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Study of Laterality Judgment and Tactile Acuity in Patients with Chronic Unilateral Shoulder Pain: A Cross-Sectional Study

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ABSTRACT

Context: Cortical organization of the painful body region may be disrupted in several chronic pain conditions. The two-point discrimination test (TPDT) and the Left/Right Judgement Task (LRJT) have been used to identify changes in the cortical body schema in these conditions. Whether changes in the cortical body schema are impaired in people with chronic shoulder pain remains unknown.
Aim: To study laterality judgment and tactile acuity in chronic unilateral shoulder pain patients.
Materials and Method: The study included an experimental group of patients with unilateral shoulder pain and a control group of healthy relatives. Shoulder pain intensity was assessed using an 11-point scale (0-10). Tactile acuity was measured with a two-point discrimination test (precision: 1 mm). Laterality discrimination was tested using shoulder images rotated randomly (0, 90, or 180 degrees).
Results: In a study of 86 subjects (mean age 49.16, 28% males, 72% females), no significant differences were found in TPDT, accuracy, or response time between affected and unaffected shoulders within Group A, or between Groups A and B. Pain intensity (NRS) did not correlate with these measures.
Conclusion: Shoulder pain showed no impact on TPDT and LRJT measures. Therefore, the above study does not provide clear evidence of altered cortical organization in chronic unilateral shoulder pain.

Keywords: TPDT, LRJT, NRS

1. INTRODUCTION

Shoulder pain is a prevalent condition, with chronic pain defined as lasting or recurring for more than three months [1]. Common causes of chronic shoulder pain include rotator cuff disorders, adhesive capsulitis, shoulder instability, and arthritis [2]. It is the third most common cause of musculoskeletal pain and significantly impacts quality of life [3], with a prevalence of 22.9% among adults aged 30-70 years [4].

Chronic pain can cause functional and structural brain changes, particularly in the primary somatosensory cortex (S1), which is essential for pain localization and discrimination [5]. The body's awareness, or "body schema," involves multiple sensory inputs and can be disrupted by chronic pain. This disruption can lead to proprioception and motor performance issues [6,7,8].

Two clinical methods to assess body schema integrity are the two-point discrimination

threshold (TPDT) test and the left/right judgment task (LRJT) [8,9,10]. TPDT measures tactile acuity by determining the smallest distance at which two points are perceived as distinct, with higher thresholds indicating decreased acuity [11,12]. LRJT involves identifying the sidedness of body part images, assessing both accuracy and reaction time, which can be affected by chronic pain [8,10].

2.MATERIALS & METHODS

Ethical clearance was obtained from the Topiwala National medical College and hospital institute ethical committee, Mumbai, India with reference number No. PT/124/ECARP/2022 178.

Study Design: Cross-sectional, observational study with purposive sampling.

Participants:

This study was conducted in the Department of Physiotherapy of Topiwala national medical college, Mumbai. Patients and controls were selected based on the eligibility criteria, and written informed consent was obtained. Informed consent documents were signed. The experimental group (n=43) consisted of patients visiting the physiotherapy department with unilateral shoulder pain, while the control group(n=43) included patient relatives without any pathology.

The study assessed shoulder pain and related factors through several methods. Pain intensity was measured using an 11-point Numerical Rating Scale, where 0 indicated no pain and 10 represented the worst pain imaginable. Tactile acuity was evaluated with a Two-Point Discrimination Test (TPDT) using an aesthesiometer to determine the smallest distance at which two points on the shoulder could be distinguished. This test was conducted on both the affected shoulder of patients and the corresponding shoulder of control participants. Additionally, the Laterality Discrimination Task assessed participants' response time and accuracy in identifying the left or right orientation of shoulder images using the Recognize App. Participants completed two trials, each involving 20 images. The entire testing process took 25-30 minutes for the experimental group and 15-20 minutes for the control group, and the collected data were analyzed statistically.

3. STATISTICAL ANALYSIS

Data analysis was conducted using IBM SPSS software. Descriptive analysis was performed, and the Shapiro-Wilk test was used to check for normality. For normally distributed data, paired t-tests were used for within-group comparisons and unpaired t-tests for between-group comparisons, specifically for TPDT and response time. Non-normally distributed data, including laterality judgment, were analyzed using the Wilcoxon Signed Ranks Test within groups and the Mann-Whitney U test between groups. The association of shoulder pain (NRS) with tactile acuity, accuracy, and reaction time was evaluated using Spearman's rho test. The significance level was set at 0.05.

Tables and Graph:

DEMPGRAPHIC DATA

TABLE 1: AGE DISTRIBUTION

	GROUP A (43)	GROUP B (43)
MEAN ± SD	49.16 ± 8.2	49.16 ± 8.2
MEDIAN	50	50
MINIMUM	20	20
MAXIMUM	63	63

Table 1 shows age distribution of the subjects included in the study.

ANALYSIS OF GENDER DISTRIBUTION

TABLE 2: GENDER DISTRIBUTION

	GROUP A	GROUP B	TOTAL
MALE	12 (28%)	12 (28%)	24 (28%)
FEMALE	31 (72%)	31 (72%)	62 (72%)
TOTAL	43	43	86

Table 2 shows gender distribution of patients in the study. The total number of subjects that participated in the study was 28% subjects were male and 72% subjects were female.

ANALYSIS of TPDT IN BOTH GROUP A AND B

Table 3: Descriptive Statistics of TPDT in Group A And B

	N	Mean	Std. Deviation
TPDTAFF	43	3.6721	.64331
TPDTNAF	43	3.5837	.72553
TPDTCON	43	3.7395	.49840

Table 4: Test for Normality In Both Groups Of TPDT Using Shapiro-Wilk Test

	Shapiro-Wilk		
	Statistic	df	Sig.
TPDTAFF	.979	43	.624
TPDTNAF	.976	43	.481
TPDTCON	.972	43	.380

Table 5: Comparison of TPDT Difference Within Groups Using Paired Sample T-Test

Table 6: Comparison of TPDT Difference Between Groups Using Unpaired Sample T-Test

Paired Samples Test								
		Paired Differences					t	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	TPDTAFF - TPDTNAF	.08837	.55953	.08533	-.08383	.26057	1.036	.306

Independent Samples Test							
		Levene's Test for Equality of Variances		t-test for Equality of Means			
		Sig.	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
TPDT	Equal variances assumed	.160	-.543	.588	-.06744	-.31423	.17935
	Equal variances not assumed		-.543	.588	-.06744	-.31446	.17957

Analysis Of Accuracy In Both Group A And B

Table 7: Descriptive Statistics Of Accuracy In Group A And B

	N	Mean	Std. Deviation
ACCURACYAFF	43	91.3953	9.27911
ACCURACYNAFF	43	91.5116	7.75632
ACCURACYCON	43	94.3023	5.51852

Table 8: Test for Normality in Both Groups Of Accuracy Using Shapiro-Wilk Test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
ACCURACYAFF	.821	43	.000
ACCURACYNAFF	.858	43	.000
ACCURACYCON	.850	43	.000

Table 9: Comparison Of Accuracy Difference Within Group Using Wilcoxon Singed Ranks Test

Test Statistics[b]	
	ACCURACYNAFF - ACCURACYAFF
Z	-.050[a]
Asymp. Sig. (2-tailed)	.960
a. Based on negative ranks.	
b. Wilcoxon Signed Ranks Test	

Table 10: Comparison of Accuracy Difference Between Groups Using Mann-Whitney U Test

	ACCURACY
Mann-Whitney U	793.000
Wilcoxon W	1739.000
Z	-1.176
Asymp. Sig. (2-tailed)	.239
a. Grouping Variable: GROUP	

Table 11: Descriptive Statistics Of Response Time (Ms) In Group A And B

Descriptive Statistics			
	N	**Mean**	**Std. Deviation**
RTAFF	43	1.7070	.44529
RTNAFF	43	1.8000	.41918
RTCON	43	1.7767	.39239
Valid N (listwise)	43		

Table 12: Test For Normality In Both Groups Of Response Time (Ms) Using Shapiro-Wilk Test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
RTAFF	.976	43	.489
RTNAFF	.974	43	.415
RTCON	.986	43	.863

Table 12: COMPARISON OF RESPONSE TIME (MS) DIFFERENCE WITHIN GROUPS USING PAIRED SAMPLE T-TEST

Paired Samples Test							
		Paired Differences				**t**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**95% Confidence Interval of the Difference**			
				Lower	**Upper**		
Pair 1	RTAF - RTNAAFF	-.09302	.34167	-.19817	.01213	-1.785	.081

Table 13: Comparison of response time (ms) difference between groups using unpaired sample t-test

Independent Samples Test								
		Levene's Test for Equality of Variances		**t-test for Equality of Means**				
		F	**Sig.**	**t**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
							Lower	**Upper**

RT	Equal variances assumed	.711	.401	-.771	.443	-.06977	-.24976	.11022
	Equal variances not assumed			-.771	.443	-.06977	-.24980	.11026

Table 14: Test For Normality In Group A Affected Shoulder (TPDT, Accuracy, And Response Time) And NRS Using Shapiro-Wilk Test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
ATPDT	.979	43	.624
ACCAF	.821	43	.000
RTAFF	.976	43	.489
NRS	.891	43	.001

TABLE 15: CORRELATION OF NRS WITH AFFECTED SHOULDER (TPDT, ACCURACCY AND RESPONSE TIME) USING SPEARMAN'S Rho TEST

			ATPDT	ACCAF	RTAFF
Spearman's correlation	NRS	Correlation Coefficient	.099	.000	.136
		Sig. (2-tailed)	.529	.999	.384
		N	43	43	43

4.RESULT

The study involved 86 participants with a mean age of 49.16 ± 8.2 years, comprising 28% males and 72% females. Normality checks using the Shapiro-Wilk test revealed that the data was normally distributed for TPDT and response time, but not for accuracy and NRS scores.

In Group A, there was no significant difference in TPDT between the affected and unaffected shoulders (mean difference 0.8 mm, p = 0.3), suggesting chronic pain does not impact tactile acuity. Similarly, no significant difference in TPDT was found between Group A and Group B (healthy controls) (mean difference -6.7 mm, p = 0.5). Accuracy rates showed no significant difference between the affected and unaffected shoulders within Group A (p = 0.9) and between Group A and Group B (p = 0.2), indicating that chronic pain does not affect accuracy. Additionally, response time did not differ significantly within Group A (p = 0.43) or between Group A and Group B (p = 0.43), suggesting that chronic pain has no effect on response time.

Finally, correlation analysis using Spearman's rho test revealed no significant relationships between NRS scores and TPDT, accuracy, or response time, indicating that pain intensity does not correlate with tactile acuity, accuracy, or response time. Overall, the study found no significant impact of chronic shoulder pain on these measures compared to healthy controls.

5.DISCUSSION

The study aimed to assess whether chronic shoulder pain affects tactile acuity and laterality judgment. It included 43 patients with unilateral shoulder pain (Group A) and 43 age-, gender-, and dominance-matched healthy controls (Group B). Both groups underwent assessments for two-point discrimination threshold (TPDT) for tactile acuity and accuracy and response time (RT) for laterality judgment.

Contrary to the hypothesis, there were no significant differences in TPDT, accuracy, or RT within the affected and nonaffected shoulders of the patient group, or between the patient and control groups. These findings suggest no significant cortical alteration or central sensitization in chronic shoulder pain patients, as also supported by similar studies in the literature [Marelia Caseiro et al 2021, Mena-del Horno et al 2020] [13,14].

The lack of significant differences may be due to factors such as the type of pain

mechanism, the specific condition studied, or the duration of pain. The study's results align with some previous research [Catley MJ et al. 2014] [7], which also found no significant association between chronic pain and changes in tactile acuity or laterality judgment. However, other studies have reported such differences, possibly due to different patient populations or study designs [Luedtke K, Adamczyk WM et al.] [15].

The study's strength lies in the matching of participants by age, gender, and dominance, though the relatively small sample size and other factors like arm use and activity levels may limit the findings. The results suggest that chronic shoulder pain might not significantly impact TPDT and laterality judgment. However, further research is needed to explore the underlying mechanisms and the potential role of factors like cortical reorganization, compensatory mechanisms, and individual differences in pain perception.

Limitation: Small sample size, pain differentiation mechanism and duration of the pain onset are the major limiting factors.

6. CONCLUSION

In conclusion, the study found no significant differences in Two-Point Discrimination Threshold (TPDT), laterality judgment, or response time between affected and non-affected shoulders in chronic shoulder pain patients, nor when compared to healthy controls. There was also no association between shoulder pain and tactile acuity, accuracy, or response time. These findings suggest that chronic shoulder pain does not alter tactile acuity or laterality judgment.

Declaration by Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest.

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