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Performing a Neurological Examination on Patients With Musculoskeletal Extremity Symptoms: Part I. Clinical Reasoning and Statistical Utility

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Clinical examination of the neurological system can determine the integrity of an individual's central and peripheral nervous system. For clinicians in the orthopedic and/or sports settings, use of a neurological examination can be integral in differential diagnosis, treatment planning, and determination of what, if any, referrals need to be made to enhance patient outcomes. When pain is in the extremities, it is essential to understand whether symptoms are primarily arising from a peripheral or central tissue at fault. The purpose of this clinical pearl is to describe the clinical reasoning behind using neurological examinations in the treatment of individuals with extremity pain.

Prior to performing a neurological examination, clinicians should perform a subjective examination to determine a patient's cognition and report of symptom location, nature, behavior, and severity. If a patient reports extremity pain or paresthesia, neurologic involvement should be considered, even if symptoms do not follow a typical dermatomal or peripheral nerve pattern. In particular, if patients complain of shooting, burning, or electric shock-like symptoms, a thorough neurological assessment should be performed. When suspecting neural involvement, clinicians should perform spinal screening because nerve roots exit the neural foramen of the associated spinal segment(s). Active range of motion with overpressure assessment, with or without passive joint accessory mobility, can be performed to detect possible spinal involvement.

When evaluating a patient with upper extremity pain or paresthesia, examination findings of dizziness, changes in speech or swallowing, global weakness, tinnitus, and nausea or vomiting may warrant further examination and possible referral to another specialist. If a clinician determines that a neural insult may be present, additional tests should be performed to determine the presence of upper motor neuron pathologies. These tests include cranial nerve assessment, Hoffman's reflex (sign), inverted Supinator Sign, and clonus in the upper extremity. Common neurological findings of segmental dysfunction of the cervical spine can be seen in **Table 1**.[1]

When evaluating a patient with lower extremity pain or paresthesia, subjective findings of changes in bowel and bladder function, decreased balance, saddle paresthesia, sexual dysfunction, and gait ataxia may be indications for further evaluation and diagnostic testing. Based on screening results, the clinician may want to add tests such as the Babinski reflex and clonus to rule out the possibility of an upper motor neuron injury. Common neurological testing for the lumbosacral segments can be found in **Table 2**.[2]

Specific components of the neurological examination should include: myotomal strength, dermatomal sensory assessment, and deep tendon reflexes. Basic neurological screening can help the clinician determine whether further examination for possible upper or lower motor neuron involvement is necessary. Although numerous factors may create variability in testing sequence, a consistent and systematic

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TABLE 1

Common Neurological Findings for Cervicothoracic Segmental Dysfunction[a]

Level	Dermatomal Pattern	Associated Myotomal Muscles	Deep Tendon Reflex	Potential Differential List
C3	Supraclavicular, suboccipital, and posterior auricular region	Trapezius, levator scapulae, sternocleidomastoid, diaphragm, strap muscles	–	Spinal accessory nerve dysfunction
C4	Infraclavicular and posterior cervical region, posterior shoulder	Trapezius, rhomboids, levator scapulae, diaphragm	–	Spinal accessory nerve dysfunction
C5	Superolateral aspect of the arm	Pectoralis major (clavicular head), supraspinatus, infraspinatus, deltoid, biceps, brachialis, brachioradialis, diaphragm	Biceps, pectoralis	Rotator cuff tear, suprascapular nerve entrapment, axillary nerve dysfunction, musculocutaneous nerve
C6	Lateral arm and forearm, thumb and index finger	Biceps, brachialis, brachioradialis, extensor carpi radialis longus, supinator, pronator teres, flexor carpi radialis, triceps	Biceps, brachioradialis	Carpal tunnel syndrome, musculocutaneous nerve, radial nerve
C7	Posterolateral arm and forearm, middle finger	Triceps, latissimus dorsi, pronator teres, flexor carpi radialis, extensor carpi ulnaris, extensor digitorum, abductor pollicis longus, extensor pollicis brevis and longus, extensor indices	Triceps	Carpal tunnel syndrome, posterior interosseus nerve compression, radial nerve dysfunction, median nerve dysfunction
C8	Medial arm and forearm, 4th and 5th digits	Flexor digitorum superficialis, pronator quadratus, flexor digitorum profundus, flexor pollicus longus, flexor carpi ulnaris, lumbricals 3 and 4	–	Anterior interosseus nerve compression, ulnar entrapment at the elbow, posterior interosseus nerve, median nerve
T1	Axillary and pectoral region, medial arm, and proximal medial forearm	Adductor pollicis, abductor pollicis brevis, opponens pollicis, flexor pollicis brevis, interossei, lumbricals 1 and 2	–	Ulnar nerve dysfunction

[a]Created using data from Abbed & Courmans.[1]

TABLE 2

Common Neurological Findings for Lumbosacral Segmental Dysfunction[a]

Level	Dermatomal Pattern	Associated Myotomal Muscles	Deep Tendon Reflex	Potential Differential List
L2	Groin, anterior thigh	Iliopsoas, pectineus, gracilis	–	Intra-articular hip pathology, ilioinguinal nerve pathology, femoral nerve pathology, TFL strain, adductor strain, psoas pathology, PVD
L3	Groin, anterior thigh, lateral thigh, anterior knee, anterior calf	Quadriceps, adductor longus, brevis and magnus	Patella	Inguinal nerve pathology, femoral nerve pathology, lateral femoral cutaneous nerve, PVD
L4	Anterior thigh, lateral thigh, anterior knee, anterior calf, medial calf, lateral calf, medial foot	Quadriceps, tibialis anterior, extensor hallucis longus, extensor digitorum longus, gluteus medius	Patella	Iliotibial band syndrome, quadriceps pathology, gastrocnemius strain, meralgia paraesthetica, plantar fasciopathy, tarsal tunnel syndrome, femoral nerve entrapment, medial tibial stress syndrome, Achilles pathology, posterior tibialis tendinopathy, PVD
L5	Lateral thigh, posterior thigh, anterior knee, posterior knee, anterior calf, posterior calf, lateral calf, dorsum foot, plantar foot	Semimembranosis, semitendinosis, gluteus medius, peroneals, TFL	Medial hamstring	Meralgia paraesthetica, iliotibial band syndrome, gluteus medius/maximus tendinopathy, piriformis syndrome plantar fasciopathy, medial or lateral plantar nerve entrapment, deep peroneal nerve injury, medial tibial stress syndrome, 1st ray dysfunction, PVD
S1	Lateral thigh, posterior thigh, posterior knee, posterior calf, lateral calf, dorsum foot, plantar foot	Gastrocnemius, soleus, biceps femoris, gluteus maximus, piriformis	Achilles	Meralgia paraesthetica, gluteus maximus dysfunction, piriformis syndrome, plantar fasciopathy, medial or lateral plantar nerve entrapment, superfical peroneal nerve injury, peroneus longus/brevis injury, gastrocnemius strain, 5th metatarsal stress fracture, PVD
S2	Posterior thigh, popliteal fossa, medial ankle and foot	Flexor hallucis longus, flexor digitorum longus	–	Hamstring injury, gastrocnemius strain, posterior tibial nerve entrapment, medial plantar nerve entrapment, PVD

TFL = tensor fascia lata; PVD = peripheral vascular disease

[a]Created using data from Suri et al.[2]

TABLE 3

Statistical Use of Neurological Tests

Test	Condition Tested	Sn	Sp	LR+	LR-
Hoffman's	Myelopathy	44	75	1.8	0.7
Babinski	Myelopathy	33	92	4	0.7
Clonus	Myelopathy	11	96	2.7	0.9
L'hermitte's sign	Myelopathy	3	97	1	1
Gonda-Allen sign	Myelopathy	90	–	–	–
Deep tendon reflexes	Myelopathy	44	71	1.5	0.8
Inverted supinator sign	Myelopathy	61	78	2.8	0.5
Suprapatellar tendon reflex	Myelopathy	56	33	0.8	1.3
Hand withdrawal reflex	Myelopathy	41	63	1.1	0.9
Biceps or triceps hyperreflexia	Myelopathy	44	71	1.5	0.8
Achilles tendon hyperreflexia	Myelopathy	15 to 26	81 to 98	1.3 to 7.8	0.87 to 0.91
ULTT median	Cervical radiculopathy	97	22	1.3	0.12
ULTT radial	Cervical radiculopathy	72	33	1.1	0.85
Anterior thigh sensation change	L2 radiculopathy	50	96	12	0.52
Femoral nerve stretch test	L3 radiculopathy	70	88	5.7	0.88
Sit to stand	L3 radiculopathy	50	77	2.2	0.65
Sit to stand	L4 radiculopathy	54	81	2.8	0.57
Crossed femoral stretch test	L4 radiculopathy	9	100	–	0.91
Medial ankle sensation change	L4 radiculopathy	31	100	–	0.69
Patellar tendon reflex	L4 radiculopathy	39	95	7.7	0.65
Achilles tendon reflex	L5 radiculopathy	33	91	3.9	0.73
Straight leg raise	L5 radiculopathy	67	67	2	0.5
Straight leg raise	S1 radiculopathy	73	63	2	0.43
Heel raise test	L5 or S1 radiculopathy	4	86	0.29	1.1
Heel walk test	L5 or S1 radiculopathy	20	86	1.1	0.98
Great toe extensor weakness	L5 radiculopathy	20	62	0.53	1.3
Hip abductor weakness	L5 radiculopathy	29	97	11	0.73
Speech production	CNS lesion	11	93	1.47	0.96
Finger to nose	CNS lesion	11	95	2.21	0.94
SLS (eyes closed firm surface)	CNS lesion	37	98	15.47	0.65
SLS (eyes open unstable surface)	CNS lesion	53	98	22.11	0.49
SLS (eyes closed unstable surface)	CNS lesion	32	98	13.26	0.7
Pupil symmetry	CNS lesion	3	100	3.31	0.97
Pronator drift	CNS lesion	61	43	1.06	0.92
Tandem gait	CNS lesion	55	95	11.61	0.47

Sn = sensitivity; Sp = specificity; LR+ = positive likelihood ratio; LR- = negative likelihood ratio; ULTT = upper limb tension test; CNS = central nervous system; SLS = single limb stance

approach can enhance the reliability and validity of testing.

One challenge with screening for neural involvement in the presence of extremity pain is the wide array of symptom presentations associated with the musculoskeletal system. Symptoms related to neural irritation can be mistaken for another condition. For example, lateral shoulder pain is often associated with subacromial or rotator cuff impingement, but may also be related to axillary nerve irritation, C4 nerve root or cervical facet joint involvement, vascular dysfunction, or visceral contributions. Conversely, descriptions of radiating symptoms can be associated with local conditions such as carpal tunnel or pronator teres syndrome. Differentiation through spinal and neurological examination is important because results will guide patient treatment and prognosis.

TABLE 4

Interpretation of Sensitivity and Specificity[a]

Statistical Term	Definition	Clinical Take Home	Example
Sensitivity	The test's ability to obtain a positive result when the condition is present (true positive).	A negative result for a highly sensitive test suggests the absence of the condition. Tip: 'SNout rule out'	The upper limb tension test is highly sensitive for cervical radiculopathy (0.97). When this test is negative, clinicians can more confidently believe that the condition is not present. Given its lower specificity (0.22), a positive result does not help rule in the condition.
Specificity	The test's ability to obtain a negative test when the condition is absent (true negative).	A positive result for a highly specific test suggests the presence of the condition. Tip: 'SPin rule in'	L'hermitte's sign is highly specific (0.97) for myelopathy. When this test is positive, clinicians can more confidently believe the condition is present. Given its low sensitivity (0.03), a negative result does not help rule the condition out.

[a]Higher numbers (closer to 1) indicate higher levels of agreement and a stronger test when compared to lower numbers (closer to 0), which show less agreement and less utility.

TABLE 5

Interpretation of Likelihood Ratios

LR+	LR-	Interpretation
> 10	< 0.1	Creates large and typically conclusive shift in probability
5 to 10	0.1 to 0.2	Creates moderate shift in probability
2 to 5	0.2 to 0.5	Creates small but possibly important shift in probability
1 to 2	0.5 to 1	Alteration to probability is small, rarely important

LR+ = positive likelihood ratio; LR- = negative likelihood ratio

Another challenge associated with the neurological examination is the lack of standardized testing. As intertester variability of testing increases, the ability to provide statistical metrics on utility decreases. Although available metrics for common neurological examination tests are provided in **Table 3**,[3-5] test results should be clustered to strengthen the presence or absence of dysfunction because individual test results offer minimal guidance for clinical decisions. Interpretation of key statistical tools such as sensitivity and specificity (**Table 4**), which help to make the presence or absence of a condition more or less likely, and likelihood ratios (**Table 5**), which help to determine the posttest probability, are also presented.[6] Until further research establishes more diagnostic information related to neurological examination testing, clinicians should use clinical reasoning to differentiate a condition's upper or lower motor neuron involvement. It is the authors' hope that this "pearl of practice" facilitates this process.

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