






■ Original Article

Posterior circulation stroke and rehabilitation: experiences in a rehabilitation clinic

Posterior dolaşım kaynaklı inme ve rehabilitasyonu: bir rehabilitasyon kliniğinin deneyimleri

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ABSTRACT

Objective: The aim of our study was to evaluate the demographic and disease characteristics of our patients with posterior circulation due to low life expectancy which may affect vital functions such as consciousness, circulation, respiration and swallowing and to convey our experience.

Materials and Methods: A total of 12 patients hospitalized in the Clinic of Physical Medicine and Rehabilitation with posterior circulation stroke were included in this study. Demographic characteristics, coma and intensive care duration and time period before the rehabilitation admission, the existence and duration of tracheostomy and mechanical ventilation support, Glasgow coma scale (GCS) was recorded. Neurological and musculoskeletal findings of all patients, swallowing and nutritional status, pressure ulcer existence, neurogenic bladder and bowel symptoms were evaluated. Rehabilitation protocol, rehabilitation clinic stay period, Brunnstrom motor functional status (BMFS) and functional independence measure (FIM) score on admission and discharge was reported.

Results: The mean age of the patients was 53.75 ± 12.77 years. Right side of the body in 4 (33%) patients, left side in 1 (8.3%) patients and both sides affected in 7 (58.4%) patients. Mean time until the admission to the rehabilitation clinic was 33.5 (7-78) days and rehabilitation clinic stay length was 39.5 (15-126) days. After the rehabilitation period BMFS, GCS and FIM scores changed significantly ($p=0.001$, $p=0.005$, $p=0.002$). At the rehabilitation discharge, 3 (25%) patients were wheelchair bound, rest of the patients were ambulatory with an assistance or independently. 3 patients continued with gastrostomy tube.

Conclusion: Early rehabilitation of severe posterior circulation (PC) stroke patients that has an essential role for the recovery; as well as in all hemiplegies, contributing to improved motor-cognitive status and better functional outcomes.

In our study, the demographic and disease characteristics of patients with stroke who had low life expectancy and posterior circulation with serious medical complications were evaluated. It was concluded that starting early rehabilitation program might be important in terms of motor functions, cognitive functions and functional independence as in all other hemiplegic patients.

Keywords: posterior circulation, stroke, rehabilitation

ÖZ

Amaç: Çalışmamızın amacı bilinç, dolaşım, solunum ve yutma gibi hayati fonksiyonları etkileyebilen ve yaşam beklentisi düşük olan posterior sirkulasyon kaynaklı inmeli hastalarımızın demografik ve hastalık özelliklerinin değerlendirilmesi ve deneyimlerimizin aktarılmasıdır.

Gereç ve Yöntem: Çalışmamızda, kliniğimizde yatarak takip edilen, posterior sirkulasyon kaynaklı inmeli 12 hasta alındı. Hastaların demografik özellikleri, koma ve yoğun bakım süresi, kliniğimize kabule kadar geçen süre, trakeostomi ve mekanik ventilasyon desteği varlığı ve süresi, Glaskow koma skalası (GKS) düzeyi gibi hastalık özellikleri kaydedildi.

Hastaların kabulündeki nörolojik ve kas iskelet sistemi ile konuşma, yutma, nütrisyon, bası yarısı, mesane ve bağırsak muayene bulguları değerlendirildi. Hastalara uygulanan rehabilitasyon yöntemleri, kliniğimizde kalış süresi ile kliniğimize kabul ve taburculuk sırasındaki Brunstrom motor fonksiyonel seviye (BMFS) ve fonksiyonel bağımsızlık ölçeği (FBÖ) düzeyi kaydedildi.

Bulgular: Çalışmaya alınan hastaların yaş ortalaması 53,75±12,77 yılıdır. Hastaların 4'ünde (%33,3) sağ, 1'inde (%8,3) sol, 7'sinde (%58,4) ise hem sağ hem de sol taraf etkilenmişti. Kliniğimize kabule kadar geçen süre ortalama 33,5 gün olup uygulanan fizik tedavi süresi 39,5 gündü (15-126 gün). Hastalara uygulanan rehabilitasyon programı sonrasında; BMFS, GKS ve FBÖ düzeylerindeki değişim anlamlı olarak bulundu (sırasıyla p=0,001, p=0,005, p=0,002). Hastaların tedavi sonrasında 3'ü (%25) tekerlekli sandalye seviyesinde, diğerleri destekli/desteksiz ambule olarak taburcu edildi. Hastaların 3'ünde beslenmeye gastrotomi yöntemi ile devam edildi.

Sonuç: Yaşam beklentisi düşük olabilen ve ciddi medikal komplikasyonlarla seyredabilen posterior sirkulasyonu içeren inmeli hastaların demografik ve hastalık özelliklerinin değerlendirildiği çalışmamızda; erken dönem rehabilitasyon programına başlamanın diğer tüm hemiplejik hastalarda olduğu gibi motor fonksiyonlar, bilişsel fonksiyonlar ve fonksiyonel bağımsızlık yönünden önemli olabileceği sonucuna varıldı.

Anahtar kelimeler: posterior dolaşım, inme, rehabilitasyon

INTRODUCTION

The blood supply to the brain is provided by the internal carotid artery and vertebrobasillar system. The circle of Willis is an anastomotic network between these arterial systems sits at the base of the brain [1]. Posterior cerebral artery is responsible for blood supply to the thalamus, temporal and occipital lobes, optic radiation and subcortical sections of this regions; while two vertebral arteries join to form the basillar artery at the pontine base that supply blood to the brainstem and cerebellum [2].

Stroke is the most common serious neurological problems all over the world. Mortality rates for stroke are about 8%-38%; as hemispheric stroke represents the 80%-86% of this

rate. Also posterior circulation (PC) stroke carries mortality over 90% [3].

Posterior circulation stroke mostly resulting in bilateral findings, contrary to the hemispheric infarctions which is leading to unilateral clinical findings. Occasionally cerebellar symptoms accompany by the asymmetric bilateral corticospinal findings [4-5]. Symptoms of posterior circulation stroke have a wide spectrum including alterations in consciousness such as coma and somnolence; respiratory and circulatory dysfunction, symptoms of cranial nerve involvement such as facial paralysis, dysarthria, dysphagia, diplopia, nystagmus, ataxia, imbalance, vertigo, hemi-tetraparesis and hemi-tetra hypoesthesia.

In the literature, small number of studies placed about the rehabilitation of PC stroke covering the execution of vital functions such as consciousness, circulation, respiration and swallowing, although many studies investigated the effects of the hemispheric stroke rehabilitation. Because life expectancy is low and there are serious medical complications [6-8]. Previous studies about the PC stroke rehabilitation mostly included patients with unilateral motor and sensory deficits without serious cranial nerve and respiratory dysfunction [3,7-8]. Unlike the literature, this study aimed to investigate the effects of early rehabilitation besides the medical treatment in non-ambulatory PC stroke patients with serious respiratory and swallowing dysfunctions.

MATERIALS AND METHODS

Total of 12 patients hospitalized in the Clinic of Physical Medicine and Rehabilitation with posterior circulation stroke between the years 2013-2015 were included in this study. Inclusion criteria of the study are age between 18-80 years, poststroke duration less than 90 days, first ischemic or hemorrhagic stroke survivors; exclusion criteria are known psychiatric and progressive neurological disorders, Alzheimer disease-dementia, severe cognitive dysfunction, mental and prestroke physical dependency in daily living activities, severe polyneuropathy, amputation, metastatic and nonmetastatic tumoral disease in the last 5 years, hypoxic and anoxic brain injury after cardiac arrest, traumatic intracranial hemorrhage and stroke affecting other than the PC.

Subjects were informed about the study procedure and they consented to participate. The study protocol was approved by the local institutional ethical committee (Date: 03/11/2014- No:17/08), and conducted in accordance with the principles of the Helsinki Declaration.

Sociodemographic characteristics of all patients were recorded as age, sex, educational level, occupational and economic status, dominant hand, comorbidities, previous operations, cigarette and alcohol usage; also disease characteristics were recorded as lesion type and location in magnetic resonance imaging (MRI), time of admission to hospital after stroke event, Glasgow coma scale (GCS) score on admission, coma and intensive care unit (ICU) stay period, requirements and duration of supplemental oxygen, tracheostomy, mechanical ventilation, nasogastric (NG) feeding and percutaneous gastrostomy. Prestroke physical activity levels of patients on the basis of working hours and prestroke job classified as "sedantary, light, moderate and high intensity".

Neurological examination findings were noted as level of consciousness, cooperation and orientation. Speech problems, difficulty of understanding, reading, writing, nomenclature and repetition were evaluated and reported as slurred speech or not. Star cancellation test was used to detect the presence of neglect. The star cancellation test is a screening tool that was developed to detect the presence of unilateral spatial neglect in patients with stroke [9]. It involves patients searching for stars and marking them with a pen on a sheet of paper. Additionally, ataxia was detected by neurological examination.

Gross motor functional status were classified according to head control, sitting balance with and without support, standing and walking level. Participants were divided in to six groups in terms of activity level as bedridden, wheelchair bound, ambulatory with single or double-support and independently. Besides that, range of motion limitation, sensory deficits, bladder and bowel incontinence, pressure ulcer, malnutrition status and presence of dysphagia by the help of bedside swallowing screen and fiberoptic endoscopic examination were identified.

GCS and Brunnstrom motor functional stage (BMFS) were recorded at admission and discharge. BMFS that is identified 1-6 stage emphasizes the flexor-extensor synergic patterns and isolated joint movements [10]. Stage 1 is defined as active movement cannot be elicited reflexively with facilitatory stimulus or volitionally and stage 6 is defined as coordination and patterns of movement can be near normal [11].

Functional independence measure (FIM) score were reported at admission and discharge. The scale includes self care (feeding, grooming, bathing, toileting), sphincter control (bladder and bowel management), mobility (bed, chair, wheelchair, toilet, shower), locomotion (walking/wheelchair, stairs, community access), communication (comprehension, expression) and psychosocial adjustment (social interaction, problem solving, memory etc.) items. Each item is scored from 1 to 7; possible scores range from 18 to 126, with higher scores indicating more independence [12,13].

Treatment Protocol

All patients underwent a rehabilitation program for five days per week which was including conventional and neurophysiological therapies. The total treatment time was at least 15 days and according to tolerability of patients it was conducted for 60-120 min per day. Previously patients were trained for sitting on the edge of a bed; if this was

Table 1. Sociodemographic Characteristics of The Patients

N=12	Mean ±SD
Age (years)	53.75±12.77
Sex	
Female	4 (33.3)
Male	8 (66.7)
Education	
Illiterate	0
5 years education	6 (50)
8 years education	1 (8.3)
11 years education	3 (25)
>11 years education	2 (16.7)
Occupation	
Housewife	1 (8.3)
Teacher	2 (16.7)
Engineer	1 (8.3)
Self employment	8 (66.7)
Income Status	
Low	6 (50)
Intermediate	4 (33.3)
High	2 (16.7)
Comorbidity	
Hypertension	8 (66.7)
Diabetes Mellitus	3 (25)
Heart Disease	4 (3.3)
Hyperlipidemia	2 (16.7)
Hypothyroidism	1 (8.3)
Surgical History	
No operation history	9 (75)
Bypass surgery	2 (16.7)
Appendectomy	1 (8.3)
Smoking	
Non smoker	8 (66.7)
Current smoker	4 (33.3)
Alcohol consumption	0
Physical Activity Level	
Sedentary	0
Light	0
Moderate	4 (33.3)
High	8 (66.7)

SD: Standard Deviation

achieved, standing on tilt table and/or paralel bar and weight transfer exercises were practiced; limb loading, shifting back and forward exercises were conducted. When these activities were achieved, ambulation practice was started. After that going up and down the stairs and balance training were conducted.

Functional electrical stimulation administered to improve muscle strength, develop active movement and gain joint proprioceptive sensation in the early stages. To reduce the hand edema, intermittent pneumatic compression neuromuscular stimulation and continuous passive motion device were used. In the early period ROM exercises started while motor functionality improved active exercises, coordination, empowerment and skills training were added.

Table 2. Characteristics of Patients Related to Stroke

N=12	Mean ±SD
Lesion type	
Ischemic	10 (83.3)
Hemorrhagic	2 (16.7)
Lesion location	
Mesencephalon	2 (16.7)
Pons	7 (58.3)
Medulla Oblongata	8 (66.7)
Cerebellum	5 (41.7)
Poststroke admission time to the hospital (days)	1.12±1.35
Coma duration (days)	16.16±24.96
Admission GCS (3-15)	7.41±4.25
ICU duration (days)	33.22±31.08
Tracheostomy (n%)	3 (25)
Tracheostomy duration (days)	44.33±23.50
Mechanical Ventilation (n%)	7 (58.3)
Duration of mechanical ventilation (days)	23.49±22.00
Supplemental oxygen requirement (n%)	4 (33.3)
Nasogastric feeding (n%)	5 (41.7)
Nasogastric feeding(days)	14.06±9.50
Percutaneous gastrostomy (n%)	5 (41.7)
Percutaneous gastrostomy duration (days)	68.42±45.41

SD: Standard Deviation, GCS: Glasgow coma scale, ICU: Intensive Care Unit

Data analysis was performed with SPSS for IBM 11.5 version. For descriptive statistics, the data were shown as the mean±standard deviation for the continuous variables, and as the number of cases (n) and percentage (%) for nominal variables. For comparison of repetitive measurements with in the groups, Wilcoxon Signed Rank Test was used for nonparametric data with non-normal distribution. A p value less than 0.05 was considered statistically significant. At the end of the study, admission and discharge GCS, BMFS and FIM scores were compared.

RESULTS

A total of 12 participants mean age was 53.75±12.77 years; 8 (66.7%) of them were male and 4 (33.3%) of them were female. Sociodemographic characteristics of the patients presented in **Table 1**.

One half of patients (n=6, 50%) had 5 years education and low income status. Mostly defined comorbidity was hypertension (n=6, 50%) and high activity level was reported at 8 (66.7%) patients.

Characteristics of patients related to stroke presented in **Table 2**.

The right body side of 4 (33.3%) patients, left side of 1 (8.3%) patients and both right and the left sides of 7 (58.4%) patients affected a result of stroke, on cranial MRI images bilateral brain stem involvement of 6 patients (50%) were observed. Tracheostomy cannula was present in 3 (30%)

Table 3. Neurological and Physical Examination Findings

N=12 (%)	
Consciousness	
No disturbance	12 (100)
Cooperation	
No disturbance	3 (41.7)
Orientation	
No disturbance	5 (41.7)
Activity Level	
Bedridden	5 (41.7)
Wheelchair	3 (25)
Standing	1 (8.3)
Double support	3 (25)
Single support	0
Independent ambulation	0
Ataxia	
	8 (66.7)
Gross Motor Functional Status	
Head control	3 (25)
Sitting with support	2 (16.7)
Sitting without support	3 (25)
Standing level	4 (33.3)
Walking level	0
Range of Motion Limitation	
Present	0
Superficial Sensation	
Normal	1 (8.3)
Hypoesthesia	11 (91.7)
Visual Problem	
	3 (25)
Speech Impairment	
	9 (75)
Neglect	
	0
Ataxia	
	0
Dysphagia	
	9 (75)
Bladder incontinence	
	6 (50)
Bowel incontinence	
	6 (50)
Pressure ulcer	
	2 (16.7)
Malnutrition	
	8 (66.7)

patients, NG and percutaneous gastrostomy feeding in 5 (41.7%) patients and oral intake in 2 (16.6%) patients. The average time from admission to rehabilitation clinic patients was 33.5 days.

Distribution of neurological and physical examination findings of patients presented in **Table 3**.

At admission to rehabilitation clinic 5 (41.7%) patients were bedridden and none of the patients (n=0) was ambulatory. Varying levels of speech disturbances in 9 (75%) patients and malnutrition in 8 (66.7%) patients were detected.

The comparison of pretreatment and posttreatment GCS, FIM, BMFS scores were shown in **Table 4**.

Average rehabilitation clinic stay duration of patients was 39.5 days; after rehabilitation program GCS, BMFS and FIM scores changes found significant (p = 0.001, p = 0.005 and p = 0.002).

Table 4. Pretreatment and Posttreatment GCS, FIM, BMFS Scores Comparison

	Pretreatment mean \pm SD	Posttreatment mean \pm SD	p value
BMFS (median, IQR)			
Upper extremity	2.75 \pm 1.95	3.83 \pm 2.03	0.001
Lower extremity	2.83 \pm 1.85	4.33 \pm 1.96	0.001
Hand	2.66 \pm 1.96	3.91 \pm 2.06	0.001
GCS	7.41 \pm 4.25	12.83 \pm 2.40	0.005
FIM	51.72 \pm 34.66	68.50 \pm 35.92	0.002

BMFS: Brunstrom motor functional status, GCS: Glasgow coma scale, FIM: functional independence measure

At discharge from rehabilitation clinic, 3 (25%) of the patients at wheelchair level and rest of them had supported or non supported ambulation. Only 3 of the patients continued with percutaneous gastrostomy.

DISCUSSION

PC stroke that is a rare type represents approximately 23% of all ischemic strokes [14]. Although symptoms vary according to the affected brainstem region, mostly vital signs such as circulatory and respiratory dysfunction and less extremity involvement, but more mortality than cortical hemispheric stroke occur in PC stroke. Therefore, first priority in acute management of the patient with a PC stroke is preservation of vital functions and they are frequently followed in ICU or neurology clinics.

The acceptance of these patients to rehabilitation clinic is often after the first three months that is the time of the majority of neurological recovery occurs [1]. Recent studies about cortical hemispheric stroke have shown that early initiation of rehabilitation improve functional recovery [15,16]. There is no study on the influence of early rehabilitation on PC stroke recovery. Consequently, this study aimed to investigate the effect of early rehabilitation on functional gains of 12 PC stroke patients accepted at first three months.

Similar to the previous studies majority of this study population was male and there were stroke associated risk factors such as hypertension, diabetes mellitus, heart disease, previous stroke history, smoking; hypertension was found most frequent risk factor [6,17,18].

Although previous studies about PC stroke point out different notifications in terms of location, mostly involved area is pons and ischemic type mostly reported [6,7,17]. Similarly our study mostly involved ischemic type, pons and medulla oblongata were mostly affected brainstem regions. Consistent with these location, 58.3% of patients were requiring mechanical ventilation and 30% had

tracheostomy cannula during acceptance to the rehabilitation clinic. Furthermore, dysphagia, speech and balance disorders incidence rates were high concordant with the literature. Mean pretreatment GCS scores of our patients was 7.41 ± 4.25 .

PC stroke related studies mostly reported motor, sensory and cognitive impairments and also these studies have shown that physiotherapy, speech and occupational therapy three hours daily for average 30 days increased FIM scores significantly. As a result, 62% of patients were discharged independently in daily living activities [6]. In another study, with the help of poststroke rehabilitation program for average 41 days, 93% of patients performed basic daily living activities independently [17]. These studies indicated that certain factors related to the patient and rehabilitation program influencing the functional outcome [6,17]. Ng et al. investigated posterior cerebral artery originated 89 stroke patients retrospectively in their study; young age, male gender, long hospital stay duration and higher FIM scores at admission were found related to better functional results and predictive for patients discharge. Low FIM scores at admission and discharge indicated more medical complications, major neurological deficits and medical comorbidities; ultimately poor functional ability [17].

Related studies mostly involved mobile patients but having balance problems as ataxia [6,17]. However, unlike the literature our study mostly consisted of immobile patients and also 41.7% were completely bedridden. At the discharge, 25% of our patients were at wheelchair level and the others were at supported or unsupported ambulation level. Although, there were major neurological deficits in our study population, posttreatment motor functionality which was assessed with FIM was improved significantly. Mean FIM score reported 65 at admission in researches, while in this study posttreatment FIM score was 68.5 that was improved significantly compared to pretreatment values. Also motor functional level of patients which was assessed with BMFS improved significantly. At admission only two patients had oral feeding in this study group, in consistent with the literature in which dysphagia reported to be 40-50% in PC stroke [16]. In this type of stroke, more severe dysphagia observed with lower healing rates [19]. At the end of this study, only three patients continued gastrostomy feeding, but oral feeding started in nine of the participants with modifications.

CONCLUSION

Early rehabilitation of severe PC stroke patients that has an essential role for the recovery; as well as in all hemiplegies, contributing to improved motor-cognitive status and better functional outcomes. For this reason, we aimed to evaluate the demographic and disease characteristics of patients with posterior circulation-induced stroke, follow up our experience in our clinic.

The most important limitations of this study were relatively small number of patients and inability to divide and compare the subgroups based on anatomic location of lesion. Also, it is necessary to compare patients who are taken to early and late rehabilitation to prove it at the study level. This was impossible because only early rehabilitation program was applied to our stroke unit in our clinic. To demonstrate the treatment efficacy of these patients followed in rehabilitation clinic, further studies in large population samples are needed.

DECLARATION OF CONFLICT OF INTEREST

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REFERENCES

1. Osborn AG. Diagnostic cerebral angiography. 2nd ed. Philadelphia: Lippincott Williams Wilkins; 1999.
2. Dalyan Aras M, Çakçı A. İnme rehabilitasyonu. In: Oğuz H, Dursun E, Dursun N ed. Tıbbi Rehabilitasyon. Nobel Tıp Kitabevi, İstanbul 2004:589-617.
3. Caplan L. Posterior circulation ischemia: then, now, and tomorrow. Stroke 2000;31:2011-2023.
4. Brandstater ME. In: Delisa JA, Gans BM, ed. Rehabilitation Medicine principles and practice. 3rd ed. Philadelphia: Lippincott; 1998.
5. Çoban O. Serebrovasküler Hastalıklar. In Öge EA, Bahar Zarko S. eds. Nöroloji Nobel Tıp Kitabevi, 2004; p: 20-1-193-9.
6. Robert T, Norine F, BASc, Timothy D, Hillel F. Clinical Characteristics of Patients with Brainstem Strokes Admitted to a Rehabilitation Unit. Arch Phys Med Rehabil 2002;83:1013-16.
7. Chua KS, Kong KH. Functional outcome in brainstem stroke patients after rehabilitation. Arch Phys Med Rehabil 1996;77:194-7.

8. Öztop P, Ayaş Ş, Ustaömer K, Saraçgil Coşar SN, Ümit Yemişci O. Functional Outcomes in Anterior and Posterior Circulation Ischemic Strokes. *Turk J Phys Med Rehab* 2013;59:13-7.
9. Wilson B, Cockburn J, Halligan P. Development of a behavioural test of visuo-spatialneglect. *Arch Phys Med*. 1987;68:98-102.
10. Karataş KD. Stroke, Ed: Beyazova M, Kutsal GY, Physical Medicine and Rehabilitation, İstanbul, 2011:2761-2788.
11. Kutlay Ş, Ed: Beyazova M, Kutsal YG, Special Kinesiotherapy Methods Used in Neurorehabilitation. *Physical Medicine and Rehabilitation* 2000:930-949.
12. Küçükdeveci AA, Yavuzer G, Elhan AH, Sonel B, Tennant BA. Adaptation of the Functional Independence Measure for use in Turkey. *Clin Rehabil* 2000;15:311-19.
13. Kidd D, Stewart G, Baldry J, et al. The Functional Independence Measure: A comparative validity and reliability study. *Disabil Rehabil* 1995;17:10-14.
14. Querol-Pascual MR. Clinical approach to brainstem lesions. *Seminars in Ultrasound CT MRI*. 2010;31:220-229.
15. Julie B, Helen D, Amanda T, Janice C, Geoffrey D. A Very Early Rehabilitation Trial for Stroke (AVERT) Phase II Safety and Feasibility. *Stroke* 2008; 39:390-396.
16. Robert T, Norine F, Norhayati H, Mark S. Evidence-Based Review of Stroke Rehabilitation. *Topics in Stroke Rehabilitation* 2007;14:56-64.
17. Ng YS, Stein J, Salles SS, Black Schaffer RM. Clinical characteristics and rehabilitation outcomes of patients with posterior cerebral artery stroke. *Arch Physy Med Rehabil* 2005;86:2138-2143.
18. Sacco RL, Benjamin EJ, Broderick JP, et al. American Heart Association Prevention Conference. IV. Prevention and Rehabilitation of Stroke. Risk factors. *Stroke* 1997;28:1507-17.
19. Burkhead LM, Sapienza CM, Rosenbek JC. Strength training exercise in dysphagia rehabilitation: principles, procedures and directions for future research. *Dysphagia* 2007;22:251-265.

