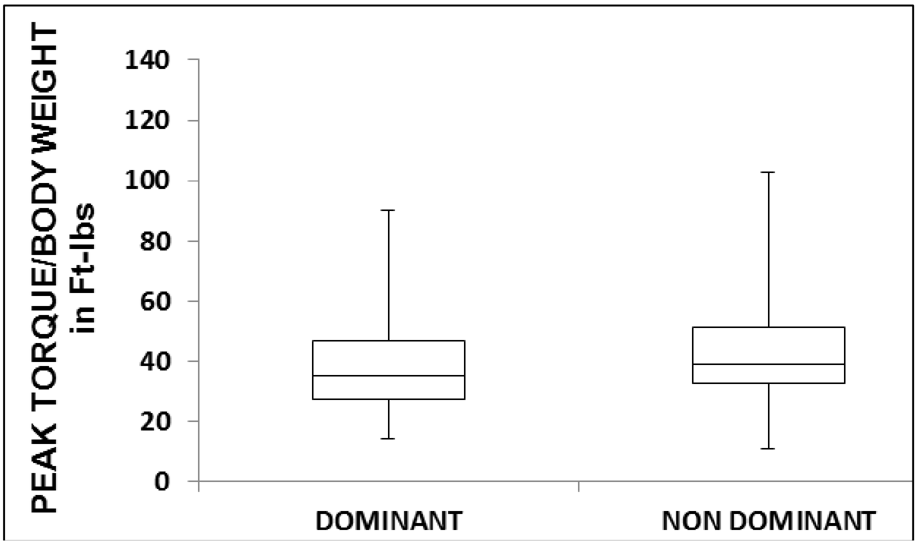

Fig 4: Within Group Comparison of hip extensor strength in control group

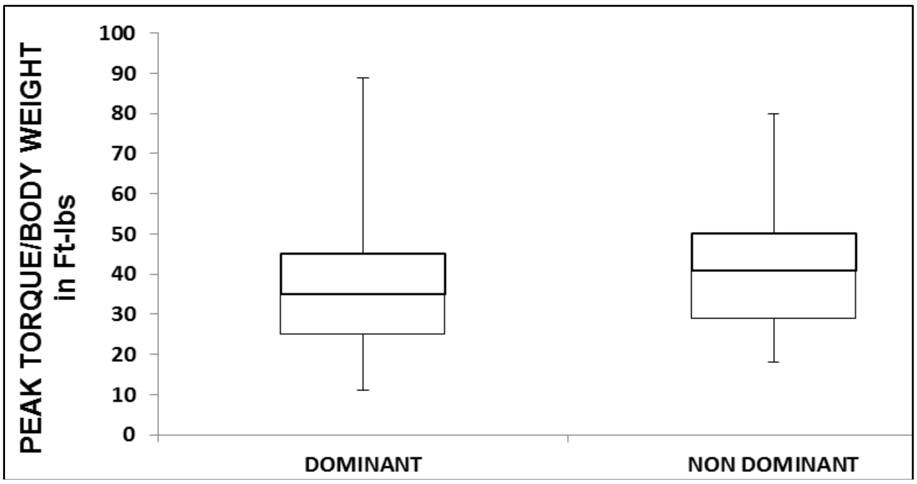

Fig 5: Within group comparison of hip extensor strength in persons with non-specific lbp

The results summarized in Figure 1 and Table 2 indicates that though the range within which participants could perform core was same in both groups, there was a statistically significant difference ($p<0.05$) with core strength being significantly less in Non-Specific LBP Group (Group B).

Table 2 with Figure 2 & 3 thus represents that there was no statistically significant difference ($p>0.05$) in the dominant leg as well as non-dominant leg hip extensor strength between Group A (Control Group) and Group B (Non-Specific LBP Group).

Figure 4 & Table 2 shows that indicates statistically significant difference ($p<0.05$) in hip extensor strength between dominant and non-dominant leg in Group A. By examining median, hip extensor strength of non-dominant leg was more as compared to the dominant leg in Group A (Control Group).

Figure 5 & Table 2 shows statistically significant difference ($p<0.05$) in hip extensor strength between dominant and non-dominant leg in Group B. By examining the median hip extensor strength of non-dominant leg was more as compared to the dominant leg in Group B (Non-Specific LBP Group).

Discussion

As described in table 2, the core strength in the non-specific LBP was significantly less than control group. In persons with LBP, the transverse abdominus muscle does not activate in advance as it has delayed onset timing when compared with asymptomatic individuals [15]. Also there is pain-related changes in muscular recruitment which causes changes in recruitment of trunk musculature and also the sensorimotor integration is disturbed, thus hampering corrective responses. Many studies have showed a reduced trunk muscle force in LBP patients as compared to healthy controls. This is not only caused by a lack of maximal activation but also wasting of extensor muscle mass and a loss of type II fibers that has been demonstrated [16]. This could be the llikely reason why core muscle strength was less in LBP group.

Table 2 shows that there is no significant difference in the isometric hip extensor strength of dominant as well as non-dominant leg when compared between Group A and Group B. Thus hip extensor strength has no difference when compared within groups.

Age, gender and BMI play an important role for the strength production of the muscle. Normalization of the hip extensor torque was done considering body weight of the person. To achieve a normalized distribution a fixed age group of range 20-40 years was chosen and BMI was kept within normal limits.

Yet,the likely reason for no difference in the strength could be due to the reason that duration of back pain being in subacute stage, probably not a sufficient duration to weaken hip extensors. Also, as VAS was≤3 it would have not affected strength of hip extensors. The function and properties of gluteus maximus may be altered when there are changes in kinetic chain of the lower limb. Wilson *et al* in 2005 found that the activation level of gluteus maximus was found to be highest when a full squat exercise was performed i.e. the outer range [5]. But in this study, muscle was tested at 60 degrees i.e. middle range as it is the position of non-specific advantage as there is optimum length-tension relationship.

Table 2 shows isometric strength of non-dominant limb was more than dominant leg in Control group as well as LBP Group. Limb dominance is related to the notion that two hemispheres of human brain are functionally dissimilar. Previc's neurodevelopmental theory states that no limb is clearly dominant limb i.e, one foot gives postural support while other executes voluntary (mobilizing) action (e.g.kicking a ball). But other aspect of Previc's theory is the notion that antigravity extension (postural support) on left side of body emerges before voluntary motor control (mobilization) on the contralateral (right) side. This suggests that dominant foot for either unilateral or bilateral task behaviors is left one for most individuals. Chibber and Singh [17] who reported that in humans, left lower limb was heavier. Cross sectional studies also indicate that, left leg tends to be longer and heavier. This could be the likely reason of why strength of non-dominant leg(mostly left) could be more than that of dominant leg(right leg) [14].

Conclusion

The study had some important findings: core strength was significantly less in persons with subacute non-specific LBP thus indicating that core becomes weak even in the early duration of LBP. Hip extensor isometric strength of non-dominant lower extremity was significantly more than dominant lower extremity in normal healthy persons as well as persons with non-specific LBP. This draws attention towards the questionability of leg dominance herey. Across group comparisons of hip isometric strength did not show any significant difference in the dominant limb as well as non-dominant limb, thus signifying that hip extensors doesn't weaknen uptill the subacute stage of Non-specific LBP.

Key Points

- Core muscle gets inhibited as early as subacute stage of back pain. Thus core training should be emphasized and made a part of early rehabilitation program.
- Hip extensors is a part of core but the hip extensor isometric strength does not get affected in subacute non-specific LBP participants.

Conflict of interest: None Declared

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