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Aneurysm Retreatment after Guglielmi Detachable Coil and Nondetachable Coil Embolization: Report of Nine Cases and Review of the Literature

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Outline

Abstract

OBJECTIVE: Guglielmi detachable coil embolization of cerebral aneurysms is becoming increasingly used to manage certain intracranial lesions based on aneurysm geometry, patient condition, and patient and surgeon preferences. Aneurysm recurrences or incomplete initial treatments are not uncommon making repeat treatment necessary using either surgical or endovascular techniques.

Between January 1993 and June 1998, 1025 cerebral aneurysms were managed by the authors at a single hospital. One hundred twenty-four of these lesions were treated using Guglielmi detachable coils, and one was managed with nondetachable coils. During the follow-up period, eight patients who underwent embolization at our institution and one who underwent embolization elsewhere received repeat treatment. Five were approached surgically, and four underwent re-embolization. All charts and films were reviewed retrospectively to determine patient outcome and clinical success.

RESULTS: No patient in the subgroup of this clinical study suffered a permanent complication from initial aneurysm coiling, no episodes of subsequent bleeding occurred, and no complications resulted from any subsequent therapies. The anatomic results were excellent, and all aneurysms were totally or near totally obliterated.

Subtotal initial coil embolization of aneurysms can be managed safely using a variety of surgical and endovascular techniques. Our approach to this predicament, lessons we have learned, and a review of the literature are herein discussed.

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Since 1990, aneurysm embolization using the Guglielmi detachable coil (GDC) system has been discussed as an alternative to surgical clipping in selected cases. The criteria for such selection may include aneurysm configuration, aneurysm location, the patient's medical and neurological condition and age, available surgical and interventional abilities at the treatment center, and patient preference. A number of publications have documented relatively favorable results during a 5-year period of aneurysm coil embolization using the GDC system (1-12,14-29). Subsequent bleeding rates seem, during this short follow-up period, to be between 1 and 2%, despite less than total lesion occlusion in a large number of cases. Many articles document retreatment of subtotally occluded or recanalized lesions (1-3,5,7-10,12-14,17-25,28). Several articles mention surgical management of recurrent or partially treated lesions (1,2,4,5,8,9,13,14,18,25,28); however, only three studies go into any detail relating to surgical strategy (4,9,18). We report eight additional cases of aneurysm treatment after initial treatment with the GDC system and one case of aneurysm retreatment after embolization with traditional nondetachable coils. Five of these cases were managed surgically, and four were managed with additional embolization.

METHODS

A retrospective review of the Southwestern Medical Center aneurysm registry was conducted to identify those aneurysms initially treated using the GDC system and subsequently retreated using GDC embolization or surgical clipping. Data relating to patient age, sex, Hunt and Hess score, Fisher grade, aneurysm location, size, and geometry, medical history, and treatment specifics were collected. All arteriograms and operative notes were reviewed. A Medline review of the English literature was then conducted to assess the published experience relating to aneurysm retreatment after GDC embolization.

PATIENT POPULATION

Between January 1993 and June 1998, 1025 cerebral aneurysms were treated at Zale-Lipshy University Hospital, a part of the University of Texas Medical Center in Dallas. GDC embolization was used to treat 124 of these, and nondetachable coils were used to treat 1. During the same period, nine patients were treated for residual or recurrent aneurysms after GDC embolization. Eight patients had initially undergone coiling at our institution, and one had been managed elsewhere. Five of these were retreated surgically, and four underwent re-embolization.

CASE REPORTS

Patient 1

A 77-year-old woman presented with an unruptured giant basilar apex aneurysm (Fig. 1A). Her medical history was significant for chronic obstructive pulmonary disease, hypertension, and pleural effusions. Nondetachable coil embolization was performed, and immediate post-treatment angiograms demonstrated residual filling of the entire aneurysm neck (Fig. 1B). Follow-up angiography performed 6 weeks later revealed coil compaction with a small amount of fundal opacification (Fig. 1C). Repeat embolization was performed, resulting in near-total occlusion,

with a 1- to 2-mm dog ear remaining (Fig. 1D). The patient did not want further follow-up. She remained with a Glasgow Outcome Scale (GOS) score of 1.

Patient 2

A 58-year-old man presented with a Hunt and Hess Grade IV subarachnoid hemorrhage secondary to a 10-mm vertebral confluens aneurysm with a 3-mm neck. Hydrocephalus was not present. In addition to his poor neurological grade, the patient suffered from chronic obstructive pulmonary disease, pleural effusions, and a recent respiratory arrest. GDC embolization was performed, leaving a small residual portion of the aneurysm neck measuring approximately 1 mm (Fig. 2). A small amount of proximal fundal filling was seen on the immediate post-GDC arteriogram. Within 2 weeks, the patient was following commands. Repeat angiography revealed continued neck and fundal opacification. The residual aneurysm neck was clipped by means of a suboccipital craniotomy, temporary aneurysm trapping, coil extraction from the fundus, and clip application. At last follow-up, the patient remained with a GOS score of 3.

Patient 3

A 41-year-old man was referred from another institution with an unruptured 15-mm left superior cerebellar artery (SCA) aneurysm with a 5-mm neck and a left basal ganglia arteriovenous malformation (no images available). The patient was to receive focused radiosurgery to the arteriovenous malformation at the outside facility and wanted his aneurysm treated without undergoing a craniotomy. GDC embolization resulted in immediate 100% obliteration. Three months later, the preradiosurgery arteriogram demonstrated recurrent aneurysm with slight opacification of the proximal fundus secondary to coil compaction. Repeat coiling was performed, resulting in near-complete occlusion. Follow-up arteriography performed at 3 and 36 months demonstrated no aneurysm recurrence (Fig. 3). The arteriovenous malformation remained despite radiosurgery. The patient remained with a GOS score of 1.

Patient 4

A 52-year-old woman was referred for embolization from an outside institution with an 8-mm unruptured left internal carotid artery (ICA) bifurcation aneurysm with a 3-mm neck, a 3-mm unruptured left SCA aneurysm, and a 4-mm unruptured right posterior communicating artery aneurysm (Fig. 4A). The patient underwent coiling of the left ICA and SCA aneurysms during a single procedure while under general endotracheal anesthesia. The former was left with a 1-mm residual dog ear and fundal opacification (Fig. 4B). While introducing the first T10 soft 2 mm x 4-cm coil into the SCA aneurysm, the aneurysm ruptured (Fig. 4C). The coil was detached, and extravasation ceased. No additional coils could be delivered because of the aneurysm's size and configuration. The patient suffered no significant neurological sequelae. One week later, repeat arteriography was performed and demonstrated complete ICA bifurcation aneurysm occlusion and residual filling of the SCA aneurysm. The patient was taken to the operating room. Via a left pterional craniotomy and trans-sylvian exposure, the aneurysm was completely trapped with temporary aneurysm clips on the basilar artery and both SCAs and posterior cerebral arteries. The aneurysm fundus was incised, the

coils were extracted, and the lesion was occluded with a single bayoneted Yasargil clip. A normal Doppler signal was auscultated from the efferent and afferent vessels. Ten minutes and thirty seconds of occlusion time under pentobarbital burst suppression with hypertension was required to achieve the clipping. The patient remained with a GOS score of 1 and has since undergone clipping of the right posterior communicating artery aneurysm and repeat arteriography at 15 months, which showed complete aneurysm clippings and no change in the coiled lesion (Fig. 4D).

Patient 5

A 54-year-old woman presented with Hunt and Hess Grade III subarachnoid hemorrhage secondary to an 8-mm left pericallosal-callosomarginal junction aneurysm (Fig. 5A). The patient's medical history was significant for hypoxia, cardiomegaly, and a large pericardial effusion, which required the emergent creation of a pericardial window. Immediately after the pericardial window was created, the patient underwent GDC embolization. Modest fundal opacification was evident after the procedure (Fig. 5B). A full neurological and cardiac recovery ensued. Angiographic follow-up 5 months later demonstrated significant recurrent aneurysm secondary to coil compaction (Fig. 5C). It did not seem that the residual aneurysm was amenable to repeat embolization because of its shape and because a single loop of coil appeared to extend into the parent vessel. The patient was brought to the operating room, and the aneurysm was approached through a midline interhemispheric exposure. Proximal and distal control was obtained. A study of the aneurysm demonstrated a loop of coil within the pericallosal vessel and a loop of coil extending out of the aneurysm fundus into the subarachnoid space. The coils appeared to be densely adherent to the intima, implying that any attempt at removal might lead to vessel rupture. The residual aneurysm, therefore, was clipped with a single clip, and all coils were left in place. Temporary occlusion was not required. An excellent Doppler signal was auscultated from the efferent and afferent vessels before closing. Follow-up angiography demonstrated near-complete aneurysm obliteration with some questionable residual aneurysm posterior to the clip blades (Fig. 5D). The patient remained with a GOS score of 1.

Patient 6

A 72-year-old woman presented with an unruptured 15-mm right ophthalmic artery aneurysm (Fig. 6A). Her medical history was significant for bronchitis and a myocardial infarction 1 year earlier. GDC embolization of the lesion resulted in significant residual fundal filling (Fig. 6B). Complete aneurysm treatment could not be achieved because of coil herniation into the parent vessel. Six months later, repeat arteriography demonstrated coil compaction with additional residual anerysm (Fig. 6C). Repeat coil embolization resulted in complete aneurysm obliteration (Fig. 6D). The patient remained with a GOS score of 1.

Patient 7

A 37-year-old woman presented with an unruptured right superior hypophyseal artery aneurysm, measuring 6 mm in greatest dimension (Fig. 7A). The patient opted for nonsurgical treatment, and GDC embolization yielded some residual

fundal opacification (Fig. 7B). Repeat angiography performed 6 months later demonstrated aneurysm recurrence secondary to coil compaction and possible aneurysm growth (Fig. 7C). Repeat coiling was attempted but was unsuccessful because of coil herniation into the parent vessel. Balloon remodeling was not attempted. The patient was taken to the operating, room where the aneurysm was exposed via a right pterional craniotomy and anterior clinoid resection. Residual aneurysm could be seen proximal to the coils. No attempt was made to remove the coils from the fundus, and the lesion was obliterated with a single straight fenestrated Yasargil clip with the coil mass within the fenestration and the clip blades across the residual aneurysm neck and fundus. A postoperative arteriogram demonstrated no residual lesion (Fig. 7D). The patient remained with a GOS score of 1.

Patient 8

A 69-year-old woman was initially treated at an outside institution with GDC embolization of a ruptured 6-mm anterior communicating artery aneurysm (images not available). Repeat arteriography performed several months later demonstrated coil compaction and residual aneurysm (Fig. 8). The patient underwent direct clipping of the aneurysm neck without the need for temporary occlusion or initial coil extraction. The aneurysm was obliterated, and the patient was discharged with a GOS score of 1. No postoperative arteriograms were obtained.

Patient 9

A 57-year-old man presented with trigeminal pain and a 20-mm left cavernous carotid aneurysm arising from the C3 segment of the vessel (Fig. 9A). The aneurysm appeared to have a wide neck, leading us to worry that an attempt at GDC embolization might lead to coil migration into the parent artery and subsequent need for vessel sacrifice and aneurysm trapping. Therefore, a 30-minute temporary balloon occlusion test was performed, which the patient passed both clinically and by single-photon emission computed tomographic cerebral blood flow study. The aneurysm was initially subtotally embolized with 115 cm of coil (Fig. 9B). Complete embolization was not possible because of the neck's size and resultant coil herniation into the ICA. Balloon remodeling was not attempted. The patient did well and achieved resolution of his pain within 3 months of the procedure. Twelve months later, a repeat arteriogram demonstrated significant coil compaction and some aneurysm growth (Fig. 9C). Repeat complete embolization with additional introduction of 150 cm of coil was performed using Moret's balloon remodeling technique (19,20) (Fig. 9, D and E). The patient remained with a GOS score of 1 and will be restudied in 6 months.

DISCUSSION

Retreatment of previously embolized aneurysms using the GDC system has been mentioned by a number of authors (1-5,7-10,12-14,17-25,28). Only three articles, however, specifically address the mechanics of aneurysm retreatment (4,9,18)

Gurian et al. (9), in 1995, reported on a series of 141 lesions that had been embolized using GDCs; 8 of the lesions required surgical procedures for aneurysm remnants. Five of these were clipped, two were bypassed and trapped, and one was

managed with Hunterian ligation. All patients achieved good to excellent results. The authors made a number of observations and suggestions relating to retreatment, as follows. 1) If additional therapy is required, repeat embolization should be attempted before considering surgical treatment. 2) Important considerations in the decision to retreat and in choosing the modality for retreatment include degree of neck occlusion, elapsed time since the previous embolization, the patient's neurological status and age, and the aneurysm's location. 3) Aneurysms without coil in the base are easier to treat with primary clipping, whereas aneurysms with coil mass in the neck are difficult to surgically clip without coil extraction. Aneurysms with small neck remnants were difficult to treat because of difficulty depositing additional coils within the remaining lesion. Observation of such lesions might be preferable to allow for coil compaction and subsequent coiling or clip application. 4) Clipping of large partially coiled aneurysms can be difficult because the coiled, relatively immobile mass makes visualization around the lesion difficult. Intraoperative angiography is valuable in such cases to permit viewing of clip position and to assess patency of parent vessels. 5) One or two coil loops in a parent vessel may be harmless in terms of thrombus or embolus generation. Attempts at coil extraction might tear the vessel if it is incorporated into the vessel wall or aneurysm fundus/neck. Such difficulty relating to coil incorporation may be seen as soon as 2 weeks after embolization. With the concept of coil incorporation in mind, the surgeon must take surgical timing into consideration when planning a subtotal embolization in a critically ill patient who improves and becomes a surgical candidate.

Civit et al. (4) once again noted that clipping was easier with initial partial fundal packing because the neck remained free of coils. Unlike Gurian et al. (9), Civit et al. (4) recommended delaying surgery 3 weeks from the time of coiling, never attempted coil removal to assist with clipping, and did not espouse the use of temporary clipping to assist with aneurysm retreatment. The author thought the goal of surgery was to occlude the aneurysm rest and therefore thought coil extraction was irrelevant if aneurysm filling could be eliminated with clip placement across the residual lesion. Civit et al. (4) did confirm the observation that at surgery, coil loops may be located extrafundally within the subarachnoid space.

We concur with many of the observations and suggestions made by Gurian et al. (9) and Civit et al. (4) and differ on others. Repeat coiling, in our opinion, is the ideal mode of treatment if the aneurysm's residual anatomy is favorable because the surgical treatment of recurrent lesions is often difficult and runs the risk of parent vessel damage or occlusion. Except on rare occasions, however, we do not favor waiting for further coil compaction to permit a nonoperative approach to the retreatment of a recurrent lesion. Although we understand that the current literature documents a 0 to 2% subsequent hemorrhage rate associated with previously ruptured lesions that are either partially or completely embolized and an even lower rate associated with unruptured lesions, the long-term (

If a partially coiled aneurysm or recurrent lesion is to be approached surgically, the basic goals of maximal exposure and early acquisition of proximal and distal control of afferent and efferent vessels is the key to successful retreatment. Unlike Civit et al. (4), we use temporary occlusion liberally in the management of both primarily and secondarily treated lesions. We assume that coil extraction will be necessary to obliterate the lesion, and we approach the aneurysm with that goal in mind. As such, complete aneurysm trapping is a prerequisite to coil removal. Once the lesion is exposed, we make a judgement regarding whether to reconstruct or clip the aneurysm with the coils in place or removed. If aneurysm neck is available and clipping is possible without stenosing the parent vessel, we favor clip application without coil removal. If part of the fundus is well filled with coils and a portion remains open, we often elect to occlude the remaining neck and fundus and leave the coils in situ. This is especially applicable in those cases in which coils were inserted weeks to months earlier and have incorporated themselves into the fundal, neck, and sometimes parent vessel wall. Coil extraction in such cases risks irreparable vessel damage. When an aneurysm has sufficient coil mass within the fundus to preclude clipping, we quickly move toward temporary trapping, fundal incision, coil removal, and neck clipping. Although this can be difficult, especially for an SCA aneurysm that requires five temporary clips for complete flow arrest, it may be the only way to leave the patient with patent vessels and an occluded lesion.

As with Gurian et al. (9) and Civic et al. (4), we too have seen coils located extrafundally and within the parent vessels without the patient's having suffered any ill effects from embolization and without any visualization of contrast extravasation during the initial treatment arteriogram. In cases involving extrafundal/transfundal coil loops, we wonder whether this finding represents perforation at the time of surgery or fundal erosion by the platinum mass. It is clear that one or two loops of coil within a parent vessel can be innocuous, and we do not think that coil removal from the parent vessel at the time of surgery is necessary, especially if the coil appears to be incorporated into the vessel wall.

CONCLUSION

In our series of 124 aneurysms that underwent embolization with GDCs and 1 lesion that underwent embolization without the use of GDCs, 8 required additional therapy. One additional case of a recurrent lesion that underwent coiling at an outside institution was referred to us for treatment, bringing our total number of retreated cases to nine. Five of these were managed surgically, and four were managed with additional GDC embolization. Surgical therapy required direct clipping without coil extraction in three cases and temporary trapping with coil extraction in two cases. For one of our four cases of re-embolization, we used the balloon remodeling technique as described by Moret et al. (19,20). Eight patients had GOS scores of 1, and the ninth patient remained with a GOS score of 3. No complications related to the secondary procedure were experienced. We agree with others that repeat therapy of partially coiled or recurrent aneurysms is more difficult than is primary

therapy. The treatment in all cases needs to be carefully planned to achieve complete control of the pathological abnormality so that aneurysm obliteration and parent vessel patency are assured.

ADDENDUM

Since the submission of our manuscript for publication, two more aneurysms underwent retreatment after incomplete coiling. One anterior communicating lesion underwent clipping without coil removal, and one superior hypophyseal artery aneurysm underwent additional coiling using the Moret balloon remodeling technique. Both lesions were completely obliterated without complication. This brings our total experience to 11 cases.

REFERENCES

1. Byrne JV, Adams CB, Kerr RS, Molyneux AJ: Endosaccular treatment of inoperable intracranial aneurysms with platinum coils. Br J Neurosurg 9:585-592, 1995. HSLS Link Resolver Search Pubmed for Abstract

2. Byrne JV, Molyneux AJ, Brennan RP, Renouden SA: Embolization of recently ruptured intracranial aneurysms. J Neurol Neurosurg Psychiatry 59:616-620, 1995.

3. Chaloupka JC, Putman CM, Awad IA: Endovascular therapeutic approach to peripheral aneurysms of the superior cerebellar artery. AJNR Am J Neuroradiol 17:1338-1342, 1996. HSLS Link Resolver Search Pubmed for Abstract

4. Civit T, Auque J, Marchal JC, Bracard S, Picard L, Hepner H: Aneurysm clipping after endovascular treatment with coils: A report of eight patients. Neurosurgery 38:955-961, 1996. Ovid Full Text HSLS Link Resolver Search Pubmed for Abstract

5. Gobin TP, Vinuela F, Gurian JH, Guglielmi G, Duckwiler GR, Massoud TF, Martin NA: Treatment of large and giant fusiform intracranial aneurysms with Guglielmi detachable coils. J Neurosurg 84:55-62, 1996. HSLS Link Resolver Search Pubmed for Abstract

6. Graves VB, Strother CM, Duff TA, Perl J II: Early treatment of ruptured aneurysms with Guglielmi detachable coils: Effect on subsequent bleeding. Neurosurgery 37:640-648, 1995. Ovid Full Text HSLS Link Resolver Search Pubmed for Abstract

7. Graves VB, Strother CM, Weir B, Duff TA: Vertebrobasilar junction aneurysms associated with fenestration: Treatment with Guglielmi detachable coils. AJNR Am J Neuroradiol 17:35-40, 1996. HSLS Link Resolver Search Pubmed for Abstract

8. Guglielmi G, Vinuela F, Duckwiler G, Dion J, Lylyk P, Berenstein A, Strother C, Graves V, Halbach V, Nichols D, Hopkins N, Ferguson R, Sepetka I: Endovascular treatment of posterior circulation aneurysms by electrothrombosis using electrically detachable coils. J Neurosurg 77:515-524, 1992. HSLS Link Resolver

Search Pubmed for Abstract

9. Gurian JH, Maratin NA, King WA, Duckwiler GR, Guglielmi G, Vinuela F: Neurosurgical management of cerebral aneurysms following unsuccessful or incomplete endovascular embolization. J Neurosurg 83:843-853, 1995. HSLS Link Resolver Search Pubmed for Abstract

10. Gurian JH, Vinuela F, Guglielmi G, Gobin YP, Duckwiler GR: Endovascular embolization of superior hypophyseal artery aneurysms. Neurosurgery 39:1150-1156, 1996. Ovid Full Text HSLS Link Resolver Search Pubmed for Abstract

11. Halbach VV, Higashida RT, Dowd CF, Barnwell SL, Fraser KW, Smith TP, Teitelbaum GP, Hieshima GB: The efficacy of endosaccular aneurysms occlusion in alleviating neurological deficits produced by mass effect. J Neurosurg 80:659-666, 1994. HSLS Link Resolver Search Pubmed for Abstract

12. Klein GE, Szolar DH, Leber KA, Karaic R, Haussegger KA: Basilar tip aneurysm: Endovascular treatment with Guglielmi detachable coils-Midterm results. Radiology 205:191-196, 1997. HSLS Link Resolver Search Pubmed for Abstract

13. Litofsky NS, Vinuela F, Giannotta SL: Progressive visual loss after electrothrombosis treatment of a giant intracranial aneurysm: Case report. Neurosurgery 34:548-551, 1994. Ovid Full Text HSLS Link Resolver Search Pubmed for Abstract

14. Malisch TW, Guglielmi G, Vinuela F, Duckwiler G, Gobin YP, Martin NA, Frazee JG: Intracranial aneurysms treated with the Guglielmi detachable coil: Midterm clinical results in a consecutive series of 100 patients. J Neurosurg 87:176-183, 1997. HSLS Link Resolver Search Pubmed for Abstract

15. Manabe H, Fujita S, Hatayama T, Suzuki S, Yagihashi S: Rerupture of coil-embolized aneurysm during long-term observation: Case report. J Neurosurg 88:1096-1098, 1998. HSLS Link Resolver Search Pubmed for Abstract

16. Marks MP, Steinberg GK, Lane B: Combined use of endovascular coils and surgical clipping for intracranial aneurysms. AJNR Am J Neuroradiol 16:15-18, 1995. HSLS Link Resolver Search Pubmed for Abstract

17. McDougall CG, Halbach VV, Dowd CF, Higashida RT, Larsen DW, Hieshema GB: Endovascular treatment of basilar tip aneurysms using electrically detachable coils. J Neurosurg 84:393-399, 1996.

18. Mizoi K, Yoshimoto T, Takahashi A, Nagamine Y: A pitfall in the surgery of a recurrent aneurysm after coil embolization and its histological observation: Technical case report. Neurosurgery 39: 165-169, 1996. Ovid Full Text HSLS Link Resolver Search Pubmed for Abstract

19. Moret J, Cognard C, Weill A, Castaings L, Rey A: Reconstruction technique in the treatment of wide-neck intracranial aneurysms: Long-term angiographic and clinical results-Apropos of 56 cases [in French]. J Neuroradiol 24:30-44, 1997. HSLS Link Resolver Search Pubmed for Abstract

20. Moret J, Cognard C, Weill A, Castaings L, Rey A: The "remodeling technique" in the treatment of wide neck intracranial aneurysms. Interventional Neuroradiol 3:21-35, 1997.

21. Nichols DA, Brown RD, Thielen KR, Meyer FB, Atkinson JLD, Piepgras DG: Endovascular treatment of ruptured posterior circulation aneurysms using electrolytically detachable coils. J Neurosurg 87:374-380, 1997. HSLS Link Resolver Search Pubmed for Abstract

22. Pierot L, Bowlin A, Castaings L, Rey A, Moret J: Selective occlusion of basilar artery aneurysms using controlled detachable coils: Report of 35 cases. Neurosurgery 38:948-954, 1996. Ovid Full Text HSLS Link Resolver Search Pubmed for Abstract

23. Raymond J, Roy D, Bojanowski M, Moumdjian R, L'Esperance G: Endovascular treatment of acutely ruptured and unruptured aneurysms of the basilar bifurcation. J Neurosurg 86:211-219, 1997. HSLS Link Resolver Search Pubmed for Abstract

24. Renowden SA, Molyneux AJ: Thrombosis of giant basilar tip aneurysms during coil embolization. AJNR Am J Neuroradiol 16:866-871, 1995. HSLS Link Resolver Search Pubmed for Abstract

25. Richling B, Grober A, Killer M: GDC-system embolization for brain aneurysms: Location, and follow-up. Acta Neurochir (Wien) 134:177-183, 1995. HSLS Link Resolver Search Pubmed for Abstract

26. Roy D, Raymond J, Bouthillier A, Bojanowski MW, Moumdjian R, L'Esperance G: Endovascular treatment of ophthalmic segment aneurysms with Guglielmi detachable coils. AJNR Am J Neuroradiol 18:1207-1215, 1997. HSLS Link Resolver Search Pubmed for Abstract

27. Tikkakoski T, Leinonen S, Siniluoto T, Koivukangas J: Isolated dissecting aneurysm of the left posterior inferior cerebellar artery: Endovascular treatment with a Guglielmi detachable coil. AJNR Am J Neuroradiol 18:936-938, 1997. HSLS Link Resolver Search Pubmed for Abstract

28. Vinuela F, Duckwiler G, Mawad M: Guglielmi detachable coil embolization of acute intracranial aneurysm: Perioperative anatomical and clinical outcome in 403 patients. J Neurosurg 86:475-482, 1997. HSLS Link Resolver Search Pubmed for Abstract

29. Zubillaga AF, Guglielmi G, Vinuela F, Duckwiler GR: Endovascular occlusion of intracranial aneurysms with electrically detachable coils: Correlation of

aneurysms neck size and treatment results. AJNR Am J Neuroradiol 15:815-820, 1994.

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