Stroke onset and courses

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Introduction

The onset and early natural course of stroke gives critical information about the stroke mechanism (Caplan, 1993). For example, the deficit which is maximal at onset and not associated with headache is most compatible with an embolic mechanism, while a stuttering onset with improvement followed by worsening in the deficit would be against cerebral hemorrhage, but most compatible with a thrombotic process. The gradual development of a progressive focal deficit, accompanied by gradually developing symptoms of increased intracranial pressure, may suggest cerebral hemorrhage (Caplan, 1993).

Despite the clinical importance of understanding the time course, there have not been many stroke databanks referring to it. In the Harvard Cooperative Stroke Registry, speed of onset was classified into four subtypes, and recorded for each type of stroke (Mohr et al., 1978). A similar classification of speed of onset has been used in the Lausanne Stroke Registry (Bogousslavsky et al., 1988). Table 1.1 shows the speed of onset for each subtype of stroke reported in these two registries. One may see the similarity of speed of onset in each subtype of stroke between the data from the two stroke registries, despite the different criteria to identify stroke subtype.

Onset and time course in early phase of stroke

Ischemic stroke

Anterior circulation damage

Jones and Millikan (1976) reported the temporal profile of 179 patients with acute carotid ischemic stroke. In their study, 39% of patients had sudden onset and no change in the neurological deficit during the first 7 days after the onset, while 35% of the patients showed improvement, 22% showed progression or remission and relapse of deficit, and 4% experienced later worsening of neurological deficit after a stable profile of at least 2 days. According to them, if hemiplegia develops within 3 hours of the onset and persists for 36 hours, there is more than a 90% chance that the patient will have a permanent incapacitating motor deficit. They also said that the combination of hemiplegia and any decrease in consciousness on admission predicted poor prognosis. However, they did not refer to the cause of stroke. Both the Harvard Cooperative Stroke Registry and the Lausanne Stroke Registry showed that sudden onset was observed most frequently in embolic infarction, followed by atherosclerotic infarction and lacunar infarction (see Table 1.1).

There are reports which analyse speed of onset among infarction in a certain cerebral artery territory. In a report of 27 patients with anterior cerebral artery (ACA) infarction, 74% of them had sudden onset and the rest of them had smooth progressive onset over a few hours to 3 weeks (Bogousslavsky & Regli, 1990). The dominance of sudden onset may be related to the frequent embolic phenomenon from the internal carotid artery (ICA) or from the heart observed in 63% of the patients, although a study from Japan which evaluated angiographic abnormalities in 17 patients with solitary infarction in ACA territory revealed atherothrombosis as the cause of infarction in 59% (Kazui et al., 1993).

Another paper from the Lausanne Stroke Registry mentioned large infarction in the middle cerebral artery (MCA) territory (Heinsius et al., 1998). According to this report, 73% of patients with large infarcts in MCA territory (infarction exceeding any one of the three main portions of MCA, that is, anterior superficial, posterior superficial, or deep white matter portion) had sudden onset of stroke. However, 40% of patients with infarction due to ICA dissection had

Table 1.1. *Time course of onset for each type of stroke*

Speed of onset		Sudden	Stepwise or stuttering[a]	Smooth or gradual[a]	Fluctuations
Atherosclerosis	HCSR	40	34	13	13
	LSR	66	27	—	7
Cardiac embolism	HCSR	79	11	5	5
	LSR	82	13	—	5
Lacune	HCSR	38	32	20	10
	LSR	54	40	—	6
Cerebral hemorrhage	HCSR	34	3	63	0
	LSR	44	52	—	4

Notes:
Data are percentage of row.
HCSR: Harvard Cooperative Stroke Registry, LSR: Lausanne Stroke Registry.
[a] In LSR, only one subtype 'progressive onset' was applied for the two subtypes of 'stepwise onset' and 'smooth onset' in HCSR.
Sources: Mohr et al. (1978); Bogousslavsky et al. (1988).

progressive onset, which was a significantly higher frequency compared with patients without dissection. Patients with ICA occlusion also showed higher frequency of progressive (34%) onset compared to patients without occlusion. Another paper from the Lausanne Stroke Registry about multiple infarction in the anterior circulation showed that 37 of 40 patients had sudden onset (Bogousslavsky et al., 1996). They reported various presumed causes of infarction, including major stenosis of ipsilateral ICA, cardiogenic embolism, granulomatous angitis, and ICA dissection.

The above mentioned may suggest a tendency of sudden onset for infarction with embolic cause and of gradual or progressive onset for infarction with vascular occlusive lesion. Yamawaki et al. (1998) studied retrospectively 523 consecutive patients with thrombotic infarction who were admitted in a stroke care unit within 7 days after onset, and showed that progressive neurological deterioration occurred in 18% of patients, which was more frequent in atherothrombotic infarction located in the corona radiata or pons compared with lacunar infarction. Yamamoto et al. also revealed the significantly higher frequency of progressive neurological deterioration in patients with large artery atherosclerosis compared to those with lacunar infarction (Yamamoto et al., 1998).

Watershed infarction occurs in the border zones between two main artery territories after severe hypotension. It may also occur under the existence of severe occlusive lesion in major arteries including ICA and MCA. A study from the Lausanne Stroke Registry about unilateral watershed infarction in the anterior circulation reported that the onset was usually immediately complete (65%),

progressed briefly (31%), or fluctuated over 24 hours (4%) in 51 patients (Bogousslavsky & Regli, 1986). More interestingly, 29% of the patients had preceding ipsilateral transient ischemic attacks (TIAs).

Posterior circulation damage

Non-sudden onset or progressive neurological deterioration has been found more frequently among infarction in posterior circulation than that in anterior circulation. Jones et al. (1980) reported 20 (54%) of 37 patients with posterior circulation infarction had non-sudden onset, while only 48 (27%) of 179 patients with anterior circulation infarction had non-sudden onset. They observed that it took a long time (up to 96 hours), for stabilization of the clinical symptoms in patients with posterior circulation infarction. A similar result was reported by another study (Patrik et al., 1980). In their paper, 56.4% of patients with posterior circulation infarction had progressing or fluctuating onset. One of their patients had progressive ataxia over 7 days. They also observed progressive neurologic impairment after the original deficit had been stabilized for 24 hours in a few patients. The stable interval time was up to 7 days. They warned that instability and late exacerbation after the stable interval time could be expected for 7 days after onset.

Vuilleumier et al. (1995) studied 28 patients with infarction in the lower brainstem. In their paper, 46% of the patients had stepwise neurological deterioration during up to 14 days after the onset. Before the onset, 46% of all patients experienced one or several warning TIAs, which were imbalance and/or vertigo.

A report of 45 patients with basilar artery embolism

found that most of them had sudden onset (41 patients, 91%), and 15 of them had complete loss of consciousness (Schwarz et al., 1997). However, four patients had slowly progressive onset despite proven embolic etiology.

Stroke in posterior circulation is rather rare territory, but Neau and Bogousslavsky (1996) reported posterior choroidal artery territory infarction. According to them, ten patients, which was 1.5% of 740 patients with posterior circulation infarction, had ischemic lesion in the posterior choroidal artery territory. None of the patients had TIA prior to their infarcts. Stroke was stabilized within a few minutes in nine of ten patients, and progressed over half an hour in one patient. Small artery disease was the most common presumed cause of infarction.

Hemorrhagic stroke

Neurological deterioration may be often observed in patients with cerebral hemorrhage. In a study from the Lausanne Stroke Registry, the rate of progressive deficit after onset was similar between cerebral infarction and cerebral hemorrhage, and in both was significantly higher than the rate of progressive deficit in cardiogenic cerebral embolism (Yamamoto et al., 1998).

A study of 204 patients with intracerebral hemorrhage, who underwent an initial CT scan within 48 hours and a repeat CT within 120 hours of the onset, reported that enlargement of hematoma was common in the hyperacute stage but seemed extremely rare after 24 hours of onset. Clinical deterioration was observed significantly more frequently in the patient group with hematoma enlargement than that without (the odds ratio; 11.7, 95% confidence intervals; 5.0–27.8) (Kazui et al., 1996). A similar result was reported by another study of 103 patients with cerebral hemorrhage (Brott et al., 1997).

Progressive stroke

Deterioration of neurological symptoms in the acute phase after the onset is not rare in patients with ischemic or hemorrhagic stroke. It has attracted clinicians' attention for more than 40 years (Millikan & Siekert, 1955a,b), and called various terms, such as progressive stroke, stroke-in-progression, or stroke-in-evolution. However, the definition of 'progressive stroke' has never been generally accepted. Some reports used certain stroke scales, others chose clinical definition (Gautier, 1985). Trials for revealing risk factors, which may predict progressive stroke, have also reached to variable and controversial results. A report investigated predictors of progressive stroke in each stroke subtype group, and revealed that different risk factors were related to progressive stroke in different subtype groups, that is, infarction in posterior circulation territory and reduced level of consciousness for large-artery atherosclerosis, while at age younger than 65, hypertension, lack of preceding TIA, reduced level of consciousness, and infarction not in superficial anterior circulation for lacunar infarction (Yamamoto et al., 1998). Another report evaluated only patients with supratentorial lacunar infarction in the internal capsule or the corona radiata, and found that diabetes mellitus and severity of motor deficit on admission were related independently to neurological deterioration (Nakamura et al., 1999). At this point, however, it remains difficult to predict progressive stroke from clinical factors alone.

There have been studies trying to reveal mechanisms involved in progressive stroke. Thrombus propagation, narrowing of arterial stenosis, development of brain edema, etc. have been suggested as causes. One study showed sequential changes of angiographic findings, including arterial stenosis or thrombus displacement in patients who had progressive stroke (Irino et al., 1983), while other studies suggested that insufficient blood supply caused by poor collateral circulation development might commonly contribute (Fisher & Garcia, 1996; Toni, et al., 1995). Recently, delayed neuronal death, mediated by the accumulation of glutamate and other excitatory amino acids in extracellular spaces, was suggested to play a role in experimental focal ischemia (Asplund, 1993). A recent study of 128 patients with ischemic hemispheric stroke found that concentrations of glutamate in plasma and cerebrospinal fluid (CSF) within the first 24 hours from stroke onset were significantly higher in patients presented with progressive stroke than in those with stable stroke (Castillo et al., 1997). This study also revealed that a plasma glutamate concentration of more than 200 μmol/l and a CSF glutamate concentration of more than 8.2 μmol/l were independently and significantly associated with progression of neurological deficit, and both of them were good predictors of progression (positive predictive value; 97% for plasma, 94.3% for CSF). This study also found that high body temperature at admission was an independent risk factor for progression within the first 48 hours of ischemic hemispheric stroke. However, it is open for future research whether these findings could explain progression of neurological deficit of other subgroups of stroke, including lacunar infarction and cerebral hemorrhage. Progressive stroke is always a sign of poor outcome in any subtypes of stroke, and early prediction and effective therapy would be mandatory.

Early spontaneous improvement

In acute phase of stroke, not only deterioration but also amelioration of neurological deficit may be observed, although it would never occur in cerebral hemorrhage. In particular, this may be found in cases of cardiogenic brain embolism, usually within minutes to hours, in the form of abrupt onset of a major hemispheric syndrome followed by dramatic improvement or complete disappearance of the symptoms. Mohr et al. (1986) called this phenomenon 'a spectacular shrinking deficit'. They assumed the mechanism to be rapid migration of an embolus from a large artery of the carotid system to its distal branches, and emphasized the phenomenon as a sign of cardiogenic embolism. A study of 118 patients with an initial major hemispheric syndrome found that 14 (12%) of them had spectacular shrinking deficit, and all but one were compatible for cardiogenic brain embolism (Minematsu et al., 1992). According to this study, recovery began from 15 minutes to 24 hours after stroke onset, and earlier onset of recovery, which means shorter duration of a major hemispheric syndrome, was significantly related to better outcome. Patients with recovery tended to be young, and had significantly fewer risk factors. The study also revealed more distal occlusion of intracerebral arteries in patients with recovery compared to those without recovery, suggesting distal migration of embolus. Another recent study investigated cerebral blood flow in acute phase of ischemic stroke with single-photon emission computed tomography (SPECT) (Barber et al., 1998). In this study, repeated SPECT images revealed that early reperfusion observed between the first SPECT scan (9.2 hours after onset of stroke) and the second SPECT scan (44.3 hours after onset of stroke) was associated with better outcome and smaller final infarct size, while non-nutritional or luxury reperfusion was not associated with either an improved or an adverse outcome. It may explain the difficulty of the timing of thrombolysis for tissue salvage. Toni et al. (1998) also suggested the existence of individual time frames for tissue recovery in their study of spontaneous improvement after ischemic stroke with serial transcranial Doppler ultrasonography. These studies agreed with the point that spontaneous neurological improvement in the acute phase may usually lead to better outcome.

Transient ischemic attack

Reports of the frequency with which TIA patients suffer cerebral infarction range from 2% to 62%. When assessed retrospectively, the range is from 9% to 74%. About 36% have infarction within the month and 50% within 12 months of onset of TIAs. It is estimated that about one-third of those who suffer recurrent TIAs continue to have attacks without developing permanent disability; another third eventually have cerebral infarction, and in the remainder the attacks stop spontaneously. So, TIA could be a clinical course before stroke. Five-year mortality rates in TIA patients average about 20% to 25%. However, the majority of causes of death are secondary to myocardial rather than to cerebral infarction. Prognosis of TIA depends on its etiology and concomitant diseases. In younger populations, etiologies such as valvular and congenital heart disease and hypotension are major contributors to TIA, while in the elderly, hypertension and atherosclerosis are major contributors to risk in the course and prognosis is poorest.

In a report of 1093 patients admitted with TIA, repetitive attacks (three or more attacks in 24 hours) in the presumed subcortical region occurred in 50 patients (4.5% of all TIAs). The episodes were usually clustered in a relatively brief interval, for example, five episodes in 3 hours, and the maximum number of events was 13. However, in 33 patients with the repetitive attacks who underwent angiographic study or duplex ultrasound of ICA, only three patients had significant stenotic change in ICA. The attacks were resistant to various forms of therapies, including hemodilution with plasma expanders, anticoagulation with intravenous heparin, and antithrombotic medication with aspirin. Twenty-one patients (42%) developed a fixed neurological deficit, although most of them presented typical lacunar syndrome (Donnan et al., 1993).

A study of 47 patients with repetitive TIAs presenting acutely with repetitive symptoms indicative of anterior circulation ischemia reported that 55% of all patients were found to have anatomically significant disease. In particular, 85% of the patients with signs or symptoms suggestive of cortical ischemia, amaurosis fugax, or both had 'positive' angiogram (75% or more carotid stenosis, less than 75% carotid stenosis associated with ulceration, or 75% or more middle cerebral stenosis) (Rothrock et al., 1988).

Conclusion

Type of onset and early clinical course may contain rich information about pathophysiology of stroke. Understanding the stroke dynamics would be necessary for active treatment in the acute phase, including thrombolysis.

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Clinical types of transient ischemic attacks

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Definition of transient ischemic attacks (TIAs)

A transient ischemic attack of the brain or eye (TIA) is a clinical syndrome characterized by an acute loss of focal brain or monocular function with symptoms lasting less than 24 hours and which is thought to be due to inadequate cerebral or ocular blood supply as a result of low blood flow (hypotension), arterial thrombosis or embolism associated with disease of the arteries, heart or blood (Hankey & Warlow, 1994).

Focal symptoms are those which allow clinico-anatomical correlation (Table 2.1), whereas non-focal symptoms are not anatomically localizing and are therefore not usually TIAs (Table 2.2). The distinction between focal and non-focal neurological symptoms has a grey area, however; sensory and motor disturbances in a pseudo-radicular pattern (such as a wrist drop or tingling in two or three fingers) probably reflect focal neurological dysfunction (Youl et al., 1991; Bassetti et al., 1993; Kim, 1996); so may cognitive changes but these can be difficult to characterize and quantify and are usually not considered as focal neurological symptoms.

The symptoms of TIAs are usually 'negative' in quality, representing a loss of function (e.g. loss of sensation, power, vision, etc.).

If different parts of the body (e.g. face, upper limb and lower limb) are affected, the symptoms usually start at the same time and do not intensify, spread or 'march'; i.e. they are maximal at onset.

The symptoms usually resolve slowly, but completely, within about 15 to 60 minutes (Pessin et al., 1977; Bogousslavsky et al., 1986; Levy, 1988; Werdelin & Juhler, 1988; Dennis, 1988). Sometimes, however, they last longer – by definition not more than 24 hours. Episodes of transient monocular blindness (amaurosis fugax (AFx)) tend to be briefer, lasting less than 5 minutes in most cases, than transient ischemic attacks of the brain (Hankey & Warlow, 1994). The difference in duration of attacks may have several explanations, all of which are speculative.

Following symptomatic recovery, a few physical signs such as reflex asymmetry or an extensor plantar response, which are not important functionally and are therefore not noticed by the patient, may be elicited in about 5% of patients (Hankey et al., 1991), depending on when the patient is examined after the resolution of symptoms, on the thoroughness of the examination, and on the competence of the examiner. Cranial computerized tomography (CT) or magnetic resonance imaging (MRI) may also reveal evidence of infarction in an area of the brain relevant to the transient symptoms (Dennis et al., 1990; Hankey & Warlow, 1994); the proportion of TIA/ischemic stroke patients with an appropriate infarct on CT scanning gradually rises with the duration of symptoms, from 10% with attacks under 30 minutes, to 40% with symptoms lasting 1–6 weeks (Koudstaal et al., 1992).

The only factor which distinguishes a TIA from a mild ischemic stroke is the duration of the symptoms of focal neurological dysfunction (i.e. less or more than 24 hours). Otherwise, patients with TIA and mild ischemic stroke are qualitatively the same; they are of similar age and sex, have a similar prevalence of coexistent vascular risk factors (and probably therefore pathogenesis), share the same long-term prognosis for serious vascular events, and describe qualitatively similar clinical symptoms (Koudstaal et al., 1992).

Clinical symptoms and types of TIAs

The symptoms of loss of function of a particular part of the brain or eye due to regional ischemia are determined by the site of ischemia (and therefore the site of the arterial

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Table 2.1. *Focal neurological and ocular symptoms*

Motor symptoms
Weakness or clumsiness of one side of the body, in whole or in part
Simultaneous bilateral weakness[a]
Difficulty swallowing[a]

Speech/language disturbances
Difficulty understanding or expressing spoken language
Difficulty reading or writing
Slurred speech[a]
Difficulty calculating

Sensory symptoms
Somatosensory
Altered feeling on one side of the body, in whole or in part

Visual
Loss of vision in one eye, in whole or in part
Loss of vision in the left or the right half of the visual field
Bilateral blindness
Double vision[a]

Vestibular
A spinning sensation[a]

Note:
[a] In isolation these symptoms do not necessarily indicate transient focal cerebral ischemia.

Table 2.2. *Non-focal neurological symptoms*

Generalized weakness and/or sensory disturbance
Faintness and/or imbalance
Altered consciousness or fainting, in isolation or with impaired vision in both eyes
Incontinence of urine or feces
Confusion or memory disturbance
A spinning sensation[a]
Difficulty swallowing[a]
Slurred speech[a]
Double vision[a]
Loss of balance[a]

Note:
[a] If these symptoms occur in combination, or with focal neurological symptoms, they may indicate a transient focal cerebral ischemia.

occlusion), the degree of ischemia, the duration of ischemia (which depends on the capacity of the collateral blood supply to perfuse the ischemic area and the rate at which the occluded vessel is recanalized), the activities in which the patient is engaged at the time of the ischemic event, the patient's recall of the event and ability to communicate it, and the quality of interrogation by the clinician. Therefore, the clinical manifestations of focal brain or eye ischemia, or clinical 'types' of TIA, are variable (Table 2.3). As many hours of wakefulness are spent in an alert state with eyes open, a keen sensorium, an upright posture, and often speaking or reading, it is not surprising that most of the symptoms that TIA patients experience are a loss of motor, somatosensory, visual or speech function. Other, more transient activities, such as swallowing and calculation, are less frequently reported as being affected. Presumably TIAs, like strokes, occur during sleep and the patient is unaware of them and there are no sequelae other than perhaps CT scan evidence of infarction if a scan is done for some other reason months or years later.

Although TIAs often occur only once, they may recur, and recur frequently up to several times a day (Dennis, 1988; Hankey et al., 1991, 1992). Recurrent TIAs may sometimes be remarkably stereotyped or they may be quite different in terms of the 'type' of attack (i.e. the nature of the symptoms).

As the Oxfordshire Community Stroke Project (OCSP) is one of the few large community-based prospective studies of TIA and the clinical types of TIA, I will describe the data from the OCSP in some detail, and supplement it with data from other well-studied hospital-referred cohorts (Pessin et al., 1977; Bogousslavsky et al., 1986). In the OCSP, 184 TIA patients reported 201 clinical 'types' of attacks; 168 patients (91%) presented with one clinical 'type' of attack, 15 patients (8%) experienced more than one 'type' of attack and one patient described three separate 'types' of attack, although sometimes these appeared to involve the same arterial territory (Table 2.3) (Dennis, 1988).

Motor symptoms

Motor symptoms are the most common symptoms described by TIA patients; in the OCSP they were experienced in 101 of the 184 patients (54%), and were a feature in 109 of the 201 (54%) clinical 'types' of attack (Dennis, 1988). 'Weakness' was by far the most common motor symptom, followed by 'heaviness' and 'clumsiness'. In most series, motor symptoms are reported to be associated with sensory symptoms of some sort; pure motor symptoms are present in only about 15–25% of patients (Pessin et al., 1977; Bogousslavsky et al., 1986; Dennis, 1988). However, it is unwise to be dogmatic about the presence or absence of sensory symptoms because often a weak limb is described by the patient as 'numb' or 'dead'

and this is often interpreted by the doctor as a combination of motor and sensory symptoms.

Weakness on one side of the body

In the OCSP, motor symptoms (i.e. weakness) involved the left side of the body in 51 patients (28%), the right side in 42 patients (23%) and were both sides in eight patients (4%) (Dennis, 1988). Among the 93 patients with unilateral motor symptoms, weakness involved the face and upper and lower limb in 8%, the face and upper limb in 36%, the upper and lower limb (hemiparesis) in 26%, and either the face, upper limb or lower limb only (monoparesis) in 30%. Similar findings were reported by Bogousslavsky et al. (1986).

Unilateral facial weakness is probably under-reported in TIAs because many patients do not realize they have had facial weakness unless they have seen themselves in the mirror, or unless the attack has been witnessed by an observer. If there is a clear history of dysarthria, in the absence of symptoms of cerebellar or bulbar dysfunction, it is reasonable to suspect facial weakness because facial weakness may cause dysarthria (if the patient attempts to speak). Having established that facial weakness was present, it can be even more difficult to determine which side of the face was weak. This is because the interpretation and recall of the patient and any witnesses may have been affected by anxiety and panic during the attack. Alternatively, the patient and witnesses may have suffered from left–right confusion or misinterpreted which side of the 'twisted' face was weak and which side was contracting. So, the side of the face which is reported to have been weak is very unreliable and cannot be assumed to have been ipsilateral to the limb weakness, unless there was also sensory loss (as well as motor loss) on one side of the face.

Transient weakness of only one lower limb usually indicates a disturbance in the parasagittal region of the contralateral cerebral cortex due to ischemia in the anterior cerebral artery territory or the boundary zone between the anterior and middle cerebral artery territories. The latter is more likely if the upper extremity is also somewhat weak and if the symptoms have been precipitated or aggravated by standing or walking. These patients usually have underlying carotid occlusive disease (Yanagihara et al., 1988).

Weakness on both sides of the body

Although generalized weakness is a non-focal neurological symptom, the sudden onset of clearcut bilateral weakness (quadriparesis, paraparesis, bilateral facial, and face and contralateral hand weakness) together with symptoms of focal neurological (usually cranial nerve) dysfunction may represent a TIA; this was the case for eight TIA patients (4%) in the OCSP (Table 2.3) (Dennis, 1988).

Unsteadiness

Unsteadiness is a fairly common symptom in TIA patients (12% of the OCSP cohort) but, unless associated with clearly focal symptoms, it can be difficult to decide whether the patient simply means weakness, incoordination or both.

Difficulty swallowing

Although dysphagia is a common feature of acute stroke, it is uncommonly reported by TIA patients. In the OCSP only one patient described dysphagia during a TIA, the attack occurring during a meal. The rarity of this symptom in a TIA is not surprising; although we are continually swallowing saliva, it is usually performed subconsciously and any transient deficit is likely to pass unnoticed. Difficulty in swallowing food is far more likely to be noticed but as we do not spend much of the day eating, a TIA is unlikely to coincide with such activity.

Movement disorders

Episodic movement disorders are rare manifestations of transient cerebral ischemia and include paroxysmal dyskinesia (Margolin & Marsden, 1982; Stark, 1985; Hess et al., 1991) and orthostatic 'limb-shaking' spells (see below) (Yanagihara et al., 1985; Baquis et al., 1985).

Speech disturbances

Patients with TIA may complain of transient speech disturbances due to an articulatory and/or a language disturbance. If the patient describes slurred speech, as if drunk, and if the ability to understand and express spoken and written language was preserved, the diagnosis is dysarthria, which is usually due to facial weakness or incoordination of the respiratory, bulbar or facial muscles. If the main difficulty was that of understanding or producing sentences, with words in their proper place, the diagnosis is dysphasia, which is usually due to dominant fronto-temporo-parietal ischemia. If speech production was so severely affected that the patient was mute, it may be extremely difficult to ascertain retrospectively whether a language deficit was present, unless there was an associated disturbance of comprehension, reading or writing (not due to weakness) or the examiner has tested language function during the attack. The type of speech disturbance during the phase of recovery may be a helpful clue. Dysphasia and dysarthria may coexist.

In the OCSP, dysarthria was the most common form of

speech disorder, occurring simultaneously with other focal neurological symptoms in 43 patients (23%) (Dennis, 1988). Dysarthria occurring in isolation, without any other symptoms, is not considered to be a TIA. Dysphasia was present in 34 patients (18%), a few of whom also described slurred speech. No patient described transient problems with reading, writing or calculation as part of the TIA; these deficits possibly occurred but were not recognized as the patient needs to be engaged in the relevant activities at the time of the TIA to notice any deficit and be asked about them later by a more than usually inquisitive clinician!

Sensory symptoms

Somatosensory symptoms

Somatosensory symptoms, when present, are usually described by the patient as a numbness, tingling or dead sensation and very rarely as pain. The anatomical distribution of somatosensory symptoms is usually unilateral affecting the face, arm and/or leg, as it is for motor symptoms (Table 2.3). In the OCSP, 64 patients (35%) described somatosensory symptoms, usually in the form of 'numbness'. Associated motor symptoms were present in 53 patients. Only 11 patients (6%) had purely somatosensory symptoms. Bogousslavsky et al. (1986) reported pure somatosensory TIAs as the most common single type of carotid TIA (27%), at least in patients who underwent angiography, with another 45% having sensory symptoms combined with motor, visual or speech disturbances. Pessin et al. (1977) found pure sensory symptoms in 15% and combined motor and sensory symptoms in another 58% of patients with carotid TIAs. However, it can be very difficult to interpret transient isolated sensory symptoms involving a part of one extremity or only one side of the face during a single attack because they may be a manifestation of other disorders such as an entrapment mononeuropathy (e.g. median neuropathy at the wrist), multiple sclerosis, hyperventilation and even hysteria. This difficulty probably accounts for some of the variation in both the diagnosis of TIA among different observers and the prevalence of sensory symptoms among different TIA cohorts.

'Neglect'

Visual–spatial–perceptual dysfunction, sometimes manifesting as 'neglect' of one side of the body or extrapersonal space, can occur in patients with ischemia of the contralateral non-dominant cerebral hemisphere. It is probably the corollary to dysphasia, which may occur during ischemia in the dominant cerebral hemisphere subserving language function. Unlike dysphasia, however, visual–spatial–perceptual dysfunction is a difficult symptom to recognize, particularly when it is transient and associated with other more striking neurological deficits, such as hemiparesis.

In the OCSP, only two patients had symptoms other than weakness or numbness that indicated ischemia of the non-dominant hemisphere (Dennis, 1988). For example, one man complained that, during the TIA, his left arm was twisted up in the sheets and this was his explanation of why he was unable to use it. His wife and the attending general practitioner were certain that he had quite severe weakness of the left side of which he was unaware. This lack of awareness may have been due to 'neglect' of his left side. It is possible that some of the patients who are described as being confused during the attack actually have non-dominant hemisphere ischemia (causing dressing apraxia, etc.) or alternatively, dominant hemisphere ischemia (causing dysphasia) and that other coexisting focal neurological symptoms are not recalled or reported; although these can be found in most stroke patients with confusional states.

Visual symptoms

Visual symptoms associated with transient cerebral and retinal ischemia are generally of three types: obscuration or loss of vision in one eye, in both eyes, or double vision. Positive visual effects such as shimmering and visual hallucinations are usually binocular and associated with migraine. In the OCSP (Dennis, 1988), 60 patients (33%) experienced visual symptoms during their TIA, most commonly monocular blindness (AFx).

Loss of vision in one eye: transient monocular blindness (amaurosis fugax)

Amaurosis fugax (meaning literally 'fleeting blindness') is a term used to describe the abrupt onset, over seconds, of loss of vision (greyish haze or black) in one eye due to transient ischemia in the territory of supply of the ophthalmic or central retinal artery.

Typically, the symptoms arise spontaneously, without provocation, and recover rapidly after several seconds to a few (usually less than 5) minutes. Uncommonly the visual loss lasts for several hours before full recovery occurs. The visual deficit is usually complete immediately but it may appear as if a curtain or shade has progressively obscured vision over a few seconds. The 'curtain' usually comes down from above but sometimes it comes up from below. The loss of vision may be complete or partial and usually involves the entire visual field. Occasionally, however, it is restricted to either the upper or lower half of the visual field and, even less frequently, to the peripheral nasal and/or

Table 2.3. *Clinical features in a cohort of 184 community TIA patients*

	% of 184	95% confidence interval
Type of attack		
'Single 'type' of attack'	91	87 to 95
'More than one 'type' of attack'	9	5 to 13
Vascular territory		
Carotid	80	74 to 86
TIA eye (amaurosis fugax)	17	12 to 22
TIA brain	62	55 to 69
TIA brain and eye	1	0 to 3
Vertebrobasilar	13	8 to 18
Uncertain (hemiphenomena)	7	3 to 11
More than one vascular territory	1	0 to 3
Motor symptoms		
Weakness/heaviness/clumsiness	54	47 to 61
unilateral	51	43 to 57
left side of body	28	22 to 34
right side of body	23	17 to 29
bilateral	4	1 to 7
quadriparesis	1	0 to 3
paraparesis	2	0 to 4
face[a] and contralateral arm	1	0 to 3
'Unsteadiness'	12	7 to 1
Dysphagia	1	0 to 3
Limb shaking	1	0 to 3
Speech disturbances	40	33 to 47
Dysarthria (with other focal symptoms)	23	17 to 29
Dysphasia	18	12 to 24
'Dyslexia, Dysgraphia, Dyscalculia'	0	0 to 3
Somatosensory symptoms	35	28 to 42
isolated	6	3 to 9
associated with motor symptoms	29	22 to 36
'Neglect'	1	0 to 3
Visual symptoms	33	26 to 40
Monocular blindness	18	12 to 24
Hemianopia (isolated)	5	2 to 8
Bilateral blindness (with other focal symptoms)	1	0 to 3
Double vision (with other focal symptoms)	5	2 to 8
Blurred vision in both eyes (with other focal symptoms)	4	1 to 7
Vestibular symptoms		
Vertigo (with other focal symptoms)	5	2 to 8
Loss of consciousness	1	0 to 3

Note:
[a] Patients have difficulty detecting facial weakness; they usually only note dysarthria and a witness is usually required to describe facial weakness.
Source: From Dennis (1988).

temporal field. Patchy and sectorial loss may also occur but presumably is less likely to be noticed by the patient (Bogousslavsky et al., 1986). Occasionally, young patients describe a series of 'blobs' or lacunae throughout the field of vision which may gradually coalesce into a complete loss of visual field; it has been suggested that this pattern of visual loss may correspond to the lobular arrangement of the blood supply in the choriocapillaris and indicate ischemia in the choroid circulation rather than the retinal circulation (O'Sullivan et al., 1992). Flashing lights, shooting stars, scintillations or other positive phenomena in the area of impaired vision can occasionally arise during retinal or optic nerve ischemia (Goodwin et al., 1987), but they are far more commonly encountered during migraine, involving the retina or occipital lobe.

Amaurosis fugax (AFx) may not be the only symptom; other symptoms may coexist such as transient sensory symptoms (paraesthesias) over the same side of the face (Ropper, 1985) and contralateral hemiparesis and hemi-sensory deficit.

Amaurosis fugax may recur, usually in a stereotyped fashion, but the area of visual impairment may vary from one episode to the next, depending on which part of the retina is ischemic.

Lone bilateral blindness
Sudden, spontaneous and simultaneous blindness in both eyes indicates retinal, chiasmal or occipital lobe dysfunction bilaterally. In the OCSP register of patients with suspected TIA (and without prior stroke), 14 patients had lone bilateral blindness, defined as rapid onset of dimming or loss of vision over all of both visual fields simultaneously, lasting less than 24 hours, without associated symptoms of focal cerebral ischemia, seizures or reduction in consciousness. The age of these patients was close to that of the 184 patients who presented with TIAs, and they had an equally high prevalence of vascular risk factors. During a mean follow-up period of 2.4 years, five of the 14 had a first-ever stroke (only 0.31 expected). In view of their 16 times excess risk of stroke, such patients are now considered, for practical purposes, as TIAs (Dennis et al., 1989b).

The differential diagnosis of patients who describe the simultaneous occurrence of binocular blurring, dimming or complete loss of vision depends on the associated symptoms. If the symptoms arise when the patient is feeling faint and experiencing other pre-syncopal symptoms, the likely cause is global cerebral hypoperfusion. If bilateral blindness occurs in isolation, it is probably caused by bilateral posterior cerebral artery ischemia, unless it has been provoked by a photostress such as bright or white light, in which case it is probably bilateral retinal ischemia (see below).

Loss of vision in the left or right half of the visual field
Isolated homonymous hemianopia is rare in comparison to other varieties of TIA, although asymptomatic visual field defects, chiefly located in the upper part of the visual field, have been reported in 29% of 17 patients with TIA and 57% of 14 patients with minor stroke (Falke et al., 1991). In the OCSP, nine patients (5%) had isolated sudden onset of hemianopia with no positive visual symptoms (or brainstem symptoms) (Dennis, 1988).

Part of the reason for the relatively low frequency of this symptom may be that patients have difficulty recognising and also describing it, particularly if there are other symptoms (such as hemiparesis) which are more readily appreciated and described. Also, it can be difficult to distinguish binocular loss of vision (such as a homonymous hemianopia) from monocular loss of vision; the patient needs to have covered each eye in turn during the symptoms and noted the effect (of objects that were previously seen in the centre of the visual field now appearing to be split in half). Even if the patient has covered each eye in turn during the attack, it may not be possible to be really confident of the distinction because an incongruous homonymous hemianopia does not necessarily split macular vision and may be interpreted by the patient as a loss of vision in one eye only. Similarly, if patients have only one functioning eye, it is almost impossible to distinguish a homonymous hemianopia from visual loss caused by ischemia in the good eye unless symptoms of posterior (or middle) cerebral artery ischemia coexist. It is therefore important to recognize that neurological conditions, such as migraine, that affect postchiasmal pathways and cause homonymous visual field defects are not infrequently described (erroneously) by the patient as monocular.

Visual loss in bright or white light
In 1979, Furlan et al. reported the phenomenon of unilateral loss of vision (causing things to appear bleached like a photographic negative) in five patients when exposed to bright sunlight. All patients had decreased retinal artery pressure on the symptomatic side and high-grade stenosis or occlusion of the ipsilateral internal carotid artery (ICA). Attenuation of the visual evoked response immediately after exposure to bright light was subsequently demonstrated in four such patients but not in controls (Donnan et al., 1982). A similar phenomenon of unilateral loss of vision induced by white light is also recognized in patients with ipsilateral carotid occlusive disease (Sempere et al., 1992).

Light exposure may also induce episodic bilateral visual impairment in patients with high-grade stenosis or occlusion of both internal carotid arteries (Wiebers et al., 1989). The visual symptoms consist of blurring, dimming or scotomata in both eyes (and never a shade or blind effect). The