# "Ear of the Lynx Sign" in a patient with Primary Lateral Sclerosis

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## Introduction

The "Ear of the lynx sign" refers to an abnormal cone-shaped hyperintensity seen on fluid attenuated inversion recovery (FLAIR) sequence of the magnetic resonance imaging (MRI) of the brain at the tip of the frontal horn of the lateral ventricles which resembles the tufts of hair on the ears of a lynx (1, 2). This radiological sign has been reported in hereditary spastic paraplegia (HSP), including spastic paraplegia (SPG) type 11 and SPG type 15 (1,2). To our knowledge, this imaging sign has never been reported in disorders other than HSP, such as primary lateral sclerosis (PLS) and/or amyotrophic lateral sclerosis (ALS). In this case report, we discuss the first description of this radiological sign in a patient with PLS.

## Case Report

A 59-year-old female presented with a history of progressively worsening bilateral lower extremity stiffness and difficulty with ambulation for over a 7-year period. Her symptoms started after a left hip replacement surgery. Prior to surgery, she was ambulatory and was able to carry out activities of daily living without any difficulties. After the hip surgery, she started using a cane for ambulation. Despite physical therapy, she was unable to progress to her previous level of ambulation. A few months later, she started developing stiffness in bilateral hips which progressively worsened thereafter and gradually progressed from bilateral hips to knees and then to ankle, over a period of 1 to 2 years in an asymmetrical pattern affecting the right lower extremity more than the left. She had a corrective hip surgery after a year which improved her left hip pain but not the stiffness. She then started having difficulty getting up from sitting position, difficulty turning and developed a shuffling gait. She eventually started requiring a walker to ambulate. 5 years later, she started having urinary incontinence. She denied any family history of similar symptoms.

Over the years, she was trialed on high doses of Sinemet for concern of parkinsonism, which did not improve her symptoms. Oral baclofen for concern of lower extremity spasticity resulted in minimal improvement. Eventually, a baclofen pump was implanted which helped with the stiffness and spasticity. Given continued symptoms, she was referred to our clinic for a second opinion.

Her physical examination revealed increased tone in bilateral lower extremities, consistent with grade 2 on modified Ashworth scale. Detailed muscle strength examination is summarized in Table 1. She had a brisk jaw jerk reflex, 3+ biceps and brachioradialis reflex bilaterally, 2+ knee and ankle reflex bilaterally and upgoing plantars bilaterally. No sensory abnormalities or lower motor neuron features including atrophy or fasciculations were noted on examination. She had reduced stride width and length and

Table 1: Detailed muscle strength examination, scored as per Medical Research Council (MRC) scale.

| Muscles | Strength Right | Strength Left | Muscles | Strength Right | Strength Left |
|---|---|---|---|---|---|
| Orbicularis oculi | 5 | 5 | Hip flexion | 5 | 5 |
| Orbicularis oris | 5 | 5 | Hip extension | 5 | 5 |
| Shoulder abduction | 5 | 5 | Hip abduction | 4- | 4- |
| Elbow flexion | 5 | 5 | Hip adduction | 5 | 5 |
| Elbow extension | 5 | 5 | Knee flexion | 4- | 4- |
| Wrist flexion | 5 | 5 | Knee extension | 4+ | 4+ |
| Wrist extension | 5 | 5 | Ankle dorsiflexion | 4+ | 4+ |
| Finger abduction | 5 | 5 | Ankle plantarflexion | 5 | 5 |
| Finger extension | 5 | 5 | | | |
| Finger flexion | 5 | 5 | | | |
| Thumb abduction | 5 | 5 | | | |

a shuffling gait.

Lab testing included zinc, copper, ceruloplasmin, vitamin D, B12, folate, vitamin E, thyroid function, antineutrophil cytoplasmic antibodies, ribosomal and centromere antibodies, glutamic acid decarboxylase 65, human immunodeficiency virus, human T-lymphotropic virus, rheumatoid factor, and serum protein electrophoresis, which were all normal. Hereditary spastic paraplegia gene panel testing was negative. Table 2 includes all the genes tested in the SPG gene panel.

DaTscan of the brain was normal. Positron emission tomography scan of the body was normal. Spinal fluid assessment showed 1 nucleated cell, mildly elevated protein to 78 mg/dL, 2 oligoclonal bands, within normal limits, and normal IgG synthesis rate and index. Paraneoplastic and autoimmune antibodies in cerebrospinal fluid and serum were negative. Very long chain fatty acids testing in serum was negative.

MRI of the brain showed T1 and FLAIR sequence cone-shaped abnormalities at the forceps minor region of genu of corpus callosum bilaterally. The signal abnormality was hypointense on T1 and hyperintense on FLAIR sequence, resembling the "Ear of the lynx sign" (Figure 1a &1 B).

MRI cervical and thoracic spine with and without contrast were normal.

Nerve conduction studies of the right upper and lower extremities were normal. Needle electromyography revealed evidence of mild to moderate, widespread reinnervation changes in the right upper and lower extremities. No fibrillation potentials or positive sharp waves were noted. A few rare fasciculation potentials were seen in the right lower extremity.

Patient was diagnosed with PLS and fulfilled the consensus diagnostic criteria (3). These consist of the following: age of symptom onset > 25 years, symptoms of progressive upper motor neuron (UMN) dysfunction for more than 2 years, signs of UMN dysfunction in upper extremity (brisk triceps and biceps reflexes), lower

Table 2: Genes tested in hereditary spastic paraplegia gene panel.

| | | |
|---|---|---|
| ABCD1 | ERLIN1 | SPAST |
| ALDH1A1 | ERLIN2 | SPG11 |
| ALS2 | FA2H | SPG21 |
| AP4B1 | FARS2 | SPG7 |
| AP4E1 | GBA2 | TECPR2 |
| AP4M1 | GJC2 | TFG |
| AP4S1 | HACE1 | UCHL1 |
| AP5Z1 | HEXA | VAMP1 |
| ARG1 | HSPD1 | WASHC5 |
| ARL6IP1 | KCNA2 | ZFYVE26 (SPG15) |
| ATL1 | KDMSC | |
| ATP13A2 | KIDINS220 | |
| B4GALNT1 | KIF1A | |
| BSCL2 | KIF1C | |
| C12ORF65 | KIF5A | |
| CAPN1 | L1CAM | |
| CPT1C | MAG | |
| CYP27A1 | NIPA1 | |
| CYP2U1 | NKX6-2 | |
| CYP7B1 | NT5C2 | |
| DDHD1 | PLP1 | |
| DDHD2 | PNPLA6 | |
| ENTPD1 | RAB3GAP2 | |
| RTN2 | REEP1 | |
| SACS | REEP2 | |
| SLC16A2 | SPART | |

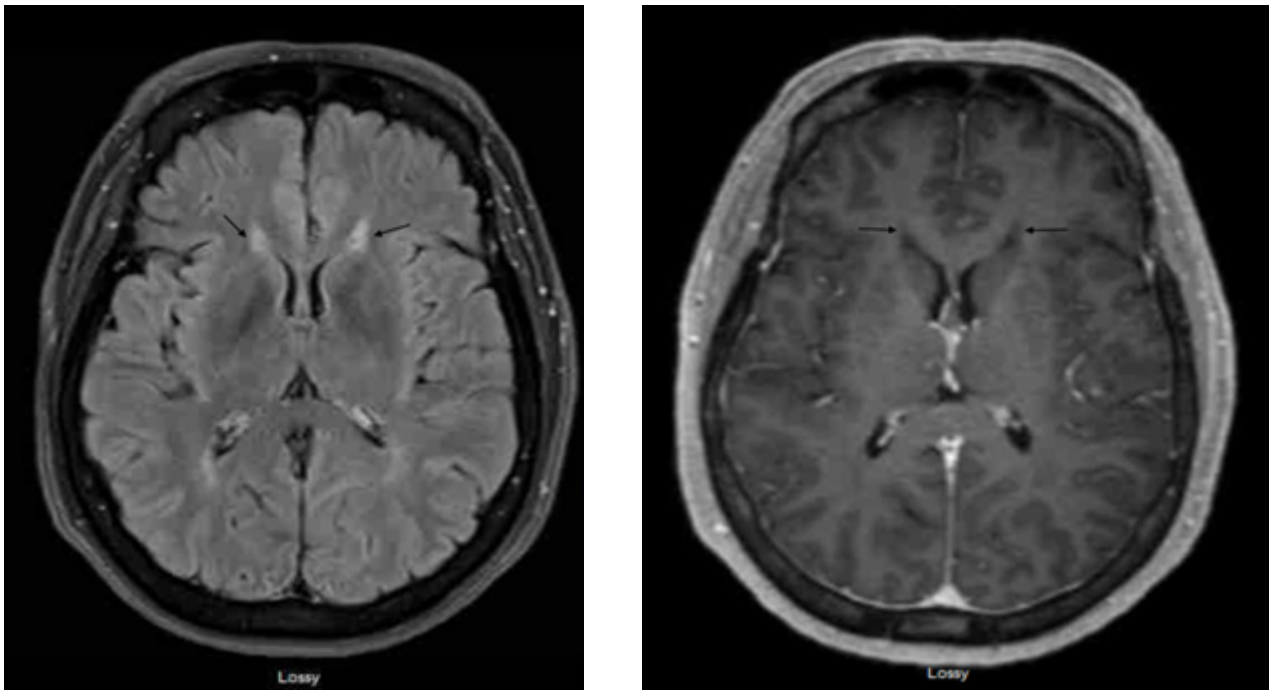


Figure 1: Axial FLAIR (A), axial T1 (B) MRI brain showing characteristic signal abnormalities involving forceps minor region of genu of corpus callosum (arrows) resembling the Ear of the Lynx sign.

extremity (spasticity of bilateral lower extremities, upgoing plantars) and bulbar (brisk jaw jerk), in absence of sensory symptoms, active LMN degeneration, and absence of UMN pathology on neuroimaging, or biofluid testing (3).

## Discussion

Our case is the first documented description of the abnormal radiological sign, "Ear of the lynx sign" in a patient with PLS.

The forceps minor is a subcortical white matter tract of the anterior corpus callosum connecting lateral and medial frontal lobes bilaterally (4, 5). Bilateral involvement of the forceps minor may lead to disruption of the adjacent descending corticospinal tracts in the corona radiata which may explain the bilateral lower extremity involvement. The anterior cingulate gyrus, located in close proximity to the forceps minor, plays an important role in behavioral control of micturition (6). Involvement of this area may result in urinary incontinence (6).

Ear of the lynx sign has been previously reported with SPG type 11 and SPG type 15 (1,2,7). Masdeu et. el compared T1-weighted and T2-FLAIR MR images from 24 patients with SPG mutations (18 in SPG11, 2 in SPG15, 2 in SPG7 and 2 in SPG4), with 24 disease controls with multiple sclerosis, and 24 healthy controls matched by age and sex. They reported that the sign was present only in patients with SPG11 and SPG15 mutations (2). The radiological sign on T2-FLAIR sequence was found to have high sensitivity (94%) and high specificity (97%) for SPG type 11 and SPG type 15 (2).

A case report from Pacheco et al described this sign in a patient with Marchiafava-Bignami syndrome (8). However, they did not obtain genetic testing for HSP (4,8).

Prior studies have suggested that PLS has considerable cerebellar, medial motor cortex, and selective corpus callosum involvement with the relative sparing of the postcentral gyrus and genu of the corpus callosum (6). Focal 'knife edge' atrophy of the precentral gyrus has been identified as the only structural abnormality allowed in PLS (10). Our study adds to the limited literature of radiologic abnormalities reported with PLS. It is important to note that these imaging findings may be suggestive of PLS, but they are not pathognomonic.

In conclusion, the "Ear of the lynx" radiological sign is not limited to SPG 11 and 15 and can be seen in patients with PLS.

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