대한뇌혈관내수술학회
SKEN
Society of Korean Endovascular Neurosurgeons

2016 대한뇌혈관내수술학회

창립20주년기념
정기학술대회 및 총회

20th Anniversary of SKEN - We lead, we leap

2016.12. 3. (토)

서울성모병원 본관 지하1층 대강당

주 최 | 대한뇌혈관내수술학회　　주 관 | 대한신경외과학연구재단

모시는 글

안녕하십니까?

2016년은 우리 학회가 창립된 지 20주년이 되는 해 입니다. 앞날을 멀리 내다보시고 학회를 만들어 주신 창립회원님, 어려운 역경을 딛고 괄목성장 시켜주신 회원님 한 분 마다, 그리고 불굴의 도전정신으로 미래의 학회를 이끌어 주실 젊은 회원님 모두에게 감사의 뜻을 전하고, 학회의 무한한 발전 가능성을 직관적으로 표현하는 포스터와 브로슈어용 사진을 과연 구할 수 있을까?

한 블로거께서 제 고민을 말끔히 해결해 주셨습니다. 강원도 동해시의 추암촛대바위[주] 로 TV에서 방영되는 애국가 첫 소절의 일출장면이 바로 이 곳이랍니다.

해돋이가 시작되기 직전의 새벽이 가장 어둡다고 합니다. 20년 전 우리 학회는 불모지나 다름없는 척박한 환경에서 태동하여, 현재 뇌혈관질환 치료에 없어서는 안 될 핵심치료기법을 선도하는 장년의 학회로 성장하였으며 무한한 발전 가능성은 언제나 우리의 가슴을 설레게 합니다.

그동안 학회가 걸어온 길, 현재의 모습, 미래의 비전은 물론 각 병원/센터에서 최선을 다하여 얻은 학문적 결실과 성과가 어우러진 우리 모두의 잔치, 2016년 대한뇌혈관내수술학회 창립 20주년 기념 학술대회에 여러분 모두를 초대합니다. 꼭 참석하시어 이 뜻깊은 자리를 빛내 주십시오.

대단히 감사합니다.

2016년 12월

대한뇌혈관내수술학회 회장 성재훈

주) http://blog.daum.net/pjb1223/13349937 귀한 사진을 허락해 주신 박재봉 님께 깊이 감사드립니다.

2016~2017 대한뇌혈관내수술학회 임원진

회장

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2016~2017 대한뇌혈관내수술학회 임원진

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제6대	안성기(작고)	(전) 한림대학교 성심병원
제7대	신용삼	가톨릭대학교 서울성모병원
제8대	권오기	분당서울대학교병원
제9대	김범태	순천향대학교 부천병원

운영위원

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프로그램

08:30-08:45 Registration

08:45-09:00 Opening remark — 대한뇌혈관내수술학회 회장 **성재훈**

Congratulatory remark — 대한신경외과학회 회장 **김재민**

09:00-10:30 **Free paper I Aneurysm** — 좌장 : 단국대 **김영준,** 울산대 **권도훈**

09:00-09:09 Coil Embolization with Semi-Jailing Technique Using Microcatheter or Stent: Effort for Post-procedural Non-medication of Anti-platelet drugs — 가천대 길병원 **이용재** • 11

09:09-09:18 Endovascular Coil Embolization of Middle Cerebral Artery Aneurysm — 가천대 길병원 **최대한** • 12

09:18-09:27 Geometric Classification of Paraclinoid Aneurysms for Selection of Microcatheter in Coil Embolization — 경희대병원 **정연구** • 13

09:27-09:36 Comparison Between Balloon-Assisted and Stent-Assisted Technique for Treatment of Unruptured Internal Carotid Artery Aneurysms — 연세대 세브란스병원 **박근영** • 14

09:36-09:45 Morbidity and Mortality in Patients with Posterior Circulation Aneurysms Treated with the Pipeline Embolization Device: A Subgroup Analysis of the IntrePED Registry — 가톨릭대 인천성모병원 **장동규** • 15

09:45-09:54 Clinical Outcome of Intraprocedural Rupture of Unruptured Intracranial Saccular Aneurysm During Coil Embolization Compared with Spontaneously Ruptured Aneurysms — 동국대 일산병원 **최현호** • 16

09:54-10:03 Stent Salvage for Coil Protrusion of Ruptured Intracranial Aneurysma Report of 3 Cases – — 고려대 안산병원 **임동준** • 17

10:03-10:12 Treatment Strategy Based on Experience of Treating Intracranial Infectious Aneurysms — 울산대 서울아산병원 **박중철** • 18

10:12-10:21 Microwire/Catheter Assisted Coil Embolization for Broad Based Basilar Top Aneurysms — 순천향대 부천병원 **박종현** • 19

10:21-10:30 Neurosurgical Clipping versus Endovascular Coiling for the Treatment of Aneurysmal Subarachnoid Hemorrhage Patients in Korea: An Analysis of the National Database from 2011 to 2014 — 한양대병원 **최규선** • 20

10:30-10:50 Coffee break

10:50-11:30 **SKEN 20th Anniversary Ceremony** — 사회 : 총무이사 **유승훈**

1) Briefing of 20 year history reptort — 연보역사이사 **김태곤**

2) The past, present and future ofK SEN

Past : 초대회장 **백민우**

Present : 기획이사 **고준석**

Future : 회장 **성재훈**

창립20주년기념 정기학술대회 및 총회

2016. 12. 3. (토) 서울성모병원 본관 지하1층 대강당

11:30-12:00 **Special lecture : Invited speaker** 좌장 : 가톨릭대 **성재훈**

Professor Aquilla S Turk (The Medical University of South Caroilna) • 22

12:00-13:00 Lunch

13:00-14:00 **Symposium :"Technological advances in endovascular surgery"**

좌장 : 한림대 **이호국,** 순천향대 **김범태**

1) CFD method and its application to neurovascular diseases 강원대 기계융합공학부 **심은보** • 27

2) Assessment of intra-aneurysmal flow using DSA-based optical flow approach 가톨릭대 **정선윤** • 35

3) Cerebral aneurysm coiling simulation using patient-specific 3D printing : from lab to real angio suit • 39

부산대 **김영수**

14:00-14:30 General assembly

14:30-14:50 Coffee break

14:50-16:00 **Free paper II Ischemia** 좌장 : 가톨릭대 **신용삼,** 서울대 **권오기**

14:50-14:59 New Application of Intra-vascular Optical Coherence Tomography (OCT) in Carotid Artery Stenosis: Case Report and Review of Literature, (First Clinical Research in Korea) • 47

계명대 동산병원 **김창현**

14:59-15:08 Clinical Analysis of Endovascular Thrombectomy for Acute Ischemic Stroke in Failed IVtPA and non-IVtPA Patients • 48

인하대병원 **심유식**

15:08-15:17 Mechanical Thrombectomy with Trevo Stent Retriever in Acute Ischemic Stroke : Two-year Experience in a Single Center • 49

강동경희대병원 **신희섭**

15:17-15:26 Implications of Mechanical Endovascular Thrombectomy for Acute Basilar and Posterior Cerebral Artery Occlusion Comparison of Modified Volume Perfusion • 50

순천향대 부천병원 **신동성**

15:26-15:35 Comparison of modified Volume Perfusion Computed Tomography with Computed Tomography Angiography at mechanical thrombectomy for Acute Ischemic Stroke: Analysis of Clinical and Radiologic outcomes • 51

가톨릭대 성빈센트병원 **이호준**

15:35-15:44 Permanent Stent Deployment for Preventing Vessel Reocclusion after Mechanical Thrombectomy in Acute Ischemic Stroke • 52

을지대 을지병원 **박상필**

15:44-15:53 Stenting as a Rescue Treatment after Failure of Mechanical Thrombectomy for Anterior Circulation Large Artery Occlusion • 53

연세대 세브란스병원 **김병문**

15:53-16:02 Importance of Truncal Type Occlusion in Stentriever Based Thrombectomy for Acute Stroke • 54

연세대 세브란스병원 **김병문**

프로그램

16:00-17:12 **Free paper III AVM/AVF etc** 좌장 : 전남대 **김태선,** 을지대 **강희인**

16:00-16:09 Endovascular Treatment of Bilateral Cavernous Sinus Dural Arteriovenous Fistula: Therapeutic Strategy and Follow-up Outcome 서울대병원 **조영대** • 57

16:09-16:18 Angiography and Surgical Decision of Traumatic Carotid Cavernous Fistula with Ophthalmological Implications. A Case Report 한국원자력의학원 **조원익** • 58

16:18-16:27 A Comparison between Ultrasound-guided and Fluoroscopy-assisted common Femoral Artery Puncture in a Vascular Procedure for Diagnostic and/or Neuro-interventional Purposes 고려대 안산병원 **진성원** • 59

16:27-16:36 Several Impressive Experiences as a Beginner Neurovascular Surgeon 영남대병원 **김종훈** • 60

16:36-16:45 Initial Clinical Experience of LVIS Jr. Stent in Coil Embolization of ACA and MCA Aneurysm 가톨릭대 부천성모병원 **김성림** • 61

16:45-16:54 The Safety and Feasibility of LVIS Jr Stent 순천향대 천안병원 **오재상** • 62

16:54-17:03 Initial Experience with the New Low-profile Visualized Intraluminal Support (LVIS®D) Device in the Treatment of Intracranial Vertebral Artery Dissection 아주대병원 **임용철** • 63

17:03-17:12 Long-term Outcomes of Low-profile Visualized Intraluminal Support Device Usage in Stent-Assisted Coiling of Intracranial Aneurysm 서울대병원 **조영대** • 64

17:12-17:30 Academic award ceremony

17:30 Closing remark

Free paper I Aneurysm

좌장 : 단국대 **김영준**, 울산대 **권도훈**

Coil Embolization with Semi-Jailing Technique Using Microcatheter or Stent: Effort for Post-procedural Non-medication of Anti-platelet drugs

이 용 재 가천대 길병원

Dae Han Choi, Myeong Jin Kim, Chan Jong Yoo
Department of Neurosurgery, Gachon University Gil Medical Center, Incheon, Korea

Objective : Supporting devices such as stent or compliant balloon may be necessary for coiling of complex aneurysm. However the deployment of permanent stent is associated with the risk of thromboembolic complication and the need for prolonged dual antiplatelet therapy. The use of a compliant balloon may increase the risk of thromboembolic complication as the inflation of the balloon arrests flow in the parent artery. And unstable microcatheter introduced in aneurysmal sac may increase the risk of coil herniation, coil migration, and rupture of aneurysm.

Methods : Between November 2015 and July 2016, five patients with five unruptured paraclinoid aneurysms were treated by the semi-jailing technique. Three wide-necked aneurysms were treated by temporary stent-assisted coil embolization with the Enterprise stent. The stent was not fully deployed during the procedure and it was recaptured after detachment of the last coil. In other 2 cases, the coil delivery microcatheter was unstable due to pulsation of the parent artery. So additional Prowler Select Plus microcatheter was introduced to ipsilateral MCA for using as a scaffold for the coil delivery microcatheter.

Result : All aneurysms were obliterated successfully without any complication. The partially deployed stents were recaptured and removed without coil herniation nor stretch. And pulsation of the coil delivery catheter was reduced after supporting by scaffolding microcatheter. The antiplatelet drugs were not administered to all of the patients after the procedure.

Conclusion : The use of the permanent stent only for temporary supporting and the use of the scaffolding microcatheter are feasible, safe, and efficient.

Endovascular Coil Embolization of Middle Cerebral Artery Aneurysm

최 대 한 가천대 길병원

Dae Han Choi, Myeong Jin Kim, Chan Jong Yoo

Department of Neurosurgery, Gachon University Gil Medical Center, Incheon, Korea

Objective : "Clip first" policy for the treatment of middle cerebral artery (MCA) aneurysm has been generally accepted by most neurosurgeons, but debate on the preferred treatment of middle MCA aneurysm is ongoing. The purpose of this study is to evaluate radiologic and clinical outcomes of coil embolization of MCA aneurysm performed without the supporting devices.

Methods : Between August 2013 and October 2016, 35 patients with 36 MCA aneurysms were treated by the coil embolization by a single surgeon. Twenty-two (61.1%) aneurysms were ruptured and 14 (38.9%) aneurysms were unruptured. The aneurysms located at MCA bifurcation in 31 cases, M1 trunk in 3, anterior temporal artery in 1, and M2 inferior division in 1. Wide-necked aneurysms (dome-to-neck ratio 〈 2 and/or neck 〉 4mm) were in 33 (91.7%) cases. All of the aneurysms were treated without stent-assisted technique.

Result : Treatments were successful in all cases, including single microcatheter coiling in 24 (66.7%) cases, double microcatheter coiling in 11 (30.5%), and balloon-assisted coiling in 1 (2.8%). Immediate angiograms showed total occlusion in 26 cases, neck remnant in 6, partial occlusion in 4. Intraprocedural thromboembolism occurred in 4 (11.1%) patients, but no neurologic deficits remained in all of these patients. Intracerebral hematoma (ICH) was increased in 2 patients on postprocedural CT scan despite complete obliteration of aneurysm, and 1 of 2 ICH patients underwent stereotactic aspiration of hematoma. Two patients died from initial severe subarachnoid hemorrhage during hospitalization.

Conclusion : Our preliminary experience demonstrates that standard coil embolization for MCA aneurysm is feasible and safe.

Geometric Classification of Paraclinoid Aneurysms for Selection of Microcatheter in Coil Embolization

정 연 구 경희대병원

Yeongu Chung, M.D.[1], Seok Keun Choi, M.D., Ph.D.[1], Sung Ho Lee, M.D., Ph.D.[1], Eui Jong Kim, M.D., Ph.D.[2], Sang Bong Chung, M.D.[3]

Department of Neurosurgery[1] and Radiology[2], College of Medicine, Kyung Hee University, Kyung Hee University Hospital, Seoul, Korea Department of Neurosurgery[3], National medical center, Seoul, Korea

Objective : It is difficult to introduce and stabilize microcatheter tips into the paraclinoid aneurysms, especially in small-sized aneurysms. There are several classification systems of paraclinoid aneurysms for the purpose of surgical clipping, however, only few for endovascular coil embolization. Thus, we classified the paraclinoid aneurysms, which is arose between the roof of the carvenous sinus to the posterior communicating artery, according to the direction and location.

Methods : We retrospectively reviewed angiographic findings and procedural records of 62 patients who underwent endovascular treatment for internal carotid paraclinoid aneurysm in our institute from February 2012 to October 2016. We classified the aneurysms according to the direction which is measured as the angle of imaginary line between the medial portion of the sac and dome of aneurysms: superior (n=4), superomedial (n=3), medial (n=12), inferomedial (n=30), inferior (n=8) and lateral (n=5). And we classified the aneurysms according to the neck geography in lateral view of angiography into the three groups: proximal (n=34), mid-portion (n=19), distal (n=9). We analyzed that which microcatheter is selected and succeeded in superselection into the aneurysmal sac for each subtypes according to the direction and location of paraclinoid aneurysms. In addition, we reviewed the cases of failure with initially selected pre-shaped microcatheter, including any microcatheter exchange or application of double catheters or tailored steam-shaping catheters.

Result : In subtypes of superior (n=4) or superomedial (n=4) projected aneurysms, pre-shaped "S" is preferred and showed highly success rate of superselection into the sac of the aneurysm. Pre-shaped "C" was tried only in subtypes of inferomedial (n=7) and inferior (n=3) projected. In the analysis according to the location among the medial, inferomedial and inferior projected aneurysms which account for 80.6% of total, microcatheters which have an additional small curve at the beginning of the shapes (pre-shaped "C" or "S") were preferred in more proximal located aneurysms (n=8, 28.6%) than distal ones (zero). On the other hand, relatively obtuse curved microcatheters like as pre-shaped "45" or "90" were preferred in distal located aneurysms (n=6, 75%). There is no correlations between the success rate of superselection of aneurysm and aneurysmal neck sizes. In addition, the failure of initial microcatheter selection (n=24, 38.7%) was found to be occurred most frequently in the cases of aneurysms located in mid-portion (n=12, 50%).

Conclusion : We suggest a simple classification system according to direction and location of paraclinoid aneurysms for microcatheter selection during coil embolization. Pre-shaped "C" microcatheter could be considered with priority in aneurysms of inferomedial or medial direction and proximal location. Meanwhile, pre-shaped "45" or "90" microcatheters are advantageous for more distally located aneurysms. At last, superselection with microcatheter into aneurysms located on the mid-portion requires more attention, and steam-shaping techniques could be considered.

Comparison Between Balloon-Assisted and Stent-Assisted Technique for Treatment of Unruptured Internal Carotid Artery Aneurysms

박 근 영 연세대 세브란스병원

Keun Young Park, Byung Moon Kim, Dong Joon Kim

Severance Hospital, Yonsei University College of Medicine

Objective : To compare clinical and angiographic outcomes between balloon-assisted (BAC) and stent-assisted coiling for internal carotid artery unruptured aneurysms (ICA-UA).

Methods : A total of 227 ICA-UA in 190 patients were treated with BAC (120 patients, 141 ICA-UA) or SAC (70 patients, 86 ICA-UA. We compared characteristics of patients and ICA-UA, and clinical and angiographic outcomes between groups.

Result : Aneurysm size and neck diameter were greater for SAC than in BAC, but aneurysm volume and coil packing density were not different between groups. Immediate angiographic occlusion grade was better for BAC than for SAC. Periprocedural thromboembolic events were more frequent during SAC (11.6%) than BAC (2.4%) per aneurysm, but hemorrhagic events were the opposite (2.4% for BAC and none for SAC per aneurysm) ($p < 0.05$). At discharge, treatment-related morbi-mortality rates were 1.6% for BAC and 1.4% per patient for SAC. At clinical follow-up (BAC, 118 patients [98.3%] for a mean of 48.4 months; SAC, 69 patients [98.6%], for a mean of 37.4 months), 1 additional treatment-related infarction occurred during SAC, resulting in a modified Rankin scale score of 4. Thus, overall treatment-related morbi-mortality rates were 1.7% in BAC and 2.9% in SAC. At imaging follow-up (BAC, 135 aneurysms [95.7%] for 28.3 months; SAC, 81 aneurysms [94.1%] for 23.9 months), BAC and SAC showed stable or improved occlusion in 94.1% and 95.0%, minor recurrence in 4.4% and 2.5%, and major recurrence in 1.5% and 2.5%, respectively.

Conclusion : Both BAC and SAC were safe and effective techniques for ICA-UA. There were no differences in morbi-mortality and recurrence rates between groups.

Morbidity and Mortality in Patients with Posterior Circulation Aneurysms Treated by the Pipeline Embolization Device : A Subgroup Analysis of the IntrePED Registry

장 동 규 가톨릭대 인천성모병원

Demetrius K. Lopes [1], Dong-Kyu Jang [2], Saruhan Cekirge [3], David Fiorella [4], Ricardo A. Hanel [5], David F. Kallmes [6] , Elad I. Levy [7], Pedro Lylyk [8]

Rush University Medical Center, Neurosurgery Chicago-United States [1] ,Incheon St. Mary's Hospital, Catholic University of Korea, Neurosurgery Incheon-South Korea [2] Koru Hospital and Bayindir Hospitals, Ankara-Turkey [3] ,Stony Brook University Medical Center, Neurosurgery Stony Brook-United States [4] ,Baptist Medical Center, Neurosurgery Jacksonville-United States [5] ,Mayo Clinic, Radiology Rochester-United States [6] ,University of Buffalo, Neurosurgery Buffalo-United States [7] ,ENERI-Clinica La Sagrada Familia, Neurosurgery Buenos Aires-Argentina [8]

Objective : A subgroup analysis from the International Retrospective Study of PipelineTM Embolization Device (IntrePED)is registry was conducted to study complications associated with the treatment of posterior circulation aneurysms.

Methods : Between July 2008 - February 2013, a total of 793 patients with 906 aneurysms were treated in 17 centers. Data from 91 consecutive patients with 95 posterior circulation aneurysms at these centers were analyzed. The primary endpoint studied in this subgroup analysis was defined as any complication leading to neurologic morbidity or neurologic death. Neurologic morbidity was defined as spontaneous rupture of the target aneurysm, intracranial hemorrhage, ischemic stroke, asymptomatic parent artery stenosis, symptomatic parent artery stenosis and permanent cranial neuropathy lasting ≥7 days. The outcomes were compared among aneurysm locations, aneurysm shapes, aneurysm sizes, aneurysm rupture status, subject ages, and the number of PEDs used. Kaplan-Meier and Cox regression methods were used for the analysis.

Result : The mean aneurysm size was 13.8 mm. There were 44 (46.3%) aneurysms at the basilar artery (BA), 33 (34.7%) at the vertebral artery, 15 (15.8%) at the posterior cerebral artery, and 3 (3.2%) at the posterior inferior cerebellar artery. The median follow-up was 21.1 months (range, 0.1-60.5 months). Twelve (13.2%) patients encountered a primary endpoint event. Spontaneous rupture occurred in 1 (1.1%) patient, intracranial hemorrhage in 2 (2.2%), ischemic stroke in 6 (6.6%), and neurologic death in 7 (7.7%). The rate of neurological morbidity and neurological mortality in patients with ≥3 PED and fusiform type aneurysms were, 7/14 (50.0%) and 7/28 (26.9%), respectively. In multivariate analysis for factors associated with neurologic morbidity and neurologic mortality, use of ≥3 PEDs and fusiform shape compared with other shapes had hazard ratios (HR) of 7.77 (95% confidence interval [CI], 2.48-25.86; P = 0.0007) and 3.48 (95% CI, 1.06-13.39; P = 0.0488), respectively. The multivariate adjusted HR of aneurysm size for neurologic morbidity after PED implantation was 1.11 (95% CI, 1.04-1.18; P=0.0015), and ruptured aneurysm and patient age for neurologic mortality had HR of 8.1 (95% CI, 1.31-41.26; P=0.0197) and 1.07 (95% CI, 1.01-1.15, P=0.0262), respectively. Compared to other aneurysm location, BA aneurysm had a HR of 3.54 (95% CI, 1.12-14.18, P=0.0529) in the univariate analysis for major complications.

Conclusion : Major neurologic morbidity and neurologic mortality rates after the implantation of PEDs in posterior circulation aneurysms appear to be acceptable, and comparable to those reported with the use of conventional clipping or coiling. This post hoc analysis suggests that PED implantation may be a feasible method to treat this patient population, especially patients with non-fusiform type aneurysms. When neurointerventionists treat complex posterior circulation aneurysms, they should consider aneurysm shape, PED number, aneurysm rupture, patient age, and aneurysm size, aneurysm location before the PED placement.

Clinical Outcome of Intraprocedural Rupture of Unruptured Intracranial Saccular Aneurysm During Coil Embolization Compared with Spontaneously Ruptured Aneurysms

최 현 호 동국대 일산병원

Hyun Ho Choi, M.D.[1], Eun Jin Ha, M.D. [2], Won-Sang Cho, M.D. [2], Jeong Eun Kim, M.D., Ph.D. [2], Young Dae Cho, M.D.[3], Moon Hee Han, M.D., Ph.D.[3], Hyun-Seung Kang, M.D., Ph.D.[2]

Departments of Neurosurgery, Dongguk University College of Medicine, Dongguk University Hospital, Ilsan, Korea [1]

Objective : Intraprocedural rupture (IPR) of intracranial aneurysms is a devastating complication in endovascular treatment. The purpose of this study was to evaluate the clinical outcome of IPR in unruptured saccular intracranial aneurysm (UIA) compared to spontaneously ruptured aneurysms.

Methods : Intraprocedural rupture (IPR) of intracranial aneurysms is a devastating complication in endovascular treatment. The purpose of this study was to evaluate the clinical outcome of IPR in unruptured saccular intracranial aneurysm (UIA) compared to spontaneously ruptured aneurysms.

Result : In this series, IPR developed in 19 patients (1.4% per patient and 1.2% per aneurysm) and morbidity related to IPR was 26.3% (95% CI, 8.5%-61.4%) with no mortality. Hospitalization days (p=0.25) and Hunt Hess grades (p=0.82) were equivalent to those of patients presenting with spontaneous aneurysm rupture. Treatment procedures followed hemorrhage including endovascular vasospasm therapy, extraventricular drainage, lumbar drainage, decompressive craniectomy and permanent shunt were comparable between two groups. However, modified Rankin Scale (mRS) scores (≥2) at 6 months post-ictus of unruptured aneurysm with IPR (5.3%) were more favorable than those of patients with spontaneous aneurysm rupture (26.8%) (p=0.049).

Conclusion : The incidence of IPR was low (less than 2%) in patients with the UIAs and the clinical outcome in UIAs with IPR was favorable compared to those with spontaneous aneurysm rupture.

Stent Salvage for Coil Protrusion of Ruptured Intracranial Aneurysm a Report of 3 Cases -

임 동 준 고려대 안산병원

Dong-Jun Lim, Sung-Kon Ha, Sung-Won Jin, Won-Hyoung Kim, Seung-Hwan Lee, Se-Hoon Kim

Neurosurgery, Ansan Hospital, Korea University Medical Center

Objective : Despite recent advances in technology, parent vessel coil herniation occasionally complicates successful coil embolization, particularly in wide-necked aneurysms. We report 3 patients with endovascular stent deployment specifically to treat this complication.

Methods : Three patients with ruptured intracranial aneurysms are treated with stent salvage due to coil protrusion during endovascular coil embolization of the aneurysms. The locations of the aneurysms were anterior communicating artery, internal carotid artery, and basilar artery respectively. Coil herniation into the parent vessel happened during procedure. Endovascular stent deployment was performed to isolate the herniated portion of the coil from the parent vessel lumen.

Result : The occluded parent vessels were completely recanalized right after the deployment of the stents. The patients recovered well and follow-up angiographies demonstrated no aneurysm recanalization and no stenosis of the parent vessel in the stented region.

Conclusion : The use of intraluminal stents has been reported to be a helpful technical adjunct to the conventional endovascular treatment of aneurysms. One additional indication for the use of this technology is sequestering herniated coils from the lumen of the parent artery to reduce potential embolic or occlusive sequelae.

Treatment Strategy Based on Experience of Treating Intracranial Infectious Aneurysms

박 중 철 울산대 서울아산병원

박중철, 박원형, 안재성, 권병덕, 이덕희

울산대학교 서울아산병원 신경외과, 영상의학과

Objective : Intracranial infectious aneurysms (IIAs) are a very rare but unique subtype of potentially life-threatening vascular lesion. However, there is no widely accepted standard protocol for their management. We reviewed our treatment experiences of IIAs from 2001 to 2015 and proposed a treatment strategy for future use.

Methods : We retrospectively reviewed 25 patients with 33 IIAs. All patients had predisposing infectious disease for which the causative organism had been identified.

Result : There were 12 patients with ruptured IIAs and 13 with unruptured IIAs. Of these, 17 (68%) had infective endocarditis, and viridans group streptococci (40%) were the most common causative organisms. All patients underwent antibiotic therapy and 17 IIAs in 13 patients resolved with intravenous antibiotic therapy. However, 16 IIAs in 12 patients required neurosurgical treatment, including parent artery occlusion with glue or coils, endosaccular coiling, or microsurgery. The mean size of IIAs that responded to intravenous antibiotics (4.1 ± 2.2 mm) was smaller than that for IIAs with no response (7.5 ± 3.1 mm) ($p = 0.01$). Two patients had treatment-related complications: an acute cerebral infarction after parent artery occlusion and a rupture of the IIA during antibiotic therapy. There was no recurrence or mortality.

Conclusion : All patients with IIAs should undergo appropriate antibiotic therapy. In cases with unruptured IIA, patients can be managed using medical therapy with antibiotics alone for 4-6 weeks. However, neurosurgical treatment should be considered in cases of ruptured IIA or unruptured IIA that does not respond to antibiotic therapy.

Microwire/Catheter Assisted Coil Embolization for Broad Based Basilar Top Aneurysms

박 종 현 순천향대 부천병원

JongHyeon Mun, JongHyun Park, DongSung Shin, BumTae Kim

Dept. of Neurosurgery, SoonChunHyang Univ. Bucheon Hosp.

Objective : To present the efficacy of microwire and/or microcatheter assisted coil embolization in the broad based basilar top aneurysms (BBBTA).

Methods : We investigated 6 BBBTA patients treated with stent assisted coil (SAC) embolization in our institute. Surgical plans were made according to the information of 3dimenstional rotational angiography (3DRA). In all patients, at least one stent or Y stenting has been anticipated in the operation. However, we could successfully occlude the BBBTAs by the microwire and/or microcatheter assisted coil embolization with or without a stent.

Result : 5 patients were female; 1 was male. Ages ranged from 65 to 83 years (mean: 72.3 years). 5 cases were unruptured aneurysm (UIA) and 1 case was ruptured aneurysms (RIA). The posterior cerebral artery (PCA) origin was non fetal type all. Aneurysms' neck size ranged from 3.81 mm to 10.00 mm (mean: 7.28 mm). Aneurysm's neck to wall angle was acute on right side in 2 case, left side in 4 cases. 3 patients have been performed on the right VA approach and 3 patients on the left VA. First stent was deployed in 5 cases. Microwire assisted in all cases and microcatheter assisted in 2 cases. Coil mass was stable on follow up study of Skull series(3m), MRA(6m), and 3DRA(1y).

Conclusion : The anticipated Y stenting can be performed with or without a stent in the SAC for the BBBTA. Careful use of microwire and/or microcatheters support could cover the neck BBBTA effectively.

Neurosurgical Clipping versus Endovascular Coiling for the Treatment of Aneurysmal Subarachnoid Hemorrhage Patients in Korea: An Analysis of the National Database from 2011 to 2014

최 규 선 한양대병원

최규선[1], 이형중[1], 정진환[1], 한명훈[1], 김재민[1], 이선희[2],김진희[3], 이지성[4]

[1]한양대의료원신경외과, [2]가천대학교간호대학, [3]조선대학교간호대학, [4]서울아산병원임상연구센터, [2]가천대학교간호대학, [3]조선대학교간호대학, [4]서울아산병원임상연구센터

Objective : Randomized trials have demonstrated a clinical benefit for the endovascular treatment of ruptured intracranial aneurysms. We investigated the association of the different treatment modalities of aneurysmal subarachnoid hemorrhage (SAH) with clinical outcomes from the national database.

Methods : A national health insurance database was used to identify a cohort of patientswith newly diagnosed aneurysmal SAH between January 2011 and December 2014. Data for the patients were extracted from the Korean Health Insurance Review and Assessment Service database. Data included patient age, sex, health insurance type, co-morbidities, medical cost, and hospital stay duration. Hospital stay duration and medical costs per person during the first admissions were evaluated. In addition, survival rates and shunt rates of aneurysmal SAH patients according to the treatment modalities.

Result : Of the 21,407 patients undergoing treatment, 9,922 (46.3%) underwent coiling, and 11,485 (53.7%) underwent clipping. Median age of all patients was 55 (men with 51 and women with 59). The coil-to-clip ratio increased from 0.69 to 1.12.The incidence rate of undergoing clipping or coiling for aneurysmal SAH were not changed during the study period. Total average first hospital stay duration 20d (range, 12-29), and median length of stay was shorter in coiling group (17, 10-27 vs. 21, 14-29). In-hospital mortality of all patients was 9.0%, and clipping group showed a survival benefit (7.5% vs. 10.8%).Treatment modality, sex, and age (each 10-year increase) were significantly affected in-hospital mortality in multivariate analysis.

Conclusion : Using a national database of patients in Korea presenting with aneurysmal SAH,our results indicate a change in the practice pattern for Korea during the observation period. Although clipping was associated with a low rate of in-hospital mortality, it was associated with a high rates of 30-day readmission, discharge to other facility and ventricular shunt placement.

Special lecture : Invited speaker

좌장 : 가톨릭대 **성재훈**

Professor Aquilla S Turk
(The Medical University of South Caroilna)

Aquilla S. Turk, III, DO

Medical University of South Carolina (MUSC)
Department of Radiology
96 Jonathan Lucas St. CSB 210
Charleston SC, 29425

PHONE : (843) 792-9226
FAX : (843) 876-2812
EMAIL : turk@musc.edu

▶ FACULTY APPOINTMENTS

July 2013 - Present	Professor, Director, Neuroendovascular Surgery Medical University of South Carolina 96 Jonathan Lucas St. CSB 301 Charleston, SC 29425
October 2007 - July 2013	Associate Professor, Director Interventional Neuroradiology Medical University of South Carolina 96 Jonathan Lucas St. CSB 301 Charleston, SC 29425
November 2003 - October 2007	Assistant Professor (CHS) University of Wisconsin Hospital and Clinics 600 Highland Ave., E1/320 Madison, WI 53792

▶ EDUCATION

July, 2000 - June, 2001	Accredited Fellow, Neuroradiology, University of Wisconsin Hospital and Clinics, Madison, Wisconsin
July, 1997 - June, 2000	Residency, Diagnostic Radiology, University of Wisconsin Hospital and Clinics, Madison, Wisconsin
July, 1997 - June, 2000	Residency, Diagnostic Radiology, University of Wisconsin Hospital and Clinics, Madison, Wisconsin
July, 1996 - June, 1997	The Cleveland Clinic Foundation, Department of Diagnostic Radiology, Cleveland, Ohio. Radiology Resident

▶ GRANT FUNDING

On-going Research Support

Investigator Initiated Research Grant Turk (National PI) 2015-2018
COMPASS The primary objective of this randomized trial is to demonstrate the direct aspiration as a first-line approach (ADAPT) is not inferior to that of conventional first-line stent retriever approach in Acute Ischemic Stroke (AIS) patients within 6 hours of symptom onset. This study is sponsored by Penumbra

Investigator Initiated Research Grant Turk (National PI) 2014–2018
COAST The primary objective of this post–marketing Study is to assess the clinical and imaging outcomes in the endovascular treatment of small (≤ 4.9 mm) intracranial aneurysms utilizing the HyperSoft® 3D (and HydroSoft® 3D, when commercially available) and HyperSoft® helical coils specifically designed for the treatment of small aneurysms. This study is sponsored by Microvention

Investigator Initiated Research Grant Turk (National PI) 2013–2018
POSITIVE – Perfusion Imaging Selection of Acute Stroke Patients for Endovascular Therapy. This is an FDA–approved prospective randomized multicenter trial evaluating the benefit of endovascular therapy for IV tPA ineligible patients, selected by perfusion imaging, presenting from 6–12 hours post–onset. This study is sponsored jointly by Stryker Neurovascular, Covidien and Penumbra

Investigator Initiated Research Grant Turk (National PI) 2012–2018
LARGE Aneurysm Randomized Trial – Flow Division Verses Traditional GDC Based Endovascular Therapy. This is a prospective randomized multicenter trial evaluating the benefit of performing aneurysm embolization with traditional coil techniques versus with flow diversion for on–label flow diversion technologies. This study is sponsored jointly by: Stryker Neurovascular, Penumbra, Microvention and Codman Neurovascular

▶ Completed Research Support

Sponsor Initiated Research Grant Turk (PI) December 2015
Microvention Animal Training. Study was sponsored by Microvention

Sponsor Initiated Research Grant Turk (PI) April 2015
SilkRoad Medical Animal Lab. Study was sponsored by Silk Road

Sponsor Initiated Research Grant Turk (PI) January 2014
Medina Medical Canine Coiling. Study was sponsored by Medina Medical.

Sponsor Initiated Research Grant Turk (PI) September 2013
Stryker SOW4. Study was sponsored by Stryker

Sponsor Initiated Research Grant Turk (PI) January 2013 – July 2013
Stryker SOW2. Study was sponsored by Stryker

Symposium : "Technological advances in endovascular surgery"

좌장 : 한림대 **이호국**, 순천향대 **김범태**

1) CFD method and its application to neurovascular diseases
강원대 기계융합공학부 **심은보**

2) Assessment of intra-aneurysmal flow using DSA-based optical flow approach
인제대 **정선윤**

3) Cerebral aneurysm coiling simulation using patient-specific 3D printing : from lab to real angio suit
부산대 **김영수**

심 은 보 (Shim, Eun Bo)

▶ **학력**

서울대학교 공과대학 기계설계학과, 1987. 2. 공학사
한국과학기술원(KAIST) 기계공학과, 1990. 2. 공학석사 (전공: 유체역학)
한국과학기술원(KAIST) 기계공학과, 1994. 8. 공학박사 (전공: 전산유체역학)
일본 京都大學(교토대학) 대학원 의학연구과, 2008.3. 의학박사 (전공: 심혈관 생리학)

▶ **경력**

삼성SDS(주), 선임연구원 (1994.8–1995.3)
미국 MIT 기계공학과 Post Doc (1998.1–1999.2)
미국 Harvard–MIT Health Science & Technology, Researcher (2002.2–2003.2)
교육과학기술부 지정 국가지정연구실(NRL) 연구책임자, (2008.6.– 2013.5)
한국연구재단 기초연구본부 공학단 전문위원 (2010. 5–2012. 5)
강원대학교 기계융합공학부, 부교수, 교수 (2003.3. – 현재)

▶ **학회활동**

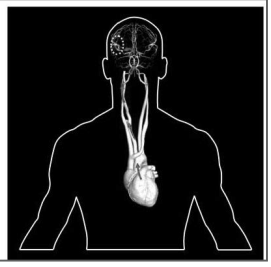
대한기계학회 바이오공학부문 이사, 부회장 (2009년 1월 – 현재)
순환기질환의공학회 총무이사, 편집이사, 부회장 (2007년 1월부터 – 현재)

CFD method and its application to neurovascular disease

심 은 보
강원대 기계융합공학부

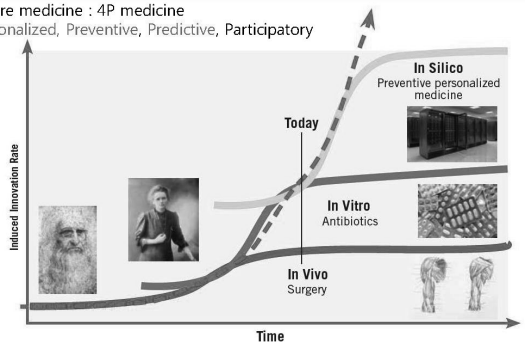
CFD method and its application to neurovascular diseases

2016. 12. 3.
Kangwon National University
Eun Bo Shim, PhD



In Silico Method

Future medicine : 4P medicine
Personalized, Preventive, Predictive, Participatory



The *in silico* approach will complement in vivo and in vitro testing to boost the innovation rate

ANSYS ADVANTAGE Volume IX | Issue 1 | 2015

VPH - @neurist Project

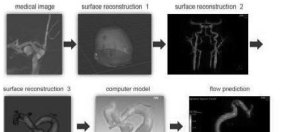
The @neurIST project is to develop a vertical and integrative approach to knowledge discovery, personalized risk assessment, patient guideline generation and treatment design for cerebral aneurysm.

- Multidisciplinary European initiative funded by the EU*
- 4-year project, budget 17 million €
- Neurosurgeons, neuroradiologists, epidemiologists, engineers, biologists and computer scientists from 32 EU institutions
- Industrial, academic and medical institutions
- Aim: improve current management of intracranial aneurysms

http://www.aneurist.org

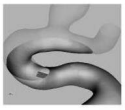
VPH - @neurist Project

Procedure of cerebrovascular CFD

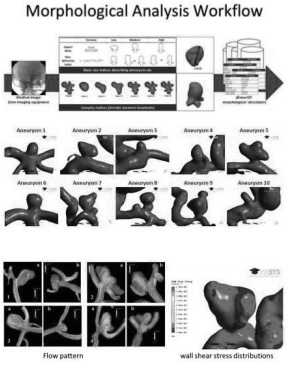


Virtual Endovascular Treatment

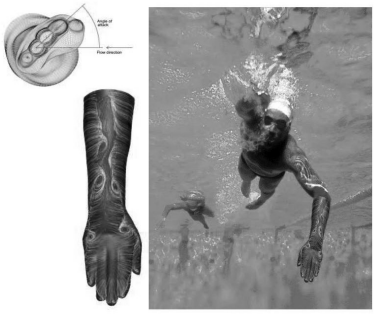
- The stent is represented by a deformable model expanding into the vascular lumen
- The stent deformation is constrained with information on the stent design (strut length, angle between struts)
- Time consumption: approximately 1 minute



Morphological Analysis Workflow



Introduction to Computational Fluid Dynamics (CFD)



What is CFD ?

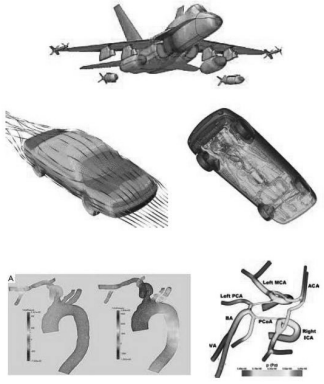
What is CFD and its objective?

- Computational Fluid Dynamics
- Historically Analytical Fluid Dynamics (AFD) and EFD (Experimental Fluid Dynamics) was used. CFD has become feasible due to the advent of high speed digital computers.
- Computer simulation for prediction of fluid-flow phenomena.
- The objective of CFD is to model the continuous fluids with Partial Differential Equations (PDEs) and discretize PDEs into an algebra problem (Taylor series), solve it, validate it and achieve simulation based design.

Where is CFD used?

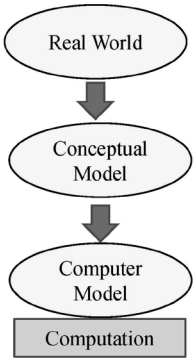
Where is CFD used?

- Aerospace
- Appliances
- Automotive
- Biomedical
- Chemical Processing
- HVAC
- Hydraulics
- Marine
- Oil & Gas
- Power Generation
- Sports



A Typical CFD Project

(PDE: Partial Differential Equation, FEM: Finite Element Method)

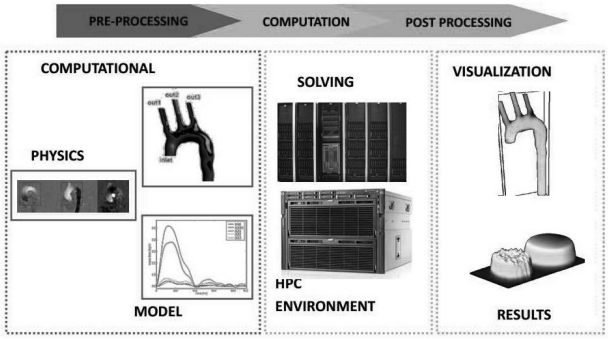


The intended application

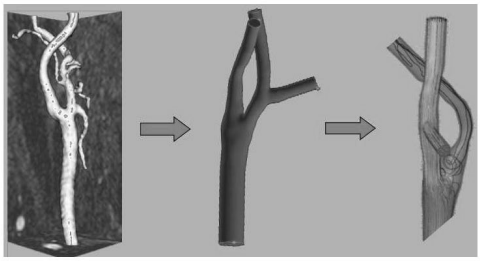
Physical laws, hypothesis and models (e.g. a set of PDEs) and initial and boundary conditions (PDE: Navier-Stokes Eqs)

A set of computational algorithms that allow to build a numerical, approximated solution to the conceptual model (Set of algebraic equations formulated by FEM)

CFD Workflow Process



Computational model



1. Image processing tools
2. Geometry modeler
3. Meshing tools
4. CFD solvers
5. Visualization tools

Commercial CFD S/W

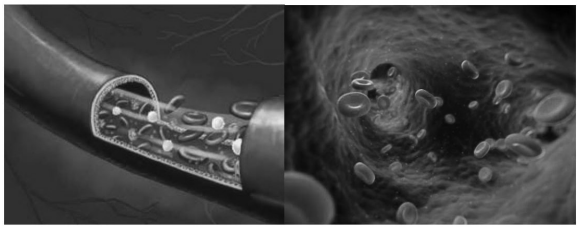
• Commercial CFD code: ANSYS FLUENT, SOLIDWORKS Flow Simulation , COSMOL, ABAQUS-simulia, PAM-FLOW, FEMAP-FLOW, Fluidyn, ADINA, NUMECA

• Features of ANSYS FLUENT:
- Mesh Flexibility (Gambit)
- Proven Solver Technology and Accurate Numerics
- Heat Transfer & Radiation Multiphase Flow
- Acoustics Fluid–Structure Interaction and Moving Mesh Solution
- Optimizer, Adjoint Solver, and Mesh Morpher
- Material Properties Customization & Project-Wide Scripting
- Post-Processing & Data Export

• Public domain software : OpenFOAM (the GNU Public License)

• Flow visualization software (e.g. Tecplot, FieldView)

CFD in Neurovascular Diseases



Large-scale Cerebrovascular Simulation using Supercomputer

Harvard Univ Hospital & Brown University, USA Karniadakis et al. 2009

- Patient-specific cerebrovascular hemodynamic simulation (Fig 1 & 2. 53 arteries, 4 inlet and 31 outlet complicated cerebrovascular model)
- Large-multi-scale modeling coupled Macro-scale (50 arteries), Meso-scale (10 million arterioles), Micro-scale(a billion capillary bed) modelling by using 0D, 1D, 3D modelling to simulate more physiologically correct cerebrovascular simulation.

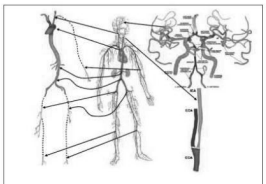


Fig 1. The human arterial tree based 3D CFD arterial models.

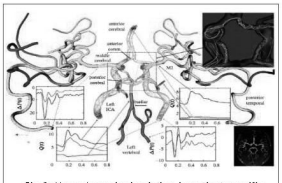


Fig 2. Hemodynamic simulation in patient-specific cerebrovascular model reconstructed from MRI.

University of Tokyo & RIKEN research centre, Japan Oshima et al. 2009

- Hemodynamic simulation in various type circle of Willis models (Fig 3)
- Influence of stenosis and occlusion in COW (Fig 3 & 4)
- Comparative study of 3D modeling and 3D-1D coupling modeling by considering wave-propagation effects. (Fig4)

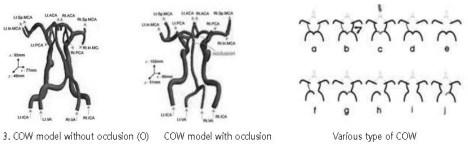


Fig 3. COW model without occlusion (O) COW model with occlusion Various type of COW

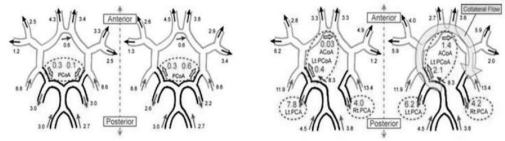


Fig 4. Flow rate (Q) in **3D** COW **wo** O Q in **1D-3D** COW **wo** O Q in **3D** COW **w** O Q in **1D- 3D** COW **w** O

CFD Simulation of Cerebral Stenosis

- 65 year old patient-specific cerebrovascular hemodynamic simulation (Fig 5) Suh et al. 2011
- Analysis of wall shear stress distribution before and after stenting.

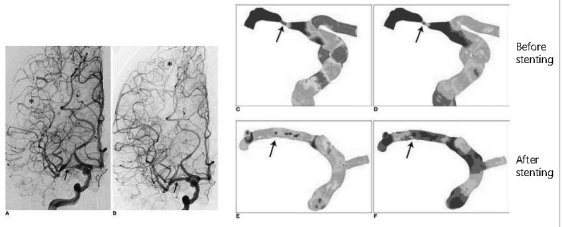


Fig 5. Angiogram (A) before and (B) after stenting. (C, E) WSS during systole (D, F) WSS during diastole

CFD Simulation of Cerebral Aneurysm (1)

University of College London University of Tokyo Torii et al. 2012

- Fluid solid interaction modeling of cerebral aneurysm

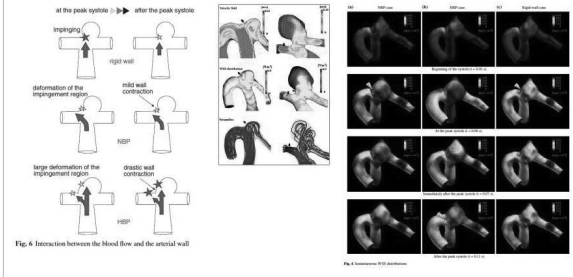


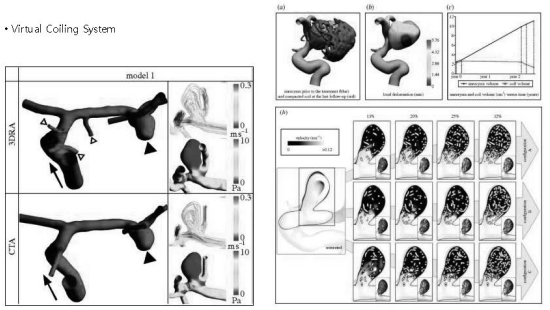
Fig. 6 Interaction between the blood flow and the arterial wall

Fig 6. Hemodynamics distribution in fluid-solid interaction modeling of cerebral aneurysm.

CFD Simulation of Cerebral Aneurysm (2)

Sheffield University & Catalunya Institute (ICREA) Villa-Uriol et al. 2010

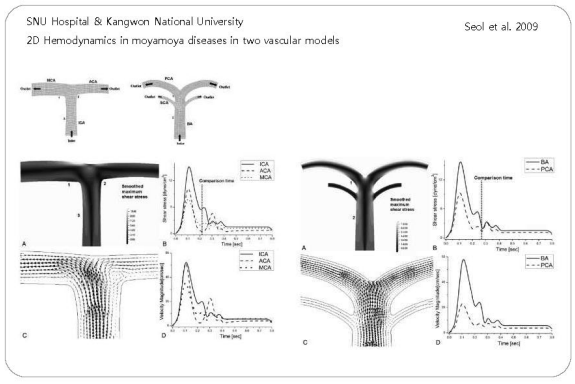
- Hemodynamics by using a virtual coil implanted in a patient-specific vascular model with aneurysm
- Virtual Coiling System



CFD Simulation for Moyamoya Disease (1)

SNU Hospital & Kangwon National University Seol et al. 2009

2D Hemodynamics in moyamoya diseases in two vascular models



CFD Simulation for Moyamoya Disease (2)

Hemodynamic parameter for assesing treatment outcome of EDAS in moyamoya disease

Macquarie University Karunanithi et al. 2015

- Hemodynamics in moyamoya diseases in 8 patient-specific vascular models
- 3D CFD analysis on eight patients (5 female, 3 male) with MMD treated by EDAS (encephalo-duro-arterio-synangio with the follow up haemorrhage outcomes)

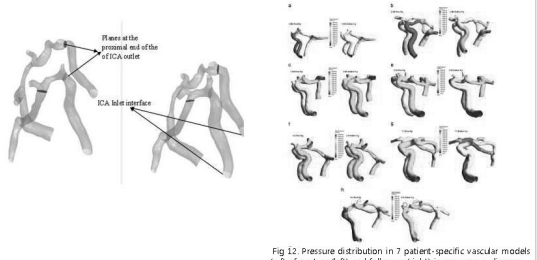


Fig 12. Pressure distribution in 7 patient-specific vascular models (a-f) of post-op(left) and follow-up(right) in moyamoya disease

Benefits of CFD Simulation

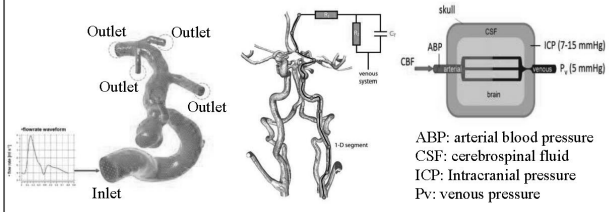
1) Noninvasive evaluation of pressure drop across and wall shear stress → early diagnosis (from medical image to physiology)
2) Virtual evaluation of interventional outcome is possible
3) Drug-induced hemodynamics can be predicted
4) Optimal interventional scheme can be found by iterative simulations
5) Cost effective, Safe, Scientific

→ Early and patient-specific diagnosis, Scientific evaluation of disease state, Optimal intervention

Limitations of CFD Simulation

1) Specialized techniques and intensive training are required for quality-of-solution
2) Advances in individual component CFD solver robustness and automation will be required
3) Mesh generation and adaptivity continue to be significant bottlenecks in the CFD workflow
4) Generally, outlet boundary condition for the CFD model of cerebral vessel is not accurate
5) CSF circulation and effect of venous flow must be considered
6) Correlation between CFD model parameters and measured data is not easy

Systemic View of Cerebral Circulation



ABP: arterial blood pressure
CSF: cerebrospinal fluid
ICP: Intracranial pressure
Pv: venous pressure

CFD +
Lumped parameter model

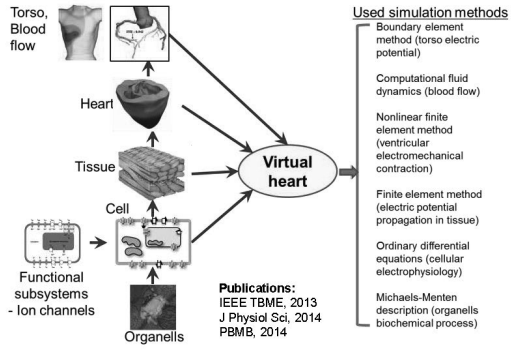
1) There have been no CFD models considering ICP or CSF effects
2) Thus, the outlet boundary conditions in CFD models were not accurate
3) Non-invasively measured data of patient-specific ICP is not available

Future Direction of CFD Research in Brain

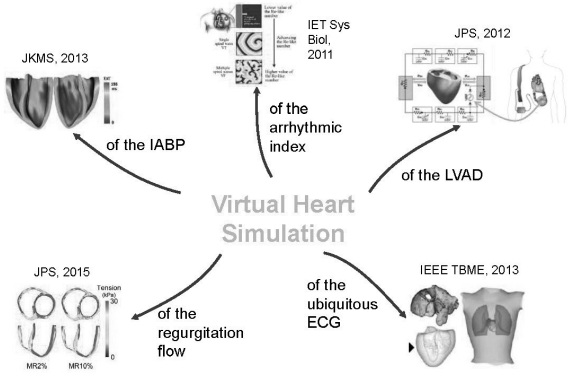
1) CFD + vessel wall mechanics (fluid-structure interaction)
2) CFD + biological process (WSS + LDL biological process)
3) Integrative CFD simulation for arteries and CSF fluid
4) Imaging data coupled CFD model
5) Patient-specific virtual intervention

Our researches on heart and vascular system

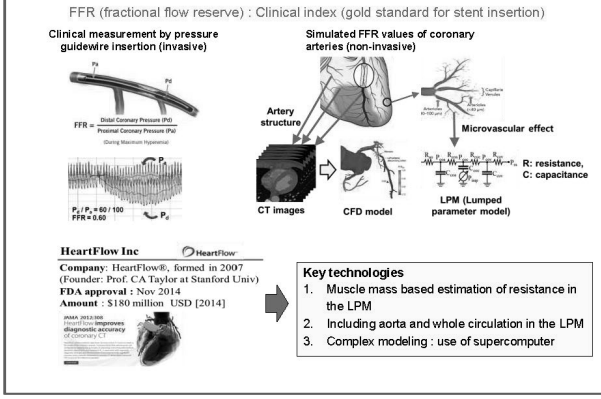
Integrated model of heart and vessels



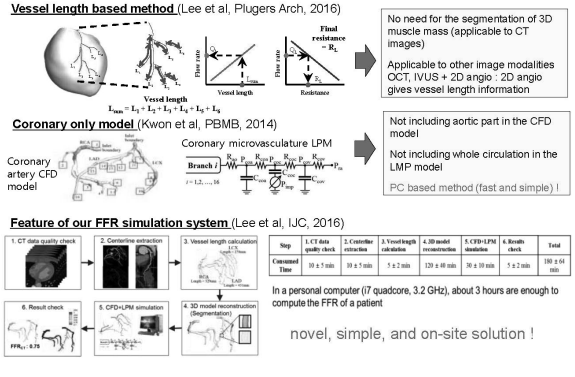
Virtual heart simulation studies



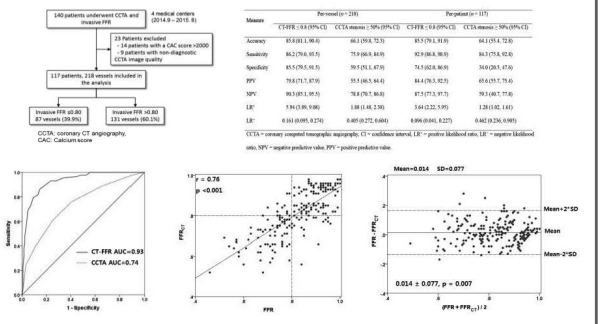
Coronary FFR simulation



Our coronary FFR simulation method



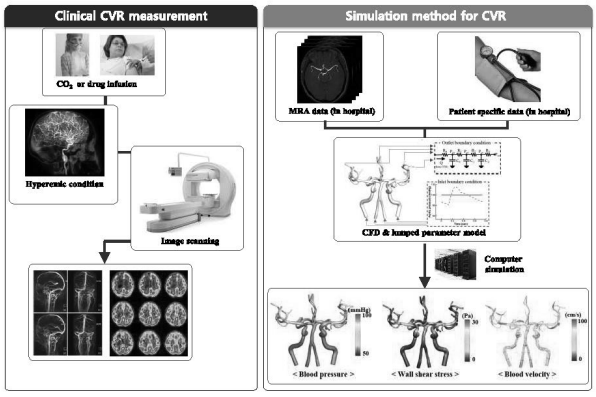
Clinical validation (multicenter, blind test)



Clinical outcome of the present study is better than that of Heartflow Inc.

Chung et al., Int'l Journal of Cardiology, Accepted, 2016

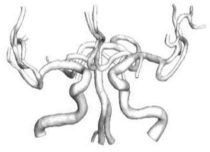
A simulation of CVR (cerebrovascular reserve)



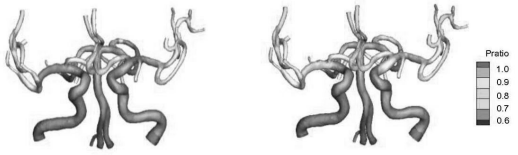
A simulation case of patient

➢ **Model geometry**

Data from Prof. KM Lee at Dept. of Neurology of SNU Hospital

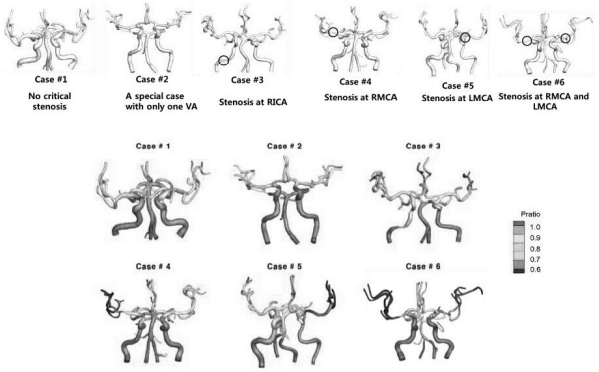


➢ **Pressure ratio (normal vs hyperemia)**

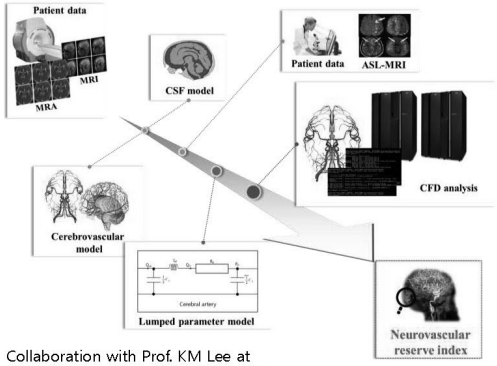


Pressure ratio = (Cycle averaged pressure)/(cycle averaged inlet pressure)

Representative cases - 6 patients under hyperemia



An Integrative Model of CFR



Collaboration with Prof. KM Lee at Dept. of Neurology of SNU Hospital

Summary

1) CFD is an effective way to analyze neurovascular diseases
2) CFD can contribute to accurate diagnosis and optimal intervention schemes in neurosurgery
3) CFD emerges as a plausible tool for precision medicine
4) But CFD model must be clearly validated
5) Collaboration between clinician and CFD scientist is required

Take Home Message

Why does nobody believe your results except yourself if you use CFD, and why does everyone believe your results except yourself if you measure fluid flow ?

Is CFD "Colored Fluid Dynamics" ?
Is CFD "Computational Fluid Dynamics" ?

It is up to the user !

Thanks for your attention

정 선 윤 인제대 상계백병원 신경외과

▶ **학력 및 경력**

2010년 3월 경희대학교 의학전문 대학원 졸업
2010년 3월 ~ 2011년 2월 경희의료원 인턴
2011년 3월 ~ 2015년 2월 가톨릭 중앙의료원 신경외과 레지던트
2015년 3월 ~ 2016년 2월 서울 성모병원 신경외과 임상강사
2016년 2월 ~ 2016년 10월 서울 성모병원 영상의학과 임상강사
2016년 11월 ~ 현재 인제대학교 상계백병원 신경외과 임상조교수

Assessment of intra-aneurysmal flow using DSA-based optical flow approach

정 선 윤

인제대

Assessement of Intra-aneurysmal flow by DSA-based optical flow approach

Sun-yoon Chung M.D.[1)]
Yong-sam Shin M.D., Ph.D.[2)]

1) *Department of Neurosurgery, Sanggye Paik hospital, Inje University*
2) *Department of Neurosurgery, Seoul St. Mary's hospital, Catholic University of Korea*

Introduction

- Each kind of intracranial stent has its own unique characteristics.
- A porosity of stent reflects capability of modifying the intra-aneurysmal blood flow and ability to induce progressive thrombosis and vascular remodeling.
- But, the assessment of real flow modifications induced by stent placement has not yet been fully accomplished.
- Recently, a new method to appraise blood flow by using DSA (Digital Subtraction Angiography) sequences acquired during endovascular treatment procedure has been reported.
- The aim of this study was to compare intra-aneurysmal flow changes induced by various types of stents.

Introduction

- Assessment of Intra-aneurysmal flow -

Currently, 2 Methods

1. Computational Fluid Dynamics

2. DSA-based optical flow technique

Introduction

- Assessment of Intra-aneurysmal flow -

DSA based Optical flow principle

Contrast material was diluted in the blood stream
Pulsating effect of the dye blood mixing flow
Two components : "contrast wave" and " wash in wash out"
- Contrast wave : modulated signal
- Wash in Wash out component : nonmodulated → Decoupled nonmodulated signal

Introduction

- Assessment of Intra-aneurysmal flow -

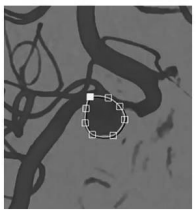
AneurysmFlow(Software) : **Advanced DSA based Optical flow principle**

- Can quantify Blood Flow
- Flow velocity, Flow amplitude
- Can visualize blood flow pattern
- Post-processing Software Tool
  : AneurysmFlow(Philips)

Methods

- To evaluate intra-aneurysmal flow modifications after stent placement
- 2 parameters, the MAFA(mean aneurysmal flow amplitude) and MAFA ratio.

$$MAFA = \frac{1}{S}\frac{1}{T}\iint \|\overline{V(r,t)}\| dsdt,$$ [1)]



1) V.M. Pereira, et al. **A DSA-Based Method using Contrast-Motion Estimation for the Assessment of the Intra-Aneurysmal Flow Changes Induced by Flow-diverter stents** AJNR Am J Neuroradiol 34:808-815

Methods

- MAFA ratio describes the flow modifications induced by stent.

$$MAFA\ ratio = \frac{mean\ aneurysm\ flow\ post}{mean\ aneurysm\ flow\ pre} \cdot \frac{mean\ arterial\ flow\ pre}{mean\ arterial\ flow\ post}$$ [2)]

- MAFA values are normalized to their respective parent artery volume flows
- The threshold analysis established that below MAFA ratio R 1.03, the likelihood of thrombosis in the aneurysm was significant. (sensitivity 0.88, specificity 0.73) [1)]
- We recorded MAFA value before and after the stent deployment at the same session.

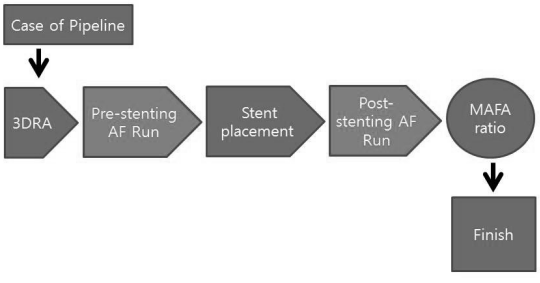
1) V.M. Pereira, et al. **A DSA-Based Method using Contrast-Motion Estimation for the Assessment of the Intra-Aneurysmal Flow Changes Induced by Flow-diverter stents** AJNR Am J Neuroradiol 34:808-815

2) D. Ruijters et al. **How to perform DSA-based Cerebral Aneurysm Flow measurements** European Society of Radiology, ECR 2016, Educational Exhibit, 1-20

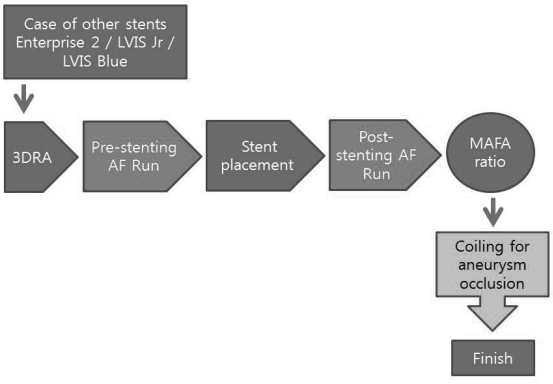
Methods

- Since March 2016, Seoul St. Mary's hospital
- 4 patients with unruptured intracranial aneurysms
- who had elected to have stent implantation for assisted technique or flow diversion alone.
- Enterprise 2, LVIS Jr, LVIS Blue, Pipeline Flex
- 3 aneurysms were treated by adding coils after flow assessment
- DSA-based optical flow approach.
- Angiographic C-arm Allura Xper (Philips)
- Post-processing Software Tool : AneurysmFlow(Philips)
- 3D rotational angiography
- Identify projection view
- high-speed DSA AneurysmFlow Run (60 frames per second) before and after stent placement and Low injection rate ≤ 2mL/s
- Injection duration : 3~4 seconds

Methods



Methods



Summary

Assessment of Intra-aneurysmal flow changes induced by various types of stents

		Metal Coverage	MAFA ratio
Pipeline		30 ~ 35%	0.73
LVIS Blue		28%	1.00
LVIS Jr		18%	1.14
Enterprise 2		10%	1.67

Conclusion

Our results suggest that **MAFA ratio** between the pre and post-stent condition successfully reflected the own characteristics of each stent.

The assessment of the intra-aneurysmal flow change by using DSA-based optical flow approach can offer **new insights** into hemodynamics of stenting technique.

This quantitative assessment method may potentially help the clinician to adapt the treatment **in real-time** during the procedure.

This prototype, but **evolving** new technique of hemodynamics may provide **rationale** for flow modification with stent of **uncoilable** or **incompletely coiled** aneurysms.

Further studies are ongoing.

김 영 수 양산부산대학교병원 신경외과

▶ **Education**

부산대학교 의과대학 신경외과학 박사 (2014.3–2016.2)
부산대학교 의과 대학 신경외과학 석사 (2010.3–2012.2)
부산대학교 의과대학 졸업 (2004.3–2008.2)
부산대학교 의예과 졸업 (2002.3–2004.2)

▶ **Postgraduate Professional Training**

부산대학교 병원 인턴 수료 (2008.3–2009.2)
부산대학교 병원 신경외과 레지던트 수료 (2009.3–2013.2)

▶ **Professional Appointments**

양산 부산대학교 영상의학과 전임의 (Prof. 백승국) (2013.5–2014.2)
양산 부산대학교 신경외과 임상조교수 (2014.3 – 현재)
일본 JIKEI 대학 의과대 혈관내수술 단기 연수 (Prof. Murayama) (2016.1)

Cerebral aneurysm coiling simulation using patient-specific 3D printing : from lab to real angio suite

김 영 수
부산대

양산부산대학교병원
Pusan National University Yangsan Hospital

Endovascular simulation using patient-specific 3D printing
;from lab to real angio suite

김영수, 백승국2, 심동현2, 노지은2, Yuichi Murayama3, 김창현, 김영하, 이상원

Department of Neurosurgery and Radiology2
Pusan national university Yangsan hospital, Korea

Division of Endovascular Neurosurgery, Department of Neurosurgery,
The Jikei University School of Medicine, Japan3

Disclose

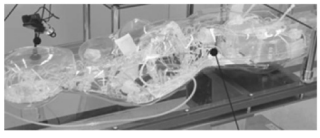
- I declare that I have no competing interests
- Fund : 부산대학교 의생명융합연구소 연구비 (2016-012)

HYPOTHESIS

Patient specific treatment planning:

- Safe and precise planning
  - Good plan ➔ good procedure
  - Good plan + simulation ➔ good procedure even junior interventionist.

Conventional model vs 3D printing company

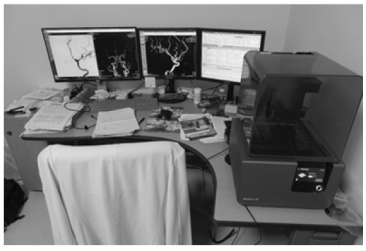


- EVE (FAIN-biomedical Inc., Japan) (endovascular evaluator)
  - Expensive (0.5~ 1억원)
  - No patient specific

- Outsourcing
  - Take time
  - Expensive/cases

My desk is small lab.
;3D printing and CFD lab

- Siemens workstation
- 3D printer
  - Form 2
- CFD workstation
  - Computational fluid dynamics



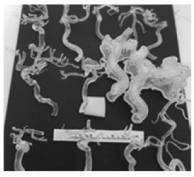
Form 2 (Stereolithography 3DP)

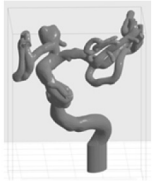
- Layer thickness 0.025-0.1 mm
- Price 약 1000만원, Resin 약 20만원/L

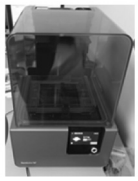
Production

1. 3D Rotational angiography (CTA, MRA)

2. Segmentation
   3D modeling 1H/case



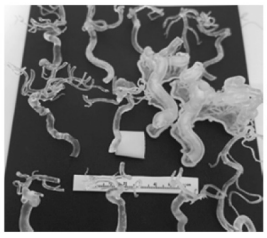




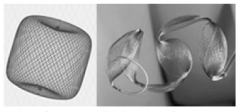
3. 3D printing 4-8H
   Max 9 in one session

4. Post processing
   세척, 후경화, 받침대제거

Pre treatment in-vitro simulation

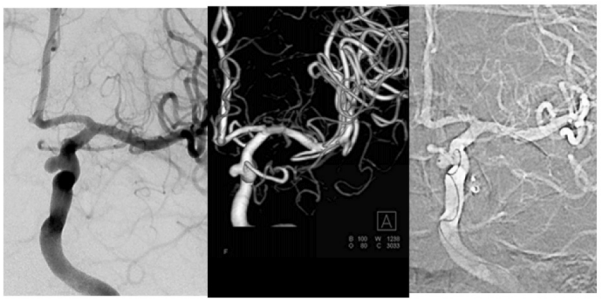


1. Coilling
   - Microcatheter shape
   - Coil shape and size
2. Flow diverter behavior and length
3. Intrasaccular flow-disrupter

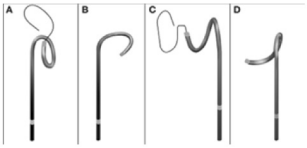


4. Mechanical thrombectomy

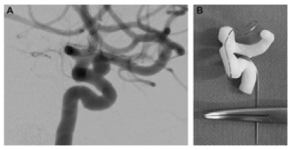
F/50, left paraclinoid ICA aneurysm



Medial paraclinoid aneurysm
Ophthalmic artery aneurysm

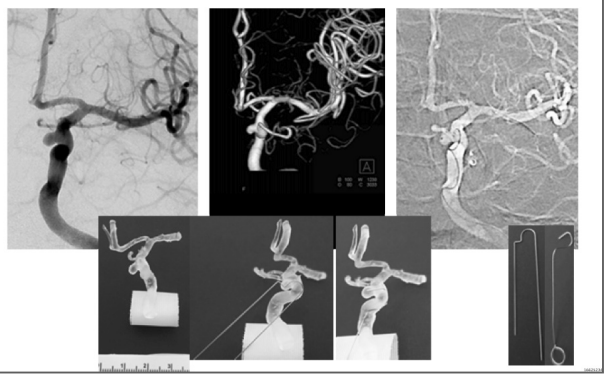


Shaping and navigating methods of microcatheters for endovascular treatment of paraclinoid aneurysms.

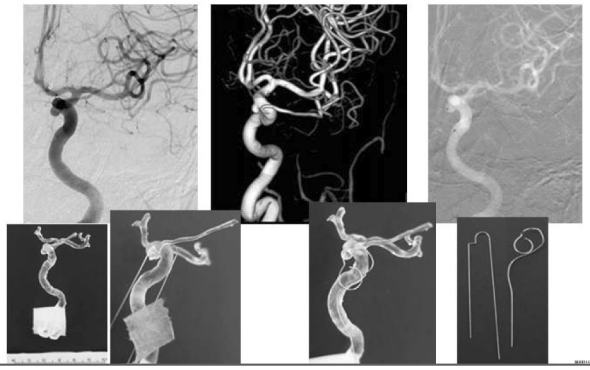


Microcatheter Shaping for Intracranial Aneurysm Coiling Using the 3-Dimensional Printing Rapid Prototyping Technology: Preliminary Result in the First 10 Consecutive Cases

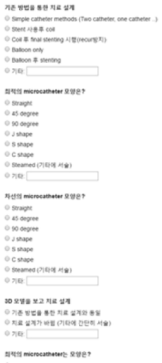
F/50, left paraclinoid ICA aneurysm

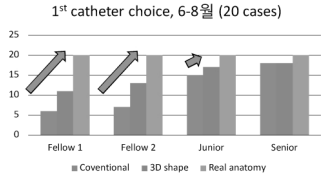


F/50, left paraclinoid ICA aneurysm



Aneurysm model trial





Unpublished data

- Understand real anatomy deeply
- Preferred preshaped microcatheter
- Catheter stability for last coil
- Estimate Catheter tip position

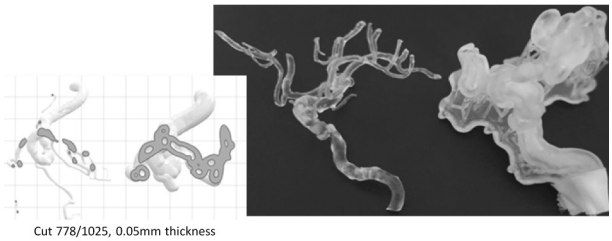
➔Expect treatment strategy: Simple, Balloon, stent

Endovascular teaching problem

- All case⇧/n⇧= small No.⇩
  - We can't be spetzler.

★Direct hollow model for treatment

- 내부 lumen을 역상으로 direct hollow model for treatment로 즉각적인 feed back 가능

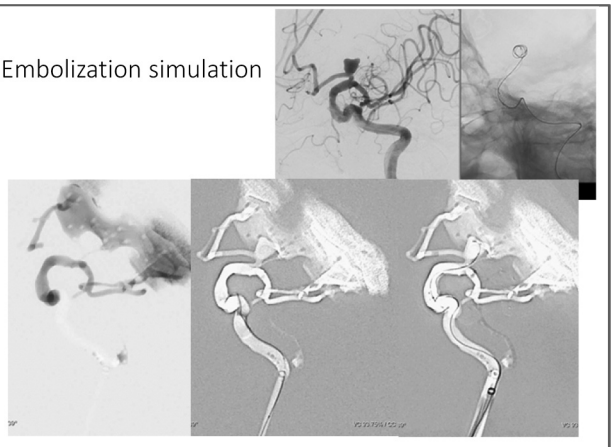


Cut 778/1025, 0.05mm thickness

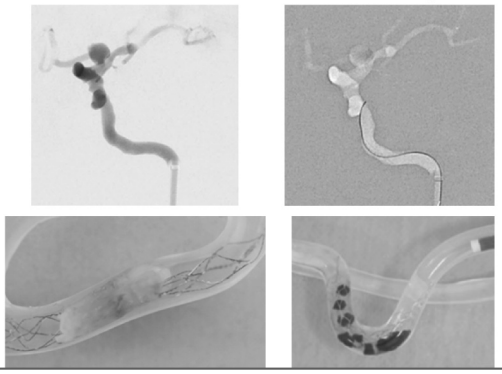
- 제작 시 6시간 정도 소요 (elective case 사용가능)

Same case for everybody

Embolization simulation

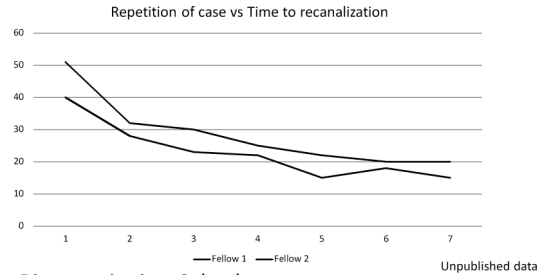


Mechanical thrombectomy trial



Mechanical thrombectomy trial

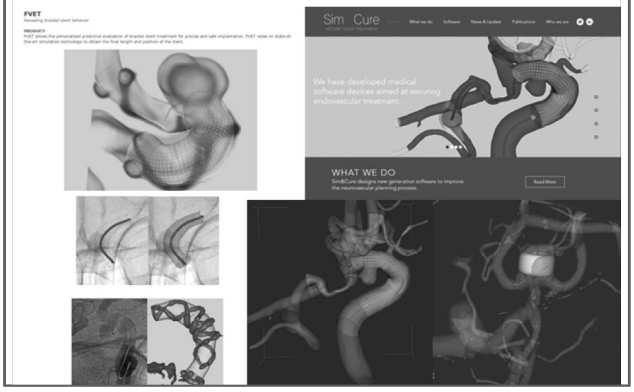
- Stentriver



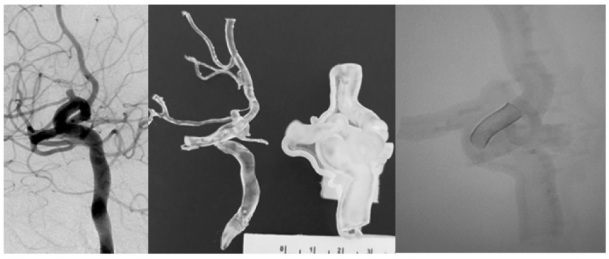
Unpublished data

- Direct aspiration, Solumbra

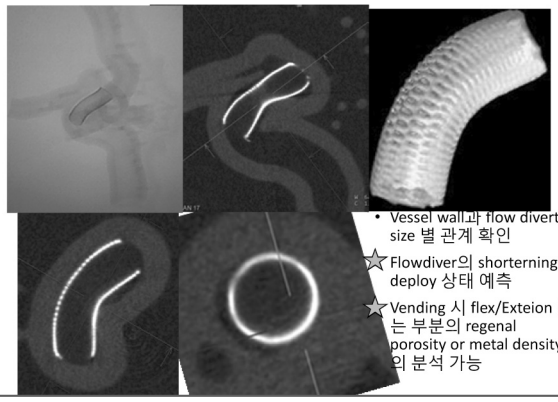
New device simulation software



Pipeline, Web, Ludinar, pCONUS trial test



High resolution CT (DynaCT micro)



- Vessel wall과 flow diverter size 별 관계 확인
- Flowdiver의 shorterning과 deploy 상태 예측
- Vending 시 flex/Exteion 되는 부분의 regenal porosity or metal density 의 분석 가능

Limitation

- Expensive TOY? , Valuable product
- Friction force (Real vessel < 3D resin < Silicon model)
- Firm product, translucent vs flexible material, black

- No way to automatically convert the scan data into a 3D file

Conclusion

- Patient specific 3DP model may facilitate easier and safe procedure in endovascular treatment
- 3D printing technology undoubtedly has great potential. However, it is unlikely to replace traditional manufacturing. Instead, we should see it as a complement, a new tool in the box, and exploit its unique capabilities

Free paper II Ischemia

좌장 : 가톨릭대 **신용삼**, 서울대 **권오기**

New Application of Intra-vascular Optical Coherence Tomography (OCT) in Carotid artery Stenosis: Case Report and Review of Literature, (First Clinical Research in Korea)

김 창 현 계명대 동산병원

Kim Chang-Hyun

Department of Neurosurgery Keimyung University School of Medicine

Objective : Recently, intra-vascular optical coherence tomography (OCT) has been introduced as a highresolution imaging tool for plaque characterization. OCT is a non-contact light-based imaging method using relatively newly developed fiber-optic technology. In-vivo application of OCT has been usually reported for coronary arteries and more recently, in the carotid artery. We first performed clinical research with 11 patients using OCT in carotid artery in our country and published case report.

Methods : An 82-year-old man visited the outpatient clinic of our stroke center because of dizziness. He had a previous history of stroke without definite sequelae. Severe stenosis in the left proximal internal carotid artery (ICA) was seen on Doppler sonography. Conventional angiography revealed focal severe stenosis with 'string sign' in the left proximal ICA and delayed distal run off. OCT showed multiple channels surrounding a narrowed central lumen (lotus root-like appearance). Carotid stent placement with a protection device was done without complications. The patient was discharged in good condition 5 days after the procedure.

Result : A 'lotus root-like appearance' is produced when thrombi undergo organization or recanalization to form lumens and neovascularization produces variably sized, endothelium-lined vascular channels within the thrombus. Although there is some debate about whether or not to treat carotid arteries with string sign, the nature of string sign is beginning to be elucidated with the help of OCT.

Conclusion : Application of OCT in carotid artery stenosis may help more information about 1) before balloon angioplasty: plaque characteristics, intraluminal thrombus, etc. 2) after stenting: edge dissection, intra-stent dissection, tissue prolapse, strut mal-apposition etc. If it is possible to make and apply OCT-guided micro-catheter, which can be applicable in intracranial vessels, as that of cardiovascular areas, we suggest that it will be helpful to improve more proper diagnosis and treatment in many intracranial vascular diseases.

Clinical Analysis of Endovascular Thrombectomy for Acute Ischemic Stroke in Failed IVtPA and non-IVtPA Patients

심 유 식 인하대병원

Yu Shik Shim, Dong Keun Hyun, Se Yang Oh, Hyeonseon Park, Eun Young Kim, Seung Hwan Yoon

Department of Neurosurgery, College of Medicine, Inha University

Objective : Although development of endovascular thrombectomy has achieved to prolong therapeutic time window, intravenous tissue plasminogen activator (IVtPA) is the most reliable and evidence based treatment in acute ischemic stroke. The authors compared clinical findings of the patients who performed endovascular thrombectomy after IVtPA administration with the patients who performed thrombectomy alone.

Methods : From 2013 April to 2016 June, 70 cases of mechanical thrombectomy using stent retriever for anterior circulation infarction have performed in the authors' clinic. We compared revascularization, development of symptomatic intracranial hemorrhages (sICH), and clinical outcome in two groups, and also analyzed characteristic findings according to the location of occlusion.

Result : Among 70 patients, 37 failed recanalization after IV tPA administration, and 33 patients were ineligible for IV tPA. Initial neurological statues showed no difference between two groups, but good clinical outcomes corresponding to modified Rankin Scale (mRS) 0-1 were more prominent in failed IVtPA patients. Final recanalization rate of TICI IIb or III was 83.8% in failed IVtPA patients which is superior to non-IVtPA paitents, but sICH and subsequent mortality rate was higher. In MCA occusion, the best revascularization rate (87. 5%) and clinical outcome (50%) was found in failed IVtPA patients, but showed poorer outcome than ICA occlusion in non-IV tPA patients. ICA occluded patients showed poorer outcomes than MCA occlusion in both groups, and non-IV tPA patients showed better outcomes than failed IVtPA patiens.

Conclusion : Endovascular thrombecromy in IVtPA failed patients showed better revascularization and clinical outcomes, but higher development of sICH and mortiality. MCA thrombectomy in failed IVtPA patients showed the best revascularization and clinical outcome, but poorer outcomes in non-IVtPA patients. In ICA thrombectomy, IV tPA administration was related to better revascularization but not to final clinical outcome.

Mechanical Thrombectomy with Trevo Stent Retriever in Acute ischemic Stroke : Two-year Experience in a Single Center

신 희 섭 강동경희대병원

Hee Sup Shin, Jun Seok Koh, Hak Cheol Ko

Department of Neurosurgery, Kyung Hee University Hospital at Gangdong, Kyung Hee University School of Medicine, Seoul, Korea

Objective : Stent retriever for mechanical thrombectomy in acute ischemic stroke is regarded as approved treatment for improving recanalization of occluded vessel and clinical outcome, and therefore new devices are used in treatment for acute ischemic stroke. We evaluated the treatment results of our experience of Trevo stent retriever for acute ischemic stroke.

Methods : Twenty-six consecutive patients who underwent mechanical thrombectomy with Trevo stent retriever were identified. We reviewed the demographic data, clinical characteristics including initial clinical status (NIHSS), stroke risk factors, and follow up results (90-days mRS), We also assessed the detailed endovascular procedure and recanalization result (TICI).

Result : The mean NIHSS score before treatment was 15.73±4.87, and all patients were anterior circulation occlusion. Successful recanalization (TICI≥2b and 3) was obtained in 22 (84.6%) patients and successful recanalization after one single pass was achieved in 8 patients. Among 4 patients with unsuccessful recanalization (TICI 2a), we switched the management to medical treatment in 3 patients, and surgical embolectomy in 1 patient. Procedure related complications of vessel injury, perforation and severe vasospasm were not observed. The good functional outcome of mRS 2 at 90 days after treatment were obtained in 14 (53.8%) patients, and 4 patients were dead.

Conclusion : Our preliminary experience suggest that the Trevo stent retriever is feasible, effective, and safe. Recanalization rate and clinical outcome are comparable to reported data in the literatures.

Implications of Mechanical Endovascular Thrombectomy for Acute Basilar and Posterior Cerebral Artery Occlusion

신 동 성 순천향대 부천병원

DongSung Shin, JongHyeon Mun, JongHyun Park, BumTae Kim

Dept. of Neurosurgery, SoonChunHyang Univ. Bucheon Hosp.

Objective : Mechanical endovascular thrombectomy(MET) for posterior circulation have spacious treatment guideline in comparison with anterior circulation. Because posterior circulation infarction may be bring critical patient outcome. Recently, several thrombectomy technique are applied to posterior circulation infarction due to new thrombectomy device development. This study investigated to clinical efficacy and characteristics of MET for basilar artery(BA) and posterior cerebral artery(PCA) occlusion in single center.

Methods : We investigate MET for posterior circulation from Jan. 2012 to Aug. 2016 retrospectively. 16 patients diagnosed with BA and PCA occlusion. one patient was excluded who treated with intra-arterial thrombolysis. Suction thrombectomy catheter and retrieval stent was used to restore blood flow. National institutes of health stroke scale(NIHSS), thrombolysis in cerebral infarction (TICI) scale and modified Rankin scale(mRS) was used for patient outcome evaluation. Successful arterial blood flow restoration was defined as TICI 2 or 3.

Result : MET performed in fifteen patients. Mean age was 71.9 year old and mean NIHSS was 17.4. Ten patients were male five were female. Tissue plasminogen activator(tPA) infused to 6 patients. 13 patients diagnosed BA occlusion and 2 patient diagnosed PCA occlusion. Among patients who diagnosed BA occlusion, 3 patients didn't achieve recanalization. We didn't able to approach occlusion lesion because of vessel tortuosity in 2 patients and one patient didn't enough thrombectomy because of procedural complication. We didn't achieve recanalization in all PCA occlusion cases. Mean procedure time was 58 minutes and successful recanalization (TICI ≥2) were 11. Mean mRS at discharge was 3.8. Three patients were expired after procedure due to herniation. However, these patients didn't performed secondary decompressive craniectomy. Hemorrhagic transformation after thrombectomy occurred 5 cases. however, these were no mass effect or small dot in susceptibility weighted imaging of magnetic resonance imaging.

Conclusion : MET for Basilar artery occlusion showed high recanalization rate. however occlusive lesion approach impossibility due to vascular tortuosity is serious procedural failure risk factor. MET for posterior circulation infarction is effective to posterior circulation infarction.

Comparison of Modified Volume Perfusion Computed Tomography with Computed Tomography Angiography at Mechanical thrombectomy for Acute Ischemic Stroke: Analysis of Clinical and Radiologic outcomes

이 호 준 가톨릭대 성빈센트병원

Ho Jun Yi, M.D., Jae Hoon Sung, M.D., Sang Wook Kim, M.D., Dong Hoon Lee, M.D., Young Il Kim, MD., Chul Bum Cho, MD., Seung Ho Yang, MD., Il Sup Kim, MD., Jae Taek Hong, MD., Sang Won Lee, M.D.

Department of Neurosurgery, St. Vincent's Hospital, The Catholic University of Korea

Objective : Recently, volume perfusion CT (VPCT) added CTA-like reconstruction from VPCT source data (VPCTA) was widely used by generate thin, high-resolution section datasets. Many studies demonstrated good correlation for CTA and VPCTA for vascular status. The authors analyzed the multiple time interval categories, clinical and radiologic outcomes in order to demonstrate the effectiveness of VPCTA compared with CTA at mechanical thrombectomy.

Methods : A total of 159 patients underwent mechanical thrombectomy at our center from February 2012 to June 2016 was reviewed, retrospectively. Acute stroke evaluation protocol of our institution changed from CTA to VPCT, then VPCTA at March 2015. The authors divided the patient with two groups : CTA and MRD based mechanical thrombectomy group (Group 1 : CTA + MRD) and VPCTA and MRD based mechanical thrombectomy group (Group 2: VPCTA + MRD) were established. Transient VPCT based thrombectomy patients were excluded because the number was too small. Multimodal factors were reviewed for patient age, gender, underlying disease, location of occluded vessel, thrombectomy devices. All patients underwent clinical assessment with NIHSS score at baseline, after 24 hours, at 30 days and modified Rankin Scale (mRS) score at 90 days and time interval was analysed with three parameters. Radiologic results was evaluated by thrombolysis in cerebral infarction (TICI) score and complication were analyzed about stroke recurrence, symptomatic hemorrhage and mortality during 90 days.

Result : The mean NIHSS score at 24 hour was lower at group 2 (6.63) compared with group 1 (8.66) with statically significant (p=0.010). The mean NIHSS score at 30 days was lower in group 2 (5.63), compared with those in group 1 (6.45), but there was no statistically significant (p=0.294). 90 days mRS were significantly lower in group 2 (2.88), compared with those in group 1(3.53) ($p<0.021$). Group 2 revealed statically significant higher final TICI score (3.25) than group1 (2.82) ($p<0.012$). Time interval from onset to groin puncture in group 2 (245.95 minutes) was shorter than in group 1 (193.85 minutes) with statically significant (p=0.001) but, there were no statically significant difference at procedure time in both group (p=0.071). The time interval from onset to reperfusion were significantly lower in group 2 (301 minutes), compared with those in group 1 (372 minutes) (p=0.010).

Conclusion : Our study shows the combination of VPCTA and MRD can render additional information and may help in therapeutic decision-making, because VPCTA can render important diagnostic information regarding the infarct, the perfusion deficit with major vascular status. This protocol enables to reduce the time interval and make better clinical and radiologic outcomes.are feasible, safe, and efficient.

Permanent Stent Deployment for Preventing Vessel Reocclusion after Mechanical Thrombectomy in Acute Ischemic Stroke

박 상 필 을지대 을지병원

박상필, 김재훈, 강희인, 김덕령, 문병관, 이승진, 김주승

을지대학교 을지병원

Objective : To evaluate the usefulness of permanent stent deployment using Solitaire retrieval stent for flow restoration in the reoccluded vessel after mechanical thrombectomy.

Methods : We retrospectively investigated 35 acute ischemic stroke patients treated by intraarterial mechanical thrombectomy (IAT) using Solitaire retrieval stent between September 2013 and August 2016. We compared the recanalization rate and clinical outcome between simple thrombectomy group (ST) and permanent stent deployment group (SD). The degrees of vessel recanalization were graded using the Thrombolysis in Cerebral Infarction (TICI) grading system. The clinical outcomes were assessed using National Institute of Health Stroke Scale (NIHSS) score and modified Rankin Scale (mRS) score at 3 months.

Result : Ten of the 35 subjects were treated with permanent stent deployment. The mean initial NIHSS score was 16.6 (± 4.7) in the ST and 13.0 (± 4.9) in the SD. The overall successful recanalization rate (TICI grade 2 or 3) was 84% in the ST and 70% in the SD (P=0.381). Procedure-related complications (symptomatic hemorrhage in one case and contrast media leakage in 2 cases) occurred in 3 ST patients during IAT. There were no significant difference in favorable outcome (decrement of NIHSS score ≥ 4 after IAT and mRS score 0-3 at 3 months) between ST and SD (P=0.377 and 0.258, respectively).

Conclusion : Permanent stent deployment showed high potential for flow restoration in the reoccluded vessel, especially when simple mechanical thrombectomy was failed.

Stenting as a Rescue Treatment after Failure of Mechanical Thrombectomy for Anterior Circulation Large Artery Occlusion

김 병 문 연세대 세브란스병원

Byung Moon Kim, Jang-Hyun Baek, Keun Young Park, Dong Joon Kim, Ji Hoe Heo, Hyo Suk Nam, Joonsang Yoo

Severance Hospital Stroke Center, Department of Radiology, Yonsei University College of Medicine

Objective : We hypothesized that permanent stenting may be a rescue treatment for stentriever-failed anterior circulation large artery occlusion (AC-LAO). We compared the outcomes among patients with permanent stenting and those without stenting after stentriever failure.

Methods : We retrospectively evaluated 208 patients who underwent stentriever thrombectomy for AC-LAO between September 2010 and September 2015. Modified Thrombolysis in Cerebral Ischemia (mTICI) 2b-3 recanalization was achieved with stentriever alone or in combination with Penumbra device in 155 patients (74.5%). An additional eight patients (3.8%) obtained mTICI 2b-3 with urokinase and/or glycoprotein IIb/IIIa inhibitor infusion. Of the remaining 45 patients (21.6%), 17 underwent stenting (stenting group [SG]; mean age, 68 years), whereas 28 did not undergo stenting (non-stenting group [NSG]; mean age, 72 years). The rate of mTICI 2b-3 in SG was assessed and clinical outcomes were compared between groups

Result : There were no differences in clinical and laboratory findings, initial NIHSS score, location of AC-LAO, and onset-to-puncture time between groups. mTICI 2b-3 was achieved in 14 (83.3%) of the SG. SG had more favorable outcomes (modified Rankin Scale [mRS] 0-2, 35.3%) and less cerebral herniation (CH, 11.8%) than NSG (mRS 0-2, 7.1%; CH, 42.9%; $p < 0.05$ for both). Symptomatic intracranial hemorrhage (sICH) and mortality rates did not differ between SG (sICH, 11.8%; mortality, 23.5%) and NSG (sICH, 14.3%; mortality, 39.3%).

Conclusion : Among patients with stentriever-failed AC-LAO, the SG had a significantly more favorable outcome and less CH than the NSG, without an increase in sICH and mortality rates. Permanent stenting may be a feasible rescue modality for stentriever-failed AC-LAO.

Importance of Truncal Type Occlusion in Stentriever Based Thrombectomy for Acute Stroke

김 병 문 연세대 세브란스병원

Byung Moon Kim, Jang-Hyun Baek, Keun Young Park, Dong Joon Kim, Ji Hoe Heo, Hyo Suk Nam, Songbeom Song

Severance Hospital Stroke Center, Yonsei University College of Medicine

Objective : To investigate whether angiographically-defined occlusion type could predict of the etiology of acute intracranial large artery occlusion and the stentriever response.

Methods : We reviewed consecutive patients with acute intracranial large artery occlusion who underwent endovascular treatment and examined their work-ups for embolic sources. Patient demographics, laboratory findings, hyperdense artery sign, and angiographic occlusion type (truncal-type or branching-site occlusion) were compared between embolic sources (+) and (-) groups. These variables were also compared between stentriever failure and success groups. Details of endovascular procedures were also compared according to occlusion type.

Result : Two hundred fifty-nine patients (mean age, 70.3 years; M:F=132:127) were finally included. Of these patients, 216 (83.4%) were assigned to embolic sources (+) group after thorough evaluation. Young age, no coronary artery disease, and truncal-type occlusion (odds ratio [OR] 9.07; 95% confidence interval [CI] 3.74 - 22.0) were independently associated with embolic source (-) group. Of the overall group, 224 patients (86.5%) underwent stentriever-based endovascular treatment. Hypertension, diabetes, high C-reactive protein level, and truncal-type occlusion (OR 32.2; 95% CI 7.78 - 133.0) were independent predictors of stentriever failure. Truncal-type occlusion was associated with more reocclusion (77.3% versus 5.0%), resulting in recanalization failure by the stentriever (81.8% versus 20.3%), a longer puncture-to-recanalization time (118.0 versus 49.5 minutes), and more rescue treatment for final successful recanalization (78.9% versus 7.0%).

Conclusion : Angiographic occlusion type was an independent predictor of the underlying stroke mechanism and stentriever response. Although truncal-type occlusion was a strong predictor of stentriever refractoriness, it showed a final successful recanalization rate similar to that of branching-site occlusion by a multimodal approach. Therefore, the angiographic occlusion type is potentially helpful in setting endovascular treatment strategy for acute ILAO.

Free paper III AVM/AVF etc

좌장 : 전남대 **김태선**, 을지대 **강희인**

Endovascular Treatment of Bilateral Cavernous Sinus Dural Arteriovenous Fistula: Therapeutic Strategy and Follow-up Outcome

조 영 대 서울대병원

Young Dae Cho, Jong Kook Rhim, Hyun-Seung Kang, Moon Hee Han

Seoul National University Hospital

Objective : Bilateral cavernous sinus dural arteriovenous fistula (CSdAVF) is very rare, in even Asian countries. Clinical and radiologic outcomes of treating such fistulas through endovascular embolization are presented herein.

Methods : All data were obtained from 220 consecutive patients with CSdAVF who were treated from January 2004 to December 2015. Bilateral CSdAVF was identified in 17 patients (7.7%). The clinical and radiologic outcomes of the fistulas were assessed, with emphasis on the technical aspects of treatment.

Result : At the time of treatment, 7 and 10 patients presented with bilateral and unilateral symptoms (or signs), respectively. In the former cases, four patients had progressed from unilateral to bilateral symptoms. Bilateral inferior petrosal sinuses (IPSs) were patent in 10 patients; unilateral and bilateral IPS occlusion was observed in six and one, respectively. Bilateral fistulas were treated with single-stage transvenous embolization in 15 patients, via bilateral IPSs (n=9) and unilateral IPS (n=6). In the other 2 patients with one-sided dominance of shunting, only dominant fistula was treated. Of the 34 CSdAVF lesions, complete occlusion was finally achieved in 32 lesions after transvenous embolization. Additional transarterial embolization was performed in two lesions. Seven patients (41.2%) developed paradoxical worsening of cranial nerve palsy after transvenous embolization. During the follow-up period, 4 patients obtained complete recovery whereas the other 3 remained with deficits.

Conclusion : With adjustments of endovascular procedures to accommodate distinct anatomical configurations, endovascular treatment for bilateral CSdAVF can achieve excellent angiographic occlusion results. However, paradoxical aggravation of symptoms after transvenous embolization may occur frequently in bilateral CSdAVF.

Angiography and Surgical Decision of Traumatic Carotid Cavernous Fistula with Ophthalmological Implications. A Case Report

조 원 익 한국원자력의학원

[1] Wonik Cho, M.D., [2] Sukh Que Park, MD., Ph. D.

[1] Korea Institute of Radiological & Medical Sciences, Seoul, Korea, [2] Soonchunhyang University Seoul Hospital, Seoul, Korea

Objective : Carotid cavernous fistulas(CCF) are a disease when arterial flow and venous flow develop abnormal communication inside the cavernous sinus, and it much occurs mostly in the event of trauma. Generally, the symptom of CCF was known to occur at the lesion homolaterally where fistula occurred. We present the result of implementing embolization of CCF case, which had fistula point on the opposite side where the symptom occurred, through the direct carotid approach.

Methods : A patient, who was receiving a hospital treatment at orthopedics after the patient developed multiple trauma due to the traffic accident three months ago, was referred to Rt. exophalmosis, echymosis, and CN 6 palsy which were performed one month ago. Through an MRI scan, which we conducted for evaluation, we observed engorgement of orbital vein and facial vein, and showed enhancement at both cavernous sinus; accordingly, we diagnosed the patient's disease as traumatic CCF. We performed TFCA for accurate lesion confirmation, but carotid selection failed due to aortic elongation and tortious vessel, and we confirmed CCF by performing aortogram. As the symptom was appearing mostly at the right side, we planned CCF embolization through Rt. carotid exposure.

Result : We conducted right carotid artery angiography after the direct carotid puncture through right neck dissection, but we couldn't observe the fistula point at the right ICA, ECA angiogram. After several days, we performed a left carotid direct approach. Fistula flow through the left ICA was observed on the angiogram, and showed signs of influx of fistula flow into the right side through intercavernous sinus. After identifying the fistula point, we performed coil embolization of the right side fistula lesion first through intercavernous sinus, and then performed embolization of the left side lesion towards the fistula point. As a result, we identified signs of disappearance of CCF on the final angiogram, and the patient's eye symptom got better in three days.

Conclusion : Accordingly, we confirmed that when traumatic CCF occurs, there was not a lesion necessarily on the side having a symptom, and that symptoms appeared diversely according to the venous drainage pattern. Also, we could learn that it' s necessary to take into account the both sides all when setting up a treatment plan. In addition, direct carotid approach was might be good option when in case a transfemoral approach was difficult to make.

A comparison Between Ultrasound-guided and Fluoroscopy-assisted common Femoral Artery Puncture in a Vascular Procedure for Diagnostic and/or neuro-Interventional Purposes

진 성 원 고려대 안산병원

Sung won Jin, Dong jun Lim, Won hyoung Kim, Seung hwan Lee, Sung gon Ha, Sang dae Kim

Department of Neurosurgery, Korea University Ansan Hospital

Objective : Ultrasound (US) guidance for vein access have become "standard treatments" to prevent access site complications, but it is not widely used in neuro-interventional population that arterial access. We performed the retrospective study of US guided femoral access during neuro-interventional procedures.

Methods : The patients, undergoing a vascular procedure for diagnostic and/or neuro-interventional purposes, were compare to undergo US-guided and fluoroscopy-assisted common femoral artery (CFA) puncture.

Result : Complications was occurring 1 groin hematoma and 1 pseudoaneurysm in the fluoroscopy-assisted group.

Conclusion : US-guided technique is safer for CFA puncture when compared to the fluoroscopic-assisted technique alone. The method was particularly helpful in the patients with un-palpable pulsation of femoral arteries.

Several Impressive Experiences as a Beginner Neurovascular Surgeon

김 종 훈 영남대병원

Jong Hoon Kim, Tae Hee Shin, Young Jin Jung, Chul Hoon Chang

Yeungnam University Medical Center

Objective : When performing independently endovascular treatment of neurovascular disease as a beginner, we will encounter various difficulties.

Methods : As a beginner endovascular neurosurgeon, the first author had experienced 56 cases of endovascular treatment during recent 6 months. There were 23 cases of ruptured aneurysm which were treated with endovascular embolization or endovascular trapping, 16 cases of unruptured aneurysm which were treated with endovascular embolization, and 15 cases of large artery occlusion of ischemic stroke which were treated with intra-arterial thrombolysis. And there was 1 case of carotid artery stenting and 1 case of AVM which was treated with onyx embolization.

Result : Endovascular embolization without stent was performed 20 cases in ruptured aneurysm patients and embolization with stent was performed 3 cases in ruptured aneurysm patients. Endovascular embolization without stent was performed 9 cases in unruptured aneurysm patients and embolization with stent was performed 7 cases in unruptured aneurysm patients. Intraoperative rupture cases were 2 in ruptured aneurysm patients and thromboembolic cases were 4 in ruptured aneurysm patients. And Thromboembolic case was 1 in unruptured aneurysm patient. Total morbidity cases were 2 and mortality case was 1.

Conclusion : It is important to share experiences among your peers and senior neurovascular surgeons.

Initial Clinical Experience of LVIS Jr. Stent in Coil Embolization of ACA and MCA Aneurysm

김 성 림 가톨릭대 부천성모병원

Seong-Rim Kim, Hoon Kim, Young-Woo Kim, Ik-Seong Park

Deparment of Neurosurgery, Bucheon St. Mary's Hospital, The Catholic University of Korea

Objective : The purpose of this study is to report authoors' initial clinical experience of coil embolization using LVIS Jr. stent in patients with ACA/MCA aneurysm.

Methods : From March 2015 to May 2016, forty patients (male 16, female 24) underwent stent-assisted coil embolization using LVIS Jr. stent. Mean age was 65 years with a range of 32 to 90. Twenty three patients (UIA 22, SAH 1) presented with MCA aneurysm and seventeen (UIA 14, SAH 3) with ACA aneurysm. Medical records and imaging studies were reviewed retrospectively.

Result : Stent-assisted coil embolization was successful in all patients. Immediate angiographic results revealed complete occlusion in 22 (55%) patients, near-complete occlusion in 14 (35%), partial occlusion in 4 (10%). In patients with UIA, procedure related morbidity/mortality was not found. In patients with SAH, thromboembolic complication was observed in 2 patients. One patient showed intraoperative stent thrombosis, rescued by intraarterialurokinase administration. The other exhibited postoperative cerebral infarction in the target-vessel territory.
Six-month follow-up angiography was available in 32 patients. Complete occlusion was found in 24 (75%) patients, near-complete occlusion in 7 (22%), partial in 1 (3%). Late stent thrombosis was noted in one (3%) patient, which was asymptomatic.

Conclusion : In this series, stent-assisted coil embolization using LVIS Jr. stent in patients with ACA/MCA aneurysm was safe and effective. In patients with SAH, thromboembolic complications can be an issue.

The Safety and Feasibility of LVIS Jr Stent

오 재 상 순천향대 천안병원

Jae-Sang Oh, Seok-Mann Yoon, Jae-hyun Shim, Hack-Gun Bae

Soonchunhyang university Cheoan hospital, neurosurgery department

Objective : We investigate the safety and efficacy of LVIS Jr stent on stent-assisted coil embolization (SAC).

Methods : Total 17 unruptured intracranial aneurysms (UIAs) were treated with LVIS Jr stent for SAC. Location was as follows; 10 Acom, 4 MCA, 2 Pcom, and 1 ICBF, respectively. Largest diameter of aneurysm was from 2.7 to 8.6 mm. Four of 17 IAs were treated for regrowing aneurysms after simple coiling.

Result : Immediately angiographic result were as follows; I (13), II (4). Silent emboli on post-procedural DWI was shown in 9 patients. All patients had good recovery. LVIS Jr stent was successfully deployed on two Pcom aneurysms with fetal Pcom artery, although even IC-Pcom angle of those was very tortuous. In another case, during double-catheter assisted coiling for one MCBF aneurysm, coil loop herniation was successfully rescued with LVIS Jr stent. However, sometimes LVIS Jr had technical problems in some situation. When parent artery was so tortuous, partial deployment of LVIS Jr stent or unexpected deployment on undesirable location were occurred. And these led to the thromboembolic event. Four cases had repositioning trials during stent deployment for appropriate location, and one of these had thromboembolic event.

Conclusion : Although LVIS Jr stent is a convenient device, we should consider that sometime it result in the technical problem during deployment of it.