Long term follow-up of patients with coiled intracranial aneurysms
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Chapter 11

Main findings and general discussion
Main Findings and General Discussion

Endovascular treatment with coils has become an established treatment modality for both ruptured and unruptured intracranial aneurysms. Coiling has several shortcomings. Not all aneurysms can be occluded completely at first treatment, leaving the patient at risk for early recurrent hemorrhage in case of a recently ruptured aneurysm. Another drawback is the possibility of reopening with time of an initially adequately occluded aneurysm as a result of coil compaction, aneurysm growth or dissolution of an intraluminal thrombus. Follow-up imaging is therefore highly recommended.

The standard follow-up imaging modality after coiling is angiography, but this diagnostic procedure is invasive, uses ionizing radiation, and exposes the patient to a small risk of serious complications. Magnetic resonance angiography (MRA) has been used as an alternative non-invasive imaging modality to assess occlusion of coiled intracranial aneurysms with promising, but not yet conclusive results. In Chapter 2 we compared catheter angiography with 3T MRA. We demonstrate that non-invasive 3D time-of-flight technique (TOF-MRA) at 3T is feasible in the follow-up of coiled intracranial aneurysms, for the detection of reopenings and remnants. In Chapter 3 we demonstrated that TOF-MRA and contrast enhanced MRA (CE-MRA) at 3T are equivalent in evaluating the occlusion status of coiled intracranial aneurysms. Because TOF-MRA does not involve contrast administration, this method is preferred over CE-MRA. TOF-MRA may replace angiography in the majority of patients for the follow-up of coiled intracranial aneurysms.

In Chapter 4 we found in a review of 46 published studies that at initial treatment more than 90% of the aneurysms are adequately occluded. Reopening of coiled intracranial aneurysms occurs in 20% and half of these aneurysms are retreated. The other half is not retreated because of the reopening is small, has an unfavorable geometry for additional coiling or retreatment is not judged indicated in the clinical context. Possible risk factors for reopening are location of the aneurysm in the posterior circulation and size of the aneurysm > 10 mm.

An important issue is the timing of occurrence of reopening after coiling. Can an aneurysm that is adequately occluded at 6 months still reopen at a later point in time? In Chapter 5 we performed a long-term multi-center follow-up study (LOTUS) focusing on patients with coiled aneurysms that were adequately occluded at 6 months angiographic follow-up. In 104 patients with 111 coiled aneurysm mean 6 years after coiling only one aneurysm needed additional treatment. We concluded that, when an aneurysm is adequately occluded at 6 months, the chance of reopening needing retreatment in the next 5-11 years is very low.

In Chapter 9 we assessed the incidence of recurrent subarachnoid hemorrhage (SAH) long-term after coiling in 283 patients with coiled ruptured aneurysms that were adequately occluded at 6 months. In addition, this incidence was compared with the incidence of recurrent SAH after clipping of ruptured aneurysms. In the subgroup of patients with coiled aneurysms that are adequately occluded at 6 months the risk of recurrent SAH was lower than after clipping.

Another reason for the need for imaging follow-up is the increasing awareness that an aneurysm might be an expression of a general disease of the intracranial arteries and not a once in a lifetime event. Many patients presenting with an aneurysm have multiple aneurysms. In Chapter 10 we compared 3D angiography to conventional 2D angiography for the detection of additional aneurysms and found that more additional aneurysms are detected with 3D angiography. When possible, additional aneurysms are treated but many are not, mostly because of small size and presumably a low rupture risk. However, these small aneurysms can grow and since the risk of rupture increases with size, prolonged imaging follow-up is advocated to detect growth. In addition,
on diseased intracranial arteries new aneurysms can develop later in time that can also become a source of recurrent SAH.

Little is known about the pace of growth of untreated additional aneurysms and the frequency and timing of development of new aneurysms and thus for need for and timing of long-term imaging follow-up for these aneurysms. In Chapter 6 we selected a subgroup of 65 patients with exact 5 year MRA follow-up after coiling from LOTUS to assess whether de novo aneurysms develop in the first 5 years after coiling. In 65 patients, 1 small de novo aneurysm had developed. Of 19 additional untreated aneurysms, 1 had slightly grown and 18 were unchanged. No therapy for these aneurysms was judged indicated. In Chapter 7, 26 patients with aneurysms treated with internal carotid artery occlusion, were followed with MRA. After a mean follow-up of 4.1 years, no de novo aneurysms were found despite increased hemodynamic stress in the circle of Willis after carotid occlusion. The results of these two studies indicate that in the first 5 years after coiling both the risk of de novo aneurysm formation and the risk of growth of existing untreated aneurysms is very low. As a consequence, the risk of SAH from such aneurysms is extremely low. It seems safe to refrain from imaging follow up to detect de novo aneurysms and growth of existing aneurysms in the first 5 years.

Although the first results of our studies strongly suggest that patients with adequately occluded aneurysms do not need prolonged imaging follow-up, not enough data are available and larger studies, preferably with fixed follow-up intervals, are needed to identify subgroups of patients with adequately occluded coiled aneurysms at 6 months that behave differently and might benefit from screening within or at 5 years. For example, some very large and giant aneurysms and partially thrombosed aneurysms may suddenly reopen after a long period of stable adequate occlusion. Also aneurysms that are additionally coiled after reopening may reopen again. In these subgroups regular MRA follow-up (every 1-3 year) may be considered. More frequent and prolonged follow-up might also be considered in patients with increased risk such as young patients with multiple aneurysms, patients with a positive family history or patients with proved growth of additional aneurysms. A proposed imaging follow-up scheme is provided in Figure 1. Whether or not patients might benefit from screening beyond the 5-10 year interval is an unsolved issue. A consideration in offering very late follow-up imaging is that from the patients’ perspective, screening may work two-sided: in patients with fear for new aneurysms it may increase quality of life when no such aneurysms are found but it may have a negative impact when new aneurysms are detected that remain untreated.

In summary, for the large subgroup of patients with coiled aneurysms that are adequately occluded at 6 months, prolonged imaging follow-up is not needed since the risk of SAH from reopening of the coiled aneurysm, development of de novo aneurysms or growth of existing untreated aneurysms is extremely low. Further studies are needed to identify subgroups of aneurysms that behave differently.
Figure 1
Proposed imaging follow-up schema after coiling of intracranial aneurysms
* for possible exceptions see text