제 25 회 대한정위기능신경외과학회 정기 학술대회 및 총회

2019

제25회 대한정위기능신경외과학회 정기 학술대회 및 총회

New Era of Korean Society of Stereotactic and Functional Neurosurgery

일시: 2019년 3월 30일(토) 07:30–18:20
장소: 가톨릭대학교 인천성모병원 신관 15층 마리아홀

주최: 대한정위기능신경외과학회
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2019년
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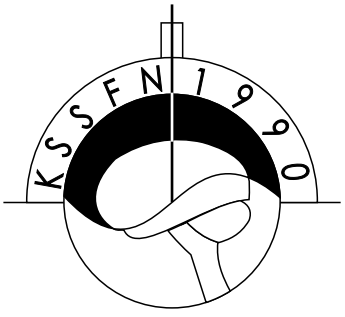
제25회 정기 학술대회



일시: 2018년 3월 30일(토) 07:30-18:20

장소: 가톨릭대학교 인천성모병원 신관 15층 마리아홀

주 최 : 대한정위기능신경외과학회

주 관 : 대한신경외과학연구재단

제23대 대한정위기능신경외과학회 임원명단

2018. 4. 1 – 2019. 3. 31

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간사(홍보)	양 세 연	가톨릭의대
〃	정 나 영	연세의대
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인 사 말

존경하는 회원 여러분!

각박한 의료 현실처럼 추운 겨울이 지나고 새싹이 돋아나는 계절 3월에 대한정위기능신경외과학회 제25회 정기 학술대회를 개최하게 되어 매우 기쁘게 생각합니다.

지난 1년간 우리 집행진은 날로 어려워지고 있는 의료 현실에 대응하고, 학회의 보다 발전적인 성장을 위해 정진해왔습니다. 새로운 진료 영역을 확대하고 그간 적극적으로 시행하지 못했던 본래의 우리 영역을 회복하기 위한 노력도 경주했습니다. 이러한 노력의 성과를 이번 정기 학술대회에서 **"New era of Korean Stereotactic and Functional Neurosurgery"** 라는 테마를 가지고 진행합니다.

이번 정기 학술대회에서는 예년과 같이 각 분야로 나누어 심포지엄과 초청연자 특강을 준비하였습니다. 이에 저명한 두 분의 해외 초청연자를 모셨습니다. 스웨덴 Umea University의 Blomstedt 교수님은 수많은 국제학회에서 흥미로운 연제 발표로 명성이 높으신 분으로 평소 우리가 접하기 어려웠던 유익한 강의를 해주실 것입니다. 일본 Fukuoka Mirai Hospital의 Miyagi 선생님도 흥미로운 최신 지견에 대해 강의를 하실 예정입니다.

심포지엄에서는 각 분야의 전문가들을 모셔서 세부적이고 다양한 강의를 준비하였습니다. 자유연제 발표 시간에는 더욱 발전된 내용의 논문들이 발표되리라 기대되며, 풍성한 학술 교류가 이루어질 것입니다.

바쁘신 일정에도 불구하고 참석하시어 자리를 빛내주신 많은 선생님들께 진심으로 감사드리며, 대한정위기능신경외과학회의 발전과 개인의 학문적인 발전을 위해 회원님들의 지속적인 관심과 참여 부탁드립니다.

감사합니다.

2019년 3월 30일

대한정위기능신경외과학회 회장 **허 륭**

제2회 뇌전증뇌심부자극술연구회 심포지엄 및
제25회 대한정위기능신경외과학회 정기 학술대회 전야제

일시: 2019년 3월 29일(금) 16:00–22:00
장소: 인천 경원재 앰배서더 호텔

16:00-17:00 **대한정위기능신경외과학회 상임이사 회의**

제2회 뇌전증뇌심부자극술연구회 심포지엄
(The 2nd Symposium of Korean Epilepsy DBS Study Group)

17:00-17:05 **개회사** — 뇌전증뇌심부자극술연구회 회장 **이정일**

17:05-17:10 **축 사** — 대한정위기능신경외과학회 회장 **허 륭**

17:10-18:10 **Part I: Neuroanatomical Basis for Deep Brain Stimulation for Refractory Epilepsy**
좌장: 성균관대 **이정일**, 가톨릭대 **손병철**

18:10-18:15 **Part II: Recent Trends in Epilepsy DBS** — 좌장: 전북대 **최하영**, 서울대 **백선하**

18:15-18:30 **총회 및 토의(경과보고/뇌전증 DBS 보험문제)** — 뇌전증뇌심부자극술연구회 회장 **이정일**, 뇌전증뇌심부자극술연구회 총무 **홍석호**

18:30-18:35 **폐회사** — 뇌전증뇌심부자극술연구회 회장 **이정일**

18:35-22:00 **제25회 대한정위기능신경외과학회 정기 학술대회 전야제**

제25회 대한정위기능신경외과학회 정기 학술대회

일시: 2019년 3월 30일(토) 07:30–18:20
장소: 가톨릭대학교 인천성모병원 신관 15층 마리아홀

07:30-08:00 **등 록**

08:00-08:10 **개회사** 대한정위기능신경외과학회 회장 **허 륭**

축 사 대한신경외과학회 이사장 **오창완**

격려사 대한정위기능신경외과학회 명예회장 **정상섭**

08:10-09:00 **Scientific Session I: Movement Disorders** 좌장: 서울대 **백선하**, 인제대 **김무성**

09:00-09:40 **Special Lecture I** 좌장: 가톨릭대 **허 륭**

09:40-10:40 **Symposium I: Novel Strategy for Epilepsy Surgery** 좌장: 인제대 **정용태**, 성균관대 **홍승철**

10:40-11:00 **Coffee Break and Poster Presentation I**

제2회
뇌전증뇌심부자극술연구회
심포지엄

1. Functional and Surgical Anatomy of Anterior Thalamic Nucleus

Kyung Rae Cho, MD

Department of Neurosurgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea

The ANT consist of 3 subnuclei with distinct connectivity with the subicular cortex, retrosplenial cortex, and mammillary bodies. The anterior nuclear group (ANT) occupies the superior region of the thalamus and is separated from the rest of the thalamus by the anterior internal medullary lamina, resulting in a Y-shaped lamina. The ANT consists of the anteroventral (AV), anterodorsal, and anteromedial (AM) nuclei. The AM is the only subnucleus of the ANT that has extensive reciprocal connections with the anterior cingulate and orbitomedial prefrontal cortex. The AM may thus relay feed-forward information from the subiculum, retrosplenial cortex, and medial mammillary nucleus to medial frontal lobe areas involved in executive and emotional functions. The AV subnucleus has the most extensive interactions with the subiculum and retrosplenial cortex and, together with the medial mammillary nucleus, conveys theta rhythm activity that promotes synaptic plasticity in the hippocampal circuit. The anterodorsal is interconnected with the lateral mammillary nucleus, postsubiculm, and retrosplenial cortex, as a component of a circuit that conveys head-direction signals required for spatial navigation. Its complex connectivity, as well as its electrophysiologic properties, including the ability of its AV subnucleus to convey hippocampal theta rhythm to downstream cortical areas, indicates a role of the ANT in mechanisms of cortical plasticity. The ANT may have an important role in seizure propagation and as target for DBS in selective patients with medically refractory seizures.

MEMO

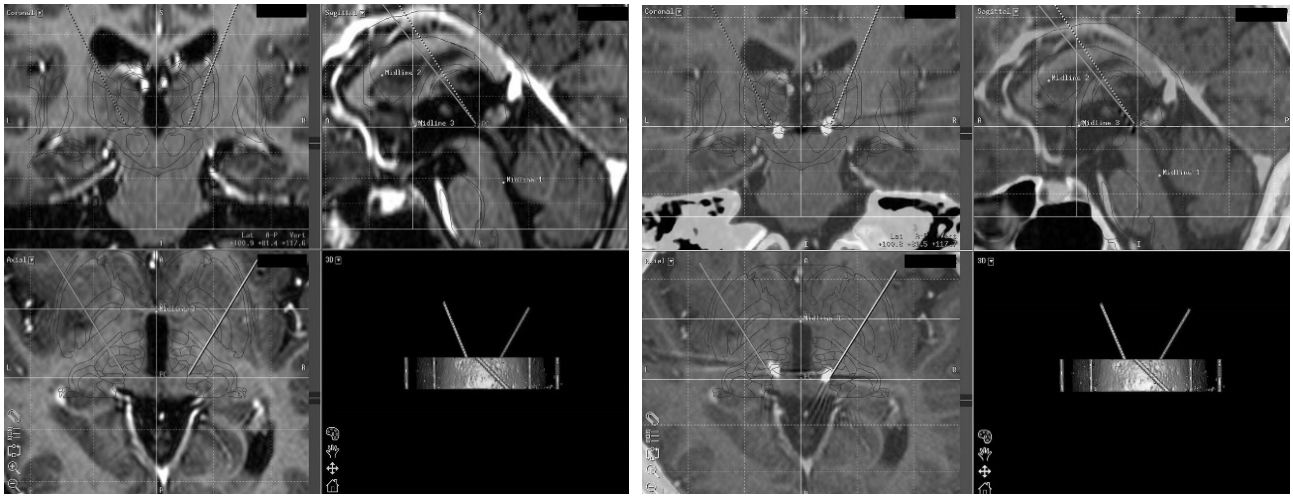
2. Centromedian Nucleus and Intralaminar Nucleus

Byung-chul Son, MD, PhD

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

DBS for refractory epilepsy

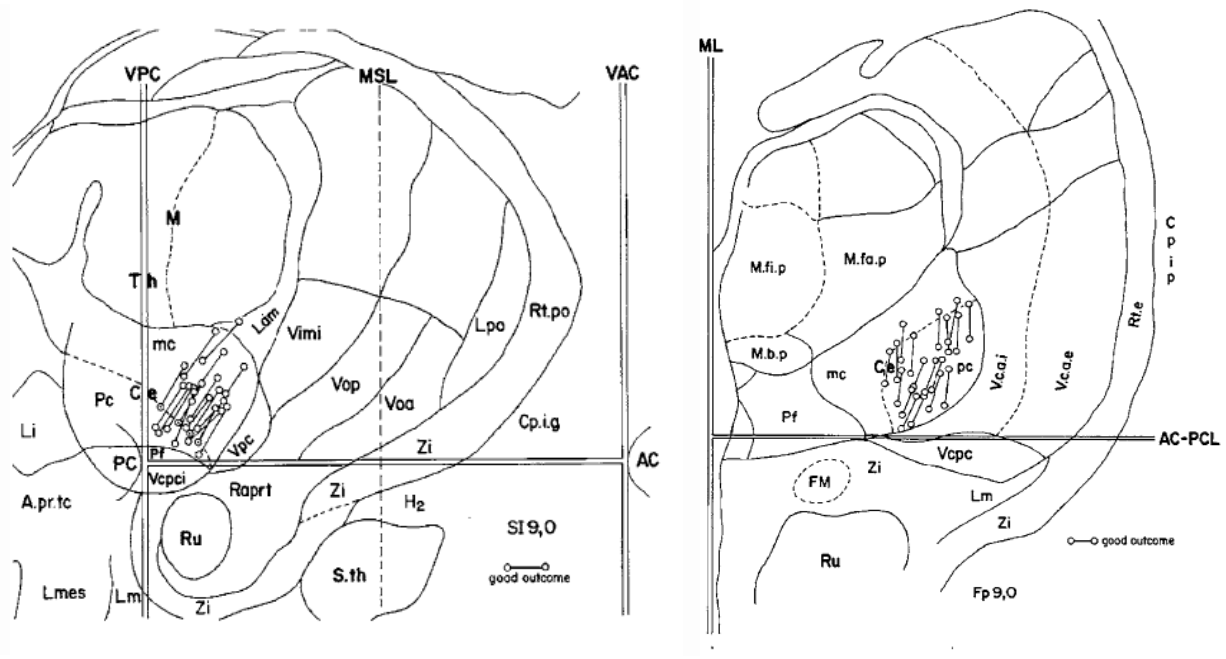
Given the large proportion of patients who fail medical therapy and who are not candidates for surgical resection, as well as suboptimal seizure control by vagus nerve stimulation, the search for appropriate brain structures to serve as targets for DBS has generated a useful body of evidence to serve as the basis for larger investigations. Early results of the SANTE trial should lay the foundation for widespread implementation of DBS for epilepsy targeting the anterior thalamic nucleus (ATN). Five-years long-term follow-up of the SANTE trial showed sustained efficacy with a 69% reduction in seizure frequency and a 34% serious device-related adverse event rate. The theoretical underpinnings of DBS are enticing. Partial onset seizures propagate through a variety of well-described and discrete anatomic locations in the brain, echoing the circuitry of the basal ganglia that prove amenable to modulation by DBS. Neurons adjacent to stimulating electrodes appear to undergo long-term inactivation following stimulation, leading to interruption of pathologic network activity.



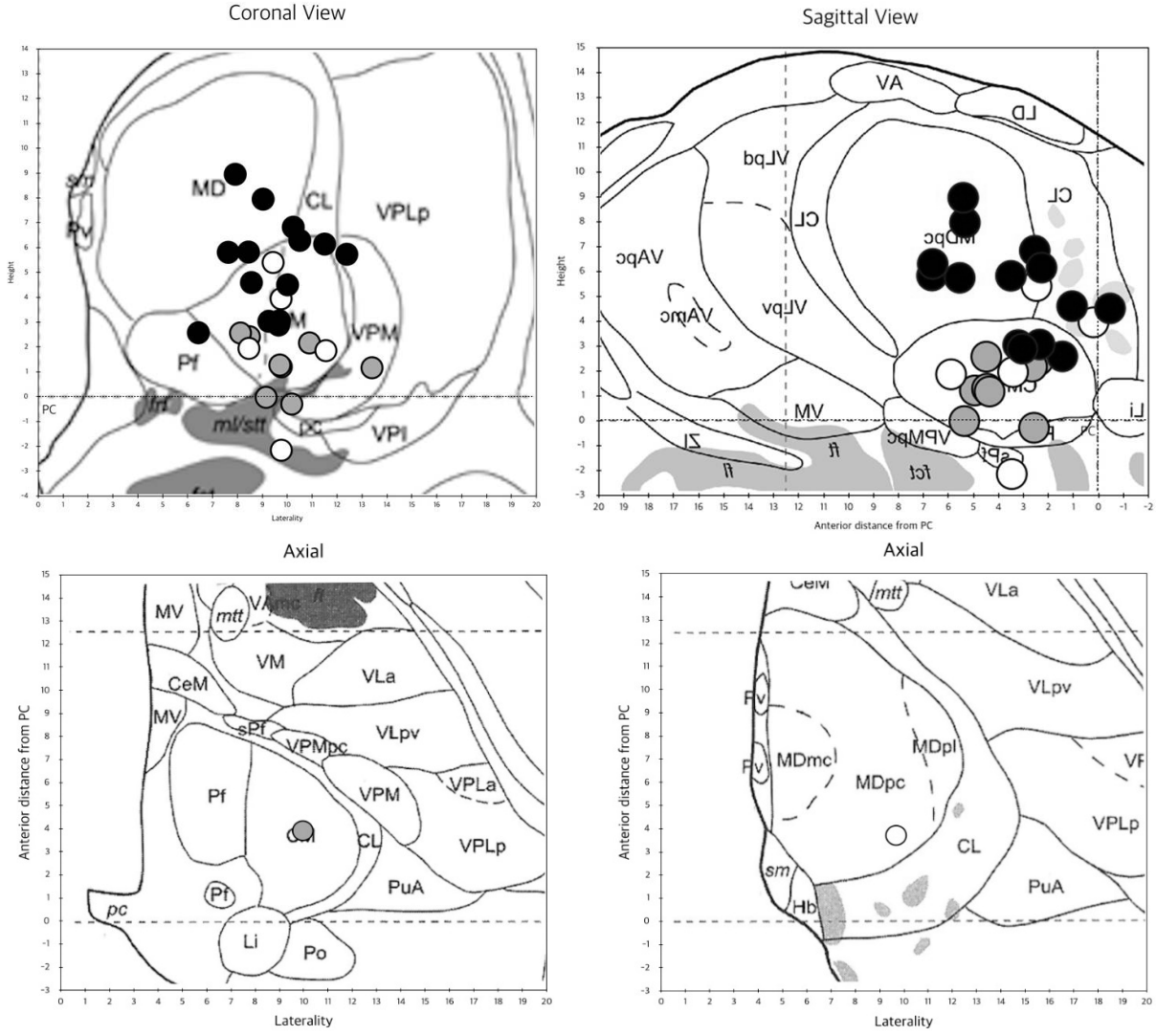
CM as a target for refractory epilepsy

The CM and parafascicular (Pf) nuclei have been traditionally regarded as a single complex in rodents that represent the essential part of the caudal intralaminar nuclei of the thalamus, which is involved in limbic motor function. However, in primates, these can be reliably separated and the lateral part of the rat PF nucleus is homologous to the primate CM nucleus. The CM of the thalamus is part of the reticulo-thalamo-cortical system that mediates cortical excitability and crucially participates in the modulation of the conscious state.

The rationale for CM intervention is when epilepsies arise due to inputs to the CM-Pf complex from the brainstem reticular core, connections with thalamic reticular nucleus and forebrain efferents, as well as a traditional view implicating intralaminar nuclei in generation of diffuse cortical recruiting and augmenting responses. In primates, neurons in the CM nucleus project mainly to the striatum and diffusely to the cerebral cortex and ipsilateral central and precentral motor areas are the primary cortical projection targets of CM. Ipsilateral central and precentral cortical projecting CM neurons are distinct from those projecting to the sensorimotor striatum and those in a lateral crescent of CM preferentially project to the cerebral cortex. Interestingly, the locations of optimal electrodes in CM for generalized epilepsy were within the ventrolateral (parvocellular) CM, and this area corresponded to the lateral crescent of CM, which preferentially projects to central and precentral cortices. Consequently, CM stimulation would be expected to be most effective in generalized and frontal epilepsies, and less so in temporal lobe epilepsy, as initially suggested.



This concept was verified electrophysiologically in a cortical activation study demonstrating reproducible time-locked cortical responses (CRs) with low frequency (2 Hz), suprathreshold stimulation in a patient with CM DBS with statistical non-parametric mapping of low-resolution electromagnetic tomography (LOREA) values. Bipolar CM stimulation led to a rather diffuse and widespread, though highly significant and still mainly predominant ipsilateral cortical action. This diffuse CR pattern agreed well with the presumed widespread and polysynaptic pathway responsible for modulation of cortical activity by CM. In addition, LORETA revealed additional cortical activation of ipsilateral somatosensory areas (BA 1-4, and 40). Therefore, the CM seems a logical target, based on anatomic and neurophysiological data, for its role in gatekeeping and rhythm generating activities. In line with this, our study incorporated several refractory patients whose epilepsies are multifocal and associated with congenital malformations like schizencephaly located adjacent to frontal somatosensory areas.



CM stimulation for epilepsy

The CM has received considerable attention as a site of neurostimulation following the pioneering studies of Velasco et al. Their studies suggested that patients with generalized epilepsy in particular appear to benefit from CM stimulation, as demonstrated by reductions in the incidence of EEG spiking and in the frequency of generalized tonic-clonic seizures and atypical absences. More specifically, patients with temporal lobe epilepsy appear not to improve with CM stimulation. Our preference in thalamic stimulation for refractory epilepsy is that we prefer ANT stimulation, incorporating mediodorsal nucleus (MD), for temporal or frontotemporal epilepsies and CM stimulation for generalized epilepsy, epilepsies diffusely arising adjacent to somatosensory cortices, and multifocal epilepsies according to the previous reports and electrophysiological evidence of cortical activation.

Lead location and clinical outcomes

Regarding the optimal target location for CM stimulation, Velasco et al. indicated that the target point for the CM electrode tip was a distance of 10 mm lateral from the midline and the intersection of the AC-PC line with vertical line passing at the anterior border of the PC (VPC) and the lead which showed 〉80% reduction of seizure frequency in final 3 months of follow-up was localized in the ventrolateral part of the CM (parvocellular), whereas those associated with 〈80% seizure reduction had more dorsal, posterior, or medial placements. The effectiveness of DBS lead placement in this target point was replicated in several reports of CM stimulation; the present results also support it.

The location of active stimulating contact seems to be always in the ventrolateral part of the CM. However, the active contact in our experience was changed by the epileptologist according to changes of the seizure frequency during follow-up. Most frequently chosen contact was contact #1 in monopolar stimulation. If the mean value of the coordinates of the active contact is searched on the stereotactic atlas, it generally corresponded to anterior and superior corner of CM. This area also involves the posterior ventral part of the medial dorsal nucleus (MDpc), central lateral nucleus (CL) of internal medullalry lamina (IML), and posterior part of ventrolateral nucleus (VLP). Considering that the electrical field of the DBS electrode has been estimated to comprise several millimeters when using clinically effective stimulation parameters, i.e. monopolar cathodic high frequency stimulation with a voltage of 3 V and a pulse width of 100 μs, the actual stimulation effect of our CM stimulation would be a summation of neural activation of complex areas of CMpc, MDpc, CL of the IML, and VLP, and not merely the modulatory effect of the ventrolateral CM alone.

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MEMO

3. Temporal Lobe and Limbic Circuit Related to Epilepsy

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Temporal lobe epilepsy (TLE), or limbic seizures refers to epileptic seizures originating in the limbic system, which typically begins with an aura, or focal seizure occurring in isolation or progress into a focal dyscognitive seizure that usually consist of behavioral arrest, staring or automatism. This type of seizure has relatively uniform pathological lesion in the mesial temporal region with hipocampal sclerosis, and the underlying pathophysiology has been well studied compared to other types of extratemporal epilepsy. The basic pathophsyology of TLE is the repeated injury to the brain by kindling, especially in the hipocampal complex. In kindling model, injury from the febrile seizures can make neuronal loss in the hilar region of the dentate gyrus and CA1 area of the hippocampus. The neuronal loss in the hilar region, especially the reduction of the mossy cells, can lead to abnormal synaptic reorganization in the dentrite of the dentate granular cells, which then result in positive feedback circuits for epileptic seizures. In patients with TLE, pathological changes are also observed in the amygdala and entorhinal area, and midline thalamic region.

The limbic circuits including mesial temporal structures and thalamic nuclei can modulate this abnormal phenomenon in either inhibitory or excitatory direction. Recent studies suggested that midline thalamic nuclei have a profound effect in the limbic seizure activity, which can be a theoretical background for deep brain stimulation of the anterior thalamic nuclei in patients with intractable epilepsy.

This presentation will review anatomical and physiological property of the limbic circuits and temporal structures, considering epileptogenesis of limbic seizures and potential therapeutic application.

MEMO

4. Recent Literature Review of Epilepsy DBS

Hae Yu Kim, MD

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Prevalence of epilepsy is 1% of all population worldwide. About 30% of epilepsy patients has been known as medically intractable. Surgical strategies for intractable epilepsy include resection of epileptic focus, disconnection of pathological area for normal brain, and neuromodulation therapy. Deep brain stimulation (DBS) is now accepted as effective neuromodulation therapy for intractable epilepsy patients who are not indicated for resection.

Majority of DBS targets reported in literature were anterior thalamic nucleus, centromedian thalamic nucleus and minority of them were subthalamic nucleus, hippocampus and cerebellum. Here the author reviewed in literatures about possible mechanisms of DBS, targeting method and tactic hitting target precisely, and clinical results after epilepsy DBS.

MEMO

Greetings and Nation-wide Study of Epilepsy DBS

Medtronic Korea

MEMO

제25회
대한정위기능신경외과학회
정기 학술대회

Scientific Session I

Movement Disorder

좌장: 서울대 **백선하**, 인제대 **김무성**

MD-1. Improving Forelimb Akinesia Through Optogenetic Inactivation of the Entopeduncular Nucleus in a Parkinson's Disease Model

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Purpose: We performed optogenetic inactivation of rats' entopeduncular nucleus (EP, homologous to primates' globus pallidus interna (GPi) and investigated the therapeutic effect of optical stimulation in PD.
Methods: 6-Hydroxydopamine (6-OHDA)-induced hemiparkinsonian rats were injected with either a virus for halorhodopsin expression or a control virus injection and received optic fiber insertion and 590 nm of light illumination. Each rat was then subjected to sequential sessions of stepping tests under controlled illumination patterns.
Results: The number of adjusting steps was significantly higher in experimental than control rats. Continuous EP illumination showed a significantly higher improvement of forelimb akinesia than other illumination patterns. Optogene expression in the GABAergic neurons of the EP was confirmed by immunohistochemistry.
Conclusions: Optogenetic inhibition of EP was effective to improve contralateral forelimb akinesia. However, further studies using prolonged illumination are needed to investigate the best illumination pattern for optogenetic stimulation.

MEMO

MD-2. Clinical Outcome Prediction with Deep Learning from Microelectrode Recording of Subthalamic Deep Brain Stimulation in Parkinson Disease

Kwang Hyon Park[1], Sukkyu Sun[2], Yong Hoon Lim[1], Beom Suk Jeon[1], Hee Chan Kim[3], Sun Ha Paek[1]

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Objectives: Deep brain stimulation (DBS) of the subthalamic nucleus (STN) is an effective treatment to improve the motor symptoms of advanced Parkinson disease (PD). Accurate positioning of the stimulation electrodes to STN is mandatory for better clinical outcomes. However, the precise identification of the STN during the microelectrode recording (MER) is not easy. In this study, we analyzed clinical outcome guided deep learning based prediction of motor function improvement from MER after bilateral STN DBS in PD patients.

Methods: 696 left MER segments of 4 seconds length from 34 PD patients who underwent bilateral STN DBS surgery in general anesthesia were included in this study. Thirty patients were assigned to the training set, and 4 patients were assigned to the test set. The wavelet transformed MER and the ratio of DBS on and off Unified Parkinson's Disease Rating Scale (UPDRS) Part III score of the off-medication state were applied for deep learning. According to the ratio, the patients were divided into two groups, good and moderate. Visual Geometry Group (VGG)-16 model with multi-task learning algorithm was used to refer to the bilateral effect of DBS.

Results: When we divided MER according to the frequency band and transformed to wavelets, the max accuracy was the highest in the 50-500 Hz group, compared with 1-50 Hz and 500-5 KHz groups. In addition, when the multitask-learning method was applied to 50-500 Hz group, the stability of the model was prominently improved. The max accuracy was the highest (80.21%) when the loss ratio of right to left was given as 5:1 in the model (77.08% at 4:1, 71.88% at 3:1, 65.63% at 2:1).

Conclusion: Clinical Improvement of PD patients who underwent bilateral STN DBS can be predicted from MER using multitask deep learning. We believe that this may be helpful for electrode positioning in new patients.

MD-3. Accuracy of Deep Brain Stimulation (DBS) Electrode Placement Using O-arm Intraoperative Computed Tomography (iCT) During Image-guided Asleep DBS for Movement Disorders

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Introduction: Intraoperative imaging allows near-real-time assessment of stereotactic accuracy during implantation of deep brain stimulation (DBS) electrodes. We investigated the accuracy of DBS electrode placement using intraoperative O-arm iCT during image-guided asleep DBS.

Methods: Over a 24-month period, forty patients (20 patients with Parkinson's disease, 11 with essential tremor, and 9 with dystonia) underwent image-guided, asleep DBS. In the current study, stereotactic accuracy for asleep DBS was investigated in 23 patients (14 patients with PD and 9 with dystonia). Electrode implant locations were the globus pallidus internus (GPI) and subthalamic nucleus (STN) in 16 and 7 patients, respectively. For image-guided asleep DBS, extraoperative 3-T MRI were merged with postframe 1.5-T stereotactic MRI. An image-guided target selection, trajectory planning, and frame-based electrode implantation were performed under general anesthesia. Immediately after electrode implantation, intraoperative O-arm images were taken to verify the accuracy of electrode placement. Coordinates of the target electrodes were transferred to Framelink software® and compared to the image-guided plan to investigate the stereotactic error with respect to side of implantation, target, and electrode approach angle, and the distance to the ventricle.

Results: Forty-two electrodes in 23 patients were examined. The average radial error was 1.28±0.27 (n= 42). There was no difference in radial error and Euclidean error between the STN and GPI (1.25 ±0.57 and 1.29±0.28; radial error, 1.58±0.44 and 1.48±0.64; Euclidean error, $p > 0.05$). The coronal approach angle to STN and the distance to the lateral ventricle were significantly greater in GPI targeting ($p < 0.05$). Although no difference was evident in the radial and Euclidean errors in the coronal approach angle and distance to lateral ventricle between the right and left STN, there was tendency in medial placement in the right STN asleep DBS (1.529±0.36 and 0.93±0.63, respectively. p=0.057). In the both

sides of the GPI implantation, no difference in the radial and Euclidean errors, coronal angle, distance to lateral ventricle was found ($p > 0.05$). No incidence of electrode reposition due to significant misplacement occurred in our initial results. There was no surgical complication experienced related to the surgical procedures in the cohort. The motor and disability scales of the Burke-Fahn-Marsden dystonia rating scale (BFMDRS) improved 65.2% and 58.6%, respectively, at postoperative 6 month. At a median follow-up of 6 months, there was a mean improvement in off- medication, motor part of Unified Parkinson's Disease Rating Scale (UPDRS III) of 27.7 points equivalent to a mean improvement of 52% ($p < 0.001$).

Conclusions: Image-guided, asleep DBS can lead to substantial improvement in motor disability of movement disorders with low morbidity. Our initial results indicate the procedure of image-guided, asleep DBS is safe, with accuracy comparable to those using microelectrode recording under local anesthesia.

MEMO

MD-4. Deep Brain Stimulation on Vim and PSA for Both Hand Tremor and Head Tremor: Two Cases

Hyoung-Gyu Jang, Eun Jeong Koh, Ha-Young Choi

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Objectives: We report the two patients who underwent Deep Brain Stimulation (DBS) on left ventral intermediate nucleus of the thalamus (Vim) and right posterior subthalamic area (PSA) for control of both hand tremor and head tremor, simultaneously.

CASES: First patient is 65-year-old female now. Ten years ago her chief complain was right hand tremor. We planned DBS on left Vim and she underwent surgery on May 2008 to control of right hand tremor. After DBS her symptom was disappeared. However, 2 years after DBS on left Vim she presented head tremor and left hand tremor. We performed DBS on PSA on November 2013. After second operation her symptom was relieved. She is symptom free until now.

Second patient is 56-year-old male. He suffered from both hand tremor and head tremor which were simultaneously occurred. His hand tremor was more severe on right hand than Lt. hand. We planned bilateral DBS on left Vim for right Hand tremor and right PSA for head tremor. After operation his symptoms were disappeared.

Conclusion: In case of simultaneous both hand tremor and head tremor contralateral Vim DBS on more severe hand tremor side and PSA DBS on the other side could be good targets for tremor control.

Key Words: Tremor, Deep brain stimulation (DBS), Ventral intermediate nucleus (Vim), Posterior subthalamic area (PSA)

MEMO

MD-5. Intrathecal Baclofen Pump versus Globus Pallidus Interna Deep Brain Stimulation in Adult Patients with Severe Cerebral Palsy

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Objective: There is no consensus on a standardized approach to spasticity or dystonia management of cerebral palsy (CP). This study aimed to investigate clinical outcomes and compare therapeutic responses for pallidal stimulation versus intrathecal baclofen (ITB) therapy in adult patients with severe CP.

Methods: We retrospectively reviewed CP patients treated with deep brain stimulation (DBS) of the globus pallidus internus (GPi) or implantation of ITB pump between June 2003 and April 2017. Patients were included if they were clinically diagnosed with medically intractable cerebral palsy and had 〉12 months of post-procedural follow-up data. Patients were assessed before and 12 months post-treatment using the Visual Analogue Scale, Burke-Fahn-Marsden Dystonia Rating Scale, self-rating improvement scale, and 36-item short form general health survey questionnaire.

Results: Patients (n=22) were divided into GPi DBS (n=12), and ITB therapy (n=10) groups. For the Burke-Fahn-Marsden Dystonia Rating Scale, DBS group movement scores and ITB group disability scores were significantly improved post-treatment. Although Visual Analogue Scales did not differ between groups, self-rating improvement scores differed significantly between groups. For quality of life, physical functioning, body pain, vitality, social functioning, and mental health significantly improved in ITB group 12 months post-treatment compared to those of preoperative period. Only mental health differed significantly between groups.

Conclusions: Despite retrospective design and relatively low number of cases, this study indicated that ITB therapy was less invasive and more effective in improving the quality of life compared to GPi DBS. ITB therapy should be considered an alternative treatment for patients with severe CP.

MD-6. Can Advancing Age be Risky to be Undergone DBS Surgery ?

장 일, 허 룡

가톨릭대학교 의과대학 인천성모병원 신경외과

Objectives: Deep brain stimulation (DBS) is a well-established modality for the treatment of movement disorders such as parkinons disease (PD), essential tremor (ET), dystonia. Although no specific age cutoff has been defined, most clinical studies have excluded patients older than 75 years of age due to various perioperative complications. Among those complications, We hypothesize that increasing age would be associated with an increased number of postoperative intracranial bleeding.

Methods: A retrospective cohort study was performed using the Incheon St. Mary hospital database that examined 111 patients who underwent DBS for PD, ET and dystonia during the period from Oct, 2011 to Dec, 2018. Multivariate logistic regression analysis was used to calculate intracranial bleeding-related odds ratios (ORs) within the elderly group after controlling for covariates.

Results: Overall, 6 of 111 patients (5.4%) experienced postoperative intracranial bleeding including subdral hemorrhage (1.8%), cerebral hemorrhge (3.6%). After adjusting for covariates, we found that advancing age (ranging from ≥65 years of age) significantly affect overall intracranial bleeding rates (OR, 6.07 [95% CI, 1.05-35.12]; p=0.045). Within the elderly group, Previous small vessel disease (OR, 3.04 [95% CI], p= 0.42) and DBS target (OR, 1.70 [95% CI]; p=0.59) did not significantly affect the bleeding.

Conclusions: Older patients with movement disorders (〉65 years) who were selected to undergo DBS surgery showed a significant intracranial bleeding risk compared with younger group. Our findings suggest that age can be a primary exclusion factor for determining candidacy for DBS.

MEMO

MEMO

Special Lecture I

좌장: 가톨릭대 **허 륭**

CURRICULUM VITAE

Patric Blomstedt, MD, PhD

Patric Blomstedt studied medicine in Umeå, Sweden, where he continued his training in 1997 in Neurosurgery with Marwan Hariz as his mentor.

He received a PhD in 2007.

He became a professor in stereotactic functional neurosurgery in 2013 and is currently the head of the Unit for stereotactic functional neurosurgery in Umeå.

He has written more than 150 scientific papers and book chapters and his current research is mostly focused on the Zona incerta as a target for DBS in movement disorders and DBS in the treatment of psychia tric disorders.

He is also director of the internet based E-learning resource-Stereotactic Academy (www.stereotactic.org).

Functional Neurosurgeon Where Did We Come from and Where are We Going ?

Patric Blomstedt, MD, PhD

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Stereotactic and functional neurosurgery had its first heyday beginning in the 40ies and continuing into the late 60ies. This period saw a great expansion of the field within both movement disorders and psychiatric disorders. During this era most targets used today for DBS were identified and many techniques such as DBS, focused ultrasound and gamma knife was first introduced. Then three decades of stagnation followed the introduction of L-dopa for Parkinson's disease, before the Renaissance of stereotactic functional neurosurgery was initiated with the re-introduction of the pallidotomy and the birth of modern DBS. In the last quarter of a century, DBS has become an established neurosurgical treatment for Parkinson's disease, dystonia, and tremors. Improved understanding of brain circuitries and their involvement in various neurological and psychiatric illnesses, coupled with the safety of DBS and its exquisite role as a tool for ethical study of the human brain, have unlocked new opportunities for this technology, both for future therapies and in research. Serendipitous discoveries and advances in structural and functional imaging are providing abundant "new" brain targets for an ever-increasing number of pathologies, leading to investigations of DBS in diverse neurological, psychiatric, behavioral, and cognitive conditions. Trials and "proof of concept" studies of DBS are underway in pain, epilepsy, tinnitus, OCD, depression, and Gilles de la Tourette syndrome, as well as in eating disorders, addiction, cognitive decline, consciousness, and autonomic states. In parallel, ongoing development with asleep surgery, visual targeting, visual programming, current steering, closed-loop concepts, machine learning etc. will make the procedures better and better. Unfortunately, this is also making the field more complex and more difficult to master, and it is evident that stereotactic functional neurosurgery is turning into a world of its own, to some extent separated from general neurosurgery.

MEMO

Symposium I

Novel Strategy for Epilepsy Surgery

좌장: 인제대 **정용태**, 성균관대 **홍승철**

CURRICULUM VITAE

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Clinical Magnetoencephalography and It's Role for Epilepsy Surgery

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Epilepsy is known to be one of the most common and serious manifestations causing functional disabilities, and the prevalence of epilepsy in children reported as ranging from 3.2 to 5.5/1,000 in developed countries and 3.6 to 44/1,000 in developing countries. Because chronic epilepsy can result in cognitive declines and psychomotor disabilities in later periods of life, it is recommended to early and aggressive control of seizure. However, despite optimized medical treatment, approximately 30% to 35 % of all patients continues to seizures and thereby have medically refractory epilepsy. For these patients, epilepsy surgery will be one of the important options for epilepsy treatment, because epilepsy surgery can reduce seizure activities when compared with continues medical treatment.

The presentation of intractable localization-related epilepsy is often heterogeneous. Patients with hemispheric or unilateral focal etiologies can have generalized seizures and electroencephalography (EEG) patterns, rapid evolution of electroclinical features, progressive neurologic disorders, and bilateral congenital brain syndromes. Therefore, if epilepsy surgery is planned, careful presurgical evaluation including electroencephalography (EEG), structural imaging, metabolic imaging, and neuropsychological evaluation should be underwent and carefully analyzed for exact identification of epileptogenic region or hemisphere. These diagnostic modalities can offer crucial information of epileptogenic region, however, they also have their own weakness such as low spatial resolution of EEG, and low temporal resolution in structural and metabolic imaging. To overcome these limitations of each modality, magnetoencephalography (MEG) had been introduced, and role of MEG for presurgical evaluation and mapping has been largely investigated in past years. Nowadays, MEG has become an essential part of diagnostic workup in all patients undergoing presurgical evaluation in many institutions, and also have been applied for not only epileptogenic localization but also eloquent brain mapping. In this talk, specific characteristics of MEG findings for each epileptogenic lesion and their correlation with findings of other modalities will be reviewed. And, surgical strategy for the patients showing specific findings from presurgical evaluation will be also suggested.

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1995-1996	Intern, Seoul National University Hospital, Seoul, Korea

Qualifications

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Neuromodulation for Epilepsy

홍 석 호

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신경조절치료(neuromodulation treatment)는 약물난치성 뇌전증(medically intractable epilepsy) 환자에서 기존의 절제 수술(resective surgery)이 불가능한 경우 대안적 치료 방법(alternative treatment)의 하나로 현재까지 다양한 방법들이 시도되었다.

미주신경자극술(VNS)은 1988년 첫 시술 이래 다수의 임상시험에서 효과와 안정성이 입증되어 1997년부터 난치성 뇌전증의 표준치료로 승인되었고, 우리나라에서도 2005년부터 국민건강보험이 적용되어 많은 증례가 시술되었다.

전시상핵에 대한 뇌심부자극술(anterior thalamic stimulation)은 무작위대조 임상시험(SANTES trial)에서 임상적 효과가 입증되어 2018년 미국 FDA에서 부분발작의 add-on 치료로 승인되었고, 시상핵 중심정중핵(centromedian nucleus), 시상하핵(subthalamic nucleus), 미상핵(caudate neucleus)에 대한 뇌심부자극술(deep brain stimulation)도 뇌전증 환자에서 유사한 효과가 있음이 보고되었다.

뇌피질의 뇌전증발작 시작부위에 삽입한 전극을 통해 발작의 시작과 관련된 신호를 감지하여 뇌전증발작부위를 자극하는 폐쇄루프 자극법(closed-loop stimulation) 인 responsive neurostimulation(RNS)도 잘 고안된 임상시험이 후 2013년 미국 FDA에서 승인되었고, 더 효과적인 자극 방법을 고안하기 위한 연구가 현재까지 진행되고 있다.

상기 방법 외에도, 직접 뇌전증 발생병소를 자극하는 편도해마자극술(amygdalohippocampal stimulation), 시상하부 과오종 자극술(stimulation of hypothalamic hamartoma), 삼차신경자극술(trigeminal nerve stimulation), 설인신경자극술(glossopharyngeal nerve stimulation), 그리고 비침습적 방법인 반복적경두개자기자극술(repetitative transcranial magnestic stimulation, rTMS) 등도 뇌전증 발생 억제 효과가 있는 신경조절치료로 연구되고 있다.

난치성 뇌전증에서의 신경조절 치료는, 가역적이고 조절가능하며, 뇌절제를 하지 않고 치료할 수 있다는 장점이 있으나, 대부분 작용기전이 뚜렷하게 밝혀져 있지 않고 효과적인 자극 방법과 적응증이 분명하지 않아 향후 이에 대한 추가적인 연구가 필요하다.

MEMO

CURRICULUM VITAE

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학력 사항

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경력 사항

1992	일본 호카이도 아사히가와 의과대학 신경외과학교실 Visiting Researcher in Epilepsy.
1994-1996	Fellowship in graduating training in CLINICAL NEUROPHYSIOLOGY AND EPILEPSY in Cleveland Clinic Foundation, Cleveland, OH. USA
1991-2019	전북대학교 의과대학 신경외과학교실 교수

Renaissance of Lesioning Surgery in Epilepsy

Ha-young Choi, MD, PhD

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- **Surgical success**
  : **Related to** the ability to localize precisely the region of seizure onset
- The chance of **good outcome from surgery**
  : **Structural pathology is neccessarily resected**

- Surgical treatment of patients **without an abnormality on preoperative imaging**
  : **associated with a poor outcome**
- **The identification of cerebral lesion is an important goal** in the management of patients with partial epilepsy

- Epilepsies can be broadly categorized as lesional or non-lesional.
- **Lesional cases** can be result from
  : malformations of cortical development, tumors, vascular malformations, or areas of old injury.
- **Non-lesional epilepsy** shows normal brain MRI.

- **30% of patients** with electrographic evidence of temporal lobe epilepsy **have normal MRI scans.**
- **In 29%** of partial epilepsy patients, **MRI was non-contributive.**
- **Quarter** of all those pre-surgical evaluation presenting **MRI-negative.**

- The overall prevalence of patients with non-lesional epilepsy in all surgical studies
  : 26%
  : significantly higher in patients with extratemporal surgery (45%), than in those with temporal (24%)

Evaluation Methods for Surgery

- EEG
- Semiology (chronic video-EEG monitoring)
- Neuroimaging studies(MRI, SPECT, PET, MRS, 3D surface rendering)
- Magnetoencephalography
- Neuropsychologic test

Lateralizing Signs in Epileptic Seizures

- Versive movements of the eyes and head
- Unilateral facial clonic movements
- Ictal vomiting
- Ictal speech and postictal dysphasia
- Unilateral automatisms
- Unilateral tonic posturing
- Unilateral dystonic posturing
- Automatisms with preserved responsiveness
- Epigastric rising sensation
- Unilateral eye blinking
- Asymmetrical limb posturing (Figure 4 sign)

Invasive EEG

- Incongruency
- visualization

Brain mapping

- Anatomical mapping
- Functional mapping

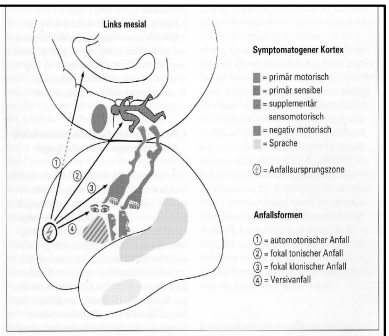

Abb. 1: Für den mesialen und lateralen Aspekt der linken Hemisphäre ist die topische Verteilung folgender Regionen dargestellt: 1) primär motorischer Kortex, 2) primär sensibler Kortex, 3) supplementär sensomotorischer Kortex, 4) negativ motorischer Kortex und 5) Sprachregionen.
Darüber hinaus sind schematisch 4 verschiedene, von einem epileptogenen Areal im Frontallappen beginnende Ausbreitungswege eingezeichnet. Die klinische Anfallssymptomatik hängt davon ab, welche symptomatogene Zone in die epileptische Erregung einbezogen wird. Bei Ausbreitung in den anterioren Gyrus cinguli kommt es zu automotorischen Anfällen. Erregung der supplementär sensomotorischen Region führt zu fokal tonischen Anfällen. Fokal klonische Anfälle entstehen bei Ausbreitung in die primär motorische Region und Versivanfälle, wenn die epileptische Aktivierung das frontale Augenfeld einnimmt.

- **In patients with non-lesional focal epilepsy**
  : Epilepsy surgery results are less favorable
- **The absence of a lesion visualized by MRI**
  : Related to poorer prognosis in resective epilepsy surgery

- **50%** of MRI negative extratemporal resections having an **Engel class I outcome** (free from disabling seizures) if they had focal ictal EEG onset by invasive monitoring

- MRI-negative patients also have the fair outcomes from surgery in several studies.
- Localization (visualization of abnormal structure or recording of focal EEG onset) of epileptogenic foci is most important.
- Congruency of Phase I and Phase II study is important factor of surgical outcome.

Visualization!!!

In neuroimaging studies

In electroencephalographic recordings

MEMO

Poster Presentation I

P-1. Management of Pulse Generators in Occurrence of Breast Cancer in a Patient with in Situ Subthalamic Nucleus Deep Brain Stimulation: Possible Problems Encountered: Report of 2 Cases

Jin-gyu Choi[1], Byung-chul Son[1], Hak-cheol Ko[1], Joong-Seok Kim[2], Woo-Chan Park[3]

Departments of [1]Neurosurgery and [2]Neurology and [3]Surgery, Seoul and Yeouido St. Mary's Hospital, The Catholic University of Korea, Seoul, Korea

Objectives: Although deep brain stimulation (DBS) has been used more than 25 years in treatment of movement disorders, management of DBS hardware is unclear. This especially the case for DBS pulse generators implanted in the anterior chest, in cases of occurrence of breast cancer that require mastectomy, radiotherapy, and future imaging studies. We describe two cases of occurrence of breast cancer in patients with in situ DBS with bilateral pulse generators in the anterior chest.

Patients and Methods:

Case #1. A 62-year-old female patient with advanced Parkinson's disease (PD) who was dependent on bilateral subthalamic nucleus (STN) DBS. She was diagnosed as left breast cancer. To avoid difficulties in breast cancer-related imaging studies, surgery, and radiotherapy, bilateral pulse generators for STN DBS that was previously implanted in the anterior chest wall were repositioned to the anterior abdominal wall with replacement of long extension cables.

Case #2. A 48-year-old female patient who has been dependent to bilateral pulse generators in her anterior chest wall for caudal zona incerta (cZI) DBS for disabling head tremor was diagnosed as left breast cancer. Through careful discussion and consultations, primary surgery for left breast cancer was performed without touching any hardwares in the chest. There was no difficulty during primary surgery, dosimetry planning for radiotherapy, and subsequent radiation therapy.

Conclusions: Coincidence of breast cancer and the need for STN DBS is extremely rare. In this circumstance, management of DBS hardware, especially the pulse generator in the upper chest, may pose a technical challenge. The several treatment options can be complex.

P-2. Focused Ultrasound-induced Blood-brain Barrier Opening Improves Cognitive Function and Adult Hippocampal Neurogenesis in a Cholinergic Degeneration Dementia Rat Model

연세대학교 세브란스병원 연구원[1], 신경외과[2]

신재우[1], 공찬호[1], 이지현[2], 심지연[2], 고진수[2], 나영철[2], 장원석[2], 장진우[2]

Objectives: Alzheimer's disease (AD) is one of the major causes of dementia. The neuropathologies of AD include the presence of amyloid-β deposition in plaques, tau hyperphosphorylation in neurofibrillary tangles, loss of synapses, loss of neuronal cells, and cholinergic system degeneration. Focused ultrasound (FUS)-mediated brain-blood barrier opening modulates tau hyperphosphorylation and the accumulation of amyloid-β proteins and increases adult hippocampal neurogenesis. However, whether FUS can modulate the cholinergic system and hippocampal neurogenesis during cholinergic degeneration remains unclear. In this study, we investigated the effect of FUS on the cholinergic system and hippocampal neurogenesis in a cholinergic degeneration rat model of dementia.

Methods: Adult male Sprague-Dawley rats (n=48; 200-250 g) were divided into control (PBS injection), lesion, and FUS groups; in the two latter groups, 192 IgG-saporin was injected bilaterally into the lateral ventricle. FUS rats were sonicated using a single-element transducer with microbubbles. Immunohistochemistry, ELISA, immunoblotting, 5-bromo-2′ -deoxyuridine labeling, an acetylcholinesterase (AChE) assay, and the Morris water maze test were used to assess choline acetyltransferase (ChAT), AChE activity, brain-derived neurotrophic factor (BDNF) expression, neural proliferation, and spatial memory, respectively.

Results: Cholinergic degeneration of lesioned rats significantly decreased the number of ChAT neurons in the basal forebrain as well as spatial memory function. Rats that underwent FUS-mediated brain- blood barrier opening exhibited significant increases in BDNF expression, neurogenesis in the dentate gyrus, AChE activity in the frontal cortex and hippocampus, and crossings over the platform in the Morris water maze relative to the lesion group following sonication.

Conclusion: FUS treatment improved spatial memory in a cholinergic degeneration dementia rat model. This improvement was mediated by the increased hippocampal BDNF, which is critical to adult hippocampal neurogenesis and neuroprotection. Future research on the lifespan of this effect and its applicability to larger animal models is warranted.

P-3. The Effects of Mesenchymal Stem Cell Transplantation Using Focused Ultrasound and Memory Recovery in a 192 IgG-saporin Rat Model

Jihyeon Lee[1,2], Younghee Seo[1,2], Jaewoo Shin[1,2], Chanho Kong[2], Won Seok Chang[2], Jin Woo Chang[1,2]

[1]Brain Korea 21 Plus Project for Medical Science and Brain Research Institute, Yonsei University College of Medicine, Seoul; [2]Department of Neurosurgery, Yonsei University College of Medicine, Seoul, Korea

Objectives: Stem cell therapy has been found to have therapeutic effects in neurodegenerative disease, but traditional transplant methods, such as parenchymal or intravenous injection, possess limitations like secondary injuries, infection, and low survival rate of stem cells in the brain. Meanwhile, recently the focused ultrasound (FUS) was found to have promising results regarding transplantation of stem cells into the rat brain. However, the mechanism of stem cell transplantation with FUS and possibility of cognitive recovery remain elusive. Therefore, this study investigates a possibility for non-invasive focused ultrasound use in stem cell transplantation into the brain of dementia rat model.

Methods: We divided rats into five groups: Normal, Lesion, Cell only, FUS + Cell, and FUS only. We used 192 IgG-saporin for degeneration of basal forebrain cholinergic neuron and it was injected into all rats except for the normal group. After a week, 5p mesenchymal stem cells (MSC: $3*10^6$/200 ul) were injected in the tail vein of all rats of the cell only and FUS + Cell group, and the FUS + Cell group received the FUS three hours before cell transplantation. FUS was applied with parameters of 0.25Mpa, 300s (Targeted hippocampal region: AP -3.5, ML±2). And last, FUS only group was received only FUS without any treatment. Five weeks after transplantation, rats performed the Morris water maze test.

Results: MSC were detected in both cell only and FUS + Cell group of the hippocampus region. After comparing FUS + MSC & cell only rats, it was confirmed that FUS increases MSC homing in the sonicated rat's brain. In addition, the most effective memory restoration occurred in the FUS + Cell group. Moreover, the FUS + Cell group exhibited better recall of the platform position than the other groups. And FUS only group did not recover.

Conclusion: Noninvasive FUS can increase the efficacy of stem cell delivery. And memory impairment due to cholinergic denervation can be effectively improved by cell transplantation with FUS. The results of this study suggest possibility of stem cell homing and therapeutic effects of the FUS in dementia rat model. However, further study regarding the function of stem cells transplanted in the brain and a more detailed mechanism of stem cell homing by FUS is needed.

P-4. Feasibility Study of the Treatment of Focused Ultrasound Reinforced Photodynamic Therapy Ex Vivo: A Preliminary Study for Photodynamic Therapy

Chanho Kong[1], Jaehyuk Kim[3], Jaewoo Shin[1,2], Seung Hee Han[4], Brian Wilson[4], Jin Woo Chang[1,2], Won Seok Chang[1]

[1]Department of Neurosurgery, Brain Research Institute, Yonsei University College of Medicine, Seoul;
[2]Brain Korea 21 PLUS Project for Medical Science, Yonsei University College of Medicine, Seoul;
[3]Health and Medical Equipment, Samsung Electronics, Seoul, Korea
[4]University of Toronto, University Health Network, Toronto, Canada

Objectives: PDT is a form of phototherapy involving light and a photosensitizing chemical substance, used in conjunction with molecular oxygen to elicit cell death. It also treats malignant cancers including head and neck, lung, bladder and particular skin. However, the main limitation of using light in clinical applications is its superficial imaging and therapeutic depth caused by high optical scattering in biological media. We investigated whether the ultrasound light penetration increases ex-vivo in order to develop a PDT for the treatment of brain tumors.

Methods: The continuous wave laser with a wave length of 660 nm was used as the light source. Ultrasound was generated using a ring-shaped 1.5 MHz transducer. The spatial-peak temporal-average intensities of the ultrasound waves were used as 100-200 W/cm^2 and its duty cycle, signal length, and pulse repetition were maintained to be 10%, 100 ms, and 1,000 ms, respectively. Chicken breast (thickness: 5 mm) was immersed in a dish filled with degassed water. The focal length of the transducer was placed 2~3 mm in depth below the surface of the tissue. The light intensity was measured using a CCD camera equipped with an optical lens positioned behind the tissue. We measured the penetration of light according to the sonication parameter of focused ultrasound.

Results: The light intensity was increased when the intensity of the simultaneously transmitted ultrasound was increased to 100-200 W/cm^2.

Conclusion: The focused ultrasound was used to confirm the increased light penetration in the ex-vivo. Also, focused ultrasound parameters have been established within the range that micro bubbles were not generated in the tissue by the ultrasound, and the tissue was not damaged by heat energy generated by the ultrasound. From the results, it sheds light on the new route for overcoming the limitations of current optical imaging and therapeutic techniques.

Special Lecture II

좌장: 가톨릭대 **이태규**

CURRICULUM VITAE

Yasushi Miyagi, MD, PhD

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Undergraduate/Graduate Education and Clinical Training

1983-1989	Medical School: Faculty of Medical Science, Kyushu University
1989-1991	Doctor of Medicine (MD), Residency
1989	Kyushu University Hospital, Department of Neurosurgery
1990	Yamaguchi Red Cross Hospital, Department of Neurosurgery
1991	Kyushu University Hospital, Department of Neurosurgery
1992-1996	Graduate School of Medical Science, Kyushu University, Graduation with Doctor of Philosophy (PhD) in 1996
1996-1999	Kaizuka Hospital, Department of Neurosurgery
1999-2000	Postdoctoral Fellowship, Department of Neurosurgery, University of Mississippi, USA

Research and Professional Experience

2000-2004	Director, Department of Stereotactic and Functional Neurosurgery, Kaizuka Hospital
2004-2006	Assistant Professor, Department of Neurosurgery, Kyushu University Hospital
2006-2010	Associate Professor, Digital Medicine and Initiative, Kyushu University
2010-2016	Director, Department of Stereotactic and Functional Neurosurgery, Kaizuika Hospital
2016-	Director, Department of Stereotactic and Functional Neurosurgery, Fukuoka Mirai Hospital

Memberships

Japanese Congress of Neurological Surgeons
Japan Neurosurgical Society
Japanese Society of Epilepsy Surgery
Japanese Society of Stereotactic and Functional Neurosurgery (Review Board)
Japan Neuromodulation Society (Review board)
Movement Disorder Society Japan
The American Society of Stereotactic and Functional Neurosurgery
International Neuromodulation Society

Directional Current Steering DBS with MICC Technology: 2 Years Experience

Yasushi Miyagi, MD, PhD

Department of Stereotactic and Functional Neurosurgery, Fukuoka Mirai Hospital, Fukuoka, JAPAN

MEMO

Symposium II

New Wave of Non-invasive Intracranial Surgery

좌장: 영남대 **김성호**, 건국대 **조 준**

CURRICULUM VITAE

장 진 우

근무처: 연세대학교 의과대학 신경외과 교수

학력 및 주요 경력

1977-1983 연세대학교 의과대학 졸업
2008-2010 세브란스병원 기획관리실장
2010-2014 연세대학교 의과대학 신경외과학교실 주임교수
2010-현재 연세대학교 의과대학 뇌연구소 소장

현재 주요 국제 학회 임원 활동

국제복원신경외과학회(International Society of Reconstructive Neurosurgery)
2007-2012 회장
2012-현재 상임이사
아시아 태평양 정위기능신경외과학회(World Society for Stereotactic & Functional Neurosurgery)
2011-2014 회장
2014-현재 상임이사
세계정위기능신경외과학회(World Society for Stereotactic & Functional Neurosurgery)
2013-2017 사무총장 겸 재무이사
2017-현재 부회장 겸 차기 회장

국제학술지 편집위원

세계신경외과학회(World Federation of Neurological Surgeons)
2015-현재 학술지(World Neurosurgery): Section Editor
국제신경조절학회(International Neuromodulation Society)
2007-현재 학술지(Neuromodulation) Reviewer
세계정위기능신경외과학회(World Society for Stereotactic & Functional Neurosurgery)
2009-현재 학술지(Journal of Stereotactic & Functional Neurosurgery) Reviewer

주요 국내학회 임원 활동

2016-2018 대한신경외과학회 이사장
2014-2018 대한치료초음파학회 초대회장
2016-2018 대한뇌신경장애연구학회회 회장

High-Intensity Focused Ultrasound: Destruction or Modulation ?

Jin Woo Chang, MD, PhD

Center for Innovative Functional Neurosurgery, Department of Neurosurgery, Brain Research Institute, Yonsei University College of Medicine, Seoul, Korea

Our knowledge of the nervous system in health and disease has, however, increased considerably during the last fifty years. Recently, neurosurgery reveals promising new stereotactic strategies such as neuromodulation by the thermal lesioning, deep brain stimulation, radiosurgery, and a laser ablation to deal with diseases of the central nervous system.

Most recently, the field of MRI guided high intensity focused ultrasound surgery (MRgFUS) is evolving and offers the new hope for the treatment of many brain disorders through both ablative mechanism and non-ablative mechanisms such as drug delivery, neuromodulation and blood brain barrier (BBB) opening. Currently we demonstrated the beneficial effect of MRgFUS by performing incisionless minimally invasive Vim thalamotomy as a treatment for essential tremor (ET). And, we also underwent the clinical studies for the evaluation of the role of MRgFUS in the management of Parkinson's disease (PD), obsessive compulsive disorders (OCD) and depression especially for those who are refractory for the medical managements. As well, we recently are undergoing the clinical trial of the feasibility study of glioblastoma (GBM). All MRgFUS was performed in a 3.0 T MRI (Signa, GE, USA) using the Exablate 4000 device (Insightec, Israel), which features a 30 cm diameter hemispherical 1024 elements phased array transduced operating at 680 KHz or 220 KHZ with immobilization of patient's head by fixation in an MRI compatible stereotactic frame (Radionics, USA). In our clinical trials, we found that MRgFUS was a safe and very effective almost non-invasive surgical method for the medically refractory functional neurological disorders. However, we also notice that there are several important issues and unsolved problems for MRgFUS. In this presentation, I will also demonstrate personal experiences, trouble shootings as well as laboratory works for MRgFUS.

MEMO

CURRICULUM VITAE

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Education

1980-1982	Premedical Course, College of Natural Science, Seoul National University, Seoul, Korea
1982-1986	College of Medicine, Seoul National University
1987-1988	Rotating Internship, Seoul National University Hospital, Seoul, Korea
1989-1993	Neurosurgical Residency, Department of Neurosurgery, Seoul National University Hospital
1993-1994	Neurosurgical Fellow, Department of Neurosurgery, Seoul National University Hospital
1991-1993	Postgraduate School of Medicine, Seoul National University, Master of Science degree, thesis on immunohistochemical findings of PNET and medulloblastoma
1994-2001	Postgraduate, Seoul National University School of Medicine, PhD degree, thesis on "Increased burst firing in SNPr neurons and enhanced response to selective D2 agonist in hemiparkinsonian rats after repeated administration of apomorphine"

Professional Career

1994-	Faculty, Department of Neurosurgery, Samsung Medical Center, Seoul, Korea
1997-2002	Assistant Professor, Department of Neurosurgery, Sungkyunkwan University School of Medicine, Suwon, Korea
1997-1999	Research Fellow, Neurological Surgery, Johns Hopkins University, Baltimore, Maryland
2002-2007	Associate Professor, Department of Neurosurgery, Sungkyunkwan University School of Medicine
2007-	Professor, Department of Neurosurgery, Sungkyunkwan University School of Medicine
2009-	Director, Brain Tumor Center, Samsung Medical Center
2009-2010	President, Korean Gamma Knife Radiosurgery Society
2014-2015	President, Korean Society of Stereotactic and Functional Neurosurgery
2015-2017	President, Korean Society of Intraoperative Monitoring
2015-	Board member, Asian Australasian Society of Stereotactic & Functional Neurosurgery
2016-2017	President, Korean Stereotactic Radiosurgery Society
2017-	Board Member, Asian Leksell Gamma Knife Society

Challenging Problems in Radiosurgery for Metastatic Brain Tumor

이 정 일

성균관대학교 의과대학 삼성서울병원 신경외과

1980년대 후반에 선형가속기 혹은 감마나이프를 이용한 전이성 뇌종양의 방사선수술이 시작되었다. 이후 수많은 연구 결과와 논쟁을 통하여 전이성 뇌종양의 치료 원칙이 발전되어 왔다. 그 결과 전이성 뇌종양의 치료 방법중 방사선수술은 과거 교과서에 일차적 치료로 제시되어 있던 전뇌방사선 치료를 대치하여 가장 흔히 선택되는 일차적 치료가 되었다. 병변의 개수에 대한 제한은 완전히 사라졌고, 수술을 하는 경우에도 수술 전 혹은 후에 방사선수술을 하는 것이 대부분의 경우 전뇌방사선 치료보다 우선적으로 추천된다. 한편 최근에는 정위틀을 사용하지 않는 방사선수술과 분할 방사선수술이 급격히 확산되어 큰 병변의 경우에도 거의 제한없이 방사선수술이 가능하게 되었다.

현재 전이성 뇌종양의 방사선 수술과 관련하여 극복해야 할 문제들을 열거하면 다음과 같다.

첫째, 전통적인 방법의 단일 분획의 방사선수술 대신에 분할 방사선수술을 어떻게 적용할 것인가이다. 분할 방사선수술의 적응증, 적정 분할 횟수 및 방사선량 등이 모두 아직 확립되지 않은 사항들이다. 결국 최선의 선택을 하는 것은 최종적으로 환자와 담당 의료진이겠지만, 그 결정과정에서 과학적으로 검증된 결과와 진료현장의 상업주의적, 편의주의적인 관점을 정확히 이해하고 엄격히 구분해서 고려해야 할 것이다.

둘째, 최근 크게 각광을 받고 있는 표적치료제나 면역요법 등의 내과적인 치료 방법으로 어떤 경우에 방사선수술을 대체할 수 있을 것인가이다. 대체로 현재까지의 경험으로는 방사선수술과 효과적인 내과적 치료를 병용하는 것이 가장 좋은 결과를 얻는다고 보고 있지만, 앞으로 이들 방법들을 어떻게 조합하여 혹은 구분하여 활용할 것인가에 대하여 많은 연구가 필요하다.

셋째, 임상 분야별 영역과 역할이 과거와 다른 양상으로 바뀔 가능성이 있다. 역사적으로 방사선수술은 신경외과 의사들에 의하여 주도적으로 발전되어 왔고, 지역이나 개별 병원의 환경에 따라 다소 차이는 있지만 대체로 정위틀을 사용하거나, 단일 분획으로 방사선수술을 하는 경우는 신경외과의 영역이라고 인정되어왔다. 특히 국내에서 감마나이프는 신경외과의 고유 영역으로 생각되어왔고, 다른 장비를 사용하더라도 뇌와 척추의 방사선수술에서는 신경외과의 역할이 컸다. 최근 정위틀을 사용하지 않는 방사선수술과 분할 방사선수술이 급격히 확산됨에 따라 방사선종양학과의 고유영역이라고 여겨진 분할 방사선치료와 방사선수술의 구분이 불명확하게 되어가고 있다.

마지막으로 국내 임상의료의 공통적인 어려움인 낮은 의료수가의 문제가 있다. 방사선수술은 2004년 건강

보험급여에 포함된 이후 15년이 경과하는 동안 물가상승을 반영하기는커녕 절대 수가금액이 인하되었고, 실질 구매력 기준으로 한다면 방사선수술의 수가는 2004년 최초 수가의 절반 이하로 내려간 셈이다. 분할 방사선수술에서 정위틀 사용시와 달리 추가로 사용되는 소모품인 마스크 비용조차 보험급여에 반영되고 있지 않은 실정이다. 한편으로는 여러 가지 이유로 인하여 그동안 수 차례의 수가 조정을 거치면서 양성자 치료나 세기조절 분할방사선 치료 등을 포함하는 분할 방사선치료의 수가에도 미치지 못하는 수준으로 내려 가고 있다. 전이성 뇌종양의 방사선수술은 병변의 크기나 수에 따라 치료계획이나, 실제 치료에 필요한 시간과 노력이 크게 달라지기도 하고 재발이 잦은 특성상 단기간에 반복 치료가 필요한 경우도 흔한데, 이러한 측면들이 건강보험수가에 전혀 반영되지 않고 있는 점도 개선해야 할 문제이다.

결론적으로 지난 수 십년간에 걸쳐 방사선수술은 전이성 뇌종양의 대표적인 치료방법으로 자리를 잡게 되었지만, 앞으로 의학적으로 더 발전시켜야 할 측면이 있음은 물론이며, 방사선수술과 관련된 의료환경이나 경제적인 측면에서도 심각한 어려움을 극복해야 할 것이다.

MEMO

CURRICULUM VITAE

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대한신경손상학회

대한노인신경외과학회

연구분야

뇌정위수술, 통증 수술, 말초신경수술, 신경외상, 신경중환자의학, 정위적방사선수술

A New Treatment Option, Laser Interstitial Thermal Therapy

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Laser interstitial thermal therapy (LITT) which is not available in Korea yet, is an emerging treatment modality for various neurological diseases. It was originally introduced in 1983 and has been more effectively and more widely applied to neurosurgical field with development of targeting, lesioning technology and thermal monitoring system such as real-time MR thermometry. An increasing number of clinical studies of LITT treating different brain pathologies have been published, including gliomas, metastatic brain tumors, epileptogenic lesions and lesioning procedures for functional neurosurgery. It is especially useful in patients with recurrent, deep-seated, critically located brain lesions refractory to other treatments modalities, where it can effectively improve prognosis with minimal risk. In this lecture, I will introduce bio-histological effect and technical aspect of LITT as well as its clinical application for various diseases.

MEMO

MEMO

Scientific Session II
Radiosurgery

좌장: 가톨릭대 **이경진**, 가천대 **김은영**

R-1. Immune Checkpoint Inhibitors for Non-small Cell Lung Cancer with Brain Metastasis: The Role of Gamma Knife Radiosurgery

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Purpose: Immune checkpoint inhibitors (ICIs) are approved for the treatment of non-small cell lung cancer (NSCLC), but the safety and efficacy of combined treatment with Gamma knife radiosurgery (GKS) remain undefined.

Methods: We retrospectively reviewed the medical records of patients with brain metastases from NSCLC, who were treated with ICIs between January 2015 and December 2017 at our institute. Of the 134 patients identified, 77 who were assessable for brain responses were enrolled and categorized into 3 groups based on the medication received and GKS: Group A, ICI alone; Group B, ICI with concurrent GKS within 14 days; Group C, ICI with non-concurrent GKS.

Results: The median follow-up duration after diagnosis of brain metastases was 16.3 months (range, 1-68.7 months). At the last follow-up, 24 patients (31.2%) had died. Between the 3 groups, there were no statistically significant differences in overall survival (p=0.603), intracranial disease progression -free survival (p=0.532), and local progression-free survival (p=0.366). Twelve patients newly developed leptomeningeal seeding (LMS) during follow-up. And, there was a significant difference in the LMS free period from the time of using ICIs (p=0.011) and from diagnosis of metastasis ($p<0.001$). There were no significant differences in the frequencies of complications between the three groups.

Conclusion: In this study, GKS showed no favorable overall survival outcome in combination with ICI for the treatment of brain metastasis from NSCLC. However, GKS with ICI may be associated with a decreased incidence of LMS compared to ICI alone.

MEMO

R-2. A Comparison in Terms of Medical Resources between Gamma Knife and Novalis

Kawngwoo Park, Ki-Taek Lee, Eun-Young Kim, Cheol Wan Park, Chan-Jong Yoo

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Through the evolutionary advance in stereotactic radiosurgery (SRS), radiosurgery has been increasingly used to the various disease on excellent efficacy and acceptable toxicities. However, there have been several reports for comparisons regarding the dosimetric parameters of different modalities, but there has been little comparison in terms of medical resources, especially under Korean medical insurance. In this literature, we attempt to compare the Gamma knife and Novalis in terms of medical resources, including cost, human resources, mechanical burden, and consumable time. In conclusion, even though Novalis can treat more effectively than the Gamma knife in a variety of conditions, the Gamma knife seems to stand superior to Novalis in terms of medical resources due to its unique simplicity. At least in the treatment of metastatic brain tumors, simplicity is the best.

MEMO

R-3. Gil Strategy for Spinal Metastasis

Kawngwoo Park, Sung Son, Yong Ahn, Sang-Gu Lee, Woo Kyung Kim, Chan-Jong Yoo

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The goals of treatment for spinal metastases are palliative in nature and include maintenance or impro vement of neurological function, local tumor control, mechanical stabilization, pain relief, and improvement in the quality of life. For these purposes, the NOMS framework, modified Tokuhashi, and Tomita scoring system have been used to spinal metastases. However, these strategies have several limitations in the era of advance for stereotactic radiosurgery (SRS). Although NOMS framework was conceived for use in a multidisciplinary fashion in conjunction with radiation, medical, and neuro-oncology, it has not been reflected in the systemic assessment, tolerability, and medical comorbidities of cancer patients. The modified Tokihashi and Tomita scoring system did not consider the patient's quality of life after treatment. To overcome these limitations, we have provided a new strategy for patients with spinal metastases. Our strategy is entirely brand-new, and we are confident that it will improve the quality of life of patients and ultimately be an accessible guideline for spinal metastases.

MEMO

R-4. Gamma Knife Radiosurgery for Cavernous Sinus Hemangioma: Yonsei Experiences

Myung-ji Kim, So-Hee Park, Gwi-Gyung Moon, Ji-Hyun Ahn, Gi-Hong Kim, Won-Seok Chang, Jin-Woo Chang, Hyun-Ho Jung

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Objectives: Cavernous sinus hemangiomas (CSHs) are rare benign vascular tumors in the cavernous sinus. Recently, Gamma Knife radiosurgery (GKS) has become an effective alternative to surgical resection indicating a good response and low complication. The purpose of this study was to evaluate the efficacy and safety of GKS for the treatment of CSHs.

Methods: We performed the retrospective study to analyze the outcome of patients with CSH after GKS. We analyzed 24 patients with CSHs who were treated with GKS between 2004 and 2017 at Yonsei Severance Hospital. The median age of the patients was 54 years (range, 10-78 years), and 17(70%) of patients were female. GKS was performed as a primary treatment for all patients. All patients were diagnosed on the basis of clinical and MRI as the primary diagnostic tool. 12 (50%) patients had cranial neuropathies before GKS and 3 patients complained only headache without any cranial neuropathy. The 9 out of 24 patients were initially asymptomatic.

Results: The mean volume of the CSHs was 7.9 cm^3 (range, 0.6-24 cm^3), and median marginal dose at the 50% isodose line was 13.4 Gy (range, 13-15 Gy). The mean follow-up period was 61 months (range, 2-129 month). The average tumor volume had decreased to 61% of the initial volume at the last follow-up MRI. The first follow-up MRI, performed 6.5 months after the SRS showed that the tumor volume had decreased to 48.5% of the initial volume. 9 out of 12 with cranial neuropathies observed before GKS had improved, with complete remission in 8 (66.7%) and partial remission in 1 (8.3%). The other 3 (25%) patients showed no improvement after GKS. The 3 patients who reported headache before GKS had subjective improvement in their headache. There are 2 possible radiation- induced neuropathy or complications during the follow-up period. But these GKS-related neuropathies were transient.

Conclusions: Gamma Knife surgery could be a safe and effective primary treatment for CSHs, however, further studies with more cases are needed to verify the benefits of this treatment.

MEMO

R-5. Factors Related to Successful Energy Transmission of Focused Ultrasound Through a Skull: A Study in Human Cadavers and Its Comparison with Clinical Experiences

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Objective: Although magnetic resonance guided focused ultrasound (MRgFUS) has been used as minimally invasive and effective neurosurgical treatment, it exhibits some limitations, mainly related to acoustic properties of the skull barrier. This study was undertaken to identify skull characteristics that contribute to optimal ultrasonic energy transmission for MRgFUS procedures.

Methods: For ex vivo skull experiments, various acoustic fields were measured under different conditions, using five non-embalmed cadaver skulls. For clinical skull analyses, brain computed tomography data of 46 patients who underwent MRgFUS ablations (18 unilateral thalamotomy, nine unilateral pallidotomy, and 19 bilateral capsulotomy) were retrospectively reviewed. Patients skull factors and sonication parameters were comparatively analyzed with respect to the cadaveric skulls.

Results: Skull experiments identified three important factors related skull penetration of ultrasound, including skull density ratio (SDR), skull volume, and incidence angle of the acoustic rays against the skull surface. In clinical results, SDR and skull volume correlated with maximal temperature (Tmax) and energy requirement to achieve Tmax ($p<0.05$). In addition, considering the incidence angle determined by brain target location, less energy was required to reach Tmax in the central, rather than lateral targets particularly when compared between thalamotomy and capsulotomy ($p<0.05$).

Conclusions: This study reconfirmed previously identified skull factors, including SDR and skull volume, for successful MRgFUS; it identified an additional factor, incidence angle of acoustic rays against the skull surface. To guarantee successful transcranial MRgFUS treatment without suffering these various skull issues, further technical improvements are required.

MEMO

R-6. 제6차 Asian Leksell Gamma Knife Society를 다녀오면서

김무성, 서인철, 하소영, 이원희, 김성태, 이근수, 팽성화, 표세영, 정영균, 정용태

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목적: 2019년 1월 18일에서 20일까지 일본 센다이 국제회의장에서 제6차 Asian Leksell Gamma Knife Society가 열렸으며, 한국에서는 40명이 참석하였다. 일본 제18회 감마나이프학술대회는 2019년 1월 18일 같은 장소에서 개최되었다.

방법: 일본 제18회 감마나이프학술대회는 많은 연제가 전이성뇌종양이 많은 일본에서 Icon이 많은 연제를 차지하였고, 2019년 1월 18일 금요일은 Symposium 1: Evidence from Asia토픽 하에 7연제 발표, 혈관질환: 7연제 발표, Functional 질환 3질환, 특별강연; 대만의 Wan-Yuo Guo의 The privileged Gamma Knife Radiosurgery in Enriching Medical Service with Imaging AI, Physic Session에서 5연제가 발표되었다.

결과: 1월 19일 토요일은 Longterm Efficacy and Complications 주제 하에 11연제, 교육강연은 동경대학의 Tadashi Nariai의 Clinical use of PET-imaging for Gamma Knife Radiosurgery Against Malignant Brain Tumor, Lunchen Seminar는 Nobukazu Nakasato 교수의 Epilepsy: The Name You Know, The story you don't, 청신경초종 Session에서는 4연제, 전이성뇌종양 4연제, 악성뇌종양 4연제, 양성뇌종양 7연제, 1월20일 일요일은 Karsson 교수의 Gamma Knife Surgery for AVMs' What Have We Learned in 30 Years?, Fractionation in GKRS에서는 8연제가, 포스터는 2연제가, 모두 한국인이 발표하였다.

결론: 센다이는 일본이 자랑하는 Jiro Suzuki 의사를 기념하는 Tohoku 대학병원이 있는 있는 곳으로 비행기는 서울에서 아시아나가 오지만, 일본 내 어느 곳이나 국내선 비행기, 신간선열차, 고속버스가 연결되어 있어 Sendai 중앙역은 일본의 어느 곳에도 연결이 되어 있고, 많은 대한민국의 신경외과의사들이 참여하여 발전하는 대한민국이 아시아 감마나이프 발전의 중추돌이 되고 있음을 느꼈다.

MEMO

Scientific Session III

Epilepsy/Cranial Rhizopathy

좌장: 아주대 **안영환**, 고려대 **김종현**

EC-1. Volumetric Analysis of Mesolimbic Structures in Surgically-treated Unilateral Temporal Lobe Epilepsy Patients

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Objectives: Surgery for medically intractable epilepsy patients especially with abnormal findings on pre-operative MRI has became the standard treatment. In addition, owing to the improvements in techniques of volumetric analysis based on thin-sliced brain MRI, abnormalities of mesolimbic structures beyond hippocampus have been highlighted in TLE patients. Hence, The present study aimed to identify the significant volume reduction of mesolimbic structures as well as the hippocampus and the substantial relationship between various clinical variables including post-operative histopathological abnormalities and the volumes of mesolimbic structures in unilateral TLE patients treated with surgical procedure.

Methods: A total of twenty-nine clinically diagnosed unilateral TLE patients (14 left TLE and 15 right TLE) who were treated using the surgical procedure of standard temporal lobectomy with hippocampectomy and 38 normal control group were enrolled in this study. Their volumes of mesolimbic structures involving hippocampus and its subfields were measured using the semi-automated measuring soft-ware program (Freesurfer Version 6.0). Then, comparison analysis between three groups and regression analysis of volumes of various mesolimbic structures were conducted.

Results: Significant volume reduction of various mesolimbic structures adjacent hippocampus in the unilateral surgically-treated TLE patients was observed compared to normal control group. And, on the multivariate regression analysis, clinical variables such as the presence of HS, epilepsy duration, the presence of aura and seizure frequency were found to be significantly correlated with the volumes of various mesolimbic structures.

Conclusion: Significant volume reduction in the various mesolimbic structures and the substantial inverse correlation between clinical variables and volume of mesolimbic structures such as isthmus cingulate cortex, fimbria, thalamus, amygdala and dentate gyrus in our study are thought to support that TLE is not restricted to the mesial temporal lobe and the progressive volume reduction of the limbic structures beyond mesial temporal lobe may play an important role in the cognitive and memory decline which are frequently observed in the chronic TLE patients.

EC-2. Anterior 2/3 Corpus Callosotomy for Twins with Lissencephaly Presenting West Syndrome and Generalized Seizures: Case Report

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Objectives: In the present study, we report anterior 2/3 callosotomy for treating twins who showed severe lissencephaly with medically intractable West syndrome and generalized seizures.

Case Report: Two 10-years-old boys were admitted to our department with medically intractable seizures. They presented with oculogyric crises at two months of age, and They took valproate for one month afterward because of generalized tonic seizures and epileptic spasms with the series formation. However, their seizures got worse despite the later addition of phenobarbital and clonazepam. They usually had a bad temper and showed hypsarrhythmia on EEG. Magnetic resonance imaging (MRI) revealed a smooth cortical surface on the bilateral parietal and occipital lobes and a little gyrus formation in the bilateral frontal and temporal lobes. Interictal single photon emission computed tomography (SPECT) showed hypoperfusion slightly in the right frontal lobe for the first time. Our diagnosis was lissencephaly presenting with West syndrome and generalized seizures. Two operations for each twin had been planned because their seizures were intractable medically and The seizures disappeared entirely for a while after surgery. More than 99% of the seizures continued to disappear, although hypsarrythmia tended to increase three months after surgery. Since then, the frequency of seizures has not yet changed (1 year after surgery)

Conclusions: These cases showed that anterior corpus callosotomy (2/3) might play an essential role in some types of symptomatic West syndrome.

MEMO

EC-3. The Optimal Site for Anterior Nucleus Deep Brain Stimulation for Intractable Epilepsy

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Objectives: The efficacy of deep brain stimulation (DBS) on anterior thalamic nucleus (ATN) is well recognized after successful results of SANTE trial and followed reports. However optimal site for stimulation in the 'ATN' is not clear with various hypothesis.

Methods: We reviewed the location of active contacts in 19 patients (38 electrode) of ATN DBS implanted in single center. Fused image of pre-operative magnetic resonance image and post-operative computed tomography image were used to identify the contact location. The location was measured by stereotactic reference and relative index which is relative location within ATN,anterior border as 0 posterior border as 1, was also measured. Futhermore, anteriority based on location of mamillothalamic tract (mtt), and the distance between active contact and the mtt was measured. Average frequency of 3 months were collected and more than 50% of seizure frequency reduction at final follow up period was considered as effective treatment.

Results: Mean seizure reduction rate was 62.3% (range, 16.7~100%) and no one has worsened seizure frequency after DBS. Five patients had less than 50% seizure frequency reduction. Relative location within the nucleus, responder group was more anterior than non-responder (4.7 vs 5.2) however no statistical significance was found. Responder were more anterior than non-responder based on mtt (0.44 mm vs 0.38 mm anterior to mtt). However, distance from mtt had significantly related to clinical outcome, responder had 3.4 mm far from mtt but non-responders had 6 mm distance from mtt (p=0.02).

Conclusions: In our series, we found clinical outcome was strongly related to the distance of active contact from mtt. Thus mtt should be targeted to achieve good seizure control after ATN DBS.

MEMO

EC-4. The Changes in Intraoperative Lateral Spread Response During Infra-floccular Microvascular Decompression for the Patient with Hemifacial Spasm

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Objectives: The authors critically assessed to evaluate the correlation between changes in intraoperative lateral spread response monitoring and the short and long term clinical outcomes after MVD (Microvascular Decompression).

Methods: The authors retrospectively identified 103 consecutive patients with HFS treated by MVD performed with intraoperative LSR monitoring. Corkscrew electrodes with Eclipse (Axon System, NY, USA) positioned at C3 or C4, and Cz was used to deliver supramaximal stimuli (15 V). LSRs were recorded from the orbicularis oculi, mentalis and orbicula oris muscles. Differences in amplitude or response duration at the final (at dural closure), on time of vascular decompression and baseline LSR (before incision) during MVD, were evaluated. The patients were assessed for the presence of HFS and surgical complications at 1 day, 7 days, 1 month and six months after surgery.

Results: Patients were divided into four groups based on intraoperative LSR changes: (1) in 18 patients, the difference of LSRs were present between incision and vascular decompression (17%); (2) in 12 patients, LSRs were persisted despite MVD but decreased at dural closure (12%); (3) in 67 patients, LSRs were present before incision and disappeared after MVD (65%) (4) in 6 patients, LSRs were absent before surgery and remained so after the procedure (0.6%). Intraoperative LSR changes during the MVD procedure correlated with HFS relief in the long term ($p<0.001$, Fisher exact test).

Conclusion: The changes in intraoperative LSR during MVD for HFS could be consistent with not only to indicate the resolution of the microvascular compression during infra-floccular MVD but also to predict the long-term relieves of HFS after MVD.

MEMO

EC-5. Transposition Using a Glue-coated Teflon Sling for Patients with Vertebral Artery Associated Hemifacial Spasm: Various Techniques

Hyung Rae Lee, Young Hwan Ahn

Department of Neurosurgery, Ajou University Hospital, Suwon, Korea

Microvascular decompression (MVD) for hemifacial spasm (HFS) involving the vertebral artery (VA) can be technically challenging. The surgical outcome of HFS is determined by appropriate decompression of causative vessel.

Since 2005, 79 patients with VA associated HFS were surgically treated. Those included two patients with recurrent HFS whose symptom was recurred or sustained even after microvascular decompression surgery. Sixty-eight patients were surgically treated with a glue-coated Teflon sling (87.1%). Various techniques such as one stitch method, two stitch method, no suture technique were used according to the operative findings. The surgical outcome was excellent (98.7%) and no recurrence took place over a 2-year follow-up. Surgical findings of each representative case will be presented.

The decompression technique using glue-coated Teflon sling is considered to be a safe and useful technique.

MEMO

EC-6. Microvascular Decompression Surgery for Patients with Recurrent Hemifacial Spasm

Young Hwan Ahn, Sung Ae Cho

Department of Neurosurgery, Ajou University Hospital, Suwon, Korea

안면경련증 수술 후 증상의 재발은 드물지만, 재발하거나, 증상이 호전되지 않고 계속 남는 경우가 있다. 증상을 유발하는 원인 혈관과 안면신경의 REZ가 충분히 분리되지 못하거나, 수술 당시에 충분히 분리되었어도 혈관이 다시 REZ를 압박하거나, 분리를 위해 사용한 물질이 신경과 혈관의 유착을 유발하면서 혈관의 압력이 다시 가해지는 것이 그 원인으로 생각된다. 증례 수가 많지는 않지만, 재수술의 소견 소견을 소개하고 최적의 수술 방법과 재수술 시점에 대한 논의를 해 보고자 한다.

MEMO

EC-7. Long-term Outcomes of Treatment with Recurrent Trigeminal Neuralgia: 10-year Experience in a Single Center

So Hee Park, Hyun Ho Jung, Won Seok Chang, Jin Woo Chang

Department of Neurosurgery, Yonsei University College of Medicine, Seoul, Korea

Objectives: Trigeminal neuralgia (TN), chronic pain condition, has a profound effect on quality of life. When medical management fails to control the pain of TN, patients require surgical intervention. All surgical procedures have variable but definite rates of pain recurrence. There are few studies on the long-term outcome of treatment with recurrent TN, so we present a single institutional experience for this.
Methods: From January 2006 to February 2017, 229 patients were treated with idiopathic TN in our medical center. Of these, we reviewed 51 patients treated with recurrent TN. The time taken for the initial treatment and recurrence, the treatment for recurrent TN, and the effect of the second treatment were analyzed.
Results: Of 51 patients, 33 patients received gamma knife surgery (GKS) as a secondary treatment, 17 patient received radiofrequency rhizotomy (RFR), and only 1 patient received microvascular decompression (MVD) as the second treatment. Their median follow-up period was 25 months (range 1-150 months). There were 9 recurrences after GKS (27.3%, 9/33), 6 recurrences after RFR (35.3%, 6/17), and 1 recur after MVD (100%, 1/1). The time to recurrence was median 32 months (range 10-105 months). GKS was median 41 months (11-105 months), RFR was 23.5 (10-77 months), and MVD was 25 months. Of these, additional surgical treatment was required for one patient with GKS and one with RFR. The other patients reported a BNI score of III or less, and the pain was controlled by medication and no further treatment was performed.
Conclusion: This study is meaningful in that it analyzed the long term outcomes of treatment with recurrent TN. GKS showed a slightly better long-term outcome compared to other modalities in this study, but a larger population and a longer follow-up period to produce meaningful results.

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Poster Presentation II

P-5. Spontaneous Intracranial Hypotension Due to Spontaneous Spinal CSF Leak Following Implantation of Intrathecal Drug Delivery System for Baclofen

Byung-chul Son, Jin-gyu Choi, Dong-uhn Lee

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

SIH is an uncommon but increasingly recognized clinical syndrome associated with reduced CSF pressure or CSF volume and is caused by spontaneous CSF leaks. Spontaneous spinal CSF leaks is known to be the typical cause of SIH. When onset of such headache is spontaneous, a diagnostic challenge is created even though SIH has been recognized for more than 6 decades, and MRI has greatly facilitated the diagnosis. Despite recent awareness of SIH by physicians, diagnosis of SIH is missed initially and the diagnostic delay is significant.

Severe headache in the head and posterior neck developed in a 59-year-old male patient who had underwent implantation of intrathecal drug delivery system (IDDS) of baclofen for distabling chronic dystonic spasm. His headache was typically orthostatic. It occurred insidously at 2 days after implantation of IDDS and was described as deep pressure-like in nature. He could not sit or walk for aggravation of headache. Because headache is one of side effect of intrathecal baclofen infusion, IDDS was stopped for 2 days. However, it did not subside. Under suspicion of CSF leakage at the dural puncture site of intrathecal catheter, myelographic CT scan of the lumbar spine was performed.

On the myelographic CT scan of the lumbar spine, diffuse periradicular leakage of dye was found along whole lumbar spine. Spontaneous spinal CSF leak was confirmed. Epidural blood patch (10 ml) was performed at the level of T1/2 interspace. His headache gradually improved until 2 days after epidural blood patch. Upon delivery of intrathecal baclofen up to 75 mcg/day, his headache did not recur.

An orthostatic headache is the prototypical manifestation but other headache patterns occur as well, and associated symptoms are common. When onset of such headache is spontaneous, a diagnostic challenge is created even though SIH has been recognized for more than 6 decades, and MRI has greatly facilitated the diagnosis. Despite recent awareness of SIH by physicians, diagnosis of SIH is missed initially and the diagnostic delay is significant.

MEMO

P-6. Effects of Spinal Cord Stimulation for Five Different Components of Chronic Refractory Neuropathic Pain

Jong Ho Ha, Moonyoung Chung

Department of Neurosurgery, Soonchunhyang University, Bucheon Hospital, Bucheon, Korea

Objective: Spinal cord stimulation (SCS) is a useful surgical option for patients with refractory chronic neuropathic pain. However, there are pain notwithstanding SCS, which remains a challenging area to physicians. Neuropathic pain is known to include five components of abnormal sensations, i.e., superficial pain, deep pain, paroxysmal pain, evoked pain and dysaesthesia. To the best of our knowledge, however, there was no study addressing effects of SCS to the different components of neuropathic pain.

Methods: In this retrospective cohort study, we analyzed the change of each of five abovementioned components of neuropathic pain in the 18 patients who underwent SCS implantation in our institute from 2014 to 2018. Paddle type SCS devices were implanted for all subjects. The neuropathic pain inventory was used for evaluating degree of pain of our patients before and after operation.

Results: Among the five elements consisting neuropathic pain, superficial and deep pain showed most significant improvement after SCS at the last follow-up time. On the other hand, the paroxysmal pain did not improved significantly after SCS at the last follow-up. Statistically significant improvement in both total pain score and daily pain duration was observed. SCS was shown to improve daily pain intensities showed worsening at the last follow-up after early dramatic improvement.

Conclusion: Our study demonstrated that SCS effectively alleviated superficial and deep pain but was not efficient to reduce paroxysmal pain. This result can be attributed to difference of change in neuroplasticity in the brain and spinal cord.

MEMO

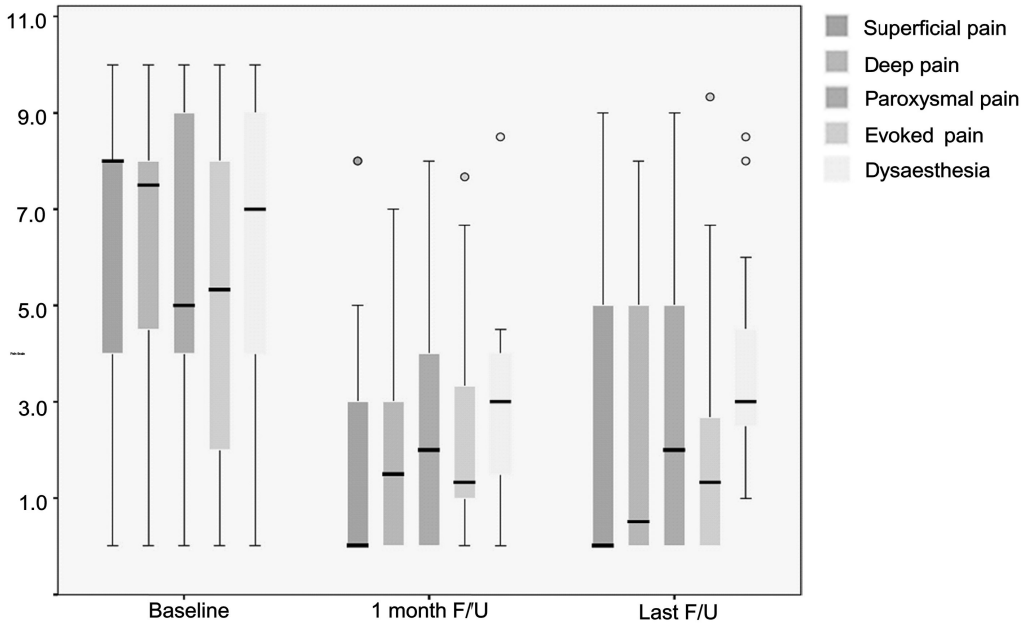

Fig. 1. Graph showing hronological comparisons of 5 different components of neuropathic pain in 18 patients who underwent spinal cord stimulation.

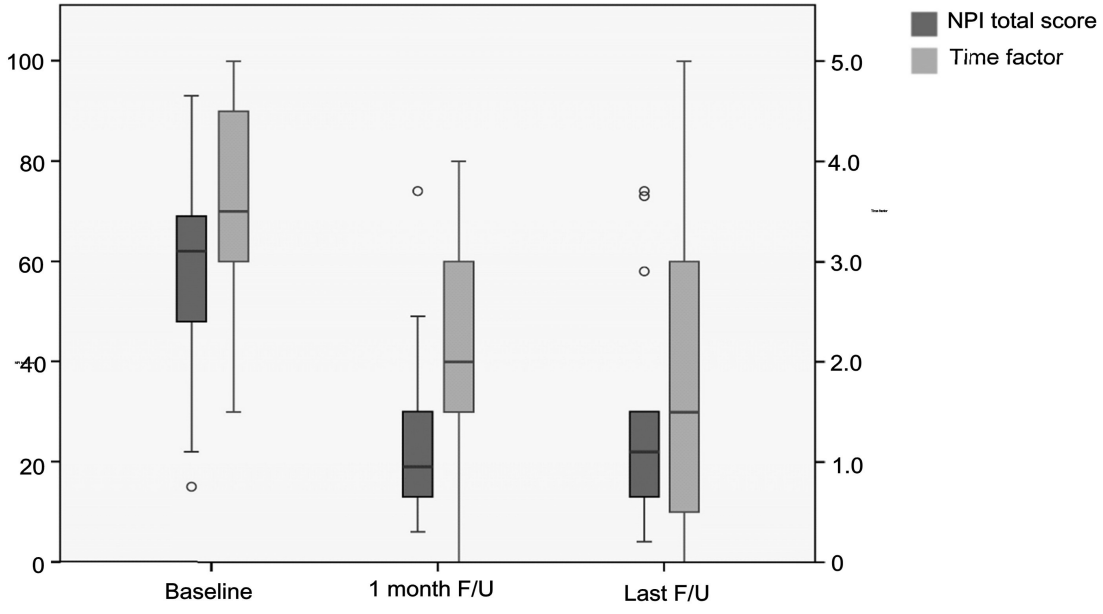

Fig. 2. Graph showing hronological comparisons of total NPI score and time factor in 18 patients who underwent spinal cord stimulation.

P-7. Effect of Exposure to RF-EMF During Pregnancy on Maternal Glucocorticoid and Fetus Brain Development in Rat (Preliminary Study)

Hyung Rae Lee[1], Hye Sun Kim[1], Hyung Do Choi[2], Young Hwan Ahn[1]

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Glucocorticoids (GC) are the end product of the hypothalamic-pituitary-adrenal (HPA) axis. ACTH triggers cortisol production and release from the adrenal cortex. GC play a critical role in fetal neurodevelopment. However, excessive increases in maternal cortisol in gestation will result in overexposure of the fetus with detrimental consequences. In this study we evaluate the effect of RF-EMF exposure during pregnancy on neurodevelopment in the fetal rat.

Sixteen pregnant Sprague-Dawley (SD) 12-week-old rats were divided into three groups: cage-control (n= 4), sham-exposed (n=5), and EMF-exposed (n=7) groups. The dams were exposed to RF-EMF signal (915 MHz radiofrequency identification) at a whole-body specific absorption rate (SAR) of 4 W/kg for 8 h/d from gestational day 1 to 19. After RF-EMF exposure, cortisol, CRH, and ACTH level in maternal serum and adrenal cortisol, pituitary ACTH, placental CRH, placental cortisol were measured by ELISA. Transcriptional level of placental 11β-HSD2 and fetal brain glucorcorticoid receptor (GR) were measured by RT-PCR.

Significantly increased both cortisol levels in maternal serum and adrenal were observed in EMF-exposed group ($p<0.05$). Besides, increased maternal CRH, maternal pituitary ACTH, placental cortisol and placental CRH were observed in EMF-exposed group, but not statisically significant ($p>0.05$). No significant changes in mRNA expression level of placental 11β-HSD2 and fetal brain GR were observed in EMF-exposed group ($p>0.05$).

Maternal cortisol level was increased by RF-EMF exposure at 4 W/kg SAR during pregnancy but was not detrimental to fetus brain development.

This work was supported by Institute for Information &communications Technology Promotion (IITP) grant funded by the Korea government (MSIT) (2017-0-00961, Study on the EMF Exposure Control in Smart Society)

YSFN Symposium

Functional Neurosurgeon's Perspectives of Craniofacial Pain

좌장: 연세대 **정현호**, 인제대 **김해유**

CURRICULUM VITAE

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Education

2010	MD. Kyung Hee University Graduate School, Seoul, Korea
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2018-2018	Clinical Assistant Professor in Kyung Hee University Hospital, Seoul, Korea
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Awards

2018	Best Paper Award (Korean Neurosurgical Society)
2018	Scholarship Award (Korean Society of Geriatric Neurosurgery)
2018	Best Scholarship Award (Korean Society of Stereotactic and Functional Neurosurgery)
2017	Travel Grant (World Society for Stereotactic and Functional Neurosurgery)
2017	Scholarship Award (Korean Society of Geriatric Neurosurgery)
2017	Scholarship Award (Korean Neurosurgical Society Seoul-Kyung in Branch)
2015	Young Medical Scientist Award (Korean Skull Base Society)

Research Funds

2018	Establishment of library data of each age of the week of neurodegenerative animal model for application of focused ultrasound (Kyung Hee University research fund)
2019	Quantitative analysis of Apolipoprotein(E) in cerebrospinal fluid for prognostic evaluation of normal pressure hydrocephalus (National Research Foundation of Korea)

Neuroanatomy and Medical treatment of Craniofacial pain

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Pain is a common symptom associated with disorders involving craniofacial tissues including the teeth and their supporting structures, the temporomandibular joint and the muscles of the head. Most acute painful craniofacial conditions are easily recognized and well managed, but others, especially those that are chronic (e.g., migraine, temporomandibular disorders and trigeminal neuropathies), present clinical challenges. Preclinical studies have provided substantial information about the anatomical and physiological mechanisms related to the initiation and modulation of nociceptive signals in the trigeminal system. While knowledge of the mechanisms underlying chronic craniofacial pain remains limited, both clini cal and preclinical investigations suggest that changes in afferent inputs to the brain as well as in brain structure and modulatory pathways occur in chronic pain. Collectively, these changes result in amplification of nociception that promotes and sustains craniofacial chronic pain states.

This presentation provides neuroanatomy related to craniofacial pain and an overview of medications that have reasonable treatment evidence and can be used to help manage these chronic pain problems.

MEMO

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FIELDS OF INTEREST

Pain intervention and Painsurgery
Stereotactic Radiosurgery
Cerebrovascular surgery
Endovascular Neurosurgery
Brain Tumor

Pulsed Radiofrequency Neuromodulation for Cervicogenic Headache

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1. Cervicogenic headache

Cervicogenic headache (CHA) was first described over 2 decades ago in 1983. Despite acceptance of the clinical aspects of headache of cervical origin, good clinical diagnostic paradigms to guide clinicians in the interventional treatment of CHA are lacking. This is due to at least 2 reasons: (1) the overlap of symptomatology between migraine and CHA and (2) the lack of an easily applicable "gold standard diagnosis" for CHA. The Cervicogenic Headache International Study Group (CHISG) Diagnostic Criteria for CHA include (a) unilateral pain (although it is recognized that bilateral CHA may occur), (b) restriction of range of motion in the neck, (c) provocation of head pain by neck movement or sustained awkward neck positions, (d) provocation of head pain with external pressure over the upper cervical or occipital region on the symptomatic side, (e) usual vague ipsilateral nonradicular nature neck, shoulder, or arm pain, occasionally radicular, (f) confirmatory local anesthetic blocks in the cervical region, (g) patients should have had only a marginal response to ergotamines, triptans, or indomethacin, and (h) posterior onset of the headache pain seems to be an another important feature. The International Headache Society diagnostic criteria for CHA attributed to whiplash injury, another category of headache related to cervical spine structures, provide more flexibility.

2. Pulsed radiofrequency Neuromodularion

Pulsed radiofrequency (PRF) is pain management technique used that creates a carefully controlled electrical field around a needle. The needles is placed near nerves that are carrying pain signals, with the aim of gently heating the nerves, which can reduce the pain signals and help control chronic pain. The heat treatment in pulsed radiofrequency doesn't destroy the nerves, but it can change the way nerves functions and reduce pain. The more common pain that pulsed radiofrequency can be used to treat include spinal pain, peripheral pain, etc. PRF also provides long-term reduction in headaches with minimal procedural risk in selected patients with medically intractable headache. PRF should be considered an effective treat-

ment modality for headache, especially in medically intractable headache patients. Future long-term prospective controlled clinical trials are warranted to establish more definitive conclusions.

3. Target

There are three main target for CHA. (1) C2 DRG, (2) ON, (3) cervical medial branch. But PRF at C2 DRG and ON, effect of PRF is limited in relief of headache. And, Previous PRF for CHA targeting C2 DRG has rare complications but if it occurs, results in fatal complications because of anatomical base such as nerve root injury, vertebral artery injury, etc. But there are no important structures in the mid-cervical area. Therefore, there are no serious complications in the PRF targeting mid-cervical medial branches.

MEMO

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2006-2010	분당차병원 신경외과 레지던트

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2016.3-2018.2	신경외과 임상조교수, 순천향대학교 부천병원

Professional Experience

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2017.11-현재	대한신경외과학회 편집위원회 간사
2017.12-현재	대한정위기능신경외과학회 학술위원회 간사

Neuromodulation for Craniofacial Pain

정 문 영

순천향대학교 의과대학 부천병원 신경외과

Craniofacial pain disorders are highly prevalent and debilitating conditions involving head, face, and neck. Many patients have consulted multiple clinicians for their condition yet remain undiagnosed or with an incorrect diagnosis. Pains related with neuroplastic changes involving the peripheral and central nervous system as well as immune mechanisms. Common condition includes trigeminal neuralgia and glossopharyngeal neuralgia. Classic trigeminal neuralgia usually affects $2^{nd}/3^{rd}$ division of trigeminal nerve. It is caused by a nerve-vessel conflict with pain characters of paroxysmal pain attack (sharp, stabbing pain with a sudden onset), and brief refractory period. Atypical trigeminal neuralgia shows classic paroxysmal pain attack with background burning sensation between the attacks (Resistant to medical treatment). It believed to be a worsening of classic TN. Central sensitization is important in genesis of atypical craniofacial pain. Ongoing discharges of peripheral afferent fibers release neuropeptides with postsynaptic changes of second-order nociceptive neurons. It causes NMDA & AMPA receptor phosphorylation and expression of voltage-gated Na^{+} channel. Consequently, mechanosensitive Aβ & Aδ afferent fiber can activate second-order nociceptive neurons. It means "Normal tactile stimuli become painful sense." Anesthesia dolorosa is a condition arising from damage to the trigeminal nerve, usually during surgery. It develops 3-6 months following the incident. Clinical feature includes painful numbness (burning, pressure, stinging, crawling), Persistent, severe, and associated with high level of psychological distress and comorbidity. Neuromodulation for craniofacial pain is considered in such debilitating pain condition which is not responsible for conventional medical & surgical treatment.

MEMO

MEMO

Scientific Session IV

Pain/Others

좌장: 가톨릭대 **손병철**, 울산대 **전상용**

PO-1. Dorsal Root Ganglionectomy for Refractory Thoracic Intercostal Neuralgia, Revisited

Byung-chul Son[1], Hak-cheol Ko[3], Jin-gyu Choi[2]

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[3]Department of Neurosurgery, KyoungHee University Hospital at Gangdong, Seoul, Korea

Objective: Invasive surgical options for benign and malignant intercostal neuralgia include dorsal root entry zone (DREZ) lesioning, dorsal sensory rhizotomy, and dorsal root ganglionectomy, we revisited dorsal root ganglionectomy in 16 selective patients with chronic intractable intercostal pain.

Methods: In 16 selected patients suffering intractable medically-refractory intercostal pain (NRS〉7/10), microsurgical dorsal root ganglionectomy was performed. There were 1 female and the mean age was 69 years (range, 54-84 years). There were 12 patients with postherpetic neuralgia, 2 thoracic cancer pain, 2 posttraumatic intercostal neuralgia, 1 lumbosacral root injury (anesthesia dorolosa). Mean preoperative NRS was 8.36 ±0.9. Minimal one to maximal 9 dorsal root ganglions (DRG) were removed with microsurgical technique Intraoperative monitoring of MEP, SSEP, and stimulation of dorsal and ventral rami was performed. Four patients underwent additional ganglionectomy in adjacent segments. The results were analyzed according to PHN group and non-PHN intercostal pain. Percentage pain relief and patient's satisfaction (intention-to-treat analysis) were measured at the last follow-up (mean 18 months).

Results: Overall pain reduction of 40±15.9% (range, 11-62.5%) was achieved with mean follow-up of 18 months. Pain relief was more significant in non-PHN group than PHN group (47.5±14%, 36.9±15.7%, respectively, $p<0.01$). One dysesthesia dorolosa and abdominal budging occurred in 2 cases. Overall, dorsal root ganglionectomy had positive effect on mechanical allodynia than ongoing continuous dysesthetic pain. However, patients' satisfaction (intention-to-treat) was low in PHN group.

Conclusion: Although allodynic pain decreased significantly in PHN, satisfaction following surgery was low in patients with PHN. However, in selective cases with chronic intractable benign and malignant intercostal neuralgias, neurosurgical dorsal root ganglionectomy is a still viable, effective option for reduction of chronic neuropathic pain.

MEMO

PO-2. Decompression of Greater Occipital Nerve (GON) for Referred Trigeminal Pain from Idiopathic Occipital Neuralgia Caused by Entrapment of GON

Byung-chul Son[1], Hak-choel Ko[3], Jin-gyu Choi[2]

Departments of Neurosurgery, [1]Seoul St. Mary's Hospital and [2]Yeouido St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul;
[3]Department of Neurosurgery, KyoungHee University Hospital at Gangdong, Seoul, Korea

Although occipital neuralgia is well-known chronic neuropathic pain, trigeminal referred pain from occipital neuralgia is unfamiliar to neurosurgeons. We report the effectivenss of GON decompression for trigeminal referred pain from chronic entrapment of the GON. Shallow knowledge of trigeminal referred pain from ON might have resulted multiple, inadequate invasive treatments with misdiagnosis of trigeminal neuralgia. During the last 3 years, 14 out of 33 patients who underwent GON decompression for chronic occipital neuralgia presented with hemifacial trigeminal referred pain and hemisensory deficits. Detailed radiologic examinations, were performed to identify possible structural lesions. There were 12 females and mean age was 56.5 (range, 41-78 years). Among 14 referred hemifacial pain, 6 have been treated with repeated alcohol denervation and radiofrequency rhizotomy, microvascular decompression under misdiagnosis of trigeminal neuralgia. GON decompressed was performed bilaterally (n=3), or unilaterally (4 right, 7 left). The mean preoperative NRS-11 was 5.9±1.3 (range, 4-8/10). Temporary relief of occipital pain by GON block was addressed. Proximal and distal course of GON around the trapezial canal was thoroughly addressed. Severe entrapment of GON in its course along the tendinous aponeurotic edge of the trapezius was universally identified during operation. Postoperative NRS-11 decreased significantly (1.86±0.7, $p < 0.01$) and percentage pain relief was 68±13% at mean follow-up (12 months). No recurrence was evident. Chronic occipital pain of ON was relieved completely in 90% of the patients. 13 patients showed immediate improvement of hemifacial pain and gradual improvement of hemifaical sensory deficit as well as chronic occipital pain. Mild dysesthesia developed in early postoperative 3 months. These findings provide clinical affirmation of the existence of trigeminal/cervical convergence and hypersensitivity. Chronic irritating afferent input of occipital neuralgia caused by entrapment of the GON seems to be associated with sensitization and hypersensitivity of the second order neurons in the trigeminocervical complex, receiving convergent input from dural and cervical structures. Referred trigeminal pain from chronic occipital neuralgia may extend to V2, V3 in addition to V1 trigeminal distribution.

PO-3. Deep Learning-based Deep Brain Stimulation Targeting and Clinical Applications

Seong-Cheol Park[1,2], Joon Hyuk Cha[1,3], Seonhwa Lee[1,4], Woo-Young Jang[5], Chong Sik Lee[6], Jung-Kyo Lee[7]

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Departments of [6]Neurology and [7]Neurosurgery, Asan Medical Center, University of Ulsan, Seoul, Korea

Objectives: We developed a deep learning semantic segmentation-based deep brain stimulation targeting and prospectively applied the method.

Methods: T2*, fast gradient-echo images from 102 patients were used for training and validation. With an axial cut ~4 mm below the anterior–posterior commissure line, manually drawn ground truth information was prepared for the subthalamic and red nuclei. A fully convolutional neural network (FCN-VGG-16) was used to ensure margin identification by semantic segmentation. Up to 102 original images and 918 augmented images were used for training and validation. The accuracy of semantic segmentation was measured in terms of mean accuracy and mean intersection over the union. Targets were calculated based on their relative distance from these segmented anatomical structures considering the Bejjani target.

Results: Mean accuracies and mean intersection over the union values were high: 90.4% and 81.3% for the 62 training images and 91.1% and 82.1% for the 558 augmented training images, respectively. Dice coefficient converted from the intersection over the union was ~90.2% in the validation. Semantic segmentation may be adaptive to high anatomical variation, including asymmetry. Concerning clinical applications, two patients were shown-one with essential tremor and another with bradykinesia and gait disturbance due to Parkinson's disease. Both improved without complications after surgery, and microelectrode recordings showed subthalamic nucleus signals in the latter patient.

Interpretation: Deep learning based semantic segmentation accuracy may surpass previous methods. Deep brain stimulation targeting and its clinical application were possible using accurate, deep learning-based semantic segmentation, which is adaptive to high variation.

PO-4. Pain Relief Effect of Downregulation of GTP Cyclohydrolase I in Rat Model of Central Neuropathic Pain

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Purpose: Central neuropathic pain (CNP) is the debilitating disease following consequences of nerve damages, which makes the ordinary life of the patients challenging. Approximately, 69% of spinal cord injury patients suffered pain and nearly one-third of them reported sever chronic pain. However, up to now, apposite therapeutic treatments have not been established. Symptomatic treatment using various pain reliever, anti-depressant, and even narcotic analgesics are common prescriptions but in many cases, CNP are refractory to conventional medical therapies. Overall, the prevention of CNP outbreak could be an alternative option. In this study, we evaluate the neuroprotection and pain alleviation of GTP cyclohydrolase I (GCH1) in spinal cord injury model of rats, by suppressing tetrahydrobiopterin (BH4) which is a key factor for cascade of cellular and molecular microenvironment changes.

Methods: Neuropathic pain was induced in Sprague-Dawley rats (180-200 g) based on spinal cord injury model method which make selective micro-lesion in spinothalamic tract using electrode. The lesions were made (0.6-0.8 mm lateral to midline and 1.8-2.1 mm deep) through the intra spinal cord in C6 and C7 without laminectomy. Either small hairpin RNA against GCH1 (rAAV-shGCH1) or rAAV-scrambled was injected dorsal part of lesion (3 ul). Von Frey test based on up and down method was conducted from post operation day 3 to evaluate the effect of rAAV-shGCH1. To identify glial activations, Iba1 and GAFP were followed after sacrifice.

Results: Pain alleviation effect of rAAV-shGCH1 was observed from post operation day 3 to 14. The mechanical withdrawal threshold was 14.87±0.26 in rAAV-shGCH1 group and 5.19±1.87 in control group on post operation day 3 ($p<0.05$). These pain relief effect was maintained for 14 days (9.73±1.38 in rAAV-shGCH group and 1.64±0.891, $p<0.05$). Furthermore, in Immunohistochemistry staining on coronal sectioned spinal cord revealed the activation of microglia and astrocyte only in control group.

Conclusion: We downregulate the GCH1 level using rAAV-shGCH1 by disrupting GCH1 mRNA selectively, to investigate its neuroprotective effect and pain relief in CNP. Based on our result, we confirmed the early stage protective effect of rAAV-shGCH1 which can extend clinical golden time to prevent outbreak of CNP.

PO-5. Enhanced Axonal Regeneration by Transplanted of 1.7 Wnt3a-secreting Human Mesenchymal Stem Cells in Chronic Spinal Cord Injured Rat Model

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Objective: Spinal cord injury (SCI) results in neurologic deficits of both sensory and motor functions with inevitable disabilities. Currently, there is no available treatment that can revert to the intact state. In the previous study, we have focused on axonal regeneration for repair of SCI. We tested the efficacy of Wnt3a-secreting cell transplantations to regenerate injured axons, leading to an increase in axonal regeneration and recovery of motor function in the sub-acute SCI. Wnt proteins are a family of signaling molecules that play roles in development, cell differentiation, and proliferation. Wnt proteins also play crucial roles in multifunctional axon guidance. However, in our previous study, we were not found significant therapeutic effects in chronic spinal cord injured rat model with Wnt3a-MSC. In Wnt3a-MSC group, a significant difference was not found other than MSC and pLenti-MSC group. In the present study, to reproduce a more practical approach of human chronic SCI, we transplanted Wnt3a-secreting human mesenchymal stem cells into the contusion site and to maximize neuro-regenerative effects, we enhanced Wnt3a protein expression level. Here, we made the 1.7 Wnt3a-secreting MSC and analyzed the therapeutic effect in chronic SCI of rats.

Methods: When the production of 1.7 Wnt3a-MSC, we used human umbilical cord blood mesenchymal stem cell (MSC). 1.7 Wnt3a-MSC was produced using the lentivirus by combination the Wnt3a gene and the pLenti vector. A total of 36 female SD rats were injured at the T9-10 level with an IH impactor (250 kdyn). Six weeks after injury, rats were divided into five groups: a hMSC infected pLenti-1.7 Wnt3a vector transplantation group (1.7 Wnt3a-MSC group, n=8), a hMSC infected pLenti-Wnt3a vector transplantation group (Wnt3a-MSC group, n=7), a hMSC infected pLenti vector only transplantation group (pLenti-MSC group, n=7), a hMSC transplantation group (MSC group, n=7), and a PBS injection only group (Sham group, n=7). Behavioral tests were performed on the first, second, and third days after injury, and then weekly for 14 weeks. Also, immunofluorescence studies were performed.

Results: We added 2 and 4 times amount of Wnt3a gene and Lentivirus, comparing when previous Wnt3a-MSC production, for producing more effective Wnt3a-MSC to secrete largest amount of Wnt3a mRNA. We

found 1.7 and 2.4 times more mRNA secretion when we used 2- and 4-times amount Wnt3a gene. However, expressed Wnt3a protein amount was largest (3.25 times more), when we used 2-time amount Wnt3a DNA, in Wnt3a-MSC secreting 1.7 times mRNA (1.7 Wnt3a-MSC). We also found this 1.7 Wnt3a-MSC expressed 1.9 times more amount beta-catenin. Eight weeks after transplantation (14 weeks after SCI), 1.7 Wnt3a-MSC and Wnt3a-MSC groups were significantly higher than the Sham group. Also, 1.7 Wnt3a-MSC group was significantly higher than the MSC and pLenti-MSC groups. However, there was no difference found between the MSC and pLenti-MSC groups. The expression of markers was analyzed in just the proximal part of the injury epicenter in which the cells were injected. Immunofluorescent staining was performed using three antibodies. The expression of GAP43, MAP2, NF, an axonal regeneration marker, were higher in the Wnt3a-MSC and 1.7 Wnt3a- MSC group MSC than in the sham, MSC, and pLenti-MSC groups. **Conclusion:** In this behavioral test, the 1.7 Wnt3a-MSC group showed significantly greater improvements than other groups 8 weeks after transplantation. Fourteen weeks after injury (8 weeks after transplantation), the scores appeared to plateau, and the evaluation at this time may be representative of the final motor recovery and appropriate for assessing therapeutic effects. Immunofluorescence was used for the visual analysis of axonal regeneration, Among the markers studied, GAP43 and MAP2 and NF are known as representative markers of axonal regeneration. Therefore, these markers were used to determine whether increased behavioral test scores were affected by axonal regeneration rather than neuroprotective effects. In this study, the 1.7 Wnt3a-MSC and Wnt3a-MSC groups had significantly higher quantitative expression of all markers compared with other groups in these immunofluorescence study. However, in the present study, we could not show the difference of the expression amount between 1.7 Wnt3a-MSC and Wnt3a-MSC groups. In the future study, the specimen clearing immunostaining will be necessary for more accurate analysis, also, the other behavior tests will be performed.

MEMO

PO-6. Long-term Outcomes of Geniculate Ganglion Decompression for Bell's Palsy, and Its Complication

정 문 영

순천향대학교 의과대학 부천병원 신경외과

Spontaneous recovery of Bell's palsy is expected within 6 months after first presentation of symptom, while facial palsy may be persisted when facial nerve degeneration rate is more than 90%. Surgical intervention could be considered at that time, but there are still debates about surgical role in patients with Bell's palsy. A 59 years old male patient with left facial palsy underwent decompression of labyrinthine segment of facial nerve. Preoperative facial weakness grade was House-Brackmann grade V, and degeration ratio was 89%. After the surgery, his facial weakness was improved significantly. However, delayed chronic subdural hemorrhage was occurred 2 months after surgery. This complication was treated by burr-hole drainage of subdural hematoma. The patient showed significantly improved facial motor with House-Brackmann grade II at 1 year after surgery. In conclusion, surgical intervention could be considered when facial weakness of a patient is supposed not to be recovered by medical treatment.

MEMO

MEMO

허곤 학술상

좌장: 가톨릭대 **허　륭**

허곤학술상

JNS

CLINICAL ARTICLE

The efficacy and limits of magnetic resonance–guided focused ultrasound pallidotomy for Parkinson's disease: a Phase I clinical trial

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OBJECTIVE Recently, MR-guided focused ultrasound (MRgFUS) has emerged as an innovative treatment for numerous neurological disorders, including essential tremor, Parkinson's disease (PD), and some psychiatric disorders. Thus, clinical applications with this modality have been tried using various targets. The purpose of this study was to determine the feasibility, initial effectiveness, and potential side effects of unilateral MRgFUS pallidotomy for the treatment of parkinsonian dyskinesia.

METHODS A prospective, nonrandomized, single-arm clinical trial was conducted between December 2013 and May 2016 at a single tertiary medical center. Ten patients with medication-refractory, dyskinesia-dominant PD were enrolled. Participants underwent unilateral MRgFUS pallidotomy using the Exablate 4000 device (InSightec) after providing written informed consent. Patients were serially evaluated for motor improvement, neuropsychological effects, and adverse events according to the 1-year follow-up protocol. Primary measures included the changes in the Unified Parkinson's Disease Rating Scale (UPDRS) and Unified Dyskinesia Rating Scale (UDysRS) scores from baseline to 1 week, 1 month, 3 months, 6 months, and 1 year. Secondary measures consisted of neuropsychological batteries and quality of life questionnaire (SF-36). Technical failure and safety issues were also carefully assessed by monitoring all events during the study period.

RESULTS Unilateral MRgFUS pallidotomy was successfully performed in 8 of 10 patients (80%), and patients were followed up for more than 6 months. Clinical outcomes showed significant improvements of 32.2% in the "medication-off" UPDRS part III score ($p = 0.018$) and 52.7% in UDysRS ($p = 0.017$) at the 6-month follow-up, as well as 39.1% ($p = 0.046$) and 42.7% ($p = 0.046$) at the 1-year follow-up, respectively. These results were accompanied by improvement in quality of life. Among 8 cases, 1 patient suffered an unusual side effect of sonication; however, no patient experienced persistent aftereffects.

CONCLUSIONS In the present study, which marks the first Phase I pilot study of unilateral MRgFUS pallidotomy for parkinsonian dyskinesia, the authors demonstrated the efficacy of pallidal lesioning using MRgFUS and certain limitations that are unavoidably associated with incomplete thermal lesioning due to technical issues. Further investigation and long-term follow-up are necessary to validate the use of MRgFUS in clinical practice.

Clinical trial registration no.: NCT02003248 (clinicaltrials.gov)

https://thejns.org/doi/abs/10.3171/2018.2.JNS172514

KEYWORDS dyskinesia; magnetic resonance imaging; pallidotomy; Parkinson disease; focused ultrasound; functional neurosurgery

Since Laitinen and colleagues reestablished the beneficial effect of lesioning the posteroventral portion of the globus pallidus (pallidotomy), pallidotomy has been highlighted as an effective treatment for the cardinal motor symptoms of Parkinson's disease (PD) and levodopa-induced dyskinesia, especially when compared with other available medical therapies.[15,21,35] Recently, deep brain stimulation (DBS) of the subthalamic nucleus has become a mainstream neurosurgical technique for managing PD, with proven superiority for treating the dopaminer-

ABBREVIATIONS DBS = deep brain stimulation; ET = essential tremor; GPi = globus pallidus interna; MRgFUS = MR-guided focused ultrasound; PD = Parkinson's disease; RF = radiofrequency; UDysRS = Unified Dyskinesia Rating Scale; UPDRS = Unified Parkinson's Disease Rating Scale.

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대한정위기능신경외과학회 회칙

제1장 총 칙

제1조 (명칭)

이회는 대한신경외과학회의 분과학회로(1990년에 창설된 대한신경외과학회의 대한뇌정위기능학술연구회를 모체로 하여 1991년에 설립되었으며), 대한정위기능신경외과학회(The Korean Society of Stereotactic and Functional Neurosurgery, 약칭 KSSFN)라 칭한다.

제2조 (목적)

이회는 대한신경외과학회의 학술연구회로서 정위기능신경외과학 분야의 임상 및 기초 연구를 통한(에 대한) 학문발전과 회원 상호간의 학술교류 및 친목을 도모하는데 그 목적이 있다.

제3조 (사업)

이회는 전조의 목적을 달성하기 위해 다음과 같은 사업을 한다.

1. 학술대회, 강연회 및 연수교육의 개최
2. 학술발전을 위한 계획 수립 및 사업시행
3. 정위기능신경외과학분야 학회지 및 도서 발간
4. 회원 상호간의 친목도모를 위한 사업 시행
5. 기타 이회의 목적 달성을 위한 제반사업 시행

제2장 회 원

제4조 (구성 회원 및 자격)

이회의 회원은 정회원, 종신회원, 준회원 그리고, 특별회원으로 구분하며, 아래의 회원자격을 갖춘 자로 한다.

1. 정회원은 대한신경외과학회 정회원으로서 이회의 목적에 찬동하고 이의 달성을 위해 협력하는 자로 한다. (정회원은 대한민국의 의사면허증과 신경외과 전문의 자격증을 소지하고 학회의 취지에 찬동하여 소정의 입회수속을 밟고 상임이사회의 승인을 얻은 자가 된다.)
2. 종신회원은 정회원 중 정해진 액수의 종신회비를 납부하고 소정의 수속을 필한 자로 한다.
3. 준회원은 이회의 목적에 찬동하는 전공의나 그에 상응하는 자격을 갖춘 자로 한다. 상응하는 자격이라 함은 의사가 아닌 공학, 생물학, 기초의학자를 포함하며, 간호사, 방사선사 등 의료관련 자격자도 포함한다. 준회원은 피선거권과 투표권이 없다.
4. 특별회원은 이회의 목적에 찬동하고 발전에 기여할 수 있는 자로서 상임이사회의 승인을 얻은 자로 한다.

제5조 (입회)

1. 정회원의 입회는 제4조 1항의 자격을 갖추고, 이회에 소정의 회원 가입 신청서를 제출한 자를 회장, 총무 상임이사, 회원관리상임이사가 회원자격을 심의 후 지체 없이 승인 여부를 결정하여 당사자에게 통보하고, 상임이사회에 보고하여 이루어진다.
2. 학회 주관 행사에서 발표하고자 하는 자는 별도의 절차없이, 회원가입 신청 및 연회비 납부만으로 회원 가입이 가능하고, 그 자격은 결격 사유가 없는 한 유지 될 수 있다.

제6조 (권리 및 의무)

1. 회원은 이회의 회칙을 준수하여야 한다.
2. 회원은 이회에서 규정한 연회비 및 기타 부담금을 납부하여야 한다.
3. 정회원 중 세계학회(WSSFN) 회원 자격을 2015년에 획득한 자는 그 자격을 유지하기 위한 연회비의 일부를 납부하면, 세계학회 회원자격을 유지할 수 있는 학회의 지원을 받을 수 있다.
4. 종신회원은 종신회비를 납부하였으므로 연회비의 납부를 면한다.(단, 종신회원 중 WSSFN 회원의 자격을 유지하고자 하는 자는 그 자격을 유지하기 위한 연회비의 일부를 납부해야한다.)
5. 회원은 이회의 각종 행사에 적극적으로 참여하여야 하며, 이회의 회원으로서 품위를 유지해야 한다.
6. 이회의 의무를 다한 정회원은 선거권, 피선거권 및 각종 집회에서의 발의 및 의결권을 갖는다.

제3장 임 원

제7조 (임원의 구성)

이회는 다음의 임원을 둔다.

1. 회장 1명
2. 부회장 1명
3. 상임이사(학술, 총무, 재무, 간행, 교육, 전산 및 홍보, 보험, 회원관리, 회칙개정, 윤리, 국제교류, 젊은정위기능신경외과모임 외) 약간 명
4. 운영위원 약간 명
5. 감사 2명
6. 전임회장단
7. 명예회장
8. 고문

제8조(임원의 선출)

1. 회장과 부회장은 상임이사회에서 선출하여 운영위원회 및 총회에서 인준을 받아야하며, 임기는 1년으로 하고 연임할 수 없다.
2. 감사는 총회에서 선출하고 임기는 2년으로 한다.
3. 전임회장은 당연직으로 전임회장단에 가입된다.

제 9조 (명예회장)
학회는 회장을 역임한 자 중에서 학회에 공로가 현저한 자를 상임이사회의 심의를 거친 후 총회에서 명예회장으로 추대할 수 있다.

제 10조 (고문)
학회는 학회에 공로가 현저한 자를 상임이사회의 심의를 거친 후 총회에서 고문으로 추대할 수 있다.

제11조 (임원의 보선)
회장 결위시에는 부회장이 회장의 업무를 대행하며, 부회장 결위시 상임운영위원회에서 잔여 임기동안의 부회장을 선출한다.

제12조 (임원의 의무)
1. 회장은 이회를 대표하고, 운영위원회, 상임운영위원회, 총회의 의장이 되며, 학술대회를 주관하고 이회의 운영에 관계되는 제반 사항을 지휘 감독한다.
2. 부회장은 당연직으로 차기회장이 되며, 회장 결위시 회장의 업무를 대행한다.
3. 이회의 상임이사는 종신회원 중에서 회장이 임명한다.
4. 총무이사는 상임이사 중 회장이 임명하며 이회의 제반 업무를 총괄 한다.
5. 감사는 이회의 회무 및 재정을 감사하고 그 결과를 총회에 보고한다.
6. 전임회장단은 학회 발전을 위해 자문하는 역할을 한다.

제4장 회 의

제13조 (회의)
이회의 회의는 정기총회, 임시총회, 상임이사회의, 운영위원회의, 젊은정위기능신경외과모임으로 구분한다.
정기총회는 정회원으로 구성되며, 매년 1회 정기학술대회 시 개최하고, 임시총회 및 기타 회의는 필요시 회장이 소집할 수 있다.

제14조 (상임이사회의)
상임이사회는 운영위원 중에서 구성되며, 의장은 회장이 된다. 위원 1/2이상의 출석으로 성립되고, 출석위원 과반수의 찬성으로 의결한다. 단, 위원이 사정상 회의에 참석하지 못할 때는 위임장이나, 이에 상응하는 의사표시로 위임할 수 있으며, 가부 동수일 경우에는 의장이 의결권을 가진다.
학술, 총무, 재무, 간행, 교육, 전산 및 홍보, 보험, 회원관리, 회칙개정, 윤리, 국제교류 등의 업무를 분담하고, 이회의 운영에 관한 중요사항을 의결한다. 전임 회장단은 투표권 없이 참석하여 자문할 수 있다.

제15조 (운영위원회)
운영위원회는 회장, 부회장, 상임이사, 운영위원으로 구성되고, 의장은 회장이 된다. 운영위원회는 위원 1/2

이상의 출석으로 성립되며, 출석위원 과반수의 찬성으로 의결한다. 단, 운영위원이 사정상 회의에 불참할 경우 위임장이나 이에 상응하는 의사표시로 위임할 수 있다.
운영위원회는 회장의 자문에 응하여 본회의 제반 활동에 관한 사항을 심의 의결한다. 운영위원은 회장이 수련병원에 종사하는 정회원 중 상임이사회의 승인을 받아 선임한다.

제16조 (젊은정위기능신경외과모임)
정위기능신경외과학회의 지속적인 발전을 위하여 만45세 이하 정회원으로 구성된 젊은정위기능신경외과 모임을 만들고, 학술활동 및 교류를 증대시킨다. 이 모임은 원활한 업무를 위해 모임의 장과 총무를 선출하고, 이는 상임이사회에서 인준한다.

제5장 회 계

제17조 (자산 및 회계)
1. 학회의 자산은 회비(연회비, 종신회비), 정기학술대회 등록비, 찬조금 및 기타 수익금으로 하며, 회장의 책임 하에 관리 운용한다.
2. 학회의 사업 연도는 매년 학술대회 및 정기총회 종료 후 차기 총회까지로 한다.
3. 각 연도의 수입, 지출, 결산은 감사의 심사를 거쳐 총회에 보고한다.

제6장 회칙 개정

제18조 (회칙개정)
이회의 회칙은 상임이사회에서 상임이사의 재적인원 2/3 이상이 참석하고, 출석위원 2/3 이상의 찬성으로 개정할 수 있으며, 총회에서 출석정회원 2/3 이상의 가결로 인준을 받는다.

제7장 부 칙
1. 이회의 회칙에 규정되지 아니한 사항은 민법의 규정 또는 일반관례에서 준용한다.
2. 회칙은 인증된 날로부터 실시한다.
3. 개정된 회칙은 총회 인증 후 당해 연도 총회 이후 실시한다.
4. 이 회칙은 2000년 2월 11일 1차 개정하였다.
5. 이 회칙은 2002년 3월 8일 2차 개정하였다.
6. 이 회칙은 2007년 3월 16일 3차 개정하였다.
7. 이 회칙은 2010년 3월 27일 4차 개정하였다.
8. 이 회칙은 2015년 3월 28일 5차 개정하였다.
9. 이 회칙은 2017년 3월 25일 6차 개정하였다.
10. 이 회칙은 2018년 3월 31일 7차 개정하였다.

이 회칙은 대한의학회의 인준을 받은 날부터 시행한다.

대한정위기능신경외과학회 정회원 명단

2019년 3월 현재 311명

성명	근무처	성명	근무처	성명	근무처
강동기	대구파티마병원	김법영	김&정신경외과의원	김종현	성균관대 삼성서울병원
강동수	서울의료원	김병남	김신경외과의원	김종현	고려대 구로병원
강삼석	전남대학교병원	김상대	고려대 안산병원	김종환	강원대학교병원
강재규	다보스병원 뇌신경센터	김상진	이화여대 목동병원	김주승	노원을지병원
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고현송	충남대학교병원	김세혁	아주대학교병원	김헌주	근로복지공단
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곽연상	광주한빛신경외과	김승범	경희의료원	김현집	분당 서울대병원
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권도훈	울산의대 서울아산병원	김양인	고려대학교병원	김형동	동아대학교병원
권익승	권익승신경외과의원	김언명	인하대학교병원	김형일	광주과학기술원
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김　결	하늘빛 신경외과의원	김영수	김영수병원	김호정	국립경찰병원
김　영	울산대학교병원	김영수	한양대학교병원	김효준	전주예수병원
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김기현	천주성삼병원	김은영	가천의대 길병원	류기영	대구파티마병원
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김동호	충북대학교병원	김재휴	전남대학교병원	박기용	인애가 송파의원
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김두원	김두원신경외과의원	김정철	희명종합병원	박동현	굿모닝요양병원
김래상	안산튼튼병원	김정훈	울산의대 서울아산병원	박문선	을지대학교병원
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김문규	한림의대 강동성심병원	김종중	조선대학교병원	박상근	인제대 상계백병원
김문찬	가톨릭대 서울성모병원	김종태	인천성모병원	박성규	순천향대학교병원

성명	근무처	성명	근무처	성명	근무처
박 세 혁	한림대 강동성심병원	송 준 호	한림대 성심병원	이 규 호	거제대우병원
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박 용 구	연세대 세브란스병원	신 준 재	인제대 상계백병원	이 기 택	가천대 길병원
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박 일 한	센텀신경외과	심 병 수	심병수신경외과의원	이 명 진	경희대학교병원
박 정 율	고려대 안암병원	심 영 보		이 민 수	고려대 안암병원
박 종 운	근로복지 공단	안 명 수	동해동인병원	이 배 환	연세대 세브란스병원
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박 진 수	안산튼튼병원	안 정 용	강남세브란스병원	이 봉 훈	영남대 영천병원
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박 춘 근	성모다인병원	여 형 태	대구가톨릭대병원	이 성 락	바른등신경외과의원
박 한 배	동아신경외과	오 경 섭	전주21세기병원	이 승 욱	강북중앙병원
박 한 준	수지삼성병원	오 민 석	오민석신경외과의원	이 승 훈	국립암센터
박 형 천	한국의료분쟁조정중재원	오 성 훈	나누리병원	이 영 희	원주대학교병원
박 환 민		우 원 철	중앙신경외과의원	이 일 옥	고려의대 안산병원
반 재 영	굿모닝신경외과	유 헌	국립암센터	이 자 규	
백 광 흠	한양대학교병원	유 찬 종	가천의대 길병원	이 재 수	이재수신경외과
백 선 하	서울대학교병원	윤 경 식	베스트원 재활요양병원	이 정 길	전남대학교병원
서 보 라	전남대학교병원	윤 도 흠	연세대 세브란스병원	이 정 일	성균관대 삼성서울병원
서 승 권	동아대학교병원	윤 병 만	근로복지공단	이 제 혁	광주병원
서 의 교	이화여대 목동병원	윤 석 훈		이 종 수	대전선병원
서 인 엽	서대구병원	윤 성 문	울산동강병원	이 주 형	장유병원
성 기 원	태백중앙병원	은 종 필	전북대학교병원	이 창 명	연합신경외과의원
성 정 남	서울나우병원	이 언	가천의대 길병원	이 한 영	
성 주 경	경북대학교병원	이 강 조	김해우리신경외과	이 혁 기	안동병원
손 문 준	인제대 일산백병원	이 강 현	연세원주의대	이 호 영	인하대학교병원
손 병 철	가톨릭대 서울성모병원	이 경 석	순천향의대 천안병원	이 화 동	인창병원
손 은 익	계명대 동산의료원	이 경 진	여의도성모병원	임 영 진	경희대학교병원
손 일 태	굿스파인병원	이 경 희	원광대 산본병원	임 종 현	
손 진 규		이 규 석	21세기병원	임 준 석	
송 광 철	보광병원	이 규 성	세브란스병원	임 호 영	안산중앙병원
송 근 성	양산부산대학교병원	이 규 창	명지병원	장 경 술	가톨릭대 인천성모병원
송 준 혁	좋은아침병원	이 규 춘	동국대 경주병원	장 상 근	

성명	근무처	성명	근무처	성명	근무처
장재칠	순천향대 서울병원	조태형		허 륭	가톨릭대 인천성모병원
장주호	동국대 경주병원	주교성		허 철	원주기독병원
장진우	세브란스병원	주문배	근로복지공단	허승곤	연세의대 세브란스병원
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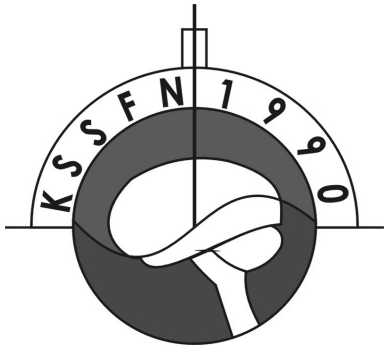
전동휘	재 미국	최 일		홍승관	동국대 일산병원
전상룡		최기환	대구가톨릭대병원	홍승길	고려대 안암병원
전세일		최병관	부산대학교병원	홍승철	성균관대 삼성서울병원
전신수		최병연	영남대학교병원	홍현종	우리병원
전태형	세동병원	최병욱	좋은삼선병원	황 금	원주기독병원
전형준	한양대학교병원	최석근	경희대학교병원	황도윤	근로복지공단
정 남	남강병원	최선길	창원산재병원	황성규	경북대학교병원
정문영	순천향대 부천병원	최선욱		황성남	중앙대학교병원
정상섭	분당차병원	최순관	순천향대 서울병원	황영학	황신경외과의원
정성헌	첨단종합병원	최승원	충남대학교병원	황용순	인제대 상계백병원
정승률	경주 굿모닝병원	최승진	강남병원	황장희	윌스기념병원
정영균	인제대 부산백병원	최영근	우리들병원	황정현	경북대학교병원
정용구	고려대 안암병원	최영호	바로나신경외과의원	황형식	한림대 동탄성심병원
정용태	인제대 부산백병원	최우진	건국대학교병원		
정유남	제주대학교병원	최정길			
정을수		최종현	대아의료재단 한도병원		
정의화	봉생병원	최중언	CHA의대 분당 차병원		
정진명	경상대학교병원	최진규	여의도성모병원		
정창오	우일신경외과의원	최진환	한림병원		
정천기	서울대학교병원	최창락	가톨릭의대 명예교수		
정현태	서울대학교병원	최창화	부산대학교병원		
정현호	연세의대	최태진	계명대동산의료원		
정효숙	혜화신경외과의원	최하영	전북대학교병원		
정희원	서울대학교병원	최훈규	한사랑아산병원		
조 준	건국대학교병원	최휴진	동아대학교병원		
조경기	CHA의대 분당차병원	하영수	관동의대 명지병원		
조기홍	아주대학교병원	하영일	미국		
조성환	조성환 신경외과의원	하호균	건양대학교병원		
조수호	CHA의대 구미차병원	한기수	검단 탑 종합병원		
조용은	강남세브란스병원	한대희	국립중앙의료원		
조우호	한마음신경외과의원	한동석	서울신경외과의원		
조재훈	대구가톨릭의대 병원	한성록	인제대 일산백병원		
조철범	한림대 성심병원	한용표	연세신경외과클리닉		
조태구	부천세종병원	한윤경	메트로병원		

MEMO



2019 대한정위기능신경외과학회
제 25차 정기 학술대회 및 총회

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