

# Neuroimaging findings in scleroderma *en coup de sabre*

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**Abstract—Objectives:** To describe the neuroimaging and clinical findings in patients with localized scleroderma *en coup de sabre* (LScs). **Methods:** Patients with LScs were evaluated by high-resolution MRI and CT. The authors performed three-dimensional reconstructions of MRI and CT scans to evaluate brain and bone structures. **Results:** Nine patients with LScs were evaluated (five women), with ages ranging from 6 to 53 years (mean, 30.7 years). Brain CT showed bone deformities with thinning of the skull under the skin lesions in six patients. MRI scans showed focal atrophy and blurring of the gray-white matter interface localized under the skin lesion in all patients. In three patients it was associated with hyperintense signal on fluid-attenuated inversion recovery (FLAIR) and T2-weighted images. Follow-up MRI showed extension of the brain lesion in one patient; in the remaining patients, the lesion did not progress. Four of the nine patients had partial epilepsy. One had surgery for management of refractory seizures, and pathologic findings indicated a focal inflammatory process. **Conclusion:** Localized scleroderma *en coup de sabre* is associated with focal, and in some progressive, brain lesions underlying the skin atrophy. Epilepsy, when present, is related to these brain lesions. Imaging findings and histopathology indicated that the process, most likely focal inflammatory, may be progressive.

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Localized scleroderma is a group of diseases that includes linear scleroderma, morphea, and generalized morphea. It differs from systemic sclerosis by the absence of esophagus, lung, and vascular involvement. The lesions are characterized by bands or plaques of fibrous pigmented skin involving mainly the extremities.<sup>1</sup> Linear scleroderma *en coup de sabre* (LScs) denotes linear involvement of the frontoparietal areas and has been reported in association with ipsilateral intracerebral lesions, epilepsy, and ocular complications.<sup>1–3</sup> A few reports have described ipsilateral or contralateral white matter lesions on CT and MRI of the brain.<sup>4–7</sup> Evidence for an inflammatory process occurring in association with LScs was documented by neuropathologic findings<sup>4,8</sup> and intrathecal production of immunoglobulin.<sup>4,9,10</sup>

Parry–Romberg syndrome (PRS) is another rare disorder characterized by progressive hemifacial atrophy of the skin and adipose tissue and, in some patients, atrophy of muscle, cartilage, and underlying bone. The atrophic process commonly appears during the first or early in the second decade of life and affects mainly the face. The most common neurologic manifestation is epilepsy.<sup>7,11–13</sup>

Some authors have considered PRS to be a variant of LScs and have attributed it to the same autoimmune mechanism.<sup>11,14</sup> Other explanations, such as regional sympathetic innervation abnormalities, an underlying inflammatory process,<sup>7,14–17</sup> and neuronal

migration disorder,<sup>3</sup> have been proposed. The pathogenic mechanism of the brain lesions is still unknown. There are few neuropathologic studies of PRS and LScs, and most reports consist of gross anatomic observations.<sup>7</sup>

We report clinical and neuroimaging findings in nine patients with LScs.

**Patients and methods.** This study was conducted at the tertiary hospital of the University of Campinas and the Montreal Neurologic Institute. From January 2000 to January 2003, all patients with LScs were evaluated. All patients agreed to participate in this study and signed an informed consent document.

**Rheumatologic evaluation.** Skin lesions were carefully examined, and skin biopsy was considered if diagnosis was doubtful. A diagnosis of LScs was considered if linear frontoparietal scleroderma was present. The diagnosis was supported if linear scleroderma or morphea in other regions of the body was found. Systemic sclerosis was ruled out by absence of characteristic progression of skin lesions or systemic organ involvement. Management of the skin lesions depended on their extension, their localization, and rate of progression.

Laboratory investigations included complete blood cell count, liver enzymes, alkaline phosphatase, and creatinine. The following immunologic investigations were performed on several occasions and were normal or negative: antinuclear antibodies (ANA), anti-double-stranded DNA (ds-DNA), antibodies to extractable nuclear antigens (ribonucleoprotein, Sm, SS/A, and SS/B), topoisomerase I (Scl 70), antisynthetase antibodies (anti-JO), and levels of C3 and C4 complement factors.

**Neurologic evaluation.** A complete neurologic examination was performed in all patients. EEGs were recorded in all patients with a 16-channel analog or 32-channel digital EEG recorder with the international 10 to 20 system of electrode placement for 20 to 30 minutes.

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**Table** Clinical characteristics of patients with LScs and PRS

Patient no.	Skin involvement	Side of face affected	Neurological symptoms	CT findings	MRI findings under skin lesion	Progression
1	LScs	Right parasagittal frontal	No	Fronto-parietal cortical depression and outer diploe thinning	Abnormal gyral pattern, blurring of gray-white matter, hyperintense signal on FLAIR and T2	NA
2	LScs	Left fronto-parietal	Seizures	Fronto-parietal cortical depression and outer diploe thinning	Abnormal gyral pattern, blurring of gray-white matter, hyperintense signal on FLAIR and T2	Increased atrophy and white matter signal
3	LScs	Right parasagittal fronto-parietal	No	Normal	Abnormal gyral pattern, blurring of gray-white matter	No
4	LScs	Left fronto-parietal	No	Fronto-parietal cortical depression and outer diploe thinning	Abnormal gyral pattern, blurring of gray-white matter	No
5	LScs	Right parasagittal fronto-parietal	Seizures	Fronto-parietal cortical depression and outer diploe thinning	Abnormal gyral pattern, blurring of gray-white matter, hyperintense signal on FLAIR and T2	No
6	LScs	Right fronto-parietal	No	Fronto-parietal cortical depression and outer diploe thinning	Abnormal gyral pattern, blurring of gray-white matter	NA
7	LScs	Right hemiface	No	Fronto-parietal cortical depression and outer diploe thinning	Abnormal gyral pattern, blurring of gray-white matter, calcification	NA
8	LScs	Left frontal	Seizures	NA	Abnormal gyral pattern, blurring of gray-white matter, pathological examination with inflammatory process	No
9	LScs	Left frontal	Seizures	NA	Abnormal gyral pattern, blurring of gray-white matter	No

NA = not available; LScs = localized scleroderma *en coup de sabre*; PRS = Parry Romberg syndrome.

**Neuroimaging evaluation.** High-resolution CTs were obtained using a spiral scanner (HeliCat Flash, Philips Medical Systems, Andover, MA) in seven patients. Section thickness was 3.2 mm; table speed was 6.4 mm/s (pitch 2); and field of view (FOV) was 250 mm. Radiologic techniques ranged from 200 to 275 mA and 100 to 120 KVp using a 512 × 512 matrix. Data were transferred, and postprocessing was performed using a high-end graphics workstation (O2, Silicon Graphics, Mountain View, CA). Multiplanar and three-dimensional reconstructions were performed by direct rendering.

MRI was performed using a 2-T scanner (Elsint Prestige, Haifa, Israel) or a Philips ACS III 1.5-T scanner (Best, The Netherlands), with T1- and T2-weighted acquisitions in three orthogonal planes. MRI acquisition parameters were 1) sagittal T1-weighted spin echo; 2) coronal images, perpendicular to the long axis of the hippocampus, defined on the sagittal images: a) T2-weighted and proton density fast spin-echo (FSE), 3 mm thick; and b) T1-weighted inversion recovery (IR), 3 mm thick; 3) T1-weighted, T2-weighted, and 3- to 4-mm thick axial fluid-attenuated inversion recovery (FLAIR) images; and 4) volumetric acquisition using T1-weighted three-dimensional gradient echo

with 1- to 1.5-mm isotropic voxel for multiplanar reconstructions. Follow-up MRI was carried out 1 year later using the same MRI sequences. Gadolinium studies were not performed initially because our epilepsy protocol is rather long, and we do not perform gadolinium studies routinely.

**Results.** Nine patients with LScs were evaluated (five women) aged from 6 to 53 years (mean, 30.6 years). The clinical characteristics of the patients are summarized in the table.

**Demographic and clinical findings.** Patient 1. A woman aged 52 years was referred at age 20 years, during pregnancy, with an atrophic right parasagittal frontal plaque. During the following 5 years, she described slight darkening and progression in extension of the lesion after which it remained unchanged. Five years ago, LScs was diagnosed.

**Patient 2.** A man aged 23 years was seen 7 years ago because of progressive thickness of the skin over the left frontoparietal area. Examination revealed skull depression under the fibrous skin. There was no other organ involvement. He was treated with asiaticoside with improvement in the lesions. Seven years after the first signs of scleroderma, he had his first partial complex seizure. Attacks have been controlled by antiepileptic medication.

**Patient 3.** A woman aged 19 years was followed for 5 years because of progressive skin atrophy in the right frontoparietal region and loss of the right eyebrow at age 4 years.

**Patient 4.** A woman aged 53 years had left parasagittal frontoparietal skull depression and skin atrophy since puberty. She recalled worsening of the depression until her 24th birthday. She had plastic surgery, and the skin atrophy was partially corrected. Three years ago, she was seen because of progression of the atrophy. Systemic sclerosis was ruled out, and she was treated with asiaticoside with slight improvement of the skin lesion. Progressive deformities of the skull were not observed during the follow-up period.

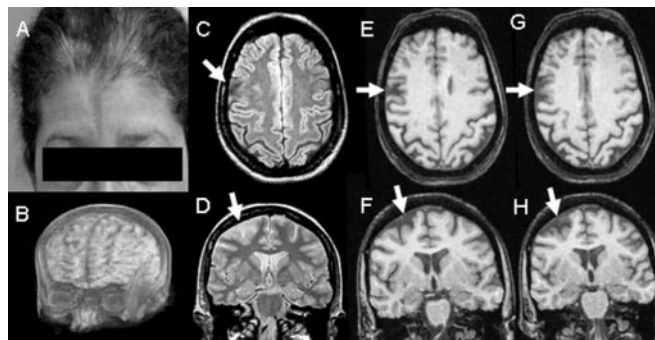
**Patient 5.** A man aged 19 years had intractable complex partial seizures since childhood. Progressive skin atrophy with underlying skull depression was noted in the right parasagittal frontoparietal region. Although he had a progressive skin lesion suggesting PRS, on further investigation, no significant muscle and cartilage involvement was observed. More recently, he presented localized scleroderma on the right foot. Instead of diagnosing a rather atypical PRS, we decided to consider the patient as having LScs with some overlapping features of PRS.

**Patient 6.** A girl aged 6 years was referred 2 years ago because of linear scleroderma of the left lower extremity, right thigh, and right frontoparietal region with rapid progression in the past months. Slight skull depression was noted under the skin lesion. Because of extension of skin atrophy, oral D-penicillamine was started with improvement of atrophy and hyperpigmentation.

**Patient 7.** A girl aged 17 years had progressive skin atrophy of her left leg, thigh, and right hemiface. Slight skull depression was noted under the atrophic skin; her face was asymmetrical, and there was a depression over the right side of the chin. Biopsy of the skin was consistent with morphea.

**Patient 8.** A man aged 45 years was referred to the Montreal Neurologic Hospital because of a 19-year history of complex partial seizures. At age 3 years, he had an abrasion lesion in the left frontal area and was left with a scar. Comparison of his lesion with old photographs showed that the scar gradually increased in depth and extent. Dermatologic consultation suggested LScs. He had a temporal lobe resection performed at another center without improvement of seizures. After new localization studies, a frontal resection was performed (under the skin lesion). Pathologic findings showed perivascular lymphocytic cuffing and microglial nodules, suggestive of an inflammatory process, without evidence of vascular dysgenesis.<sup>8</sup> He had been seizure free for 18 years and then had his first postoperative seizure.

**Patient 9.** A man aged 42 years was first seen at age 6 years because of complex partial seizures. At age 1 year, a reddish discoloration was noted on the left side of his fore-



**Figure 1.** Patient 1. (A) Photograph showing focal skin atrophy, localized scleroderma en coup de sabre. (B) MRI three-dimensional rendering showing focal atrophy of the right frontal lobe. (C through H) MRI showing focal cortical atrophy and blurring of gray-white matter interface and abnormal hyperintense cortical signal under the area of skin and brain atrophy (arrows). (C) Axial fluid-attenuated inversion recovery (FLAIR) image. (D) Coronal proton density image (PD). (E through H) Axial and coronal T1-weighted gradient echo images.

head and medial eyebrow with an important underlying bone depression unrelated to trauma. Dermatologic consultation suggested LScs. He responded well to anticonvulsant medication but had occasional seizures when missing medication or being deprived of sleep.

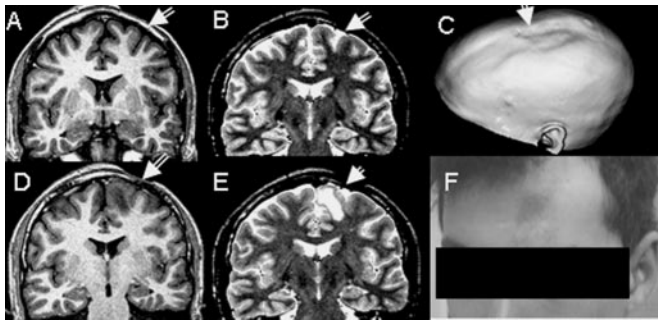
**Family history and prenatal events.** All patients were born to nonconsanguineous healthy parents and had no family history of scleroderma. No history of prenatal injury was identified. Patient 2 had a family history of partial complex seizures occurring in his father and brother.

**Neurologic examinations.** Neurologic examination was normal in all patients. EEG was normal in six patients and abnormal in Patients 5, 8, and 9, showing epileptiform abnormalities coincident with the area under the skin lesion.

**Neuroimaging findings.** CT scans showed cortical depression and outer diploe thinning in the frontoparietal region, underlying the area of more severe skin atrophy in six of seven patients. Patient 3 had normal CT, and Patients 8 and 9 had no cranial CT. The bone deformity was mild in four patients and moderately severe in two patients. Brain CT showed focal subcortical calcification under the skin lesion in Patient 1. Facial asymmetry was observed in Patient 7.

MRI showed focal cortical atrophy and blurring of the gray-white matter interface in the superior frontal gyrus in all nine patients (figures 1, 2 and 3). In three patients (Patients 1, 2, and 5), an abnormal hyperintense signal in the underlying white matter was observed. In Patient 1, the lesion was associated with a subcortical hypointense linear image (the area of calcification on CT) under the skin lesion (figure 1). Worsening of hyperintense T2-weighted and FLAIR signals in cortical and subcortical white matter on follow-up MRI was observed in Patient 2 (figure 2). In five other patients (Patients 3, 4, 5, 8, and 9), no lesion progression was documented.

**Discussion.** LScs and PRS and their neurologic complications have been discussed since the 19th century.<sup>1</sup> Both conditions have been reported in asso-



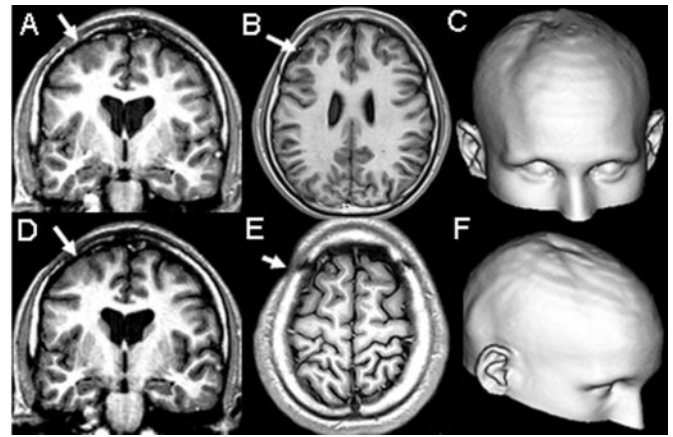
*Figure 2. Patient 2. (A, B) Coronal T1-inversion recovery (IR) and T2-weighted images showing focal cortical atrophy and blurring of gray-white matter interface (arrows). (C) Three-dimensional reconstruction of CT images showing the bone deformity (box) over the frontoparietal region. (D, E) Coronal T1-IR and T2-weighted images 1 year later, after seizure onset, show progression of focal atrophy and abnormal white matter signal (arrows). (F) Photograph showing focal skin atrophy, characteristic of localized scleroderma en coup de sabre (arrow).*

ciation with focal contralateral seizures and pyramidal signs, ipsilateral intracranial calcifications, and ophthalmologic abnormalities.<sup>3</sup> Although some authors suggest a distinction between the atrophy of deeper tissues in PRS and the more prominent skin induration in LScs, they are most certainly overlapping conditions and sometimes coexist.<sup>11,12,16</sup> One of our patients (Patient 5) had progressive skin lesion suggesting PRS, but on further investigation, no important muscle and cartilage involvement was observed. Instead of considering him to have rather atypical PRS, we decided to suggest that he had an overlapping condition.

Skin biopsy was only performed in Patient 7. Two patients underwent facial plastic surgery without biopsy. The remaining six patients refused skin biopsy because it could leave an additional scar.

The most common brain lesion in patients with LScs is intraparenchymal calcification, which may involve the basal ganglia, thalami, and dentate nuclei. Characteristically, the calcifications are ipsilateral to the skin lesion<sup>1,2</sup> but may also be contralateral.<sup>4,7</sup> Other MRI findings include hyperintense ipsilateral cortical and subcortical lesions.<sup>2,3,6,8,16,17</sup> Ipsilateral changes, consisting of an abnormal gray-white matter interface, were previously interpreted as a neuronal migration disorder.<sup>2</sup> Our patients had localized cortical atrophy under the skin lesions with abnormal gyral pattern and blurring of the gray-white interface. Similar abnormalities have been presented in other reports.<sup>2,16-20</sup> The etiology of these abnormalities remains unclear. In the absence of pathologic confirmation, malformations, infection, and an inflammatory etiology have been proposed.<sup>2,4,8,11</sup> Few authors reported lesion biopsy;<sup>4,5,8</sup> one found evidence of vascular dysgenesis,<sup>5</sup> and the other two found pathologic evidence of an inflammatory cerebral process.<sup>4,8</sup>

Because LScs involves predominantly ipsilateral facial tissues and the underlying brain parenchyma,



*Figure 3. Patient 5. (A, B) Coronal T1-inversion recovery images showing focal cortical atrophy and blurring of gray-white matter interface (arrows). (B) No apparent progression of the lesion is seen on second MRI 2 years later. (C, D) Three-dimensional reconstruction of CT images showing bone deformity (box) over the frontoparietal region.*

which have a common cell progenitor, the theory that early malformation of the rostral neural tube may be responsible for the diversity of the clinical picture has been proposed.<sup>19</sup> In this case, no lesion progression should be observed. Although the blurring between the gray and white matter may be consistent with cortical dysgenesis,<sup>2,5</sup> the pathologic data available from one of our patients support the concept that the nature of these lesions is inflammatory.<sup>2,4,8,9,14</sup> Furthermore, the fact that we could document progression of the lesion in one of our patients supports the concept of a chronic inflammatory process. Lesion progression has been reported by other authors,<sup>4,9</sup> and corticosteroids used to ameliorate clinical symptoms showed improvement of lesion volume, again supporting the inflammatory nature of these lesion.<sup>9</sup>

Skull abnormality was documented in six of seven patients who had CT scans, but even the patient without skull abnormalities showed the same underlying gray-white matter abnormalities on MRI.

Although all of our patients had cortical lesions, only four have had epileptic seizures. No other potentially epileptogenic lesions could be found after a comprehensive investigation. Family history of seizures before the skin atrophy was reported by one of four patients with seizures. It is unlikely that ongoing seizures are the cause of subcortical white matter abnormalities (hyperintense signal on T2-weighted and FLAIR images): of the three patients with subcortical hyperintense signal, one did not have seizures, and the other two have had few attacks. Furthermore, the only patient with refractory seizures did not have T2-weighted hyperintense signal abnormalities in subcortical white matter.

Intracerebral abnormalities should always be considered in patients with LScs. The investigations of choice are high-resolution CT to detect progressive

skull abnormalities and MRI scans to identify underlying brain lesions. Longitudinal studies should be performed to identify progression of cortical lesions that could be responsible for epileptic seizures in some patients with LSCs.

## References

1. Uziel Y, Miller MR, Laxer RM. Scleroderma in children. *Pediatr Clin North Am* 1995;42:1171–1203.
2. Grosso S, Fioravanti A, Biasi G, et al. Linear scleroderma associated with progressive brain atrophy. *Brain Dev* 2003;25:57–61.
3. Liu P, Uziel Y, Chuang S, Silverman E, Krafchik B, Laxer R. Localized scleroderma: imaging features. *Pediatr Radiol* 1994;24:207–209.
4. Stone J, Franks AJ, Guthrie JA, Johnson MH. Scleroderma “en coup de sabre:” pathological evidence of intracerebral inflammation. *J Neurol Neurosurg Psychiatry* 2001;70:382–385.
5. Chung MH, Sum J, Morrell MJ, Horoupian DS. Intracerebral involvement in scleroderma en coup de sabre: report of a case with neuropathologic findings. *Ann Neurol* 1995;37:679–681.
6. David J, Wilson J, Woo P. Scleroderma “en coup de sabre.” *Ann Rheum Dis* 1991;50:260–262.
7. Fry JA, Alvarellos A, Fink CW, Blaw ME, Roach ES. Intracranial findings in progressive facial hemiatrophy. *J Rheumatol* 1992;19:956–958.
8. Pupillo G, Anderman F, Dubeau F. Linear scleroderma and intractable epilepsy: neuropathologic evidence for a chronic inflammatory process. *Ann Neurol* 1996;39:277–278.
9. Unterberger I, Trinka E, Engelhardt K, et al. Linear scleroderma “en coup de sabre” coexisting with plaque-morphea: neuroradiological manifestation and response to corticosteroids. *J Neurol Neurosurg Psychiatry* 2003;74:661–664.
10. Luer W, Jockel D, Henze T, Schipper HI. Progressive inflammatory lesions of the brain parenchyma in localized scleroderma of the head. *J Neurol* 1990;237:379–381.
11. DeFelipe J, Segura T, Arellano JI, et al. Neuropathological findings in a patient with epilepsy and the Parry-Romberg syndrome. *Epilepsia* 2001;42:1198–1203.
12. Woolfenden AR, Tong DC, Norbash AM, Albers GW. Progressive facial hemiatrophy: abnormality of intracranial vasculature. *Neurology* 1998;50:1915–1917.
13. Stone J. Parry-Romberg syndrome: a global survey of 205 patients using the Internet. *Neurology* 2003;61:674–676.
14. Garcia-de la Torre I, Castello-Sendra J, Esgleyes-Ribot T, Martinez-Bonilla G, Guerrerosantos J, Fritzler MJ. Autoantibodies in Parry-Romberg syndrome: a serologic study of 14 patients. *J Rheumatol* 1995;22:73–77.
15. Gambichler T, Kreuter A, Hoffmann K, Bechara FG, Altmeyer P, Jansen T. Bilateral linear scleroderma “en coup de sabre” associated with facial atrophy and neurological complications. *BMC Dermatol* 2001;1:9–13.
16. Lehman TJ. The Parry Romberg syndrome of progressive facial hemiatrophy and linear scleroderma en coup de sabre. Mistaken diagnosis or overlapping conditions? *J Rheumatol* 1992;19:844–845.
17. Higashi Y, Kanekura T, Fukumaru K, Kanzaki T. Scleroderma en coup de sabre with central nervous involvement. *J Dermatol* 2000;27:486–488.
18. Dupont S, Catala M, Hasboun D, Semah F, Baulac M. Progressive facial hemiatrophy and epilepsy: a common underlying dysgenetic mechanism. *Neurology* 1997;48:1013–1018.
19. Terstegge K, Kunath B, Felber S, Speciali JG, Henkes H, Hosten N. MR of brain involvement in progressive facial hemiatrophy (Romberg disease): reconsideration of a syndrome. *AJNR Am J Neuroradiol* 1994;15:145–150.
20. Shah JR, Juhasz C, Kupsky WJ, et al. Rasmussen encephalitis associated with Parry-Romberg syndrome. *Neurology* 2003;61:395–397.

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