**Prevalence of Deep neck flexor weakness and Deep neck extensor tightness in college-going students suffering from Cervicogenic Headache**

**ABSTRACT**

**Background:**

Cervicogenic headache (CGH) is generated from the upper three cervical vertebraes, which generally cause dull, achy pain in the head. It lasts one hour to one week. It estimates 15% to 20% of all headache disorders. College students are more addicted to smartphones due to internet addiction and online education. They are more prone to develop cervicogenic headache due to anomaly in the upper cervical vertebrae. In the previous studies it has been found people suffering from cervicogenic headache have alteration in strength in deep neck flexors and they develop trigger points in deep neck extensors.

Although the assessment of deep neck flexors strength and deep neck extensor tightness is done in other studies separately. But to the best of our knowledge, no studies have exposed the correlation between the prevalence of both deep neck flexor weakness and deep neck extensor tightness in an individual suffering from cervicogenic headache in Kolkata. So there is a greater need to find the prevalence of Deep neck flexor weakness and Deep neck extensor tightness in college-going students suffering from cervicogenic Headache.

**Methodology:**

A Cross-Sectional Survey study was conducted among 300 college student within the age group of 18 to 30 years. Participants were assessed for smartphone addiction using smartphone addiction scale (SAS), which is a 1-6 point scale containing 48 questions related to smartphone addiction. Participants scored above 40% out of 288 are included in the study. The participants were assessed for deep neck extensor (DNE) tightness for both left and right suboccipital musculature using pain pressure threshold algometry (PPT) and for deep neck flexor (DNF) strength using pressure biofeedback stabilizer (PBS). The correlation between the left DNE with DNF and right DNE with DNF is established using Pearson correlation test.

The obtained data were analysed using descriptive statistics of Mean, Standard deviations, Minimum and Maximum values of continuous data and frequency and percentage values of nominal and ordinal data. The statistical package for the social science SPSS trial version 27 was used for data analysis.

**Result:**

The Pearson correlation for DNF with right DNE was positive, 1 for DNF and 0.074 for right DNE. The Pearson correlation for DNF with left DNE was negative, 1 for DNF and -0.093 for left DNE.

**Discussion**

The desired result of the present study was to find the Prevalence of Deep neck flexor weakness and Deep neck extensor tightness in college-going smartphone addicted students suffering from cervicogenic headache and to find the correlation between deep neck flexors weakness with right and left deep neck extensor tightness.

The study was cross-sectional survey type, which found positive correlation for deep neck flexor weakness with right deep neck extensor tightness and negative correlation for deep neck flexor with left deep neck extensor tightness, which gave us an idea regarding text neck syndrome in smartphone addicts due to which the more right handedness right deep neck extensor tightness have positive correlation with deep neck flexor weakness.

**CONCLUSION:** This study signifies that deep neck flexor weakness and right deep neck extensor tightness and trigger point formation is having a positive correlation. It means deep neck flexor weakness may lead the formation of trigger point formation at right deep neck extensor muscles.

**Keywords:** Smartphone addiction, Cervicogenic Headache, Deep neck flexor and deep neck extensor.

1. **Introduction:**

Cervicogenic headache (CEH) was first studied as a particular type of headache, where the symptoms aggravate with head and neck movements.[1] Cervicogenic headache is described as a ‘Headache attributed to a disorder of the neck.’ The International Headache Society (IHS) recommended three diagnostic criteria for cervicogenic headache (adapted from IHS classification, 3rd edition). [2] The Cervicogenic Headache International Study Group’s (CHISG) has also recommended certain diagnostic criteria for CEH that are more specific. [3]

A “cervicogenic episode” can last one hour to one week. Pain typically is unilateral, i.e., on one side of the head, which often correlates with the side of the neck, where there is increased tightness. “Common causes of Cervicogenic headache can be chronic or due to poor posture, as noted above, or arthritis. They also can be traumatic: the result of the sudden, forceful movement of the skull and neck, as with whiplash caused by a car accident, a fall, or an athletic collision”. (4) Headaches associated with high fever, stiff neck. [5]

 According to a study done in 2007, approximately 47% of the global population suffers from a headache; 15-20 percent of those headaches are cervicogenic. [8]

The epidemiological researchers suggested that a higher prevalence of headache in adults is associated with neck pain. Females are more prone to develop CEH. [9]

Smartphones have become an essential object in our day-to-day life; people of almost every age have started using smartphones for different variety of tasks. Smartphones are not only used for communication purpose but also provide additional features by providing information and entertainment in our daily life, which can gradually lead to various musculoskeletal problems. [10]

“According to a survey by the National Information Society Agency in 2012, the percentage of Korean teenagers reportedly addicted to their smartphones is reported to be increasing annually”. [17]

“In South Korea, the National Information Society Agency (NIA) has developed the Korean Scale for the Internet Addiction (K-Scale) and Smartphone Scale for Smartphone Addiction (S-Scale), and this scale has been further developed into a new scale to measure the addiction level of smartphone users, and it was called the Smartphone Addiction Scale (SAS)”. [18]

“Recent studies have revealed a high prevalence of smartphone addiction in university students and not only urban but also rural school students. Studies on medical students in Jammu and Kashmir, Delhi, and Maharashtra have found a high prevalence of smartphone addiction, ranging from 34% to 40%”. [19]

According to a study 146 medical students in India, 25% scored in the addicted category in CGH. [20]

Clinical observation suggests that Forward Head Posture (FHP) and weakness of the deep cervical flexor musculature are associated with, and co-exist in, the cervical headache patient. [21]

“The forward neck posture causes severe muscle weakness in the deep neck flexors of the cervical spine, that not only reduces neck stability but also causes pain. Deep neck flexors, such as the longus capitis and longus colli, are less active than the superficial muscles, such as the anterior scalenus and sternocleidomastoid”. [24]

Recent research has found that patients with cervical pain have shown certain delays in deep neck flexor (DNF) activation when they are doing specific tasks with their upper extremity, which indicates that there must be a significant deficit in the DNF muscles of the neck which controls the cervical spine. [22]

A pilot study demonstrated and supported the theory that headaches may be cause due to abnormality of the cervical muscle strength and due to the weakness of the neck flexor musculature of the cervical spine, which may lead to abnormal stress on the upper cervical facets which are related to head and neck pain.It was reported that disability in deep neck flexor muscles in an individual with CGH makes reduction in the performance of the cranio-cervical flexion test (i.e., reduced strength or holding capacity of the DNF muscles). [21]

Cervical muscular abnormalities may lead to CGH. Involuntary muscle spasm pulls the neck from a normal neutral position, resulting in abnormal posture, muscle hypertrophy and tenderness. Abnormal posture leads to trigger point formation splenius capitus and splenius cervicis, which are considered as deep neck extensor muscles. These trigger points ultimately refer to pain in the head which causes chronic headaches with neck pain. [23]

“FHP is a condition in which the head of an individual move forward in the sagittal plane of the cervical spine, and the head of the individual is placed in front of the trunk. It also causes continuous and abnormal muscle contraction and relative compensatory action of the muscles of the sub-occipital bone, neck, and shoulders, which results in a change in the structure of the cervical lordosis”. [24]

“FHP leads to lengthening and weakness of the anterior cervical muscles and shortening of the posterior cervical muscles. If imbalances in the cervical muscles resulting from postural misalignment are prolonged, an excessive load is imposed on the muscle, eventually making the problems chronic”. [25]

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Pain, referred from a source in the neck and perceived in one or more regions of the head and/or face is one of the most important diagnostic criteria of CGH. [37] It has been noticed that patient with CGH has a high prevalence of depression. [26]

The previous studies have reported that in an individual with CGH and neck pain, the deep neck musculature is primarily affected which is the primary cause of pain and weakness in the neck region. [27,28] Also it has been proposed that chronic smartphone use may lead to weakness of deep neck flexors muscle group. [30,31] However, in the recent years due to excessive usage of smartphones neck pain and CGH is common among individuals but there is no study which concluded the occurrence. So, this study is undertaken to exclusively identify the Prevalence of Deep neck flexor weakness and Deep neck extensor tightness in college going students suffering with CGH.

1. **Methodology:**

A Cross-sectional Survey study was conducted among College students age between 18 to 30 years. A total 298 college students in Kolkata were participated in the study and were Assessed for the prevalence of deep neck flexor weakness and deep neck extensor tightness.

The students whose age ranges from 18 to 30 years and suffering from CGH were included in the study. [14] Cervical spondylosis, Cervical radiculopathy, Inflammatory arthropathy of the cervical spine, Patients on medication or any other treatment and Cervical trauma or post surgical case were excluded from the study

 All participants of this study were given a university-approved consent form. The participants were given Korean smartphone addiction scale which is a 1-6 points scale questionnaire which contain 48 questions related to smartphone addiction [29]. Those who were smartphone addicted i.e. whose score came more that 40% (inclusion criteria) were included in the study for further assessment. The students suffering from CGH and smartphone addicts were assessed with pain pressure threshold algometer which is a reliable and valid tool. [32] Research process started only after receiving the signed consent from the participants. Data was collected from the measurements taken from the instruments. Participants were free to withdraw their participation without prejudice.

This SAS will measure smartphone addiction which uses 48 items which are: divided into 7 subscales daily- i.e., daily-life disturbance, disturbance of reality testing, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance. Each item was assigned 1–6 points, where 6 denotes severe addiction and 1 denotes minimal addiction. On the basis of the scoring in the questionnaire, the total points were calculated out of 288. The inclusion criteria for the participant to be recognized as smartphone addicted is 0.40 or 40% of 288. The internal-consistency test result (Cronbach’s alpha) was 0.97. [12]

For assessing the strength of the deep neck flexors, the pressure Biofeedback unit is used and the neck in supine lying. [33] The possible trigger points were identified by palpating the sub occipital muscles (deep neck extensors), then the pain pressure algometer which has a 1cm square rubber tip, was vertically placed under the identified trigger points by palpating both right and left deep neck extensors. The algometer exerts a vertical force on the tender point, when the pressure sensation changes into pain sensation the pressure was noted. The deep neck flexor strength was measured using pressure biofeedback stabilizer. The patient was asked to perform supine lying with the cervical spine in a neutral position and a pressure biofeedback stabilizer unit was placed under the cervical spine which is inflated to 20mmHg and the patient is asked to slowly nod the head and hold for 10 seconds 3 times. If the patient can do, the pressure in the sensor is increased by 2mmHg and the process is repeated. In addition, the research process was explained in full. [22]

For assessing the tightness of the deep neck extensors, the pain pressure threshold is placed vertically on the tender point on the neck and vertical pressure is applied. When the pressure changes to pain, the value is noted. [23]

Patient position- Patient where on prone lying, therapist where on the side of the patient near the cervical region therapist then kept Algometer indicator on then the algometry placed over the sub occipital region of the patient. Pressure exerted on that region and initial pain agrrevesion was noted from the Algometer. (Pain pressure threshold normal value is for sub occipital region for healthy people is 4.07 kg/cm2). [23]

All participants of this study were given a consent form approved from the university. Full explanation of the importance of research and follow up was given to the participants in a language understand by them.

The research was started only after receiving the consent form from the participants with their signature. The participants were explained that they are free to withdraw their participation at any point of time without prejudice.

Confidentiality of identity and health status records was kept for all participants who were taken part in this study.

1. **Statistical Analysis**

Data was derived from the following questionnaire SAS, PBS and PPT Algometer. Demographic questioner formulated by the researcher to analyse the risk factor. The obtained data were analysed using descriptive statistics of Mean, Standard deviations, Minimum and Maximum values of continuous data and frequency and percentage value of nominal and ordinal data. Pearson correlation was used as test statistics that measures the statistical relationship between DNF and DNE. The statistical package for the social science SPSS trial version 27 was used for data analysis.

1. **Results:**

298 college students within the age group of 18-30 years were assessed for smart phone using by the Smartphone addiction scale. These question give a direct approach through their daily smartphone uses.

Normally the addiction Score 115.2 above of that is considered as smartphone addicted. In our study the mean value of Smartphone addiction scale score is 146.18 which shows all the participants is above the baseline value of smartphone addiction.

The mean value of deep neck flexor weakness among 298 students is 25.006 ± 3.497 as measured using Pressure Biofeedback stabilizer.

The mean value of 298 participants for deep neck extensor tightness of Rt. side of the neck is 23.49 and SD ± 5.316.

The mean value of 298 participants for deep neck extensor tightness of Lt. side of the neck is 23.59 and SD ± 5.53.

Table 1: Frequency distribution of Age, BMI, Smartphone addiction with Deep neck flexor weakness and Deep neck extensor tightness

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| --- | --- | --- |
| **Frequency** | **Participants (n)** | **Mean**±**SD** |
| **Age**  | 298 | 21.68±2.09. |
| **BMI** | 298 | 23.869±4.11 |
| **Smartphone Addiction scale score** | 298 | 146.186±14.229 |
| **Deep Neck Flexor Weakness** | 298 | 25.006±3.497 |
| **Deep Neck Extensor Tightness- Right** |  | 23.496±5.316 |
| **Deep Neck Extensor Tightness- Left** |  | 23.593±5.539 |

Table 2: Correlation between Right deep neck extensor tightness and deep neck flexor weakness

|  |  |  |
| --- | --- | --- |
|  | **DEEP NECK FLEXOR WEAKNESS** | **DEEP NECK EXTENSOR TIGHTNESS- Right** |
| **Pearson Correlation** |  1 |  0.074 |

The Pearson correlation for the right deep neck extensor muscles comes to be positive i.e. deep neck flexor weakness and deep neck extensor tightness for the right side have a positive correlation.

Table 3: Correlation between Left deep neck extensor tightness and deep neck flexor weakness

|  |  |  |
| --- | --- | --- |
|  | **DEEP NECK FLEXOR WEAKNESS** | **DEEP NECK EXTENSOR TIGHTNESS- Left** |
| **Pearson Correlation** | 1 | -0.093 |

The Pearson correlation for the left deep neck extensor muscles comes to be negative i.e. deep neck flexor weakness and deep neck extensor tightness for left side have negative correlation

1. **Discussion**

The present study was conducted on 298 students aged between 18-30 years. All the participants underwent the 6-point scale assessment, which consists of 48 questions. The 6-point scale consists of 1-6 points marked in by the participants given in the smartphone addiction scale questionnaire.

The association of smartphone use with new-onset headache and/or increased intensity of headaches in patients with primary headache was explored in a cross-sectional study by Pratik Uttarwar et al. in age group >14 years. 400 individuals were enrolled in the trial, of whom 206 used smartphones and 194 did not. The study found that the headache characteristics were similar in both groups, except for a higher occurrence of aura in the smartphone user group. However, there was a higher proportion of patients taking analgesics in the smartphone user group. [38]

The study by Demirci S et al. in 2016 which investigated the frequency of headaches in smartphone users and compare the characteristics of headaches between smartphone users and non-users among university students. The study involved 242 participants who were divided into three groups: smartphone non-users, low smartphone users, and high smartphone users. The findings revealed that headache complaints were significantly higher in high smartphone users than in low smartphone users and non-users. [34]

 In our study, smartphone addiction was measured using the 6-point smartphone addiction scale, where out of 298 participants took part in the study. The Mean ± SD score for the 298 participants comes to be 146.186±14.229 out of 298. The inclusion criteria for being smartphone addicted is 0.4, i.e.,115.2/288. The participant included in this study had SAS score of more than the inclusion criteria, i.e. 115/298.

In this study using the Pearson correlation was found to be a positive correlation, i.e. 1 for deep neck flexor weakness and 0.074 for right deep neck extensor weakness, which means the right deep neck extensors are more prone to develop tightness and tenderness along with weak deep neck flexors in a patient with cervicogenic headache.

The Pearson correlation was done between the left deep neck extensors and deep neck flexors, which was found to be negative, for the left deep neck extensors, it is -0.093, and for the deep neck flexors it is 1, which means the tightness of the left deep neck extensors will negatively influence with the strength of the deep neck flexors.

In a study done by Giovanni Battista in 2021, they found that out of 4215 unilateral migraine pain attacks, 3412 are right-handers, where 62.8% of the pain is perceived on the right side and 37.2% perceived on the left side. Other 803 are left-handers, where 63.5% of pain attacks are on the left side, and 36.5% of pain attacks are on the right side. [35] This signifies the hand dominance and the side of pain has a positive correlation. Similarly, in our study we also found that Depp neck flexor weakness has its positive correlation with Right deep neck extensor tightness. So right hand dominance might be the probable cause for the same.

In a study by Priyal P Shah in 2018, a correlation study was done on smartphone addiction and text neck syndrome, which states that the neck disability among smartphone addicted users might be a result due to frequent neck flexion posture, which changes the natural curve of the cervical spine, which gradually increases the stress on the cervical spine, leading to irritation and spasm in the surrounding skeletal

Structures. [36] The exposure while text messaging on a smartphone consists of low physical load, repetitive thumb movements and excessive neck flexion. Text neck syndrome most commonly causes neck pain which directly affects the cervical spine while flexing the head forward at varying degrees - when the head tilts forward at 15 degrees, the force on the neck increases to 27 pounds; at 30 degrees, the force is 40 pounds, at 450 degrees 49 pounds and 60 degrees 60 pounds. Hence dominance of right-handedness in smartphone usage led to an increased trigger point on the right deep neck extensors, which positively correlates with the weakness of the deep neck flexors with respect to the left deep neck extensors in this study.

**CONCLUSION:**

This study signifies that deep neck flexor weakness and right deep neck extensor tightness and trigger point formation is having a positive correlation. It means deep neck flexor weakness may lead the formation of trigger point formation at right deep neck extensor muscles.

**Limitations:**

The study used a 298 sample size, which limited the strength of statistical analysis. In this study, we only observed the correlation between Deep neck flexor weakness with right and left deep neck extensor tightness in smartphone addicted college going students suffering from CGH.

**Future recommendation:**

A future study with a large sample size from different colleges of the west Bengal both urban and rural can be done.

There is a need to find out risk factors and suitable preventive measures for minimize problems of students using smartphones for long hours and suffering from CGH.

**Social Impact:**

While this study provides insight into the muscular involvement in CGH, college students must be more aware about the maintenance of posture as they spent maximum amount of time into it both during educational and recreational activities.

**Consent:**

**A written informed consent has been obtained from each participants those who included in this study**

**Ethical Approval:**

**Institutional Ethical Committee approval has been obtained prior to the formulation and conduction of this study**

**Abbreviation:** Cervicogenic Headache (CGH), International Headache Society (IHS), Pain Pressure Threshold(PPT), Deep Neck Extensor(DNE), Deep Neck Flexor(DNF), Cervicogenic Headache International Study Group’s (CHISG), National Information Society Agency (NIA), Korean Scale for the Internet Addiction (K-Scale)

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Disclaimer (Artificial intelligence):**

We hereby declare that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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