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Upper limb neural tissue extensibility in asymptomatic health care professionals

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Abstract

Aim Is upper quadrant neural tissue extensibility affected in asymptomatic health care professionals?

Participants Ninety asymptomatic health care professionals of 26–60 years (30 surgeons, 30 dentists, 30 physiotherapist) were selected on the basis of inclusion and exclusion criteria.

Methodology This was a cross-sectional type of observational study, and the data was collected by *simple random sampling*, in which various ULTT were performed on both upper extremities for median (ULTT1), radial (ULTT2), and ulnar (ULTT3) nerve. Elbow position was measured at first onset of discomfort perceived by participants (R1) and, secondly, when the firm resistance to movement was felt by the examiner (R2), by using universal goniometer. The test was considered positive if the symptoms arise before 60° of end elbow ROM.

Results The results showed that there was reduced upper quadrant neural tissue extensibility in asymptomatic health care professionals. The median nerve was most affected, and the ulnar nerve was least affected. The prevalence rate of reduced neural extensibility was highest among dentists as compared to the surgeons and physiotherapists. High correlation was found between R1and R2 for all three ULTT (p-value = 0.000).

Conclusion More than half, specifically 51.1%, of asymptomatic health care professionals had reduced extensibility of the neural tissues in their upper limbs. Therefore, early introduction of exercise will help in combating the occurrence of these nerve-related issues in further life.

Keywords ULTT, Range of motion, Neural tissue extensibility, Health care professionals

Introduction

Nerve connects the nervous system with other parts of the body. The nerve conducts impulses either towards or away from the central nervous system. Nerves are protected by three connective tissue layers—the endoneurium, the perineurium, and the epineurium [1]. Nerves experience various mechanical stresses under normal physiological conditions which are usually caused during different postures and movements [2]. During complete flexion and extension of elbow joint, the median and ulnar nerve may glide 7.3 and 9.8 mm, respectively, and the excursion of the nerve is maximum, just proximal to the wrist (14.5 and 13.8 mm, respectively) [1]. In daily life, certain activities increase the tension or pressure on the nerves. These stances might be achieved during many work-related or nonwork-related activities in which abnormal positions of various body parts are either repeated or kept in a static position for prolonged period of time. If further sufficient time is not given to these tissues for relaxation, then it can result in chronic nerve compressions [1]. These stresses of greater magnitude may lead to structural changes in myelin sheaths which ultimately can cause damage of axons due to restriction of blood flow which further leads to ischemia [2].

Milan et al. (2020) found that 47% of population was affected by occupational disorders in Czech Republic.

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These problems are common in people like health care professionals, IT industry, banking, and laboratory technicians. Among all, health care professionals are most affected in context to work-related disorders than any other profession [2, 3]. Various health care professionals include surgeons, physicians, dentists, physiotherapists, nurses, and laboratory technicians [4–6]. Work demands in physiotherapy profession are physically challenging which includes continuous bending, repetitive movements, quick response to unanticipated movements by patients, and maximum patient support during treatment [7, 8]. In dental practice, there are a huge number of ergonomic risk factors including repetitiveness of work during various procedures done while treating the patient, vigorous exertions and contact stress over the carpal tunnel caused by dental instruments, and steady position of wrist for longer periods which consequently can cause the compression of median nerve [9]. Surgeons also work in prolonged standing positions, attain trunk and neck bending postures while performing their procedures for long working hours, and do repetitive movements [8, 10, 11].Overweight and fat subjects complained of more serious torment than typical weight patients [12]. Way of assessing the increased sensitivity is by means of multijoint movements, referred to as neurodynamic tests. Clinical provocation tests for the upper quadrant are known as the upper limb tension neurodynamic tests or neural tissue provocation tests [13]. Upper limb tension tests are of three types that examine the neural tissue originating from C5 to T1 nerve roots [14]. ULTT1, ULTT2, and ULTT3 place tension on the median nerve, radial nerve, and ulnar nerve respectively [13]. Test is considered positive when there is production of nerve-related symptoms like pain, tingling sensation, paraesthesia, and numbness while performing elbow ROM and reduction of symptoms when the cervical spine is laterally flexed towards the testing limb. The range of motion during neurodynamic testing becomes a valuable comparable sign in the clinical evaluation for patients with minor peripheral nerve injuries. Davis suggested that 60° of elbow ROM as a possible cut-off score for the analysis of a positive ULTT [13].

Materials and methods

Design

This was *a cross-sectional type* of study in which 90 asymptomatic health care professionals were recruited from three different professions (30 surgeon, 30 dentists, & 30 physiotherapists). Firstly, the ethical clearance for the study proposal was taken from the "Institutional Ethics Committee of MT Saket College of Physiotherapy" (no.: SCP/2020–21/287). After the first clearance, the proposal was sent to the "PG board of studies in college of Physiotherapy, Pt. B.D. Sharma University of Health Sciences, Rohtak" from where approval was taken. Then, the sample of 90 subjects was collected with the help of simple random sampling. Informed consent was signed prior to participation in the study. Subjects went through the upper quadrant screening examination including cervical spine, shoulder, elbow, and wrist range of motion.

Participants

Ninety asymptomatic health care professional subjects with the following criteria were included in the study because this study was performed in asymptomatic subjects.

1. Age 26–60 years (increasing age can cause alteration in results)
2. Both males and females were included in the study.
3. Subjects who did not complain of any pain *around upper quadrant (B/L)* of the body since last 3 months
4. Subjects had minimum of 1-year experience in clinical practice (experience is necessary to find the occupational risk factors.)
5. Subjects who were willing to participate
6. Participants were surgeon, dentist, and physiotherapist (these professions involve the use of various tools and posture that can produce the nerve entrapments).
7. Subjects should have normal pain-free active and passive range of motion with overpressure.
8. *Both the sides/upper limb should be asymptomatic.*

Exclusion criteria

Subjects having distal peripheral nervous system injury of upper limb, central nervous disease, recent episode of cervical spine or upper extremity fracture, systemic arthritis, recent episode of breast, cervical spine, and upper extremity surgery, and diabetes mellitus were excluded from the study.

Outcome measure

For all the tests, subjects were positioned supine lying comfortably on the couch, and it was made sure that clothing did not restrict any procedure. Accessories of examiner and the subject worn in upper extremity were removed prior to the procedure. Their head and neck were in neutral position. In the starting, cervical was maintained in neutral position throughout the testing to focus on specific upper extremity motion during the combined joint movements that comprise the test. Each test was started by adding the components of the shoulder first, then followed by the forearm, wrist, and fingers, and then the elbow in the last. All the neural tissue tension tests procedure was performed as given by Butler D. The neurodynamic test was performed on both upper extremities of each subject. The test was performed for median (ULTT1), radial (ULTT2), and ulnar nerve (ULTT3) biased motions. The contralateral and lateral cervical flexion was added to further provocation of the symptoms in all the tests. Subjects were instructed to communicate with the examiner if the test movement was too painful to continue and wished to stop the test. The examiner proceeded through the neurodynamic test sequence until the onset of discomfort (pain, paraesthesia, numbness, tingling, stretch) perceived by the subject; firstly, the elbow position was measured at this point (R1). Secondly, when the firm resistance to movement was felt by the examiner, again elbow range of motion was measured (R2). For the median and radial nerve biased tests, the degree of elbow extension was measured. For the ulnar nerve-biased test, the degree of elbow flexion was measured. The test was considered positive if the symptoms arise before the 60° of end elbow ROM, and below this, the results will be considered negative. The range of motion was measured with the help of handheld universal goniometer.

To start with ULTT1 (median nerve), the subjects were positioned in supine lying as described above. The examiner faces the subject in stride standing position. Firstly, the shoulder girdle was depressed, and then glenohumeral was taken to the appropriate abduction position (90–110°). With this positioned maintained, the forearm was then supinated, and wrist and fingers were extended. Then shoulder external rotation was added, followed by elbow extension which was performed at the last to stress the median nerve. To further sensitize the test, cervical, contralateral, and lateral flexion was added.

The examiner proceeded through the neurodynamic test sequence until the onset of discomfort (pain, paraesthesia, numbness, tingling, stretch) is perceived by the subject; firstly, the elbow position was measured at this point (R1). Secondly, when the firm resistance to movement was felt by the examiner, again elbow range of motion was measured (R2). For measuring extension at the elbow joint, fulcrum was laid at the lateral epicondyle of humerus, stationary arm was aligned with the long axis of humerus, and movable arm was aligned be with the long axis of radius (Table 1).

To start with ULTT2 (radial nerve), the subjects were positioned in supine lying as described above. The examiner faces the subject in stride standing position. Firstly, the shoulder girdle was depressed, and then glenohumeral was taken to the appropriate abduction position (10°). With this positioned maintained, the forearm was then pronated, and wrist and fingers were flexed. Then, shoulder medial rotation was added, followed by elbow extension which was performed at the last to stress the radial nerve. To further sensitize the test, cervical contralateral lateral flexion was added.

The examiner proceeded through the neurodynamic test sequence until the onset of discomfort (pain, paraesthesia, numbness, tingling, stretch) is perceived by the subject; firstly, the elbow position was measured at this point (R1). Secondly, when the firm resistance to movement was felt by the examiner, again elbow range of motion was measured (R2). To measure extension at the elbow joint, fulcrum was laid at the lateral epicondyle of humerus, stationary arm was aligned with the long axis of humerus, and movable arm was aligned be with the long axis of radius (Table 2).

To start with ULTT3 (ulnar nerve), the subjects were positioned in supine lying as described above. The examiner faces the subject in stride standing position. Firstly, the shoulder girdle was depressed, and then glenohumeral was taken to the appropriate abduction position (10–90°). With this positioned maintained, the forearm was then pronated, and wrist and fingers were extended. Then shoulder lateral rotation was added, followed by elbow flexion which was performed at the last to stress the ulnar nerve. To further sensitize the test, cervical contralateral lateral flexion was added.

The examiner proceeded through the neurodynamic test sequence until the onset of discomfort (pain,

Table 1 ULTT 1 median nerve bias

Joint	Movement
Shoulder girdle	Depression
Shoulder joint	Abduction (90–110°)
Forearm	Supination
Wrist	Extension
Finger and thumb	Extension
Elbow	Extension
Cervical spine	Contralateral side flexion

Table 2 ULTT 2 radial nerve bias

Joint	Movement
Shoulder girdle	Depression
Shoulder joint	Abduction (10°)
Forearm	Pronation
Wrist	Flexion and ulnar deviation
Finger and thumb	Flexion
Shoulder	Medial rotation
Elbow	Extension
Cervical spine	Contralateral side flexion

Table 3 ULTT3 ulnar nerve bias

Joint	Movement
Shoulder girdle	Depression
Shoulder joint	Abduction (10 to 90°), hand to ear
Elbow	Flexion
Forearm	Pronation
Wrist	Extension and radial deviation
Finger and thumb	Extension
Shoulder	Lateral rotation
Cervical spine	Contralateral side flexion

Table 4 Showing the different categories of body mass index (BMI)

Low BMI (UW)	≤ 18.5 kg/m^2
Normal BMI (NW)	18.5–24.9 kg/m^2
High BMI (OW)	25.0–29.9 kg/m^2
Obese	30.0 kg/m^2 and above

Fig. 1 Showing the neurodynamic assessment of median nerve

paraesthesia, numbness, tingling, stretch) is perceived by the subject; firstly, the elbow position was measured at this point (R1). Secondly, when the firm resistance to movement was felt by the examiner, again elbow range of motion was measured (R2). To measure flexion at the elbow joint, fulcrum was laid at the lateral epicondyle of humerus, stationary arm was aligned with the long axis of humerus, and movable arm was aligned be with the long axis of radius (Table 3).

BMI calculation

BMI = weight (kg)/height (m^2) (Table 4 and Figs. 1, 2, 3 and 4).

Fig. 2 Showing the neurodynamic assessment of radial nerve

Fig. 3 Showing the neurodynamic assessment of ulnar nerve

Fig. 4 Showing the goniometric measurement of elbow ROM

Data analysis

Analysis of the data for upper limb tension test, R1 and R2, and BMI was done by several statistical tests by using

SPSS software version 23.0 in order to verify the investigations of the study. The results were considered statistically significant if the p-value ≤ 0.05.

Point biserial correlation was applied to check the correlation of age and experience with neural tissue extensibility.

Pearson chi-square test was applied to see the association of exercise and reduced neural tissue extensibility.

Levene's test of equality of error variance was used for testing of homogeneity.

T-test was used for the equality of means of different BMI.

Pearson correlation was done to see the correlation between R1 and R2.

Results

In this study, a total of 90 subjects participated, with 30 individuals in each of the three groups: surgeons, dentists, and physiotherapists. The study includes 53 (58.8%) males and 37 (41.1%) females with the mean age of 33.34 ± 3.545 years. Eighty-nine (98.8%) subjects were right-hand dominant, and one (1.1%) participant was left-hand dominant (Tables 5 and 6).

This shows that there is no correlation between the age of the health care professionals and the neural tissue extensibility (Tables 7, 8 and 9).

Table 5 Showing the number of health care professionals on the basis of age

Age	No. of health care professional
26–30 years	42
31–35 years	20
36–40 years	14
41–45 years	7
46–50 years	3
51–55 years	2
56–60 years	2
Total	90

Table 7 Showing the frequency of total number of subjects according to the body mass index (BMI)

BMI	No
Underweight	1
Normal	39
Overweight	41
Obese	9
Total	90

The p-value is > 0.05 in both the tests. This shows that there is no significant relationship between the BMI and the means of negative and positive dominant ULTT1 (MN) (Tables 10, 11 and 12).

The p-value is > 0.05 level in all tests. This shows that there is no correlation between the years of experience and the neural tissue extensibility (Tables 13 and 14).

The abovementioned table describes that chi-square test of independence was applied, and it shows the correlation between the variables exercise, and ULTT are significant at 5% level of significance. It means that the rate of neural tissue extensibility depends on exercise (Tables 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and 26).

The abovementioned table describes the Pearson correlation between R1 and R2. In all the tables, the p-value is 0.000 which is < 0.01. This shows that there is significant correlation between the R1 and R2.

Discussion

The data obtained from this study documents that 51.1% (46) of health care professionals had neural hypersensitivity in upper limb. Shahanawaz, S. D. (2016) checked the upper limb neural tissue extensibility in asymptomatic professional computer users and found that abnormal posture leads to abnormal neural tissue mobility [15].

Correlation between the age and neural tissue extensibility

In the current study, the mean age of the respondents was 33.34 ± 3.545 years. Out of the total subjects, 46.6% of them were below 30 years of age. Correlation between

Table 6 Showing the correlation between the age of health care professionals and neural tissue extensibility

Correlations

		Age	Dominant ULTT1 (MN)	Non-dominant ULTT1 (MN)	Dominant ULTT2 (RN)	Non-dominant ULTT2 (RN)	Dominant ULTT3 (UN)	Non-dominant ULTT3 (UN)
Age	Point biserial correlation	1	−0.159	.017	−0.145	.075	−.090	.010
	Sig. (2-tailed)		0.133	0.876	0.174	0.481	0.398	0.928
	N	90	90	90	90	90	90	90

Table 8 Showing the mean and standard deviation of BMI of positive and negative variables in different upper limb tension tests

		BMI	
		Mean	**Standard deviation**
Dominant ULTT1 (MN)	Negative	25.75	4.07
	Positive	25.15	3.05
Non-dominant ULTT1 (MN)	Negative	25.37	3.67
	Positive	25.62	3.39
Dominant ULTT2 (RN)	Negative	25.35	3.35
	Positive	25.94	4.65
Non-dominant ULTT2 (RN)	Negative	25.55	3.50
	Positive	24.89	4.08
Dominant ULTT3 (UN)	Negative	25.56	3.65
	Positive	24.26	2.53
Non-dominant ULTT3 (UN)	Negative	25.41	3.65
	Positive	25.87	2.58

the age of the health care professional and the upper limb neural tissue extensibility was also seen. There was no correlation found between the age and neural tissue extensibility. Therefore, according to the results, age does not cause any reduced neural tissue extensibility. This might be due to the less number of participants above the age of 46 years. Olanrewaju et al. (2011) reported that age is not an independent risk factor for MSD in workplace. Though older workers (>46 years or more) were 3.48 times more likely to be injured than youngest age group (<29 years), moreover, it is more related to the demands of work and the worker's physical work capacity than the age [16].

Table 11 Showing the no. of respondents on the base of years of experience in clinical practice

Experience (in years)	No
1–5 years	51
6–10 years	14
11–15 years	15
16–20 years	6
21–25 years	1
26–30 years	3
Total	90

Correlation between the BMI and neural tissue extensibility

In the present study, mean BMI of the participants is 25.39 ± 3.51 kg/m^2. Out of total sample of 90 subjects, 1 (1.1%) subject was underweight, 39 (43.3%) subjects were in normal category, 41 (45.5%) subjects were in overweight category, and 9 (10%) subjects were in obese category. Relationship of BMI with dominant and non-dominant ULTT1 (median nerve), ULTT2 (radial nerve), and ULTT3 (ulnar nerve) was also analyzed. The *p*-value in all the groups was > 0.05, so no relationship between BMI and dominant/non-dominant variables was found in the current study. This may be due to that maximum number of subjects falls in overweight category. Only 10% of total population falls in the obese category. Alexis et al. (2004) revealed that the prevalence

Table 9 Showing the relationship of BMI and dominant ULLT1

Independent samples test						
Dominant ULTT1 (MN)		Levene's test for equality of variances		*t*-test for equality of means		
		F	Sig	*T*	df	Sig. (2-tailed)
BMI	Equal variances assumed	0.986	0.323	0.785	88	0.435
	Equal variances not assumed			0.780	79.666	0.438

Table 10 Showing the relationship of BMI and non-dominant ULLT1

Independent samples test						
Non-dominant ULTT1 (MN)		Levene's test for equality of variances		*t*-test for equality of means		
		F	Sig	*T*	df	Sig. (2-tailed)
BMI	Equal variances assumed	.005	0.943	− 0.288	88	0.774
	Equal variances not assumed			− 0.298	50.053	0.767

Table 12 Showing the relationship between the years of experience with ULTT1, ULTT2, and ULTT3 in dominant and non-dominant side

Correlations								
		Experience	**Dominant ULTT1**	**Non-dominant ULTT1**	**Dominant ULTT2**	**Non-dominant ULTT2**	**Dominant ULTT3**	**Non-dominant ULTT3**
Experience	Point biserial correlation	1	−0.166	−.020	−0.139	.003	−0.106	−.010
	Sig. (2-tailed)		0.117	0.849	0.191	0.980	0.322	0.923
	N	90	90	90	90	90	90	90

Table 13 Showing the number of surgeons, dentists, and physiotherapist, who have positive and negative upper limb neural tissue test among who do and do not do exercises

		Professions		
		Surgeons	**Dentists**	**Physiotherapists**
Subject who performs regular exercises	Negative	10	6	11
	Positive	6	10	5
Subject who did not perform regular exercises	Negative	2	0	3
	Positive	12	14	11
Total		30	30	30

of nerve entrapment was 9.30% for obese subjects, 2.11% for those simply overweight, and 2.42% for those with a normal weight. [17] Vivek et al. (2021) did a study to see the association of working hours, job position, and BMI with WRMSDs among physiotherapists of Gujarat and found that there was no significant relation of job position, weekly working hours, or BMI with prevalence rate of WRMSDs. [18] In contrary to this, other study done by Laura et al. (2013) to see the relation between body mass index and musculoskeletal symptoms in the working population revealed that BMI was associated with musculoskeletal symptoms (obese) and was found to be prevalent in lower extremity [19].

Table 14 Showing the Pearson chi-square test is applied to see the association of neural tissue extensibility with exercise

Chi-square tests					
	Value	**df**	**Asymtomaticresults significance (two-sided)**	**Exact sig. (two-sided)**	**Exact sig. (one-sided)**
Pearson chi-square	19.224a	1	.000		
Continuity correction[b]	17.338	1	.000		
Likelihood ratio	20.695	1	.000		
Fisher's exact test				.000	.000
Linear-by-linear association	19.011	1	.000		
No. of valid cases	90				
No. of valid cases	90				

Table 15 Showing the percentage of negative and positive variables of dominant ULTT1 (median nerve) in surgeons, dentists, and physiotherapists

			Profession			
			Surgeon	**Dentist**	**Physio**	**Total**
Dominant ULTT1 (MN)	Negative	Count	14	12	18	44
	Positive	Count	16	18	12	46
	Total	Count	30	30	30	90

Table 16 Showing the percentage of negative and positive variables of non-dominant ULTT1 (median nerve) in surgeons, dentists, and physiotherapists

			Profession			
			Surgeon	Dentist	Physio	Total
Non-dominant ULTT1 (MN)	Negative	Count	25	18	21	64
	Positive	Count	5	12	9	26
	Total	Count	30	30	30	90

Table 17 Showing the percentage of negative and positive variables of non-dominant ULTT1 (median nerve) in surgeons, dentists, and physiotherapists

			Profession			
			Surgeon	Dentist	Physio	Total
Non-dominant ULTT1 (MN)	Negative	Count	25	18	21	64
	Positive	Count	5	12	9	26
	Total	Count	30	30	30	90

Table 18 Showing the percentage of negative and positive variables of non-dominant ULTT2 (radial nerve) in surgeons, dentists, and physiotherapists

			Profession			
			Surgeon	Dentist	Physio	Total
Non-dominant ULTT2	Negative	Count	27	24	25	76
	Positive	Count	3	6	5	14
	Total	Count	30	30	30	90

Table 19 Showing the percentage of negative and positive variables of dominant ULTT3 (ulnar nerve) in surgeons, dentists, and physiotherapists

			Profession			
			Surgeon	Dentist	Physio	Total
Dominant ULTT3	Negative	Count	27	28	27	82
	Positive	Count	3	2	3	8
	Total	Count	30	30	30	90

Table 20 Showing the percentage of negative and positive variables of non-dominant ULTT3 (ulnar nerve) in surgeons, dentists, and physiotherapists

			Profession			
			Surgeon	Dentist	Physio	Total
Non-dominant ULTT3	Negative	Count	28	29	27	84
	Positive	Count	2	1	3	6
	Total	Count	30	30	30	90

Table 21 Showing the correlation between R1 and R2 of elbow extension (dominant side) of median nerve

		Elbow extension (dominant MN) R1	**Elbow extension (dominant MN) R2**
Elbow extension (dominant MN) R1	Pearson correlation	1	0.884[a]
	Sig. (2-tailed)		.000
	N	90	90

[a] Correlation is significant at the 0.01 level (2-tailed)

Table 22 Showing the correlation between R1 and R2 of elbow extension (dominant side) of radial nerve

		Elbow extension (dominant RN) R1	**Elbow extension (dominant RN) R2**
Elbow extension (dominant RN) R1	Pearson correlation	1	0.861[a]
	Sig. (2-tailed)		.000
	N	90	90

[a] Correlation is significant at the 0.01 level (2-tailed)

Table 23 Showing the correlation between R1 and R2 of elbow flexion (dominant side) of ulnar nerve

		Elbow flexion (dominant UN) R1	**Elbow flexion (dominant UN) R2**
Elbow flexion (dominant UN) R1	Pearson correlation	1	0.974[a]
	Sig. (2-tailed)		.000
	N	90	90

[a] Correlation is significant at the 0.01 level (2-tailed)

Table 24 Showing the correlation between R1 and R2 of elbow extension (non-dominant side) of median nerve

		Elbow extension (non-dominant MN) R1	**Elbow extension (non-dominant MN) R2**
Elbow extension (non-dominant MN) R1	Pearson correlation	1	0.867[a]
	Sig. (2-tailed)		.000
	N	90	90

[a] Correlation is significant at the 0.01 level (2-tailed)

Table 25 Showing the correlation between R1 and R2 of elbow extension (non-dominant side) of radial nerve

		Elbow extension (non-dominant RN) R1	**Elbow extension (non-dominant RN) R2**
Elbow extension (non-dominant RN) R1	Pearson correlation	1	0.924[a]
	Sig. (2-tailed)		.000
	N	90	90

[a] Correlation is significant at the 0.01 level (2-tailed)

Table 26 Showing the correlation between R1 and R2 of elbow flexion (non-dominant side) of ulnar nerve

		Elbow flexion (non-dominant UN) R1	Elbow flexion (non-dominant UN) R2
Elbow flexion (non-dominant UN) R1	Pearson correlation	1	0.997[a]
	Sig. (2-tailed)		.000
	N	90	90

[a] Correlation is significant at the 0.01 level (2-tailed)

Correlation between years of clinical experience and neural tissue extensibility

Correlation between the years of clinical experience and upper limb neural tissue extensibility was seen. The *p*-value was > 0.05 level in all tests. Hence, no correlation between the years of clinical experience and the upper limb neural tissue extensibility of dominant and non-dominant side was found. According to Wilhelmus et al. (2011), a large number of female physiotherapists with more than 15 years of job experience to be more prone to compressive neuropathies of upper limb and develop a higher risk of reporting WRMSDs [20]. A study done by Rania et al. (2017) reveal that there was no statistically significant difference of WRMSDs prevalence in participants and years of job experience in all body regions except for upper back [21].

Correlation between performing exercises and neural tissue extensibility

It was also found that the positive rates in context to decreased upper limb neural tissue extensibility was low among the groups who exercised regularly as compared to the ones who do not have the routine of doing so. Median nerve involvement was found to be most prevalent in all the three age groups. Statistically, association between exercise and neural tissue extensibility was found at 5% level, and *p*-value was found to be 0.000 which is less than 0.05. Hence, a strong correlation between the exercise and upper limb neural tissue extensibility was found. Thus, the rate of reduced neural tissue extensibility was found maximum in subjects who did not have the routine of doing exercises at regular intervals. Qais et al. (2017) did a literature review to see the effect of various stretching exercises in reducing the risk of developing WRMSDs and found that most of the literature supports that performing stretching exercises at regular intervals at workstation can contribute in reducing pain and increase in muscle flexibility, endurance, and range of motion [22].

Alam et al. (2016) reveal that other factors that may contribute to pain and paraesthesia were prolonged postures, performing the task repeatedly, attaining uncomfortable positions and no proper relaxation, etc. [3]. According to the results, median nerve (dominant side > non-dominant side) was found to be most prevalent to be affected as compared to radial nerve and the ulnar nerve. The least affected nerve among the three is ulnar nerve. With repetitive motions and awkward postures, the tissue surrounding the nerve becomes swollen and squeezes or compresses the nerves [23]. All professions have compromised upper limb neural tissue extensibility, but according to the results, among the three health care professionals, reduced neural tissue extensibility of median nerve is found to be most prevalent among dentists. Data found that the prevalence rate of reduced upper neural tissue extensibility among dentists is 62.5% who had a routine of doing exercises, while it is 100% in those who do not had a routine of doing so. Sabike et al. (2020) reported that 24.2% dentists were suffered from median nerve compression at wrist (carpal tunnel syndrome) in Qatar [9].

Correlation of the range of motion of elbow at two intervals

In this study, correlation of the range of motion of elbow at two intervals (R1 & R2), first at which the symptoms of pain, paraesthesia, and tingling are felt by the participant (R1) and second at which the resistance to movement is felt by the examiner (R2), was analyzed. The *p*-value of Pearson correlation was 0.000, which was significant at 0.01 level. So, there was a strong correlation between onset of symptoms (R1) and onset of resistance to passive movement (R2) in the study for all the tests. Michelle et al. (2018) compared elbow flexion ROM at two end points, onset of resistance (R1) and symptom onset (P1), on each side while performing ulnar neurodynamic test and found that there was no significant difference in mean ROM between sides [24]. While the nerve is elongated or stretched to an extent, it produces the symptoms of pain, paraesthesia, tingling, and numbness which are known as sensory response. Onset of these symptoms varies on the basis of neural health. According to Bragard (1929), resistance to movement is motor response in which resistance to further elongation is provided by the soft tissue aligned longitudinally along the nerve. It is unclear which factors contribute to the reduction in range of motion and/or resistance to normal movement. Heide et al. (2001) did a study to see the onset of pain (P1) and muscular responses (resistance to movement) (P2) to a neural tissue provocation test in the upper limb. Measurement of onset of muscle activity was done by using surface electromyography (EMG). He concluded that the onset of perceived pain was moderate-to-strong positive correlation with the onset of trapezius muscle activity at 1% level of significance. Although the muscle activity of biceps and triceps was also seen while performing the neural tissue provocation test, but that was not much reliable [25].

Thus, the results of our study show that there is reduced upper limb range of motion and upper quadrant neural tissue extensibility in asymptomatic health care professionals. When asymptomatic population is exposed to certain occupational risk factors, then they become more prone to reduced neural tissue extensibility. If early identification of these risk factor is not done, thus, in later life, the risk of getting WRMSDs increases. This can further lead to reduction in work efficiency and quality of life. Therefore, WRMSDs can affect health care professionals work life in many ways. Adequate preventive and appropriate management strategies are recommended to minimize such injuries in their clinical practice which can help in improving their performance. As according to the results mentioned above, doing exercise on regular basis reduces the risk of getting involved in this kind of diseases or disorders. And so, it will increase not only the quality of life but also the work efficiency.

Hence, the upper quadrant neural tissue extensibility is compromised in asymptomatic health care professionals. Therefore, early introduction of stretching and other exercise protocols at particular age will help to prevent the occurrence of these nerve-related issues.

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Patient involvement
Not applicable.

Practical implication
Existence of abnormal tension in asymptomatic health care professionals might be an early marker of approaching radiculopathy in later phases of life. And petite literature is available in this respect, especially in India. So, this study will help to prevent or minimize the results of abnormal neural tension in future life. So, early identification of these symptoms and timely introduction of preventive physiotherapy program like performing proper stretching exercises, etc. at appropriate age may act as a prophylaxis for later stage of life.

Research gap
There are various studies that evaluated about the musculoskeletal disorders in health care professionals, but as per our concern, there is no study that has seen upper quadrant neural tissue extensibility in asymptomatic heath care professionals. Existence of abnormal tension in asymptomatic health care professionals might be an early marker of approaching radiculopathy in later phases of life.

Need for study
Various studies have shown that abnormal posture, long-standing hours and use of various technical equipments, etc. lead to many work-related disorders in health care professionals. These risk factors affect the quality of life and functional ability of health care professionals. If the upper limb range of motion and upper quadrant neural tissue extensibility get compromised in asymptomatic health care professionals, then we can timely introduce different exercise protocols in them. Hence, this will help in preventing various work-related disorders which are a common cause of sick leaves and absenteeism in health care professionals. It will help to reduce the risk of different disabilities which can impose heavy cost on employers as well as society. Therefore, early introduction of stretching and other exercise protocols at particular age will act as prophylaxis.

Authors' contributions
Conceived and designed the analysis, collected the data, contributed data, performed the analysis and wrote the paper.

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Availability of data and materials
Data are available upon request. Data includes the subject's age, BMI, years of experience, and details of negative and positive results of neurodynamic testing.

Declarations

Ethics approval and consent to participate
Ethical approval was given by the Ethics Committee and PG Board of Pt. BD Sharma University of Health Sciences, Rohtak.
Consent for participation was obtained from the subjects.

Consent for publication
Consent for publication was obtained from the subjects.

Competing interests
The authors declare that they have no competing interests.

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