

Safety of cerebral digital subtraction angiography : complication rate analysis

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ABSTRACT

BACKGROUND

Cerebral digital subtraction angiography (DSA) continues to be used for the examination of patients with cerebrovascular diseases. In the past decade, safer contrast agents have been used and there have been important technical advances including smaller catheters, hydrophilic guide wires, and digital imaging systems. The objective of this study was to determine the neurological complication rates of cerebral angiography performed for inpatients.

METHODS

A prospective study was conducted from January 2009 until December 2011. The patient's demographic characteristics, the procedural details as well as complications appearing during and after the procedure were documented. Neurological complications are classified based on the international classification: (a) transient, disappearing within 24 hours; (b) reversible, lasting more than 24 hours but less than 7 days; (c) permanent, if the complication last for more than 7 days. The complications were examined by a neurologist.

RESULTS

The patients comprised 82 (41%) women and 118 (59%) men, ranging from 11 to 86 years of age. From 200 patients who underwent the procedure, permanent neurological complications were found in 1 (0.50 %) patient. Neither reversible nor transient neurological complications were found.

CONCLUSION

The cerebral digital subtraction angiography procedure, when conducted by a neuro interventionist, is relatively safe, both from the aspect of neurological and non-neurological complications, and from the number of deaths. The overall neurological complication rate fell within the limits recommended by quality improvement and safe practice guidelines.

Keywords: Cerebral angiography, safety, neurology complications

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Cerebral digital subtraction angiography : *analisis komplikasi*

ABSTRAK

LATAR BELAKANG

Digital subtraction angiography (DSA) serebral masih sering digunakan untuk memeriksa penderita dengan gangguan serebrovaskular. Selama decade terakhir banyak kemajuan yang telah diperoleh untuk meningkatkan keamanan penggunaan DSA serebral, seperti kontras yang lebih aman, kateter yang lebih kecil, kawat (hydrophilic guides), dan sistem pengamatan digital yang semakin baik. Penelitian ini bertujuan untuk menentukan besarnya komplikasi neurologi yang terjadi pada penggunaan DSA serebral.

METODE

Penelitian prospektif telah dilakukan mulai dari Januari 2009 hingga Desember 2011. Data yang dikumpulkan meliputi karakteristik demografi pasien, rincian proses prosedur, termasuk ada tidaknya komplikasi yang timbul, baik selama atau setelah dilakukan prosedur. Komplikasi neurologi dikelompokkan menjadi: (a) transient, yang akan menghilang setelah 24 jam, (b) reversibel, bila terjadi lebih dari 24 jam tetapi kurang dari 7 hari, (c) permanen, bila komplikasi terjadi lebih dari 7 hari. Penilaian terjadinya komplikasi dilakukan oleh seorang ahli neurologi.

HASIL

Subjek terdiri dari 84 (41%) perempuan dan 118 (59%) laki-laki, dengan usia berkisar antara 11 sampai 86 tahun. Sebanyak 200 pasien telah menjalani prosedur DSA serebral, dan komplikasi neurologi yang bersifat permanen terjadi pada 1 kasus (0,50%). Tidak didapatkan komplikasi yang bersifat reversibel ataupun transient dalam penelitian ini.

KESIMPULAN

DSA serebral yang dilakukan oleh seorang ahli neuro-intervensi adalah relatif aman, baik dalam hal komplikasi neurologi, komplikasi non-neurologi maupun terjadinya kematian. Komplikasi neurologi yang terjadi masih dalam batas yang direkomendasikan sesuai dengan petunjuk keamanan untuk melakukan DSA serebral.

Kata kunci: Angiografi serebral, keamanan, komplikasi, neurologi

INTRODUCTION

Recent advances in noninvasive neurovascular imaging techniques, including magnetic resonance angiography (MRA) and computed tomography angiography (CTA), have reduced the number of catheter-based cerebral angiograms performed for purely diagnostic reasons. Cerebral digital subtraction angiography (DSA) remains, however the gold standard to find vascular abnormalities of the brain, such as arterial stenosis, arteriovenous malformation (AVM) and brain aneurysm.^(1,2)

In the past decade, safer contrast agents have been used and there have been important technical advances including smaller catheters, hydrophylic guide wires, and digital imaging systems.⁽³⁾ However, the usage of cerebral DSA for those cases, particularly in Indonesia, seems slowly developed. Some neurologists are still considered that cerebral DSA as an expensive and invasive procedure that able to cause morbidity as well as mortality. Clinician has expressed concerns about the complications, particularly neurological complication associated with cerebral angiography.

Knowledge of the complication rates and/or risk factors is important to improve the examination procedure and patient selection.

There were not any reports about characteristic and safety of cerebral DSA done by Indonesian interventional neurologist as well as other interventionist. The objective of this study was to determine the complication rates related to digital subtraction angiography (DSA) in patients with stroke and non stroke.

METHODS

Research design

A prospective study was conducted from January 2009 to December 2011 in four institutions in Jakarta.

Subjects

Two hundred consecutive diagnostic cerebral angiograms obtained at the four institutions were studied prospectively with institutional review board approval and patient informed consent. All studies were performed on the basis of accepted clinical indications for treatment.

Angiographic protocol

The medical history of the subjects was collected by interviewing the patients as well as their relatives. The subjects were also examined for vital and neurological signs before and after the procedures. Patients were restricted from having solid foods 6 hours before the procedure, but were allowed clear fluids. In each patients, an intravenous catheter was placed prior to angiography. Electrocardiography, pulse oximetry, and vital signs were monitored throughout the procedure. Femoral arterial puncture, using a 5-F sheath, was performed in all procedures. The sheath was constantly flushed with heparinized saline (1,000 IU of heparin in 1,000 mL of normal saline). A similar heparinized saline solution was used for intermittent flushing of the

catheter. A bolus of 40-60 IU/kg of heparin was administered at the beginning of the procedure⁽⁴⁾ For diagnostic purposes, guide wires and normal diagnostic catheters of the head hunter type 0.035 inch of width, were used. The catheter was flushed intermittently with isotonic heparinized saline solution to prevent blood clots.

Non-ionic contrast mixed with saline at a ratio of 2 : 1 was used. Contrast was injected manually in the following volumes: 8–10 ml at a rate of 4-5 ml/second into the main and internal carotid arteries, 5 ml at 3-4 ml/second into the vertebral artery, and 6 -8 ml at 3-4 ml/second into the subclavian artery.

On completion of the procedure, the femoral sheath was pulled and the patient's groin at the location of the puncture site, was compressed for 15–20 minutes. Neurological examination was performed by a neurologist after completion of the procedure. After the patient's condition was stable, the patient was transferred to the recovery room for 4-6 hours, during which the patient was observed. The patient would be hospitalized upon the occurrence of any complications.

Data collection

For each procedure, information was collected about the patient's demographic characteristics, contrast volume, fluoroscopic time, date of the procedure, operator's name, patient's status, indication(s) for the procedure, size and type of catheter, type and number of injected blood vessels, type of anesthesia (local, general), heparin bolus dosage, emerging complications after the procedure. Neurological complications were classified based on the international classification as follows; (a) transient, disappearing within 24 hours; (b) reversible, lasting more than 24 hours but less than 7 days; (c) permanent, if the complication lasted for more than 7 days. Any occurring hematomas were classified as small hematomas if the hematomas were less than 5 cm in

diameter, and large hematomas, if the diameter was more than 5 cm.

Statistical analysis

Statistical analysis was conducted by descriptive statistics (SPSS 16). After data collection, the data were classified in accordance to particular characteristics, which are sex, case type, age, number of catheters used, co-morbidity and fluoroscopy time.

Ethical clearance

This study was approved by the Ethical Committee of Research Ethical Commission and Development Resources of Fatmawati General Hospital Jakarta Indonesia.

RESULTS

A total of 200 cerebral DSA procedures were conducted for this study and are summarized in Table 1. The proportion of stroke and non-stroke cases was 73% and 27%, respectively. The subjects comprised 82 (41%) women and 118 (59%) men, in the age range of 11-86 years of age (mean age 51.14 ± 16.08). Most of the procedures in this study (97%) used one catheter, while fluoroscopy time was mostly less than 30 minutes (95%). All of the angiograms were technically successful. There was no intraprocedural complications, and in particular, no occurrence of iatrogenic vessel injury (arterial dissection). There was no instance of contrast agent allergy and no evidence of contrast nephrotoxicity. There was only one neurological postprocedural complication (0.5%). Co-morbidities of all the patients are shown in Table 2.

Table 3 shows that the cause of most non-stroke cases was brain arterio-venous malformation (33.3%). On the other hand, most stroke cases were caused by recurrent ischemic stroke (45.2%), ischemic stroke (24.7%) and recurrent transient ischemic stroke (23.3%), respectively.

Table 1. Characteristics of patients and procedures (n=200)

Characteristics	n (%)
Sex	
Male	118 (59.0)
Female	82 (41.0)
Cases	
Stroke	146 (73.0)
Non stroke	54 (27.9)
Age	
< 30 years old	27 (13.5)
31-50 years old	48 (24.0)
51-70 years old	110 (55.0)
> 70 years old	15 (7.5)
Number of catheters used	
1 catheter	194 (97.0)
> 1 catheters	6 (3.0)
Complications	
No complication	199 (99.5)
Complication(s) present	1 (0.5)
Fluoroscopy time	
< 30 minutes	190 (95.0)
30-60 minutes	8 (4.0)
> 60 minutes	2 (1.0)

Table 2. Patients' comorbidity (n=200)*

Comorbidity	n (%)
Hypertension	82 (41.0)
Hyperlipidemia	96 (48.0)
Heart diseases	24 (12.0)
Diabetes mellitus	32 (16.0)

*A number of patients had multiple comorbidities

Table 3. Underlying diseases of patients

Cases	n (%)
Non-stroke	54
Vascular headache	12 (22.2)
Brain AVM*	18 (33.3)
Intracranial tumor	8 (14.8)
Other (ptosis, serious head injury)	16 (29.7)
Stroke	146
Recurrent transient ischemic	34 (23.3)
Ischemic	36 (24.7)
Recurrent ischemic	66 (45.2)
Hemorrhagic	6 (4.1)
Recurrent hemorrhagic	1 (0.7)
Subarachnoid hemorrhage	3 (2.0)

*AVM=arteriovenous malformation

Table 4. Distribution of DSA* findings

DSA Findings	n (%)
Normal	37 (18.5)
Intracranial AVMs**	18 (9.0)
Intracranial aneurysm	8 (4.0)
Extracranial stenosis/occlusion	72 (36.0)
Intracranial stenosis/occlusion	65 (32.5)

*DSA=digital subtraction angiography

**AVM=arteriovenous malformation

In this study there was one patient with comorbidities such as hypertension, hyperlipidemia, diabetes mellitus and stroke, who experienced neurological complications in the form of motor weakness (deterioration of motor strength from 3 to 1 degree). The patient was 72 years old and the indication for DSA was recurrent ischemic stroke. During the DSA procedure for this patient, 2 catheters were used and fluoroscopy time was 25 minutes and 38 seconds.

The disease findings in all 200 cerebral DSA procedures in this study are summarized in Table 4. Among 200 patients, extracranial stenosis/occlusion was found in 36% patients and intracranial stenosis/occlusion in 32.5% (Table 4).

DISCUSSION

Cerebral DSA is an invasive procedure using catheters, guide wires, contrast with the image by angiography machine.⁽⁵⁾ The procedure is performed to find any cerebral vascular abnormality (such as aneurysm, artery-venous malformation, stenosis) as well as to determine blood-flow and vascular conditions (such as vasospasm, vasculitis, vascularization of brain tumor). By doing this procedure, optimal therapy can be achieved for any brain vascular abnormality.^(5,6) Cerebral DSA is still used as the gold standard for detection of brain vascular abnormalities, particularly aneurysm and artery-venous malformation.^(7,8)

Although imaging technology has developed rapidly, cerebral DSA is still important because the results of this examination are highly comprehensive in providing information about brain vascularization.^(9,10)

A number of studies about the risks of cerebral DSA in the past ten years have shown that the proportion of neurological complications that may occur during the procedure is 0.05% - 2.9%, while the proportion of non-neurological complications is 0.05% - 14.7%. The mortality risk of the procedure is around 0.05% - 0.08%.^(1,2) Some modifications and approaches have been performed to minimize the number of complications occurring. It turns out that the duration of the procedure, high co-morbidity, patient's age, and the vessel anatomy.⁽¹¹⁾

The complications, in particular neurological complications, are predicted to be the most common complications occurring as a result of thromboembolism from the use of catheters and guide wires.⁽³⁾ Thromboembolism occurs in the catheter during the guide wire manipulation (when the catheter is pulled out and the guide wire is inserted). The skill of the operator has a major influence on the number of this complication occurring.⁽¹¹⁾ It is caused by the insertion of the guide wire into the catheter, leading to blood clots in the empty space inside the catheter.^(12,13) In daily practice, the operator tries to minimize the empty space inside the catheter by minimizing the frequency and duration of use of guide wires in the procedure. Furthermore, the continuous flux of heparin in the 3-way stopcock will decrease the risk of thromboembolism.^(14,15) Atherosclerotic plaque disruption by catheters and wires has often resulted in stroke.⁽¹⁵⁾

The operator will perform a minimum of selective intra-arterial examination into the blood vessel if on initial examination the operator has found plaque disruption that may cause fatal complications on prolonged manipulation of the catheter in the area.^(16,17) Other causes of complications are arterial dissection, platelet activation, coagulation

modifying factors, and neurotoxicity of the contrast agent.⁽¹⁸⁾


In this study, we found that the percentage of angiographic procedure complications in the form of neurological complications was 0.5%. There were no deaths in this study. Several previous studies yielded similar results, with the proportion of neurological complications between 0.4 – 1.2% for combined permanent, reversible and transient.^(10,19) A study to evaluate the proportion of complications in cerebral digital angiography procedures for detection of aneurysms and aneurysm malformations, involving 155 subjects, showed consistent results, with 1.5% of permanent neurological complications (95% confidence interval 0.3-4.3%).⁽⁶⁾

Computed tomographic angiography (CTA) has recently emerged as a non-invasive alternative to digital subtraction angiography (DSA) for the detection of residual cerebral aneurysms (RA). This meta-analysis supports CTA as an acceptable modality for postoperative detection of RA, although DSA remains the gold standard. By implementing multidetector CTA technology in experienced centers, the sensitivity and specificity of CTA may approach that of traditional DSA for detecting RA. As a cost-effective, non-invasive modality, CTA is a promising alternative to DSA for initial and long-term evaluation of RA.⁽²⁰⁾ An adequate knowledge of the risk factors associated with cerebral angiography may assist clinical decision making and closer observation of patients at high risk of complications.

CONCLUSION

We conclude that cerebral DSA procedures are relatively safe and have a low number of complications. There were no temporary or reversible neurological and non-neurological complications. The overall neurological complication rate was within the limits recommended for quality improvement and safe practice guidelines.

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