



Clinical Article

Complications and risk factors after digital subtraction angiography: 1-year single-center study

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Objective: Digital subtraction angiography (DSA) is an imaging technique used to diagnose and confirm abnormal lesions of cerebral blood vessels in various situations. Several complications such as cerebral infarction, contrast-induced allergy, and angio-site hematoma or infection can occur after DSA. We investigated complication rates and risk factors related to DSA.

Methods: All patients who underwent DSA at Incheon St. Mary's Hospital from January to December 2021 were included. Those who underwent emergency DSA due to stroke or who underwent endovascular surgery within 1 week after DSA were excluded. Complications that occurred within 1 week after DSA were included in the study and was classified into three categories (neurologic complications, contrast-induced allergy, and wound complications).

Results: The mean age was 57.7±13.2 years old and the female was dominant at 63.9%. The overall complication rate was 5% (n=20/407). Regarding neurologic complications, the presence of malignancy ($p<0.01$), and a longer procedure time (>15 minutes, $p=0.04$) were statistically significant factors. Contrast-induced allergy did not show any statistically significant difference in any parameter. The wound complication rate was higher in men ($p=0.02$), trans-femoral approach ($p=0.02$), frequent alcohol drinkers ($p=0.04$), those taking anticoagulants ($p=0.03$), and longer procedure time (>15 minutes, $p<0.01$).

Conclusions: DSA is an invasive diagnostic modality and can cause several complications. Patients with cancer should be more careful about the occurrence of cerebral infarction, and men taking anticoagulants or drinking frequently should be more careful about the occurrence of angio-site hematomas.

Keywords Digital subtraction angiography (DSA), Ischemic complication, Angio-site complication

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INTRODUCTION

Digital subtraction angiography (DSA) is an imaging technique used to diagnose and confirm abnormal lesions of cerebral blood vessels in various situations such as

aneurysm, cerebral vessel stenosis, arteriovenous fistula, malformation, etc.²⁾⁽⁸⁾⁽¹⁵⁾ It is the gold standard imaging modality for the assessment of intracranial vascular pathology and can be used for planning treatment in patients with a suspected underlying vascular abnormality.⁶⁾⁽¹²⁾⁽¹³⁾ DSA is frequently reserved for treatment planning of endovascular or open surgical procedures in which noninvasive imaging results are not confirmative or consistent.⁵⁾ After performing DSA, different complications such as cerebral infarction, contrast-induced allergy, and angio-site hematoma or infection can occur.⁵⁾⁽¹⁰⁾ Recently, complication rates are decreasing due to technological improvements in catheters, guide wires, and nonionic contrast agents, and the development of high-resolution digital subtraction imaging with roadmap capabilities.²⁾⁽⁵⁾ But serious neurologic complications such as hemiparesis or dysarthria can occur after the DSA procedure due to ischemic or hemorrhagic stroke.⁸⁾⁽¹⁵⁾ In several literatures, the most common complication is groin hematoma although there is a chance that the contrast used during the DSA may cause damage to the kidneys, mainly in patients whose kidney function is abnormal already.²⁾⁽⁸⁾ A complete understanding of the complications associated with DSA can help in improving the treatment strategy.⁸⁾ We studied the incidence of complications and associated risk factors in patients who underwent DSA for the past year.

MATERIALS AND METHODS

Among all patients who underwent DSA at Incheon St. Mary's Hospital from January 1 to December 31 in 2021, patients who received only the DSA were included. Emergency DSA due to hemorrhagic strokes like subarachnoid hemorrhage or ischemic strokes like thrombolysis were excluded. The patients who underwent endovascular or surgical procedures within 1 week were also excluded. We investigated symptomatic complications that occurred within 1 week after DSA and was classified into three categories as follows.

First, if neurological symptoms occurred, including transient ischemic attack (TIA), intracranial hemorrhage, or encephalopathy, with or without acute stroke lesions on MRI, it was defined as a neurologic complication. If the patient showed obvious neurologic symptoms like weakness or mental deterioration, it was also classified as a neurologic complication even though there is no definite infarct lesion on MRI. Second, in the case of skin rash, angioedema, or other allergic reaction after DSA, it was defined as a contrast-induced allergy. Third, it was defined as wound complications if complications were caused by an arterial puncture like hematoma, ulcer, infection, thrombosis, or pseudoaneurysm at the angio-site. Also, if infection on the angio site occurred after DSA, it was included in wound complications. Asymptomatic complications such as small dissections or asymptomatic small infarcts were not classified as symptomatic complications.

To perform the DSA, the femoral or radial approach was tried and we also studied statistically significant differences by approach. Pulsation of dorsalis pedis artery in femoral approach and Allen's test in radial approach was confirmed before DSA. The time taken for DSA was measured from the time taken from puncture to closure of accessing artery. The age of the patient was divided into two groups based on the age of 65 years old and the time required for the DSA was also divided into two by 15 minutes. We compared the various parameters between good and poor surgical and clinical results.

A student t-test was applied for comparison between two groups and Chi-square test for checking the association for the outcome variable. In each case, the values were expressed as mean±SD, and $P<0.05$ was considered statistically significant. Statistical analyses were conducted using the SPSS statistical package (version 25, SPSS Inc, Chicago, IL, USA).

RESULTS

Baseline characteristics of DSA patients are listed in Table 1. Complications were analyzed by classifying

Table 1. Baseline characteristics of DSA patients

Demographic factors		n=407	%
Sex	F	260	63.9
	M	147	36.1
Age	<65	280	68.8
	≥65	127	31.2
Angio-site	Femoral	149	36.6
	Radial	258	63.4
Diabetes mellitus	No	331	81.3
	Yes	76	18.7
Hypertension	No	205	50.4
	Yes	202	49.6
Stroke history	No	353	86.7
	Yes	54	13.3
Cardiovascular history	No	391	96.1
	Yes	16	3.9
Hepatic failure	No	397	97.5
	Yes	10	2.5
Renal failure	No	404	99.3
	Yes	3	0.7
Other malignancy	No	378	92.9
	Yes	29	7.1
Smoking	No	350	86
	Yes	57	14
Alcohol	No	319	78.4
	Yes	88	21.6
Anticoagulant	No	399	98.0
	Yes	8	2.0
Antiplatelet	No	48	11.8
	Yes	359	88.2
Procedure time	<15 min	349	85.7
	≥15 min	58	14.3

them into three categories as follows (Table 2): neurologic complications, contrast-induced allergy, and wound complications. Although complications were associated with age greater than 65 years old in most other literature, age had no statistically significant effect on any of the three complications in this study.

Regarding neurologic complications, combined other malignancy was a statistically significant factor ($p<0.01$). The presence or absence of hypertension and diabetes mellitus did not show a significant difference ($p=0.32$ and 0.74 , respectively). The risk of neurologic

complications was higher when the time required for DSA was longer than 15 minutes ($p=0.04$). In our study, neurologic complications were meant to include all TIA, hemorrhage, and encephalopathy, but there were no other complications such as hemorrhage, and encephalopathy in our study. Contrast-induced allergy did not show any statistically significant difference with any parameter.

The incidence of wound complications was significantly higher in men than in women ($p=0.02$) and in the femoral approach than in the radial approach ($p=0.02$). Those who drink or takes anticoagulant is more likely to develop wound complications than those who do not ($p=0.04$ and 0.03 , respectively). Those who took a longer time (>15 minutes) were also more likely to develop wound complications than those less than 15 minutes ($p<0.01$). In addition, procedure time (<15 min) was significantly short in the radial approach than in the femoral approach ($p=0.02$).

DISCUSSION

DSA remains the gold standard investigation for subtle cerebral vascular structures.⁴⁾⁽¹²⁾ There is a slight chance of cancer from excessive radiation exposure but the benefit of an accurate diagnosis far outweighs the risk. Complications are relatively uncommon, and their incidence has decreased in recent decades. But DSA is still an invasive diagnostic modality in comparison to other non-invasive diagnostic modalities such as MRI or CT and can cause several symptomatic complications such as ischemic stroke, pseudoaneurysm, hematoma, etc.⁵⁾⁽⁸⁾⁽⁹⁾

Regarding neurologic complications, the most common cause implicated is thromboembolism from catheters or guide wires.⁸⁾ This thrombus is most likely to develop inside the catheter during the manipulation of the guidewire, when the guidewire is withdrawn into the catheter, allowing blood to stagnate within this dead space. In addition, catheters or wires can damage the endothelial atherosclerotic plaque or cause dissection of the intima, causing cerebral infarction.²⁾ Especially, the

Table 2. Three category of complications and correlating factors

		Neurologic complication			Contrast-induced allergy			Wound complication		
		No	Yes	<i>p</i>	No	Yes	<i>p</i>	No	Yes	<i>p</i>
Number of cases (n)		403	4		399	8		399	8	
Sex	F	259	1	0.10	254	6	0.51	258	2	0.02
	M	144	3		145	2		141	6	
Age	<65	276	4	0.17	274	6	0.70	276	4	0.25
	≥65	127	0		125	2		123	4	
Angio-site	Femoral	146	3	0.11	145	4	0.43	143	6	0.02
	Radial	257	1		254	4		256	2	
Diabetes mellitus	No	328	3	0.74	325	6	0.64	325	6	0.64
	Yes	75	1		74	2		74	2	
Hypertension	No	202	3	0.32	201	4	0.98	199	6	0.16
	Yes	201	1		198	4		200	2	
Stroke history	No	350	3	0.40	345	8	0.26	346	7	0.95
	Yes	53	1		54	0		53	1	
Cardiovascular history	No	387	4	0.68	383	8	0.56	383	8	0.56
	Yes	16	0		16	0		16	0	
Hepatic failure	No	393	4	0.75	389	8	0.65	389	8	0.65
	Yes	10	0		10	0		10	0	
Renal failure	No	400	4	0.86	396	8	0.81	396	8	0.81
	Yes	3	0		3	0		3	0	
Other malignancy	No	376	2	<0.01	370	8	0.43	371	7	0.55
	Yes	27	2		29	0		28	1	
Smoking	No	346	4	0.42	342	8	0.25	344	6	0.36
	Yes	57	0		57	0		55	2	
Alcohol	No	316	3	0.87	311	8	0.13	315	4	0.04
	Yes	87	1		88	0		84	4	
Anticoagulant	No	395	4	0.77	391	8	0.68	392	7	0.03
	Yes	8	0		8	0		7	1	
Antiplatelet	No	47	1	0.41	46	2	0.24	47	1	0.95
	Yes	356	3		353	6		352	7	
Procedure time	<15 min	347	2	0.04	342	7	0.88	345	4	<0.01
	≥15 min	56	2		57	1		54	4	

vertebral arteries are probably more prone to iatrogenic injury than carotid arteries due to their smaller vessel caliber, being surrounded by transverse foramina that limit the flexibility of the catheter, and having a tortuous origin.²⁾

To reduce unexpected neurologic complications, some physicians prefer to prescribe antiplatelet drugs several days before DSA. However, in this study, the use of prophylactic antiplatelet drugs before DSA had no

statistical significance with neurologic complications ($p=0.41$). On the other hand, patients with the malignant disease were more likely to develop neurologic complications than those without cancer ($p<0.01$). It is thought that cancer caused a hypercoagulable state or circulating cancer particles caused infarction. Cancer is the leading cause of death in the world. The association between cancer and thrombotic disease including cerebral infarction is referred to as Trousseau syndrome.⁷⁾ Patients with

solid tumors, including lung, breast, ovary, and pancreas cancers, have a significantly higher risk of thromboembolic complications than patients with hematologic malignancies such as leukemia and malignant lymphoma.⁷⁾ The term “Trousseau syndrome” is defined as unexplained thrombotic events that either precede the diagnosis of an occult visceral malignancy or appear concomitantly with tumors.³⁾ Currently, there are no definite diagnostic guidelines for Trousseau syndrome associated with cerebral infarction.³⁾ Stroke may either follow the initial cancer diagnosis or precede the cancerous disease diagnosis.³⁾ In another study, a large retrospective cohort study found cerebral infarction was greater in patients with adenocarcinomas compared with other histopathological cancer subtypes.³⁾

Although the presence or absence of hypertension did not show a significant difference with neurologic complications ($p=0.32$), all neurologic complications occurred in patients not taking antihypertensive drugs ($n=4$). Three of the four patients with neurologic complications had no history of blood pressure, and one had a history of blood pressure but did not take blood pressure medication. There were no neurologic complications among patients taking hypertension medication and in hypertensive patients, taking anti-hypertensive medication may reduce the risk of infarction.

In addition, our study shows that neurologic complications were more common in patients who took more than 15 minutes from an arterial puncture to the end of the procedure ($p=0.04$). The reason is estimated that the blood vessels run tortuous and it takes a long time because the selection of the vessels is difficult, and rupture of plaque or occurrence of thrombus may have increased.¹⁾ In general, a skilled physician can complete the DSA test in about 10-15 minutes from an arterial puncture to 4 blood vessels for patients with normal running blood vessels.

There were no statistically significant factors causing the contrast-induced allergy. Contrast allergy seems to occur in unspecified patients with no risk factors. Wound complications were more common in men than women ($p=0.02$) and alcohol drinkers ($p=0.04$). The reason is

not clear, it is thought that men, who drink more than women, are more active after DSA causing wound complications. Trans-femoral showed more wound complications than the radial approach ($p=0.02$).¹¹⁾ Two cases of skin ulcers developed in the trans-radial approach, which spontaneously healed within a few days, while 4 cases of hematomas and 2 pseudoaneurysms occurred in the trans-femoral approach.¹¹⁾ In the radial approach, the angio-site hematoma was rare even though some blood leakage occurred. Wound complications were more common in patients who take anticoagulants ($p=0.03$) which inhibited hemostasis. Longer DSA time was also another risk factor for wound complications ($p<0.01$) such as ischemic complications. It is thought to be that a longer angio-sheath holding time would require more aggressive hemostasis.¹⁴⁾

There are several limitations to this study. First of all, it was difficult to identify significant risk factors conclusively due to the small sample size. And the data analysis was retrospective, so limitations include all the anticipated deficiencies of a retrospective analysis, including the loss of patient information and poor follow-up.

CONCLUSIONS

Despite several limitations, this study has several notable points. Ischemic stroke is markedly frequent in cancerous patients, and wound complication was more frequently associated with anticoagulants. Longer DSA time was a risk factor for both neurologic and wound complications.¹⁴⁾ As the DSA is performed for examination rather than treatment, more attention should be paid to avoiding complications than therapeutic purposes such as endovascular procedures.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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