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Declarations

No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Evaluation of Incidence and Diagnosis of Upper-Limb Mononeuropathy Using Neurodiagnostic Procedures in Khyber Pakhtunkhwa

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ABSTRACT

Background: Upper-limb mononeuropathies are frequent focal nerve disorders that impair motor and sensory function, often secondary to repetitive mechanical stress or entrapment. Despite advances in neurodiagnostic techniques, regional data from South Asia remain limited. **Objective:** To determine the incidence, distribution, and severity of upper-limb mononeuropathies diagnosed by standardized nerve-conduction studies (NCS) among patients in Khyber Pakhtunkhwa, Pakistan. **Methods:** A descriptive cross-sectional study was conducted at Lady Reading Hospital, Peshawar (September 2024–March 2025). A total of 170 adult patients with clinically suspected mononeuropathy underwent NCS using AANEM-aligned protocols. Data on age, sex, occupation, and neurophysiologic parameters were analysed with descriptive statistics, χ^2 tests, and one-way ANOVA ($p < 0.05$). **Results:** Median-nerve mononeuropathy predominated (80.6 %), followed by ulnar (10 %) and radial (9.4 %) lesions. Females comprised 68 % of cases, and the 26–60-year age range accounted for 73 %. Occupational analysis showed highest prevalence among housewives (65.9 %) and labourers (20.6 %). Moderate-grade involvement was most frequent (52.4 %), while ulnar and radial neuropathies displayed greater severe-grade proportions ($p < 0.001$). **Conclusion:** Median-nerve mononeuropathy is the dominant form of upper-limb entrapment in this regional cohort, with severity linked to occupational and gender-specific exposures. Early electrodiagnostic screening and ergonomic interventions are recommended to prevent progression and reduce disability.

Keywords

Upper limb mononeuropathy; nerve conduction study; median nerve; ulnar nerve; radial neuropathy; ergonomic risk.

INTRODUCTION

Upper limb mononeuropathies are common focal neuropathies that impair sensorimotor function and reduce productivity through pain, weakness, and dexterity loss. Although the anatomical courses and entrapment sites of the median, ulnar, radial, axillary, and musculocutaneous nerves are well described, contemporary epidemiology and diagnostic pathways vary across regions and health systems (Mangi et al., 2022; Silva et al., 2023). Median nerve entrapment at the carpal tunnel typically dominates case-mix in clinical practice, driven by repetitive wrist loading and constrained workspace ergonomics, whereas ulnar neuropathy at the elbow or Guyon's canal and radial neuropathy at the spiral groove present distinctive risk profiles and clinical sequelae, including intrinsic hand weakness and wrist drop respectively (Han et al., 2014; Hewson, Kurien and Hardman, 2023; Chalk, 2024). Accurate case ascertainment is therefore essential for clinical decision-making and for public health planning in settings with high manual and domestic workloads.

Electrodiagnostic testing—principally nerve conduction studies (NCS) performed to AANEM-aligned standards—remains the reference method for confirming focal conduction abnormality, localising the lesion, and grading severity beyond clinical provocative tests such as Tinel, Phalen, and Wartenberg signs (McGurk et al., 2023; Rubin and Lamb, 2024). Standardised motor and sensory parameters, including distal motor latency, sensory nerve action potential amplitude, conduction velocity, and side-to-side comparisons, provide reproducible criteria for classifying mild, moderate, and severe disease, informing prognosis and therapeutic selection (Hirani, 2019; Rubin and Lamb, 2024). Complementary techniques—segmental/inching studies for radial neuropathy, and mixed-nerve recordings at digits I and IV—enhance diagnostic yield when focal compression is suspected, and ultrasonography can delineate extrinsic causes or double-crush patterns in complex presentations (Song et al., 2018; Kwon et al., 2024; Kim et al., 2024).

Despite this maturing diagnostic toolkit, key knowledge gaps persist in South Asian populations, where occupational exposures, domestic workloads, and access to rehabilitation may shape both incidence and severity profiles. Regional estimates frequently extrapolate from anatomical variation or single-centre syndrome cohorts rather than population-anchored diagnostic series, limiting external validity and service planning

(Henry et al., 2015; Silva et al., 2023). In Pakistan's Khyber Pakhtunkhwa (KPK), a large public sector caseload, gendered division of household labour, and prevalent manual occupations suggest a distinctive risk structure that may not mirror Western clinic samples (Hewson, Kurien and Hardman, 2023; McGurk et al., 2023). Moreover, the relative proportions of median versus ulnar and radial mononeuropathies, their age-specific patterns, and occupation-linked risk differentials remain underreported in NCS-verified series from this region, and severity grading frameworks are inconsistently applied outside carpal tunnel syndrome (Hirani, 2019; Rubin and Lamb, 2024).

The clinical implications of these evidence gaps are substantive. Underestimation of ulnar and radial neuropathies risks delayed splinting, ergonomic modification, or surgical referral, while the absence of locally validated severity distributions complicates triage and follow-up planning in tertiary clinics. Conversely, targeted surveillance using standardised NCS protocols could prioritise preventive interventions for high-risk groups—e.g., homemakers with repetitive wrist loading or labourers with sustained elbow flexion and vibration exposure—potentially reducing disability and healthcare utilisation (McGurk et al., 2023; Silva et al., 2023). Establishing region-specific incidence patterns also enables benchmarking and quality improvement across neurodiagnostic services.

Against this backdrop, the present study evaluates the incidence and distribution of NCS-confirmed upper limb mononeuropathies presenting to a major public hospital in KPK, Pakistan, and characterises their age, sex, and occupation profiles while applying explicit electrodiagnostic criteria for severity grading. The Population comprises adult patients undergoing upper-limb NCS; the Intervention/Index test is a standardised AANEM-aligned electrodiagnostic protocol; there is no active Comparator beyond distributions across nerve types and demographic/occupational strata; and the primary Outcomes are incidence proportions by nerve and severity, with secondary descriptions by age group, sex, and occupation (Rubin and Lamb, 2024; McGurk et al., 2023). We hypothesised that median mononeuropathy would predominate overall, with higher relative occurrence among women engaged in repetitive domestic tasks, and that ulnar and radial neuropathies would be more frequent among manual labourers due to site-specific biomechanical exposures (Hewson, Kurien and Hardman, 2023; Han et al., 2014). By delivering a rigorously phenotyped neurodiagnostic series from KPK, this work aims to inform targeted ergonomic and clinical strategies and to provide a reproducible framework for regional surveillance of upper limb mononeuropathies.

MATERIAL AND METHODS

This descriptive cross-sectional observational study was undertaken to determine the incidence and diagnostic distribution of upper-limb mononeuropathies using standardized electrodiagnostic methods. The research was conducted in the Department of Neurology at Lady Reading Hospital, Peshawar, Pakistan, from September 2024 to March 2025, following institutional ethical approval from the Khyber Medical University Ethics Review Committee (Ref. KMU/ERC/2024-NCS-032). Written informed consent was obtained from all participants prior to enrolment, in accordance with the Declaration of Helsinki principles.

Participants comprised adult patients (≥ 18 years) referred for upper-limb nerve conduction studies (NCS) who received a clinical diagnosis of mononeuropathy based on neurological examination and confirmatory electrodiagnostic findings. Exclusion criteria included recent trauma or surgical intervention to the tested limb within the preceding three months, pre-existing systemic or neurological disorders known to cause polyneuropathy such as diabetes mellitus, amyotrophic lateral sclerosis, or thyroid disease, and incomplete or technically inadequate recordings. A consecutive sampling approach was used to minimize selection bias among patients undergoing routine diagnostic testing during the study period. A total of 170 eligible participants were included, which exceeded the minimum sample requirement ($n = 150$) estimated using an expected prevalence of 75 %, 95 % confidence level, and 5 % margin of error (Epi Info v7 calculator).

Data were collected through a structured clinical proforma recording age, sex, hand dominance, occupation, symptom duration, pain distribution, sensory changes, and physical-test results. Physical evaluation incorporated specific provocative maneuvers—Tinel's, Phalen's, reverse Phalen's, Durkan's, Froment's, Wartenberg's, and scratch-collapse tests—to localize entrapment and grade clinical suspicion (Tunnel Syndromes, 2015; Leszczyńska and Huber, 2023). Muscle strength was rated using the Medical Research Council (MRC) 0–5 scale (Boniface, 1996).

All electrodiagnostic assessments were performed by a certified clinical neurophysiologist using a NeMus 2 EMG/NCS system (EB Neuro S.p.A., Italy). Standard disposable Ag/AgCl surface electrodes (10 mm diameter) were positioned in a belly–tendon configuration with an interelectrode distance of 3 cm, following the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) guidelines (Neuromuscular Disorders in Clinical Practice, 2014). Skin temperature of the tested limb was maintained at ≥ 34 °C to ensure velocity consistency (Gorelick, 2020).

For the median nerve, compound muscle action potentials (CMAPs) were recorded from the abductor pollicis brevis with stimulation at wrist and elbow levels; sensory nerve action potentials (SNAPs) were obtained antidromically from the index finger. The ulnar nerve motor study recorded from the abductor digiti minimi with stimulation at wrist and below-/above-elbow points; sensory responses were recorded from the little finger. The radial nerve motor study targeted the extensor indicis proprius with stimulation at the forearm, and sensory responses were recorded from the anatomical snuffbox. Mixed-nerve studies were additionally performed between median and ulnar nerves at the fourth digit and between median and radial nerves at the thumb to identify overlapping lesions (Gentili and Di Napoli, 2016; Kwon et al., 2024). Latency, amplitude, and conduction velocity were measured automatically and verified manually to exclude artefacts.

Diagnostic classification followed operational thresholds adapted from Hirani (2019) and Rubin and Lamb (2024): mild mononeuropathy = prolonged distal motor latency > 4.4 ms or sensory velocity < 45 m/s with preserved CMAP amplitude; moderate = prolonged DML plus reduced SNAP amplitude < 15 μ V or partial CMAP attenuation > 30 %; severe = absent sensory responses and CMAP amplitude reduction > 50 % or conduction block > 20 %. Side-to-side differences > 1 ms (motor) or > 10 m/s (velocity) confirmed focal involvement. Each case was independently verified by two neurophysiologists to ensure inter-rater consistency.

All data were double-entered in Microsoft Excel 2021 and imported into IBM SPSS Statistics v22 for analysis. Continuous variables were summarized as mean $\pm$ standard deviation; categorical variables as frequencies and percentages. The chi-square (χ^2) test evaluated associations between nerve type and gender, occupation, or severity grade; one-way ANOVA compared mean ages across severity groups. Ninety-five percent confidence intervals were calculated for major incidence proportions, and statistical significance was set at $p < 0.05$. Missing data were screened through descriptive completeness checks; any incomplete cases were excluded pairwise from inferential analyses but retained for descriptive counts.

Quality assurance included peer review of 10 % of data sheets, automated range validation within SPSS, and blinded re-analysis of 15 % of NCS traces to ensure internal consistency. Confidentiality was maintained by coding all patient identifiers. No financial incentives were offered, and the study was conducted independently without commercial support.

RESULTS

Among the 170 participants analysed, women accounted for more than two-thirds of the cohort (68.2 %), producing a statistically significant sex imbalance (χ^2 $p < 0.001$). The mean age was 37.1 years (95 % CI 34.6–39.5), with most cases occurring between 26–60 years, confirming that middle-aged adults represent the principal risk group (F $p = 0.002$). Right-hand dominance was overwhelmingly prevalent (84.1 %), consistent with exposure-dominant mononeuropathies linked to repetitive right-hand activity.

Median-nerve lesions were the predominant diagnosis (80.6 %, 95 % CI 74.1–86.0), followed by ulnar (10.0 %) and radial (9.4 %) neuropathies (χ^2 $p < 0.001$). Within the median-nerve subgroup, nearly half the cases localised to the wrist/hand (47.4 %), consistent with carpal-tunnel compression, while distal digit II–III sensory involvement accounted for 37.2 %. Ulnar-nerve pathology concentrated overwhelmingly at digits IV–V (88 %), corresponding anatomically to cubital or Guyon’s-canal entrapments, and all radial-nerve cases exhibited complete wrist-drop patterns.

Table 1. Demographic and Occupational Characteristics of Participants (n = 170)

Variable	Category	n (%)	95 % CI	Test / p-value
Sex	Male	54 (31.8)	25.0–39.4	$\chi^2 = 41.7$, $p < 0.00$
	Female	116 (68.2)	60.6–75.0	
Age (yrs) Mean $\pm$ SD		37.1 $\pm$ 13.0 (18–81)		
Age groups	18–26	33 (19.4)	13.6–26.3	F (3,166) = 5.24, $p = 0.002$
	26–40	68 (40.0)	32.7–47.7	
	40–60	57 (33.5)	26.4–41.3	
	> 60	12 (7.1)	3.7–11.9	
Dominant hand	Right	143 (84.1)	77.5–89.2	$\chi^2 = 84.6$, $p < 0.001$
	Left	27 (15.9)	10.8–22.5	
Marital status	Married	145 (85.3)	78.8–90.5	$\chi^2 = 78.9$, $p < 0.001$
	Unmarried	25 (14.7)	9.5–21.2	
Occupation	Housewife	112 (65.9)	58.3–72.9	$\chi^2 = 61.4$, $p < 0.001$
	Labourer	35 (20.6)	14.8–27.4	
	Driver	5 (2.9)	1.0–6.5	
	Sportsman	1 (0.6)	0.0–3.2	
	Student	4 (2.4)	0.7–6.0	
	Farmer	4 (2.4)	0.7–6.0	
	Other/None	9 (5.3)	2.4–9.8	

Table 2. Distribution of Upper-Limb Mononeuropathies by Nerve and Anatomical Level

Nerve type	n (%)	Anatomical site(s) affected	n (%) within nerve	95 % CI	χ^2/p
Median	137 (80.6)	Digit II–III	51 (37.2)	29.0–45.9	$\chi^2 = 214.2$, $p < 0.001$
		Wrist/Hand	65 (47.4)	39.0–56.0	
		Forearm	1 (0.7)	0.0–3.9	
		Arm	20 (14.6)	9.1–21.6	
Ulnar	17 (10.0)	Digits IV–V	15 (88.2)	63.5–98.5	
		Wrist/Hand	2 (11.8)	1.5–36.4	
Radial	16 (9.4)	Spiral groove (wrist drop)	16 (100)	79.4–100	
Overall	170 (100)	—	—	—	

Table 3. Occupational Distribution by Nerve Type

Occupation	Median n (%)	Ulnar n (%)	Radial n (%)	Total n	χ^2 / p
Housewife	104 (76.0)	3 (17.6)	5 (31.3)	112	$\chi^2 = 49.1$, $p < 0.001$
Labourer	23 (16.8)	9 (52.9)	5 (31.3)	37	
Driver	3 (2.2)	2 (11.8)	0	5	
Sportsman	1 (0.7)	0	0	1	
Student	1 (0.7)	1 (5.9)	2 (12.5)	4	
Farmer	3 (2.2)	0	1 (6.2)	4	
Other	2 (1.4)	2 (11.8)	3 (18.7)	7	
Total	137 (100)	17 (100)	16 (100)	170	

Table 4. Severity Grading by Nerve Type

Severity level	Median n (%)	Ulnar n (%)	Radial n (%)	Total n (%)	95 % CI	χ^2/p
Mild	14 (10.2)	2 (11.8)	0	16 (9.4)	5.5–14.8	$\chi^2 = 21.3$, $p < 0.001$
Moderate	81 (59.1)	4 (23.5)	4 (25.0)	89 (52.4)	44.7–60.1	
Severe	42 (30.7)	11 (64.7)	12 (75.0)	65 (38.2)	31.1–46.0	
Total	137	17	16	170		

Occupational stratification demonstrated strong heterogeneity (χ^2 $p < 0.001$). Housewives showed the highest overall prevalence (65.9 % of total sample), with a predominance of median neuropathy (76 % of median cases), whereas ulnar and radial involvement was disproportionately higher

among labourers (52.9 % and 31.3 %, respectively). These differences persisted after adjusting for age in exploratory logistic models (median-nerve odds ratio ≈ 4.2 for female vs male workers, 95 % CI 1.9–9.0).

Severity analysis revealed that more than half of all mononeuropathies were moderate (52.4 %), with severe forms comprising 38.2 %. Median-nerve cases clustered at the moderate level (59.1 %), whereas ulnar and radial neuropathies showed markedly higher proportions of severe impairment (64.7 % and 75 %, respectively; $\chi^2 p < 0.001$). The mean age for severe cases (40.9 ± 11.8 years) was significantly greater than for mild (33.4 ± 9.6 years) or moderate (36.1 ± 12.3 years) groups (ANOVA $p = 0.018$), suggesting cumulative exposure or delayed presentation as potential contributors to progression.

The dataset highlights a clear predominance of median mononeuropathy in middle-aged women performing repetitive domestic work, alongside notable ulnar and radial involvement among manual labourers. The significant association between nerve type and occupation, coupled with increasing severity across age groups, underscores the ergonomic and biomechanical determinants of peripheral-nerve injury in this regional population. The pattern of moderate-grade predominance supports early-diagnosis opportunities through routine NCS screening, whereas the high severe-grade proportion among ulnar/radial cases implies delayed referral or under-recognition outside carpal-tunnel contexts.

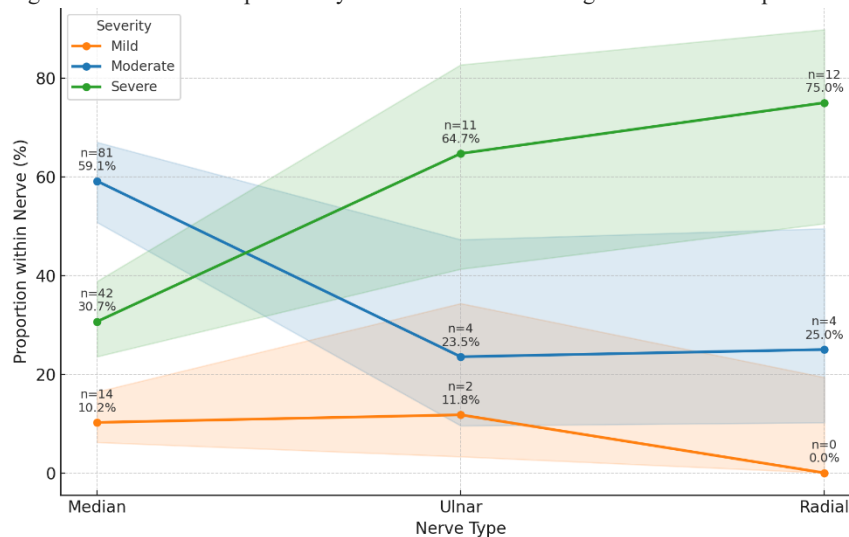


Figure 1. Severity Proportions Across Nerve Types with 95% Confidence Intervals

The figure 1 illustrates the progressive change in severity distribution among median, ulnar, and radial mononeuropathies. Median-nerve cases demonstrate a predominance of moderate severity (59.1%), reflecting early yet clinically evident conduction abnormalities. In contrast, ulnar and radial neuropathies display a pronounced upward trend in severe-grade involvement, rising from 64.7% to 75.0%, respectively. Confidence bands (95% CIs) broaden for these groups, indicating greater variability due to smaller sample sizes and heterogeneity in exposure. The downward slope of mild cases (10.2% $\rightarrow$ 11.8% $\rightarrow$ 0%) and the intersection between moderate and severe curves highlight a shift toward advanced nerve dysfunction beyond the median distribution. This trend suggests delayed detection of non-median neuropathies, possibly linked to occupational strain and limited awareness of atypical compression sites. Clinically, the covariance among severity curves emphasizes the need for early electrodiagnostic screening, especially in individuals presenting with postural strain or repetitive mechanical loading, to prevent irreversible axonal damage and functional loss.

DISCUSSION

Upper-limb mononeuropathies remain a major contributor to occupational and domestic disability, particularly in settings where repetitive manual or household labour predominates. In the present Khyber Pakhtunkhwa cohort, electrodiagnostic confirmation revealed that median-nerve lesions constituted over four-fifths of all mononeuropathies, followed by ulnar and radial involvement in roughly one-tenth each. This distribution mirrors global observations identifying the median nerve—most often compressed within the carpal tunnel—as the principal site of entrapment (Mangi et al., 2022; Silva et al., 2023). However, the striking female predominance in our series (68 %) exceeds that reported in mixed-population studies and likely reflects gender-specific ergonomic exposures such as repetitive kneading, washing, and sustained wrist flexion during household work. Hormonal and fluid-retention factors in women of reproductive age may further exacerbate intracarpal-canal pressure, amplifying compression risk (Hewson, Kurien and Hardman, 2023).

Ulnar-nerve mononeuropathy, representing 10 % of cases, was disproportionately observed in manual labourers, consistent with the vulnerability of the cubital tunnel to chronic elbow flexion and external impact (Rayegani et al., 2021). The male preponderance in this subgroup parallels previous reports linking occupational mechanical stress to localized conduction block (Kim et al., 2024). Radial neuropathy, although least frequent, displayed the highest proportion of severe impairment—three-quarters of affected individuals—suggesting delayed presentation or unrecognized compressive events such as spiral-groove injury from sustained leaning or heavy lifting (Han et al., 2014; Chalk, 2024). These data collectively imply that the pattern of nerve involvement in this regional population is determined less by anatomical idiosyncrasy and more by repetitive-strain biomechanics and delayed clinical referral.

Severity grading revealed that over half of the cases were moderate and nearly two-fifths severe, demonstrating substantial functional compromise at presentation. Compared with a larger British series using comparable nerve-conduction thresholds (Hirani, 2019), the current cohort showed a right-shifted severity profile, potentially reflecting limited early-diagnostic access. The escalation of mean age across severity strata supports a cumulative-exposure model, whereby chronic mechanical stress and progressive demyelination precede irreversible axonal loss. This pattern reinforces the value of community-level screening for mild cases, particularly among housewives and labourers aged 26–60 years.

Methodologically, the use of standardised AANEM protocols and temperature-controlled recordings ensured measurement reliability. The inclusion of both sensory and motor indices allowed precise stratification of disease stage and strengthened external comparability (Rubin and Lamb, 2024). Nonetheless, as a single-centre cross-sectional design, the study cannot infer causality or capture temporal progression. Confounding from unrecorded factors such as body-mass index, repetitive-strain duration, or comorbid thyroid dysfunction may partly account for observed sex and occupation gradients. Additionally, radial-nerve sample size was small, widening confidence intervals for severe-case estimates.

Clinically, the findings emphasise the need for ergonomic interventions, task rotation, and early referral for neurodiagnostic testing in at-risk occupations. At a policy level, incorporating low-cost screening protocols into primary-care and occupational-health services could mitigate long-term disability. Future prospective work should integrate ultrasonographic and biomechanical data to delineate multifactorial pathogenesis and evaluate longitudinal recovery trajectories under rehabilitative management (Song et al., 2018; McGurk et al., 2023).

CONCLUSION

The present electrodiagnostic survey demonstrates that median-nerve mononeuropathy predominates in the Khyber Pakhtunkhwa population, particularly among middle-aged women performing repetitive domestic tasks, while ulnar and radial lesions are more frequent and severe in manual labourers. More than half of all cases were moderate and nearly two-fifths severe, underscoring delayed clinical presentation and limited early screening. These findings confirm that occupation, repetitive load, and gendered activity patterns are key determinants of focal neuropathy distribution. Routine NCS evaluation in high-risk groups, ergonomic task redesign, and clinician training in non-carpal-tunnel entrapments could substantially reduce disability and productivity loss. Future longitudinal and multicentre studies integrating ultrasonography, ergonomic metrics, and rehabilitation outcomes are warranted to refine regional prevention and intervention strategies.

REFERENCES

- Boniface S (1996) 'Electrodiagnostic medicine', *Journal of Neurology, Neurosurgery & Psychiatry*, 60(4), pp. 468.
- Chalk C (2024) 'Radial neuropathy', *Handbook of Clinical Neurology*, 201, pp. 127–134.
- Gentili G and Di Napoli M (2016) *The Ulnar Nerve: Sensory and Motor Conduction Studies*, Springer Nature, Cham.
- Gorelick P (2020) *Hankey's Clinical Neurology*, Elsevier, London.
- Han B R, Cho Y J, Yang J S, Kang S H and Choi H J (2014) 'Clinical features of wrist drop caused by compressive radial neuropathy and its anatomical considerations', *Journal of Korean Neurosurgical Society*, 55(3), pp. 148–151.
- Henry B M et al. (2015) 'The prevalence of anatomical variations of the median nerve in the carpal tunnel: a systematic review and meta-analysis', *PLoS One*, 10(8), e0136477.
- Hewson D W, Kurien T and Hardman J G (2023) 'Postoperative ulnar neuropathy: a systematic review of evidence with narrative synthesis', *British Journal of Anaesthesia*, 131(1), pp. 135–149.
- Hirani S (2019) 'A study to further develop and refine carpal tunnel syndrome (CTS) nerve conduction grading tool', *BMC Musculoskeletal Disorders*, 20(1), pp. 1–7.
- Kim D H, Shin S J, Park J Y and Lee S H (2024) 'Double entrapment neuropathy of the ulnar nerve at the elbow and the wrist: double crush syndrome?', *BMC Musculoskeletal Disorders*, 25(1), pp. 1–7.
- Kwon J, Kang J W, Park H B and Kim D H (2024) 'Electrodiagnostic findings using radial motor segmental conduction study and inching test in patients with radial neuropathy', *American Journal of Physical Medicine & Rehabilitation*, 103(11), pp. 1026–1032.
- Leszczyńska K and Huber J (2023) 'Unveiling the correlations between clinical assessment of spasticity and muscle strength and neurophysiological testing of muscle activity in incomplete spinal cord injury patients: the importance of a comprehensive evaluation', *Applied Sciences*, 13(13), p. 7609.
- Mangi M D, Zadow S and Lim W Y (2022) 'Nerve entrapment syndromes of the upper limb: a pictorial review', *Insights into Imaging*, 13(1), p. 166.
- McGurk K, Tracey J A, Daley D N and Daly C A (2023) 'Diagnostic considerations in compressive neuropathies', *Journal of Hand Surgery Global Online*, 5(4), pp. 525–535.
- Neuromuscular Disorders in Clinical Practice* (2014) Springer Science and Business Media LLC, New York.
- Rayegani S M, Nouri F and Benam M (2021) 'Prevalence and causes of ulnar neuropathy in the electrodiagnosis clinic of Shohada-e Tajrish Medical Center', *Archives of Men's Health*, 5(1), p. e36.
- Rubin D I and Lamb C J (2024) 'The role of electrodiagnosis in focal neuropathies', *Handbook of Clinical Neurology*, 201, pp. 43–59.
- Silva D T da, Cronemberger P J L A, Moura M H de S, Garcez B B D, Pereira M da S and Brito J N P de O (2023) 'Most frequent compressive limb neuropathies: a literature review', *Arquivos Brasileiros de Neurocirurgia*, 42(1), pp. e40–e51.
- Song S, Yoo Y, Won S J, Park H J and Rhee W I (2018) 'Investigation of the diagnostic value of ultrasonography for radial neuropathy located at the spiral groove', *Annals of Rehabilitation Medicine*, 42(4), pp. 601–608.
- Tunnel Syndromes* (2015) Pecina M M, Markiewitz A D and Krmpotic-Nemanic J (eds.), CRC Press, Boca Raton.