

# Selective Hand Motor Cortex Lesions Masquerading as “Pseudoperipheral Nerve Palsy”

**Bhaskara P. Shelley, Prakash Harishchandra<sup>1</sup>, Acharya K. Devadas<sup>2</sup>**

Departments of Neurology and <sup>2</sup>Radiodiagnosis and Imaging, Yenepoya Medical College, Yenepoya (Deemed to Be) University, <sup>1</sup>Department of Medicine, HAMCO Government Wenlock Hospital, Kasturba Medical College, Manipal University, Mangalore, Karnataka, India

## Abstract

Strategic cortical lesions involving the hand motor cortex (HMC) presenting acutely as distal upper limb pure motor weakness certainly do need to be differentiated on clinical grounds from “pseudoperipheral palsy.” This rare phenotype can imitate peripheral motor nerve deficits and should not be easily overlooked. The isolated “central hand and finger weakness” presenting as an acute onset of varying combinations such as pseudomedian, pseudoradial, and/or pseudoulnar nerve palsy is intriguing to the novice. In literature, this phenotype has been reported solely to result from cortical cerebral infarction and documented to occur in <1% of all ischemic strokes. The apropos of six “unforgettable patients” here highlights the heterogeneous pathophysiologic etiologies and mechanisms that included not only the conventional stroke risk factors but also hyperhomocysteinemia, common carotid artery thrombosis due to hyperhomocysteinemia and severe iron-deficiency anemia, biopsy-proven giant cell arteritis (GCA), cerebral metastasis, and dilated cardiomyopathy-related left ventricular thrombosis. Physicians and neurologists alike, as clinicians, need to be familiar with the peculiarities and clinical presentations of central hand control network cortical lesions.

**Keywords:** Diffusion-weighted imaging, hand motor cortex, magnetic resonance imaging, precentral hand knob area, pseudomedian nerve palsy, pseudoperipheral palsy, pure motor weakness, cerebral metastasis stroke, stroke chameleon, Giant cell arteritis, stroke masquerader, hyperhomocysteinemia, common carotid artery thrombosis, iron-deficiency anemia

## INTRODUCTION

Isolated pure motor distal hand palsy, a rare presentation of a precentral “hand knob” (hand motor cortex [HMC]) lesion, often is mistaken for peripheral nerve lesion. In this context, it is worthwhile to be aware of predominant motor hand weakness restricted to a particular group of fingers is exceptionally rare. A diligent search of the published literature on this phenotype has stamped the etiology to be of an ischemic origin (ischemic stroke) and reported to be <1% of all ischemic strokes. HMC does represent the cortical somatotopy of hand motor function where selective involvement of this strategic region could indeed present as “pseudoperipheral nerve palsy” [Figure 1]. This clinical phenotype of an ischemic aetiology was first reported by Lhermitte in 1909.<sup>[1]</sup> The recent advances in brain imaging have improved our understanding of cortical brain mapping of the HMC.

Literature has solely attributed “pseudoperipheral palsy” due to an ischemic stroke pathophysiologic mechanism.<sup>[2]</sup> This case report does add to the published literature the other varied heterogeneous etiologies and pathophysiologic mechanisms such as strategic metastatic lesions from a bronchogenic carcinoma, hyperhomocysteinemia and iron-deficiency anemia causing carotid artery thrombosis, and biopsy-proven GCA in the clinical expression of this rare phenotype. As a gestalt and “pattern recognition” heuristic skill, we must inevitably be familiar with the peculiarities of clinical presentations of central hand control network cortical lesions. This clinical wisdom would enable us to establish a timely diagnosis which is absolutely crucial to direct the appropriate emergent investigations and enable the prompt initiation of treatment.

## SELECTED ILLUSTRATIVE CASES

A brief summary of the specific and relevant clinical presenting symptoms is evident from Table 1. Case 1 and case 3 are highlighted below as illustrative cases. These cases of “pseudoperipheral nerve” palsy are described with corroborative clinico-electrophysiologic-neuroradiologic correlations.

### Case 1

A patient is a right-handed 59-year-old male, a regular alcohol consumer, and a chronic smoker, who noticed a sudden onset unable to extend right wrist and fingers one hour after waking up from an uneventful night sleep. He had Type IIb dyslipidemia for two years on atorvastatin with no other comorbidities. He admitted to having a binge of alcohol the night before, and he was referred to us as retrohumeral radial nerve palsy.

On neurologic examination, he was alert and oriented and cooperated well during the entire examination. Motor

examination demonstrated weakness of the right wrist and finger extensor muscles with a muscle strength grading of 2 Medical Research Council Scale (MRC), with normal strength right brachioradialis, triceps, biceps, flexors of the fingers and wrist as well as the thenar and hypothenar muscles [Figure 2]. Sensory examination did not reveal any impairment in sensation over the dorsal aspect of the right hand. Since neurologic examination did not show any evidence of a central origin of his neurologic deficits, a nerve conduction study and needle electromyography (EMG) were done immediately upon admission which were normal.

The constellation of sudden onset of distal radial motor weakness without any accompanying upper motor neuron signs, a normal neurography and EMG, history of dyslipidemia, a 20-year history of alcohol consumption (4 units/day), and 20 pack-years of tobacco smoking prompted us to undertake an emergent magnetic resonance imaging (MRI) brain with diffusion-weighted imaging (DWI) and magnetic resonance angiography (MRA) on the same day, considering the stroke masquerader of pseudoradial peripheral palsy. The MRI revealed an acute left precentral gyrus infarction, hyperintense on T2, FLAIR, and T1 hypointense with restricted diffusion on DWI along with watershed left MCA-PCA (middle cerebral artery-posterior cerebral artery) left parietal area infarction [Figure 3]. Intracranial MRA, carotid artery Doppler ultrasonography, echocardiography, complete blood picture, vasculitis screen, HIV and treponema serology, antiphospholipid antibodies, and relevant stroke workup were normal except for hyperhomocysteinemia of 18.9 μmol/L. He was initiated on Triple therapy with dual antiplatelet agents, atorvastatin, and ramipril along with folate. Over the ensuing 2 weeks of admission, he demonstrated improvement in his right-hand weakness with the strength of the extensor of the wrist and fingers graded as 3+ MRC at the time of his discharge. During the subsequent neurology follow-up over a 2-month period, he has made a complete motoric recovery.

### Case 3

This is “an unforgettable” lesson where a patient has given insight into varied and “unexpected” clinical expression of

**Address for correspondence:** Prof. Bhaskara P. Shelley, Department of Neurology, Yenepoya Medical College, Yenepoya (Deemed to Be) University, Mangalore, Karnataka, India. E-mail: drbps Shelley@gmail.com

Received: 05.01.2019 Accepted: 11.01.2019 Published: 08.12.2020

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

DOI: 10.4103/aian.AIAN\_9\_19

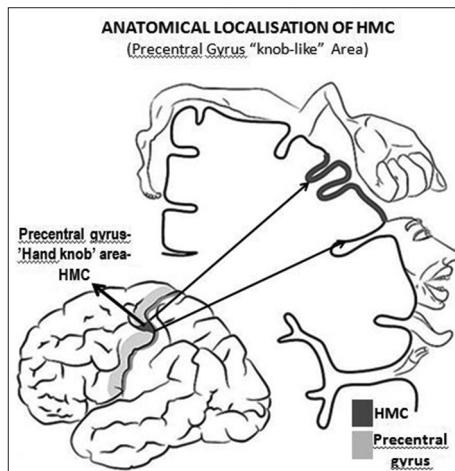
“pseudomedian” nerve palsy. A 30-year-old pre-morbidly healthy woman presented to the neurology department with acute onset, nonprogressive one day history of weakness of the left distal hand in the form of difficulty in putting toothpaste on her toothbrush, could not pleat her hair, and found her handgrip to be weak. She felt no sensory disturbances. However, she did report of a one month history of a persistent nonproductive cough.

Neurological examination of the left hand revealed a moderate pure motor paresis of muscles of the hand innervated by the involvement of the median nerve with an “ape thumb” deformity, a positive “pen test,” a 50% decrease in her left hand grip, weakness of flexor digitorum longus, and Brevis I–III, was unable to correctly oppose the tips of Digits I and II due to weakness of the flexor pollicis longus muscle and the flexor digitorum profundus muscle of the index finger, and had prominent impairment of abduction and opposition of the thumb. Ulnar and radial innervated muscles were unremarkable with striking preservation of muscle tone, tendon reflexes, and power in her left proximal arm muscles. Her higher cortical functions, language, cranial nerves, and plantar reflexes were unaffected. She was admitted as a left median nerve paresis in the orthopedics ward for evaluation. The subsequent nerve conduction studies being normal led to a neurology consultation. An emergent MRI revealed multiple well-defined altered signal intensity involving gray–white matter junction of both cerebral and cerebellar hemispheres with surrounding perilesional edema. An isolated 20-mm ring-enhancing lesion over the gray–white junction of the right frontal involving the right precentral hand knob area

with surrounding perilesional edema was seen. A metastatic etiology with a “stroke-like” presentation masquerading as “pseudomedian” nerve palsy was considered. An electroencephalogram revealed right frontocentral Delta II dysrhythmia without interictal epileptiform or background activity abnormalities. During her 2<sup>nd</sup> day of neurology admission, her clinical course evolved into a stormy clinical picture when she developed epilepsy partialis continua of the left upper limb. Her chest X-ray showed a right lower lobe well-defined, irregular heterogeneously enhancing lesion measuring 3.8 cm × 3.6 cm with speculated margins, along with adjacent interstitial thickening with alveolar-type patchy consolidation. A computed tomography (CT) of the chest, abdomen and pelvis demonstrated the same lesion in the medial segment of the right lower lobe of lung with multiple enhancing right hilar, perivascular and paratracheal lymph nodes; multiple focal areas of hypodensities in both the lobes of the liver with para-aortic lymph node involvement, the largest measuring 2 cm, and a lytic lesion over the L1 vertebral body and left pedicle with soft-tissue component extending into the epidural space. A CT-guided biopsy confirmed adenocarcinoma. She was transferred to palliative oncology care where she died 4 months later.

Table 1 summarizes the cumulative clinical features of the six patients that detail their demographic, clinical, and neuroimaging features. The male-to-female ratio was 1:1 with the mean age of onset in our series being 49 years (range: 30–65 years; standard deviation: 14.4). All patients presented with a high grade of flaccid differential distal monoparesis of acute onset with sparing of the proximal upper limb and unaccompanied by any neighborhood signs such as long-tract signs of somatosensory abnormalities, pronator drift, cranial nerve involvement, hyperreflexia, or a positive Babinski sign to suggest a central origin of localization. All patients underwent nerve conduction studies that were normal.

The most reliable landmark for the HMC and in the



**Figure 1:** Schematic diagram showing the concept of “homunculus,” in particular, the neural elements involved in motor hand function (hand motor cortex). Hand motor cortex is located in the superior aspect of precentral gyrus, in the region of the “middle knee” of the central sulcus. This area has a characteristic morphological shape in the form of “knob-like” area protruded into the central sulcus; hence, hand motor cortex is also referred to as “cortical hand knob,” that is, characteristically referred to as the “omega sign” in axial neuroimaging

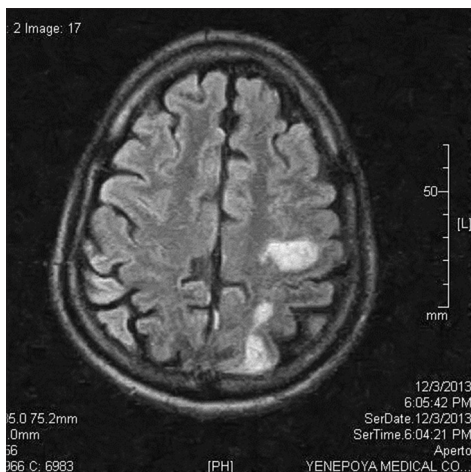


**Figure 2:** Case 1 illustrating differential isolated right upper limb monoparesis sided with wrist drop and preservation of the proximal shoulder muscles



identification of the central sulcus in axial-plane images obtained with CT and MRI is classically described as having an “omega sign” or “sigmoidal hook” sign. This was characteristically seen in cases 2, 4 [Figure 4], and 6. Emergent neuroimaging done after a negative neurography demonstrated acute ischemic infarct in the contralateral precentral HMC in cases 1, 2, 4, and 6 while case 1 had additional middle cerebral artery–posterior cerebral artery (MCA-PCA) watershed infarction. Case 3 had cerebral metastasis to the HMC region in addition to multiple silent metastases in the brain. Case 5 demonstrated MCA-PCA watershed infarction. This case was unique in having severe iron-deficiency anemia with hemoglobin (6.4 g/dl), packed cell volume (27.8%), microcytic hypochromic peripheral smear, reactive thrombocytosis (450,000/mm<sup>3</sup>), low serum iron (20 µg/dl), serum ferritin (68 ng/ml), and elevated total iron-binding capacity (598 mcg/dL) that caused common carotid artery (CCA) thrombosis. Carotid duplex sonography shows 4 cm × 1 cm hyperechogenicity thrombus from the lower portion up to the bifurcation of CCA causing 70% luminal stenosis without any evidence of carotid intima–medial atheromatous changes in the left CCA. Doppler studies demonstrate retrograde flow in the left external carotid artery and antegrade flow in the left internal carotid artery (ICA). Other major causes of CCA thrombopathy including nonatherothrombotic vasculopathy, dissection of the CCA or the aortic arch, and aortic arch aneurysm were ruled out by CT angiographic study.

Cases 1 and 2 had an additional risk factor of hyperhomocysteinemia of 18.9 µmol/L and 12.8 µmol/L, respectively. In case 2, hyperhomocysteinemia was etiologically linked to CCA thrombosis. The carotid artery ultrasonography in case 2 revealed a 3.8 cm × 0.5 cm homogeneous echogenic soft thrombus from the mid-portion up to the bifurcation of CCA causing 60%–70% luminal stenosis with atheromatous changes of the underlying intima–media of the right CCA.



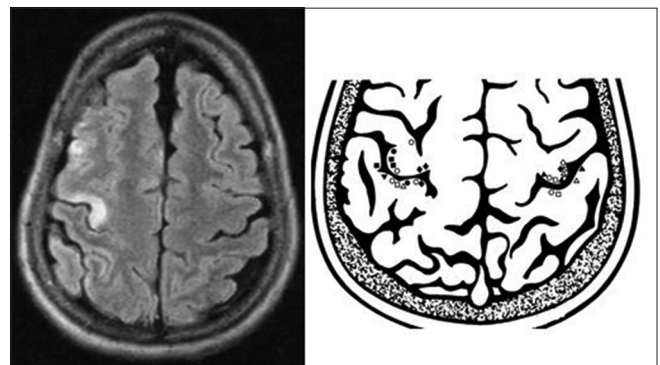
**Figure 3:** Case 1 magnetic resonance imaging fluid-attenuated inversion recovery sequence demonstrating left precentral gyrus infarct with middle cerebral artery–posterior cerebral artery parietal ischemic infarction

Case 4 proved to be GCA.

Case 6, a hypertensive and diabetic, was noteworthy as she was detected to have a subclinical cardiomegaly on chest skiagram, with echocardiograms showing left ventricular (LV) dysfunction, an LV ejection fraction of 45%, a mobile thrombus at the basal septum and apical inferior portions of the left ventricle, and features of dilated cardiomyopathy. An MRA showed focal luminal narrowing in the cavernous segment of the left ICA and the M1 segment of the right MCA. Therefore, artery-to-artery embolism from the left ventricle is a likely pathogenic mechanism. She was treated with low-molecular-weight heparin and initiated on vasodilators and diuretics. The weakness of the right-hand fingers resolved within 12 days of anticoagulation therapy. All patients except for case 3 (cerebral metastasis) had a favorable outcome with appropriate emergent treatment without stroke recurrence and excellent recovery from their initial deficits.

## DISCUSSION

This apropos of six consecutive unique and challenging cases we have had the opportunity to see during a span of 2-year period (2016–2018), though reported to be rare in literature, does highlight that isolated acute pure motor hand paralysis can indeed be caused by small and strategic cortical lesions of the HMC which could then masquerade as “pseudoperipheral palsy.” Literature on “pseudoperipheral palsy” underlines the etiology to be that of an ischemic infarction involving the HMC due to traditional stroke vascular risk factors. However, nonstroke etiology, hitherto, has not been well described in the literature. Strategic and isolated HMC lesions will lead the unwary clinician to suspect peripheral nerve problems. To the best of our knowledge, a metastatic lesion, carotid artery thrombosis, carotid artery-to-artery embolism, hyperhomocysteinemia and iron deficiency anemia, and



**Figure 4:** A well-defined acute infarction of the right precentral hand motor cortex area depicting the characteristic the “omega sign” in axial fluid-attenuated inversion recovery magnetic resonance imaging. A schematic drawing showing the anatomical location of hand motor cortex, as areas of activation by functional magnetic resonance imaging (Source: Schematic drawing from Ref<sup>[7]</sup>)

**Table 1: Demographics, risk factors, type of pseudoperipheral palsy with the clinco-neuroimaging correlates, and outcome**

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Age	59 years	47 years	30 years	60 years	35 years	65 years
Gender	Male	Male	Female	Female	Male	Female
Time of onset	1 h after waking up from night sleep	After returning from toilet at 2 am in the night	Early morning could not grasp and pleat her hair	2 h after waking up from night sleep	1 h after waking up from night sleep	Early morning while making coffee
Duration from onset to admission	18 h	24 h	72 h	12 h	48 h	8 h
Pseudoperipheral palsy pattern	Right pseudoradial	Left pseudoradial + ulnar	Left pseudomedian	Left pseudomedian > radial > ulnar	Right pseudoradial	Right pseudomedian
Risk factors	Type IIb dyslipidemia, alcohol, smoker, HHcy 18.9 µmol/L	Smoker, alcohol HHcy 12.8 µmol/L CAUS - 3.8 cm × 0.5 cm thrombus from mid portion up to bifurcation of right CCA causing 60%-70% luminal stenosis with atheromatous changes	None Later evolved to left UL motor simple partial seizures HRCT chest and biopsy: 3.8 cm × 3.6 cm medial segment of right lower lobe-bronchogenic Adenocarcinoma	Hypertension Dyslipidemia Forme fruste presentation of new-onset left-side locked vascular headache of 2 months Left temporal artery biopsy-giant cell arteritis	None Hb: 6.4 g/dl, PCV: 27.8%, and platelets: 450,000/mm <sup>3</sup> , serum iron: 20 µg/dl Serum ferritin: 68 ng/ml TIBC: 598 4 cm×1 cm left CCA thrombus causing 70% luminal stenosis with atheromatous changes	Hypertension Type 2 DM Mild exertional intolerance-6 months CXR: Diffuse cardiomegaly ECHO: Dilated cardiomyopathy with; LV dysfunction, LVEF of 45%, mobile thrombus at the basal septum and apical inferior portions of the left
Neuroimaging (MRI, MRA, DWI)	Left precentral gyrus + left MCA-PCA watershed infarction	Right precentral gyrus infarction (omega sign)	The “culprit” 20-mm enhancing lesion involving right frontal and precentral hand knob area, with multiple “silent” lesions over the right temporal and bilateral cerebellum	Right precentral gyrus infarction (omega sign)	Left MCA-PCA watershed infarction	Left precentral gyrus infarction (omega sign) MRA: Focal luminal narrowing in the cavernous segment of the left ICA and the left M1 segment
Outcome	Recovered in 2 weeks with anticoagulation therapy	Anticoagulation therapy with complete resolution of carotid thrombus	Died after 4 months of palliative care	Recovered in 2 weeks with pulse methylprednisolone, oral prednisolone, and dual antiplatelet therapy	Recovered within 1 week 2 weeks of enoxaparin; ferric carboxymaltose infusion, iron supplements	Recovered in 2 weeks with enoxaparin Vasodilator, diuretic, and ACEI for DCM

MRI=Magnetic resonance imaging, MRA=Magnetic resonance angiography, DWI=Diffusion-weighted imaging, MCA=Middle cerebral artery, PCA=Posterior cerebral artery, CAUS=Carotid artery ultrasonography, CCA=Common carotid artery, HRCT=High-resolution computed tomography, Hb=Hemoglobin, PCV=Packed cell volume, TIBC=Total iron-binding capacity, ACEI=Angiotensin-converting enzyme inhibitors, DCM=Dilated cardiomyopathy, LV=Left ventricular, LVEF=LV ejection fraction, DM=Diabetes mellitus, ICA=Internal carotid artery, CXR=Chest X Ray (Chest Skiagram)

GCA as etiologies to isolated hand monoparesis involving the HMC have not been previously reported to present as “pseudoperipheral palsy” phenotype.

We reiterate that the prompt recognition of this rare pattern will avoid the potential misdiagnosis as peripheral nerve lesion and be to redirect the clinician for a “central localization.” In our series, it is quintessential to realize that not all lesions of the HMC are ischemic in nature as case 3 was due to cerebral metastasis and case 4 attributed to biopsy-proven GCA (a stroke chameleon).<sup>[3]</sup>

This report also emphasizes the neuroanatomical underpinnings of strategic central hand control network lesions. With the advent of MRI, functional MRI (fMRI)

has helped visualize lesions that were missed on CT.<sup>[4,5]</sup> The use of transcranial magnetic stimulation and fMRI has helped to precisely identify the anatomical areas related to neural elements involved in motor hand function referred to as the “hand knob” (extending from the precentral gyrus into the central sulcus). This is described in the shape of an “omega” or an “epsilon” in axial-plane images and like a “hook” in the sagittal plane obtained with MRI.<sup>[6,7]</sup> Recent work has further elucidated on three new morphological variants of the HMC in MRI to include medially asymmetric epsilon, epsilon, laterally asymmetric epsilon, and the null variant.<sup>[8]</sup> It is interesting to be cognizant of the presence of somatotopic gradients, in which thumb and index finger movements are slightly more heavily

represented laterally and little and ring finger movements are slightly more heavily represented medially.<sup>[9]</sup> It is also hypothesized that discrete functional cortical areas as evidenced by a highly distributed network for each finger exist and are sequentially arranged. We reiterate the crucial need to recognize the “omega” sign on MRI brain, which corresponds to the cortical motor hand area, provides excellent clinical–radiological correlation, and allows the diagnosis to be clinched confidently. The cases with MCA-PCA border zone infarct do reiterate possible that the inferior parietal lobe contains somatotopic representation of the hand, and lesions here affect only motor aspect of perceptuomotor function of the hand.<sup>[10-13]</sup> Case 2 with a differential pseudoradial plus pseudobulbar palsy did have the etiology as CCA thrombosis<sup>[14]</sup> with an artery-to-artery embolism as the predicted pathomechanism.

## CONCLUSION

These cases underscore the value of precise neurological examination in patients presenting with focal hand paresis and demonstrate that a strategic lesion in the central hand control network can mimic a peripheral nerve lesion. From a “pattern-recognition” heuristic clinical skill viewpoint, isolated pure motor distal hand palsy should not be mistaken for peripheral nerve lesion, as the timely diagnosis would enable appropriate emergent investigations and the prompt initiation of treatment. We caution that in strategic lesions of the HMC, the CT Brain may be normal, and we underscore the need for brain MRI with diffusion restricted to demonstrate the small strategic lesion affecting the central hand control network areas of the precentral gyrus.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

## Acknowledgment

Informed patient consent was obtained for the publication of

these case details and any accompanying images.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Lhermitte J. De la valeur sémiologique des troubles de la sensibilité à disposition radicaire dans les lésions de l'encephale. *Sem Med* 1909;24:277.
2. Orosz P, Szöcs I, Rudas G, Folyovich A, Bereczki D, Vastagh I, *et al.* Cortical hand knob stroke: Report of 25 cases. *J Stroke Cerebrovasc Dis* 2018;27:1949-55.
3. Shelley BP, Harishchandra P, Chhakraborti S. Temporal arteritis presenting as hand motor cortex infarction: A report from India. *Neurol Asia* 2018;23:267-71.
4. Tei H. Monoparesis of the right hand following a localised infarct in the left “precentral knob”. *Neuroradiology* 1999;41:269-70.
5. Hopkins WD, Pilcher DL. Neuroanatomical localization of the motor hand area with magnetic resonance imaging: The left hemisphere is larger in great apes. *Behav Neurosci* 2001;115:1159-64.
6. Boroojerdi B, Foltys H, Krings T, Spetzger U, Thron A, Töpper R, *et al.* Localization of the motor hand area using transcranial magnetic stimulation and functional magnetic resonance imaging. *Clin Neurophysiol* 1999;110:699-704.
7. Yousry TA, Schmid UD, Alkadhi H, Schmidt D, Peraud A, Büttner A, *et al.* Localization of the motor hand area to a knob on the precentral gyrus. A new landmark. *Brain* 1997;120 (Pt 1):141-57.
8. Caulo M, Briganti C, Mattei PA, Perfetti B, Ferretti A, Romani GL, *et al.* New morphologic variants of the hand motor cortex as seen with MR imaging in a large study population. *AJNR Am J Neuroradiol* 2007;28:1480-5.
9. Kawabata Y, Miyaji Y, Joki H, Seki S, Mori K, Kamide T, *et al.* Isolated index finger palsy due to cortical infarction. *J Stroke Cerebrovasc Dis* 2014;23:e475-6.
10. Paciaroni M, Caso V, Milia P, Venti M, Silvestrelli G, Palmerini F, *et al.* Isolated monoparesis following stroke. *J Neurol Neurosurg Psychiatry* 2005;76:805-7.
11. Timsit S, Logak M, Manaï R, Rancurel G. Evolving isolated hand palsy: A parietal lobe syndrome associated with carotid artery disease. *Brain* 1997;120:2251-7.
12. Celebisoy M, Ozdemirkiran T, Tokucoglu F, Kaplangi DN, Arici S. Isolated hand palsy due to cortical infarction: Localization of the motor hand area. *Neurologist* 2007;13:376-9.
13. Phan TG, Evans BA, Huston J. Pseudoulnar palsy from a small infarct of the precentral knob. *Neurology* 2000;54:2185.
14. Pikula A, Romero JR, Kase CS. An unusual clinical presentation of ischemic stroke due to carotid dissection: The wrist drop. *Int J Neurol* 2009;11:1-3.