New developments in imaging and treatment of intracranial aneurysms

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Citation for published version (APA):

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Chapter 1

Introduction
In the past two decades, new techniques in imaging and treatment of intracranial aneurysms have been introduced that greatly influenced clinical practise.

Since the introduction of detachable coils in the early nineties of the last century, the endovascular treatment of intracranial aneurysms has largely overtaken the surgical approach. Coiling has several advantages over surgery: it is less invasive, has better outcome, and can be performed in patients with acutely ruptured aneurysms in poor clinical condition. The only disadvantage of coiling is the possibility of reopening of the aneurysm with time due to coil compaction necessitating additional coil treatment. This occurs in about 10% of coiled intracranial aneurysms and imaging follow up of all coiled aneurysms is mandatory. Follow up angiography is invasive and is associated with patient discomfort and relatively high costs. Non-invasive imaging with sufficient resolution to replace follow up angiography would be welcomed by patients and institutions.

In an attempt to reduce the reopening rate of aneurysms after coiling, several new types of coils, coated with "biologically active" substances, have been developed. These substances were intended to accelerate the natural biological processes involved in cellular proliferation and healing of the aneurysm orifice on the parent artery thereby reducing the risk of reopening.

Parallel to this dramatic change in aneurysm therapy, improvements in imaging of intracranial aneurysms has facilitated diagnosis and follow up. Digital subtraction catheter angiography (DSA) has moved to a higher level owing to the introduction of 3D Rotational Angiography (3DRA). With this technique, high resolution 3D images of the cerebral vessels can be acquired that can be freely rotated. With 3DRA, small aneurysms are more easily depicted and evaluation of local aneurysm anatomy is more reliable. With use of 3DRA, time-consuming evaluation of aneurysm anatomy with multiple 2D projections is redundant. With 3DRA new angiographic insight in anatomic variations such as arterial fenestrations is offered. Another major step forwards is the development of non-invasive angiographic imaging techniques with CT and MR. CT is performed with increasing multi-slice techniques and MR with increasing field strength. With CT Angiography (CTA) and MR Angiography (MRA), imaging of cerebral vessels can be performed without the need for catheterization and with less patient discomfort. Image resolution of CTA and MRA is not yet sufficient for reliable aneurysm depiction and evaluation of anatomy in the acute setting of aneurysm rupture but can play a major role in follow up imaging after treatment and in screening. The increased use of CT and MRI in general has resulted in detection of more asymptomatic intracranial aneurysms. In the decision whether or not to treat these incidentally found aneurysms, risk of rupture has to be balanced against the risk of treatment.
The aim of this thesis is to describe consequences for diagnosis, treatment and imaging follow-up in some aspects of these new developments in imaging and treatment.

In chapter 1, we compared a newly developed coil coated with transforming growth factor-β (TGF-β) with a standard platinum coil in a rabbit model for cellular proliferation on the transition of aneurysm and parent artery.

In chapter 2, we clinically evaluated another new type of coil with interwoven polyglycolic/polyactid (PGLA) microfilament threads in 101 aneurysms and results were compared to historical results of aneurysms treated with standard coils.

In chapter 3, we evaluated the clinical results of coiling of 58 asymptomatic aneurysms in 48 patients, discovered on CT or MRI performed for reasons unrelated to the aneurysm. Treatment complications and results of follow-up were compared with natural history of patients with incidental aneurysms that were not treated. In addition, clinical decision making in indication for treatment or non treatment was observed.

In chapter 5, we used a newly installed MRI at 3.0 Tesla as mid term imaging follow up in 39 patients with unruptured large and giant carotid artery aneurysms that presented with symptoms of mass effect and were treated with therapeutic carotid artery occlusion. In particular, we assessed whether aneurysm size decreased with time and sought to find a relation with evolution of clinical symptoms.

In chapter 6, we used a newly developed high resolution 3.0 Tesla MRA protocol to assess the incidence of de novo aneurysm formation and growth of existing untreated aneurysms in 39 patients mid-term after therapeutic carotid artery occlusion for carotid artery aneurysms.

In chapter 7, we used 3D Rotational Angiography to assess the incidence of visible fenestrations of the anterior communicating artery and evaluated the relationship with aneurysms on this location.

In chapter 8, we evaluated whether introduction of 3D Rotational Angiography, among other factors, reduced procedural time of coiling. Procedural time of coiling of 642 aneurysms was assessed and risk factors for long procedural time were sought for.

In chapter 9, a summary of this thesis is provided.