

Original Paper

Insular Ischemic Stroke: Clinical Presentation and Outcome

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Key Words

Stroke · Insular cortex · Clinical presentation

Abstract

Background: The insula is a small but complex structure located in the depth of the sylvian fissure, covered by the frontal, parietal and temporal operculum. Ischemic strokes limited to the insula are rare and have not been well studied. Our objective is to better define the clinical presentation and outcome of insular ischemic strokes (IIS). **Methods:** We reviewed the institutional prospective, consecutive stroke database from two centers to identify patients with IIS seen between 2008 and 2010. We also searched the Medline database using the keywords insula(r), infarction and stroke to identify previously published IIS cases confirmed by MRI. Minimal extension to an adjacent operculum or subinsular area was accepted. Clinoradiological correlation was performed by distinguishing IIS involving the anterior (AIC) or posterior insular cortex (PIC). We collected clinical, demographic and radiological data. The outcome was determined using the modified Rankin Scale (mRS). **Results:** We identified 7 patients from our institutions and 16 previously published cases of IIS. Infarcts were limited to the AIC (n = 4) or the PIC (n = 12) or affected both (n = 7). The five most frequent symptoms were somatosensory deficits (n = 10), aphasia (n = 10), dysarthria (n = 10), a vestibular-like syndrome (n = 8) and motor deficits (n = 6). A significant correlation was found between involvement of the PIC and somatosensory manifestations ($p = 0.04$). No other statistically significant associations were found. IIS presenta-

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tion resembled a partial anterior circulation infarct ($n = 9$), a lacunar infarct ($n = 2$) or a posterior circulation infarct ($n = 2$). However, most cases presented findings that did not fit with these classical patterns ($n = 10$). At the 6 month follow up, mRS was 0 in 8/23 (35%) patients, 1–2 in 7/23 (30%) and unknown in 8/23 (35%). **Conclusions:** IIS presentation is variable. Due to the confluence of functions in a restricted region, it results in multimodal deficits. It should be suspected when vestibular-like or motor but especially somatosensory, speech or language disturbances are combined in the same patient. The outcome of IIS is often favorable. Larger prospective studies are needed to better define the clinical presentation and outcome of IIS.

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Introduction

Hidden by the frontal, temporal and parietal opercula, deep in the sylvian fissure, the insular lobe is thought to play multiple roles including visceromotor, viscerosensory and limbic functions, as well as roles in gustatory, pain and other somatosensory processing, volitional swallowing, speech and language [1]. In addition, recent studies suggested that the insula is a convergence zone implicated in the coordination between internal and external information through emotional subjective awareness [2]. The insula may facilitate motor recovery in stroke [3, 4]. The role of the insula in stroke survival has been subject to controversy [5].

The clinical presentation and outcome of insular ischemic strokes (IIS) have not been well described, mainly due to its relative rarity [2]. In this study, we review 16 published cases of IIS and report 7 additional ones.

Methods

Consecutive stroke patients hospitalized at the Stroke Unit of the Centre Hospitalier de l'Université de Montréal (CHUM) and the Neurocenter of Southern Switzerland are prospectively registered in databases. We reviewed medical charts and neuroimaging studies of the last 200 patients of each database with middle cerebral artery (MCA) stroke. Those with infarcts predominantly affecting the insular cortex were eligible. Extension to the adjacent operculae or subinsular area (extreme capsule, claustrum, external capsule) was accepted as long as it accounted for <50% of the total infarct volume. Using the keywords insula(r), infarction and stroke, we searched the Medline database to identify published cases of IIS corresponding to our inclusion criteria. Patients from both sources without brain MRI or with confounding neurological conditions (e.g., other structural brain lesions) were excluded, as were studies that presented cases without patient-specific information. We retrospectively collected clinicodemographic and neuroimaging data at presentation and at follow-up. The reported presenting signs and symptoms were reviewed by a stroke neurologist with 12 years of experience and a senior resident in neurology to classify the pattern of presentation using the Oxfordshire classification. The clinical outcome at 6 months was defined using the modified Rankin Scale (mRS) [6]. The central insular sulcus delimited infarct of the anterior insular cortex (AIC; short gyri A1, A2 and A3), posterior insular cortex (PIC; long gyri B1 and B2) or both locations. Relative risk estimates were computed to assess the association between each clinical manifestation and IIS location.

These associations were tested using z tests applied to the natural log of the relative risks. The study was approved by our institutional ethics committee.

Table 1. Clinicodemographic data and topographical localization

	AIC (4)	PIC (12)	Both (7)	p (statistical)
Mean age (range), years	61 (53–67)	59 (34–73)	64 (32–78)	0.8
Females, n (%)	2 (50)	5 (42)	6 (86)	0.17
Clinical manifestations, n				
Somatosensory	0	8	2	0.04
Weakness	1	1	4	0.07
Aphasia	2	6	2	0.63
Dysarthria	1	5	4	0.58
Vestibular-like	1	5	2	0.76
Outcome, n				
mRS 0–2	4	12	7	NS
mRS 3–6	0	0	0	NS

NS = Nonsignificant.

Results

Study Group

We identified 7 patients from our databases who fitted our inclusion criteria. No patient was excluded. Of the 50 articles describing IIS cases, we excluded 21 (53%) with incomplete data, 11 (33%) because the ischemic lesion was deemed too extensive and 6 (15%) without brain MRI. In the end, 12 articles that presented a total of 16 cases were included for analysis. Table 1 summarizes the clinicodemographic data and outcome by infarct location of the 23 patients forming the entire study group. For a detailed description of individual cases from the literature and from our institutions, please refer to the online supplementary material (for all online suppl. material, see www.karger.com/doi/10.1159/000343177). In the following sections, patients A–G refer to those patients seen at our institutes.

Clinical Manifestations

Somatosensory manifestations were reported in 10 patients (43%; 6 patients from the literature and patients A, B, E and G from our institutes) [7–10]. Symptoms included numbness (n = 2), dysesthesia (n = 2) and paresthesia (n = 2). At examination, sensory deficits were limited to pain (n = 6), temperature (n = 1) or both (n = 1), or affected all elementary and discriminative modalities (n = 2). The deficit was contralateral to the lesion in all cases. It affected a hemibody with (n = 1) or without facial sparing (n = 3), or was limited to one or two limbs (n = 6).

Aphasia was reported in 10 patients (43%; patients B, C, D and E) [7, 10–13]. Non-fluent aphasia with anomia and phonemic paraphasia was the most frequently reported clinical picture (n = 8), combined with mild comprehension impairment with normal (n = 1) or poor repetition (n = 1). Wernicke’s aphasia (n = 2) and a mild receptive aphasia (n = 1) were also reported. In general, language deficits were transient. However, in one case, speech initiation and verbal fluency were still impaired 5 months after stroke [13]. Interestingly, transient resolution of aphasia during an emotional outburst was reported (patient C) [13].

Dysarthria (n = 10, 43%; patients A, F and G) [7, 11–15], a vestibular-like syndrome variably described as vertigo, dizziness, unsteadiness or instability (n = 8, 35%; patients A, F and G) [7, 16, 17] and weakness contralateral to the lesion (n = 6, 26%; patients B and F) [11–13] were also frequently reported. Weakness was either brachial, brachiofacial, proportional, combined with hemiataxia (n = 1 each) or limited to the lower face (n = 2). Dysautonomic

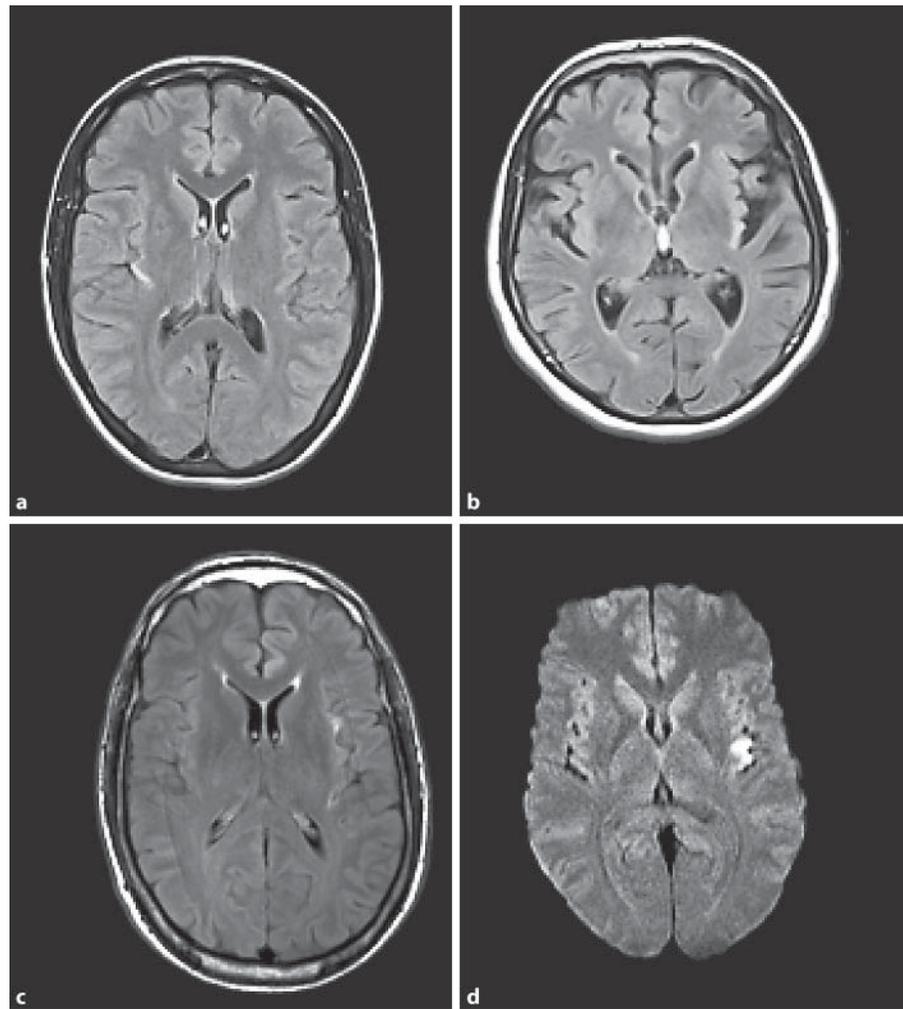


Fig. 1. Cerebral MRI (FLAIR) of the patients from our institutions, showing the localization of the insular lesion: right PIC lesion (a); left PIC lesion (b); left AIC lesion (c); left PIC lesion (d).

disorders were also reported (n = 4), characterized by hypertension bursts [7], T-wave inversion [12], syncope [17] or lipothymia (patient G). Gustatory disturbances (n = 3; patient E) [7, 8] somatoparaphrenia (n = 3; patients A and E) [7], speech and oral-buccal apraxia (n = 1) [18], auditory processing deficit (n = 1) [14], movement disorder (n = 1) [17] and hypersalivation (n = 1) [8] were rarely reported.

Clinical Syndromes

Using the Oxfordshire classification [19], the partial anterior cerebral infarct (PACI) was the most frequent pattern (n = 9; patients B, C and D) [7, 10, 11, 13, 15, 18] followed by the lacunar infarct (LACI; n = 2) [9, 11] and posterior cerebral infarct (POCI; n = 2) [7, 16]. However, most cases (n = 10; patients A, E, F, G and H) had manifestations that did not fit exactly with these classical patterns or presented unusual clinical patterns rarely encountered in stroke [7, 8, 12, 14, 17]. We consider those findings as unusual. Four patients with a non-POCI pattern presented with vestibular-like symptoms (patients A and F) [7, 17]. Unusual

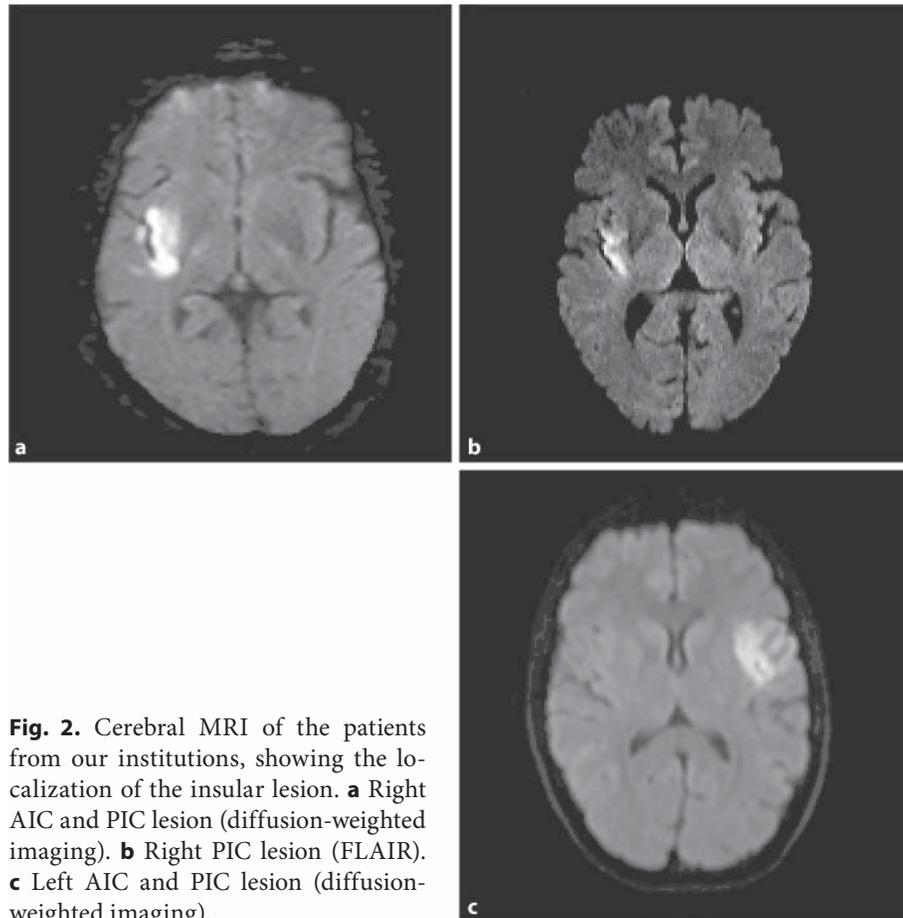


Fig. 2. Cerebral MRI of the patients from our institutions, showing the localization of the insular lesion. **a** Right AIC and PIC lesion (diffusion-weighted imaging). **b** Right PIC lesion (FLAIR). **c** Left AIC and PIC lesion (diffusion-weighted imaging).

stroke manifestations were dysautonomic disorders (n = 3; patient G) [7, 12, 17], somatoparaphrenia (n = 3; patients A and E) [7], gustatory disturbances (n = 3; patient E) [7, 8], auditory processing deficit (n = 1) [14] and hypersalivation (n = 1) [8].

Infarct Location

The infarct involved the dominant hemisphere in 14 patients (61%). It affected the AIC only (n = 4, 17%; patients D and G) [13, 16, 18], the PIC only (n = 12, 52%; patients A, B and E) [7, 9–11, 15, 17] or both (n = 7, 30%; patients C and F) [7, 8, 11, 12, 14]. Limited extension to the adjacent structures was present in 17 cases (74%), involving the subinsular area (n = 11, 48%), the frontal (n = 4, 17%), temporal (n = 5, 22%) and/or parietal opercula (n = 3, 13%) (fig. 1, 2). Table 1 shows that involvement of the PIC was significantly associated with somatosensory manifestations (p = 0.04). However, no other statistically significant associations were found.

Outcome

Among the 15 patients with known outcome, most (n = 9, 60%) were asymptomatic or had minimal clinical deficit within 48 h of symptom onset. Among the 7 patients evaluated at our centers, 3 had a normal neurological examination (patients C, E and D) and 2 had only mild sensory findings (patients A and G) within 24 h of symptom onset. Among the patients with known outcome, at 6 months, mRS was 0 in 8 patients (35%; patients C, D, E, F and G) [7, 17] and 1 or 2 in 7 patients (30%; patients A and B) [7, 8, 13, 15, 18].

Discussion

Our study shows that IIS can result in a vast array of deficits, the most frequent being somatosensory, language, speech, vestibular-like and motor symptoms. These deficits are in line with known functions of the insula, based on previous electrophysiological, functional and lesional studies [1, 20]. For example, Penfield and others [21–24] have consistently reported somatosensory- but also language-, speech-, vestibular- and motor-evoked responses during stimulation of the insular cortex. While a combination of somatosensory, speech, language and motor disturbances may suggest a larger MCA stroke, certain unusual concomitant symptoms should raise suspicion of a smaller stroke in the multimodal insular area and include vestibular, gustatory and auditory deficits or somatoparaphrenia, as well as a rapid improvement of deficits. Furthermore, although IIS may sometimes result in proportional motor or sensory deficits, mimicking a lacunar infarct (pure motor, sensory, ataxic hemiparesis), concomitant language, vestibular, gustatory or auditory processing deficits should raise the suspicion of an IIS. Less commonly, IIS can also present as a posterior circulation stroke, with acute vertigo, nausea and/or ataxia.

The functional prognosis of IIS appears to be excellent as more than half of the patients were asymptomatic or had minimal deficits within 48 h, and all had a mRS inferior or equal to 2 at 6 months. This is somewhat not surprising considering that IIS are small by definition. Our group and others [25, 26] have also previously observed rapid and complete recovery of hemiparesis and dysphasia following insular resection in the context of tumor resection and epilepsy surgery. This suggests that surrounding or distant structures can generally compensate limited insular damage.

A statistically significant association between somatosensory deficit and IIS involving the PIC was observed, consistent with findings from most stimulation studies in which somatosensory responses were more frequently located in the posterior part of the insula [2, 27]. However, there were no clear correlations between the localization of the ischemic infarct and the other most common symptoms mentioned above. This is most likely due to the small number of patients. Nonetheless, converging evidence from anatomical and functional studies in humans and non-human primates indicates a functional differentiation exist in the insula [28].

The arterial supply of the insula arises solely from the MCA, mainly from the M2 segment. The insular arteries arising from the M2 segment supply the insular cortex, the capsula extrema and sometimes the claustrum and capsula externa [29, 30]. Most likely, IIS are secondary to embolic occlusion of an M2-MCA division or its branches, with good collateral flow protecting the more distal cortex; thus, the insula becomes the terminal perfusion area [31].

The main limitation of our study relies on its partial retrospective nature including a non-systematic and incomplete evaluation of clinical and neuropsychological deficits at presentation, and biased reports of certain symptoms of interest or outcome. For instance, the association between the insular cortex and autonomic control has been eluded by several authors [32]. In our study, the low number of reported autonomic disturbances, their heterogeneity and the presence of confounding factors did not allow for further interpretation. Such disturbances can only be assessed using a standardized quantitative approach in a prospective manner. In addition, although this is the largest series of IIS cases reported in the literature to our knowledge, the sample size remains modest.

Conclusion

Due to the confluence of functions in a restricted region, IIS results in multimodal deficits combining in descending order somatosensory, speech or language, vestibular-like, motor, gustatory and somatoparaphrenic disturbances. Recuperation is generally rapid and the outcome excellent. Larger prospective studies are needed to better define the clinical presentation and outcome of IIS.

Disclosure Statement

The authors have no conflicts of interest to declare.

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