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How Common is Laterality-Deficits in Patients Attending Outpatient Physiotherapy with Lower Extremity Injuries?

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Abstract

Introduction: Alterations in cortical body maps (body schema), have been tied to the initiation and maintenance of a pain state. One clinical test of altered body schema is left-right discrimination or laterality, which is abnormal in people with chronic pain. To date, the prevalence of these changes in clinical practice has not been studied or reported.

Materials and Methods: Patients attending outpatient physiotherapy for lower extremity injuries were recruited for the study. Following completion of consent and demographic data collection, patients completed two laterality tests of the foot. Mean score of two tests of foot laterality accuracy and speed was collected for each patient. Laterality scores were compared to current normative data to determine patients presenting with abnormal values and which clinical presenting signs and symptoms correlate to abnormal laterality scores.

Results: Forty patients (female 22), participated in the study. Fourteen patients (35%) recorded an abnormal laterality score (speed or accuracy), indicating a relative high prevalence of laterality issues in patients attending outpatient physiotherapy for lower extremity injuries. Older patients and patients identifying as female were more predictive of poor laterality score, compared to other demographic and clinical variables including duration and intensity of pain, immobilization and surgery.

Conclusion: Laterality deficits are common in patients attending outpatient physiotherapy for lower extremity disorders. Older adults and patients identifying as female have a higher chance of recording an abnormal laterality score. Clinicians should recognize this, test for it and use it as a guide in their treatment planning.

Keywords: Pain; Physiotherapy; Laterality; Body Schema

Abbreviations: GMI: Graded Motor Imagery; PT: Physiotherapy; S1: Primary Somatosensory Cortex

Introduction

Traditional pain models often associate injury, various disease processes, inflammation, emotional stressors, etc., with a human's pain experience [1,2]. Emerging neuroscience research has shown that altered body maps (schema) in the brain may also be associated with human pain experiences [3,4]. It is now well established that the physical body of a person is represented in the brain by a network of neurons, often referred to as a representation of that particular body part in the brain or homunculus [5-8]. This representation refers to the pattern of activity that is evoked when a particular body part is stimulated. One of the most studied regions of the brain associated with representation is the primary somatosensory cortex (S1) [5-8]. Body schema is thus an integrated neural representation of the body [9]. These neuronal representations of body parts are dynamically maintained, which plays a significant role in a person's pain experience as well as treatment options [3,10-14]. It is proposed that movement therapy (i.e., exercise, Feldenkrais, yoga, Pilates, etc.) or tactile treatments (i.e., manual therapy, massage, dry needling, etc.), can strengthen these maps, which in turn may ease pain and disability [15-17].

It has been shown that patients with pain display different body schema maps than people with no pain [3,10-14]. Growing evidence additionally supports the notion of these body schema maps expanding or contracting thus essentially increasing or decreasing the body map representation in the brain, most notably in patients with complex regional pain syndrome, phantom limb pain, and chronic low back pain [3,7,18,19]. The clinical importance is that these changes in shape and size of body maps seem to correlate to increased pain and disability [10,20]. Although various factors have been linked to the development of this altered cortical representation of body maps in S1, it is believed that issues such as neglect and decreased use of the painful body part [18], may be a significant source of the altering of body maps [21,22]. A vicious cycle soon emerges between decreased movement, cortical reorganization, and increased pain [18].

In research settings, altered representation of S1 is studied using various forms of advanced brain imaging [11]. In clinical practice, some tests are available to similarly infer changes in the cortical maps, including two-point discrimination, localization, and laterality [15,23,24]. Laterality testing is the process whereby an individual is presented with either a left or right image of an affected body part and they must report if it's left or right [25-27]. In normal, pain-free adults, normative data has been established for hands, feet, back and neck [23,25]. In people experiencing pain, especially chronic pain, there is a delay (slower ability to identify left/right) and less accuracy [25-27]. It has been postulated that cortical smudging of the S1, neglect and pain influence these measures [4]. When laterality is abnormal, a structured, series of laterality treatments (test becomes the treatment), referred to as graded motor imagery (GMI) is used to normalize these measures with the intent to decrease pain and disability [28,29]. Current evidence for GMI for complex pain states is emerging as a evidence-based approach for people in pain [30].

Given that laterality is an emerging approach in rehabilitation and movement science, there are various unknowns. One of the unknowns is what percentage of patients attending physiotherapy (PT) present with laterality deficits? How common is this phenomenon? The aim of this study was to determine what percentage of patients attending outpatient PT with lower extremity injuries present with a laterality deficit? Secondary analysis established if other presenting variables at the initial visit correlated to laterality deficits.

Methods

Patients

The study design called for a convenience sample of patients attending outpatient PT with lower extremity pain (knee, ankle and foot) to be recruited, complete a demographic survey and a laterality test. Institutional review board approval was be obtained from St. Ambrose University for this study. Participation was entirely voluntary, and the patient had to consent to being part of the study. In order to participate, patients must have presented with a primary complaint of knee, ankle or leg pain, over the age of 18 and proficient in reading and writing the English language. Two outpatient PT clinics where two St. Ambrose orthopedic residents worked served as data collection sites. Data was collected at each clinic over a 4-month period.

Instrument

Two distinct data sets were collected per patient

a) Demographics: In line with previous similar studies, demographic data was collected including age, gender, employment status, education background, pain experience, pain rating (numeric pain rating scale), family history of persistent pain, location of pain, amount of sleep per night, amount of exercise per week, if they smoke, weight, height, family history of depression and having had imaging for their leg pain [31,32].

b) Laterality: In order the assess the speed and accuracy of laterality, a laterality application (Recognise™-noigroup.com) was be used for the foot. For testing, patients started a test of alternating foot images with no cofounding background or texture (vanilla feet) for 60 seconds. The program automatically tracked and reported on the speed and accuracy of the test. In line with previous laterality studies [33], two tests were completed by the patient and the mean score used as their final measure. Normative data for accuracy has been reported as > 80% and recognition speed of 2 seconds / image with a standard deviation of 0.5 [34].

Procedure

New patients attending PT with lower extremity pain (knee, ankle and foot) were recruited for the study. Patients were provided with an explanation of the purpose of the study and informed their participation is entirely voluntary. If patients agreed, they were provided a demographic survey to complete and then participated in laterality testing using a tablet with the Recognise™ foot module pre-loaded. Upon completion of each of the two tests, the results were entered onto the paper demographic sheets to ensure demographic data coincide with the relevant patients. Upon completion of data collection, data was entered manually into a Microsoft Excel™ spreadsheet for data analysis by an independent statistician.

Analysis

Microsoft Excel™ was used to enter data into spreadsheets and explore summary statistics such as counts, means, ranges, and percentages. RStudio Cloud version 1.4 of RStudio IDE was used in analysis what variables lead to a "yes" response as to whether the patient scored overall abnormality. Height and weight were originally recorded in foot-inches and pounds. These values were converted to meters and kilograms, then used to calculate each patient's body-mass index. Variables recorded as factors

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with more than two levels were converted into binary variables indicating whether the patient answered "yes" to the variable in question. Additionally, not applicable values were replaced with the mean variable value for numeric variable types, and the most occurring value for factor variable types (binary). Finally, binary variables were converted to factors while remaining observations were kept numeric. Logistic regression was used in determining what variables were the best predictors of overall abnormality. Bayesian Information Criteria was used in determining the lowest-scoring model to find what best predicted overall abnormality. Post-hoc power analysis was used to determine the replicability of the findings and showed a high level of power near 1 with df = 36.

Results

Patients

Table 1: Demographics.

Characteristics	Patients (n = 40)
Mean age (years) (range)	45 (19-93)
Female (%)	22 (55)
Race	
White/Caucasian (%)	31 (77.5)
Hispanic (%)	5 (12.5)
African American/Black (%)	3 (7.5)
Asian American (%)	1 (2.5)
Employment	
Full-time (%)	23 (57.5)
Retired (%)	6 (15)
Part-time (%)	5 (12.5)
Students (%)	4 (10)
Homemaker (%)	2 (5
Educational Background	
Four-year college degree (%)	16 (40)
High school diploma (%)	12 (30)
Post-graduate degree (%)	8 (20)
Other (%)	4 (10)
Social Status	
Married (%)	25 (62.5)
Single (%)	11 (27.5)
Divorced (%)	3 (7.5)
Widowed (%)	1 (2.5)
Currently experiencing pain (%)	34 (85)
Mean duration of pain for those currently experiencing pain in months (range)	8.32 (0.5-60)
Mean pain score (numeric pain rating scale) for those currently experiencing pain	4.4
Experienced pain for more than 6 months (%)	18 (45)
Family member that has experienced pain > 6 months (%)	15 (37.5)
Most Common Diagnoses	
Knee pain (%)	8 (20)
Ankle sprain (%)	5 (12.5)
Foot pain (%)	5 (12.5)
Knee replacement (%)	4 (10)

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Knee meniscus injury (%)	4 (10)
Knee anterior cruciate ligament injury (%)	3 (7.5)
ankle surgery (%)	2 (5)
Achilles' injury (%)	2 (5)
Other (%)	7 (17.5)
Mean body mass index	30.99
Have had surgery before (%)	37 (92.5)
Currently using an assistive device (%)	9 (22.5)
Been in a cast or brace for current lower extremity issue (%)	20 (50)

Forty patients attending outpatient PT for lower extremity pain participated in the study (Table 1). The mean pain rating was 4.4 on the numeric pain rating scale, with a mean duration of pain 8.32 months.

Laterality

Fourteen patients (35%) recorded a score on the laterality test considered as abnormal (> 2.5 seconds per image and/or accuracy less than 80%). Mean speed and accuracy are found in Table 2. Five patients scored abnormal on speed which was also (100%) accompanied by an abnormal accuracy score for those patients. Nine patients scored abnormal on the accuracy test but not abnormal on the speed test. Logistic regression revealed that only age and gender were associated with abnormal laterality scores. Older age (ß =0.05, Pr = 0.06) and being female (ß =1.52, Pr =0.06) was associated with a higher likelihood of scoring an abnormal laterality test.

Table 2: Mean speed (Second) and accuracy for laterality testing.

	Speed: Test 1	Speed: Test 2	Accuracy: Test 1	Accuracy: Test 2
Left	1.73	1.69	86.50%	89%
Right	1.73	1.68	87%	88.90%

Discussion

This is the first study exploring the prevalence of laterality deficits in patients attending outpatient PT for lower extremity pain and /or dysfunction. The results from this study show that laterality deficits are prevalent in one in three patients attending outpatient PT in this study population. GMI, which aims to target cortical changes in the brain associated with pain, has primarily been studied in phantom limb pain and complex regional pain syndrome [18,19,35]. Both these clinical presentations, however, are quite rare [18,19,35]. In recent years, studies started showcasing more and more clinical presentations associated with disturbed body schema, including chronic low back pain, obesity, aging, immobilization and more [36-38]. These studies, however, did not look into the prevalence of these distortions, but rather the presence of altered body schema. The results from this current study are surprising, as it indicates one in three patients attending outpatient PT for a lower extremity injury has some deficit in terms of laterality testing, be it accuracy or speed. This finding is clinically important, as clinicians often view body schema alterations as very rare events confined to a small percentage of patients only presenting with complex pain states such as complex regional pain syndrome or phantom limb pain. In this study, focusing on lower extremity injuries, common conditions such as knee pain, ankle sprain, foot pain and knee replacement presented with laterality deficits. In the US alone over 5 million knee replacements are performed annually [39,40], with many of those patients attending outpatient PT [41]. These results would indicate that laterality deficits, possibly indicative of altered body schema maps, is far more prevalent and can be a significant factor in the initiation and/or maintenance of a pain state in patients attending outpatient PT.

Previous studies have implicated that the presence and intensity of pain, as well as immobilization with a cast or brace is associated with cortical map changes and possibly initiate or maintain a pain state [4,37,42]. In this study, however, this was not found to be the case. Even though this is a small sample size of patients, the presence of pain, intensity of pain, duration of pain, history of undergoing surgery, body mass index, using an assistive device and having been immobilized did not correlate with a poorer laterality test. Older age was associated with poorer laterality scores, which concurs with previous research tying aging to altered body schema [37]. Although pregnancy has been tied to body schema changes [36], gender as a stand-alone has not previously been implicated in altered body schema, warranting further examination.

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The study contains various limitations. First, the sample size is small and larger studies will be needed to extrapolate on the findings. This study focused on lower extremity injuries (knee, ankle and foot) and prevalence for other laterality deficits in PT are unknown, thus cautioning extrapolation of these findings. Laterality is only one clinical measure associated with proposed cortical map changes. Other tests should be done to correlate laterality findings with these tests, including two-point discrimination, localization and even more advanced brain imaging studies. This study, similar to current neuroscience research, infer laterality deficits are associated with cortical body map schema alterations, but future studies will need to be done to strengthen this correlation. Finally, the presence of laterality deficits does not provide information of prognosis or treatment, which must be further explored.

Conclusion

Laterality deficits associated with altered body schema is very common, presenting in one of three patients attending outpatient PT with lower extremity injuries. Older patients and patients identifying as female were more likely to present with an abnormal laterality measurement in PT for a lower extremity injury. Future, larger scale studies are needed to expand on this research including prevalence of other pain states attending outpatient PT and other predictive variables.

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