Outcome of patients with cryptogenic stroke and patent foramen ovale

K Nedeltchev, M Arnold, A Wahl, M Sturzenegger, E E Vella, S Windecker, B Meier, H P Matte

Objectives. The aim was to estimate the recurrence rate and to define subgroups at increased risk for recurrent cerebral ischaemia in patients with patent foramen ovale (PFO) and so-called cryptogenic stroke due to paradoxical embolism.

Methods. Patent foramen ovale was diagnosed in 318 patients with otherwise unexplained ischaemic stroke or transient ischaemic attack (TIA). One hundred and fifty nine were treated medically (oral anticoagulation 79, platelet inhibitors 80) and represent the study population. The remaining 159 patients underwent endovascular or surgical closure of the PFO and are not part of this study.

Results. Mean age was 50.7 (SD 13.5) years. The event leading to the diagnosis of PFO was a TIA in 38 patients (23.9%), an ischaemic stroke in 119 (74.8%), and an amaurosis fugax in two patients (1.3%). Forty four patients (27.7%) had experienced multiple cerebrovascular ischaemic events before the diagnosis of the PFO. During mean follow up of 29 (SD 23) months 21 patients (13.4%) had a recurrent cerebrovascular event (seven strokes and 14 TIA). The average annual rate of recurrent strokes was 1.8% and that of recurrent strokes or TIA was 5.5%. When patients with PFO with multiple cerebrovascular events before the diagnosis of the PFO were analyzed separately, the average annual rates of recurrent cerebral ischaemia were 3.6% for recurrent strokes and 9.5% for recurrent strokes or TIA. These rates were significantly higher than in patients with first ever stroke or TIA (p=0.02).

Conclusions. The study confirms a risk of stroke recurrence that is similar to the rates of previously published series of patients with PFO and cryptogenic strokes. Patients with more than one previous event were at increased risk of recurrent cerebral ischaemia.

The cause of ischaemic stroke in young patients is often not found despite systematic investigations. Such strokes are classified as cryptogenic. In patients with cryptogenic strokes patent foramen ovale (PFO) can be detected in more than 50%, whereas its prevalence in the general population is at least 25%.

Therefore, PFO is likely associated with cryptogenic stroke. The presumed mechanism is paradoxical embolism of venous thrombotic material across the atrial right to left shunt. A thrombus crossing the PFO and subsequently embolizing to the brain has been rarely detected.

However, because direct evidence for paradoxical embolisation is rare in the individual clinical situation the potential role of the PFO in stroke is still a matter of debate. Earlier studies have suggested that a patent foramen ovale is an incidental finding in patients with cryptogenic strokes and does not represent a risk factor for cerebral ischaemia. On the other hand, later studies and a meta-analysis support PFO as a risk factor for stroke, and more recent investigations also found a strong association between the morphological characteristics of the PFO and the risk of embolic cerebrovascular events. The coincidence of an atrial septal aneurysm (ASA) seems to increase the risk of brain infarcts further.

Which patient with PFO is at risk of cerebral embolism, the recurrence rates after initial infarction, and the optimal prophylactic strategy have been the objectives of several studies. Controlled trials on therapy and secondary prevention in patients with PFO and cryptogenic stroke have not been performed yet. Well conducted observational studies on large series could therefore provide valuable information on the natural history of PFO and stroke, elucidate the relevance of the risk factors for stroke recurrence, and allow a better estimate of the risks associated with specific medical, endovascular, and surgical preventive measures.

For these reasons we analyzed the recurrence rate in patients with PFO and cryptogenic stroke. Using survival analyses, we aimed to define subgroups at increased risk for recurrent cerebral embolisation and to estimate the effect of oral anticoagulant drugs, platelet inhibitors, or no antithrombotic treatment on stroke recurrence.

PATIENTS AND METHODS

Patients

We identified all patients with ischaemic stroke, transient ischaemic attacks (TIAs), or amaurosis fugax, who were admitted to our university based stroke centre between January 1994 and July 2000.

The diagnosis of stroke was based on a focal neurological deficit and the corresponding findings on CT or MRI. A TIA was defined as a focal neurological deficit resolving completely within 24 hours. Transoesophageal echocardiography (TEE) had been performed in all patients suspected of paradoxical embolism via right to left shunt. After excluding those with a concurrent aetiologic for the cerebrovascular event we identified 318 patients who had a PFO and otherwise unexplained ischaemic stroke or TIA.

The patients were offered several treatment options to prevent a recurrent stroke: endovascular or surgical closure of the patent foramen ovale, or long term antithrombotic treatment.

Abbreviations: PFO, patent foramen ovale; TIA, transient ischaemic attack; ASA, atrial septal aneurysm; TEE, transoesophageal echocardiography; BMI, body mass index; INR, international normalised ratio; PICSS, PFO in cryptogenic stroke study; WARSS, warfarin/aspirin recurrent stroke study
Follow up data could not be obtained from two patients themselves were contacted. In order not to miss any recurrent cardiovascular disease, family physicians of all patients and afterwards the patients themselves were contacted. Thereafter, the medical records of all patients and the relevant information concerning recurrent events and treatments. Twenty patients, who had been on antithrombotic treatment for a prolonged period and then decided for some reason to have endovascular or surgical closure of the PFO, were included in the analysis for the time they had been treated medically.

Statistics
Continuous variables are expressed as mean (SD). Nominal variables were compared by \( \chi^2 \) test for contingency tables. Statistical significance was assumed at a value of \( p<0.05 \).

RESULTS
The study population consisted of 93 men and 66 women. Their mean age was 50.7 (13.5) years (range 15 to 77 years). One hundred and twenty one patients (76.1%) were 60 years old or younger at the time when they experienced the ischaemic event that led to the diagnosis of a PFO (fig 1).

This event was a transient ischaemic attack in 38 patients (23.9%), an ischaemic stroke in 119 (74.8%), and an amaurosis fugax in two patients (1.3%). In 90 patients (56.6%) it occurred in the carotid territory and in 69 patients (43.4%) in the vertebrobasilar territory. Forty four patients (27.7%) had experienced more than one cerebrovascular ischaemic event before the diagnosis of the patent foramen ovale.

The vascular risk factors that were considered to increase the risk for stroke or TIA are summarised in table 1. Hypertension, diabetes mellitus, cigarette smoking, hypercholesterolaemia, and familial history for stroke occurred with frequent in the group with more than one prior event \( (p=0.02) \). There were five patients with coronary artery disease in the group with one cerebral ischaemic event before diagnosis of the PFO. Fifty of the 159 patients (31.4%) did not show any vascular risk factors.

The right to left shunt was minimal in 19 patients (11.9%), moderate in 44 (27.7%), and severe in 96 (60.4%) patients. Thirty three patients (20.7%) had an ASA in addition to the PFO.

Antithrombotic treatment such as anticoagulation, aspirin, or clopidogrel was given according to the judgement of the attending physician after the event leading to the diagnosis of

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**Table 1** Vascular risk factors in patients with one and in patients with multiple ischaemic events before diagnosis of PFO

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>All patients (n=159)</th>
<th>Patients with one ischaemic event (n=115)</th>
<th>Patients with multiple ischaemic events (n=44)</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>52 (32.7)</td>
<td>37 (32.2)</td>
<td>15 (34.1)</td>
<td>0.79</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>15 (9.4)</td>
<td>10 (8.7)</td>
<td>5 (11.4)</td>
<td>0.55</td>
</tr>
<tr>
<td>Smoking</td>
<td>52 (32.7)</td>
<td>36 (31.3)</td>
<td>16 (36.4)</td>
<td>0.59</td>
</tr>
<tr>
<td>Hypercholesterolaemia</td>
<td>48 (30.2)</td>
<td>33 (28.7)</td>
<td>13 (34.1)</td>
<td>0.49</td>
</tr>
<tr>
<td>Positive familial history</td>
<td>42 (26.4)</td>
<td>30 (26.1)</td>
<td>12 (27.3)</td>
<td>0.84</td>
</tr>
<tr>
<td>Obesity</td>
<td>82 (51.6)</td>
<td>52 (45.2)</td>
<td>30 (68.2)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Values are n (%).
PFO. Seventy nine patients received oral anticoagulant drugs. The target international normalised ratio (INR) was 2.0–3.0. In 26 of them the oral anticoagulation was replaced by antiplatelet drugs after 12 (SD 11) months. Platelet inhibitors were given to 80 patients (77 patients were treated with aspirin at a mean dosage of 233 (SD 83) mg/day, three patients were non-compliant and discontinued antithrombotic therapy. No bleeding complications were seen either in patients treated with oral anticoagulants or in those with platelet inhibitors.

Mean follow up was 29 (23) months. During this period 21 patients (13.4%) had a recurrent cerebrovascular event, seven strokes and 14 TIA. Six strokes occurred in patients who were taking aspirin and one stroke in a patient with anticoagulant drugs. Five TIA occurred in the aspirin group, six in the oral anticoagulant group, and three in patients who had discontinued the antithrombotic therapy. No bleeding complications were seen either in patients treated with oral anticoagulants or in those with platelet inhibitors.

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24% of our patients were older than that. However, there was no association between age and stroke recurrence in our series.

A relevant finding of the present study is that patients with a positive personal history of stroke or TIA before the event leading to the detection of the PFO had a higher rate of recurrent cerebral ischaemia (table 2 and fig 2). Obesity was more frequent in the group with multiple ischaemic events before diagnosis of PFO. However, the higher recurrence rate was unlikely to be associated with body weight. When patients with BMI less than 25 kg/m² were analyzed separately, the risk of recurrence remained significantly higher in patients with multiple ischaemic events than in those with one stroke or TIA before diagnosis of PFO. Mas et al and De Castro et al excluded patients with multiple ischaemic events from their studies and Bogousslavsky et al tended to treat such patients surgically.

Several authors have found that atrial septal hypermobility and ASA combined with PFO and also the size of the PFO are independent risk factors for stroke. Our data do not support this finding. Neither the coexistence of ASA nor the size of the right to left shunt was associated with an increased recurrence rate in our series. A possible explanation of this disagreement could be the relatively small number of only 33 patients with ASA (21%) in our series. Methodological factors might also play a major part in the proper assessment of the size of a right to left atrial shunt, with difficulties comparing the data of different studies. Grading is usually performed during provocative manoeuvres (Valsalva’s manoeuvre or cough) and therefore may depend on the strain exerted by the examined patient, the delay after the beginning of contrast injection, etc. Attempts to standardise the provocative manoeuvres have been shown to improve the sensitivity of the methods used for identification of the PFO. In addition, microbubbles are counted from a single two dimensional imaging plane that does not necessarily reflect the exact amount of all the microbubbles shunted into the left atrium. Therefore, results from grading of the right to left shunts should be interpreted with caution.

Our results do not favour any medical treatment regimen. Six strokes occurred in patients with aspirin and one in a patient with anticoagulation; however, this difference was not significant. The PFO in cryptogenic stroke study (PICSS), an ongoing substudy of the warfarin/aspirin recurrent stroke study (WARRIS), is about to address this question. It compares aspirin and anticoagulation in patients with PFO and cryptogenic strokes. To summarise, our study confirms a risk of recurrent strokes and TIsAs that is similar to the rates of previously published series of patients with PFO and cryptogenic strokes. Patients who had experienced multiple cerebrovascular events before diagnosis of PFO were at increased risk of recurrent cerebral ischaemia.

### Table 3

<table>
<thead>
<tr>
<th>Source (1st author)</th>
<th>Number of patients</th>
<th>Stroke</th>
<th>Stroke and/or TIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mas12</td>
<td>132</td>
<td>1.2%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Bogousslavsky20</td>
<td>140</td>
<td>2.4%</td>
<td>3.8%</td>
</tr>
<tr>
<td>De Castro3</td>
<td>74</td>
<td>1.8%</td>
<td>2.4%*</td>
</tr>
<tr>
<td>Present study</td>
<td>157</td>
<td>1.8%</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

*In the original article the overall cumulative estimate of risk of cerebrovascular event recurrence is given. We derived the average annual event rate from the overall cumulative estimate of risk of stroke or TIA recurrence, at 3 years of follow up, according to the formula 1-(1-P)\(^n\), where P equals the cumulative event rate at n years of follow up.

### Authors’ affiliations

K Nedeltchev, Arnold, Wahl, et al

### REFERENCES

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