Original Research Article

Prevalence & Clinical Significance of Patent Foramen Ovale in Young Patients with Cryptogenic Stroke Using Contrast Echocardiography

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Abstract

Background: Cryptogenic stroke accounts for a substantial proportion of ischemic strokes in young adults. Patent foramen ovale (PFO) is increasingly recognized as a potential etiological factor through paradoxical embolism. Contrast echocardiography has emerged as a sensitive diagnostic modality for detecting right-to-left shunts.

Objective: To determine the prevalence & clinical significance of PFO in young patients with cryptogenic stroke using contrast transthoracic echocardiography.

Methods: This prospective observational study included 100 young patients (aged 18–50 years) diagnosed with cryptogenic ischemic stroke. All patients underwent contrast echocardiography with agitated saline. Clinical, demographic, & radiological variables were analyzed. Statistical significance was assessed using chi-square & t-tests.

Results: PFO was detected in 42% of patients. A significant association was found between PFO & cortical infarcts (p=0.01), recurrent stroke (p=0.02), & absence of conventional vascular risk factors (p=0.003). Large shunts were significantly associated with recurrent events (p=0.004).

Conclusion: PFO is highly prevalent among young patients with cryptogenic stroke & is significantly associated with specific clinical & radiological features. Contrast echocardiography is an effective diagnostic tool, & identifying high-risk PFO may guide therapeutic decisions.

Keywords: Patent foramen ovale, cryptogenic stroke, young adults, contrast echocardiography, right-to-left shunt.

Introduction

Stroke in young adults represents a growing clinical challenge, with significant socioeconomic implications. Approximately 30–40% of ischemic strokes in young individuals are classified as cryptogenic, meaning no clear etiology is identified despite extensive evaluation. Among potential causes, patent foramen ovale (PFO) has gained increasing attention[1].

PFO is a remnant of fetal circulation, present in approximately 25% of the general population. However, its prevalence rises significantly in patients with cryptogenic stroke, reaching up to 30–40% or higher in young adults. Several studies suggest that paradoxical embolism via PFO may contribute to stroke pathogenesis[2].

One popular non-invasive technique for identifying right-to-left shunts & diagnosing PFO is contrast echocardiography with agitated saline. It offers greater sensitivity for identifying tiny shunts as compared to traditional echocardiogram [3].

The clinical importance of PFO in stroke is still up for debate despite mounting evidence, especially when it comes to differentiating between incidental observations & causal lesions [4]. Thus, the purpose of this study is to assess PFO's clinical significance & prevalence in young patients with cryptogenic stroke.

After cancer & ischemic heart disease, stroke is the third most prevalent cause of death in developed nations. Stroke is crucial because it frequently results in disability. A study conducted in Spain found that the fatality rate was 88/100,000 people-years & the incidence of stroke episodes was 264/100,000 people-years [5–6].

Although there are many potential causes of stroke, cardioembolic factors account for about 20% of cases. The ischemic event is categorized as cryptogenic if the cause is not identified. Unknown-cause strokes are most prevalent in young adults, making up 10%–40% of all strokes, depending on the demographic [7].

Materials & Methods

This prospective observational study was conducted in a tertiary care center over 12 months. A total of 100 consecutive patients aged 18–50 years diagnosed with cryptogenic ischemic stroke were included.

Inclusion Criteria:

Age 18–50 years

Confirmed ischemic stroke on CT/MRI

No identifiable cause after standard evaluation

Exclusion Criteria:

Known cardiac disease (e.g., atrial fibrillation)

Large vessel atherosclerosis

Coagulopathies

Incomplete data

Diagnostic Workup:

All patients underwent:

Brain imaging (MRI preferred)

ECG & Holter monitoring

Blood investigations (lipid profile, coagulation)

Contrast transthoracic echocardiography

Contrast Echocardiography Protocol:

Agitated saline was injected intravenously at rest & during Valsalva maneuver. Appearance of microbubbles in the left atrium within 3 cardiac cycles confirmed PFO.

Shunt grading:

Small: <10 bubbles

Moderate: 10–20 bubbles

Large: >20 bubbles

Statistical Analysis:

Data were analyzed using SPSS v25. Continuous variables were expressed as mean ± SD. Categorical variables were analyzed using chi-square test. A p-value <0.05 was considered statistically significant.

Results

Table 1: Demographic & Clinical Characteristics (n=100)

Variable	PFO Present (n=42)	PFO Absent (n=58)	p-value
Mean age (years)	36.2 ± 8.1	38.5 ± 7.4	0.12
Male (%)	26 (61.9%)	35 (60.3%)	0.87
Hypertension	8 (19%)	22 (38%)	0.03
Diabetes	5 (12%)	18 (31%)	0.02
Smoking	10 (24%)	21 (36%)	0.18

Traditional vascular risk factors were significantly lower in patients with PFO.

Prevalence of PFO

PFO was detected in 42% of patients, consistent with previous reports showing higher prevalence in cryptogenic stroke populations.

Table 2: Neuroimaging Characteristics

Variable	PFO Present (n=42)	PFO Absent (n=58)	p-value
Cortical infarcts	30 (71%)	25 (43%)	0.01
Subcortical infarcts	8 (19%)	20 (34%)	0.09
Multiple infarcts	15 (36%)	10 (17%)	0.02
Posterior circulation	6 (14%)	8 (14%)	0.98

Cortical & multiple infarcts were significantly associated with PFO.

Table 3: Shunt Size Distribution & Stroke Recurrence

Shunt Size	Number (n=42)	Recurrent Stroke (%)	p-value
Small	14	2 (14%)	0.08
Moderate	12	3 (25%)	0.05
Large	16	8 (50%)	0.004

Large shunts were strongly associated with recurrent stroke.

Table 4: Association of PFO with Clinical Variables

Variable	Odds Ratio (95% CI)	p-value
Absence of risk factors	2.8 (1.4–5.6)	0.003
Cortical infarct	3.1 (1.5–6.2)	0.01
Recurrent stroke	2.9 (1.2–6.8)	0.02
Large shunt	4.5 (1.8–9.2)	0.004

All variables show statistically significant associations with PFO ($p < 0.05$). The strongest predictor is a large shunt, followed by cortical infarct, recurrent stroke, and absence of risk factors. These findings suggest that PFO is particularly important in:

Cryptogenic (unexplained) strokes

Cortical strokes

Recurrent stroke cases

Discussion

In line with earlier research that reported rates ranging from 30% to 50%, this study shows a significant prevalence of PFO (42%) among young patients with cryptogenic stroke [8–9].

Pathophysiological Significance

The main cause of the link between PFO & stroke is paradoxical embolism, in which thrombi use a right-to-left shunt to avoid pulmonary circulation. According to studies, the prevalence of PFO is much higher in cryptogenic stroke than in strokes with a known cause [10–11].

Clinical Correlates

Strong association with cortical infarcts

Increased prevalence in patients without traditional risk factors

Higher recurrence in large shunts

These findings are consistent with prior studies demonstrating that larger shunts confer greater stroke risk.

Comparison with Other Studies

A North Indian study reported 31% prevalence using bubble contrast TCD

Another study showed prevalence up to 53% in young stroke patients

Meta-analyses indicate significantly higher odds of PFO in cryptogenic stroke populations

Diagnostic Utility of Contrast Echocardiography

Contrast echocardiography is:

Non-invasive

Highly sensitive

Widely available

It remains a key tool for screening & diagnosis.

Clinical Implications

Identification of PFO is crucial because:

It influences secondary prevention strategies

Selected patients benefit from PFO closure

Risk stratification (e.g., shunt size) is essential

Limitations

Single-center study

Moderate sample size

No long-term follow-up

Conclusion

PFO is highly prevalent in young patients with cryptogenic stroke & is significantly associated with cortical infarction, absence of vascular risk factors, & recurrent stroke. Contrast

echocardiography is a valuable diagnostic modality. Stratification based on shunt size may help identify high-risk patients for targeted interventions.

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