Digital subtraction angiography: The intravenous approach

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Summary

With further improvement of digital subtraction angiography (DSA) equipment, and the development of sophisticated soft-ware programs, the intravenous approach again has become an promising diagnostic alternative in certain clinical settings, if the patient’s cardiac output is not severely diminished. In many cases an additional arterial study is not neccessary. The diagnostic results, advantages and limitations of the intravenous approach in imaging the brachiocephalic, renal and peripheral vessels are discussed.

Introduction

This article reports upon the benefits and diagnostic value of intravenous digital subtraction angiography (iv-DSA) in 3 major vascular regions. Using the intravenous approach for imaging the arterial system, the diagnostic results are strongly influenced by technical factors (DSA-equipment, post-processing facilities, injection modalities), patient’s compliance and cardio-pulmonary status, and the personal experience of the radiologist [1, 2, 3].

Especially the technical factors may differ significantly among institutions, giving one explanation for the different amount of iv-studies being performed. The choice of the proper angiographic technique also depends distinctly on the kind of surgical and interventional procedures, which are applied.

Cervico-cerebral circulation

When iv-DSA was first introduced as a technique to evaluate the cervico-cerebral circulation, it was predicted by some radiologists that this new technique would eventually totally replace other non-invasive methods and might even replace transarterial angiography.

These predictions have not completely come true, even though iv-DSA has certainly become a valuable test e.g. for screening the carotid artery bifurcation, if Doppler-tests cannot be performed in a constantly high quality. On the contrary to Doppler-studies, hard-copies or the electronically stored images of iv-angiographies can be reevaluated by another experienced investigator and the quality of the examination can be easily assessed.

On the other hand, due to disappointing diagnostic results obtained with poorly designed first-generation systems, some users have become disillusioned with iv-DSA. They either completely abandoned it in favour of conventional film-angiography or have used their digital equipment to perform intraarterial DSA (ia-DSA). It is easily recognized that even with most sophisticated DSA equipment ia-DSA offers certain advantages compared to the intravenous approach and is even preferred to conventional angiography in appropriate clinical settings [4, 5].
The potential advantages of iv-DSA for head and neck angiography are considerable. First there is no risk of embolic stroke due to arterial catheterization and there is a relatively low incidence of severe complications [6]. Second iv-DSA is a time-saving, technically easy performed outpatient procedure. Third it is less expensive, not regarding the system-costs, than either ia-DSA or conventional angiography. With proper selection of patients, good equipment and meticulous technique good to excellent results can be obtained in more than 75% of all cases [7], fair but still diagnostic studies can be achieved in additional 20%. Table 1 shows some results of our group.

Iv-DSA also has several disadvantages. In order to gain a high yield of diagnostic studies, iv-DSA should be reserved for cooperative patients with reasonable good cardiac-output. Unfortunately, a significant percentage of patients with carotid artery disease has also coronary artery disease. Even in cooperative patients, misregistration artifacts from involuntary swallowing or pulsating calcified plaques can obscure important pathologic findings in the carotid bifurcation. This occurs in as many as 10% of all studies. The simultaneous, not selective opacification of all arterial brachiocephalic branches may pose problems due to vessel-overlap [8]. The relatively low arterial iodine-concentration (5–15 mg J/ml) achieved by venous injection-techniques leads to a poorer spatial resolution (about 1.5 linepairs/mm) as compared to ia-DSA. As the total dose of contrast-medium is limited, the radiologist is usually restricted to 4 or 5 injections, which can be disappointing, when the runs are unsatisfactory owing to suboptimal positioning, motion artifacts or equipment malfunction. This may happen not only in patients who are examined in the cervico-cranial region but also in renal iv-DSA and in distal run-off studies.

With these disadvantages of iv-DSA and the availability of small sized catheters, which allow arterial studies in outpatients, some investigators questioned the justification for iv-DSA.

At our institution iv-DSA is for example used in patients with asymptomatic carotid bruits and equivocal Doppler-tests. Iv-DSA can also easily differentiate an ectatic carotid or subclavian artery from an aneurysm or some other pulsatile neck masses, it can demonstrate clearly proximal stenosis and occlusions (Fig. 1) of the brachio-cephalic vessels, such as in a subclavian-steal syndrome. Iv-DSA can assess sufficiently postoperative conditions e.g. carotid arterectomies, grafts between the subclavian and the carotid arteries and the state of large occluded or ligated intracranial aneurysms or arterio-venous malformations [9, 10].

Table 1. Iv-DSA carotid bifurcation* – image quality.**

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<tr>
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<th>Right %</th>
<th>Left %</th>
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<tbody>
<tr>
<td>Good</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td>Fair</td>
<td>25</td>
<td>20</td>
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<tr>
<td>Not diagnostic</td>
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* Pulsed mode, not triggered.
** 8% of the examinations were excluded (low cardiac output).

Fig. 1. Cerebrovasc. Insuff. II; iv-DSA of the cranial vessels: Complete occlusion of the left internal carotid artery, no major obstruction of the right internal carotid artery and the vertebral arteries.