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Time spent standing as indicator for benefit from core stabilization program in patients with spine pain: preliminary prediction from a case series

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Purpose: A large number of patients seek physical therapy for spine pain (low back pain, cervical pain, or both). Due to variability and differing demographics, patients sometimes fail to fit neatly into a treatment-based classification category. The purpose of this study was to describe which variables would potentially enable a therapist to predict if a patient with spine pain would benefit from a stabilization exercise program. **Measures/Interventions**: Patients with spine pain for greater than 3 months were included. Predictive and outcome variables were recorded and patients were each given a similar spinal stabilization program. T-test and correlation tests were performed after 4 weeks to determine which variables could potentially predict improvement. **Outcomes**: Only the amount of time spent standing in a day showed an association to improvement (p-value < 0.05). The average time spent standing for the improved group was 167 minutes and 50 minutes for the non-improved group. The LSI and the Orebro showed no association with the Double Leg Lower test, but did demonstrate a positive correlation with pain scores. **Conclusion**: How long a patient stood during a typical day was the only variable that had an association with improvement following a 4-week spinal stabilization program. The group that improved spent more time standing than the non-improved group. Future studies could utilize these findings to determine if the results are consistent in larger sample sizes, and whether there are cutoff values for standing times. **Clinical Relevance**: If standing times truly are predictive of improvement with a stabilization program, prescription of standing could be utilized to improve outcomes in patients with spinal pain.

Key Words: *LBP, cervical, neck, standing, case series, Double leg lower, DLL*

Introduction

Low back pain affects two-thirds of Americans, and neck pain affects one-fourth. [1, 2] With these proportions, many patients that seek physical therapy treatment will have cervical pain, low back pain, or both. There is an array of treatment options available for these patients, with differing results from one patient to the next. Using a treatment-based classification process to group these individuals further helps to pinpoint the most appropriate treatment plan, but there will always be those that fail to fit into one category and benefit. This is because individuals differ in demographics, medical history, etc., which can result in differences in healing times, illness presentation, etc. This causes increased difficulty with placing a patient into a treatment-based category.

Treatment-based categories for the back include: manipulation, stabilization, specific-exercise and traction.[3] Categories for the neck include: pain with mobility deficits, radiating pain, headache, and pain with movement coordination. [4] Each category has a specific set of characteristics that help with differential diagnosis and with choosing the best treatment plan. Some patients meet all the characteristics in one category, but there are some that meet criteria in multiple categories or in the incorrect category. While the literature overall shows an improvement in outcomes with the use of a classification system, there are still patients that do not show improvements. Apeldoorn, et. al. reports that 75% of their patient population fit into only one category when grouping low back patients according to the classification system. [5]

There is a lack of research with high levels of evidence for decision making tools for patients with low back pain that would enable therapists to further categorize patients into the best treatment prescription. [6] As of 2008, research concerning clinical prediction rules for low back pain included studies that were in the early stages of research, with small sample sizes and lack of blinding. [6] For the cervical population, there is also a lack of high quality research for a specific treatment approach for those with chronic neck pain. [7] While studies do indicate that strengthening and stabilization is beneficial to patients with neck pain, there are few high quality studies that specify which exercises are the most beneficial, and to which patients. [7] Further research in this area, as well as in the area of low back pain would be useful.

Core stabilization exercises, which target the "core" – muscles from our hips to our neck - have been shown to decrease pain and decrease the risk of future injury in patients with low back pain. [8] There is mixed evidence for the use of stabilization exercises to reduce pain in those with whiplash-associated disorders, and limited research on the use of stabilization exercises for those with other cervical disorders. [9]

With therapists frequently seeing patients with spinal pain (patients with cervical pain, lumbar pain, or pain in both areas), prognostic information that could steer therapists in the right direction on which treatment plan would be the most beneficial would be extremely advantageous. The therapist's, as well as the patient's, number one goal is to see quick recovery and improvement. By being able to better classify patients into the stabilization category of a treatment-based classification system, and further predict which patients would benefit from a core stabilization program, we would potentially see quicker and better outcomes. The purpose of this study was to describe which variables would potentially enable a therapist to predict if a patient with spine pain would benefit from a stabilization exercise program.

METHODS

Overview

A prospective case series was conducted on patients that presented with spine pain. New and current patients were recruited at either week 1 or 2, giving all participants at least 4 weeks of data by end of week 6. All patients that met the inclusion criteria and the exclusion criteria were asked to participate. Inclusion criteria consisted of ability to exercise and attend therapy for at least two times a week, being between the ages of 21 and 80, experiencing chronic pain for greater than three months, and ability to speak and understand written and spoken English. Exclusion criteria included pregnancy, current or recent fractures or cancers, nerve root or central nervous system involvement and current cardiac conditions. Patients were referred to physical therapy from either their physician, or from worker's compensation.

Measures

Patients that agreed to participate and met all criteria then performed a standardized test and responded to several questionnaires. Each patient was asked to fill out the Lumbar Spine Instability Questionnaire (LSI), Rapid Assessment of Physical Activity (RAPA), the Orebro, as well as answer demographic questions. Pain, using the 0-10 Numeric Pain Rating Scale (NPRS), was also recorded. Questions on how much time they spent standing, sitting and performing strenuous activity was documented. These questions were asked to determine if daily activity or occupation influenced recovery. Thorough examination during the initial evaluation (either before recruitment or during recruitment) was also performed, where range of motion, strength, joint mobility and soft tissue integrity were assessed.

All tests and measures were documented on day one. Demographics were noted only once, but the Orebro, the LSI, the NPRS, and the DLL test were also recorded after 5-6 weeks, depending on when the participant was recruited. Additionally, the NPRS score was also documented after two weeks. Please see Table 1 for data.

TABLE 1: Participant Data

WEEK	1	2	3	4	5	6	7
Weeks in study	6 weeks	6 weeks	6 weeks	6 weeks	6 weeks	5 weeks	5 weeks
Problem area	low back	neck and back	neck and back	neck	low back	low back	low back
Age	71	64	60	25	48	57	75
Sex (1=Male)	1	2	2	2	2	2	2
Race (1=Caucasian, 2=Black, 3=Indian)	1	2	2	1	1	1	1
RAPA1	underactive	underactive regular	underactive regular-light	underactive regular	active	underactive regular-light	active
RAPA2	2	1	0	3	3	0	0
Weight (pounds)	169	190	132	125	134	200	191
Height (inches)	69	67	62	64	64	63	61
Expectation	5/10	10/10	7/10	8/10	9/10	9/10	10/10
Comorbidities	HTN, HBP, arthritis, allergies	Asthma, arthritis, anemia, allergies, HBP, HA, thyroid	RA, HBP, Diabetes, HA	Anxiety, anemia, allergies, HBP, HA	Allergie s, HA	Allergies, arthritis, depression, HBP, thyroid	Allergies, HBP, Diabetes
Smoker (1=Yes)	2	1	2	2	2	2	1
Months with pain	3	15	288	36	29	180	12
Occupation	Investment	retired	retired	student	librarian	child dpment coordinator	realtor
Time in sitting	180	280	350	300	360	300	720
Time in standing	60	200	130	30	120	180	60
Time doing strenuous activity	10	0	0	0	15	0	0
Pain Scale - day 1	3/10	3/10, 6/10	5/10, 3/10	4/10	2/10	7/10	2/10
Pain Scale – post 2 weeks	3/10	2/10, 4/10	5/10	2/10	2/10	5/10	0/10
Pain Scale - end week 6	2/10	2/10, 4/10		0/10	0/10	2/10	0/10
LSI - day 1	7/15	7/15, 11/15	13/15, 13/15	10/15	6/15	12/15	3/15
LSI - end week 6	7/15	4/15, 7/15		5/15	5/15	8/15	4/15
Orebro (/210) - day 1	91	113	145	110	74	128	64
Orebro - week 6	83	78		74	75	99	56
DLL angle - day 1	60	38	55	50	30	90	60

DLL angle - end week 6	45	0		40	0	65	50
+ve result - NPRS	No	Yes		Yes	Yes	Yes	Yes
+ve result – DLL	Yes	Yes		No	Yes	Yes	No
"Improved" (0 = No)	0	1		0	1	1	0

NPRS = Numeric Pain Rating Scale, DLL = Double Leg Lower, LSI = Lumbar Spine Instability Questionnaire, RAPA = Rapid Assessment of Physical Activity, HTN = hypertension, HBP = high blood pressure, HA = headaches, RA = Rheumatoid Arthritis

All measures, except for pain and the DLL test were used as independent variables to determine which would help predict patients that would benefit from core stabilization exercises. The NPRS and the DLL test were the dependent variables in this study. The NPRS was used, as it is a measure that is important to the patients on whether they feel like they have improved or not. The DLL test involved lowering both legs from 90 degrees with the patient's abdominals engaged and their back flat against the table. The goniometric angle right before their abdominals disengaged and the participant's back curved away from the table was recorded. The fulcrum of the goniometer was held at the greater trochanter, with the stationary arm lined up with the lateral side of the abdomen/parallel to the table, and the moving arm lined up with the lower extremities. Only one individual conducted this test in order to improve inter-rater reliability. Based on the work by Krause et al., the DLL test consists of an isometric contraction of the abdominal muscles, and can therefore be used as a part of "a lumbar stabilization program". [10] Ladeira, et. al., also determined that the DLL test has a high re-test reliability of 0.932, but that the construct validity is low when the test is used to assess abdominal strength.[10] Ladeira, et al., reports that the test would be useful though for determining the amount of control the patient has and how well they are able to stabilize their spine. [11] For this reason, this test was used to help determine if patients improved based on an increase in spinal stability; it was used to see if the core stabilization exercises implemented increased the patient's ability to stabilize their spine, and therefore, decrease their pain and disability.

The LSI (both the original form for the low back and a modified form for the cervical spine) was used because of its prior success in predicting which patients with lumbar spine instability would benefit from either graded activity or motor control. [12] The modified version changed any wording that referred to the "low back" for "neck", with the assumption that it would accurately describe the amount of instability in the cervical spine as it does for the lumbar spine. A score greater than 9 indicated low spinal instability. [12] The RAPA provided a glimpse into their physical activity level, which was hypothesized to have a positive relationship with a core stabilization program, since physical activity can influence adherence to a home exercise program and/or ability to perform the exercises. Certain demographics, such as occupation and history of smoking, were asked due to the relationship their occupation and history of smoking may have with causing and/or worsening their recovery/injury. The Orebro predicts long-term disability, with a score above 105 indicating low chance of recovery, and increase chance of long-term sick leave from work. The Orebro was used in this study to see if an association exists between improvement after spinal stability exercises and a patient's chronicity risk, as this would enable therapists to potentially minimize long-term disability.

Intervention

Two therapists, one student, and three rehab aides conducted the interventions for patients. All patients underwent a certain set of exercises that was beneficial to both cervical and/or low back pain. There were also other exercises that were impairment-specific. Starting points were the same for all exercises for all patients, but progressions were made at the discretion of the therapist, depending on the patient's performance and pain levels. The exercises used were prescribed because they are considered standards for core stabilization. Please see Table 2 for a list of exercises performed by all patients, as well as the problem-area-specific exercises.

Table 2: Exercise List and Description

Exercises Performed By All Participants	Starting Sets/Reps/Weights
Warm- up (treadmill, elliptical, UBE or recumbent bike)	5 min
Stretching (upper trapezius, levator, scalenes, ITB, etc.)	3x 30 sec hold
Framing • Patient stands with back against wall with elbows and shoulder at 90 deg. • Patient tries to tuck chin and engage core	5x 10 sec hold
Pulldowns (Core Stix or traditional pulley machine)	1x10 Purple Stix or 5 lbs
Rows (Core Stix or traditional pulley machine)	1x10 Purple Stix or 5 lbs
Stir the Pot • Using Core Stix - flexible, long sticks that are inserted into holes at various degrees to provide resistance with various exercises • This exercise involves engaging the abdominals to keep your body still, while your arms bend the stick to create a circular pattern	1x10 Purple Stix
Opposite Limb Reach	1x10 on ball or quadruped
Ball Toss (on/off rockerboard with rebounder)	2 min with 1 kg ball
Pelvic Tilt/Bridging	5x 5 sec hold
Double Leg Lift	10x 5 sec hold
Lower Spine Specific Exercises	
Balance/Star Routine • Patient stands with one foot on floor or therex pad with a slight bend in knee • Core is engaged while other foot points ahead, to the side, and then behind	2x10
Upright Routine • On ground/therex pad: calf raise, squat, rise from squat, descend from calf raise	2x15
Trunk Extension	5x 5 sec hold
Straight Leg Raise	10x 5 sec hold
Clamshells	2x10 Yellow theraband
Total Gym Leg Press	30x level 10
Upper Spine Specific Exercises	
Cervical Tuck and Lift	10x 5 sec hold

"T"s / "W"s • Patient lies on stomach and with/without hand weights raises arms straight at 90 deg ("T") or at scapular angle with elbows bent ("W")	12x
PNFs (D1, D2 pattern – with or without theraband)	10x
Unloader Shoulder ER/IR	2x10 with 2kg
Body Blades	3x 30 sec
Rhythmic Stabilization • Patient lies on back with shoulder retracted to table and fist straight in the air at 90 deg • Patient tries to maintain shoulder/arm position while it is pushed by therapist in various, unpredictable directions	3x 1 min
Total Gym Perturbations or Shoulder ER/IR	2x10 level 10
Pulleys	3 min

UBE = Upper Body Ergometer, ITB = Iliotibial band, deg = degrees, PNF = proprioceptive neuromuscular facilitation, ER = external rotation, IR = internal rotation

All patients were given home exercises programs that consisted of some variation of the exercises performed in the clinic. Each treatment session was 45 minutes for at least two times a week. Exercises were tracked in charts online to monitor progressions.

Outcome Determination

The minimal clinically important difference (MCID) for pain scores on the NPRS has been found to be anywhere from 2.0 to 4.5 for patients with back and neck pain. [13, 14, 15] For this study, a MCID of 2.0 was used. So, if the patient reported a decrease in pain by at least 2.0 points, then that patient was seen to have a positive result. An increase in 15 degrees on the DLL test was used in this study as a sign of a positive result. Patients were classified in one of two groups: "improved" or "not improved". A patient met the criteria for the "improved" group if they had positive results for both the pain scale and the DLL test. All other patients were classified as "not improved".

Statistical Analysis

T-tests and correlation tests were conducted in order to determine if there were any relationships of the variables to whether the patient improved (in regards to DLL angle and pain).

For patients that had two problem areas, the NPRS, LSI, and Orebro scores were combined and averaged; totals were rounded up. Please see Table 1 for details. RAPA 1 scores, as well as the categorical data, were not included in the statistical analyses. The most common comorbidities across the participants were asthma, allergies and high blood pressure. Please refer to Table 3 for data that was complied for the tests.

Table 3: Data Comparing Groups

Variable	Non-Improved Group (Mear / Range)	Improved Group (Mean / Range)	P-value	t-statistic
Age	57 / 50	56 / 27	0.97	-0.04
RAPA2	1.7 / 3	2 / 3	0.80	-0.27
Weight (pounds)	162 / 66	175 / 66	0.67	0.46
Height (inches)	65 / 8	65 / 4	1.00	0.00

Variable	Non-Improved Group (Mear / Range)	Improved Group (Mean / Range)	P-value	t-statistic
Expectation (/10)	7.7 / 5	9.3 / 1	0.33	1.12
Months having pain	17 / 33	75 / 165	0.34	1.07
Minutes spent sitting in a day	400 / 540	313 / 80	0.63	-0.52
Minutes spent standing in a day	50 / 30	167 / 140	0.01*	4.48
Minutes doing strenuous activity in a day	3 / 10	15 / 15	0.80	0.28
Pain Scale – day 1	3 / 2	4.7 / 5	0.35	1.07
Pain Scale – after 2 weeks	1.7 / 3	3.3 / 3		
Pain Scale – end week 6	0.7 / 2	1.7 / 2		
LSI – day 1	6.7 / 7	9 / 6	0.43	0.88
LSI – end week 6	5.3 / 3	6.3/ 3		
Orebro – day 1	88.3 / 46	105 / 54	0.47	0.80
Orebro – end week 6	71 / 27	84 / 24		
DLL angle – day 1	56.7 / 10	52.7 / 60	0.84	-0.21
DLL angle – end week 6	45 / 10	21.7 / 65		

RAPA = Rapid Assessment of Physical Activity, LSI = Lumbar Spine Instability Questionnaire, DLL = Double Leg Lower, SD = standard deviation

* Statistically significant if $p < 0.05$

OUTCOMES

In order to allow for at least four weeks of follow-up, potential participants were recruited during a two-week period. Seven patients met the inclusion and exclusion criteria; there was one male and two African American participants. Four out of the seven were low back pain patients, two were cervical and low back patients, and one participant had only cervical pain. Ages ranged from twenty-five to seventy-five. For specific demographics please see Table 1. One participant was lost to follow-up due to her inability to attend therapy as a result of being a worker's compensation patient. Her data was not included in the statistical analysis.

When comparing groups of improved versus non-improved, all variables had p-values greater than 0.05, except for time spent standing (p-value = 0.01). Therefore, there is a 1.1% chance that there is no difference between the group that improved and the group that did not improve when assessing the amount of time spent standing. For the non-improved group, the average time spent standing was 50 minutes (standard deviation: 15.28), while the improved group spent an average of 167 minutes a day standing (standard deviation: 41.63).

For the linear correlation tests, both the LSI and the Orebro showed no association with the DLL test, with both p-values greater than 0.1. But, for pain, both the LSI and the Orebro showed positive correlations (p-values < 0.001). (Please see Figure 1 and 2). 72% of the variance in pain scores is explained by the LSI scores (r = 0.85). Please refer to Table 4 for detailed results of all tests.

DISCUSSION

The data shows that the minutes spent standing may predict whether a patient will improve or not with a core stabilization program. With an increase in pain, both an increase in score on the LSI and the Orebro can also be expected.

The Orebro and the LSI showed no association with the DLL test, indicating that the DLL test measured different aspects of spinal instability than the Orebro and the LSI. This is consistent with the fact that the DLL test looks at muscle strength, while the Orebro and LSI are questionnaires that ask about functional activities.

Table 4: Results of All Statistical Tests

Linear Correlation	P-value	Pearson's r Statistic
Pain and LSI	<0.001 *	0.849
Pain and Orebro	<0.001 *	0.870
DLL and LSI	0.142	
DLL and Orebro	0.135	

t-test	P-value	t-statistic
Age	0.970	-0.040
RAPA1	0.802	-0.267
Weight	0.669	0.460
Height	1.000	0.000
Expectation	0.326	1.118
Chronicity	0.344	1.073
Time Sitting	0.628	-0.524
Time Standing	0.011 *	4.481
Time Strenuous	0.795	0.277
Pain	0.346	1.066
LSI	0.431	0.875
Orebro	0.470	0.797
DLL	0.844	-0.209

These results suggest that asking the question "how many minutes do you spend standing?" could provide a glimpse into whether a patient with back or neck pain would benefit from a core stabilization exercise program. This begs to question why those that spent more time standing in a given day demonstrated improved outcomes. This could be due to the fact that mobility in the spine is more beneficial than sitting (decreased activity) and strenuous activity (increased stress on the spine). Standing seems to be healthier for those with spine pain, and could be a result of spinal alignment that corresponds with standing versus the poor posture that is usually associated with sitting. This could also demonstrate that those that stand for longer periods of time increase their ability for spinal stability. This could be due to the fact that more muscle activation is required during standing compared to sitting, thereby resulting in a greater awareness for muscle activation during therapy. And, while the DLL test has no association with the LSI or the Orebro, it can possibly still be useful for increasing spinal stability. Pain, on the other hand, is associated with the LSI and the Orebro. So, these tests could be used to verify a high or low pain level associated with their injury.

Study Limitations

There were some limitations to this study. First of all, the small sample size makes statistical analysis difficult. Although predictive association can be described, the results cannot be used to determine a cause and effect relationship, as this was a case series, not a randomized control trial. Also, during the intervention, there were variations between therapists and when/how to progress the patients since progressions were made at the therapist's discretion. Treatment frequency was at least twice a week, but some patients came to therapy three times a week, which may have influenced results. Follow-up was limited to four weeks, which could have produced different results if patients were shadowed longer. There is also a potential that the DLL did not adequately capture "improvement".

One specific question generated from this case series is whether minutes spent standing in an average day could predict the benefit of a spinal stabilization program in a larger sample size, as well as what the potential cut-off time values would be in order to show improvement. If a cohort study with 100+ patients was conducted on patients with low back pain and/or cervical pain, then a better picture of the association/causation could be determined as confounding factors could be controlled. A longer follow-up time of at least 3 months would be beneficial, as well as continuing to look at other potential predictor variables. Getting a better idea about which patients would benefit the most from spinal stabilization, as well as what factors predict this, would enable faster recovery. Also, by knowing the predictors, therapists and researchers can then begin to question why these factors predict and if these factors are also in some way contributing to the onset of the patient's pain.

CONCLUSION

The purpose of this case series was to determine if any of the included variables had an association with improvement for patient with spine pain. The results of this study suggest that the amount of time a patient spends standing in a given day could predict whether they would benefit from a spinal stabilization exercise program in physical therapy. The results also imply that pain is positively associated with the LSI and the Orebro test. No other associations were found between the other potential predictor variables and whether or not the patient showed improvement. These results could also be due solely to the fact that those that spend more time standing in a given day may just have a better prognosis for spontaneous recovery without physical therapy intervention. The data provides potential hypotheses for further research in this area to identify specific prognostic factors in order to improve prediction of patient outcomes.

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