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RESEARCH

ASSESSMENT OF UPPER EXTREMITY DOPPLER ULTRASONOGRAPHY IN HEMIPLEGIC PATIENTS

ABSTRACT

Introduction: This study aims to evaluate the upper extremity vessels of hemiplegic patients by Doppler Ultrasonography (DU) and to determine pulsatility-resistive index (PI-RI) values and factors related to these values.

Materials and Method: The study evaluated 50 hemiplegic patients and 36 healthy controls with no complaints in their upper extremities. In both groups, a radiologist measured the brachial artery PI and RI values with DU and checked the veins for thrombosis in the upper extremities.

Results: The mean age of the patients was 61.98±12.46 years, and the mean age of the controls was 60.88±8.57 years. The intra and inter group comparisons of both upper extremities of the groups showed no statistically significant differences and no thromboses were detected in the venous structures. In the patient group, the PI and RI values of the affected side were not statistically correlated with Brunnstrom or Ashworth scores, subluxation or limited motion in the shoulder, or the presence of clinical complex regional pain syndrome (CRPS) in the hand. In both the patient and control groups, PI and RI values and age were correlated.

Conclusion: The findings of this study showed that in hemiplegic patients, arterial PI and RI values in the upper extremities were affected by age.

Key Words: Stroke; Hemiplegia; Ultrasonography, Doppler.

ARAŞTIRMA

HEMİPLEJİK HASTALARDA ÜST EKSTREMİTE DOPPLER ULTRASONOGRAFİ DEĞERLENDİRMESİ

ÖZ

Giriş: Bu çalışmada hemiplejik hastalarda üst ekstremite damarlarını doppler ultrasonografi ile incelemek ve pulsatil- rezistif indeks (PI ve RI) değerlerini ve bunları etkileyecek faktörleri belirlemek amaçlanmıştır.

Gereç ve Yöntem: Çalışmaya 50 hemiplejik hasta ve üst ekstremite şikayeti olmayan 36 sağlıklı kontrol alınmıştır. Her iki grubun üst ekstremite brakiyal arter PI ve RI değerleri bir radyolog tarafından doppler ultrasonografi kullanılarak değerlendirilmiş ve venleri tromboz açısından gözden geçirilmiştir.

Bulgular: Hasta grubunun yaş ortalaması 61.98±12.46 yıl, kontrol grubunun yaş ortalaması 60.88±8.57 yıldı. Her iki grup arasında ve grupların kendi içinde üst ekstremite arteriyel RI ve PI değerleri arasında istatistiksel olarak belirgin farklılık olmayıp, venöz tromboz izlenmemişti. Hasta grubunda etkilenmiş taraf Ashworth ve Brunnstrom evresi, omuzda subluksasyon, limitasyon ve elde klinik kompleks bölgesel ağrı sendromu (KBAS) varlığı ile PI ve RI değerleri arasında istatistiksel olarak belirgin bir ilişki izlenmemiştir. Her iki grubun PI ve RI değerleri ile yaşları arasında istatistiksel olarak belirgin bir ilişki olduğu gözlenmiştir.

Sonuç: Bu çalışmada hemiplejik hastalarda üst ekstremite doppler ultrasonografik indeks değerlerinin yaştan etkilendiği gözlenmiştir.

Anahtar Sözcükler: İnme; Hemipleji; Doppler Ultrasonografi.

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Introduction

Stroke is a syndrome that develops due to heterogeneous vascular etiologies and requires various treatment modalities (1). It is the third most common reason of death following cardiovascular diseases and cancer (2).

In stroke related hemiplegic patients, upper extremity complications of vascular origin are rare. In hemiplegic patients, the rate of upper extremity deep vein thrombosis (DVT) development corresponds to 4% of all DVT cases (3). The incidence may be higher as the clinical picture is usually asymptomatic and may be confused with other complications. (4). Because in such patients all three elements of Virchow triad (catheterization of the upper extremity, presence of a pace maker, surgical manipulation, trauma, hypercoagulability, drugs used, and venous stasis associated with immobility) are found, DVT in the upper extremity may occur (5).

In humans, vascular adaptations after immobilization (diameter size, blood flow, shear stress) have been reported to be completed in six weeks (6). Although the autonomic vasomotor disfunction that developed after the stroke increases the blood flow via vascular bed to the tissues, the prolonged inactivity may reduce the blood flow to the paretic extremity, rather than increasing it. (7,8). Muscular flaccidity or disability in the paretic upper extremity may be accompanied by the impaired function of peripheral circulation (9). The reduction that occurs in the central sympathetic tonus reduces the vascular tonus and increases the blood flow by changing the capillary permeability as it increases the filtration pressure(8). Or on the contrary, immobilisation, inactivity or paralysis may increase peripheral vascular resistance, and thus, reduce the arterial blood flow (10).

In two recent studies, vascular changes that occurred due to immobility in the lower extremities of animals have been evaluated, and it was found that the diameter of the femoral artery was reduced by 6-12% one week after the casting of the lower extremity, and four weeks later, the blood flow temporarily ceased (11,12).

Doppler ultrasonography (DU) is a non-invasive technique used in evaluation of blood flow in the superficial vessels (13). The terms 'pulsatility index (PI)' and 'resistive index (RI)' are generally used to refer to vascular bed resistance and are the markers to evaluate the arterial blood flow during heartbeats (14); and yet both were advocated in order to test peripheral vascular diseases. The literature presents numerous studies evaluating the carotid artery, extremity vessels, and vascularization of the transplanted kidney by these indices (13).

This study aimed to evaluate the upper extremity vessels of hemiplegic patients by Doppler Ultrasonography (DU) and to determine whether PI-RI values are related to clinical findings.

Materials and Method

The local ethics committee of our hospital approved the study protocol and informed consent was obtained from the subjects. This prospective randomised-controlled study was conducted at Ankara Physical Medicine and Rehabilitation Training and Research Hospital in Turkey. The study evaluated 50 hemiplegic patients (28 male, 22 female) and 36 healthy controls (13 male, 23 female) with no complaints in their upper extremities. The demographic data of all the subjects were recorded. The disease etiology and duration, number of attacks, affected side, Brunnstrom and Ashworth scores of the affected upper extremity, any limitation of motion and subluxation in the affected shoulder, and the presence or absence of (CRPS) in the affected upper extremities (through clinical examination) were recorded for each patient group. The circumference of both upper extremities of the patients and the controls (the healthy and affected sides of the patients, dominant and non-dominant sides of the controls) were measured. The same radiologist measured the brachial artery PI and RI through DU and the images were evaluated for thrombosis. Descriptive statistics for demographic variables were tabulated. Values were compared with x2 analysis for categorical variables. A P value of less than 0.05 was accepted as significant. Spearman's correlation tests were conducted to examine the associations between indices and clinical parameters. Unpaired t tests were conducted to compare the numeric means between the affected and normal side of the patients and also to compare the mean ages between the patients and the controls and the mean DU indices between the affected side of the patients and the controls.

Results

The mean age of the patients was 61.98±12.46 years, and the mean age of the controls was 60.88±8.57 years. The mean age and gender of the two groups did not have a significant statistical differences. The distribution of the affected side was the right side in 29 patients (58%) and the left side in 21 patients (44%). Forty-six patients (92%) had had one stroke attack, and remaining four patients (8%), had two stroke attacks. The etiology was thromboembolism (TE) in 36 patients (72%) and hemorrhage in 14 patients (28%). The mean disease duration was 17.45±17.33 weeks. There were subluxation in the hemiplegic shoulders of 27 patients (54%); limitation of motion in 17 patients (34%); CRPS in the affected hands of 14 patients (28%); and the measurements of the upper extremity circumferences in 36 patients (72%) were similar; increased in 2 patients (4%) and decreased in 12 patients (24%). The demographical variables are shown in Table 1 and the mean PI and RI values of the patient and the

control groups are presented in Table 2. The intra and inter group comparisons of both upper extremities (dominant and nondominant; affected and healthy) of the groups showed no statistically significant differences (p>0.05). The forms of the arterial blood flow in both groups were triphasic and no thromboses were detected in the venous structures. In the patient group, the PI and RI values of the affected side were not statistically correlated with Brunnstrom or Ashworth scores, presence of subluxation or limited motion in the shoulder, or the presence of clinical CRPS in the hand. In both the patient and the control groups, not only PI and RI values with age but also PI and RI values with the duration of the illness were positively correlated (p=0.001). Age increase in both groups caused an increase in index values.

Discussion

Recently, measurements of PI and RI by DU have been used to determine the prognosis of renovascular diseases, systemic arterial hypertension, various cardiovascular and renal diseases, and post-stroke period. Both of these indices reflect the resistance of tissues against the blood flow in the vascular bed. PI is usually affected by the resistance of the tissues in the peripheral areas of the vessel. RI is also affected by the elasticity of vessels and the systemic arterial pressure. For both indices, the smaller the value measured, the higher the resistance becomes. These evaluations are preferred because they are reliable and replicable (15). Rossi et al evaluated the changes between different evaluators and the different measurements of the same evaluators of DU measurements and concluded that conventional B mode ultrasonography was a reliable method in the evaluation of peripheral arterial circulation (16).

In this study we aimed to compare arterial and venous inflow in the affected and the non affected upper extremities

Table 1— The Demographic Data of Patients

Affected side	Right 29 (%58)
	Left 21 (%42)
Stroke attack	One 46 (%92)
	Two 4 (%8)
Etiology	TE 36 (%72)
	Hemorrhage 14 (%28)
Subluxation of affected shoulder	Positive 27 (%54)
	Negative 23 (%46)
Limitation of motion of affected shoulder	17 (%34)
CRPS of affected hand	14 (%28)
Upper extremity circumferences	Similar 36 (%72)
	Increased 2 (%4)
	Decreased 12 (%24)

Table 2— The Mean PI and RI Values of the Patient and Control Groups

		PI	RI
Hemiplegic	Hemiplegic extremity	4,7±2,01	0,9824±0,21
Groups	Healthy extermity	4,6±2,09	0,9863±0,19
Controls	Dominant extremity	4,04±1,19	0,9714±0,18
Groups	Non dominant extremity	4,00±1,28	0,9674±0,19

in stroke patients and the healthy controls. At the end of the study, both arterial indexes and venous inflow in affected upper extremity showed no significant difference than the non-affected upper extremity both in patients and in healthy controls. In a study of Wang et al.,in the hemiplegic patients' resting arterial inflows and venous capacities tone and outflows showed no significant difference in paretic and non-paretic extremities. They concluded that cutaneous microcirculatory function in the paretic upper extremities after stroke may be impaired (9). In our study; we found the similar results in the hemiplegic group.

Mastorakou et al evaluated the RI and PI values of the intrarenal arteries of healthy adults and showed that these values increased with age (13). Petersen et al studied the renal artery in chronic renal failure patients with hypertension by DU and found a correlation between the progression of the disease and the indices. They also reported that these indices increased with age (14). Padayachee et al. concluded that ultrasound measurements of the aortic communis had significantly lower values in elderly stroke patients compared to elderly asymptomatic volunteers. Velocity transit times from the stroke affected and non-affected limbs showed no consistent effect of the stroke vascular tone in patients assessed. In our study, similarly, a positive correlation was determined between these two indices and age. With an increase in age of the patient and control groups, the index values also increased. This supports the hypothesis that vascular resistance increases with age (17).

In our study, CRPS presence was evaluated only on a clinical basis, and it was concluded that DU was not required in establishing a diagnosis of CRPS. The diagnosis is ordinarily made on a clinical basis, primarily with the use of history and observation and the physical signs. The technetium diphosphonate bone scan has been used as a sensitive and specific test to objectively ascertain the presence of CRPS. One limitation of our study was the lack of three-phased bone scintigraphy for CRPS diagnosis.

In the study by Pekindil et al, CRPS patients who were diagnosed by three-phased bone scintigraphy were evaluated for indices and flow waveforms of the brachial and popliteal arteries through DU, and in stage 1 CRPS, PI was reduced,

and the waveform was transformed from triphase to monophase. They concluded that in combination with other methods, DU could be used in the diagnosis and that it might contribute to staging of CRPS (18). However, no correlations were found between the presence of CRPS and indices, and no changes were observed in the flow waveforms in our study.

Some authors consider vascular PI changes at rest as a marker for stenosis. Osada measured the PI of the brachial artery by DU after ischemic and non-ischemic isometric handgrip exercises. A more significant reduction at PI values was determined at the time of the arterial occlusion during exercise in comparison to the PI values obtained just at arterial occlusion or only during exercise (19). Hedera et al measured the internal and external carotid artery through DU on the same side of the stroke patients within the first two days of the stroke and found that PI values were lower on the side that was obstructed. They attributed this to the reduced peripheral resistance behind the obstructed vessel and compensatory vasodilatation. They concluded that PI was not correlated with neurological deficit, but those with more severe involvement tended to have a reduced PI, thus increasing the hypoperfusion in the ischemic area (20).

In our study, the presence of hemiplegia did not change the arterial indices of the extremity involved despite factors such as immobilization, spasticity, subluxation or limited motion of the shoulder. However, age was an important factor affecting the resistance of vessels. No venous thrombosis was observed in the hemiplegic upper extremity of our hemiplegic patients.

In conclusion, the findings of this study showed that arterial PI and RI values were affected by the age only. It can also be said that in the evaluation of the upper extremity of hemiplegic patients, DU may be considered a reliable and additional diagnostic tool that can support the diagnosis of arterial and venous thromboses in the presence of clinical findings, contrary to its use in the lower extremity as a screening test.

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