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ORIGINAL RESEARCH

# Evaluation of Risk Factors for Invasive Mechanical Ventilation Requirement in Posterior Circulation Stroke

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**ABSTRACT**

Ischaemic stroke is recognised as one of the common causes of disability and death today, and it is a primary reason for admission to intensive care units. Posterior circulation strokes account for 20-25% of ischaemic strokes. Respiratory failure is among the leading causes of mortality. Identifying risk factors may aid in taking preventive measures. This study aims to identify the risk factors associated with invasive mechanical ventilation in patients with posterior circulation stroke. This study included patients diagnosed with posterior circulation stroke by the Neurology Clinic at our tertiary centre between 01.01.2019 and 01.01.2021. It was designed to compare patients who required invasive mechanical ventilation with those who did not, and to identify associated risk factors. Independent risk factors for requiring invasive mechanical ventilation in patients with posterior circulation infarcts were found to be stroke-related pneumonia, basilar artery occlusion, and ischaemic stroke due to large artery disease. SOFA and APACHE II scores, along with 28-day mortality rates, were assessed in patients requiring invasive mechanical ventilation. 28-day mortality occurred in 6 patients. The mean SOFA score was 4.72 ± 2.72, and the mean APACHE II score was 19.88 ± 5.34. In this study, the need for invasive mechanical ventilation in posterior circulation strokes was associated with basilar artery occlusion, stroke aetiology being large artery atherosclerosis, presence of stroke-related pneumonia. The main limitation of this study is its retrospective design, and as it was conducted at a single centre, it may not reflect the wider population. Multicentre and prospective studies are necessary to address this issue.

**Keywords: Posterior circulation stroke. Respiratory failure. Mechanical ventilation.**

**Posterior Dolaşım İnfezyonunda İnvaziv Mekanik Ventilasyon Gereksiniminin Risk Faktörlerinin Değerlendirilmesi**

**ÖZET**

İskemik inme günümüzde yaygın sakatlık ve ölüm nedenlerinden biri olarak kabul edilmekte ve yoğun bakım ünitelerine yatışın birincil nedenidir. Posterior sirkülasyon inmesi, iskemik inmelerin %20-25'ini oluşturur. Solunum yetmezliği önde gelen mortalite nedenleri arasındadır. Risk faktörlerinin belirlenmesi koruyucu önlemlerin alınmasına yardımcı olabilir. Bu çalışma, posterior sirkülasyon inmesinde invaziv mekanik ventilasyon için risk faktörlerini belirlemeyi amaçlamaktadır. Bu çalışmaya, 01.01.2019-01.01.2021 tarihleri arasında üçüncü basamak merkezimiz Nöroloji Kliniği tarafından posterior sirkülasyon inmesi tanısı konulan hastalar dahil edilmiştir. İnvaziv mekanik ventilasyon gerektiren ve gerektirmeyen hastaları karşılaştırmak ve ilişkili risk faktörlerini belirlemek amacıyla tasarlanmıştır. Posterior sirkülasyon infarktüsü olan hastalarda invaziv mekanik ventilasyon gereksinimi için bağımsız risk faktörlerinin inme ilişkili pnömoni, baziler arter tıkanıklığı ve büyük arter hastalığına bağlı iskemik inme olduğu bulunmuştur. İnvaziv mekanik ventilasyon gerektiren hastalarda SOFA ve APACHE II skorları ile 28 günlük mortalite oranları değerlendirilmiştir. 28 günlük mortalite 6 hastada görüldü. Ortalama SOFA skoru 4,72 ± 2,72, ortalama APACHE II skoru ise 19,88 ± 5,34 olarak bulundu. Bu çalışmada, posterior sirkülasyon inmelerinde invaziv mekanik ventilasyon ihtiyacı, inme etyolojisi büyük arter aterosklerozu olan baziler arter oklüzyonu ve inme ilişkili pnömoni varlığı ile ilişkilendirildi. Bu çalışmanın temel sınırlaması retrospektif tasarımıdır ve tek bir merkezde yürütüldüğü için daha geniş popülasyonu yansıtmayabilir. Bu konuyu ele almak için çok merkezli ve prospektif çalışmalara ihtiyaç vardır.

**Anahtar Kelimeler: Posterior sirkülasyon inmesi. Solunum yetmezliği. Mekanik ventilasyon.**

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Ischaemic stroke is recognised as a common cause of disability and death today, serving as a major reason for admission to intensive care units[1,2]. One of the primary reasons for the need for intensive care follow-up of ischaemic stroke patients is the requirement for invasive mechanical ventilation (MV). The infarct location in patients with ischaemic stroke is the most significant factor associated with the need for invasive MV. In such cases, damage to brain regions responsible for regulating consciousness—including the limbic system, thalami, and reticular formation in the brainstem—as well as areas controlling breathing, such as the respiratory centres in the cortex, medulla oblongata, and pons, and those governing swallowing, including the medulla oblongata and its brainstem connections, increases the risk of respiratory failure[3]. Stroke-related pneumonia may increase the need for invasive mechanical ventilation in patients with ischemic stroke[4]. Stroke-associated pneumonia is defined as a lower respiratory tract infection that develops within the first 7 days after an acute stroke in a patient with no prior respiratory infection. Stroke-associated pneumonia is diagnosed based on clinical, laboratory, and radiological findings. It occurs as a complication resulting from mechanisms such as aspiration, dysphagia, decreased level of consciousness, and stroke-induced immunosuppression[5,6]. Posterior circulation stroke (PCS) makes up about 25% of ischaemic strokes[7]. Basilar artery occlusion is related to high mortality and morbidity, particularly if blood flow is not restored to the vessel[8]. Mortality in PCS ranges from about 3% to 18%, depending on the stroke registry surveyed, and is traditionally considered more favourable than in anterior circulation stroke (ACS). However, that notion has been challenged in the literatüre[9]. Respiratory failure is a major cause of mortality. Ischemic stroke is a heterogeneous group of diseases caused by many complex mechanisms[10]. Identifying some risk factors may be useful for taking precautions. This study aims to establish the risk factors for invasive MV in PCS.

## Material and Method

This study included patients diagnosed with PCS by the Neurology Clinic at our tertiary centre between 01.01.2019 and 01.01.2021. The inclusion criteria for our study were being diagnosed with acute ischemic stroke, having a computerised tomography (CT) angiography, determining the stroke aetiology, and being followed up in our neurology clinic for 3 months after discharge. The exclusion criteria for the study were incomplete examinations to determine the aetiology of ischaemic stroke and the patient being discharged from the neurology clinic. This study was prepared in accordance with the Helsinki Declaration. Data such as age, gender, presence of hypertension, coronary artery disease (CAD), atrial fibrillation (AF), congestive heart failure, liver or kidney failure, medication use, and the presence of diabetes were queried from the MIA operating system. To establish the aetiology of stroke, cranial magnetic resonance imaging (MRI), brain-neck CT angiography, electrocardiogram, echocardiogram, and 24-hour Holter rhythm recordings were performed on all patients and documented in the epicrisis. The patients' stroke aetiology was classified by a stroke neurologist using the TOAST stroke classification. The anterior circulation was depicted as the internal carotid artery, the medial cerebral artery, and the anterior cerebral artery[11]. Posterior circulation was depicted as both vertebral arteries, the basilar artery, and its branches[12]. The infarct localisation of the patients was determined blindly by a radiologist through examining cranial MRIs. The lesion localisation was classified as the thalamus, occipital lobe, mesencephalon, pons, and bulbous. Post-stroke pleural complications were evaluated before intubation and classified as pulmonary thromboembolism, pneumonia, pleural effusion, pulmonary oedema, and acute respiratory distress syndrome. The diagnosis of stroke-associated pneumonia was made according to the PISCES criteria and evaluated before endotracheal intubation[13]. The need for invasive mechanical ventilation was assessed by an intensive care specialist. Acute Physiology and Chronic Health Evaluation (APACHE II) scores and Sequential Organ Failure Assessment (SOFA) scores were recorded after intubation[14,15]. Clinical outcomes were evaluated three months after the stroke using the modified Rankin scale score (mRS) (mRs 0-2 for favourable clinical outcome, 3-6 for unfavourable clinical outcome). Whether patients diagnosed with PCS required invasive mechanical ventilation (MV) was determined from epicrisis. It was planned to compare patients who required invasive MV with those who did not and to identify the associated risk factors.

### *Statistical Analyses*

The data of patients with PCS were assessed. Patients both requiring and not requiring invasive MV were analysed. Statistical analysis was performed using IBM SPSS Statistics 25.0 software (IBM Corp., Armonk, New York, USA). The Shapiro-Wilk test, along with a histogram and a Q-Q plot, was used to establish the normality of the data. Means and standard deviations or medians (25%–75% quartiles) were used to analyse continuous variables. Frequencies and percentages were reported for categorical variables. An independent two-sided sample t-test or a Mann–Whitney U test was applied to compare continuous variables between the two groups. Fisher's exact test, Pearson chi-square test, and

continuity correction test were applied to examine differences in categorical variables between groups, utilising 2 × 2 or r × c tables. Binary logistic regression analysis was applied to establish independent risk factors for requiring invasive MV. $p<0.05$ was considered statistically significant.

## Results

A total of 201 patients were included in this study, with 119 (59.20%) male and 82 (40.80%) female. Among these patients, 156 (77.61%) had hypertension (HT), 101 (50.24%) had diabetes mellitus (DM), 82 (40.79%) were smokers, 34 (16.91%) had atrial fibrillation, 19 (9.45%) had heart failure, and 39 (19.40%) had CAD. The stroke etiologies were classified as ischemic stroke due to large artery disease in 68 (33.83%) patients, cardioembolic stroke in 38 (18.90%) patients, small vessel disease in 65 (32.33%) patients, other causes in 7 (3.48%) patients, and stroke of unknown cause in 23 (11.44%) patients. Eighteen (8.95%) patients required invasive mechanical ventilation (MV). When radiological features were evaluated, anterior circulation stroke with accompanying posterior circulation stroke (PCS) was present in 21 (10.44%) patients. Occlusions were observed in various regions: occipital lobe infarction in 41 (20.39%) patients, thalamic infarction in 41 (20.39%), mesencephalon in 15 (7.46%), pons in 66 (32.83%), basal ganglia in 29 (14.42%), and cerebellar infarction in 73 (36.31%) patients. Stroke recurrence within the first three months occurred in 34 (16.91%) patients. Unfavourable clinical outcomes were seen in 51 (25.37%) patients. Comparing PCS patients with and without invasive MV, a significant statistical association was found with stroke aetiology ($p=0.028$), unfavourable clinical outcome ($p<0.001$), presence of atherosclerotic stenosis in the basilar artery ($p<0.001$), basilar artery occlusion ($p<0.001$), occipital lobe infarction ($p=0.001$), thalamic infarction ($p<0.001$), mesencephalon infarction ($p<0.001$), pons infarction ($p=0.031$), bulbar infarction ($p<0.001$), cerebellar infarction ($p=0.011$), and stroke- related pneumonia ($p<0.001$). However, no significant relationship was found with age, gender, hypertension, diabetes, smoking, atrial fibrillation, congestive heart failure, CAD or atherosclerotic stenosis in segments V1, V2, V3, or V4 of the vertebral artery, nor with pleural effusion, ARDS, pulmonary oedema, or pulmonary thromboembolism (Table I). A binary logistic regression model was created with statistically significant variables. A binary logistic regression model incorporating significant variables identified stroke-related pneumonia ($p<0.001$), basilar artery occlusion ($p=0.010$), and ischemic stroke due to large artery disease ($p=0.035$) as the most influential factors (Table II). The SOFA and APACHE II scores, along with 28- day mortality, were calculated for patients requiring invasive MV. Six patients died within 28-days. The mean SOFA score was $4.72 \pm 2.72$, and the mean APACHE II score was $19.88 \pm 5.34$.

## Discussion and Conclusion

In this study, the independent risk factors for requiring invasive MV in PCS were identified as basilar artery occlusion, stroke aetiology being large artery disease, infarct location being bilateral, and stroke-related pneumonia. Invasive MV was found to be associated with an unfavourable clinical outcome. The requirement for invasive MV in our patients was determined to be 8.95%. Our data aligns with the existing literature. Previous studies reported that the requirement for invasive MV in patients with PCS was around 10%[16]. In patients with PCS, the causes for requiring invasive MV can be classified as reversible and irreversible. Reversible causes include stroke-related pneumonia, pulmonary oedema, and pleural effusion, while irreversible causes include infarction development[17]. Among the reasons for invasive MV in our patients, 8 had a low Glasgow Coma Scale score at presentation to the emergency department, 1 had a low score due to stroke recurrence, 1 due to haemorrhagic transformation, 6 due to early neurological deterioration, 1 because of pneumonia, and 1 due to hypovolaemic shock from gastrointestinal bleeding. The most common reasons for intubation in our patients were irreversible causes. One of the independent risk factors associated with invasive MV was stroke-related pneumonia. Possible causes of stroke-related pneumonia include immunological responses after stroke and dysphagia related to stroke[18-22]. Additionally, PCS is one of the risk factors for stroke-related pneumonia[23,24]. Stroke-related pneumonia is linked with prolonged hospital stay and increased mortality risk[25]. Mortality rates for basilar artery occlusion range between 45-86%[26-28]. Worse prognosis has been reported when the stroke's aetiology is embolic, compared to atherosclerotic in basilar artery occlusion[29]. However, in our study, where we evaluated all PCS, large artery disease was identified as an independent risk factor for the need for invasive MV according to our binary logistic regression analysis. Bilateral lesions in PCS have been associated with ischaemic stroke due to large artery disease. Bilateral infarcts in the posterior circulation are linked with higher NIHSS scores at stroke onset and poorer clinical outcomes[30]. In our study, bilateral infarcts in the posterior circulation were found to be an independent risk factor for requiring invasive MV. The main limitation of this study is its retrospective design and single-centre scope, which may not fully reflect the broader population. Multicentre and prospective research are needed to address this issue.

In this study, the requirements for invasive MV in PCS were found to be associated with basilar artery occlusion, stroke aetiology being large artery atherosclerosis, presence of stroke-related pneumonia, and bilateral infarcts.

**Researcher Contribution Statement:**
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