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Area of Expertise: Radiology and Organ Imaging, Anatomy

Title: Evaluation of infarct types and related cerebral vessels in the presence of different risk factors by three-dimensional (3D) imaging methods in patients with ischemia.

Short title: Infarct types and related cerebral vessels in different risk factors.

Abstract

Purpose: The factors that predispose to stroke are defined as risk factors. The subtypes of stroke can be classified by considering the changeable risk factor and its relationship with stroke. The aim of this study is It is the examination of infarction types and related brain vessels in the presence of different risk factors in ischemia patients by rendering three-dimensional (3D) cross-sectional ischemic damaged brain regions on magnetic resonance (MR) and computed tomography (CT) images obtained from patients.

Material and methods: 105 patients (53 male, 52 female) with ischemia and 50 normal (23 male, 27 female) members of control group were participated in the study. A number of cross-sectional images (transverse, sagittal and coronal sectiones) were reconstructed on computer. Infarct types were classified as atherosclerotic, cardioembolic, lacunar, cryptogenic and transient ischemic attacks. The infarct size was determined in infarct types in patients with hypertension, diabetes, smoker and coronary artery disease. The arteries that irrigate the infarct area were classified. The most infarcted arteries and the largest infarcted arteries were evaluated statistically.

Results: Infarct types were anatomically correlated with their infarct size and the arteries causing infarction. Thus, which arteries cause which types of infarcts in which risk factors are described firstly in the literature.

Conclusion: The infarct size in the brain is of great clinical importance. It has been observed that clinical findings become more pronounced as infarct size increases. This situation varies according to the localization of ischemia. The risk factors and types of infarcts vary in men and women. These results are thought to be the basis for explaining the mechanisms of clinical findings.

Keywords: Brain, image, 3D, infarct type, risk factor.

Makale başlığı: İskemi hastalarında farklı risk faktörlerinin varlığında enfarktüs tipleri ve ilişkili beyin damarlarının üç boyutlu (3D) görüntüleme yöntemleri ile değerlendirilmesi.

Öz

Amaç: İnmeye zemin hazırlayan faktörler risk faktörleri olarak tanımlanmaktadır. İnmenin alt tipleri, değişken risk faktörü ve bunun inme ile ilişkisi dikkate alınarak sınıflandırılabilir. Bu çalışmanın amacı iskemi hastalarında farklı risk faktörlerinin varlığında enfarktüs tipleri ve ilgili beyin damarlarının, hastalardan elde edilen manyetik rezonans (MR) ve bilgisayarlı tomografi (BT) görüntüleri üzerinde kesitsel iskemik hasarlı beyin bölgelerinin üç boyutlu (3D) hale getirilerek incelenmesidir.

Gereç ve yöntem: Çalışmaya 105 iskemi hastası (53 erkek, 52 kadın) ve 50 normal (23 erkek, 27 kadın) kontrol grubu üyesi katıldı. Bir dizi kesitsel görüntü (enine, sagittal ve koronal kesitler) bilgisayarda yeniden oluşturuldu. Enfarktüs tipleri aterosklerotik, kardiyoembolik, laküner, kriptojenik ve geçici iskemik ataklar olarak sınıflandırıldı. Hipertansiyon, diyabet, sigara içen ve koroner arter hastalığı olan hastalarda enfarktüs tipine göre enfarktüs boyutu belirlendi. Enfarktüs alanını sulayan arterler sınıflandırıldı. En çok enfarktüslü arterler ve en büyük enfarktüslü arterler istatistiksel olarak değerlendirildi.

Bulgular: Enfarktüs tipleri anatomik olarak enfarkt boyutu ve enfarktüse neden olan arterlerle ilişkiliydi. Böylece literatürde ilk olarak hangi arterlerin hangi tip enfarktüslere, hangi risk faktörlerine neden olduğu anlatılmaktadır.

Sonuç: Beyindeki enfarktüs büyüklüğü klinik açıdan büyük önem taşımaktadır. Enfarktüs boyutu arttıkça klinik bulguların daha belirgin hale geldiği gözlenmiştir. Bu durum iskemi lokalizasyonuna göre değişmektedir. Risk faktörleri ve enfarktüs türleri kadın ve erkeklerde farklılık gösterir. Bu sonuçların klinik bulguların mekanizmalarını açıklamada temel oluşturacağı düşünülmektedir.

Anahtar kelimeler: Beyin, görüntüleme, 3B, enfarktüs tipi, risk faktörü.

Introduction

Stroke includes all diseases in which the vessels supplying the brain are directly affected by a pathological process and subsequently caused by a temporary or permanent involvement of a part of the brain due to ischemia or bleeding [1, 2]. The infarct in any part of the brain causes insufficiency in the functions of the human body depending on the regional anatomical and physiological effects of the brain. Stroke with sudden onset of nonconvulsive focal neurological deficits is the most common form of stroke [2]. Thrombotic or embolic vascular occlusion resulting from the passage of a clot, plaque, or agglutinated platelets into the circulation, or systemic reduction in blood flow such as cardiac arrest or shock, leads to ischemia particularly in the delicate border regions between the main cerebral blood vessels, such as the middle cerebral and posterior cerebral arteries.

Ischemic strokes are manifested by different neurological symptoms depending on the function of the vessel disturbed blood flow and the brain area irrigated by this vessel. It is possible to identify infarct subtypes reflecting the location and width of the infarct, by assessing basic neurological findings, and thus predict prognosis [3].

A detailed examination of the neurological findings in these diseases with advanced methods will allow the discovery of new informations not only related to the mechanism of the diseases but also to the anatomical and physiological functions of brain. 3D anatomical imaging is widely used in medicine today. Firstly, computer-aided 3D program “Surf-Driver” developed by anatomist Scott Lazonof has found wide usage. The body of a male prisoner in death was divided into 1 mm sections as cadavers and photographs were transferred to the computer with the Human Visible Human Project in developed in 1986, and the 3D reconstructions were made in the Surf-Driver program for the first time [4]. These kinds of works were later made in Korea and China. Nowadays, computer aided 3D programs have developed with computer technology. Osirix is one of these programs [5]. Nowadays, real time simulations are performed with 3D method, and physicians develop difficult operations by practicing in 3D environment. At the same time, radiologists can easily identify pathologies that they have difficulty understanding in two-dimensional (2D) images in 3D environment. 3D methods are also used in medical education. Imaginary dissection is possible with the 3D method. Thus, it was possible to be easier to understand by making them 3D. The patients with ischemia were generally evaluated by 2D radiological imaging. The areas of ischemia with 3D have not been previously studied with clinical findings. Our aim is to examine the damage of patients with ischemia in 3D and provide the basis for clinical studies.

Material and method

A total of 105 patients with ischemia (53 male and 52 female) and 50 normal control patients (23 male and 27 female) were included in the study (Table 1). The ages of male and female were compared. 2D MR images of the patient with ischemia were obtained (Figure1). Cross-sectional images were reconstructed on computer (Figure2-4). Computer-assisted (Apple-Mac) 3D program Osirix was used for this three-dimensional (3D) examination. The infarct fields were identified. The volumes of infarct dimensions were calculated automatically. The cross-sectional calculations were made with Cavalieri method at the same time. The total number of points was calculated in these two-dimensional and three-dimensional calculations, and compared with each other.

The patients were classified according to the presence of risk factors as hypertension, diabetes mellitus, smoking and coronary artery disease. The infarct types were classified as atherosclerotic, cardioembolic, lacunar, cryptogenic and transient ischemic attacks. The effects of these personal characteristics on infarct type and size were evaluated. The infarct size was determined in infarct types in patients with hypertension, diabetes, smoking and coronary artery disease.

The arteries irrigating the infarct area were identified. The deep arteries that descended into the deeper part of the cerebrum and irrigate the capsular interna and basal nuclei were called “central arteries”. Multiple arteries were responsible for multiple infarct areas and large infarct areas. The responsible artery was evaluated as “normal” in patients with neurological findings but no infarction was detected on imaging tools.

The vessels with the highest infarct and the largest infarct were evaluated statistically. The infarct-forming multiple arteries were not examined. Only one responsible artery was looked at.

Two-dimensional (2D) follow-up and three-dimensional (3D) follow-up were correlated with infarct volumes. SPSS 17.0 program was used for statistical calculations. Independent sample T test were applied to compare the means. Pearson test was used for correlations. Pearson correlation cofficient was given as “r” with stars. p<0.05 was evaluated as statistically significant.

The data of the patients consists of Pamukkale University Faculty of Medicine archives between 2016 and 2019.

Results

53 male and 52 female patients with ischemia were studied. 23 male and 27 female normal individuals were used for the control group. There were sufficient patient and control groups and the distribution of male and female was very close to each other

(Table 1). There was no statistically significant difference between the control and patient groups (*p*=0.89). The mean age of the patients was 66.26±15.12. The minimum age was 19 and the maximum age was 89. There was no statistically significant difference between men and women in terms of age (*p*=0.67).

The infarct types of patients were determined. We investigated whether hypertension, diabetes, smoking and coronary artery diseases were present in the patients. Infarct types and hypertension, diabetes, smoking and coronary artery diseases were compared in terms of infarct size. In terms of hypertension, the largest infarct area was detected in the cryptogenic infarct type. The mean infarct size was 257.03±263.98 mm^3. The second size of infarction area was in atherosclerotic type. The cardioembolic type was following them. Lacunar type infarcts had very small size (Table 2, Graph 1). Table 2 shows the infarct dimensions of infarct types in patients with and without hypertension.

The largest infarct area in atherosclerotic infarct type was determined in terms of diabetes. The mean infarct size was found to be 347.70±316.24 mm^3. The second common cause of infarction in these patients was cardioembolic type. The lacunar type was following them. The cryptogenic type of infarcts were very small in size (Table 3, Graph 2). Table 3 shows the infarct size of infarct types in patients with and without diabetes.

In terms of smoking, the largest infarct area was detected in atherosclerotic infarct type. The mean infarct size was 535.26±706.97 mm^3. The second common cause of large infarction was cardioembolic type. The lacunar type was following them. The cryptogenic type of infarcts were very small size (Table 4, Graph 3). Table 4 shows the infarct dimensions of infarct types in smokers and nonsmokers.

In terms of coronary artery disease, the largest infarct area was determined as atherosclerotic infarct type. The mean infarct size was 306.81±293.13 mm^3. The type that caused the second-degree infarction was cardioembolic type. Lacunar type infarcts had very small size (Table 5, Graph 4). Table 5 shows the infarct dimensions of infarct types in patients with and without coronary artery disease.

In terms of gender, atherosclerotic infarct type was the largest infarct in men, while cardioembolic infarct was the largest infarct type in women. The mean size of atherosclerotic infarction was 437.63±587.28 mm^3 in men and 257.11±386.81 mm^3 in women. The second common cause of infarction in men was cardioembolic type followed by lacunar infarction. Cryptogenic type infarcts had a very small size. The second most common cause of infarction in women was cryptogenic type. The atherosclerotic type followed. Lacunar type infarcts had very small size (Table 6, Graph 5). The infarct size of the male and female infarct types was statistically different (p=0.01). However, there was no statistically significant difference was found between male and female (p=0.93). Sick male and sick female infarct types and sizes are shown in Table 6.

The most common artery causing the cerebral infarction is the left middle cerebral artery (20%). This was followed by the right middle cerebral artery (13%). The central branches of left middle cerebral artery (11%) and basilar artery (8%) were listed as other causative arteries (Table 6, Graph 6). In addition, 18 cases with arteries causing multiple infarcts were detected in our study (18%) (Table 7). The distribution of all vessels causing infarction is shown in Table 7.

The artery causing the most infarction is left middle cerebral artery, while the infarct size of the artery causing the largest volume right middle cerebral artery found. The mean size was 445.77±350.31 mm^3 (Table 7, Graph 7). The distribution of infarct sizes by vessels is shown in Table 7.

In the evaluation of the data, the following findings were obtained regarding statistical analysis;

The correlation between two-dimensional (2D) follow-up and infarct area was statistically significant (p=0.01, r=0.992*).

The correlation between three-dimensional (3D) follow-up and infarct volume was statistically significant (p=0.01, r=0.950*).

Discussion

Factors that predispose to stroke are defined as risk factors. The subtypes of stroke can be classified by considering the change in risk factor and its relationship with stroke. The aim of our study was to relate these factors to the anatomical features of the brain and vessels. In our study, we performed the stroke types according to the most common ones with the suggestion of Neurology Department of Pamukkale University Faculty of Medicine. Stroke was divided into subtypes. These were divided into atherosclerotic, cardioembolic, lacunar, cryptogenic and transient ischemic attacks in our study. We correlated infarct types anatomically with infarct size and vessels causing infarct. Thus, we first identified which vessels cause which types of infarcts in which risk factors. Approximately 40% of ischemic strokes do not have a definite etiological cause and these cases are called cryptogenic stroke [6]. Some of the cryptogenic strokes are undetectable paradoxical emboli (PDE) [7, 8]. The second is atherosclerotic type. Cardioembolic type is the most common infarct type in patients with hypertension (33%). Atherosclerotic type is the second most common type of infarction in patients with hypertension (20%). Accordingly, we can say that embolic brain damages cause large brain ischemia. Atherosclerotic type infarction is the most common cause of stroke in all risk groups. Stroke was less common in females in literature, and This suggests that estrogen has a protective effect against stroke according to the current literature [9]. But, this was not statistically significant in our study. On the other hand, atherosclerotic type infarction is statistically significantly less, while cardioembolic and cryptogenic type infarct is significantly higher in women. This information proves that the protective effect of direct estrogen is in atherosclerotic type infarcts. There are studies in the literature that estrogen prevents atherosclerosis. However, the findings showing the protection of atherosclerotic infarct in this way were first presented in our study.

It has been shown that infarct types vary according to risk groups. In patients with hypertension, cardioembolic infarct type appears to be more frequent, while atherosclerotic type is the second. Although the results of diabetes mellitus (DM) and coronary artery disease were similar to hypertension, cardioembolic type infarction was not very common. In contrast, atherosclerotic type infarction is the highest in smokers. However, in our study, smoking has been shown to be more effective in atherosclerotic type infarction than the other three major risk factors. The size of the infarct area caused by infarct types may also vary according to four major risk factors. While the cryptogenic type causes the greatest infarct size in patients with hypertension, the infarct size caused by the atherosclerotic type infarct is statistically significant in the other three major types. This suggests that cryptogenic infarcts are more dangerous in patients with hypertension. In patients with hypertension, such an approach may be based on the anatomical features of the patient. These may be related to the presence and frequency of anostomoses between these vessels, or structure of the vessel walls. In the light of this information, anatomical characteristics of the person may be determinative in diagnosis and treatment in future studies. In order to do this, computerized neuroscience has started to work. With the development of technology in the last 30 years, human anatomy has been digitalized with computer-aided 3D programs parallel to imaging techniques.

Although the incidence of cardioembolic infarct was higher in DM, atherosclerotic infarct type caused the largest infarct area in DM. Among the risk factors of cerebrovascular diseases, DM is among the most common factors after hypertension [10]. Determination of the size and type of infarct in DM is new information in the literature.

Smoking is another risk factor for infarction. Many large-scale studies investigating stroke risk factors (Framingham, Cardiovascular Health Study, The Honolulu Heart Study) have shown that smoking is a risk factor for ischemic stroke and increases the risk by about two-fold compared to other risk factors [11, 12]. In our study, the most common infarct type caused by smoking was again cardioembolic infarct type (12%). Atherosclerotic type was the infarct type that has largest infarct area in volume.

Symptomatic and asymptomatic cardiac diseases have been reported to be strongly associated with cerebrovascular diseases [13, 14]. Myocardial infarction predisposes a risk for the development of atrial fibrillation and may be a source of cardiogenic embolism. Acute coronary syndrome is rarely associated with stroke [15]. In our study, the most common infarct type in coronary artery disease was cardioembolic. However, atherosclerotic type was the infarct type that causes the largest infarct in volume.

When the risk factors and infarct types were evaluated in terms of infarct size, the most common infarct type was found to be atherosclerotic type in all risk factors except hypertension. In hypertension, this is the cryptogenic type.

One of the important results in our study is that women and men differ in terms of risk factors and infarct types. In terms of atherosclerotic type, infarct was seen in a much higher volume in males and less in females. The life time risk of stroke is considered to be higher in men, regardless of any age group [9, 16]. However, recent studies show that the risk of stroke is increasing in women. According to the studies, the rate of stroke has increased threefold in middle-aged women, while it has remained constant in men. While the lifetime risk of stroke is about 20% in women aged 55-75 years, it is between 14-17% in men [9]. In our study, in terms of infarct size, it was observed that males developed larger infarcts than females. But, this finding is not statistically significant. The lower incidence of stroke in women and the smaller infarct volume in our study compared to men may be attributed to estrogen.

In our study, the arteries that irrigate infarct areas were also studied in detail. The frequency of infarct formation of each artery was determined in this study. Left middle cerebral artery was the most common artery causing infarction (20%). This was followed by right middle cerebral artery.

After middle cerebral artery, the most common bleeding arteries were left central arteries (10%). These were followed by right central arteries (7%).

In our study, the third most common artery in infarcts was the basilar artery. Right and left vertebral artery involvement is 6%. Right and left involvement is equal. In our study, the anterior cerebral arteries were the least responsible arteries in the lesions.

In the literature, infarct sizes caused by vessels were compared in each other in this study. The right cerebral medial artery is the vessel that causes the largest infarct in volume. This was followed by the left cerebral medial artery. The left vertebral artery followed by the right vertebral artery, together with the central arteries, are the most common arteries to cause infarcts.

These results will be the basis for explaining the mechanisms of these clinical findings if they are evaluated in comparison clinical conditions of the patients with the whose images used in this study.

Infarct areas and clinical findings should be evaluated together to determine whether the symptoms and clinical findings are related to anatomic localization or infarct size.

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Author contributions: E.S. and M.B.O collected the data and contributed to the discussion. They reviewed and edited the manuscript and contributed to the discussion.

Conflict of interest: The authors have declared that no competing interest exists.

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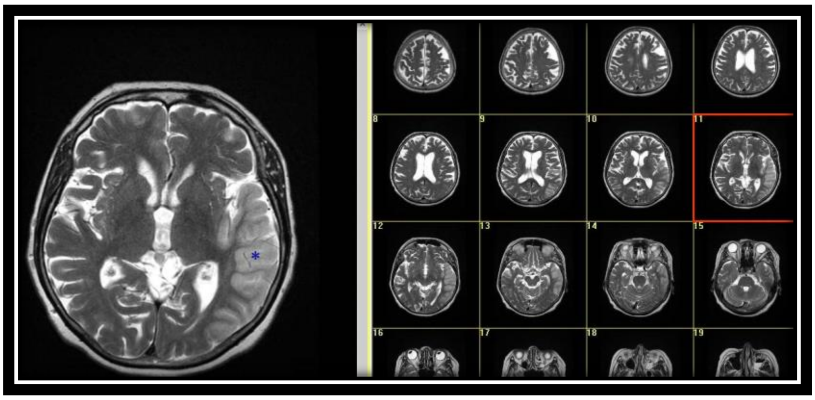


Figure 1. MR images of a patient with ischemia

A large infarct area (*) is shown in the right hemisphere. Transverse serial section of the patient is located on the right side. These sections were transferred to computer and used for 3D images

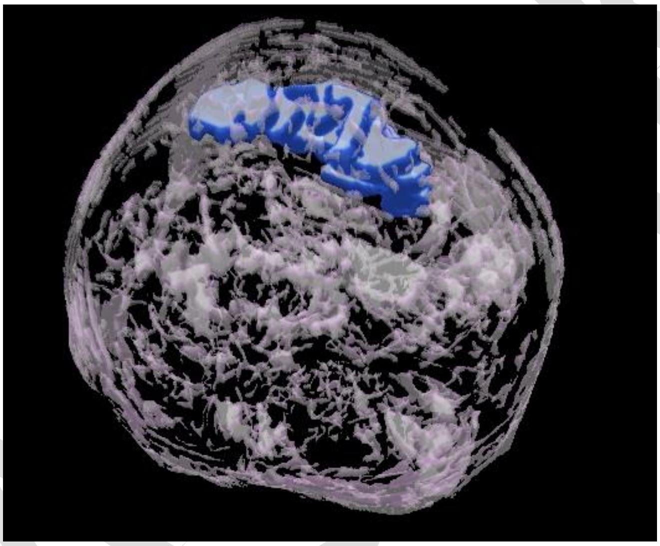


Figure 2. The infarct area is shown in blue in 3D

The relationship between the infarct area and brain gray matter (neuron bodies) is shown (top view)

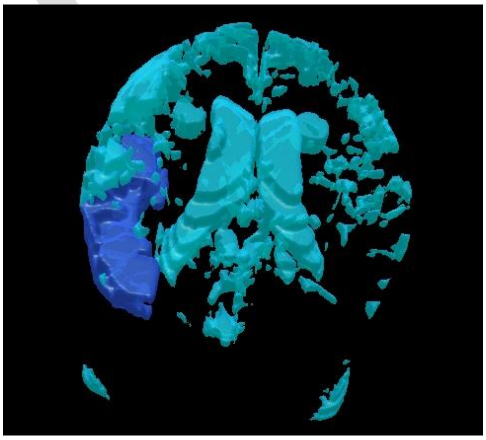


Figure 3. The infarct area is shown in blue in 3D

The relationship between the infarct area and CSF circulation is shown (anterior view)

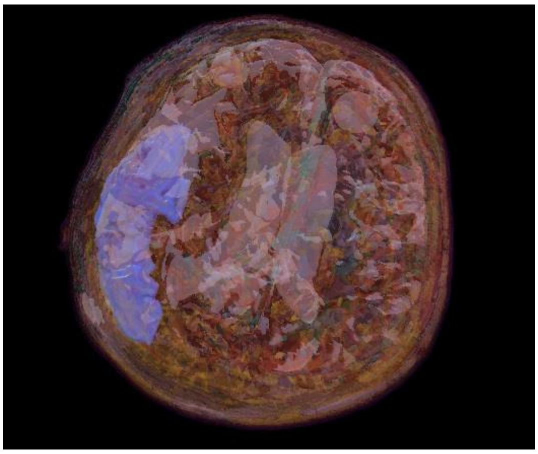


Figure 4. The infarct area is shown in blue in 3D

The relationship between the infarct area and all brain structures is shown (top view)

Table 1. Number of patients

	No	**Percent**
Patient Male	53	34.2
Patient Female	52	33.5
Control Man	23	14.8
Control Woman	27	17.4
Total	155	100.0

Table 2. Comparison of infarct size and infarct types in patients with hypertension

Hypertension	Infarct Type	Mean (mm³)	N	SD*
Exist	**Atherosclerotic**	257.03	18	263.98
	Cardioembolic	166.15	35	304.77
	Lacunar	12.00	11	9.19
	Kriptojenic	347.22	1	.
	Other reasons	18.94	1	.
	Transient isch.attack	0.00	8	0.00
	Total	147.84	74	261.82
Absence	**Atherosclerotic**	463.02	12	726.22
	Cardioembolic	308.61	11	360.43
	Lacunar	6.49	3	2.77
	Kriptojenic	52.08	2	24.55
	Other reasons	192.55	1	.
	Transient isch.attack	0.00	2	0,00
	Total	298.94	31	516.19
Total	**Atherosclerotic**	339.43	30	501.43
	Cardioembolic	200.21	46	320.66
	Lacunar	10.82	14	8.46
	Kriptojenic	150.46	3	171.28
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	10	0.00
	Total	192.45	105	360.24

*SD: Standart Deviation

Table 3. Comparison of infarct size and infarct types in patients with diabetes mellitus

Diabetes Mellitus	**Infarct Type**	**Mean (mm³)**	**N**	**SD***
Exist	**Atherosclerotic**	347.70	10	316.24
	Cardioembolic	125.38	16	197.04
	Lacunar	14.21	2	6.70
	Kriptojenic	69.44	1	.
	Other reasons	18.94	1	.
	Total	186.66	30	256.18
Absence	**Atherosclerotic**	335.29	20	579.95
	Cardioembolic	240.13	30	367.06
	Lacunar	10.25	12	8.84
	Kriptojenic	190.97	2	220.97
	Other reasons	192.55	1	.
	Transient isch.attack	0.00	10	0.00
	Total	194.76	75	395.79
Total	**Atherosclerotic**	339.43	30	501.43
	Cardioembolic	200.21	46	320.66
	Lacunar	10.82	14	8.46
	Kriptojenic	150.46	3	171.28
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	10	0.00
	Total	192.45	105	360.24

*SD: Standart Deviation

Table 4. Comparison of infarct size and infarct types in patients with smokers

Smoke	Infarct Type	Mean (mm³)	N	SD*
Exist	**Atherosclerotic**	535.26	13	706.97
	Cardioembolic	111.36	12	183.18
	Lacunar	11.14	6	12.20
	Kriptojenic	69.44	1	.
	Transient isch. attack	0.00	2	0.00
	Total	247.97	34	497.14
Absence	**Atherosclerotic**	189.67	17	160.85
	Cardioembolic	231.58	34	353.76
	Lacunar	10.58	8	5.15
	Kriptojenic	190.97	2	220.97
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	8	0.00
	Total	165.86	71	272.18
Total	**Atherosclerotic**	339.43	30	501.43
	Cardioembolic	200.21	46	320.66
	Lacunar	10.82	14	8.46
	Kriptojenic	150.46	3	171.28
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	10	0.00
	Total	192.45	105	360.24

*SD: Standart Deviation

Table 5. Comparison of infarct size and infarct types in patients with coronary artery diseases

Coronary Artery D.	Infarct Type	Mean (mm^3)	N	SD*
Exist	**Atherosclerotic**	306.81	6	293.13
	Cardioembolic	92.11	11	126.06
	Lacunar	4.00	1	.
	Transient isch.attack	0.00	2	0.00
	Total	142.90	20	210.04
Absence	**Atherosclerotic**	347.58	24	545.89
	Cardioembolic	234.19	35	355.59
	Lacunar	11.34	13	8.57
	Kriptojenic	150.46	3	171.28
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	8	0.00
	Total	204.10	85	387.26
Total	**Atherosclerotic**	339.43	30	501.43
	Cardioembolic	200.21	46	320.66
	Lacunar	10.82	14	8.46
	Kriptojenic	150.46	3	171.28
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	10	0.00
	Total	192.45	105	360.24

*SD: Standart Deviation

Table 6 Comparison of infarct size and infarct types in patients with gender

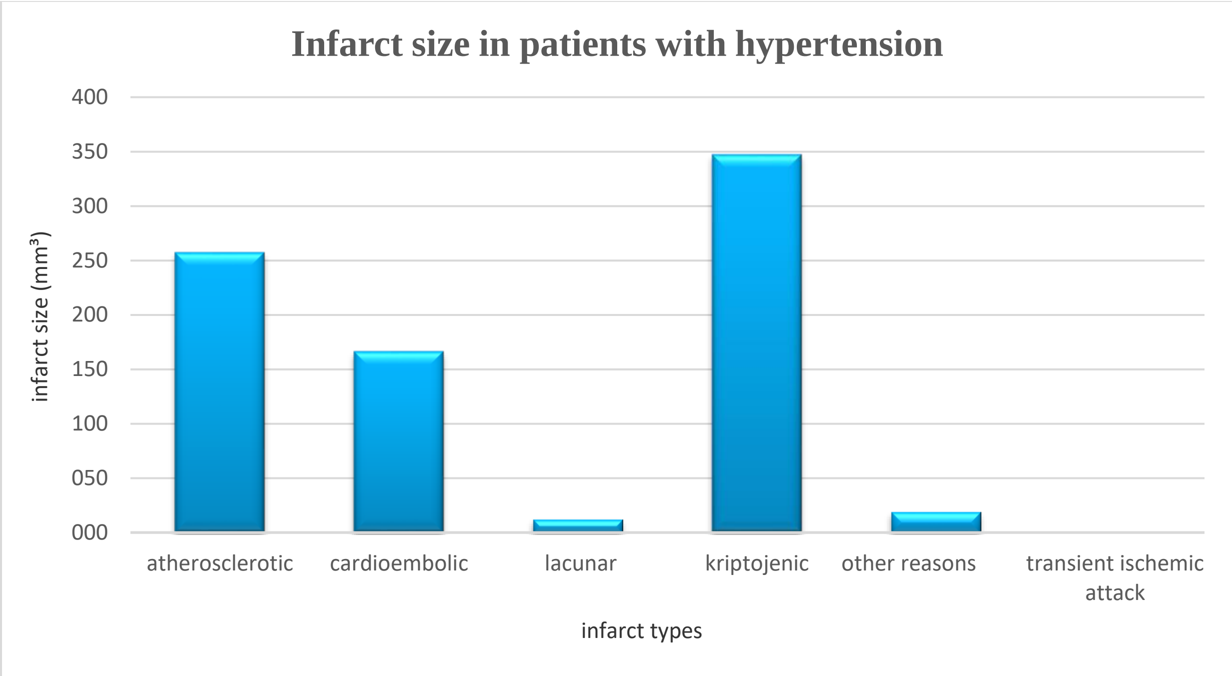
Sex	Infarct Type	Mean (mm^3)	N	SD*
Patient Male	**Atherosclerotic**	437.63	20	587.28
	Cardioembolic	126.25	20	190.97
	Lacunar	12.08	9	10.42
	Kriptojenic	69.44	1	.
	Transient isch.attack	0.00	3	0.00
	Total	216.14	53	414.31
Patient female	**Atherosclerotic**	143.02	10	133.24
	Cardioembolic	257.11	26	386.81
	Lacunar	8.55	5	2.33
	Kriptojenic	190.97	2	220.97
	Other reasons	105.75	2	122.76
	Transient isch.attack	0.00	7	0.00
	Total	168.29	52	297.39

*SD: Standart Deviation

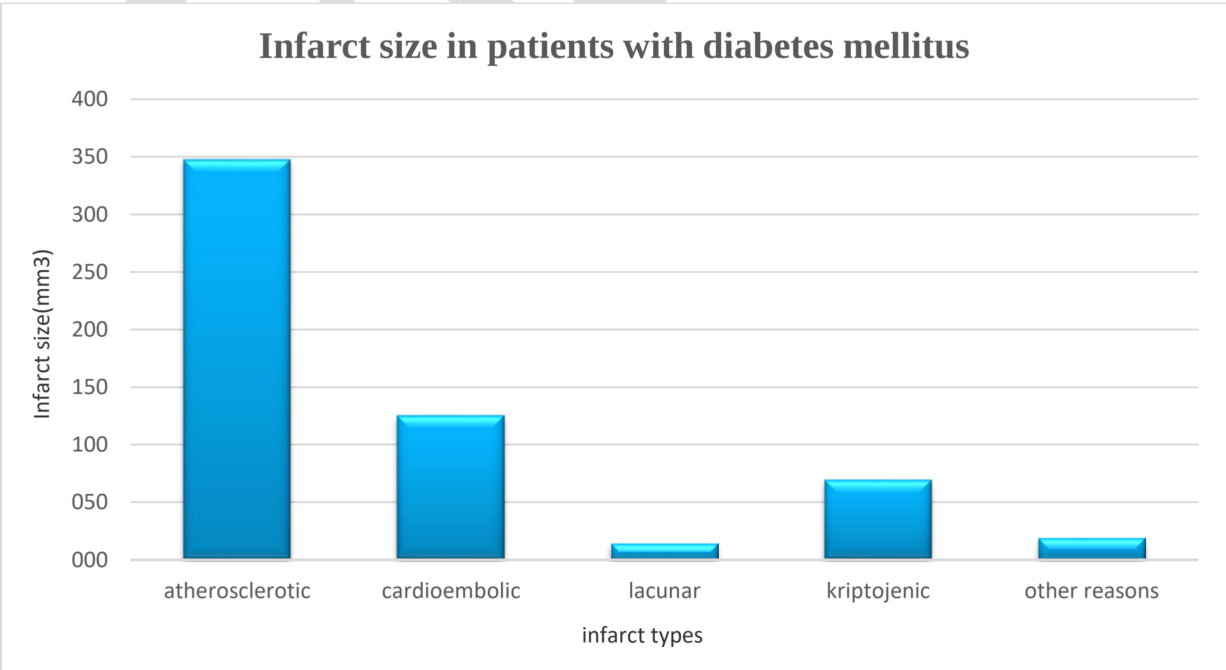
Table 7. Frequency of vessel retention and relation with infarct size

VESSELS	Mean (mm³)	N	SD*
Normal	1.00	10	1.63
Left middle cerebral artery	252.03	20	409.10
Right middle cerebral artery	445.77	13	350.31
Left anterior cerebral artery	23.15	3	4.82
Right anterior cerebral artery	71.03	2	87.05
Left posterior cerebral artery	98.24	2	98.75
Left central arteries	70.70	11	126.46
Right central arteries	95.75	6	88.24
Left vertebral artery (PICA)	228.33	3	204.14
Right vertebral artery (PICA)	120.49	3	91.33
Basilar artery	22.92	9	18.24
Left middle cerebral artery and left posterior cerebral artery	64.69	3	64.76
Right middle cerebral artery and right posterior cerebral artery	299.87	1	.
Left middle cerebral artery and basilar artery	114.36	4	41.19
Left middle cerebral artery and left basilar artery	655.85	6	1123.93
Left posterior cerebral artery and left basilar artery	344.07	1	.
Right vertebral artery (PICA) and basilar artery	154.68	1	.
Middle cerebral artery and right posterior cerebral artery	205.47	4	79.93
Right posterior cerebral artery and right central artery and right vertebral artery (pıca)	34.72	1	.
Left middle cerebral artery and left central artery and right central artery	239.91	1	.
Right middle cerebral artery and right central artery	202.02	1	.
Total	195.50	105	367.37

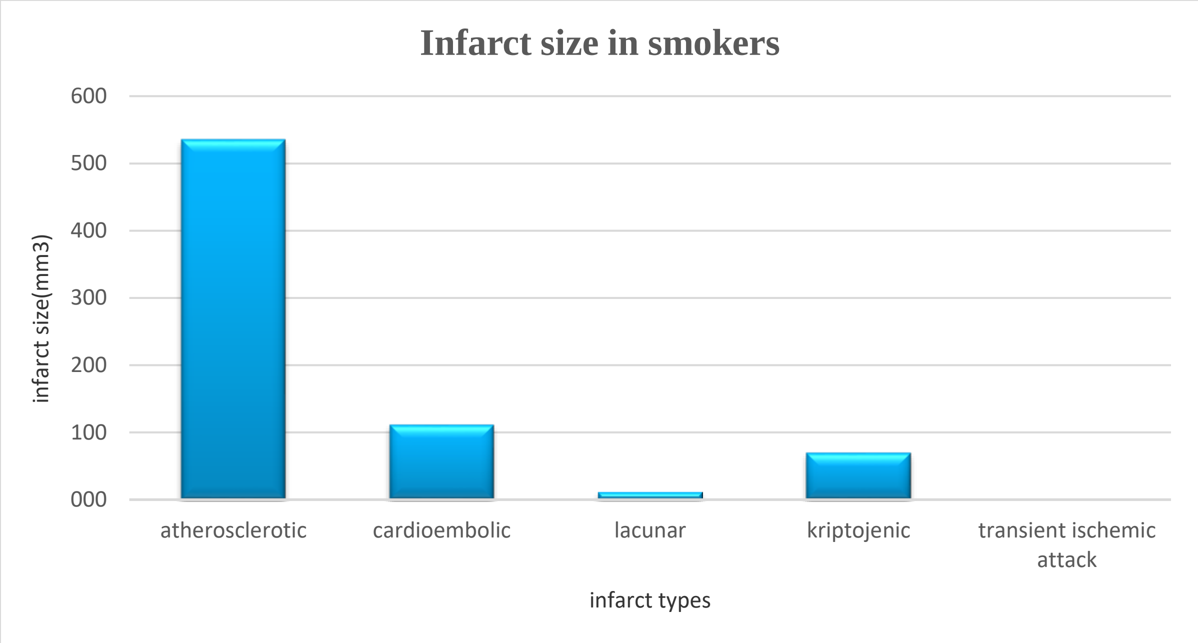
*SD: Standart Deviation



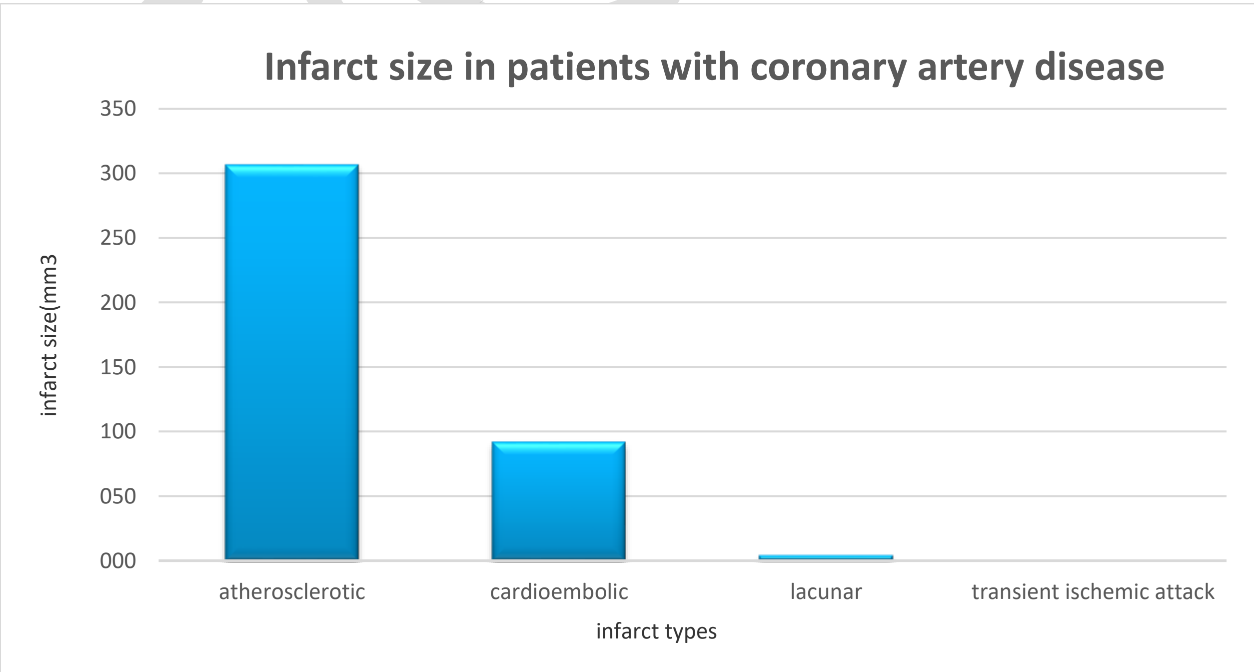
Graph 1. Infarct size in patients with hypertension



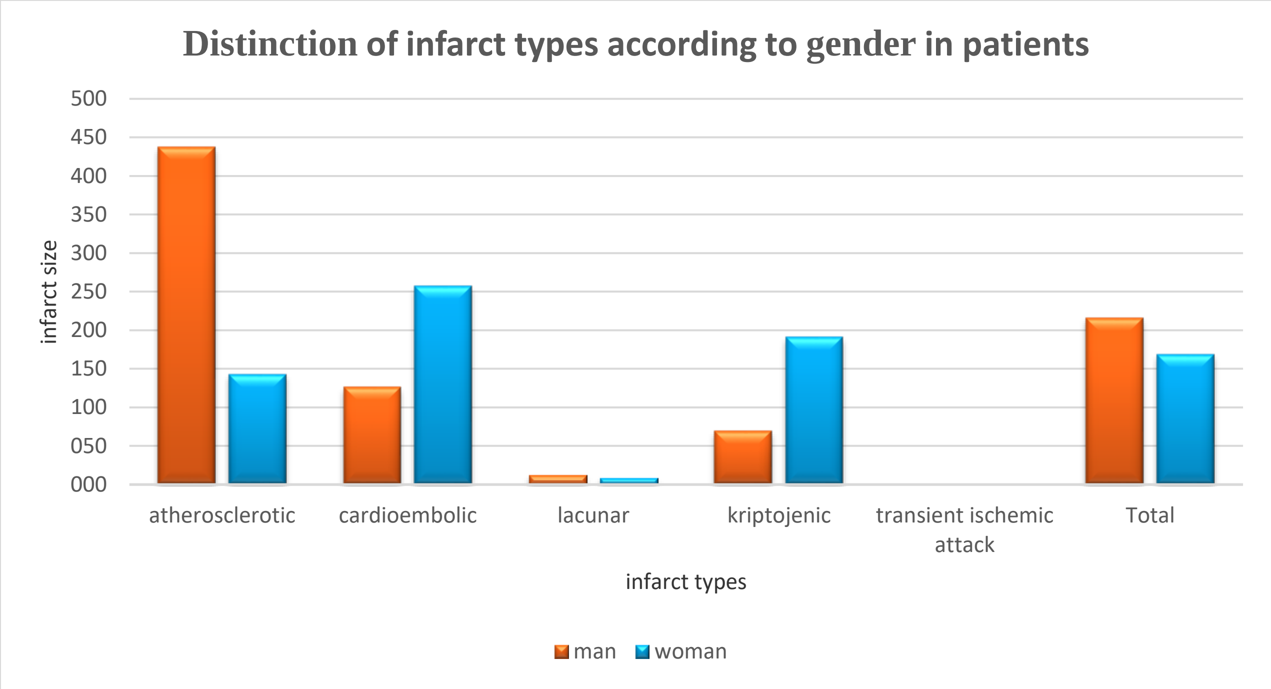
Graph 2. Infarct size in patients with diabetes mellitus



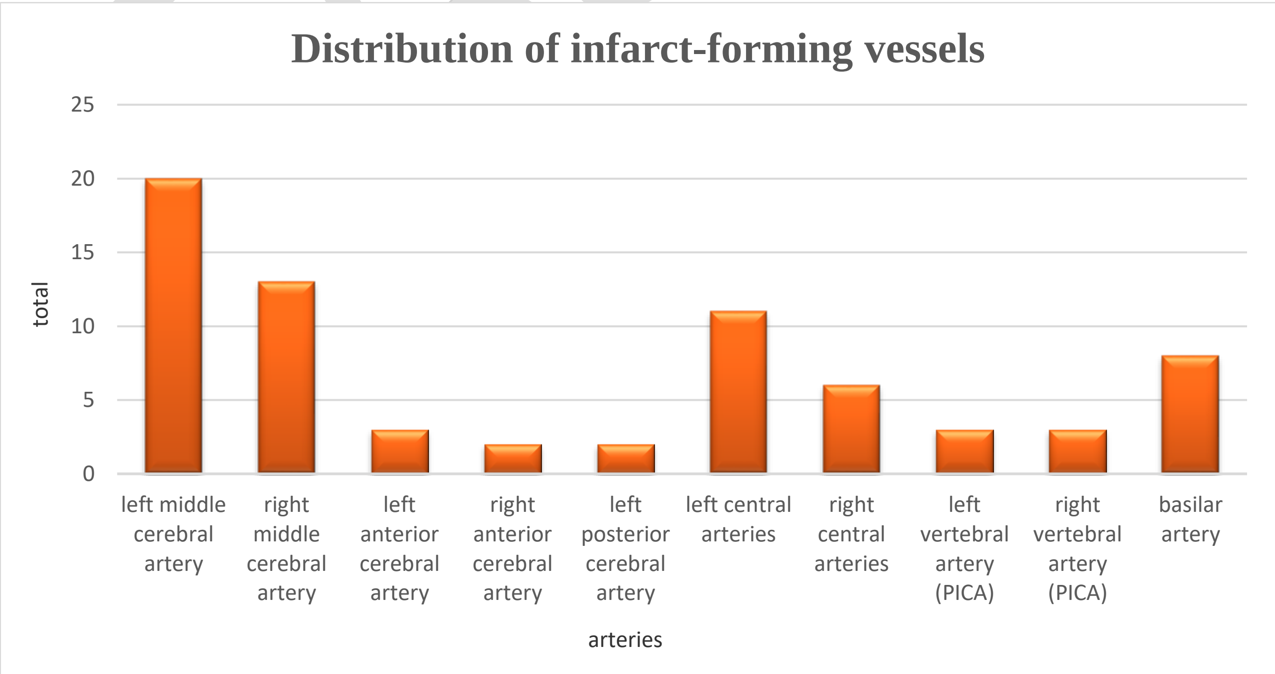
Graph 3. Infarct size in smokers



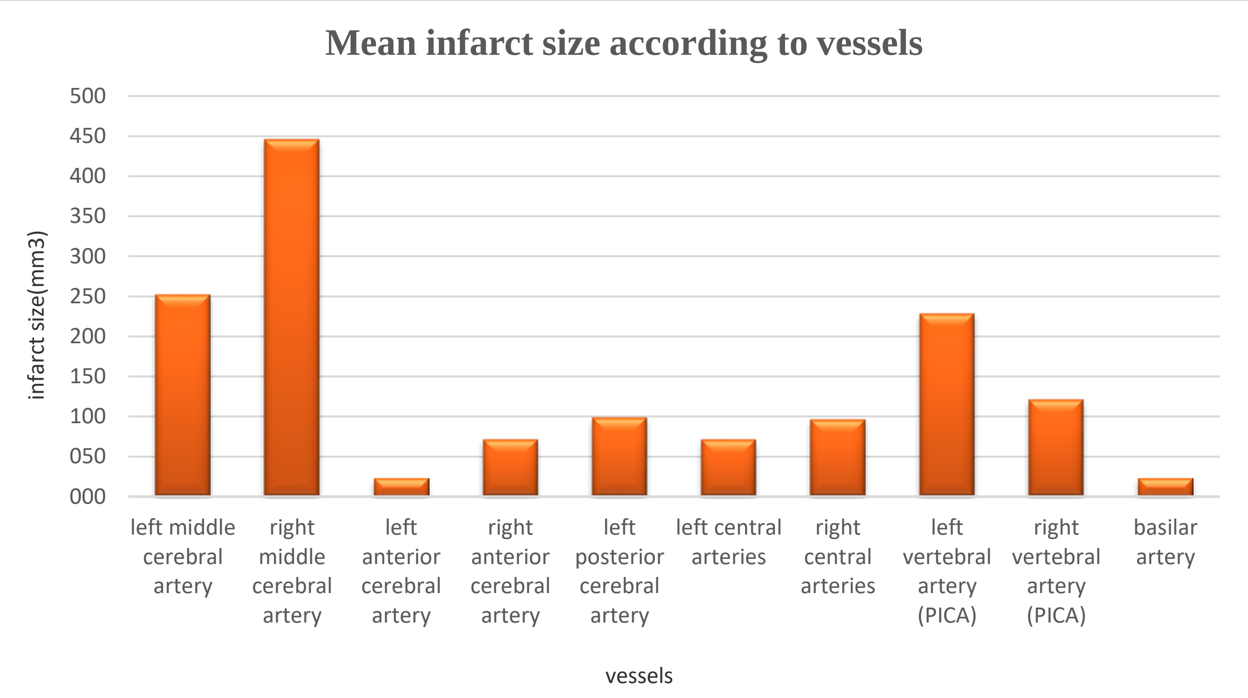
Graph 4. Infarct size in patients with coronary artery disease



Graph 5. Distinction of infarct types according to gender in patients



Graph 6. Distribution of infarct-forming vessels



Graph 7. Mean infarct size according to vessels

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