


# Hirayama Disease: An Important Cause of Focal Hand Weakness in Young Adults

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## Abstract

Patients with progressive hand weakness may be seen in ambulatory medical clinics or in emergency rooms due to direct effects on activities of daily living or inadvertent injury associated with overuse or attempts to maintain normal function. It is important to recognize potential cause(s) and perform appropriate diagnostic tests and referrals that aid guide appropriate treatment that may lead to good outcomes. Hirayama disease is an underrecognized disorder in young adults due to an asymmetric growth-associated cervical spinal cord compression injury. Awareness of this disorder by internists, emergency room physicians, and radiologists would prevent unnecessary tests and interventions that may contribute to disease progression by delaying appropriate treatments or treating inappropriately, with consequential effects on outcomes. In this article, we describe 3 Hirayama disease cases from a single tertiary care institution and demonstrate how delayed diagnosis affected outcomes in 2 patients and early recognition facilitated improved outcomes in a patient.

## Keywords

amyotrophy, early diagnosis, hand weakness, Hirayama disease, magnetic resonance imaging

## Case Presentation

Case 1 is a 20-year-old male college student of Indian origin at presentation. He saw his primary care physician with a 4-year history of difficulty using his right hand, especially an inability to lift up the right middle finger with his palm downward, as well as wrist extension weakness (wrist drop). He was diagnosed with a posterior interosseous nerve compression injury based on electrodiagnostic (EDX) studies and clinical evaluation performed elsewhere. Due to symptom progression despite wrist and finger bracing, he underwent decompressive surgery 2 years afterward. He experienced worsened wrist drop after surgery and was referred to our neuromuscular medicine clinic where he was evaluated ~28 months after surgery. A repeat EDX study performed 32 months postoperatively showed C7-T1 radiculopathies or lower cervical motor neuron disorder (also known as neuronopathy). A diagnostic cervical spine magnetic resonance imaging (MRI) with flexion study was performed that showed the classic epidural venous enhancement associated with focal cervical cord atrophy consistent with Hirayama disease (Figure 1). Minor improvements with significant residual deficits remain despite neck flexion avoidance and physical/occupational therapy (PT/OT). In this case, limitations in clinical evaluation, lack of disease recognition, and the inaccurate initial EDX study delayed establishing the diagnosis and resulted in unnecessary surgery that most likely worsened clinical outcome.

Case 2 is an 18-year-old Caucasian man at presentation who complained of left hand weakness for 3 years, followed by right hand weakness a year later, coupled with bilateral hand tremors. The weakness of both hands was slowly progressive with muscle atrophy observed in both hands and forearms. He denied neck pain or any symptoms in his lower extremities. Initial EDX study performed in a specialist EDX laboratory reportedly showed C6-T1 radiculopathies versus cervical motor neuronopathies. Hirayama disease was clinically suspected and cervical MRI scan without flexion was performed. The MRI scan was reported to show plexiform neurofibromatosis (NF) but genetic tests for NF and multiple endocrine neoplasia disorders were negative. Due to mild clinical progression for 4 years after his initial presentation with unrevealing genetic testing, a cervical spine MRI with contrast and neck flexion study was performed, and he was diagnosed with Hirayama disease. Discernible mild improvements with residual deficits persist despite PT/OT. In this case, the failure to perform the required MRI study and recognition of the classic features of Hirayama disease

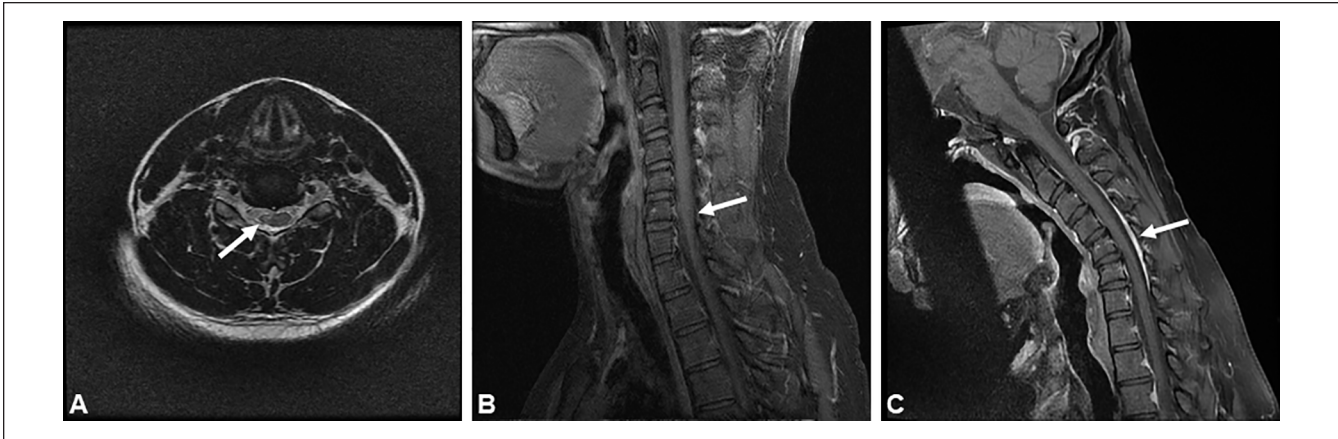
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**Figure 1.** Representative digital magnetic resonance images of the cervical spine of Case 1. (A) Axial T2 image reveals hemicord atrophy at the right C5-C6 vertebral level with increased T2 signal. (B) Sagittal T1 image with contrast reveals no epidural venous enhancement with the neck in neutral position. (C) Sagittal T1 image with contrast and neck flexion reveals the classic enlarged epidural venous enhancement. The white arrow in each panel indicates the above findings.

significantly delayed the diagnosis, resulting in unnecessary genetic testing and persistent neck flexion, which most likely affected clinical outcome.

Case 3 is a 17-year-old Caucasian male high school student at presentation who developed bilateral hand tremors and right arm, forearm, and hand weakness that started 3 years prior to initial presentation. Neurologic examination showed weakness in the right elbow extension, finger extension, and fingertip flexion, suggesting mainly C7-T1 myotomal involvement. He had normal subjective sensory examination to multiple modalities. EDX study demonstrated C7-T1 radiculopathies versus cervical motor neuronopathies. Due to a high index of clinical suspicion, a cervical spine MRI with flexion study was performed, and he was diagnosed with Hirayama disease ~1 month after initial presentation without need for further investigations. Significant improvement occurred within 4 months with PT/OT and cervical collar use to limit neck flexion.

## Case Synopsis

In summary, we present 3 adult men seen by at least one of the authors (who are board certified in neurology, EDX medicine, and neuromuscular medicine) in our ambulatory neuromuscular medicine clinic. The average age of symptom onset was 15 years. Case 1 presented with right finger and wrist extension weakness for 6 years prior to our assessment and had been diagnosed with a compressive posterior interosseous neuropathy (ie, neuropathy affecting the terminal radial motor nerve branch in the forearm), and he underwent decompressive nerve surgery without improvement prior to referral to the neuromuscular clinic. EDX studies in our laboratory demonstrated a chronic disorder involving the C7-T1 myotomes that lead to subsequent evaluation with a cervical spine MRI. Case 2 presented with sequential hand weakness

over 4 years, and was diagnosed with plexiform NF based on radiologist interpretation of his initial MRI cervical spine study despite a clinical suspicion of Hirayama disease from his initial specialist EDX study. Genetic tests for NF and multiple endocrine neoplasia were negative, prompting further evaluation with a repeat cervical spine MRI, with flexion views included. Case 3 presented to the neuromuscular clinic with bilateral hand weakness and tremors for 3 years. EDX findings were similar to Cases 1 and 2, and diagnostic neuroimaging was performed 1 month after initial presentation as described with the former 2 cases.

Minimal improvement in strength has been seen 36 and 40 months after correct diagnosis in Cases 1 and 2, respectively, despite rehabilitative measures and cervical spine support. Symptom improvement due to early initiation of OT, prevention of intrinsic hand muscle overuse, and avoidance of repetitive neck flexion by cervical bracing has been seen over the past 24 months in Case 3. These cases emphasize the importance of being aware of Hirayama disease as a differential diagnosis of painless hand weakness, especially in young men, as clinical suspicion would lead to early referral for specialist electrophysiological studies that may be performed with or without referral to a neurologist or neuromuscular specialist. This would direct appropriate investigation with cervical spine MRI with contrast and flexion to establish an accurate diagnosis. As a consequence, clinicians would avoid unnecessary even harmful interventions and institute conservative measures to prevent progression and support recovery.

## Discussion

The differential diagnoses of isolated hand weakness may be divided into neurological and nonneurological causes, while neurological causes could be divided into peripheral

**Table 1.** Differential Diagnoses of Isolated Hand Weakness.

Neurological—PNS	
Muscle disease	Muscular dystrophy, myotonic dystrophy, and inclusion body myositis
NMJ disorder	Lambert-Eaton myasthenic syndrome, myasthenia gravis
Mononeuropathy	Median neuropathy, ulnar neuropathy, and radial neuropathy
Multiple mononeuropathies	Mononeuritis multiplex (e.g., secondary to vasculitis), inherited (e.g., HNPP)
Brachial plexopathy	Lower trunk or medial cord involvement (e.g., autoimmune, neoplastic, and traumatic)
Radiculopathy	Lower cervical radiculopathy (e.g., secondary to degenerative spondylosis, infection, and tumor)
Motor neuron disease	Cervical motor neuron disorder (e.g., local trauma, infection, inflammation, or degenerative disease, early signs of ALS)
Neurological—CNS	
	Lesions affecting corticospinal tracts from the cervical spinal cord to homunculus in the lateral frontal lobes (e.g., hemorrhage, infarction, abscess, and tumor)
Nonneurological	
	Bone, tendon, or ligament disease in hands; psychogenic

Abbreviations: ALS, amyotrophic lateral sclerosis; CNS, central nervous system; HNPP, hereditary neuropathy with liability to pressure palsies; NMJ, neuromuscular junction; PNS, peripheral nervous system.

and central nervous system disorders (Table 1). Peripheral nervous system causes are readily organized based on the neuroanatomy of the motor unit, that is, muscle disease (e.g., muscular dystrophies, myotonic dystrophy, inclusion body myopathy), neuromuscular junction disorders (e.g., Lambert-Eaton myasthenic syndrome, myasthenia gravis), mononeuropathy (e.g., isolated median, ulnar, radial mononeuropathies, or multiple mononeuropathies [such as mononeuritis multiplex due to vasculitis or inherited]), brachial plexopathy (particularly lower trunk or medial cord: due to trauma, neoplastic infiltration, autoimmune disorders, etc.), low cervical radiculopathies (e.g., secondary to degenerative spondylosis, infection, tumor infiltration), and low cervical motor neuron disorders (e.g., due to local trauma, spinal cord infection/inflammation or degenerative, as an early sign of amyotrophic lateral sclerosis). It is important to recognize that EDX studies cannot distinguish between radiculopathies and motor neuron disorders. Radicular pain and subjective dermatomal sensory loss, increased sensitivity, or heightened perception on examination are clinically supportive of radiculopathies.

Hirayama disease is a rare, slow or nonprogressive focal motor neuron disorder that typically affects the upper extremities in adolescent or young adult men. It is considered an asymmetric growth-associated spinal cord compression injury attributed to forward displacement of the posterior cervical dural sac during neck flexion with resultant cord compression and/or venous congestion.<sup>1-3</sup> This disease was first reported by Hirayama et al in 1959.<sup>1</sup> It occurs predominantly in male adolescents as insidious onset, slowly progressive predominantly unilateral hand and forearm wasting and weakness (sparing the brachioradialis muscle), followed by a spontaneous arrest within several years.<sup>2,3</sup> Several cases or case series have been published, reviewing the demographics, epidemiology, clinical presentation, diagnoses, and treatment of Hirayama disease<sup>1,3-7</sup>; however, early recognition and diagnosis remain a clinical challenge among neurologists and non-neurologists.

In these 3 cases, the common findings were the following: (1) onset in adolescence or early adulthood (average onset age was 15 years), (2) male sex, (3) no neck pain, (4) weakness in at least one hand, (5) EDX studies demonstrating multiple cervical radiculopathies versus motor neuronopathies, and (6) cervical MRI with flexion showing classic epidural venous enhancement associated with focal cervical cord atrophy. These demographic, clinical, and investigative observations should guide internists, emergency room physicians, and general radiologists to diagnose Hirayama disease with confidence, especially in settings with limited specialist neurological or neuromuscular medicine access.

In addition to the cervical collar and PT/OT, surgical intervention (cervical duraplasty and anterior cervical discectomy and fusion) may be beneficial to some severe cases.<sup>8</sup> Predictors of good postoperative outcomes include younger age, short disease duration, normal myotactic stretch reflexes, unilateral cord involvement, and mild cord atrophy on MRI at neutral position.<sup>8</sup> Tendon transfers in patients with extensive intrinsic hand atrophy can improve outcomes based on activities of daily living.<sup>9</sup> We did not consider surgery in our patients due to clinical stability (Cases 1 and 2) or improvement (Case 3) with conservative approaches.

## Conclusions

The differential diagnosis of focal hand weakness may be divided into neurological and nonneurological causes, and neurological causes may be divided into peripheral and central nervous system causes. Neurological causes are readily considered, guided by basic neuroanatomy knowledge supported by a good clinical history and careful examination. Our case series emphasizes the importance of having a high index of clinical suspicion for Hirayama disease in adolescent or young men with painless, progressive upper extremity weakness. Cervical spine MRI with contrast and neck flexion views should be performed if EDX studies suggest multiple cervical radiculopathies or focal motor neuronopathies. Clinicians

should be aware of the classic radiological findings in Hirayama disease: focal cervical cord atrophy and enlarged epidural venous enhancement with neck flexion. Early accurate diagnosis of Hirayama disease would prevent unnecessary tests and unwarranted procedures. This may be associated with good outcomes following conservative measures such as cervical collar immobilization and PT/OT, as seen in one of our patients, compared with two others with delayed diagnosis and significant residual deficits most likely secondary to repetitive cervical cord injury with neck flexion.

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### Ethical Approval

Our institution does not require ethical approval for reporting individual cases or case series.

### Informed Consent

Verbal informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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