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Association Of Elevated Blood Pressure With Cervical Spine Dysfunction: A Cross-Sectional Study

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Abstract

Objective
To determine the association between elevated blood pressure and cervical spine dysfunction.

Methodology
A cross-sectional study was conducted over a period of four months in cardiology and general medicine departments of government and private hospitals and clinical setups of Mansehra and Abbottabad. Sample size was 354. A non-probability convenience sampling technique was used. Data were collected using a self-structured questionnaire. Data were analyzed using SPSS version 22.0.

Results
Out of 354 participants, 234(66.1%) were female and 129(33.9%) were male. Neck pain or stiffness was reported by 284 participants (80.2%). The mean systolic and diastolic blood pressure were 149.01±44.61 mmHg and 94.68±16.00 mmHg, respectively. A statistically significant difference was demonstrated in systolic BP between participants with and without neck pain or stiffness (U=8073.0, p=0.014), while no significant difference was observed for diastolic blood pressure (p=0.269).

Spearman's correlation revealed a weak but significant positive correlation between frequency of neck pain per month and systolic BP (ρ=0.147, p=0.006), whereas the correlation with diastolic BP was not significant (p=0.158)

Conclusion

The study demonstrated a significant association between cervical spine dysfunction and elevated systolic blood pressure. Participants with neck pain or stiffness showed higher systolic blood pressure and more frequent blood pressure spikes.

Introduction

Hypertension is a chronic non-communicable disease characterized by a persistent elevation of systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg on repeated standardized measurements(1) . It is one of the leading causes of cardiovascular morbidity and mortality worldwide and is often referred to as a silent killer due to its asymptomatic presentation in early stages(2) The pathophysiology of hypertension is multifactorial and involves complex interactions between genetic, environmental, neural, hormonal, and vascular mechanisms (2). (3)One of the central mechanisms is increased sympathetic nervous system activity, which results in vasoconstriction, increased heart rate, and elevated cardiac output(4). Activation of the renin–angiotensin–aldosterone system further contributes to sodium and water retention, increased blood volume, and heightened peripheral vascular resistance(5). Common symptoms of HTN include headaches, dizziness, blurred vision, palpitations, fatigue, epistaxis, tinnitus, and chest discomfort (6) Prolonged uncontrolled hypertension results in complications such as ischemic heart disease, left ventricular hypertrophy, cerebrovascular accidents, hypertensive retinopathy, nephropathy, and peripheral arterial disease(2)

Globally, about 1.4 billion adults aged 30–79 years have hypertension, this represents 33% of the population of this age range and nearly half are unaware of their condition(7).The global age- standardized prevalence of hypertension among adults was 32% (30 -34 years) in women and 34% (32-37) in men(8). In Europe 22% of population aged 15 years and over have high blood pressure(9) while in Canada approximately one in four adults has hypertension (10) Whereas in Middle East and North Africa the pooled prevalence of pre-HTN and HTN were 33% and 26% respectively. Over the past three decades, prevalence of hypertension increased significantly in the region(11) In 2021 UAE reported that the pooled prevalence of hypertension was 31% (aged 27–36), and a higher prevalence was observed in Dubai (37%) than in the Abu Dhabi region (29%) (12) According to research the prevalence of HTN was 9.2% among Saudi population aged 15 years and older in 2023. It was relatively higher in women (10.0%) than in men (8.5%). Which increased with advancing age (aged 65 years and older), accounting for 55.3% in women and 48.0% in men(10) In South Asia, prevalence ranges between 25–40% due to rapid lifestyle changes(11) In Pakistan, national surveys estimate that approximately 18% of adults and over 33% of individuals above 45 years of age are hypertensive, highlighting a significant public health challenge(11) where in Punjab prevalence of hypertension was reported to be 35.1%. (16)Where as in Peshawar the prevalence rate of hypertension was 38.5% (17) with KPK having the prevalence rate (29.2%), showing a significant difference between females (32.7%) and males (25.0%) (13). Hypertension is a leading contributor to the global burden of non- communicable diseases. According to a 2025 World Health Organization (WHO) hypertension report, uncontrolled high blood pressure remains a primary cause of death and disability, contributing significantly to healthcare demands and lost productivity internationally (11). In high-income countries such as the United States, annual medical expenditures associated with high blood pressure were estimated at about $219 billion in 2019, with individuals having hypertension incurring approximately $2,759 more each year in

medical costs than those without hypertension Several studies have suggested an association between cervical spine dysfunction and elevated blood pressure. Clinical evidence indicates that cervical spondylosis and related disorders may contribute to hypertension through autonomic dysregulation and sympathetic overactivity 27 Spinal manipulation and cervical mobilization have been shown to influence cardiovascular autonomic activity, supporting a potential link between cervical musculoskeletal function and blood pressure regulation (14)

The pathophysiology of cervical spine dysfunction involves degenerative disc changes, facet joint arthropathy, muscle tightness, weakness of deep cervical flexors, altered neuromuscular control, and impaired proprioceptive input(15). Chronic cervical dysfunction is a result of joint hypomobility and muscle imbalance brought on by prolonged poor posture and repetitive strain. These biomechanical and neuromuscular changes may also affect adjacent neurovascular structures, including the cervical sympathetic chain. The cervical spine has a close anatomical and functional relationship with the autonomic nervous system. The cervical sympathetic chain plays a crucial role in regulating vascular tone, heart rate, and blood pressure(3). Dysfunction in the cervical region may lead to increased sympathetic activity and reduced parasympathetic influence, resulting in elevated blood pressure (16). Altered afferent input from cervical mechanoreceptors may further disrupt central autonomic regulation. Dysfunction or disorders of the cervical spine can therefore lead to a spectrum of symptoms, ranging from localized pain to neurovascular deficits. The cervical spine is closely related to autonomic nervous system regulation through the cervical sympathetic chain and vertebral arteries(16). Cervical spine dysfunctions, such as restricted mobility, muscle spasm, and postural abnormalities, may potentially influence autonomic activity, vascular tone, and thereby affect systemic blood pressure.

Methodology

This study was carried out in the outpatient departments, particularly in the Cardiology and General Medicine departments of government and private hospitals, and clinical setups in Mansehra and Abbottabad. This Study was a cross-sectional study conducted to determine the association between elevated blood pressure and cervical spine dysfunction. A non-probability convenience sampling technique was used to recruit participants Sample size was calculated using Rao soft. The total sample size calculated was n=354, which was calculated from the total resident of the inclusive age group i- e 3216249 from the population census 2023 i-e 365244 (17) Which was then multiplied with the prevalence of hypertension i-e 29.2% [18] with confidence interval of 95% and the response distribution of 36.07% which is prevalence of cervical dysfunction[51]. The duration of this study was almost four months Inclusion Criteria. Adults aged 20-60 years with diagnosed hypertension. Willing to participate and comply with study procedures. Both male and female were included. Exclusion Criteria Known cardiovascular diseases (other than hypertension) Recent cervical trauma or surgery. Cognitive or communication problems (MMSE <24).

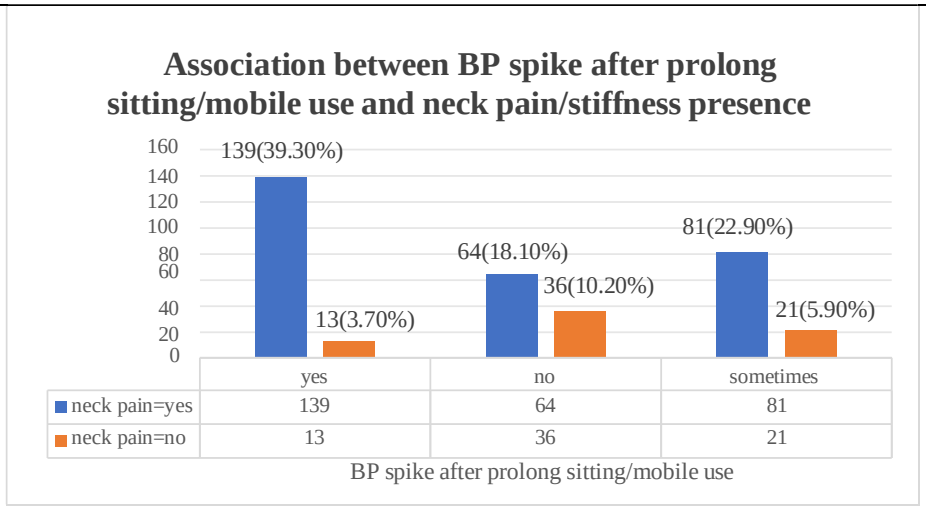
Data Analysis

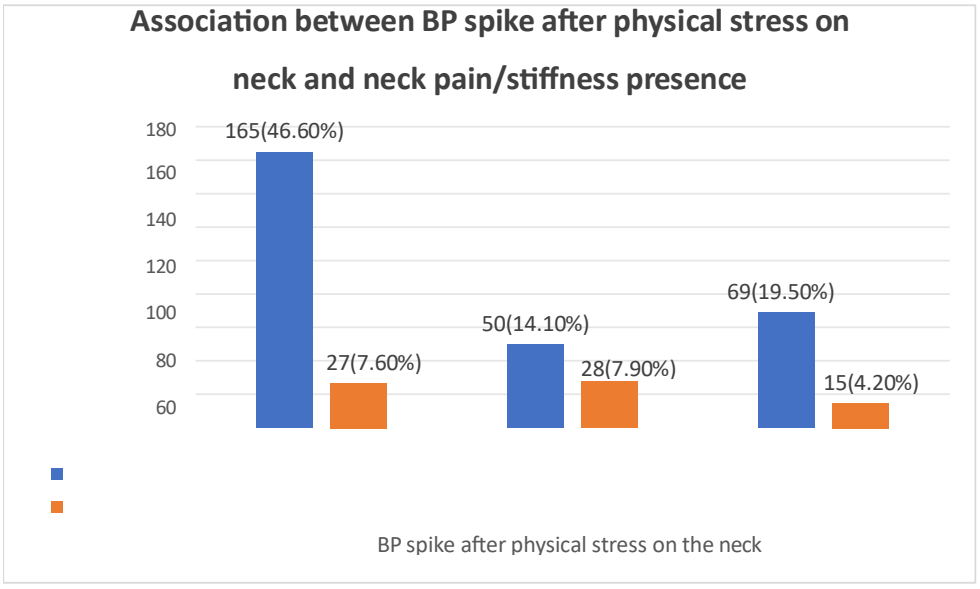
SPSS (Statistical Package for Social Sciences) version 22.0 was used to analyze the data. There was an analysis of descriptive statistics. For continuous variables, the standard deviation and mean were calculated. For categorical variables, frequencies and percentages were computed. And the data was checked for normality using Kolmogorov Smirnov test. As the data was non-parametric, it was analyzed using the Mann-Whitney Test, Spearman correlation, and Chi square test.

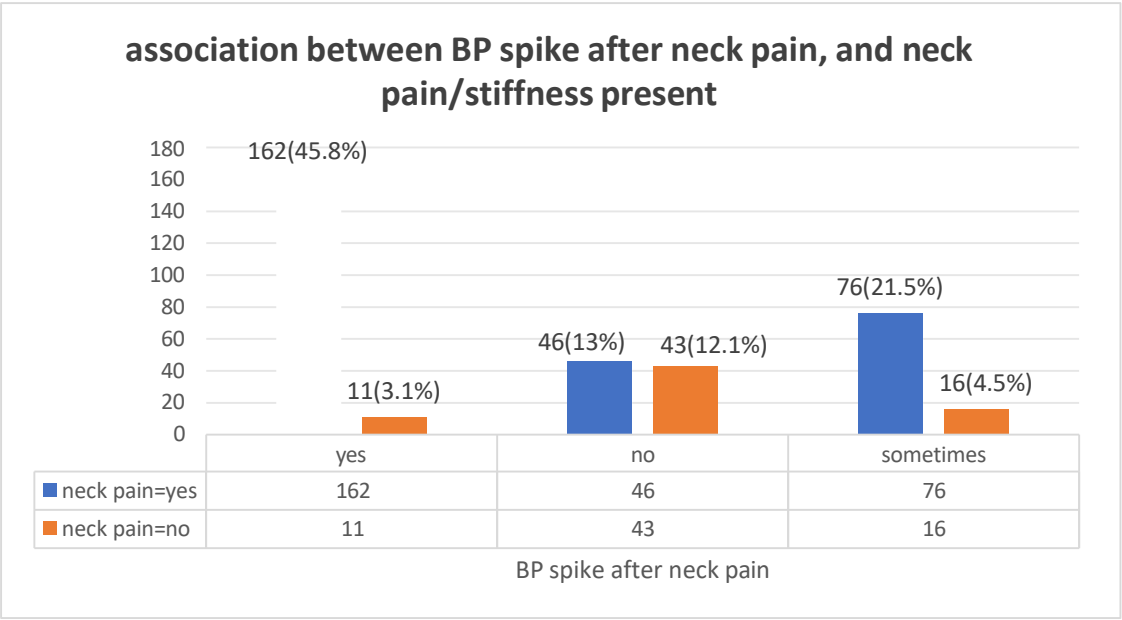
Results

cervical spine related symptoms, lifestyle factors, and their perceived association with elevated blood pressure among the participants (n = 354). Most participants were female (234, 66.1%), and a large proportion were on antihypertensive medication (279,

78.8%). Neck pain or stiffness was reported by 284 participants (80.2%). Blood pressure was most commonly monitored only during symptomatic episodes (164, 46.3%), while 68 (19.2%) monitored it daily. Frequent stress or anxiety was reported by 211 participants (59.6%), and neck stiffness during stress was reported by 213 (60.2%). Blood pressure worsening with neck issues was perceived by 177 participants (50%), and 153 (43.2%) reported that neck symptoms and blood pressure occurred at the same time of day. Neck or shoulder tightness before blood pressure monitoring was reported by 176 participants (49.7%). Blood pressure spikes were noted after neck pain episodes by 173 (48.9%), after prolonged sitting or mobile use by 152 (42.9%), and after physical stress on the neck by 192 (54.2%). Regular physical activity was reported by 148 participants (41.8%), while prolonged sitting (>5 hours/day) was reported by 161 (45.2%). Neck tightness after prolonged sitting was present in 209 participants (59%). Only 115 participants (32.5%) reported improvement in blood pressure symptoms following neck treatment.







Discussion

The present study was conducted to examine the association between cervical spine dysfunction and elevated blood pressure among hypertensive adults. The results showed that blood pressure changes, especially systolic blood pressure, are substantially correlated with cervical spine dysfunction, indicating a possible role for cervical musculoskeletal impairment in hypertension. People with neck pain or stiffness had higher systolic blood pressure readings and more frequent blood pressure changes than people without cervical symptoms. These results imply that blood pressure dysregulation may be exacerbated by cervical spine dysfunction, possibly through altered autonomic nervous system activity and cervical neurovascular processes.

Participants who reported neck pain or stiffness had significantly higher systolic blood pressure values than those who did not. This finding suggests that malfunction of the cervical spine may have an impact on blood pressure management, particularly systolic blood pressure. Given that there was no statistically significant difference in diastolic blood pressure between patients with and without neck discomfort, cervical dysfunction may have a higher effect on systolic blood pressure than diastolic blood pressure.

These findings are consistent with past research emphasizing the role of the autonomic nervous system in blood pressure regulation. Systolic blood pressure is more affected by sympathetic nervous system activity, vascular tone, and stress-related responses. Dysfunction of the cervical spine, particularly in the higher cervical segments, can alter proprioceptive input and result in sympathetic overactivity through the cervical sympathetic chain. Yung and associates reported similar results(18). By demonstrating reductions in systolic blood pressure following cervical mobilization in patients experiencing mechanical neck discomfort, he demonstrated the influence of cervical therapies on cardiovascular parameters.

The correlation analysis in the current study further supported this association. There was a small but statistically significant positive correlation between the monthly frequency of neck pain and systolic blood pressure. This suggests that cervical pain episodes are more common in those with higher systolic blood pressure. Since blood pressure regulation is influenced by several connected processes, the weak link is nevertheless clinically meaningful. The lack of a significant correlation between the frequency of neck pain and diastolic blood pressure may be explained by the relatively stable nature of this measurement, which depends more on chronic peripheral vascular resistance than on sudden autonomic fluctuations.

The findings of this study are in line with those of Peng et al. (16) and Cui et al. (19), who found that patients with anomalies of the cervical spine who had cervical treatment

or decompression experienced improvements in their blood pressure. These results support that autonomic and neurovascular pathways may cause hypertension when the cervical spine malfunctions. The significance of cervical alignment and posture in regulating cardiovascular health was therefore confirmed by Malik et al.(20) and Kadu et al.[1] who demonstrated that those with forward-leaning heads had higher blood pressure readings.

Another important finding of this study was the high proportion of participants who reported blood pressure increases following neck pain episodes, prolonged sitting or mobile use, and physical stress on the neck. Most individuals who reported significant increases in blood pressure complained neck pain or stiffness. extended neck flexion, increased cervical muscular stress, and postural strain are all associated with extended sitting and movement, and these factors can exacerbate cervical dysfunction. This mechanical stress may cause an increase in afferent input from cervical mechanoreceptors, which would raise sympathetic activity and momentarily raise blood pressure.

The connection between physical strain on the neck and blood pressure increases highlights the role that mechanical loading plays in cervical spine dysfunction. Stress can result in muscle spasms, joint pain, and neural compression, all of which can set off the cervical sympathetic chain and alter cardiovascular responses. Research demonstrating increased sympathetic activity and decreased heart rate variability in patients with chronic neck pain and postural issues supports these findings.

The majority of participants reported having stiff necks under stress, and they commonly reported feeling apprehensive and disturbed. Psychosocial stress is a known cause of hypertension and is intimately associated with the activation of the sympathetic nervous system. Stress, cervical muscular tension, and high blood pressure all coexisted in this study, indicating a reciprocal link in which stress makes cervical dysfunction worse and cervical dysfunction makes autonomic imbalance worse. The frequent co-occurrence of participants' reported blood pressure variations and neck pain may be explained by this interaction

The current study also found lifestyle factors that could be linked to hypertension and cervical spine dysfunction. Many individuals said they sat for extended periods of time each day and did not engage in regular physical activity. Poor posture, decreased cervical muscular endurance, increased musculoskeletal strain, and an increased risk of cardiovascular disease are all linked to sedentary activity. These results are consistent with earlier studies showing that prolonged static postures and physical inactivity are linked to both hypertension and musculoskeletal discomfort.

Only a small percentage of individuals reported an improvement in blood pressure after receiving neck treatment, despite the high prevalence of cervical complaints. Physical therapy, however, was the most often used strategy among those who did report improvement. According to this research, physiotherapy-based treatments such as exercise, cervical mobility, and posture correction may help with blood pressure control and cervical discomfort. The small number of individuals undergoing cervical therapy indicates a lack of knowledge about the possible contribution of musculoskeletal management to the treatment of hypertension.

A few of the current study's conclusions did not entirely align with earlier research. Although some studies have shown that cervical therapies, such as decompressive cervical surgery in patients with hypertension who have cervical spondylosis, can lower both systolic and diastolic blood pressure, (21), Chinese massage, or tuina, and its impact on cervical hypertension(22), The current investigation showed a strong correlation, mostly with systolic blood pressure. Variations in study design, demographic characteristics, assessment methods, and intervention procedures could be the cause of this disparity. The current study's cross-sectional design restricts the ability to draw conclusions about causality and might miss long-term vascular changes that affect diastolic pressure.

Furthermore, differences in the results could have been caused by differences in the severity of cervical dysfunction, length of hypertension, medication use, and age distribution. The majority of trial participants were already using antihypertensive drugs, which might have lessened the impact of increases in diastolic blood pressure. This may help to explain why cervical dysfunction was more strongly associated with systolic blood pressure than with diastolic blood pressure

Overall, the findings of this study support the growing body of evidence suggesting a connection between cervical spine dysfunction and high blood pressure. Although a causal relationship cannot be established, the correlations indicate that cervical dysfunction may play a role in blood pressure dysregulation, particularly through autonomic nervous system pathways. These findings demonstrate the importance of treating hypertension holistically, integrating medication with musculoskeletal assessment, posture correction

Conclusion

The investigation's findings showed a clear connection between high blood pressure and cervical spine dysfunction. Along with symptoms linked to posture, stiffness, and neck pain, a considerable portion of patients also experienced blood pressure changes. Prolonged sitting, poor posture, and physical strain on the neck were often linked to elevated blood pressure. These findings suggest that cervical musculoskeletal factors may have an impact on blood pressure regulation.

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